

**FINAL**

**TECHNICAL MEMORANDUM  
Depleted Uranium Scoping Investigations**

**Makua Military Reservation  
Pohakuloa Training Area  
Schofield Barracks Impact Area  
Islands of Oahu and Hawaii**



*Prepared for*

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## 1.0 INTRODUCTION

In August 2005, tail fin components and spotter round bodies (SRB) from the Cartridge, 20mm Spotting M101 associated with the Davy Crockett Light Weapon M28 were discovered during routine activities at Schofield Barracks. As a result of archive searches conducted by the U.S. Army Corps of Engineers (USACE) regarding the potential for contamination resulting from the firing of spotter rounds for the Davy Crockett weapons system at Schofield Barracks, suspicion arose that this weapons system may have been used at other firing ranges in the Hawaiian Islands. The suspected ranges include Makua Military Reservation (MMR) on Oahu, Pohakuloa Training Area (PTA) on Hawaii, and Schofield Barracks Impact Area on Oahu. For MMR and PTA, details of the archive searches were reported in “Archive Search Report On the Use of Cartridge, 20 mm Spotting M101 for Davy Crockett Light Weapon M28, Islands of Oahu and Hawaii” (USACE, St. Louis District, May 2007). The basis for the Schofield Area scoping survey was from observations and information provided by USAG-HI.

The primary suspected contaminant associated with the spotter rounds body (SRB) is D-38 uranium alloy, also called depleted uranium (DU). The DU was used in the SRB of training rounds for the Davy Crockett weapon system because of its high density and weight. The DU component is approximately four inches in length and one inch in diameter. In the following sections of this report, a summary of the archive search for each area is provided, followed by the methods and results of field scoping survey investigations conducted at each of these three areas in August of 2007. The surveys were performed to assess the presence of DU fragments that might have originated from past training activities involving Davy Crockett SRB. The results of these survey activities will be used to develop the criteria and plans for a follow-on characterization survey of the potentially impacted areas.

Cabrera Services, Inc. (CABRERA) was tasked by the U.S. Army Sustainment Command (ASC) to perform a scoping survey of the suspected ranges to assess the presence of DU at those locations. The scope of work included:

- Review of archive searches,
- Perform a Site Reconnaissance,
- Collect soil samples from locations likely to contain DU,

- Analyze soil samples for isotopic uranium using alpha spectrometry, and
- Prepare a summary report documenting the results of the scoping survey.

## 2.0 SITE BACKGROUND

The MMR is located in the western portion of Oahu near Kaena Point (Figure 2-1). The training site extends west from the Waianae Range ridge line to the ocean and is approximately three miles north of Makaha. State Highway 93 extends through the site along the shoreline and ends at the northern boundary of the site. The site is approximately 18 miles from Schofield Barracks via Kolekole Pass Road. The MMR has been used by the U.S. Army and Marine Corps for training since 1943. The area is used as an infantry and artillery range, with some use of the shoreline for amphibious assault training. The area also has several archeological and cultural sites.

PTA is located on the island of Hawaii between Mauna Loa, Mauna Kea, and the Hualalai Volcanic Mountains (Figure 2-2). It extends up the lower slopes of Mauna Kea to approximately 6,800 feet in elevation and to about 9,000 feet on Mauna Loa. The training area is about midway between Hilo on the east coast and the Army landing site at Kawaihae Harbor on the west coast. The area is the largest Department of Defense (DOD) installation in Hawaii. The area is accessible by military helicopter or land via Saddle Road from Hilo.

Schofield Barracks is the largest Army post in Hawaii, located on an 18,000 acre site in central Oahu. The Schofield Training Area Impact Area (SBIA) totals 2650 acres and consists of fee and ceded land. The Schofield Training Area, shown in Figure 1-2, is in a large valley, with a ridgeline along the north, west and southwest boundaries. The valley faces east and extends into the central Schofield saddle. The SBIA is at the western end of the valley, and the majority of the SBIA is of moderate slope increasing in steepness towards the west. Beyond the SBIA to the west and southwest, the land rises steeply and is not considered usable for maneuvers. The steep area is used as a safety zone for the SBIA. The ridge of the Waianae Range has the highest point on Oahu,; Mount Kaala, which has an elevation of over 4,000 feet. The elevation of the SBIA ranges between maneuver areas varies from 800 and to 1,400 feet in elevation above sea level. Vegetation varies from heavy woods on the steeper western slopes to open grassland in the SBIA impact and range areas. Several thickly wooded gullies with steep sides cut through the impact area. The western portion of SBIA includes the ridges and valleys at the western edge of the impact area where 15 SRB containing DU were recovered by a contractor clearing unexploded

ordnance and scrap metal in August 2005. A scoping survey was completed for the western portion of SBIA in 2007 (Technical Memorandum, Schofield Barracks Firing Range Phase I Depleted Uranium Investigation, Cabrera Services, Inc. for the Army Joint Services Command, January 2007). The part of SBIA scoped during this project includes the eastern portion of the impact area and a secondary impact area located to the north. Figure 2-3 shows the location of the north/eastern area at Schofield Barracks.

Fifteen SRBs containing DU were recovered from the western upsloping area of the SBIA by a contractor clearing the range impact area of unexploded ordnance and scrap metal in August, 2005. A scoping survey was completed for the western upsloping area of the SBIA in 2007 (Technical Memorandum, Schofield Barracks Firing Range Phase I Depleted Uranium Investigation, Cabrera Services, Inc. for the Army Joint Services Command, January 2007). The focus of this scoping survey includes the northern and eastern, mostly flat portions of the SBIA. These impact areas fall within range of the firing locations where training with the Davy Crockett System was potentially performed. Figure 2-3 shows the location of the current scoping survey activities at the SBIA.

