Table 4-3:
Management units

Unit	*Location, size and description*	*Characteristics*
Kaluakauila	• in and around the Kaluakauila drainage area, north of Makua Valley • approximately 45 acres • primarily consists of dry forest on steep slopes • contains a lot of cliff habitat	• susceptible to fires due to the habitat surrounding the intact native forest patches • composed of introduced grasses and shrubs that have high fire potentials • five endangered plant species
Kahanahaiki	• on northern rim of Makua Valley, bound to the east by the Pahole Natural Area Reserve • approximately 110 acres characterized as a diverse mesic forest	• contains ten endangered plant species • contains one endangered animal species • first site of endangered species reintroduction on Army lands • easy access • abundant resources
C-Ridge	• north exposure of the large ridge that dissects Makua Valley • 4 acre patch of native dry forest between 800 and 1,200 feet in elevation • surrounded on the lower side by introduced grasses and on the upper side by steep cliffs	• susceptible to fires from live-fire training • four endangered plant species
East Rim	• at the head wall of the southern side of Makua Valley • approximately 10 acres • native mesic forest patches dominated by non-native canopy and understory species • substrate is loose rocky soil • extends from 2,200 to 2,600 feet in elevation	• three endangered plant species
Ohikilolo	• on the Ohikilolo Ridge • approximately 40 acres • terrain is extremely steep and rocky • access to the upper portion by helicopter only	• large patches of the Ohikilolo Ridge are bare of vegetation • erosion by wind and rain is prevalent • large population of goats consumes most of the vegetation on the ridge • ten endangered plant species and one endangered animal species • largest population Oahu tree snails in Makua Valley
Lower Makua	• located at the base of the cliffs on the southern side of Makua Valley • approximately of 270 acres • portions of the lower valley contain extensive intact stands of dry forest that become intermixed with mesic forest as elevation increases • ranges from 800 to 2,200 feet	• contains six endangered plant species • one endangered animal taxon

Source: USAH and 25th ID(L), 1999

MOKULEIA FOREST RESERVE

PAHOLE NATURAL AREA RESERVE

Pacific Ocean

Kaluakauila Stream

Punapohaku Stream

Makua Valley Road

Makua Stream

Koiahi Gulch

Makua Beach

Kaneana Cave

Ohikilolo

Road/Trail
Stream
Makua Military Reservation
CCAAC Impact Area
Other Land

Management Units

- C Ridge
- East Rim
- Kahanahaiki
- Kaluakauila
- Lower Makua
- Ohikilolo
- East Rim Fence
- Kahanahaiki Exclosure
- Ohikilolo Fence
- Pahole Nar Exclosure

Data Source: Final Biological Assessment for Programmatic Section 7 Consultation on Routine Military Training at MMR, 1998

0.5 0 0.5 1 Miles

Contour Interval: 40 Feet

Figure 4-9: Management Units

BACK OF FIGURE 4-9

Table 4-4:
Rare plant and animal species at Makua

Common name	*Scientific name*	*Federal status*
Plants		
Mahoe	*Alectron macrococcus var. macrococcus*	Endangered
Plant, no common name	*Alsinidendron obovatum*	Endangered
‘Ahakea	*Bobea timonioides*	Species of Concern
Plant, no common name	*Bonamia menziesii*	Endangered
Maiapilo	*Capparis sandwichiana*	Species of Concern
Kamanomano	*Cenchrus agrimonioides var. agrimonioides*	Endangered
Akoko	*Chamaesyce celastroides kaenana*	Endangered
Pauoa	*Ctenitis squamigera*	Endangered
Haha	*Cyanea superba superba*	Endangered
Haha	*Cyrtandra dentata*	Endangered
Haha	*Delissea subcordata*	Endangered
Fern, no common name	*Diellia falcata*	Endangered
Na’ena’e	*Dubautia herbstobatae*	Endangered
Na’ena’e	*Dubautia sherffiana*	Species of Concern
Spurge	*Euphorbia haeleeleana*	Endangered
Mehamehame	*Flueggea neowawraea*	Endangered
Plant, no common name	*Hedyotis degeneri var. degeneri*	Endangered
Plant, no common name	*Hedyotis parvula*	Endangered
Hibiscus	*Hibiscus brackenridgei ssp. mokuleianus*	Endangered
Kamakahala	*Labordia kaalae*	Species of Concern
Pepperwort	*Lepidium arbuscula*	Endangered
Nehe	*Lipochaeta tenuifolia*	Endangered
Plant, no common name	*Lobelia niihauensis*	Endangered
Plant, no common name	*Lobelia oahuensis*	Endangered
Alani	*1994 Melicope makahae*	Candidate
Plant, no common name	*Morinda trimera*	Species of Concern
Plant, no common name	*Neraudia angulata var. angulata*	Endangered
Plant, no common name	*Neraudia angulata var. dentata*	Endangered
Ma`aloa	*Neraudia melastomilofolia*	Species of Concern
Keahi	*Nesoluma polynesicum*	Species of Concern
Aiea	*Nothocestrum latifolium*	Candidate
Kului	*Nototrichium humile*	Endangered
Kuahiwi laukahi	*Plantago princeps princeps*	Endangered
Pilo Kea	*Platydesma cornuta decurrens*	Candidate
Halapepe	*Pleomele forbesii*	Candidate
Loulu	*Pritchardia ka' alae*	Endangered
Kaula	*Pteralyxia macrocarpa*	Candidate
Snakerroot	*Sanicula mariversa*	Endangered

Table 4-4:
Rare plant and animal species at Makua

Common name	*Scientific name*	*Federal status*
Plant, no common name	*Schiedea hookeri*	Endangered
Plant, no common name	*Schiedea mannii*	Species of Concern
Plant, no common name	*Schiedea nuttallii var. nuttalli*	Endangered
Plant, no common name	*Schiedea pubescens purpurescens*	Species of Concern
Plant, no common name	*Silene lanceolata*	Endangered
Plant, no common name	*Spermolepis hawaiiensis*	Endangered
Plant, no common name	*Strongylodon ruber*	Species of Concern
Plant, no common name	*Tetramolopium filiforme (2 varieties)*	Endangered
Opuhe	*Viola chamissoniana chamissoniana*	Endangered
Animals		
Oahu tree snail	*Achatinella mustelina*	Endangered
Oahu creeper	*Paroreomyza maculata*	Endangered
Hawaiian hoary bat	*Lasiurus cinereus semotus*	Endangered
Oahu elepaio	*Chasiempis sandwichensis ibidis*	Endangered
Hawaiian short-eared owl	*Asio flammeus sandwichensis*	Species of Concern

Source: USFWS, Biological Opinion, 1999, US Army, 2000.

In 1998, the Army initiated formal consultation under Section 7 of the Endangered Species Act (16 USC 1531 *et seq*.) with USFWS to determine if routine military training at Makua would jeopardize the continued existence of 41 endangered species. The consultation used an action area (AA) or area potentially affected by military training which extended beyond the boundaries of Makua and was based on vegetation types, fire history, natural and human-made barriers, and a consensus of where fire could be stopped by state, Federal, and Army fire-fighting resources. Because a significant proportion of the largest and most viable populations of 28 (target taxa) of the 41 taxa occur in the AA or are at extremely low numbers throughout their range the Army centered its consultation efforts on those 28 taxa.

In 1999, USFWS issued a BO concluding that the routine military training would not jeopardize the endangered species if certain conditions were met. In order to return to training, the Army would have to comply with certain restrictions to military training, and prepare and implement the Wildland Fire Management Plan. After the Army returns to training, the Army would be required to complete a plan (the Implementation Plan) to stabilize the 28 target taxa out of the 41 taxa. The Army had already been providing certain interim stabilization (currently initiated) actions for the listed species in Makua as part of their environmental program. The Implementation Plan (IP) would provide additional management actions for the 28 target taxa. At the time of the consultation, the target taxa consisted of 27 plants and 1 snail species.

