Appendix A

California Red-Legged Frog Habitat Assessment

California Red-Legged Frog Habitat Assessment of the University of California, Santa Cruz Lower Campus

Prepared for:

Campus and Community Planning Department
University of California, Santa Cruz
515 Swift Street
Santa Cruz, CA 95060
Contact: Dean Fitch
831/460-3574

Prepared by:

Jones & Stokes
2841 Junction Avenue, Suite 113
San Jose, CA 95134
Contact: Shannon Bane
408/434-1563

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Figures and Tables

Jones & Stokes. 2002. California red-legged frog habitat assessment of the University of California, Santa Cruz, Lower Campus. October. (J&S 01-557.) San Jose, CA. Prepared for UCSC Campus and Community Planning Department Santa Cruz, CA.

Executive Summary

California Red-Legged Frog Habitat Assessment of the University of California, Santa Cruz, Lower Campus

Introduction

Jones & Stokes biologists conducted a habitat assessment on December 5 and 14, 2001, to determine the suitability of Lower Campus of the University of California, Santa Cruz, for the California red-legged frog (CRLF) (see discussion of "Study Area" below). This report presents the results of that assessment and summarizes all existing data on CRLF occurrences and sightings in Lower Campus. We also assessed the potential for sites proposed for future development to support CRLF, including Inclusion Area D, the sites of the proposed Emergency Response Center, and the site of the proposed Early Education and Child Care Center. The information presented in this report is intended to build upon a previous CRLF site assessment (draft) prepared by Ecosystems West in 2000.

Summary of California Red-Legged Frog Use and Potential Habitat in Lower Campus

The conclusions of this report are summarized as follows.

- The Arboretum pond is the only known breeding pond for CRLF on campus. CRLF observed on campus most likely disperse from this location.
- All CRLF sightings are associated with the Moore Creek drainage; sightings have occurred at the Arboretum pond, Moore Creek, and the student project ponds adjacent to Moore Creek (near Oakes College).
- CRLF are known to use the mist houses and other sheltered, moist areas in the Arboretum for upland refuge.

- CRLF likely use upland habitat in the vicinity of the Arboretum pond for dispersal during the rainy season.
- The most likely movement routes from the Arboretum pond are north along the Moore Creek tributaries (on campus) and southwest between Moore Creek and Cave Gulch/Wilder Creek or Lower Moore Creek (off campus).
- CRLF may occasionally use the Farm as upland habitat. There is no suitable breeding habitat east of the Farm, so this area does not function as a movement route.
- There is no evidence that CRLF currently use Inclusion Area D, although they may use it infrequently as an aestivation site. There is no breeding habitat on Inclusion Area D, and aestivation habitat is marginal. Inclusion Area D does not function as a dispersal route because there are barriers and hazards to dispersal to the west and south of the site. It is effectively a dead-end for frogs that may find their way into the area from the Arboretum pond approximately 1,500 feet away.
- Two of the 3 proposed sites for the Emergency Response Center (ERC) do not provide suitable habitat for CRLF. Debris piles on the LPG site may provide occasional refuge sites for dispersing CRLF.
- The proposed site for the Early Education and Care Center (EECC) does not provide suitable habitat for CRLF. Upland habitat on the site is relatively far from known occurrences of CRLF at the Arboretum pond. In addition, the proposed project site is separated from the pond by the busy Heller Drive.

California Red-Legged Frog Habitat Assessment of the University of California, Santa Cruz, Lower Campus

Introduction

This report evaluates the suitability of University of California, Santa Cruz (UCSC) Lower Campus for the California red-legged frog (CRLF). Lower Campus is located in the southern portion of the UCSC campus, and for the purposes of this report, includes portions of Central Campus near McHenry Library and Clark-Kerr Hall.

The purposes of this report are to:

- build upon a previous CRLF site assessment prepared for UCSC by Ecosystems West (2000),
- refine the current understanding of CRLF habitat suitability and potential utilization in Lower Campus,
- assess the potential for CRLF to occur on specific sites in Lower Campus planned for development, and
- facilitate review by the U.S. Fish and Wildlife Service (USFWS) of projects in Lower Campus.

This report comprises the following.

