Western Pond Turtle Habitat Management Plan

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Acronyms and Abbreviations

ARC	NASA Ames Research Center
C	Celsius
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CL	carapace length
DFG	California Department of Fish and Game
EATS	East Side Aquifer Treatment System
ESA	Endangered Species Act
F	Fahrenheit
g	gram
GCP-NE#2	Golf Course Pond: Northeast #2
gpm	gallons per minute
in	inch
km	kilometer
m	meter
mi	mile
mm	millimeter
NGVD	National Geodetic Vertical Datum
oz	ounce
PCB	polychlorinated biphenyl compounds
ppt	parts per thousand
SSC	Species of Special Concern
USFWS	United States Fish and Wildlife Service

Western Pond Turtle
Habitat Management Plan

Executive Summary

In the spring of 2000, the Western pond turtle (*Clemmys marmorata*) was discovered on the grounds of the NASA Ames Research Center (ARC) at Moffett Field, CA. *C. marmorata* was found in the freshwaters channels located in the southeastern corner of the facility surrounding the Moffett Field Golf Course. The purpose of this plan is to identify methods for protecting and studying the Western pond turtle at the ARC facility. Several existing activities at the site can and will impact the population. The recommendations outlined in this report are intended to minimize possible impacts.

ARC is located in northern Santa Clara County at the southern end of the San Francisco Bay. U.S. Highway 101, adjacent to the southern boundary of the facility, provides primary transportation access to the facility (Figure 1). ARC is part of the metropolitan Bay Area; San Francisco is located 40 miles (mi) (65 kilometers [km]) to the northwest, and San Jose is located 10 mi (16 km) to the southeast.

C. marmorata is not listed as endangered or threatened under the Federal ESA or CESA, but is listed as under a third category of *Species of Special Concern* (SSC) (Jennings and Hayes 1994) and is subject to California Environmental Quality Act (CEQA) review.

The ecology of *C marmorata* includes utilization of a wide variety of permanent and ephemeral aquatic habitats, and may spend a significant amount of time in upland terrestrial habitats as well. Both adult and juvenile turtles favor aquatic habitats with access to areas of deep slow water with underwater refugia and emergent basking sites. Hatchlings are relatively poor swimmers and tend to seek areas with slow, shallow, warmer water, often with emergent vegetation. Mating takes place underwater in May though August, but is likely later (July and August) at ARC, given the mating periods of other regional populations.

The current extent of the population is 16 individuals in the Northern Channel and Marriage Road Ditch, as observed in surveys conducted on June 14, 2004 (Alderete pers. comm). The population at that time consisted of 14 adult turtles and 2 juveniles, each measuring approximately 2 inches (in) (50.8 millimeters [mm]) in length. Whether the population at ARC is a self-contained, isolated

population or one that is part of a larger meta-population is an unanswered question about the landscape ecology of the species. It is likely that the turtles migrated into the system from the San Francisquito watershed to the north or from one of the watersheds to the south, but the exact movement and extent of the population is unknown.

Site fidelity to the standing water areas in the Northern Channel and Marriage Road Ditch appears to be extremely high. A board has been placed in the Marriage Road Ditch just north of the golf course maintenance yard access road and is used as the primary basking site for the individuals.

Activities such as golf course landscaping and maintenance, Navy contaminant clean-up, and future construction and/or remodeling of facilities could result in impacts to the pond turtle population. This study makes recommendations to avoid, minimize, mitigate, and enhance for any such impacts. The ARC wildlife biologist would be the primary contact for implementing these measures and would consult with the California Department of Fish and Game (DFG) to ensure the protection of the population. This study also proposes additional marking and recapture studies to track the extent and characteristics of the population. Such observation of the population would allow ARC to continue to revise and expand this plan, as necessary, to maintain the integrity of the *C. marmorata* population at the NASA Ames Research Center at Moffett Field.

Regulatory Status

This section describes relevant local, state, and federal regulations of biological resources under which the western pond turtle, *Clemmys marmorata*, is specifically protected. The western pond turtle is not listed or proposed for listing under the Endangered Species Act (ESA). There are no other federal regulations that apply to the species. *C. marmorata* is not listed under the California Endangered Species Act (CESA), nor protected under Section 5050 of the California Fish and Game Code (fully protected reptiles and amphibians). There are no existing local laws governing or protecting the western pond turtle.

California State Species of Special Concern

C. marmorata is not listed as endangered or threatened under CESA, but is listed under a third category as a *Species of Special Concern* (SSC) (Jennings and Hayes 1994). SSC status applies to animals not listed under the federal Endangered Species Act or the California Endangered Species Act, but which nonetheless (1) are declining at a rate that could result in listing, or (2) historically occurred in low numbers and known threats to their persistence currently exist. A species of special concern meets one or more of the following criteria.

1. Occurs in small, isolated populations or in fragmented habitat, and is threatened by further isolation and population reduction.

2. Shows marked population declines. Population estimates are unavailable for the vast majority of taxa. Species that show a marked population decline, yet are still abundant, do not meet the Special Concern definition, whereas marked population decline in uncommon or rare species is an inclusion criterion.

3. Depends on a habitat that has shown substantial historical or recent declines in size. This criterion infers the population viability of a species based on trends in the habitats upon which it specializes.

4. Occurs only in or adjacent to an area where habitat is being converted to land uses incompatible with the animal's survival.

5. Has few California records, or historically occurred here but is not documented with recent records.

6. Occurs largely on public lands, but where current management practices are inconsistent with the animal's persistence.

This designation, though it has no legal definition, and therefore is not subject to any specific regulatory requirements, is intended to result in special consideration for specific sensitive species by the DFG, land managers, consulting biologists,

and others. It is also intended to focus attention on the species to help avert the need for costly listing under federal and state endangered species laws and cumbersome recovery efforts that might ultimately be required. This designation is further intended to stimulate collection of additional information on the biology, distribution, and status of poorly understood at-risk species, and focus research and management attention on them.