During preparation of the IP, four additional endangered plant species *(Hibiscus brackenridgei* ssp. *Mokuleianus, Chamaescycy celastroides* var. *kaenana, Colubrina oppositifolia,* and *Abutilon sandwicense)* were discovered in the AA. USFWS amended the BO to incorporate these four newly discovered species and determined that routine military training activities as described in the July 23, 1999, BO are not likely to jeopardize the continued existence of *Chamaesyce celastroides* var. *kaenana, Hibiscus brackenridgei* ssp. *Mokuleianus, Colubrina oppositifolia,* and *Abutilon sandwicense* (see

Appendix E, USFWS letter, amendment to the BO). Two of these *(Chamaesyce celastroides* var. *kaenana* and *Hibiscus brackenridgei ssp. Mokuleianus)* were determined to require stabilization , thereby increasing the number of target taxa to 30. When stabilization of all target taxa is achieved, restrictions to routine training may be eliminated following reinitiation of consultation with the USFWS. As a result of the Consultation, the following terms and conditions were stipulated by USFWS in the 1999 BO. The Army will:

- Monitor and report any incidental take of threatened or endangered species that occurs.
- Provide USFWS with an annual report containing the conservation measures that were accomplished during the year.
- Notify USFWS within 3 working days if take of any Oahu tree snail, Oahu elepaio, Oahu creeper, and Hawaiian hoary bat occurs. The depository designated to receive any killed specimens is the Bishop Museum.

Coordination with the Army's Directorate of Public Works Environmental Division and approval by the USFWS are required before conduct of training in areas outside the firebreak. Training activities which may occur outside the CCAAC; include:

- Hikes coming down the northern side of Makua, which originates from Dillingham Airfield using the Kealia Trail (one to four times per year, one day each time)
- US Army and Marine Corps snipers use of a small arms firing point on the ridge south of the range control building (six to eight exercises per year, two to three days per exercise, hike in and out on each day)

4.6.1.5 Wildfire Wildfire from training activities is the single largest potential impact on the Makua ecosystem. Wildfires have the potential to threaten the existing ecosystem and can affect the Army's training mission. If fire is allowed to consume native vegetation, especially trees that provide overstory shade, alien weeds can more easily colonize the area, extending the grass boundary and increasing the risk to endangered species. Native Hawaiian plants are not known to reclaim areas devastated by fire (US Army, 1998).

Wildfires influence the ecosystem directly and indirectly by altering the distribution of plants and animals, accelerating or retarding the succession of stages, making nutrients available or scarce to plants, and changing habitat structure and forage composition. Although fires and decomposition are two processes that regulate the removal of woody debris from the system, fire can also be an important agent of disturbance for watersheds by creating areas of bare mineral soils susceptible to runoff and erosion, (US Army, 2000), particularly in areas such as Hawaii where the vegetation is not fire-adapted.

Wildfires also limit the Army's ability to accomplish its training mission effectively. Wildfires can easily overtake soldiers training in the field, trapping them and potentially causing injury or death. Wildfires in proximity to normal or UXO can create extreme explosive hazards for personnel in the immediate vicinity. Fires deny access to training areas and ranges during and after a fire, disrupt training schedules, destroy targets/control systems, require costly repair and lost training time, destroy vegetation used for cover during training exercises, cause erosion that may result in unsafe driving conditions, and result in

expensive wildfire prevention and suppression actions. Damage to off-post resources also presents economic and political costs (US Army, 2000).

Fire history Prehistoric fire was most likely rare in the Hawaiian Islands and did not impact a significant area. Active volcanoes were likely an ignition source, but information on volcano-caused fires from recorded history indicates that they tended to be small, until the time of discovery of Hawaii by the Polynesians about 1,600 years ago (Beavers *et al*, 1999). Anthropogenic influences by native Hawaiians include introduction of grasses and use of slash-and-burn agriculture; these resulted in a vegetative cover more prone to ignition and fire spread.

When the Europeans arrived, they brought many new species of plants and animals that could out-compete the native species. Several hundred species were introduced, of which nearly 90 are considered a serious threat to native biota. Pyrophytic (fire-adapted) grasses are among the most aggressive species. They quickly out-compete the native grasses, rapidly colonizing burned areas, and are difficult to eradicate once established. The conversion of Makua to a live-fire range in the 1940s fostered the spread of seeds by vehicles and personnel, and provided a constant source of ignition. Alien grasses, particularly Guinea grass *(Panicum maximum)* and molasses grass *(Melinis minutiflora)*, introduced as forage for cattle heavily dominate the valley floor and some ridges. Molasses grass has encroached into the forested areas. These grasses can invade native systems without the aid of fire and spread even more rapidly after fire occurs (Beavers, *et al*, 1999).

Most manual records that were kept have been destroyed in accordance with the Army's 5-year record-retention policy (US Army, 2000). Therefore, it is difficult to illustrate accurately fire-causing trends on Makua prior to 1996 (Beavers, *et al*, 1999). To collect fire data more consistently and accurately, the Army has developed a Wildland Fire Incident Report Form to be used at Makua.

In 1994, the Army voluntarily suspended training with live ammunition because of a fire caused by a tracer bullet on Kahanahaiki Ridge. Following this event, the Army realigned the targets to minimize the chances of fires outside the firebreaks.

In the past, fires have burned onto the adjacent land of the Silva Ranch, the Kuaokala Game Management Area, and the US Air Force Kaena Point Satellite Tracking Station. State of Hawaii records show large fires started on Makua in 1970 and 1975. The fire in 1970 was not initiated by military training. In June 1995, a prescribed burn by the Army escaped and burned 2,400 acres within Makua and into Kuaokala Game Management Area. A report after this fire prepared by the USFWS and the Army indicated individuals of five species of endangered plants perished in that fire. Beavers, *et al*, (1999) identified six off-post fires that the Army extinguished between 1970 and 1999 plus four on Makua of non-military origin. Three small fires occurred outside of the firebreak roads in 1997. In March 1998, a fire of unknown origin burned approximately 100 acres outside the firebreak. Later in March, a grenade simulator initiated a fire next to the firebreak road and burned approximately 20 acres outside the firebreak, and a TOW missile ricocheted and started a fire that burned approximately 30 acres outside the firebreak. In September 1998, a fire from a mortar round started outside the firebreak and burned approximately 800 acres. Although no listed species perished in these fires, once fire came within 100 feet, and another within 350 feet, of listed plant species. These and other fires may have also impacted listed, candidate, or species of concern where individual specimens may have been overlooked. As a result of the 1997 and 1998 fires, the Army voluntarily suspended training to investigate the fires and

evaluate its fire management program and training procedures. No training has occurred at Makua since September 1998.

Section 7 Consultation with the USFWS was conducted in 1989-1991. As a result, all targets located outside the firebreak roads were moved to within the firebreak roads. Ordnance with high fire risk, such as flares and rockets, were prohibited, and other fire-causing explosive and tracer ammunition was restricted to targets inside the firebreak road. The Army was to furnish the USFWS with semi-annual reports of all fires escaping immediate control and any fire that escapes the firebreak must be reported to the USFWS within 24 hours of its occurrence (US Army, 1998).

The main ignition source from Army activities in the past has been tracers. From 1970 through 1998, approximately 61 percent of all recorded fires were attributed to now-prohibited weapons or ammunition (such as tracer bullets or TOW missiles) (Beavers, *et al*, 1999). Anti-tank missiles, mines, mortars, and demolitions were other ignition sources from training activities (US Army, 2000). Excluding an escaped prescribed fire that burned 2,400 acres in 1995, the average area burned was approximately 15 acres; 38 of the 99 fires were less than 1 acre. Tracers and missiles are not part of the Proposed Action; therefore the probability of fires resulting from training exercises would decrease substantially. A list of weapons that would be used at Makua under the Proposed Action is provided in Table 2-1.