- background discussion, including a description of the study area, results of previous CRLF studies on campus, and a description of the proposed projects in Lower Campus
- description of the environmental setting of Lower Campus relevant to CLRF
- description of the methods used for this habitat assessment
- results of this habitat assessment
- conclusions
- list of references used in this report
- summary of CRLF ecology (Appendix A)

Study Area

The City of Santa Cruz is located at the northern limit of Monterey Bay, approximately 75 miles south of the City of San Francisco and 50 miles north of the City of Monterey (Figure 1). The UCSC campus is located approximately 2 miles north of the City of Santa Cruz, and covers approximately 2,000 acres (University of California, Santa Cruz 1988). The campus is bordered by urbanization to the south, and city and state parks (Pogonip City Park, Henry Cowell Redwoods State Park, and Wilder Ranch State Park) and other rural residential areas to the east, west, and north (University of California, Santa Cruz 1988). The campus can be split into 3 geographic areas: the undeveloped North Campus; the Central Campus, which houses the 10 colleges, academic and support buildings, and infrastructure; and the Lower Campus, which contains a low density of administration and other support buildings, the bulk of the campus historic features, the Farm and Arboretum, and extensive open space.

This habitat assessment focuses on approximately 430 acres in Lower Campus and the southern portion of Central Campus considered by a previous consultant to have the highest potential for CRLF to occur on Campus (Study Area, Figure 2) (see "Comparison with Previous CRLF Habitat Assessments" below for further discussion of this report). Although the Study Area covers both the Lower Campus and a small portion of the Central Campus, for the purposes of this report, the general location of the Study Area will be referred to as "Lower Campus".

Environmental Setting

The natural history of the UCSC campus has been described previously (e.g., Black et al. 1983, Warrick 1992). In general, the campus is dominated by evergreen forest and grassland. Evergreen forests are dominated by redwood (*Sequoia sempervirens*), California bay (*Umbellularia californica*), and madrone (*Arbutus menziesii*). Grasslands are dominated by rattlesnake grass (*Briza maxima*), wild oat (*Avena barbata*), and rat-tail fescue (*Vulpia myuros*). The Central Campus is densely forested, while the North Campus and Lower Campus areas contain a mixture of forest and meadows. Chaparral is also present in North Campus, and is dominated by heartleaf manzanita (*Arctostaphylos andersonii*), brittleleaf manzanita (*Arctorstaphylos tomentosa* ssp. *crinita*), and wartleaf ceanothus (*Ceanothus papillosus*). In Lower Campus, forest habitats are restricted to drainages, while meadow habitats occupy the ridges and gentle slopes.

The meadows in Lower Campus are extensive. East of Hagar Drive, the meadow is grazed by cattle and the grasses are short. The majority of the meadow is dominated by non-native grass species common to most grasslands on site (see above). However, native bunch grasses such as purple needlegrass (*Nassella pulchra*) and California oatgrass (*Danthonia californica*) are also able to persist