### **3.0 SCOPING SURVEY METHODOLOGY**

Scoping surveys are performed to provide additional radiological information on sites where the presence of radioactive materials is suspected. Scoping surveys were performed at the MMR, PTA, and north/eastern SBIA firing ranges in Hawaii. The following sections summarize the survey design for investigating the potential presence of DU fragments at these firing ranges. The objectives of the scoping surveys were to:

Use historical knowledge, real-time radiation detection instruments,

- Use historical knowledge, real-time radiation detection instruments, laboratory analytical results from shallow soil samples, and visual identification of Davy Crockett weapons system components (pistons, SRBs, tailfin assemblies, tail ring, etc.) to confirm that SRBs containing DU were fired and remain on the ranges, and
- Provide a summary of the scoping data along with recommendations and conclusions to the Army for future decision making regarding investigation or closure of the DU issue.

#### **3.1 Scoping Activities**

The scoping surveys at each location included three major activities: archive records review, site reconnaissance, and sample collection and analysis.

##### ***3.1.1 Archive Records Review***

Archive searches were conducted by USACE regarding the potential for the firing of spotter rounds for the Davy Crockett weapons system at firing ranges in the Hawaiian Islands. Details of the archive searches were reported in “Archive Search Report On the Use of Cartridge, 20 mm Spotting M101 for Davy Crockett Light Weapon M28, Islands of Oahu and Hawaii” (USACE, 2007).

##### ***3.1.2 Site Reconnaissance***

The Site Reconnaissance is a visit to the site to collect sufficient information to support decisions regarding further action. The Site Reconnaissance combined aerial surveillance of the firing ranges with ground investigations of accessible areas to obtain visual confirmation of the use of the Davy Crockett weapons system at each site.

Potential visual indicators of the Davy Crockett weapons system, as identified in the Archive Search Report include:

- Aluminum shrapnel from the rear body assembly and plastic fiberglass from the fins and windshield of the Projectile, Atomic Supercaliber 279 millimeter (mm) Practice M390,
- Aluminum fin assemblies and projectile body pieces from the Cartridge, 20mm Spotting M101,
- Pistons from either the light or heavy Davy Crockett weapon, or
- Bright yellow (oxidized) fragments from uranium alloy components.

Helicopters were used as a platform for visual observation to locate Davy Crockett pistons. Once pistons were located, the team calculated the likely positions of firing locations and impact areas in which to perform ground searches for other visual indicators of Davy Crockett use. Where terrain, vegetation, and safety concerns allowed access, radiological surveys to measure levels of alpha, beta, and gamma radiation using a Ludlum Model 43-93 alpha-beta probe, Ludlum 44-9 Geiger-Mueller (GM) Pancake Probe, or Field Instrument for the Detection of Low Energy Radiation (FIDLER) were performed.

### ***3.1.3 Sample Collection and Analysis***

Biased surface soil samples were collected in suspected impact areas where visual and radiological indicators of the Davy Crockett weapons system were identified. For example, a soil sample was collected from an area of bright yellow soil with elevated gross gamma readings in the SBIA.SBIA scoping site. Biased locations were selected based upon professional judgment.

If evidence of the use of the Davy Crockett weapons system was found in a firing area (i.e., pistons were found) but no visual or radiological evidence was found in suspected impact areas, surface soil and sediment samples were collected from outfalls for suspected impact areas. These sample locations were selected where runoff could occur and sediments might collect. Surface soil and sediment samples were also collected from outfalls for areas where vegetation, terrain, ecological, or safety issues prevented access to complete the Site Reconnaissance.

The scoping surveys were performed during the dry season to reduce the number of inaccessible areas, so no surface water was present during the scoping survey.

All samples were sent to a National Environmental Laboratory Accreditation Program (NELAP) accredited laboratory for analysis of uranium nuclide activity concentrations by alpha spectrometry. Activity concentrations were reported for the three naturally occurring uranium radionuclides;  $^{234}\text{U}$ ,  $^{235}\text{U}$ , and  $^{238}\text{U}$ .

A total of twenty soil samples were collected for this scoping survey. A Global Positioning System (GPS) unit was used to identify sampling and scanning measurement locations. Nine soil samples were collected from MMR, 10 soil samples were collected from PTA, and 1 soil sample was collected from the Schofield Area. Only one sample was collected in the north/eastern SBIA due to the fact that this was an effort to determine if the survey area at Schofield should be increased in size. Once DU from a SRB was located at the far north/eastern end of SBIA, the efforts of the scoping survey were satisfied.

### **3.2 Survey Equipment**

Three instruments were available for performing radiological measurements during the scoping surveys. The Ludlum Model 2360 scaler/rate meter with a Ludlum Model 43-93 Alpha Beta Probe, Ludlum Model 2241 scaler/rate meter with a Ludlum Model 44-9 GM Pancake Probe, and Ludlum Model 2221 scaler/rate meter with a FIDLER. Site-specific conditions based on accessibility, terrain, vegetation, ecological, and safety concerns determined which instrument was appropriate for use in each area.

Soil samples were collected at the sites based upon professional judgment. Small hand tools and latex gloves were used for sample collection, and samples were collected and stored in re-sealable plastic bags. Soil was collected from the top two inches of the ground, in area that was generally six by six inches in size. A minimum of 1kg was collected at each sample location. Field personnel removed all visible vegetation and rocks from the soil. Cabrera personnel wore thermoluminescent dosimeters (TLDs) to measure any potential external radiation encountered during the surveys. The accompanying USAG-HI personnel did not wear TLDs, but were in close proximity to CABRERA and ASC personnel at all times and would have received equivalent doses. No radiation doses significantly greater than background, as measured using a control TLD, were detected.

A GPS was used to link survey data to spatial locations (northing and easting) using state plane coordinates for Hawaii Zone 1 (island of Hawaii) and Zone 3 (island of Oahu), North American Datum 1983. By design, the GPS unit is self-checking, using data received from the satellite constellation to determine the precision and accuracy of its readings.

### 3.3 Quality Control Measures

Data collection activities were performed in a controlled, deliberate manner. Data were collected by trained individuals with calibrated instruments following written procedures and/or protocols. Data were recorded and reviewed, and documentation is auditable. Instrumentation capable of detecting the radiation types and energies of interest were selected, calibrated, and maintained for survey data collection and sample analysis.