Fuel types Wildland fire fuels are the portions of the biomass that is likely to burn if ignited. At Makua these include dead vegetative litter, dry or flammable standing foliage, and the live vegetation that can be dried and become a fire fuel. Dead fuels can be classified according to the amount of time required for a fuel material to gain or lose approximately two-thirds of the moisture above or below its equilibrium moisture content. There are four classifications of dead fuels: (a) 1-hour fuels consist of dead vegetation less than ¼ inch in diameter, (b) 10-hour fuels are ¼ to 1 inch in diameter, (c) 100-hour fuels are 1-3 inches in diameter, and (d) 1000-hour fuels are 3-10 inches in diameter (US Army, 2000). The 1-hour fuels are termed fine fuels and are the most sensitive to ignition; they react rapidly to changes in weather conditions and are the primarily carrier of fire, especially in wind-driven conditions.

Fuel types at Makua have been categorized into eight vegetation classes and one non-vegetated class (US Army, 2000). The fuel types are described below.

Grass. Alien grasses are generally greater than 3 feet in height, though grass in areas that have been burned or managed within the past year may be shorter. The principal species are Guinea grass and molasses grass. The latter has been known to result in exceptionally high fire intensity, probably due to oils secreted from the base of leaf hairs onto the leaf surfaces. Heavy accumulations of dead biomass, nearing 100 percent of all grass biomass in the dry months, are common in the grass class. Pockets of shrubs, particularly haole koa (*Leucaena leucocephala*), exist with the grass vegetation class. Virtually no native species are present.

Grass/Shrub. Alien grasses grow in the understory or are co-dominant with shrubs. Grass biomass remains high and the influence of the shrubs is the addition of larger diameter fuels to the fuel matrix as well as a firebrand source for spotting. Personnel with fire experience at Makua disagree about whether the intensity and spread rate of grass/shrub fires in areas which have been repeatedly burned in the past several years are therefore small, and probably will have little effect on fire behavior, as the grasses will be the primary carrier of fire.

Shrub. Alien (generally at middle elevations) and native (at higher elevations) shrub species dominate this class. Shrublands tend to occur at middle elevations in scattered patches and at high elevations on ridges unsuitable for the production of a forest stand of full stature. Many areas classified as shrub are occupied by species technically classified as trees that have taken on a shrubby growth form.

Mixed Forest. All tree species, with the exception ofkukui (*Aleurites moluccana*), are included in this class. These forests are heavily dominated by the native species of 'ohi'a, wiliwili, and koa, though the areas of alien infestation occur. Forested areas are exclusively located above 650 feet. Where forested areas exist below this elevation they are limited to locations with favorable soils, moisture, and aspect.

Kukui Dominated Forest. Kukui dominated forest is any area where kukui canopy cover is greater than 50 percent. This class of vegetation occurs almost exclusively in moist gullies within the native forest class.

Vegetated Cliffs. This class includes any heavily to lightly vegetated cliff faces with a slope greater than 75 degrees. Vegetation cover ranges from virtually none (in isolated areas) to complete cover of grasses and low stature shrubs. Individual trees are present but uncommon and closed canopy forests are absent.

Savanna. Grasslands with a tree canopy greater than 50 percent fall into this category. Grasses in the understory are consistently the alien species named above. Tree species include both native and exotic individuals.

Forest/Shrub. Shrublands with a tree canopy greater than 50 percent make up the forest/shrub category. Shrub and tree species include both native and exotic individuals. This vegetation class occurs only in one location along Farrington Highway.

Roads, Areas Around Buildings, and Bare Soil. This class includes roads, buildings and the surrounding landscaped vegetation, and areas within very sparse vegetation. Areas impacted enough by training exercises to remove continuous vegetation cover are included. This category is composed of areas where there is very little risk of fire ignition or spread. Locations that have been mowed and/or burned for fuel management are not included because they represent areas of higher fire ignition and spread risk.

Fire Danger Rating System Fire management planning requires reliable information about when and where fires can occur, and the type of behavior that can be expected of a fire. A fire danger rating system (FDRS) has been established to warn people when dangerous conditions can be expected, but it also forms the basis for all fire management programs. The system provides a computer-generated set of indices that forecast the ignition component (percent of fires that would start as a result of firebrands), the spread component (rate of spread), and a burn index (effort required to contain a fire) (US Army, 2000). The FDRS used at Makua since the 1980s was revamped in 1999 to reflect more accurately the conditions present. The National Fire Danger Rating System fuel model N is now used because it better represents fire behavior and the fuels outside the firebreaks than the model L formerly used (Beavers *et al*, 1999).

The FDRS gives the probability of a fire starting and the difficulty of control the fire once started. This information is used to control the types of training allowed on the ranges; high danger ratings are more restrictive than low ratings. Managers can then plan the type of training appropriate for the conditions to minimize the likelihood of wildfire ignition. The danger ratings also enables a wildland fire response to

be planned appropriate to the expected fire behavior, and is used to alert range operation manager, fire managers, and training officers to the expected fire danger.

Fuel breaks and firebreaks The Army maintains a firebreak system to minimize the spread of fires. If a wildfire escapes the initial attack, fuel breaks and other fuel modification areas provide the most logical location for fire containment lines. Maintained firebreaks and fuel modification areas provide defensible space that aids in fire containment. Roads, streams, and barren lava can be used as natural fire barriers and integrated into the fuel break/firebreak system.

Fuel breaks are strategically located blocks or strips of land on which vegetation has been manipulated to reduce fuel volume or flammability to aid in fire control. They are most effective if linked to other fire containment barriers. Widths are determined by fuel type, terrain features, and expected weather conditions, especially wind speed and direction. The wider the fuel break, the higher the probability of containing a fire; a wide fuel break also increases the safety factor for fire fighters. Fuel breaks can have a 10-foot strip of bare soil or a mowed path inside a wider brush-cleared area; they are effective only if continually maintained.

Firebreaks are defined as cleared-to-mineral-soil potential fire control lines, 15 to 20 feet wide. The firebreak system includes north and south firebreaks as well as interior fire access roads within the south firebreak area. Figure 4-10 shows the north and south firebreak areas. The existing firebreak system is designed to serve as control lines for fire containment and allow safe vehicle access for firefighting personnel and all emergency and support equipment.

The north firebreak is a roadway that completely encircles the north training area. Fuel loading within the north firebreak can be high depending on the last wildfire/prescribed burn. The south firebreak is a roadway that completely encircles the south training and impact area. This is the critical firebreak because this is the CCAAC where training takes place and most of the fires start. Interior fire access roads within the south firebreak serve as additional control lines during fire suppression (US Army, 2000).

Fuels modification is defined as removing or modifying an area of flammable vegetation to reduce the fire hazard. The fire hazard is managed by changing the fuel type to a more fire-resistant vegetation through the use of herbicides, growth retardants, and selection for certain species; reducing the fuel volume by prescribed burning; by reducing the distribution/loading of fuels by hand labor, mechanical methods (mowing, chopping, disking).

Prescribed burning is a proven method of reducing vegetative fuel loading under controlled planned burning procedures, and thereby minimizing the risk of a large wildfire burning out of control. Because of rough terrain, prescribed burning is usually the only fuels modification action taken in the north area. There is a potential for prescribed fires to escape and burn outside the firebreak road. However, the Army has successfully done large-scale prescribed burning within firebreak roads in the past.