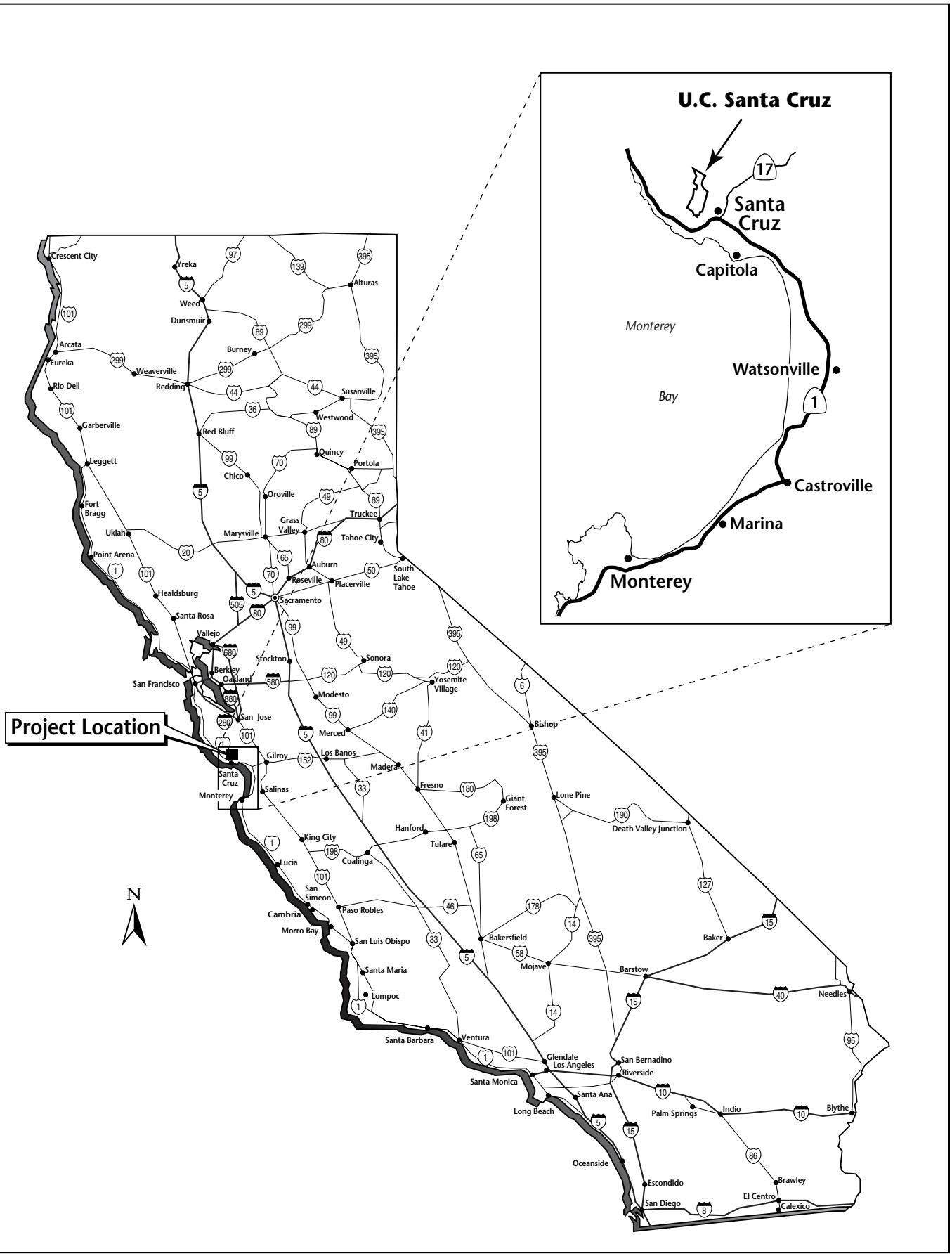

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Figure 1
Regional Location

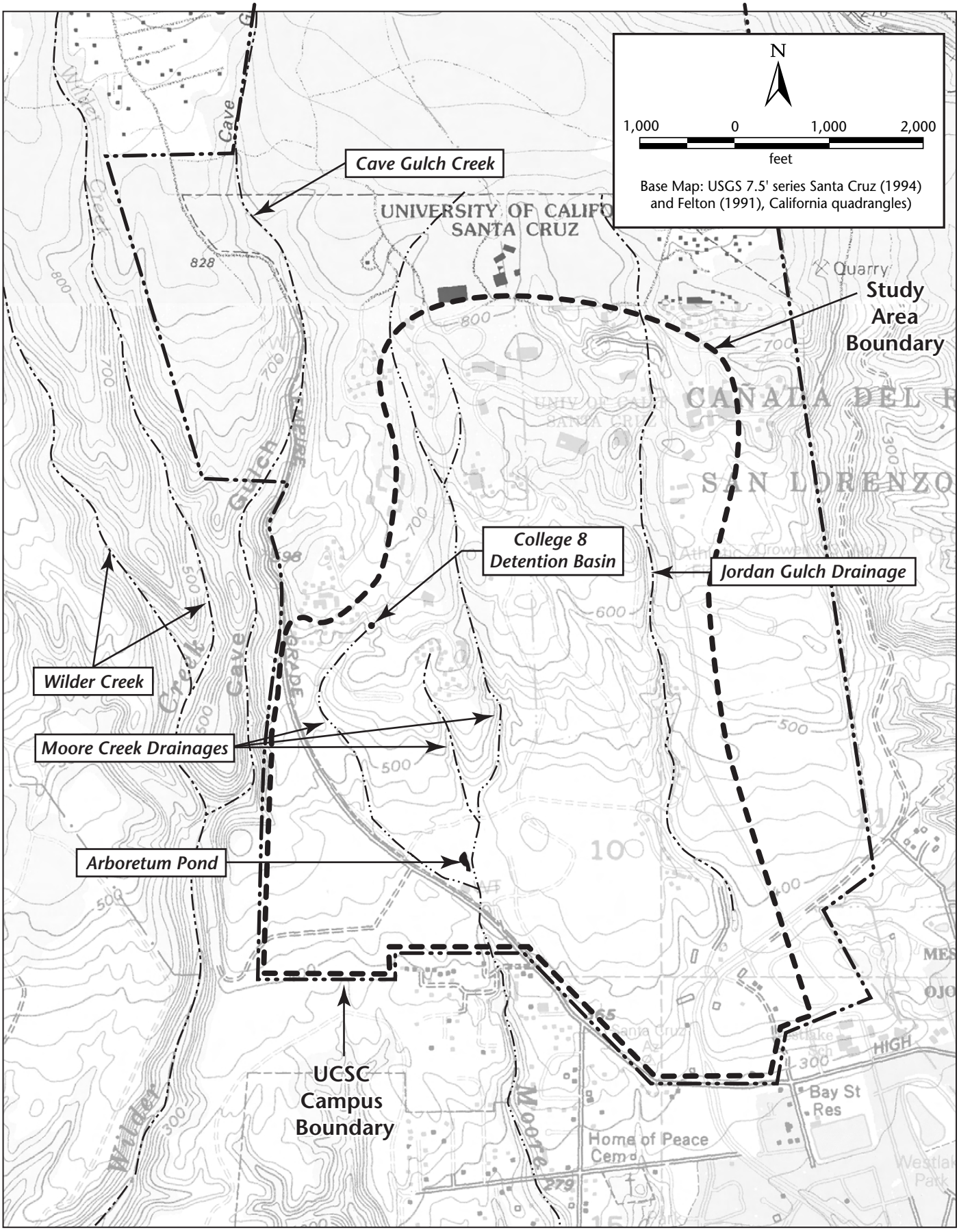

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Figure 2
Study Area

in this area. The low height of the vegetation facilitates the use of this area by many species of wildlife such as California ground squirrel (*Spermophilus beecheyi*), golden eagle (*Aquila chrysaetos*), American kestrel (*Falco sparverius*), coyote (*Canis latrans*), bobcat (*Lynx rufus*) and others. Because of the short vegetation and presence of ground squirrel burrows, burrowing owls have also been seen in this area in the past (1987) (California Department of Fish and Game 2001).

In recent years, the grasslands to the west of Hagar Drive have not been grazed. Without grazing this area has become dominated by tall non-native annual grasses and herbs such as rattlesnake grass, wild oat, and Italian thistle (*Carduus pynchnocephalus*). Tall and dense vegetation provides less value to wildlife than the short-grass areas that are grazed.

Forested areas in Lower Campus are associated with the steeper slopes and riparian corridors in drainages. The structure and composition of these riparian areas indicates that they are old, well established second-growth stands. The overstory of the forests in Lower Campus is dominated by redwood and California bay trees. In more flat, transitional riparian areas within the Great Meadow, such as the confluence of the branches of Moore Creek, the riparian overstory is dominated by willows.

Two major drainages drain Lower Campus: Moore Creek and Jordan Gulch. Moore Creek is an ephemeral creek that drains the western portion of Lower Campus. Redwood forest is found in the upper reaches of the creek. Further downstream, plunge pools are found in the section of lower Moore Creek near College Eight and Oakes College. This indicates that this portion of the drainage remains wet or ponded throughout the year, even when other reaches have dried. Near Oakes athletic field, willow scrub and grassland dominate the riparian corridor. From there, Moore Creek flows into the Arboretum