All equipment used in the field was checked using either a thorium-230 ( $^{230}\text{Th}$ ) alpha check source, a technetium-99 ( $^{99}\text{Tc}$ ) beta check source, or a cesium-137 ( $^{137}\text{Cs}$ ) beta/gamma check source. Operational checks were performed for each instrument before and after each use. All instruments used in the field met data quality requirements.<sup>1</sup>

Samples were collected in the field using clean tools and gloves. All samples were scanned before and after being collected and, as were all sample containers prior to packaging for shipment to the laboratory. Sample tools were cleaned between each sample collection.

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<sup>1</sup> Instrument quality control data is described in detail in the draft characterization report for the SBIA (Characterization Report: Schofield Barracks Davy Crockett Impact Area, Cabrera Services for the Army Sustainment Command, April 2008).

## 4.0 SCOPING SURVEY RESULTS

The results of the scoping surveys are provided in the following sections.

### 4.1 Makua Military Reservation

#### 4.1.1 *Summary of Archive Search for MMR*

The following information summarizes the detailed descriptions of past uses of the MMR as presented in “Archive Search Report On the Use of Cartridge, 20mm Spotting M101 for Davy Crockett Light Weapon M28, Islands of Oahu and Hawaii” (USACE, 2007).

Research conducted by the Army into training records did not discover any documentation of requests for Davy Crockett sections to use range facilities at MMR. These types of records are not long-term and may no longer exist. Research also did not find any maps from the 1960s with Davy Crockett ranges specifically noted. However, the majority of the MMR is identified on maps as an impact area. Based on a review of maps and range regulations, one possible area for a Davy Crockett Range was located. Figure 4-1 shows an area originally suspected for contamination from Cartridge, 20mm Spotting 101. Later research by the Army showed that this area does not meet all the criteria for a Davy Crockett range and is no longer suspect. The entire MMR was considered a potential Davy Crockett range impact area and field observations at the range were recommended.

#### 4.1.2 *MMR Site Reconnaissance*

An aerial survey using a Bell Long Ranger helicopter was conducted to look for pistons and other visually identifiable indicators of the Davy Crockett weapons system. The aerial team included two personnel, one situated on each side of the aircraft. Due to limits on prescribed burns in the Makua valley to keep the range clear, the vegetation was very dense, and the aerial survey was limited to ravines and dry stream beds. No pistons were spotted during the aerial survey of MMR.

Physical entry to range areas was precluded by safety concerns, including the likely presence of Unexploded Ordnance (UXO) and Improved Conventional Munitions (ICM). No DU fragments were identified at the MMR.

### ***4.1.3 Sample Results for MMR***

Soil samples were collected at areas where sediment had collected from past runoff/erosion events. Ten soil samples were collected around the perimeter of the MMR during the scoping survey. The soil sample locations are shown in Figure 4-2. All of the samples were analyzed for isotopic uranium by alpha spectrometry. The results of the analyses are provided in Table 4-1. All of the results are consistent with naturally occurring concentrations of uranium. None of the results indicate uranium depletion, where the  $^{234}\text{U}$  activity concentration is significantly lower than the  $^{238}\text{U}$  activity concentration.

## **4.2 Pohakuloa Training Area**

### ***4.2.1 Summary of Archive Search for PTA***

The following information summarizes the detailed descriptions of past uses of the PTA, as presented in “Archive Search Report On the Use of Cartridge, 20mm Spotting M101 for Davy Crockett Light Weapon M28, Islands of Oahu and Hawaii” (USACE, 2007).

Historic records searches and map analyses identified at least twelve present and past range locations at the PTA. Based on criteria known to have been regulated for Davy Crockett ranges (e.g., size of area, security provisions) the USACE identified four potential Davy Crockett Ranges. Field observations at these four ranges were recommended.

### ***4.2.2 PTA Site Reconnaissance***

An aerial survey was conducted to look for pistons and other visually identifiable indicators of the Davy Crockett weapons system. The aerial team included two helicopters, a Hughes 500 and Bell Long Ranger, and included four survey personnel; two in each aircraft. The aerial surveys confirmed pistons in four locations, as shown on Figure 4-3. A rough estimate showed there to be approximately 30-100 pistons at each of the locations.

Based upon the locations of the pistons, the field team determined that Range 11T offered the best prospects for locating a Davy Crockett spotter round on the ground. This determination was made due to the large number of pistons (estimated at ~100). The field teams made rough calculations based upon the location of the pistons, the operational range of the Davy Crockett system, and the likely firing points. Once these calculations were made, field personnel traveled downrange to the likely impact areas.

Field teams made two trips into the impact area. The field team consisted of three personnel, one of which was the UXO escort who provided detection and avoidance safety support to the team. The rough terrain limited accessibility to the suspected impact areas. The Ludlum Model 2241 scaler/rate meter with a Ludlum Model 44-9 GM Pancake Probe was selected as the most appropriate radiological instrument because of its size and ruggedness. During the first trip into the impact area, no locations with SRB and associated Davy Crockett debris were identified in the suspect impact areas. No areas with SRB DU fragments or soil stained bright yellow were identified, nor were any locations with anomalous radioactivity detected.

During the second trip into the impact area, the team located a Davy Crockett SRB (location shown in Figure 4-4). The round was recovered intact and is now in the possession of USAG-HI. No soil samples were collected at the site of the recovery as the round was resting on basaltic rock in which no soil profile has yet developed.

#### **4.2.3 Sample Results for PTA**

Soil samples were collected at areas where sediment had accumulated from past runoff/erosion events. Ten soil samples were collected around the perimeter of the suspect impact areas at the PTA during the scoping survey. The soil sample locations are shown in Figure 4-4. All of the samples were analyzed for isotopic uranium by alpha spectrometry. The results of the analyses are provided in Table 4-2. All of the results are consistent with naturally occurring concentrations of uranium. None of the results indicate uranium depletion, where the  $^{234}\text{U}$  activity concentration is significantly lower than the  $^{238}\text{U}$  activity concentration.