The Army has established procedures to maintain regularly the fuel break/firebreak roads to ensure their effectiveness. The Makua Range Operations Supervisor and Wildland Fire Program Manager have coordinated with the Range Facilities Manager and Range Planner to develop and implement an annual work plan. Briefly, the work plan includes:

- Plans and capital for construction of fuel breaks/firebreaks, maintenance, and rehabilitation of existing fuel break/firebreak roads
- Fuel modifications (mowing, applying herbicides, prescribed burning, grazing)
- Maintaining firebreaks to a minimum of 15–20 feet wide of fuel-free surface where they pass through vegetated areas
- Erosion control
- Ensuring roads are passable to fire emergency vehicles and support equipment
- Emergency repairs to firebreak roads (US Army, 2000)

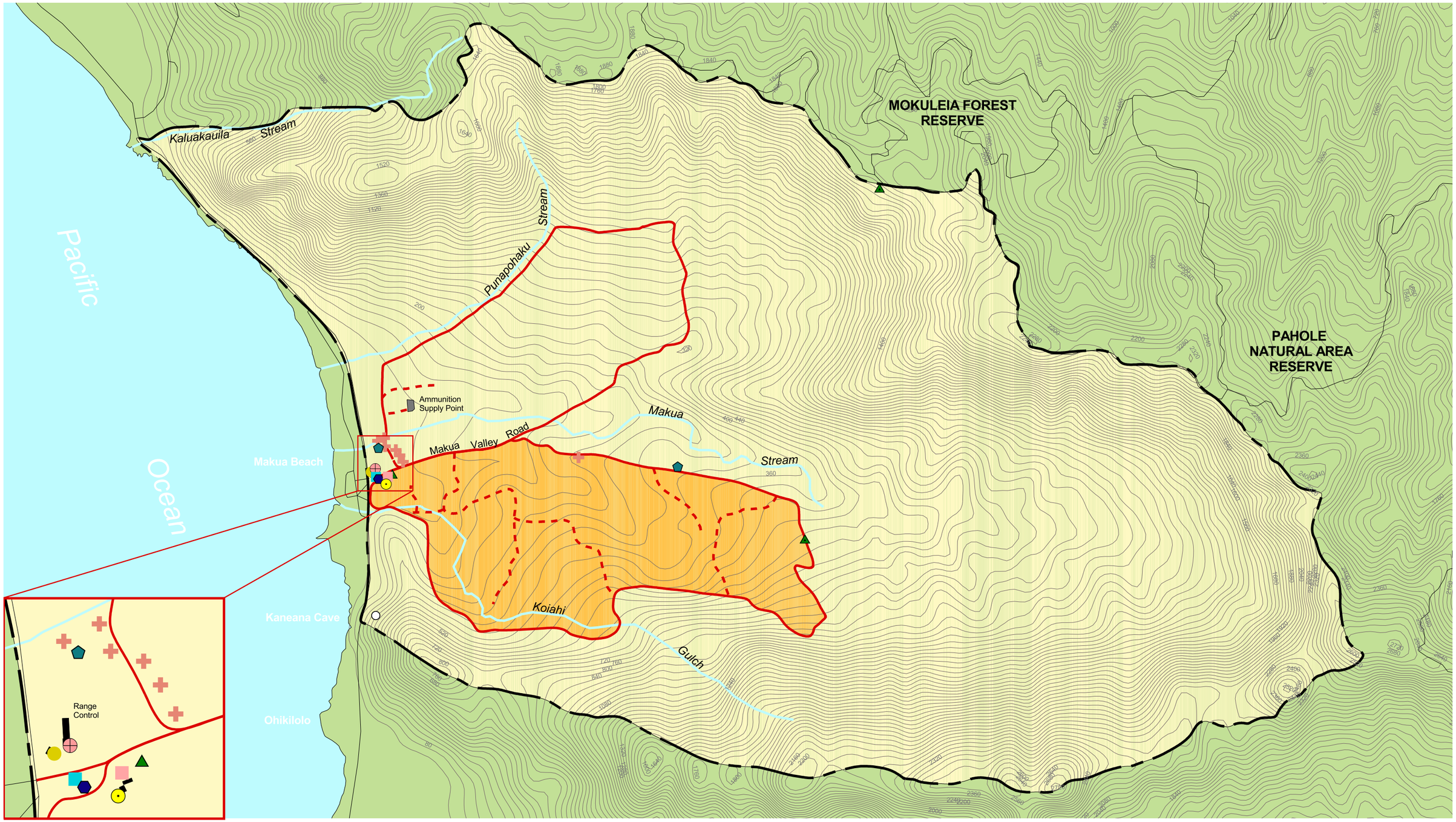
Fire management The Wildland Fire Management Plan for Pohakuloa and Oahu Training Areas (US Army, 2000) was developed as a result of the 1997-1999 Section 7 Consultation. The Plan details actions that would be taken to minimize the occurrence of fires and the adverse effects of fire on Hawaiian Army lands, including Makua. The Wildland Fire Management Plan estimates the influence of fire on the Hawaiian ecosystem by describing fire distribution, frequency, return interval, predictability, and magnitude over time. The Makua site-specific Wildfire Standard Operating Procedures (SOP) identifies responsibilities of the fire managers, Range Control staff, training units, Federal firefighters, and other agencies in the prevention and suppression of fires within Makua. All fire-planning efforts consider what the impacts of fire pre-suppression and suppression activities would have on the natural and cultural resources, including rare and endangered species (US Army, 2000).

Makua has a comprehensive fire protection plan and a trained firefighting staff. Restrictions have been placed on use of specific categories of ordnance which pose a high risk of fire, and specific range boundaries for certain weapon systems have been designated. The SOP sets forth training restrictions during periods of high fire danger and training personnel receive instruction briefings regarding the fragility of native Hawaiian ecosystems and the devastating effects of fire (US Army, 2000).

During training, all weapons are aimed so that their projectiles land within the confines of the southern fire/fuel break road. Mortars and howitzer cannon have a potential range that is farther than the limits of the firebreak road. However, the direction and angle at which these weapons are aimed and the amount of propellant used limits the range of the projectiles so that they will impact within the area circumscribed by the firebreak road. Additionally, all indirect firing positions whose azimuths of fire cross areas outside the firebreak road have been eliminated.

In recent years, with the exception of the fires that occurred in 1998, the Army has effectively prevented and contained fires at Makua. This is due in part to the following actions:

- The presence of a helicopter with water bucket whenever live ammunition is fired
- Construction of two 300,000-gallon helicopter dip ponds
- Installation of the roads within the perimeter road, and repair of roads as needed to provide effective fuel breaks and access to firefighting equipment and vehicles
- Installation of remote automated weather stations and use of the fire danger rating system to determine the type of training allowed and what ammunition can be used



Road/Trail
Intermittent Stream
Makua Military Reservation
CCAAC Impact Area
Other Land

Firebreak Road
Fire Access Road
Dip Pond
Fire Cache
Fire Pump

Foam Storage
Helipad
Humvee Watertender
Remote Auto Weather Station

Water Tank
Wet Standpipe System

DataSource: Final Draft Wildland Fire Management Plan, Pohakuloa & Oahu Training Areas, January 2000

0.5 0 0.5 Miles

Contour Interval: 40 Feet

Figure 4-10: Fire Management

BACK OF FIGURE 4-10

- Mowing and application of herbicides to grass inside the southern firebreak to minimize fuel loading
- Procurement of additional firefighting equipment and vehicles
- Training Range Control staff in firefighting techniques and procedures (US Army, 1998)

The following are firefighting requirements (i.e., personnel, fire vehicles, and equipment and aircraft support) required during training exercises (US Army, 2000):

- Trained firefighting personnel from Makua
- Twenty soldiers from the training unit, immediately available to Makua staff should a fire break out, including a non-commissioned officer to provide unit supervision of the detail
- One aerial fire-bucket-trained helicopter crew
- One operational Hummer brush engine, equipped with 300-gallon slip-on pump unit and one 6x6 water tanker/tender (1,200-gallon capacity). If a Hummer is not available and operational, training would cease until another engine is brought on site
- Backup and extended attack vehicles
- A cache of fire equipment on site at all times and inspected periodically to ensure all resources are in place. Any deficiencies would be identified and immediately corrected
- One aircraft dedicated and physically on site at the helicopter area in front of Makua Range Control during live-fire or use of pyrotechnics, including blank ammunition activities
- One backup aircraft on station at Wheeler Army Airfield or Marine Corps Base Kaneohe Bay, or a general response aircraft. This aircraft must be on standby and have a one-hour response ability while training is being conducted at Makua.
- A serviceable primary and a reserve Bambi fire bucket available for use at all times.