pond, a seasonal, man-made reservoir known to support a breeding population of CRLF (see discussion of Arboretum in "Potential for CRLF to Occur on Lower Campus" below). From the Arboretum pond, Moore Creek runs parallel to Western Drive and eventually empties into Antonelli Pond and then the Pacific Ocean at Natural Bridges State Park, approximately 2 miles from campus. Moore Creek does not retain all of the runoff it receives. Several sinkholes within Moore Creek capture some of the surface flows and transmit them to the subsurface karst aquifer below campus.

Jordan Gulch is an ephemeral creek that drains much of the central portion of the campus, flowing first through redwood, then California bay-dominated forest. This drainage has been highly modified, especially through the Lower Quarry area where the bed and bank were destroyed by quarrying activities and water traveled downstream through the quarry by sheet flow. A channel has recently been re-established through this area with construction of the Village, a housing facility located within the old Lower Quarry. At the downstream end of Jordan Gulch near the Farm, the bed and bank of the creek disappear, and the structure and function of the drainage is that of a swale rather than a creek. Virtually all of

the flows within the lower portions of Jordan Gulch on campus are transmitted to the karst aquifer by sinkholes.

Proposed Projects

Several development projects proposed in Lower Campus were evaluated in this report for their suitability for CRLF: Inclusion Area D, the ERC, the EECC, and relocated Farm plots.

Inclusion Area D

Inclusion Area D encompasses 28 acres at the south edge of campus (see Figure 3). Of this, 13 acres in the northern portion of the site are proposed for an approximately 90-unit faculty housing development. The grounds will be fully landscaped. An on-site loop road will be constructed and connected to an existing gravel road in order to provide access between Hagar Drive and the residences. Emergency access will be provided to the north of the proposed development via improvements to an existing gravel fire road that will connect with Hagar Drive.