Western Pond Turtle Ecology

Distribution

Historically, the western pond turtle had a relatively continuous distribution in most Pacific slope drainages from Klickitat County, Washington along the Columbia River (Slater 1962) to Arroyo Santo Domingo, northern Baja California, Mexico. Records also exist for isolated populations in the Carson, Humboldt, and Truckee drainages in Nevada (LaRivers 1962, Banta 1963), but whether these records represent historical remnants, recent introductions (LaRivers 1962), or a combination of introductions and historical remnants is not known. The known elevational range of the western pond turtle extends from near sea level to approximately 4690 feet (ft) (1430 meters [m]) (Jose Basin Creek, Fresno County). It has been recorded from somewhat higher elevations, but these records do not necessarily imply original range, because turtles are known to have been introduced at all such sites. In California, it was historically present in most Pacific slope drainages between the Oregon and Mexican borders.

Reproduction

Mating takes place underwater. Behavior, likely courtship behavior, reported by Holland (1988) describes an interaction between a male and a female turtle. The reported interaction involved multiple scratching of the anterior edge of the female's carapace by the male's forelimbs, followed by the female raising her posterior end up off the substrate. Copulation was not observed, and the male turtle noticed the observer after about five minutes and fled (Holland 1988). Holland goes on to say, "Copulation has been observed in the field in mid-June in southern California, and in captive specimens in late August and early September." Adult females of several turtle species can store sperm for months or years (Gist and Jones 1989, Galbraith 1993).

The majority of mature females in a given population oviposit every other year, although some turtles oviposit in consecutive years. Reports of double-clutching also exist for locales throughout the range of this species (Holland 1994, Goodman 1997, Reese 1996). Known clutch size ranges from three to 13, with most clutches containing four to seven eggs (Holland 1994).

Oviposition occurs on land, usually above the flood plain, up to several hundred meters from water. For nesting, gravid (with eggs) females tend to seek out open

areas with sparse, low vegetation (annual grasses and herbs), a low slope angle, and dry hard soil. After voiding her bladder to soften the soil, the female excavates a pear-shaped nest chamber with her hind feet. Eggs are deposited and the nest chamber is plugged by kneading wet soil and vegetative fragments into the throat of the nest chamber (Holland 1994, Reese 1996). Nest site philopatry has been observed in several species of turtles and some evidence suggests that nest site philopatry is exhibited by *C. marmorata*, but this has not been proven (Holland 1994).

Growth and Development

Eggs are hard-shelled and oval in shape, measuring 1.2–1.5 inches (in) (31–38 millimeters [mm]) long by 0.8–1 in (20–24 mm) wide and weighing 0.3–0.4 ounces (oz) (8–10 grams [g]) (Holland 1994). Incubation takes about three months and overall hatching rates are about 70% (Holland 1994). In northern California, hatching occurs in the fall, and the hatchlings usually remain in the nest chamber over the winter and emerge in spring (Holland 1994, Reese 1996). In southern and central California, some hatchlings may emerge from the nest chamber in the fall, while others overwinter in the nest chamber and emerge in spring (Holland 1994). Hatchlings overwintering in the nest chamber receive nourishment from an umbilical yolk sack (Holland 1994).

Ontogeny, environmental conditions, geography, and individual variation all contribute to the variable growth rates seen in this species. Growth rates are highest in hatchlings, which can almost double in size by the end of the first growing season (Holland 1991). Generally, the growth rate decreases each successive year and by the end of the eighth year the average growth rate drops to less than 0.02 in/month (0.4 mm/month) or less, with some adults growing extremely slowly (Holland 1991). An adult female recaptured after 11 years grew only 0.03 in (0.8 mm) in that time (Holland 1991).

Growth rates may also be regulated by environmental factors, such as water temperature and variation in prey base (Goodman 1997). Geographic variation in growth rates may be attributable to environmental factors, as well as phylogenic variation across the range. In the southern portions of the *C. marmorata* range, females reach maturity at a smaller size (4.3–4.7 in [110–120 mm] CL [carapace length]) than females to the north (4.9 in [125 mm] CL in the Trinity River Basin, 5.1 in + (130+ mm) CL in the Rogue River Basin) (Holland 1994). Males mature at a smaller size than females from the same region (Holland 1994).

With so much variation in growth rates, using size to estimate age only offers a rough approximation, so age structure studies often rely on counting annuli on the plastral shields (Zug 1991). Counting annuli is based on the assumption that one growth ring is added each season, although this assumption may not be valid. Annuli are the result of alternating periods of maximum growth and minimum growth. In areas with little seasonal variation, growth spurts will be correlated with periodic abundance of prey, which may have several peaks in a year. The reliability of counting annuli decreases as the age of the turtle increases for two

reasons: (1) older turtles grow more slowly, so the new annuli are narrower each year, and (2) abrasion of the plastron, over time, may wear off the annuli or render them unreadable, especially in rocky environments.

Maximum life span in the wild has not been determined with certainty, but Holland (1991) estimates it may be 50–70 years. An anecdotal account exists of a turtle that was marked as an adult being recovered some 50 years later (Holland 1991).

Feeding and Prey

Clemmys marmorata is considered a dietary generalist, but it does not select food items based on general availability (Bury 1986). They prefer live prey, which they capture by opportunistic foraging tactics, but also scavenge carrion and browse on plant material. Prey items are ingested in the water; it appears this species is unable to swallow in air (Holland 1994). Preferred food items include aquatic insect larvae, crustaceans (cladocerans and crayfish), and annelids. Small vertebrates (including *Rana boylii* tadpoles and egg masses) have been found during gut content analysis of *C. marmorata*, but it is unclear whether these were ingested as prey or carrion (Bury 1986; Holland 1994). *C. marmorata* have been observed feeding on carcasses of mammals, birds, reptiles, amphibians, and fish (Holland 1994).

Consumption of plant material is less frequent, although adult females are most likely to engage in herbivory (Bury 1986). Post-partum females have been observed to ingest large amounts of tule (*Scirpus* sp.) and cattail roots (*Typha latifolia*) (Holland 1994). Foraging has also been noted on pond lily inflorescences (*Nuphar polysepalum*) (Evenden 1948), willow and alder catkins, ditch grass inflorescences, and green filamentous algae (Holland 1994). Seston and other small animals are abundant in filamentous algae and may supplement the diet when other animal prey items are scarce (Bury 1986). *C. marmorata* may also feed on *Daphnia* sp. and other small invertebrates in the water column by neustophagia, a modified form of gape-and-suck feeding (Holland 1994).