The primary firefighting measures include the use of two dip ponds and the firebreak system. Makua Lower Dip Pond #1 is located 650 feet to the northeast of the range control building. Makua Upper Dip Pond #2 is 6,500 feet east of range control along the fuel break road (see Figure 4-8). Makua staff ensures the dip ponds are filled to a minimum of 70 percent (above the 7-foot mark) of their maximum capacity prior to any live-fire training. The lower pond is filled using the waterline into Makua. The upper pond is filled by tankers from another off-site location (US Army, 2000).

A four-inch commercial water line feeds all water needs and two freshwater fire standpipes at the Range Control building. These pipes are designed to feed directly from the 30,000-gallon reserve tank. While the use of freshwater is preferred over the use of sea and brackish water, during extended attack operations, fresh water can become limited. The helicopters can also apply seawater for fire suppression when required (US Army, 2000).

Makua's firefighting staff is supported by several federal agencies. Fire protection services on USARHAW installations are provided by the consolidated Federal Fire Department (FFD), Naval Station Pearl Harbor (NAVSTA PH) through an Interservice Support Agreement (ISA). The FFD has historically only been staffed to carry out the structural firefighting mission on Army installations (US Army, 2000). The Army auxiliary wildland firefighting force was established by Range Control to augment the FFD during wildfires that are first reported on the training ranges and to provide initial attack until the FFD arrives (US Army, 2000).

4.6.2 Environmental consequences of No Action The No Action alternative is described in detail in 3.2. Potential impacts to endangered species could include invasion of native species habitat by alien species that could out-compete native species. Under this no action alternative, the Army may have to reconsult with the US Fish and Wildlife Service regarding cessation of interim stabilization measures identified in 4.6.3. However, some of the measures that are currently under way (*e.g.,* existing fencing) would be maintained during this caretaker period.

Cleanup of UXO could disturb endangered species and their habitats. The magnitude and threat of direct loss of biological resources from wildfire suppression actions could be much greater than for the Proposed Action alternative if pre-suppression actions are not utilized and a fire management plan is not in place. Removal of military personnel and equipment could adversely affect the ability to prevent and fight wildfires. These potential impacts would be analyzed and evaluated in the NEPA disposal document. Therefore, as both pre-disposal land management and the disposal action are subject to consultation with the USFWS under Section 7 of the Endangered Species Act, no significant impacts will result so long as any new consultation-derived mitigation measures are followed.

4.6.3 Environmental consequences of Proposed Action Under the Proposed Action the Army would continue interim stabilization actions (actions currently implemented). This includes the Wildland Fire Management Plan (WFMP) details of which are found in Appendix F, the restrictions on training (no TOWS, incendiary munitions, or tracers), and the additional ongoing interim measures which are described in the BO (see Appendix E) that are necessary to immediately protect and conserve existing threatened and endangered species now in Makua. These measures include all actions, which currently protect against fire, as well as against the following threats feral ungulates, small mammals, invertebrates, and alien plant species. Such actions include:

- Site-specific ungulate control measures
- Site specific weed control measures
- Erosion control measures
- Species specific insect control

Under the Proposed Action, the Wildland Fire Management Plan, which is currently implemented, would continue to reduce threat of wildfires at Makua. Two categories of actions in the Wildland Fire Management Plan would have environmental consequences. These are pre-suppression (specific actions that are put in place before wildfires start), and suppression (emergency operations to attack and suppress existing wildfires).

Pre-suppression actions include fuels management and prescribed fire, which result in deliberate environmental consequences initiated to avoid the much greater consequences of wildfire. Fuels management includes creating fuel breaks by reducing or manipulating vegetative cover to reduce or eliminate the fuel volume or flammability, thus inhibiting the passage of wildfire. Grading and mowing to create and maintain the fuel breaks/firebreaks directly destroy existing habitats and make the soil more susceptible to erosion. Fuel breaks and firebreaks create corridors that allow greater movement of wildlife, humans, and equipment, which can transport alien seeds to unintended locations. The equipment (e.g., tractors, graders, mowers, bulldozers) used to construct and maintain fuel breaks and firebreaks

disturb the environment and adversely affect established vegetation, which allows the invasion of undesired species that may subsequently have to be controlled. Fuels management also includes modifying the existing species composition in a plant community to create a community that is more resistant to rapid combustion. Pre-suppression options include the use of herbicides or growth retardants to kill existing vegetation or inhibit growth of existing species, and cattle grazing to reduce the amount of vegetation.

Prescribed fires would function as a pre-suppression tool to remove vegetation and excess fuel under defined conditions. They would be a source of air emissions and modify the existing habitat for wildlife. Prescribed fires can result in damage to sensitive areas if they escape the defined boundary or if the burn area has not been accurately assessed prior to initiation of the fire.

Fire suppression impacts can be much greater than pre-suppression impacts. The extent, location, and time may be largely out of administrative control as the goal is to minimize unintended and potentially extensive loss of habitat and resources from an unplanned event (wildfire). Firebreaks and fire lines may be placed through sensitive habitats in order to suppress or control wildfires that threaten extensive areas. During emergency construction of firebreaks, sensitive areas are avoided to the maximum extent possible. Implementation of the Wildland Fire Management Plan would reduce loss of habitat of vegetation and wildlife, including sensitive and protected species, to wildfires and would not significantly adversely impact the environment. However, suppression actions are implemented only under emergency conditions.

It is this group of actions, coupled with the modified training which permits the Army to resume training with no significant impact to the threatened and endangered species in Makua.

4.6.3.1 Future stabilization efforts The Proposed Action consists of ongoing interim stabilization measures described above. In addition to the ongoing activities, the Army is committed to additional long-term stabilization measures that are not part of the Proposed Action. The Army will initiate the long-term stabilization measures designed to promote the continued existence of threatened and endangered species at Makua.

Stabilization Plan The Stabilization Plan identifies both the ongoing interim stabilization measures and long-term stabilization measures designed to stabilize endangered species. It includes a description of species-specific stabilization actions. Many of the stabilization actions that the Army will be implementing at Makua are experimental. These management actions will be closely examined and modified as needed to ensure success and reduction of impacts to listed species. This would be done through an Implementation Plan, which is being developed by the Army with consultation and advice from an implementation team of biologists from the Army, USFWS, State of Hawaii, The Nature Conservancy, and a minimum of three experts jointly chosen by the USFWS and the Army for their knowledge of habitat management and/or population biology and genetics in Hawaii. The Implementation Plan would direct future actions over the next decades to protect and preserve the listed species and their habitat in the Army's long-term species stabilization efforts in Makua and adjacent lands.

The Implementation Plan will provide the following:

- Identify priority species and areas within Makua and in off-site stabilization areas.
- Determine the gross scale estimate of a minimum viable population for each species considered likely to be jeopardized by Army activities.
- Determine intermediate and final definitions of success for stabilization of each species.
- Develop collection protocols to achieve the highest possible genetic representation that can be sampled within the Waianae Range.
- Develop reintroduction and augmentation protocols which include the determination of adequate number of individuals to reintroduce or augment to reach success, number of populations, size or life stage distribution of the population, how to achieve the highest number of individuals possible within a population, contamination issues, timing of reintroduction and augmentation, and site selection.
- Determine habitat management requirements (quality and quantity) for each species.
- Develop a method to monitor, integrate and evaluate data, and report results.
- Identify priority incipient weeds and the areas to be surveyed within Makua and on off-site stabilization areas.
- Develop a schedule for completion of implementation actions and a cost estimate for implementation of each identified action.
- Develop scopes of work for implementation of actions.

The Army would continue to monitor the health of the existing populations and survey for new populations of listed species so that long-term stabilization efforts can be directed. Surveys are conducted in areas previously known to have Federally-listed species and also in areas yet unexplored that are suitable habitat (USAGH, 1998).