Emergency Response Center

The proposed ERC would occupy 2 separate locations in Lower Campus: a communication/dispatch center site and an equipment storage site (see Figure 3).

The site proposed for the communication/dispatch center would be located in the historic core of the campus, adjacent to and just south of Barn G. It would encompass approximately 0.3 acres.

The proposed equipment storage site would provide storage for equipment associated with the ERC. It would encompass approximately 0.2 acres and could be located in either of 2 proposed locations. One of the proposed locations is on a paved pad southeast of the Arboretum and adjacent to Empire Grade. The site previously housed liquid propane gas tanks (it is still known as the “LPG site”) and is now occasionally used to store debris and equipment. The other potential site is in the equipment barn adjacent to the historic blacksmith shop, which is located northeast of the intersection of Bay Street and High Street.

Early Education and Care Center

The EECC facility will comprise a building and accompanying play yards on approximately 0.08 acres adjacent to the family-student housing area, between the playing field, existing buildings, and Empire Grade (see Figure 3).

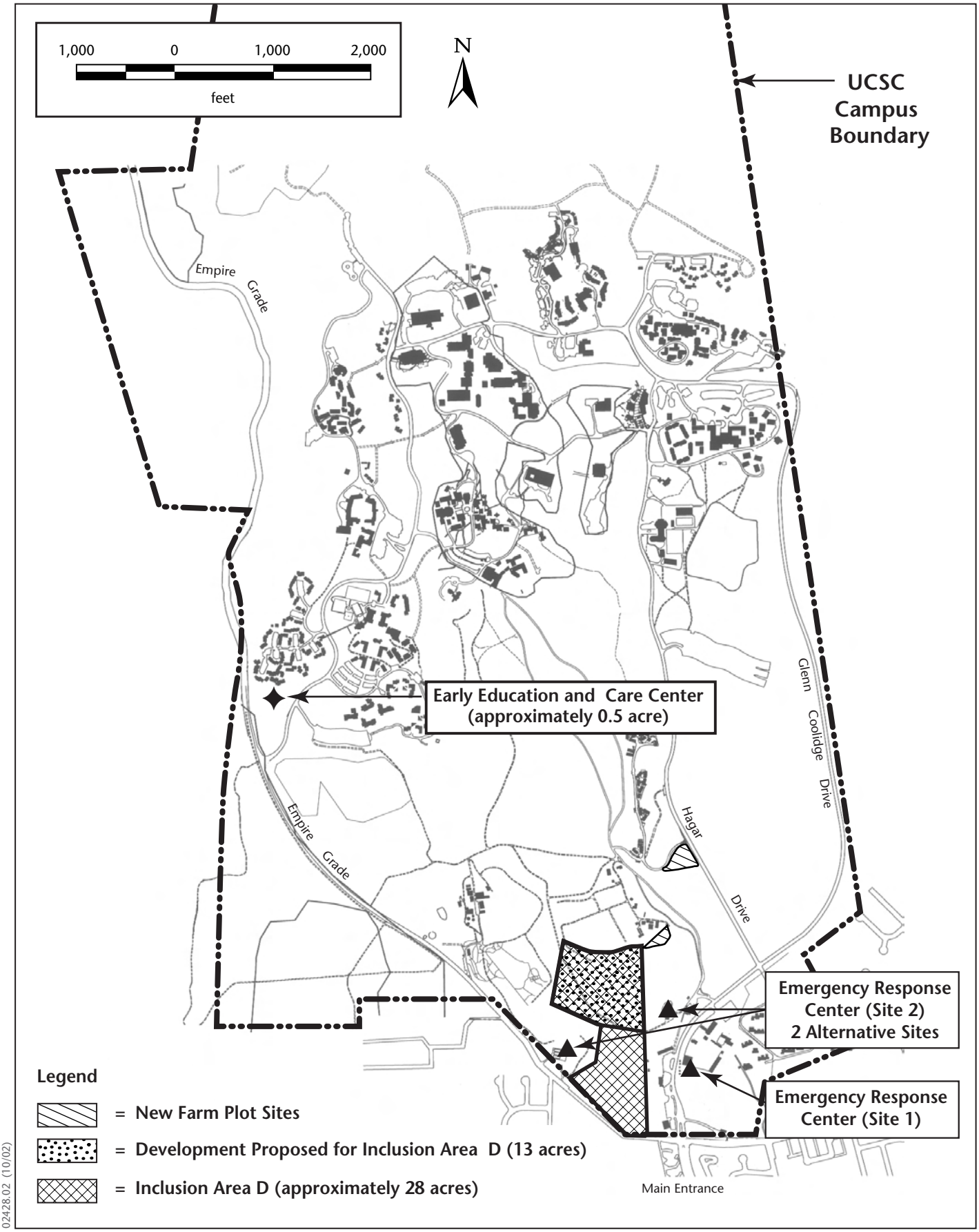

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Figure 3
Proposed Projects on the UCSC Campus