Upon hatching, hatchlings have an umbilical yolk sac, which provides nourishment in the early stages of growth (Holland 1991). Later, the hatchling diet consists mainly of the aquatic larvae of small insects, such as mosquitoes, other small invertebrates, and nekton (Holland 1994).

Predation

Raccoon (*Procyon lotor*), coyote (*Canis latrans*), grey fox *(Urocyon cinereoargenteus*), feral and domestic dogs (*Canis familiaris*), black bear (*Euarctos americanus*), river otter (*Lutra canadensis*), mink (*Mustela vison*), Osprey, Bald Eagle, bullfrog (*Rana catesbeiana*), and largemouth bass (*Micropterus salmoides*) are known to prey on *C. marmorata* (Holland 1994). Suspected predators include giant water bugs (Belastomatidae), rainbow trout (*Oncorhynchus mykiss*), squawfish (*Ptychocheilus* spp.), channel catfish

(*Ictalurus punctatus*), smallmouth bass (*Micropterus dolimeiui*), northern red-legged frog (*Rana aurora aurora*), California red-legged frog (*Rana aurora draytonii*), two-striped garter snake (*Thamnophis hammondii*), giant garter snake (*Thamnophis gigas*), Great Blue Heron (*Ardea herodias*), Black-Crowned Night Heron (*Nycticorax nycticorax*), Golden Eagle (*Aquila chrysaetos*), Red-Shouldered Hawk (*Buteo lineatus*), red fox (*Vulpes fulva*), beaver (*Castor canadensis*), and nutria (*Myocastor coypu*) (Holland 1994). Adult turtles often show scarring on the shell and/or missing limbs, indicating attempted predation. Holland (1994) found a six-fold greater scarring rate on females and attributed it to greater exposure to predators during nesting movements.

Hatchlings are especially vulnerable to predators because their shell is soft and they can be swallowed whole. Overland movements from the nest site to the aquatic habitat expose turtles to a wide range of terrestrial predators. Exotic aquatic predators, such as bullfrogs (*Rana catesbeiana*) and largemouth bass (*Micropterus salmoides*), can be especially effective at reducing recruitment in this species when turtles arrive at the preferred aquatic microhabitat after leaving the nest site (Holland 1994).

Spotted skunks (*Spilogale putorius*), raccoons (*Procyon lotor*), and coyotes (*Canis latrans*) are known to seek out turtle nests and consume the eggs (Holland 1994). Suspected nest predators include opossum (*Didelphis virginianus*), red fox (*Vulpes fulva*), grey fox (*Urocyon cinereoargenteus*), Raven (*Corvus corax*), Common Crow (*Corvus brachyrhynchos*), yellow-bellied racer (*Coluber constrictor*), gopher snake (*Pituophis melanoleucus*), common kingsnake (*Lampropeltis getulus*), California mountain kingsnake (*Lampropeltis zonata*), and possibly small rodents such gophers (*Thomomys* spp.). There is evidence to suggest snakes and rodents may also prey on turtle eggs (Rathbun et al. 1993). In some areas, most of the nests (90 to 99%) in a given year are predated (Holland 1994). By driving out larger predators, human influences can cause local increases in small carnivore populations ("meso-predator release") (Soule et al. 1988), possibly resulting in greater predation on nests and younger turtles. This has been documented in sea turtle populations (Ehrhart 1979).

Given the exposure of the population at ARC, it seems unlikely that there is a heavy predatory influence on the population. While predation is a concern, it appears that the heavy human use of the site and fencing inherent to a military facility has dampened the intrusion of predators.

Habitat Requirements

Clemmys marmorata utilize a wide variety of permanent and ephemeral aquatic habitats, and may spend a significant amount of time in upland terrestrial habitats as well. Both adult and juvenile turtles favor aquatic habitats with access to areas of deep slow water with underwater refugia and emergent basking sites. Hatchlings are relatively poor swimmers and tend to seek areas with slow, shallow, warmer water, often with emergent vegetation.

Terrestrial habitat requirements are variable throughout the range, but must include basking sites and nesting habitat. In most areas, terrestrial overwintering habitat is also required (Reese 1996). While emergent basking sites are preferred because they offer some protection from terrestrial predators and quick escapes to deep water, terrestrial basking sites are also utilized. Terrestrial basking sites include mud banks, rocks, logs, and root wads on the bank, and are never far from water. Nesting occurs terrestrially, usually in open low-slope areas a few meters to over a hundred meters from the watercourse. The nest site has good exposure to the sun and compact soil (Holland 1994, Reese 1996). Overwintering can be aquatic or terrestrial (Holland 1994). Terrestrial overwintering site characteristics are highly variable, but the microsite usually includes a thick duff layer (Holland 1994).

Younger turtles appear to have more specialized aquatic habitat requirements than adult turtles. Reese (1996) found basking site characteristics were similar between juveniles and adults with respect to water depth and perch diameter, but differed in flow characteristics. Juveniles used basking sites in lower flow areas than adults, and their disproportionate representation in ponds adjacent to the river suggest a strong association with low-velocity and/or warm waters (Reese 1996). This is reasonable, given the higher metabolic rates and poorer swimming ability conferred by their small body size. Lentic (still) waters offer a situation in which juveniles can maneuver more effectively to forage and reach refugia. Juveniles were found in areas with water temperatures of 54–91 degrees Fahrenheit (F) (12–33 degrees Celsius (C)), while adults used areas with temperatures from 50–63 degrees F (10–17 degrees C). Analysis of habitat characteristics showed that side channels are slightly more suitable for juveniles than the river itself, because they offer lower flows (Reese 1996).

Hatchling turtles may have even more stringent microhabitat requirements than juveniles or adults. Hatchlings are most commonly associated with shallow, warm water, free of predacious aquatic vertebrates, with at least some aquatic vegetation (Reese 1996, Holland 1994). The nesting season for the turtles is from late April to early August. In the spring, following an incubation period ranging from 3 to 4.5 months, most hatchling turtles emerge from their nests and utilize these habitats (Jennings 2000).

Movement and Dispersal

Clemmys marmorata exhibit a high degree of site fidelity, in both aquatic and terrestrial environments. In the aquatic environment, *C. marmorata* utilize a home range on the order of several hundred yards (Holland 1994), with males using a larger aquatic home range than females. Individuals may occasionally make sporadic long-distance aquatic movements outside their home range (Holland 1994). Reese (1996) suggested that sporadic, long-distance movements may represent dispersal and male mate searching, and that these movements may facilitate genetic dispersal.