The advisory implementation team would review progress annually and make recommendations to the Army as to needed adaptive management changes. Habitat management would occur concurrently with species-specific stabilization. The USFWS would have final approval as to whether changes would meet the goals of the consultation (USFWS, 1999b).

4.6.4 Conclusion Fire is the greatest threat to continued existence of endangered species at Makua. The Army's Proposed Action, which includes, modified training (elimination of TOW missiles, incendiary munitions, and tracers), an extensive program of wildland fire management activities, using state of the art technologies, and advanced techniques for monitoring fire risks, substantially reduces the possibility of fire ignitions within Makua. It also provides increased capabilities for fire suppression.

The Army's program of monitoring and control of rats, goats, pigs, and weeds, monitoring of rare plants, and rare birds, will protect the environment for endangered species at Makua. The ongoing interim species stabilization measures would mitigate or offset any negative impact of training.

The Proposed Action, with its accompanying interim stabilization measures protects threatened and endangered species and would have no significant impact on those species. This conclusion is supported by the BO, which concludes that the Proposed Action is not likely to jeopardize the continued existence of the endangered species at Makua (USFWS, 1999).

4.7 AIR QUALITY The National Ambient Air Quality Standards (NAAQS) created by the Federal

Clean Air Act of 1970 to regulate the amounts of six major Criteria Pollutants (carbon monoxide, nitrogen dioxide, ozone, particulate matter, sulfur dioxide, and lead) are set forth in Title 40 of the Code of Federal Regulations, Part 50. With the exception of stricter standards for carbon monoxide and nitrogen dioxide, State of Hawaii Air Quality Standards are similar to the NAAQS (see Table 4-5).

Table 4-5:
State of Hawaii and federal ambient air quality standards

Pollutant	*Period*	*Hawaii State Standard a ($\mu g/m^3$)*	*Federal Primary Standard b ($\mu g/m^3$)*	*Federal Secondary Standard c ($\mu g/m^3$)*
Carbon Monoxide	1-hour	10,000	40,000	40,000
	8-hour	5,000	10,000	10,000
Nitrogen Dioxide	Annual (arithmetic)	70	100	100
PM10	24-hour (arithmetic)	150	150	150
		50	50	50
Ozone	1-hour	100	235	235
Sulfur Dioxide	3-hour	1,300	----	1,300
	24-hour	365	365	----
	Annual (arithmetic)	80	80	----
Lead	Calendar Quarter (arithmetic)	1.5	1.5	1.5

Standard a: Designated to protect public health and welfare and to prevent the significant deterioration of air quality.
Standard b: Designated to prevent adverse effects on public health.
Standard c: Designated to prevent adverse effects on public welfare, including comfort, visibility, vegetation, animals, aesthetic values, and soiling and deterioration of materials.
Source: State of Hawaii, Department of Health, Clean Air Branch, 1999.

4.7.1 Affected environment Hawaii operates 12 monitoring stations on the islands of Oahu, Kauai, and Maui to measure ambient air concentrations of these six criteria pollutants. Each year the Clean Air Branch of the State Department of Health releases a summary of air quality data. In October of 1997, ambient air monitoring for lead was discontinued with Environmental Protection Agency (EPA) approval due to consistent levels below the federal standard (to zero or nearly zero) and the elimination of lead in gasoline (State of Hawaii, 1999). Lead and ozone are not measured because they are not viewed as a problem.

Regionally, most air pollutant sources come from commercial, industrial, and transportation activities on the island of Oahu, and the monitoring sites are located to detect these pollutants. Data used in the analysis of air quality from the *Annual Summary, Hawaii Air Quality Data, 1998*, for this Environmental Assessment were taken from the three air monitoring stations located nearest to Makua (Makaiwa, Kapolei, and West Beach). The data show that overall air quality throughout Hawaii, and the air quality monitored at these three stations, is good. The quantities of criteria pollutants detected are far below both the federal and state standards.

Training and operations at Makua do influence the local air quality. Various emissions from transportation and explosive sources can become a factor during dismounted troop movement, vehicular movement, use of helicopters, and use of ordnance simulators, pyrotechnics, and blank and live ammunition. Five of the six criteria pollutants (with the exception of sulfur dioxide) can be generated

from training operations, most notably vehicle emissions in small amounts. Primary sources of man-made emissions result from helicopters and vehicle exhaust during training. Dust is also indirectly created from vehicles along the dirt roads. Air emissions from prescribed burns for wildfire management and control also occasionally influence local air quality. Such air quality problems are usually localized and temporary, however, and impacts are minor due to the intermittent nature.

4.7.2 Environmental consequences of No Action The No Action alternative is described in detail in 3.2. The minimal adverse air quality impacts stemming from Army activities would no longer be present. This situation would continue until completion of the disposal process, but the air quality impacts of subsequent reuse are not known, but might be expected to follow the guidance of the Waianae Sustainable Communities Plan. The reuse action would be the subject of a separate NEPA document.

4.7.3 Environmental consequences of Proposed Action Overall air quality on Oahu exceeds both federal and state standards. Military activities at Makua are not anticipated to affect the overall air quality of the region, and no long-term or significant impacts are anticipated. Impacts from the operation of training vehicles and equipment would be temporary and minor. Temporary increases in pollutants from engine emissions and firing activities would be experienced, and increases in particulate matter would result from vehicle operation and maneuvers. These impacts are temporary and minor in nature.

Under implementation of the Fire Management Plan, emissions from wildfires would diminish as the number and extent of wildfires are controlled and reduced; emissions from prescribed burns would increase but with less total net emissions than from uncontrolled wildland fires.

Plants and animals would experience minor secondary impacts from the increased particulate matter from training activities, which could interfere with activities such as photosynthesis if the vegetative matter were covered with dust. Animal impacts would most likely include minor disturbances associated with increased carbon monoxide, sulfur dioxide, and local, temporary increases of other gases from ordnance explosions, which disperse quickly. Vehicles are not used extensively in actual training exercises, and therefore can only be expected to create minimal impacts on local air quality. No significant or long-term air quality impacts due to training would occur to humans, plants, or animals under the Proposed Action.

4.8 NOISE ENVIRONMENT Noise is defined as unwanted sound. The degree of annoyance caused by noise depends primarily upon the amplitude of the sound (loudness), its frequency (or pitch), and its duration. The unit of measure used for quantifying the levels of sound amplitude is a decibel (dB). Sound levels can be adjusted to account for the non-uniform frequency sensitivity of the human ear, using A-weighted decibels (dBA). The A-weighted sound level is typically used to measure community and transportation noises. The A-weighting scale closely resembles the frequency response of human hearing providing a good indication of the impact of noise produced from transportation activity. The C-weighting scale measures the low frequency component of high amplitude noise associated with mortar, artillery, and demolition activities. The low frequency component of this scale can cause buildings and windows to vibrate. Noise from small arms ranges is described in terms of dBP. The dBP is unweighted and weighs all frequencies of noise equally.

4.8.1 Affected environment Small arms, demolition, mortar, artillery, and aircraft gunnery activities all generate noise at Makua (US Army, 1988). Federal and state laws concerning environmental

noise for Army training activities have been implemented. The Army prepared a *Draft Environmental Noise Management Plan* that located and assessed noise sources due to training activities and operations at Makua (US Army, 1999). The study also evaluated the impacts of noise beyond the Makua boundary.

The Army's primary environmental noise abatement strategy for land use planning purposes uses the Installation Compatible Use Zone (ICUZ) Program. The ICUZ program uses goals and strategies to minimize impacts of noise on non-training areas and surrounding communities. ICUZ defines three noise zones, presented in Table 4-6, US Army Noise Limits, to categorize the levels of noise and disturbance produced by training activities. Zone I is compatible with noise-sensitive land uses such as housing, schools and medical facilities. Zone II is also typically compatible with noise-sensitive land uses; whereas Zone III is not compatible with noise-sensitive land uses. The noise levels for these zones are only goals for planning purposes, and not regulatory requirements.