Relocated Farm Plots

The UCSC Farm occupies approximately 25 acres between the Arboretum and Jordan Gulch in cultivated fields, gardens, temporary trailers, and other out-buildings. Of this, 4.3 acres of cultivated fields occur within the boundaries of the proposed development in Inclusion Area D. These fields would be replaced at one or both of 2 locations: a 2.5-acre site adjacent to the Farm's southern boundary, or a 2.9-acre site adjacent to Hagar Drive along the Farm's eastern boundary.

Methods

Background Research

Jones & Stokes biologists Steven Avery and Shannon Bane reviewed existing literature on the natural history of the site, location of aquatic habitats, and CRLF records on and near campus (University of California, Santa Cruz 1988; Ecosystems West Consulting Group 2000; Environmental Assessment Group 2000, 2001; Nolan Associates 2000). Jones & Stokes biologists also consulted the California Natural Diversity Database (CNDDB) for additional records of CRLF (California Department of Fish and Game 2001). UCSC supplied aerial photographs and topographic maps to document existing conditions.

Background information was also collected through phone and in-person interviews with local biologists, university employees, and residents who have claimed to have seen or may have seen CRLF on campus (Table 1). The information collected during these interviews was used to identify new credible records of CRLF and verify the reliability of the known occurrences and existing data regarding CRLF on campus.

Table 1. Local Biologists and University Employees Interviewed

Name	Affiliation	Contact Date
Mark Allaback	Herpetologist at Biosearch Wildlife Surveys	February 6 and 11, 2002
Christof Bernau	Former Greenhouse Manager at UCSC Farm	February 8, 2002
Ray Collette	Professor of Natural Science and Past Arboretum Director	January 17, 2002
Margaret Fusari	Director of Campus Natural Reserves	February 11, 2002
Dan Harder	Arboretum Director	January 28, 2002
Jim Leap	Farm Operations Manager	January 31, 2002
Dawn Reis	Herpetologist at Ecosystems West Consulting Group	February 11, 2002

Field Methods

Jones & Stokes biologists Steven Avery and Shannon Bane conducted the habitat assessment in the field on December 5 and 14, 2001, to examine aquatic and upland habitats in the study area for suitability for CRLF. The assessment

focused on all potential aquatic habitat, upland habitat, movement routes, and barriers or hazards to movement. All sites known or suspected to support CRLF were visited and assessed in detail. All areas were surveyed on foot. Data were recorded in notebooks, on aerial photographs, and on topographic maps of the site. Colleen Sculley from USFWS approved the methodology prior to beginning the work.

The suitability of aquatic features for CRLF was determined based on site conditions such as water quality, depth of ponding, duration of ponding, presence of exotic fish or bullfrogs, and proximity to known occurrences. The hydrology of sites without visible water was determined based on clues such as vegetation, soil moisture, debris location, high-water marks, the presence of dried algae, and other features. All aquatic sites were evaluated as to whether they could support CRLF breeding, foraging, or resting (temporary use).

The suitability of upland habitat for use by CRLF was based on vegetation, topography, distance from known occurrences, the presence of small mammal burrows, soil cracks, debris piles, or other features that could provide aestivation habitat or temporary refuge for CRLF. Potential movement routes on campus were determined based on the locations of known breeding sites, suitable aquatic sites, suitable upland habitat, and the presence of barriers or hazards to CRLF dispersal. Barriers to dispersal are defined as features that would prevent or seriously deter CRLF from crossing the feature. Examples of barriers include buildings, dense development, vertical or near-vertical cliffs, and solid fences greater than 4 feet tall. Hazards to dispersal are defined as features that present a risk of injury or mortality to CRLF. Hazards to dispersal include active roads or low-density development. All potential barriers or hazards were recorded on the topographic map in the field.

Potential movement routes of CLRF to and from campus were assessed based on the known locations of breeding and non-breeding populations and habitats off-site and the suitability of upland habitat in between.

Key aquatic sites identified by this assessment were monitored every 2 weeks from mid-February to July, 2002, to determine the approximate length of ponding and their overall suitability for CRLF.