Although primarily considered an aquatic turtle (Nussbaum et al. 1983), *C. marmorata* may spend half the year or more on land in some environments. Overland journeys between multiple bodies of water, often round trip, have been recorded (Reese 1996). It is unclear whether access to mates, food resources, basking sites, or cover or predator avoidance prompts this behavior (Reese 1996). Response to drought conditions can initiate terrestrial movements to other aquatic habitats or estivation sites. In lentic environments, *C. marmorata* often overwinter underwater, buried in mud; however, in lotic environments, complete departure from the aquatic environment is the norm (Reese 1996, Goodman 1997). These turtles leave the watercourse in the fall to overwinter burrowed in duff or soil. This may represent an adaptive response to the high flow conditions of winter in riverine systems.

Radio-telemetry studies have shown individuals often return to the same terrestrial overwintering site each fall (Reese 1996, Goodman 1997). Reese (1996) determined the average distance of overwintering sites from the watercourse to be 167 meters. During terrestrial overwintering, turtles may emerge to bask on sunny days, and may even move to new overwintering sites (Reese 1996, Goodman 1997). After overwintering, turtles may congregate in vernal pools before returning to the river in the springtime. This may allow them to take advantage of warmer, more productive waters while high flow conditions still exist in the river.

During the nesting and mating seasons (late April or early May and late April to early August, respectively [Jennings 2000)], gravid females usually leave the water to nest on land in the late afternoon, returning to the water by morning, although this is quite variable. Nest sites have been found as far as 400 m from the water (Reese 1996).

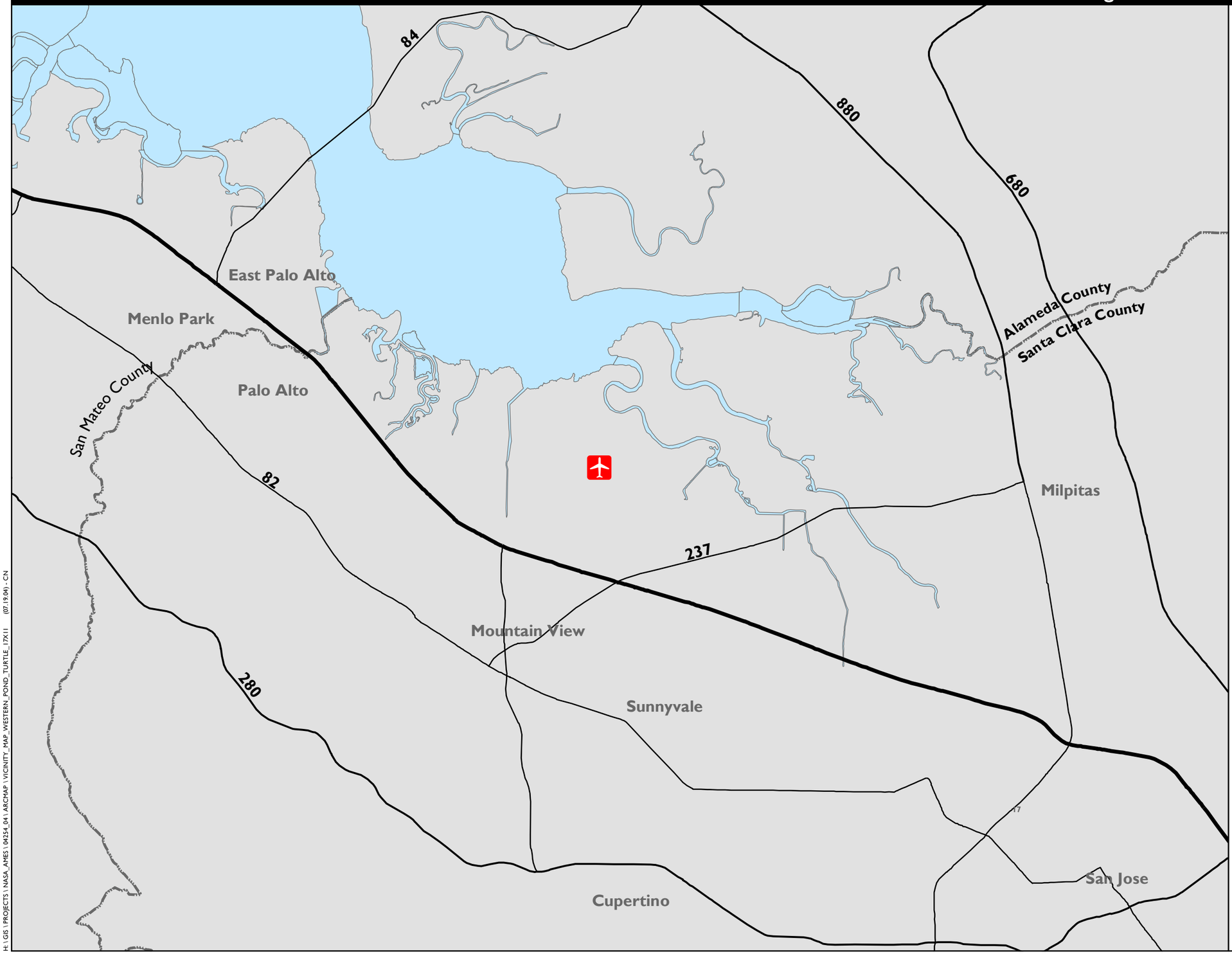
Reese (1996) found that over the summer months (May–September), juvenile turtles have an average maximum movement of approximately 84 m. Their mean weekly aquatic travel is 19.9 m. Their home range is smaller than that of adults but larger than previously recognized, and also includes terrestrial components (Reese 1996). Juveniles sometimes travel back and forth between low-flow portions of the river and adjacent ponds. These journeys may be motivated by thermal preferences, the distribution of food resources, swimming abilities, and/or predator avoidance.