### **4.3 Schofield Barracks Impact Area**

#### **4.3.1 Summary of Archive Search for the SBIA**

The following information summarizes the detailed descriptions of past uses of the SBIA, as presented in “Archive Search Report On the Use of Cartridge, 20mm Spotting M101 for Davy Crockett Light Weapon M28, Islands of Oahu and Hawaii” (USACE, 2007).

Historic records searches and map analyses confirmed that Davy Crockett spotter rounds had been fired into the impact area on the western edge of the Schofield Barracks firing range. A characterization survey of the impacted area was designed to investigate the extent of DU contamination in the area.

#### ***4.3.2 SBIA Site Reconnaissance***

USAG-HI conducted a prescribed burn of the SBIA between July 30 and August 2, 2007. During that operation, USAG-HI observed remnants of the Davy Crockett weapon system outside the western upsloping area of the SBIA where the characterization activities were planned. It was determined that the north-central mostly flat northern and eastern portion of the SBIA should have a scoping survey performed to determine if there were Davy Crockett rounds fired into that area.

The field team consisted of two team members, one which provided UXO detection and avoidance safety support for the team. Visual observations during the Site Reconnaissance identified an area with bright yellow stained soil and fragments (generally less than 1 square centimeter) of yellowish metal. Radiological measurements with the Ludlum Model 2221 scaler/rate meter with a FIDLER confirmed the presence of elevated gamma radiation in that area.

The remainder of the Site Reconnaissance focused on establishing new boundaries for the characterization survey to identify nature and extent of DU from the spotter rounds.

#### ***4.3.3 Sample Results for the SBIA***

A single surface soil sample was collected during the SBIA scoping survey. This sample was collected at the location with the bright yellow colored soil and elevated gross gamma activity. The sample location is shown on Figure 4-5. The results of the sample analysis are provided in Table 4-3. The results show the uranium activity concentrations are elevated and show significantly less  $^{234}\text{U}$  activity than  $^{238}\text{U}$  activity, indicating the uranium is depleted.

Although no surface water samples were available for collection during the scoping survey, the Army monitors surface water runoff from Schofield Barracks. Five surface water samples were analyzed for isotopic uranium by alpha spectrometry. The results of the surface water analyses are provided in Table 4-4. All of the results are consistent with naturally occurring concentrations of uranium. None of the results indicate uranium depletion, where the  $^{234}\text{U}$  activity concentration is significantly lower than the  $^{238}\text{U}$  activity concentration.

## 5.0 CONCLUSIONS AND RECOMMENDATIONS

Scoping surveys were performed at the MMR, PTA, and SBIA where Davy Crockett spotter rounds may have resulted in DU fragments being present in the soil.

The results of the MMR scoping survey were limited by accessibility issues. The aerial visual observations were obscured by vegetation and no radiological measurements were performed in the impact area. Entry to the impacted area was not allowed for safety reasons, and no samples of DU fragments were recovered or analyzed. The soil samples collected around the perimeter of the site did not identify any indications of DU. CABRERA recommends the Army should complete the scoping survey or perform a characterization survey to further investigate the potential for DU at the MMR if the area becomes more accessible in the future. Continued monitoring of storm water runoff in the area with sample analysis for isotopic uranium is recommended.

The results of the PTA scoping survey confirmed several areas with pistons used to fire the Davy Crockett weapon system. Visual observations confirming the presence of the DC pistons, qualitative measurements, and recovery of an intact Davy Crockett spotter round all support that the Davy Crockett system was used at PTA. While the soil samples collected around the perimeter of the site did not indicate the presence of DU, these data do not represent a statistically significant data set. A statistical field sampling design focused on the suspect Davy Crockett impact areas would yield more representative results. CABRERA recommends that the Army conduct a characterization survey of the impact range, with an emphasis on defining the impact areas, eliminating areas where possible from further evaluation, and developing data appropriate to support a human health risk assessment.

The results of the SBIA scoping survey confirmed the presence of DU contamination in the mostly flat northern and eastern portions of the SBIA and established boundaries for characterization of the potentially contaminated area. CABRERA recommends completing the characterization of these areas while they are currently accessible to determine the nature and extent of the DU fragments at SBIA CABRERA has already completed a characterization survey in the area, and the results of that survey will be presented along with the area Alpha data in a Baseline Human Health Risk Assessment for the Schofield Barracks impact range.

The results of surface water sampling at Schofield Barracks do not indicate the presence of DU contamination in the surface water runoff. CABRERA recommends the Army continue analyzing the runoff from Schofield Barracks for at least three additional monitoring cycles to confirm current analysis and determine if continued monitoring is required.

## **TABLES**

**TABLE 4-1: ALPHA SPECTROMETRY RESULTS FOR MMR SOIL SAMPLES**

Sample	Analyte*	Activity (pCi/g)	2 $\sigma$ Counting Error (pCi/g)	Total Error (pCi/g)	MDA (pCi/g)
4000	U-233/234	0.086	0.05	0.053	0.019
	U-235	0	0	0	0.024
	U-238	0.131	0.064	0.069	0.037
4001	U-233/234	0.069	0.048	0.05	0.044
	U-235	0	0	0	0.023
	U-238	0.1	0.056	0.059	0.036
4002	U-233/234	0.239	0.089	0.101	0.02
	U-235	0.018	0.026	0.027	0.025
	U-238	0.234	0.089	0.1	0.039
4003	U-233/234	0.326	0.103	0.122	0.019
	U-235	0.004	0.02	0.02	0.046
	U-238	0.325	0.103	0.122	0.019
4004	U-233/234	0.272	0.091	0.106	0.018
	U-235	0.034	0.034	0.035	0.023
	U-238	0.339	0.103	0.123	0.018
4005	U-233/234	0.461	0.135	0.164	0.043
	U-235	0.05	0.045	0.048	0.027
	U-238	0.512	0.142	0.175	0.022
4006	U-233/234	0.216	0.085	0.096	0.021
	U-235	0.01	0.019	0.019	0.026
	U-238	0.23	0.088	0.1	0.021
4007	U-233/234	0.344	0.109	0.129	0.039
	U-235	0.009	0.018	0.019	0.025
	U-238	0.398	0.117	0.142	0.02
4008	U-233/234	0.136	0.06	0.066	0.017
	U-235	0.034	0.035	0.037	0.04
	U-238	0.12	0.057	0.062	0.032
4009	U-233/234	0.225	0.084	0.095	0.036
	U-235	0.034	0.034	0.036	0.023
	U-238	0.251	0.089	0.102	0.036