Study Limitations

The assessment of aquatic and upland habitats were based on the conditions during the field surveys, which may or may not be typical. Rainfall for 2002 was slightly less than normal, although most likely not different enough to cause substantial changes in CRLF aquatic or upland habitat. Determining potential movement routes of CRLF was limited by the lack of data on this species on campus. To date, no studies on CRLF movements or population dynamics have been conducted on campus. Potential movement routes were determined based

on habitat conditions, landscape features, and professional experience and judgment.

Results

Known Occurrences on Campus

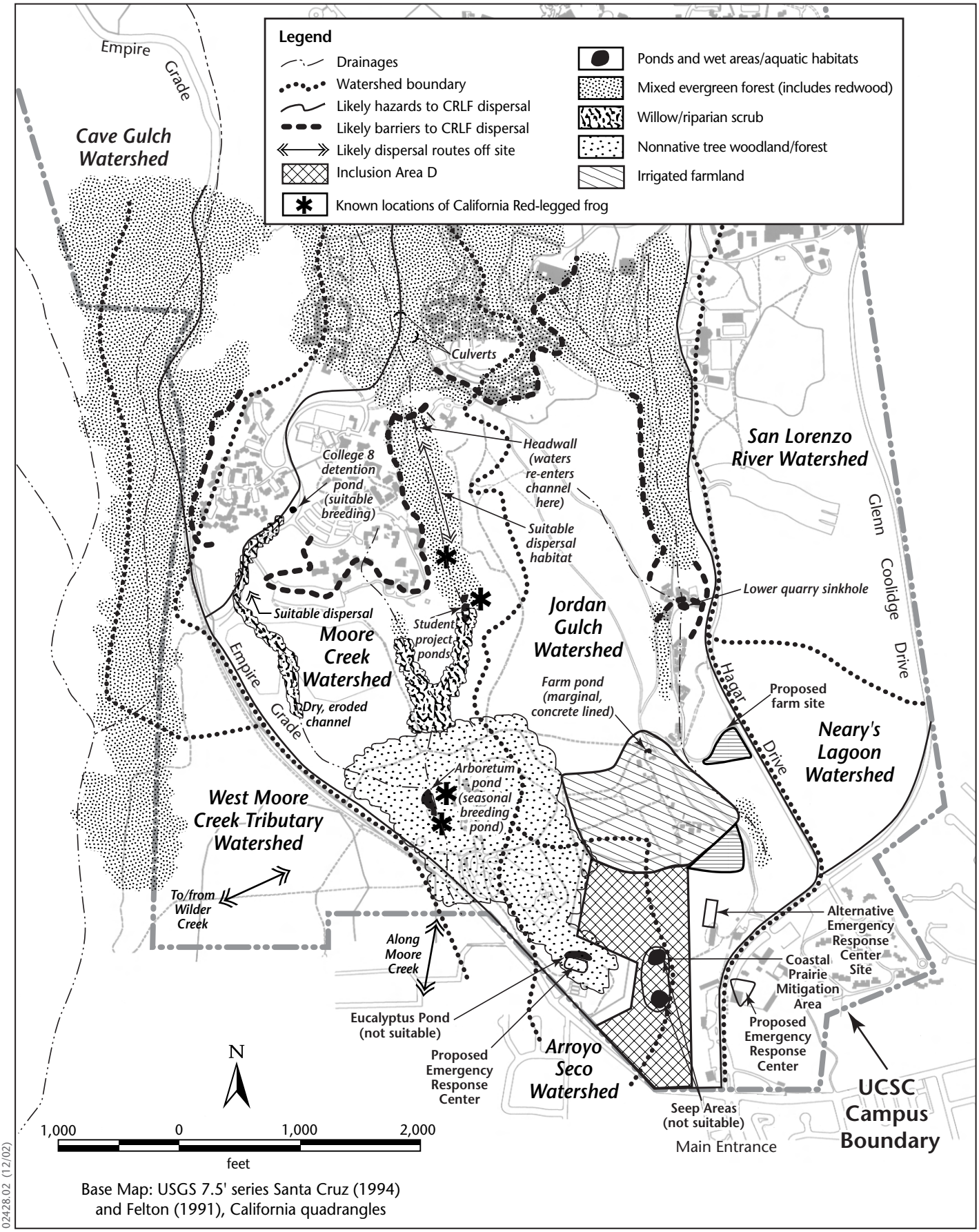
We confirmed that the only known locations of CRLF on campus are associated with the Moore Creek drainage in Lower Campus. No additional credible records were identified for Lower Campus, either through interviews or in published accounts. Confirmed known locations are shown in Figure 4, and include (Ecosystems West Consulting Group 2000):

- the extant breeding population at the Arboretum pond and adult frogs found adjacent to the Arboretum mist house;
- adult and sub-adult frog(s) observed between Empire Grade and the Arboretum pond (in east Moore Creek);
- adult frogs observed in student project ponds, adjacent to Moore Creek just east of Oakes Field; and
- adult frogs observed along the upper east fork of Moore Creek, adjacent to Oakes College.