Habitat Conditions at NASA Ames Research Center

Regional Context

Ames Research Center (ARC) is located in northern Santa Clara County at the southern end of the San Francisco Bay. U.S. Highway 101, adjacent to the southern boundary of the facility, provides primary transportation access to the facility (Figure 1). ARC is part of the metropolitan Bay Area; San Francisco is located 40 mi (65 km) to the northwest and San Jose is located 10 mi (16 km) to

Figure 1: Ames Research Center Vicinity Map



Legend

- Nasa Ames Research Center
- County Boundary
- US Highway
- Interstate
- State Highway

1 : 100,000

0 1 2 4

Miles

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the southeast. The cities of Mountain View and Sunnyvale are adjacent to ARC, across Highway 101.

The U.S. Fish and Wildlife Service (USFWS) manages the salt ponds and marshes north of Moffett Field previously used for salt production by Cargill Salt Company. North of the USFWS property is the San Francisco Bay, approximately 1 mi (1.6 km) to the north of Moffett Field. No direct hydrologic connection links the facility and the waters of San Francisco Bay, although there is limited connection to Guadalupe Slough (through gates and pumps), located to the northeast of Moffett Field, through the Northern Channel and Moffett Channel.

NASA Ames Research Center

The research center is primarily developed land that has been extensively altered over the history of the site. The site has been removed from tidal action due to the creation of salt evaporation ponds. The site was also previously diked and used for agricultural production, which continued until the 1980's. The topography of the site is generally flat and ranges from 20 ft (6 m) NGVD (National Geodetic Vertical Datum) at filled sites, such as the Moffett Field Golf Course, to sea level within storm water retention ponds and drainage ditches.

The Moffett Field Golf Course (Figure 2) is drained via overland flow into the East Patrol Road Ditch along the east side of the golf course and the Marriage Road Ditch, which roughly bisects the golf course and flows through a culvert under the North Patrol Road into the North Patrol Road Ditch. Additionally, the airfield storm water drainage system is at a low elevation, allowing groundwater to enter the system and flow into the North Patrol Road Ditch throughout the entire year (Alderete pers. comm.) As the culverts outflow into the North Patrol Road Ditch, a pump station can move water on demand into the adjacent Northern Channel. The Northern Channel flows east off the site and through a culvert into the easternmost Lockheed Channel adjacent to Moffett Channel. Another pump station lifts the water into Moffett Channel where it flows by gravity into Guadalupe Slough and into San Francisco Bay.

East Patrol Road Ditch

The East Patrol Road Ditch drains the northeastern portion of the property. Water runoff pools in the northern portion of the ditch, causing a saline pond surrounded by coastal salt marsh vegetation in the northern half and by freshwater marsh vegetation in the southern half. The southern portion of the open water is characterized by cattails and prairie bulrush (*Scirpus maritimus*). The northern portion is characterized by pickleweed, salt grass, and spearscale (*Atriplex triangularis*) (Dungan and Klug 1999).

Figure 2: Presumed Extent of Western Pond Turtle at Ames Research Center

Legend

- Western Pond Turtle Occurrences
- Known Extent of Western Pond Turtle

1 : 6000

0 100 200 400 600 800

Feet

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Marriage Road Ditch

Currently, Marriage Road Ditch receives water at approximately 20 gallons per minute (gpm) from a pipe in the vicinity of Macon Road during the dry months of the year. This 20 gpm is an estimate of water supplemented by ARC since the East Side Aquifer Treatment System (EATS). Prior to this, Marriage Road Ditch received about 30 gallons per minute of water flow directly from the EATS for approximately 5 years, ending in 2003 (Alderete et al. 2003). This flow appears to be responsible for the creating the turtle habitat in the Marriage Road ditch. Before the EATS treatment plant began pumping and treating water, the only source of water flow during the summer was surface runoff from golf course maintenance activities. Water from EATS flowed toward the northeast and entered mid-way along the North Patrol Road Ditch (Figure 2) through a culvert. Every spring the cattails and rushes are cleared out of the ditch by ARC staff and the tall grass on the upper banks is mowed. Because of its proximity to the golf course, the upland grassland found on the banks only extends for about 6.6 ft (2 m). In 2002 a pool formed on the north end of the golf course maintenance yard access road because cattails slowed the flow.

Northern Channel

The Northern Channel receives water from pumps at the end of North Patrol Ditch. The Northern Channel starts out wide and shallow, but quickly increases in depth, reaching 4 feet in many spots. The channel is bordered by levees that support upland grassland habitat along the sides, and a dirt levee road along the top. Along the edge of the water, vegetation is characterized by salt grass, pickleweed, cattails, rushes, and pepperweed. Large algae mats also grow along the edges of the channel. Aquatic vegetation also covers the muddy bottom of the channel. Within the channel, water flows to the east through a culvert, emptying into Lockheed Channel. NASA shares ownership of the Northern Channel with Cargill Salt Company.

North Patrol Road Ditch

North Patrol Road Ditch is found on the northern edge of the golf course on the East Side of the base (Figure 2). It receives storm water flow from both the East Patrol Road Ditch and Marriage Road Ditch and sends it to the west, where a lifting station pumps the water over the levee to the north The pump is on a float regulator and pumps on demand at higher (i.e. flood) flows. The vegetation at North Patrol Road Ditch is characterized by upland grassland species on the very tops of the ditch. The grass never gets very tall or dense. In the past, ground squirrel foraging probably kept the grass short. Recently, domestic goats have been used to keep the vegetation short in this area. Lining the lowest part of the ditch are coastal wetland species such as salt grass and pickleweed. The water here is slow-moving and shallow throughout the summer.

Lockheed Channel

Lockheed Channel receives water from the Northern Channel and Lockheed wetlands and then heads toward the Sunnyvale Treatment Plant, where it is pumped over a levee into the Moffett Channel. The vegetation here is very similar to the vegetation at North Patrol Road Ditch. One exception is that upland grassland grows tall on the tops of the ditches and is thick near the water's edge. Coyote brush (*Baccharis pilularis*) is also found on portions of the ditch. This ditch, on private property adjacent to ARC, is wider and deeper than any of the ditches found at ARC. Because the waterway is crossed by levees and channelized, it tends to pool water in the summer and never dries up. Large alga mats form on top of the water here in the heat of the summer where they serve as potential basking areas for turtles.