Table 4-6:
Noise zones and associated impacts

Noise Zone	*Percentage of Highly Annoyed*	*ADNL*	*Noise Limits CDNL*	*dBP*
Zone I	<15	<65 dBA	<62 dBC	<87 dBP
Zone II	15-39	65-75 dBA	62-70 dBC	87-104 dBP
Zone III	>39	>75 dBA	>70 dBC	>104 dBP

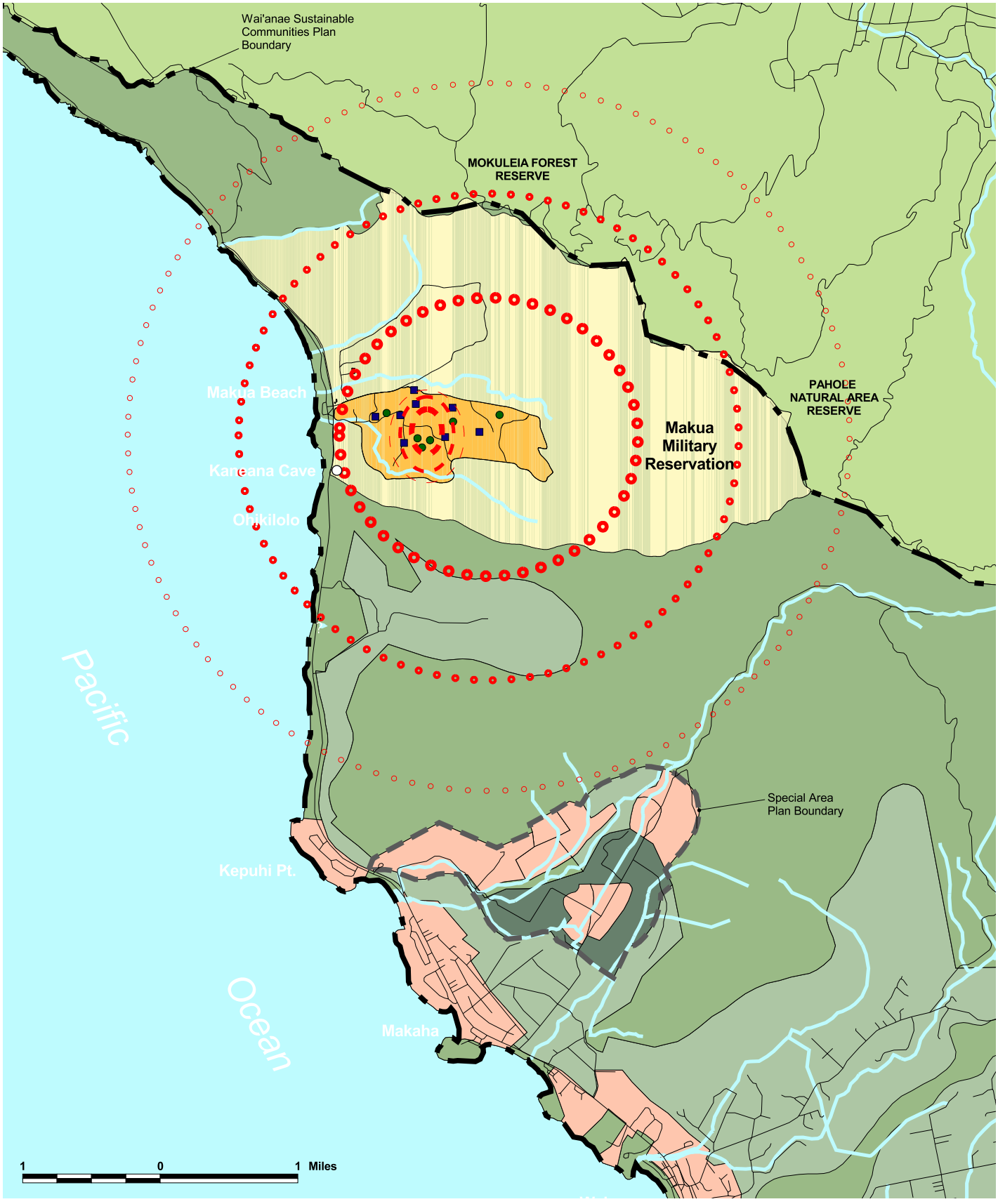
DBA = A-weighted decibels; dBC = C-weighted decibels; dBP = Peak sound level; ADNL = A-weighted day/night level
Source: US Army, 1988

Table 4-7:
State of Hawaii acceptable noise levels (dBA) for land uses

Zoning District	*Daytime (0700-2200 Hrs)*	*Nighttime (2200-0700 Hrs)*
Residential, Preservation	55 dBA	45 dBA
Apartment, Business	60 dBA	50 dBA
Agricultural, Industrial	70 dBA	70 dBA

Source: US Army, 1977

When assessing noise, characteristics to be considered are noise level, the temporal character of the noise, frequency or tonal characteristics of the noise, and the time of day. Noise models were used to map the noise contours from training activities at Makua (US Army, 1999). The modeling is based on the worst-case assumption that the land is flat. Noise generated from small arms ranges at Makua is compatible with adjacent land use because the associated noise contours do not extend outside the training area; however, noise contours do extend beyond the training area for blasts from exploding ordnance from large weapons firing (see Figure 4-11). Noise Zone III (>70 dBC for impulse noise) extends beyond the southern boundary to land designated as agricultural and preservation. Noise Zone II for impulse noise extends beyond the southern, western, and northern boundaries. The buffer, Zone I for impulse noise encircles the entire installation. The modeled noise contours do not take into consideration the topography of the land, but the surrounding mountains of Makua Valley would tend to reflect, or prevent the noise from going beyond their walls, reducing the extent of the noise contours over land, and projecting noise farther out towards the ocean.



Data Source: Digitized from Makua Blast Noise Contours Map, Draft Environmental Noise Management Plan, USARHAW, March 1999.

Figure 4-11: Noise Contours

Because the majority of the land uses in Zone III are non-noise-sensitive land uses, *i.e.,* agricultural and preservation land, Zone III noise is not incompatible with those land uses. The land uses in Zone II that extend beyond the Makua boundary are the same for Zone III and are also not incompatible with the noise environment. Makua Beach, however, is located across Farrington Road from Makua, would be affected by the occasional noises resulting from training activities. Land uses within the buffer, Zone I, include preservation, agricultural, parks and recreation, and residential. This Zone has a lower intensity of noise, causing fewer disturbances, and is therefore compatible with each of the encompassing land uses.

Actual noise measurements in 1989, when the Army was conducting training activities similar to those in the Proposed Action, showed that noise levels at the reservation boundary would ordinarily not exceed the standards of the Oahu community noise rule (US Army, 1989). Moderate risks of noise complaints could exist due to propagation of noise into the surrounding areas.

When addressing noise, consideration must also be given to wildlife and endangered species. A study to assess the effects of noise from artillery fire and demolition of UXO on the endangered Oahu elepaio was conducted at Schofield Barracks West Range. (Vanderwerf, Ebisu, and Assoc., 2000). This study was prepared in coordination with the USFWS. The original intention was to include Makua, but the suspension of training at Makua made this impossible. The results obtained at Schofield Barracks are considered applicable at Makua.

The study found that the elepaio population at West Range was not seriously disturbed by artillery fire within the range of sound levels recorded during the study. It was judged that the noise had a negligible effect on the elepaio's behavior, and that its nesting behavior was not significantly affected. The study also concluded that the elepaio population at Makua is not likely to be affected by artillery noise. The existing population (one pair) at Makua is at a greater distance from the noise sources than was the elepaio studied at Schofield. Therefore, there is no anticipated significant impact from the proposed action on the elepaio in Makua.

4.8.2 Environmental consequences of No Action The No Action alternative is described in detail in 3.2. During the period between the decision to stop training and the completion of the disposal process, there would be no noise impacts from Army activities. Noise would significantly decrease and the absence of noise would benefit the Waianae community, including people using Makua Beach.