**TABLE 4-2: ALPHA SPECTROMETRY RESULTS FOR PTA SOIL SAMPLES**

Sample	Analyte	Activity (pCi/g)	2 $\sigma$ Counting Error (pCi/g)	Total Error (pCi/g)	MDA (pCi/g)
4010	U-233/234	0.117	0.04	0.046	0.009
	U-235	0.004	0.008	0.008	0.011
	U-238	0.132	0.042	0.05	0.009
4011	U-233/234	0.157	0.047	0.057	0.009
	U-235	0.008	0.011	0.012	0.011
	U-238	0.215	0.056	0.07	0.009
4012	U-233/234	0.344	0.078	0.104	0.01
	U-235	0.009	0.013	0.013	0.012
	U-238	0.324	0.075	0.099	0.01
4013	U-233/234	0.098	0.037	0.042	0.009
	U-235	0	0	0	0.011
	U-238	0.114	0.04	0.046	0.009
4014	U-233/234	0.12	0.043	0.049	0.01
	U-235	0	0	0	0.012
	U-238	0.127	0.044	0.051	0.01
4015	U-233/234	0.1	0.037	0.042	0.009
	U-235	0.004	0.008	0.008	0.011
	U-238	0.086	0.035	0.039	0.009
4016	U-233/234	0.302	0.068	0.091	0.009
	U-235	0.025	0.02	0.021	0.011
	U-238	0.238	0.059	0.076	0.009
4017	U-233/234	0.254	0.061	0.079	0.009
	U-235	0.008	0.012	0.012	0.011
	U-238	0.22	0.056	0.071	0.009
4018	U-233/234	0.285	0.067	0.088	0.009
	U-235	0.021	0.019	0.02	0.012
	U-238	0.239	0.061	0.077	0.009

**TABLE 4-3: ALPHA SPECTROMETRY RESULTS FOR SCHOFIELD AREA SOIL SAMPLES**

Sample	Analyte	Activity (pCi/g)	2 $\sigma$ Counting Error (pCi/g)	Total Error (pCi/g)	MDA (pCi/g)
MFZ-WP-073	U-233/234	360	44.9	84.9	1.8
	U-235	35.2	11.2	15.4	2.22
	U-238	2180	211	485	1.79

**TABLE 4-4: ALPHA SPECTROMETRY RESULTS FOR SCHOFIELD BARRACKS  
 SURFACE WATER SAMPLES**

Sample	Analyte	Activity (pCi/L)	Uncertainty (pCi/L)	MDA (pCi/L)
RAB-SW-4-1	U-233/234	0.14	0.14	0.18
	U-235	0.00	0.08	0.12
	U-238	0.09	0.11	0.15
RAB-SW-3-2	U-233/234	0.02	0.11	0.27
	U-235	-0.01	0.02	0.22
	U-238	-0.05	0.04	0.27
RA1-SW-6FF-1	U-233/234	0.76	0.27	0.16
	U-235	0.05	0.09	0.17
	U-238	0.80	0.28	0.12
RA2-SW-5-2	U-233/234	0.39	0.22	0.15
	U-235	0.05	0.11	0.23
	U-238	0.55	0.26	0.20
RA1-SW-3-2	U-233/234	0.03	0.11	0.25
	U-235	-0.01	0.07	0.16
	U-238	-0.01	0.06	0.19