Golf Course Ponds

Two ponds that lie within the range of the western pond turtle at the Moffett Field Golf Course could potentially serve as habitat for the western pond turtle. Golf Course Pond: Northeast #2 (GCP-NE#2) is located in the northeast corner on Hole #2. The Marriage Road Golf Course Pond is located west of Marriage Road. Both ponds are heavily managed for vegetation control around the banks. Salinity in the golf course ponds varies throughout the year and can range from 0 parts per thousand (ppt) to 34 ppt (Scott and Alderete 2001). Based on a survey conducted by Scott and Alderete in 2001, the following fish species were present: threespine stickleback (*Gasterosteus aculeatus*), rainwater killifish (*Lucania parva*), mosquitofish (*Gambusia affinis*), and silversides (Atherinidae spp.) (Scott and Alderete 2001). Sparse cattails (*Typha* spp.) and rushes (*Juncus* spp.) are the dominant plant species found lining the edges of both ponds.

Population Status and Trends at NASA Ames Research Laboratory

Background

In Santa Clara County, Jennings et al. (1999) found that western pond turtles were extinct in the northern portion of Ames Research Center, despite a few observations of turtles in nearby locations such as within the lower Stevens Creek watershed, at Crittendon Avenue, and in San Thomas Aquino Creek Ponds. However, a survey of western pond turtles (Alderete et al. 2003) in 2002 found one individual in the North Patrol Road Ditch, two individuals in Marriage Road Ditch, and five individuals in the Northern Channel (Alderete et al. 2003).

The turtles observed in 2002 and in 2003 were of all age classes (juveniles and adults), suggesting a viable breeding population. Although only two turtles were

documented for Marriage Road Ditch in spring of 2002, four were observed there in February 2003 (Alderete et al. 2003). This could be the result of local reproduction and recruitment or evidence for continued migration from another source population.

Current Status

The current extent of the population consists of 16 individuals in the Marriage Road Ditch, observed in surveys conducted on June 14, 2004 (Alderete pers. comm.). The population consisted of 14 adult turtles and two juveniles, each measuring approximately 2 inches (51 mm) in length. Site fidelity to the standing water just downstream of the maintenance yard culvert appears to be extremely high. A board has been placed in the Marriage Road Ditch just north of the golf course maintenance yard access road and is used as the primary basking site for the individuals. Whether the population at ARC is a self-contained, isolated population, or one that is part of a larger meta-population is an unanswered question about the landscape ecology of the species. It is likely that the turtles migrated into the system from the San Francisquito watershed to the north or from one of the watersheds to the south, but the exact movement and extent of the population is unknown.

Potential Impacts of Ongoing and Proposed Activities at NASA Ames Research Laboratory

General Landscaping and Maintenance at Moffett Field Golf Course

Both the shoulder of Marriage Road and the surrounding golf course are extensively landscaped and regularly mowed, and Roundup, an herbicide, is applied to manage spotty weeds around trees, structures, and the ponds within the landscaped areas of the course. Roundup binds quickly to particulate matter, flocculates out of the water column, and accumulates in bottom sediments. While it is likely that the water column in Marriage Road Ditch is low in herbicides, the substrate of the channel may have accumulated herbicides. These herbicides can enter the food chain through benthic invertebrates and vegetation, which the turtle could consume and accumulate.

Guidelines for Vegetation Management within the Riparian Zone, below, provides impact avoidance and mitigation recommendations to address the impact of herbicides on local populations of western pond turtle.

Navy Clean-up Activities

Historical activities outside and on Moffett Field have resulted in contaminant accumulation in the local soils and groundwater. The primary site of concern to the pond turtle population is Site 27, which is a Navy Superfund site, which includes the Marriage Road Ditch, East Patrol Road Ditch, and North Patrol Road Ditch. PCBs (Polychlorinated Biphenyl) were detected in May 2002 above cleanup levels in the upper sediment layers and soil of the Marriage Road Ditch and in the North Patrol Road Ditch. Concentrations of PCBs in the deeper clay layer samples from these areas were below the cleanup levels for total PCBs. Pesticides and metals were detected above the cleanup levels in the Marriage Road Ditch, but generally below cleanup levels in the other two ditches. PCBs and pesticides were not detected in any surface water samples from the Marriage Road Ditch, East Patrol Road Ditch, or the North Patrol Road Ditch.

The effect of contaminants on western pond turtles is largely unstudied. Bury (1972) reported the effects of a diesel spill on California stream fauna. One western pond turtle was among the nearly 4,500 vertebrates killed, and 30 pond turtles captured over 1 month after the spill had swollen necks and eyes, and sloughed off pieces of epidermis on their appendages. The 1993 Yonella Creek diesel spill in Oregon had negative effects on invertebrate food, habitat and health of western pond turtles. All 30 turtles recovered after the Yonella Creek diesel spill exhibited debilitating conditions that appeared to be the result of exposure to diesel fuel (USFWS 1993). Given the long lifespan of turtles and their position as a tertiary consumer in the food chain, they may act as bio-accumulators of certain contaminants such as PCBs and heavy metals, a situation known to occur in other turtle species (e.g., common snapping turtle [Helwig and Hora 1983]).

Proposed Remediation

Site remediation, as is currently planned, is expected to include the excavation and off-site disposal of contaminated sediments from the Northern Channel and drainage ditches, and contaminated soil from the Northern Channel berm. No treatment of the sediments or soil would be conducted before disposal. The approximate total volume of sediments and soil that would be excavated is 64,113 cubic yards (53,606 cubic meters), which would be disposed of properly in an appropriate landfill. Water would be diverted, the channel and ditches would be dewatered, and the contaminated sediments would be excavated. Following excavation, samples would be collected to confirm that the impacted sediments and soil have been removed and that cleanup goals have been met.

Excavated sediments and soil would be tested, transported, and disposed of off-site at an appropriately permitted facility. All sediments would be dewatered, as required, prior to transport off-site, utilizing best management practices to minimize impacts to the area. Sediments would be placed on an elevated platform inside a bermed and lined containment cell that would allow the

sediments to drain. The drained liquid would be transferred into appropriate storage containers, sampled, and disposed of as required by law.