Considerable but temporary noise could be generated by UXO clearance, if undertaken. The type, timing, and location of future reuse activities are not known, but significant noise impacts could also result, depending on the subsequent use of the property. These potential impacts would be analyzed and evaluated in the NEPA disposal document.

4.8.3 Environmental consequences of the Proposed Action There would be noise from live-fire training within the training areas at Makua, Makua Beach, and in agricultural and preservation lands immediately adjacent to Makua. The noise levels in the Waianae community would be of a low nuisance level due to the relatively large amount of agricultural and preservation land and the tall ridge between the noise source and the residential community. The northern portion of the Special Area Plan boundary is adjacent to Noise Zone III, while the beach across from Makua falls within Noise Zone I. Noise studies found that noise generated at Makua normally would not exceed the levels allowed by the

local noise ordinance for more than 10 percent of any 20 minute period outside the reservation boundary (US Army 1977). Using this standard, users of Makua Beach would be minimally impacted by noise for short periods during training activities. Waianae as a whole may experience some low nuisance level noise.

A study of the effects of noise from training on the Oahu elepaio conducted at Schofield Barracks concluded that noise from live-fire training operations would have no effect on the elepaio, and the results are considered valid for the elepaio at Makua as well.

The Army will continue its ICUZ program, which provides a framework to coordinate with local planning and zoning agencies in the development of compatible land use plans and for avoiding conflicts with and danger from Army activities.

4.8.4 Conclusion Army noise generation at Makua falls within acceptable ICUZ guidelines. Implementation of these guidelines protect the Army's training mission at Makua as well as protecting the adjacent communities of Makaha and Waianae from undue noise impacts due to training activities at Makua. Under the Proposed Action, Makua would be used at a lower intensity than in the past. Therefore, although some occasional noise would occur, noise impacts are anticipated to be low. No significant noise impacts would result from this action.

4.9 SOCIOECONOMIC ENVIRONMENT

4.9.1 Affected environment

4.9.1.1 Community and rural value qualities The Waianae community is built on strong foundations of community and rural values and qualities. The vision statement for the long-range plan of the Waianae District best expresses this:

> The vision for the future of Waianae is a vision of a community living by values and customs that are firmly embedded in the rural landscape, the coastal shore lands, the ocean waters, the forested mountains, the diversity of cultures, the warmth of family and friends, and the Waianae traditions of independence, country living, and aloha. (City and County of Honolulu, 2000)

Waianae community values encompass the history, heritage, and traditions of the Hawaiian people and their relationships to their natural and cultural surroundings. The values summarized and captured in the development of the vision statement are:

- "Ours is a living culture of the land and the sea"—The community enjoys the natural and cultural surroundings of Waianae, as has many generations before them. The people are working to restore resources, and traditional and cultural practices of the past to ensure that these resources will be there for future generations.

- "Relationships are fundamental to our values and identity"—Family relationships, extended families and close kinship are identities of the Waianae community and their diverse ethnic culture. These relationships, in concert with their relationships to the land and the ocean are a necessary part of their lives.

- "We are a rural community"—Waianae is a relatively small community where much of life is focused around rural and agricultural means. The rural community is a country environment that is cherished by the people. The rural surroundings are a meaning of freedom to the people where their can live as their choose, farm, and enjoy the serenity of open space.

- "We are a community with small town values"—The people of Waianae are proud of their traditional social values that involve long-time family and friend relationships, the helping of one another, gathering areas, and social interdependence. While newcomers are welcome, many of the community members have concerns that the small town atmosphere and social values may change.

- "We value economic choices in Waianae"—Economic choices are very important to the community's vitality. Families want to spend time together, have the convenience of purchasing goods and services within the community, and reduce the amount of traffic and stress.

- "Our elderly have much to teach us"—The community has the highest respect for the elderly and their history and legends of the past. The older generations are the teachers of the young.

- "We cherish our children"—While the elderly are the teachers, the future is in the hands of the children. A safe and preserved environment, adequate shelter, and a supportive community with educational opportunities are necessary for the future of the children and the community.

Rural values and qualities are also important socioeconomic elements of the Waianae community. These values and qualities involve:

- Numerous family-owned and family operated farm operations that cultivate agricultural crops and livestock (mainly situated in Lualualei and Waianae Valley) The aesthetics of expansive open spaces and cultural qualities of the valleys of Nanakuli, Lualuaei, Waianae, Makaha, and Makua
- The aesthetics of the Waianae Mountains
- The beauty of the extensive shoreline, beaches and parks
- The small-town values of the community

4.9.1.2 Population and housing

Makua No businesses, homeowners, or tenants are located on Makua, and no future development is planned. For safety reasons, access is restricted. A staff of seven people provides security and fire protection at Makua. Makua is situated in the Waianae District Development Planning Area (Figure 4-3).

Waianae The population of the Waianae District was 7,000 people in 1950, or 2 percent of the total population on Oahu. The population grew to 40,000 people in 1998, which equates to 4.5 percent of Oahu's total population. With trends continuing in the same mode, anticipated growth for 2020 could add 10,000 to 20,000 people to the Waianae population. (*City and County of Honolulu*, 2000) (The Waianae District is depicted in Figure 4-3).

The minority population (those who are in the minority of the population of the US as a whole), consisting of Blacks, American Indians, Eskimos, Aleuts, Asian, Pacific Islanders, and other races, was 28,711 or 78.9 percent of Waianae District compared to 31.7 percent for the Island of Oahu. The 9,429 households have an average of 3.79 persons per each household (City and County of Honolulu, 1996).

Housing trends for 1990 showed 10,680 occupied units for the Waianae District, compared to 281,683 for all of Oahu, while the median house value was $136,200, compared $281,500 for Oahu as a whole. From 1990 to 1996, 1,301 housing units were constructed and sold. The forecast for 1990 to 2020 projects a total increase of 4,447 units for the entire Waianae District.

Housing affordability is a critical issue throughout the State of Hawaii. The need for affordable housing is especially acute in lower income areas like Waianae, where the typical 1998 for-sale house price was in the range of $200-250,000 including land, and rent for a typical three-bedroom dwelling was in the range of $800 to $1,000 per month. According to the Housing Finance Development Corporation (HFDC), in 1997, house prices were higher than HFDC guidelines, but rents were actually lower (City and County of Honolulu, 1999).

Planned housing projects as of June, 1998 include: 900 units for Nanakuli Valley, 500 for the Lualualei/Voice of America site, 1,000 units at Mailikai, 150 units at the Village of Pokai Bay, and 600 units at Makaha alley (City and County of Honolulu, 2000).

4.9.1.3 Economy, employment and income

Makua The full-time staff of seven people at Makua, and the soldiers on site during training operations inject very little money directly into the local economy. Units training at Makua bring all supplies with them (including meals ready-to-eat, portable toilets for sanitation and equipment for bivouacking on site). Therefore, only minimal purchases such as fuel, refreshments and small cost items are purchased in the community. The Army does purchase services from utility providers and solid waste hauling by a private contractor (refer to 4.12 Infrastructure), Army lands are also exempt from property taxes.

Waianae In 1990, the labor force in the Waianae District consisted of 13,901 people employed in civilian positions and 596 employed in the armed forces (55.7 percent and 2.4 percent of persons 16 years of age and over, respectively). The median household income was $32,392, while it was $40,581 for all of Oahu. Some 1,418 families or 24.1 percent live below the poverty level, compared to 10,733 families or 3.2 percent for the total population of Oahu. Some 7,084 (23.9 percent) individuals were living below the poverty level, as compared to 60,093 (2.8 percent) of the population of Oahu, according to the 1990 figures (City and County of Honolulu, 1999).

4.9.1.4 Facilities and services

Army personnel who receive minor injuries are evacuated by ambulance or any other available wheeled vehicle on the site. Injured personnel categorized as “priority” or “urgent” can obtain a medical evacuation helicopter by calling Range Control. No health services are located near Makua.