## **FIGURES**





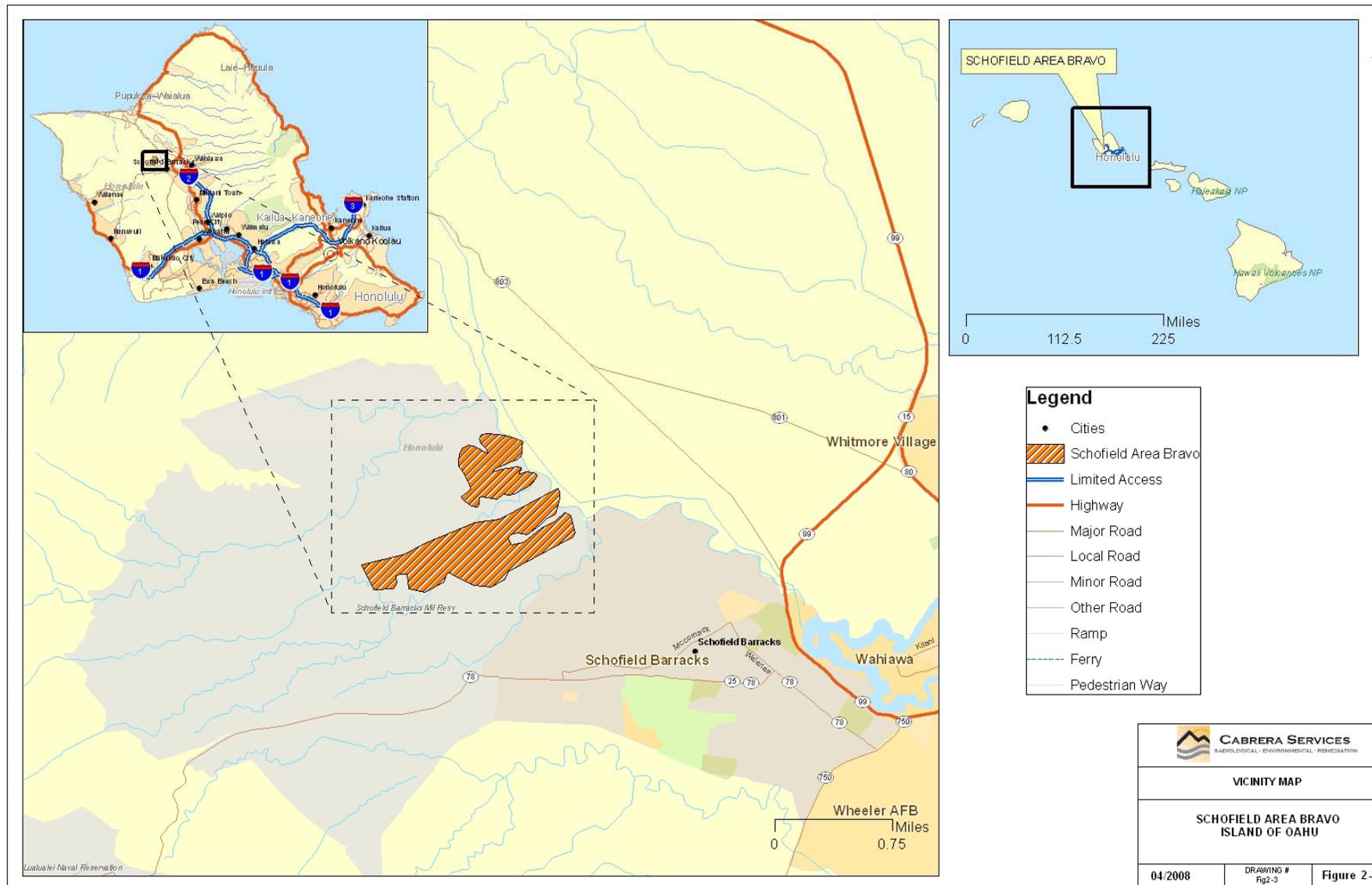


FIGURE 2-3: SCHOFIELD BARRACKS TRAINING AREA LOCATION

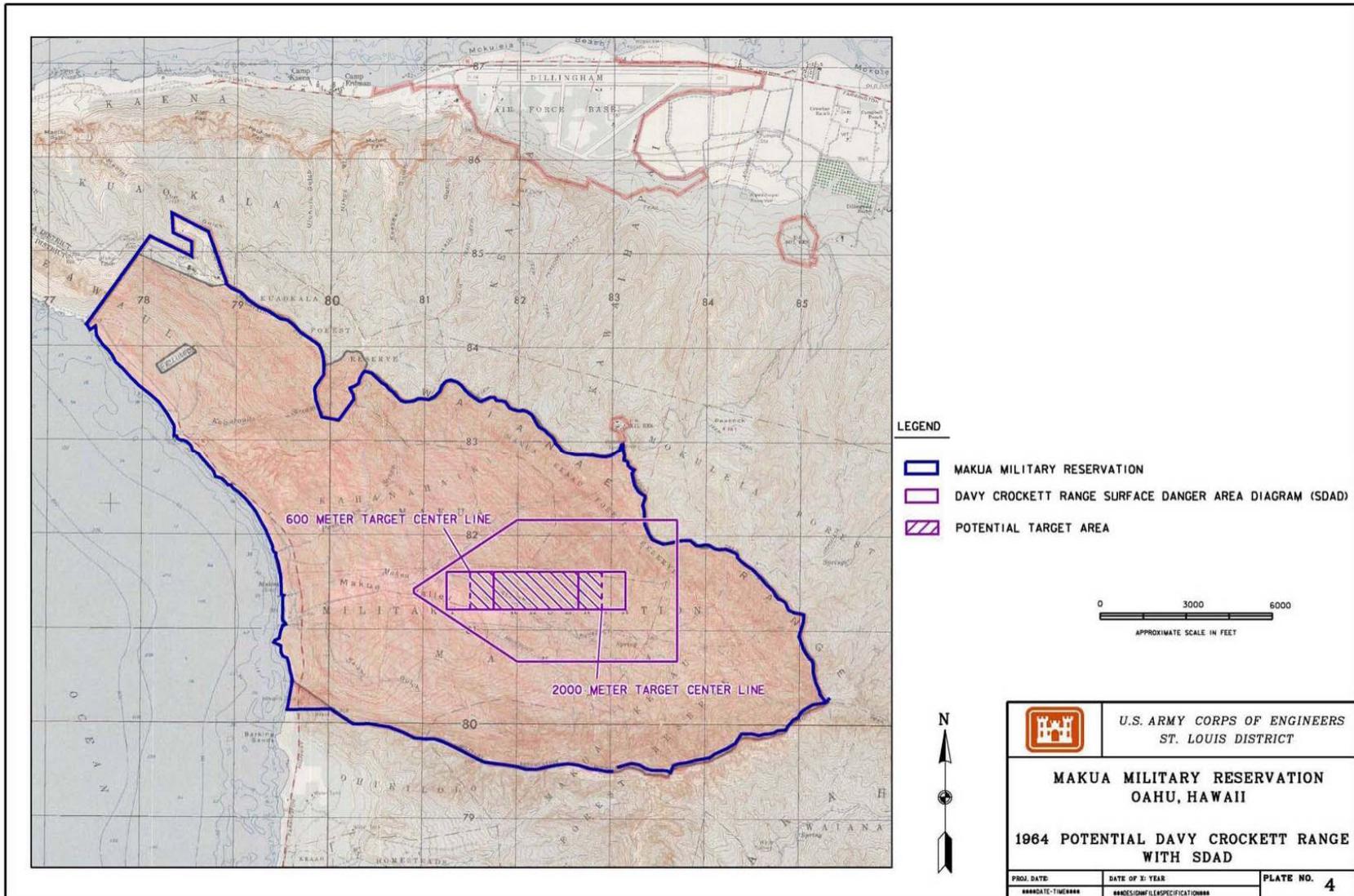