Once the excavation is complete, habitat would be re-established where necessary. Clean soil brought on-site as backfill would be carefully selected to be of a similar composition (i.e. type of soil, organic material, pH, etc.) to the existing soil. Efforts would be made to obtain soil completely free from noxious weeds. The clean backfill would be transported in trucks in accordance with a transportation plan to be developed as part of the cleanup design. Wetland plant species would then be reintroduced, where necessary, based on a revegetation plan that would be prepared. A trained wetlands biologist would be present to monitor all on-site construction activities.

Recommendations for impact avoidance and mitigation can be found below in *Specific Plan Recommendations for Turtle Protection During Remediation of Site 27*.

Construction or Remodeling of Facilities

Construction and/or expansion of existing facilities could impinge on the habitat of the pond turtle population at Moffett Field. Most of the turtles' site fidelity is centered on drainage ditches and stormwater facilities. While no modification of these facilities is proposed, any future modifications could impact the movement and breeding potential of the population. Any modification of the existing golf course maintenance yard and/or golf course facilities could impact the movement and viability of the turtle population.

Temporary Protection for Western Pond Turtle During On-Site Clean-Up and Construction Activities, below, provides impact avoidance and mitigation recommendations to address impacts of construction and remodeling activities on local populations of western pond turtle.

Impact Avoidance and Mitigation Recommendations

Specific Plan Recommendations for Turtle Protection During Remediation of Site 27

The proposed remediation of Site 27 would result in the complete removal of all known pond turtle habitat at ARC. However, the project is necessary for the site to be in compliance with federal regulations. The following measures are recommended to protect the integrity of the pond turtle population and to minimize distress to the population during remediation activities. A more specific plan for the remediation tailored to specific remediation requirements should be developed from these recommendations in conjunction with the CEQA

analysis for the Navy remediation project. The final plan should be reviewed by DFG and any alterations of the final plan from the following should be noted.

All of the recommendations that follow are intended only as recommendations. If better solutions are found in the interim, it is recommended that they be used in lieu of the following.

1. Conduct the remediation project in multiple phases, preferably with each phase no longer than 6 weeks in duration. Phasing of the project maintains portions of the turtle population range during construction and provides relocation opportunities for turtles directly affected by each phase of remediation. NOTE: this recommendation is the primary recommendation of the remediation plan.

   The geography of the site suggests completing the Marriage Road ditch in one phase and each of the Northern Channel and North Patrol road ditch in two phases.

   It is hoped that the remediation program would be used as an opportunity to quantify and study the existing population and provide enhanced habitat opportunities for turtles in the area.

2. Relocate turtles into a temporary holding site before remediation. Turtles would be trapped under the supervision of the ARC wildlife biologist using methods approved by DFG. At the time of capture, the location of the turtle would be recorded and the turtle marked with a non-intrusive tag so that the turtle could be returned to its home site after construction and site restoration. It is also recommended that basic measurements (i.e. morphological measurements, mass, and sex) of each turtle captured be taken to define the characteristics of the population.

   It is recommended that trapping take place in July at all sites in which construction is planned for that year and continue at regular intervals up to the initiation of construction. Trapping in July should facilitate capture of the entire population because young of year would have emerged and adults would not yet have buried eggs. While it is recognized that this could impact reproduction for that year, this is considered a better solution than destroying buried eggs. It is possible that some reproduction could occur at the relocation site.

   Capture techniques should using wire funnel traps baited with dead fish, buried pit buckets, and hand trapping while snorkeling. All captured turtles should be individually marked in the marginal scutes of the carapace. Markings should annotate the individual and the portion of the site from which the turtle was collected.

3. The ARC wildlife biologist in consultation with DFG would determine the relocation site, at a minimum of 90 days before the initiation of remediation activities. The golf course ponds adjacent to Marriage Road and East Patrol Road have been identified as a potential relocation sites.

Relocation sites are anticipated to provide an inundated area for the turtles, such as a pond, basking habitat, and upland habitat. It would be preferred to keep the turtles within the immediate vicinity of the project area to minimize stress during relocation but greater than 1000 feet from the actual construction area in order to minimize noise disturbance.

All relocation sites would be isolated and monitored during construction activities. The relocation sites should be isolated with a low (2–3 foot [0.6–0.9 m]) chain link or post and beam fence lined with filter fabric fencing, in order to provide monitors visual access to the site while providing an isolated environment for the turtles during construction. Any fence material should be buried 6 inches to 1 foot (152–304 mm) underground to reduce the potential for turtles to dig out of the enclosure. Monitors would routinely check the population for signs of escape from the enclosure. If escape becomes routine or problematic, it is recommended that DFG be contacted and the enclosure modified.

4. While the timing of activities is intended to avoid recovery of eggs, it is possible that eggs may be found. In the event that eggs are recovered, DFG has recommended captive incubation and rearing for 10–14 days (or until the yolk is reabsorbed) before placing the turtles into the enclosure. Basic information for incubation follows.

   Incubation period varies with latitude, but is typically 80–126 days (Goodman 1997; Holland, 1994). Lardie (1975) and Feldman (1982) incubated eggs at 77–91° F (25–33° C) and determined an incubation period of 73–81 days. Hatchlings did not leave the egg if the temperature exceeded 81° F (27° C), but they emerged within 2–3 hours after moving the egg to a cooler environment (Feldman 1982). Environmental sex determination occurs in pond turtles. At low incubation temperatures, males are produced, and females are produced at high temperatures. Ewert et al. (1994) found the pivotal temperature to be approximately 86°F.

5. Monitor for turtle presence during remediation activities. Remediation activities would require the isolation and dewatering of the channels. The ARC wildlife biologist would be on-site throughout dewatering to monitor for turtles potentially missed during the initial capture stage. During soil removal, it is highly recommended that all construction personnel be aware of possible turtle presence and be able to recognize turtles if encountered during construction. Work is anticipated to last 6–8 weeks for each of the two phases of remediation. If either phase is found to require more time, it is recommended the phasing be adjusted to ensure that turtles are relocated for no more than 8 weeks.

   If turtles and/or eggs are encountered during construction, construction would halt immediately and the ARC wildlife biologist would be notified. In the event that turtles are encountered during construction, the ARC biologist would relocate the turtles to the relocation holding site. If eggs were encountered, the eggs would be retrieved and reared in an incubator at NASA Ames.