FIGURE 4-1: LOCATION OF SUSPECTED DAVY CROCKETT RANGE, MAKUA

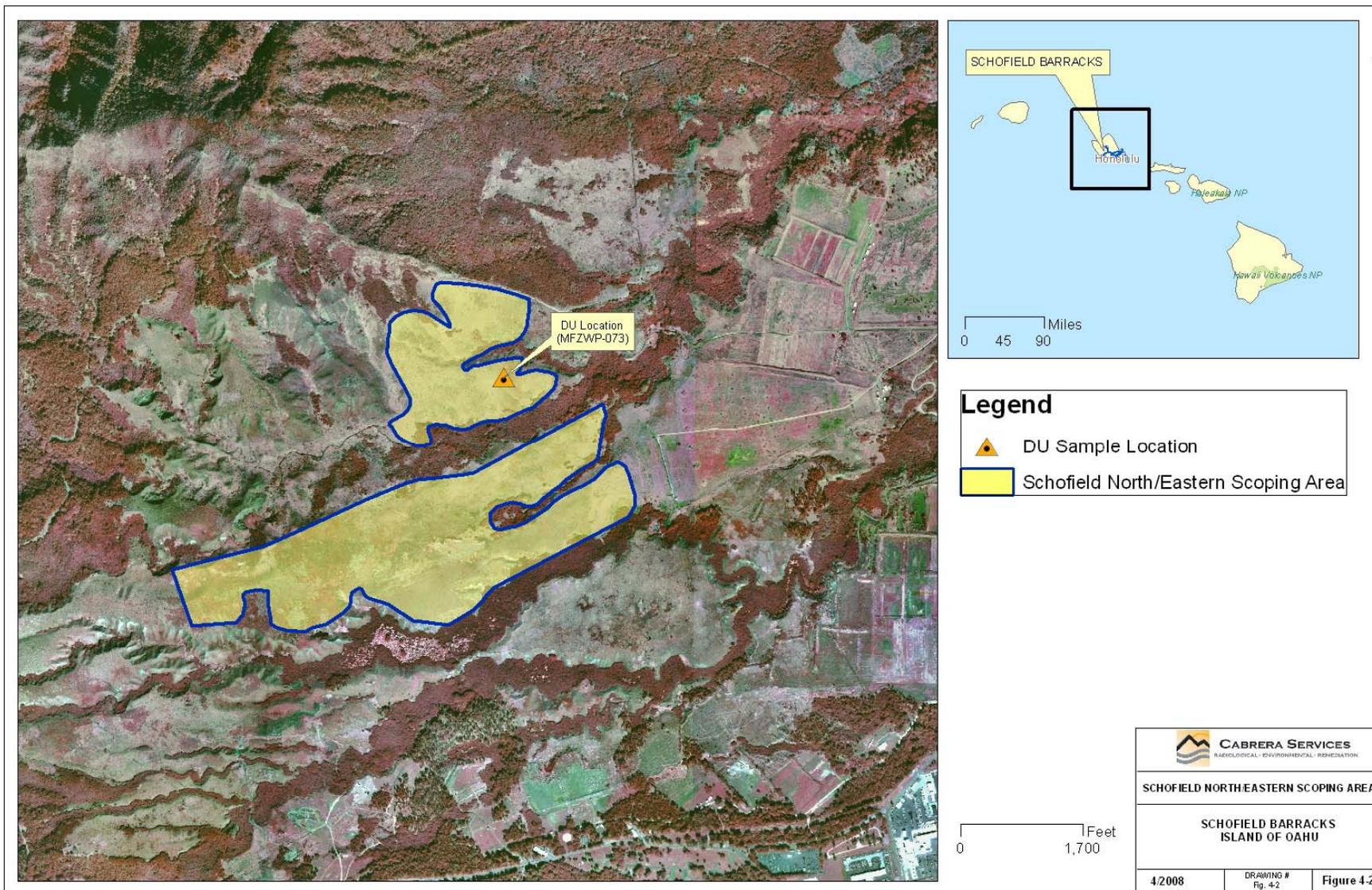
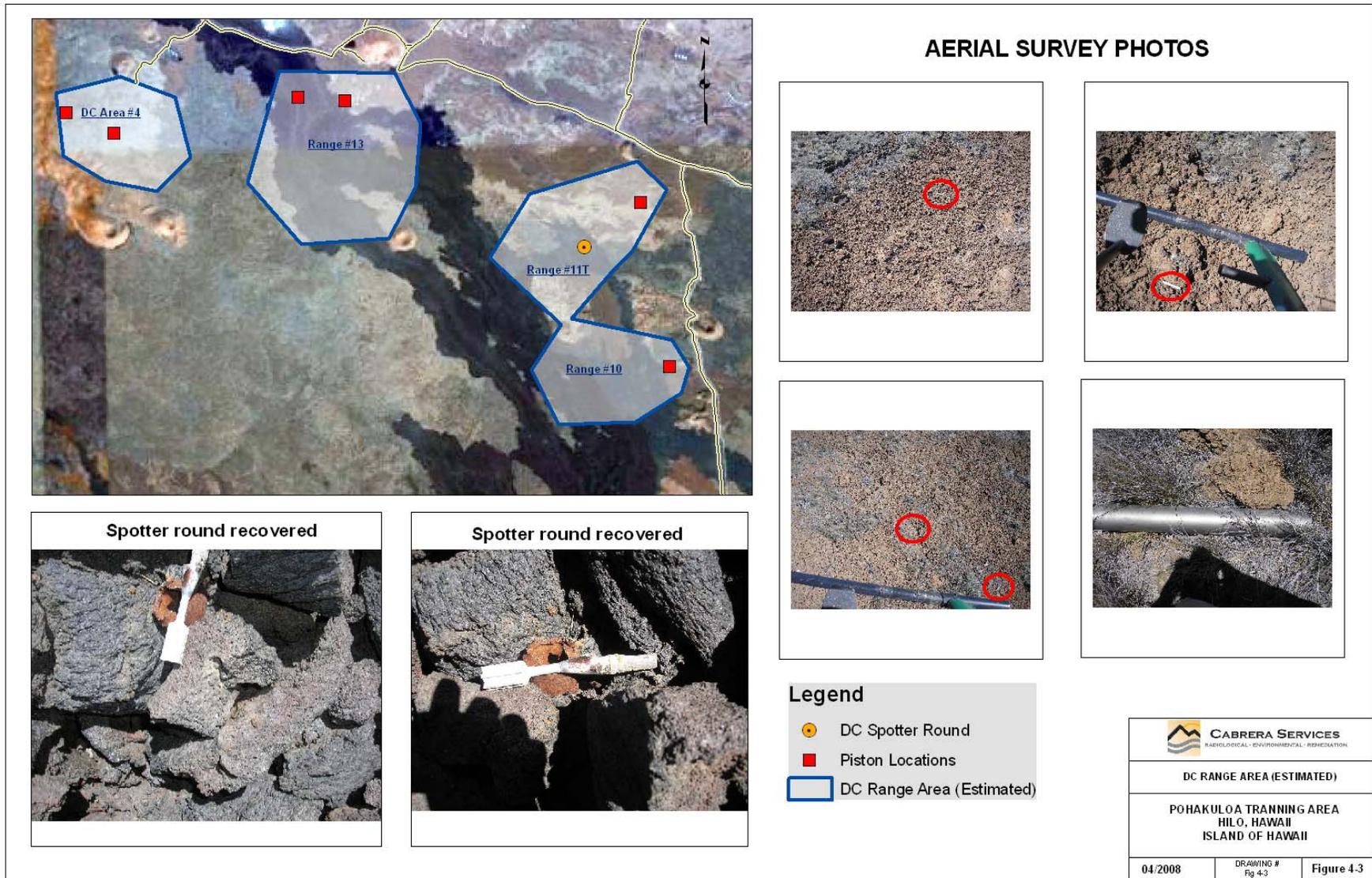