6. Restore the habitat after remediation. After the removal of contaminated sediments is completed, a clean, organic source of sediment would be used to backfill the site back to the original grade. Minor modification can be made the channel grades in order to promote turtle habitat and to help promote flood conveyance while allowing the growth of vegetation. If a non-permeable layer is needed to line the excavation area, is recommended that natural clays be used. Man-made, impermeable liners are highly discouraged. Revegetation of the site with native wetland vegetation is recommended. At a minimum, all areas of existing vegetation should be replaced after remediation and it is recommended that vegetation be managed along the channel banks to promote turtle habitat (See *Guidelines for Vegetation Management within the Riparian Zone*).

Temporary Protection for Western Pond Turtle During On-Site Clean-Up and Construction Activities

If any additional construction and/or clean-up activities are proposed within 500 m of the population, the following measures should be undertaken in the order indicated.

1. Avoidance

Avoidance of possible impact should be the first priority. This would involve relocation of proposed facilities and/or activities to outside of 1,650 ft (500 m) of the existing population, if possible. It is likely, given the existing developed nature of the site, that this would not always be possible. Any land use alteration that replaces the existing recreational use of the site with a more developed use of the site should be discouraged.

2. Construction Monitoring

If any additional construction activities are approved for the site, a wildlife biologist familiar with the site and the species should be present at the initiation of any activity to clearly define and flag the current extent of the population. Consultation with a DFG herpetologist at least 90 days prior to the initiation of construction is highly recommended. The monitor should be on-site whenever any construction takes place within 165 ft (50 m) of the delineated population. Construction within 330 ft (100 m) of a confirmed breeding nest would be strictly prohibited during the breeding and nesting seasons (April through August).

3. Relocation

Relocation should only be considered if it is impossible to protect the population during other potential construction and/or clean-up activities (as is the case with Site 27). If activities are approved that would temporarily or permanently displace and/or stress the population, the population should be relocated to an area of equal or greater habitat value. DFG should be consulted during the planning of any proposed relocation of the population. Relocation would be strictly prohibited during the breeding season, unless it can be confirmed by a DFG herpetologist that the entire population is not breeding during that season.

See *Specific Plan Recommendations for Turtle Protection During Remediation of Site 27*, above, for relocation recommendations.

Guidelines for Vegetation Management within the Riparian Zone

While *Clemmys marmorata* shows strong fidelity to the aquatic environment, turtles do move into upland habitats for breeding and overwintering. Because this mobility brings increased exposure to possible threats, the maximum amount of protection possible should be provided for the turtles, especially given the close proximity of developed land to the site. It is recommended that the entire Marriage Road Ditch corridor, from the shoulder of Marriage Road to 1 foot (0.3 m) from the fence line of the golf course maintenance yard, should not be landscaped or mowed to avoid physically damaging individuals or their habitat, or sprayed with herbicides to avoid potential of bioaccumulation of this potentially harmful substance.

Additional maintenance should be undertaken to remove invasive and exotic species from the corridor while maintaining the protection and shading of the Marriage Road Ditch. Gradual removal of invasive vegetation and the planting of native vegetation would be beneficial to the success of the population. Shrub growth should be promoted in lieu of dense grasses on channel banks. Wetland vegetation in ponded areas should not be removed, unless the material consists of non-native invasive plants. Non-native material should be removed and replaced with native material. Revegetation should be done in consultation with the ARC biologists and DFG.

Goats have been used for natural vegetation management at the site in the past. It is recommended that this practice be halted in the vicinity of the turtle population. Because much of the early turtle life history occurs underground, the potential for trampling and/of crushing of eggs and young of year would increase with livestock on site.

All upland areas in the project area consist of the Moffett Field Golf Course and the maintenance yard adjacent to the Marriage Road ditch. While a more natural area of upland habitat is preferred, there is little natural buffer around the golf

course that could be protected. Additionally, the closest areas to the primary sites of turtles consist primarily of asphalt and graded gravel. In the future and as part of the reclamation project, it is recommended that options for increasing upland habitat around Marriage Road be explored in conjunction with the other environmental analyses.

Habitat Preservation and Enhancement

Habitat management for western pond turtles must include both upland areas and aquatic habitat.

Open vegetation should be maintained in upland areas to allow high sun exposure for adequate incubation of underground nests.

Extensive shallow water areas with a mixture of submergent and emergent aquatic vegetation contribute to ideal habitat conditions for western pond turtles. Aquatic habitat should include logs or other emergent platforms for basking. Newly created or restored pond turtle habitats should offer both stagnant and flowing water habitats along with a mixture of emergent and submergent vegetation. These transitional habitats, interspersed with basking structures, will provide the entire range of habitat conditions that turtles utilize and will consequently allow more opportunities for the population to remain robust.

It is highly recommended that ARC staff consult with DFG before modifying the pond turtle habitat. Given that *Clemmys marmorata* has adapted to free flowing and standing aquatic environments, alterations to the existing flow structure should be carefully analyzed before being implemented.

Basking Structures

The installation of woody debris to serve as basking structures is strongly recommended at the Marriage Road Ditch, the Northern Channel, and all of the golf course ponds. All such structures should be properly sized for each channel to provide appropriate habitat and to maintain flood flow capacity. No more than three pieces of woody debris should be placed for each 165 ft (50 m) of channel or in each individual pond in order to maintain habitat heterogeneity. It is recommended that all installed woody debris include the rootwad and be properly secured to the bank to protect downstream structures.

Non-Native Predator Removal/Protection

Site-specific control should be implemented to include (1) fencing the nesting area to inhibit movements of predators, (2) protecting nesting habitats with predator-excluding wire covering, and (3) trapping non-native predatory mammals.

Research and Monitoring Recommendations

Mark and Recapture Studies

Given the strong site fidelity of the population, mark and recapture studies are strongly recommended and could provide easily accessible information on the population. After the initial marking of the individual, photographic monitoring of the individual would be possible between more intensive monitoring of the population (such as tagging and measuring, which require handling of individuals). If at all possible, any marking should occur during the proposed remediation of Navy Site 27 to minimize distress to the turtle population. This strategy would facilitate annual photographic census numbers for the population that could be submitted to DFG.

Radio Tagging

If undertaken, radio tagging should be used sparingly to avoid stress on the population. Radio tagging should be considered for females in the population during the spring and summer to monitor the potential breeding activity among the population.

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Personal Communications

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Acronyms

Citations

Figures