FIGURE 4-2: SAMPLE LOCATIONS AT MMR



**FIGURE 4-3: LOCATIONS OF PISTONS SUGGESTING PAST DAVY CROCKETT RANGE AT PTA**



FIGURE 4-4: SAMPLE LOCATIONS AT PTA

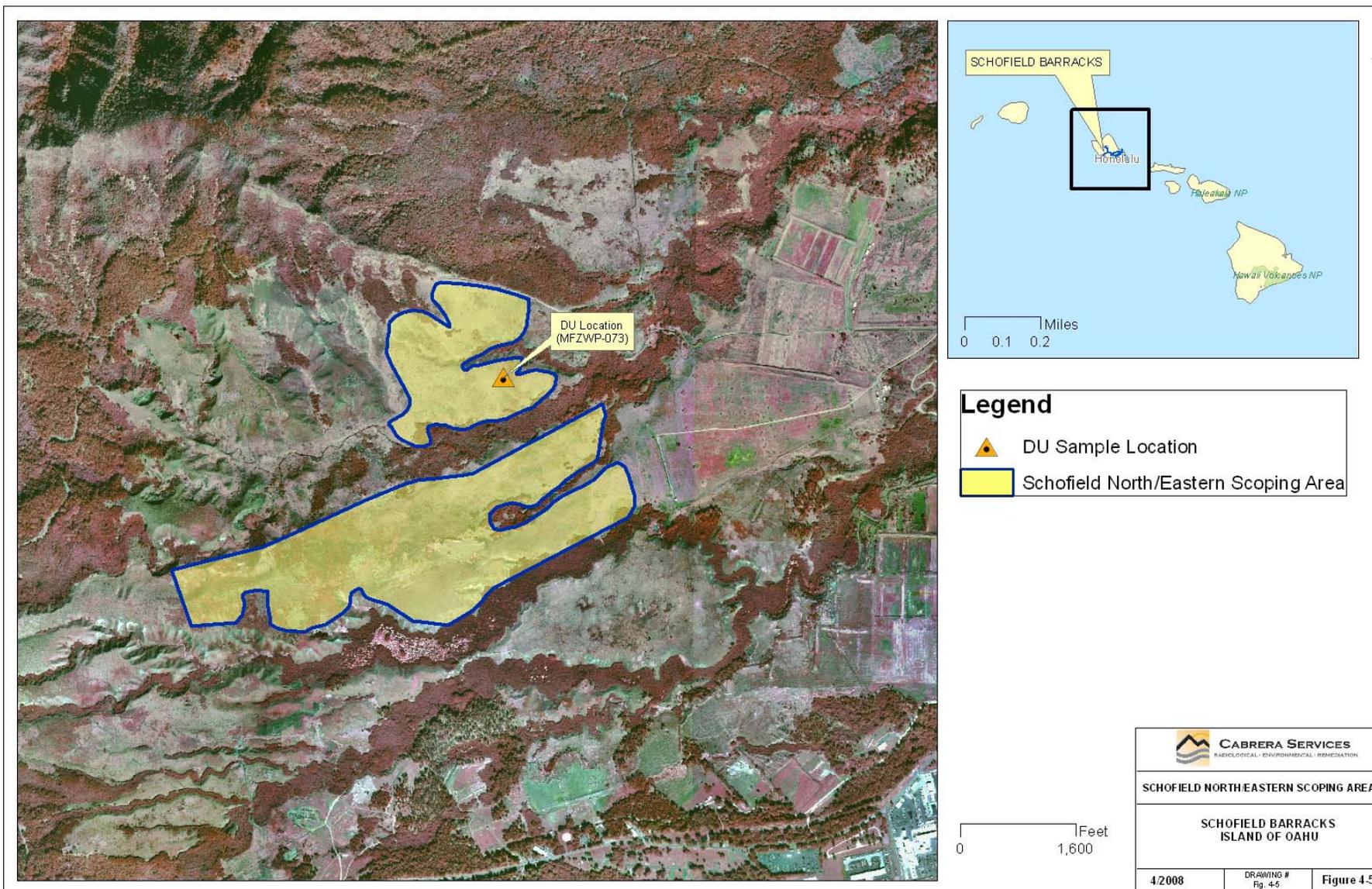


FIGURE 4-5: SAMPLE LOCATION AT SCHOFIELD SCOPING AREA