Potential for California Red-Legged Frog to Occur on Lower Campus

The breeding population at the Arboretum pond serves as the source of CRLF for the Lower Campus, therefore the likelihood of occurrence of CRLF in other areas is related, in part, to the distance from the Arboretum pond. For instance, as CRLF disperse from the Arboretum pond in the Fall to seek out refuge or aestivation sites, the chances of encountering a frog are highest in areas near the pond, such as the upland areas adjacent to the pond or the Arboretum mist houses or greenhouses. The likelihood of encountering a frog decreases as the distance from the Arboretum pond increases.

Other factors that influence the likelihood of frog use are hazards or barriers to dispersal. For instance, areas in the eastern portion of Lower Campus (i.e., east of Hagar Drive), most likely do not support any CRLF because of their distance from the Arboretum pond and the presence of hazards and/or barriers to frog movement such as roads and near-vertical cliffs in Jordan Gulch. Other important barriers and hazards to frogs dispersing from the Arboretum pond that we identified in Lower Campus are discussed in the section below on movement routes on campus.



Base Map: USGS 7.5' series Santa Cruz (1994) and Felton (1991), California quadrangles

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Figure 4
General Vegetation and California Red-Legged Frog Habitat Suitability, Lower Campus, UCSC

The chance of encountering frogs dispersing widely from the Arboretum pond also depends on the size of this population. The population size of CRLF at the Arboretum pond is unknown. However, based on anecdotal observations, it is thought to number in the tens or hundreds of individuals, and is considered a moderate-sized population (Mark Allaback, pers. comm.).

Potential movement routes along moist drainages are more likely to support CRLF than dry upland areas. Although CRLF are known to move large distances over upland habitat, the water provided by the streams and moist areas in these riparian corridors increases the likelihood that frogs would move through or be active in those areas. This is because wet areas provide higher quality habitat than upland areas. The only likely movement routes in streams and moist areas we identified in Lower Campus were the east branch of Moore Creek north of the Arboretum pond and Moore Creek south of the Arboretum pond (see discussion below on potential movement routes on campus).

The quality of upland areas also affects the likelihood of encountering frogs. For instance, areas that have high densities of rodent burrows or large cracks in the ground that may be used by CRLF for aestivation are more likely to support frogs than areas that have very dense weedy vegetation and low densities of rodent burrows or large soil cracks. These types of features are common in the northern and eastern areas of the meadows in lower campus.

Jordan Gulch

Jordan Gulch is an ephemeral drainage that drains much of the middle portion of campus. The portions of the drainage near McHenry Library and the Hahn Student Services building are located in redwood forest habitat. Further downstream, near the East Field House, the redwood canopy becomes interspersed with California bay trees. Through these reaches of Jordan Gulch, the banks are very steep, and the bed and bank substrate are rocky and capable of forming pools when water is flowing.

The portion of Jordan Gulch from the McHenry Library and Hahn Student Services buildings to the Lower Quarry could potentially provide non-breeding or dispersal habitat for CRLF. The drainage has a well-defined bed and bank, with rocky substrate capable of forming pools for short periods of time. In addition, the densely wooded banks could provide shade and cover for CRLF. However, no CRLF have been observed in Jordan Gulch. The steep cliffs on the west side of the drainage could pose a barrier to movement of CRLF into the gulch, and the Village housing development to the south of the drainage could pose a barrier to movement of CRLF from the south. Nevertheless, if a frog were to find its way into these reaches of Jordan Gulch, it would find a cool, moist, shaded travel corridor during the wet season.

The lower portions of Jordan Gulch, including the Lower Quarry, are unsuitable for CRLF. The creek bed has been destroyed by historic mining operations, and

the flow of water has been diverted into a sinkhole at the bottom of the old quarry. This part of the creek is adjacent to roads leading to and from the Farm from Hagar Drive, trails, and developed areas such as the Village housing development. Within and below the quarry flows from the original creek were changed into sheet flow by quarry operations. In 1999, the construction of the Village included construction of a new channel that directs surface water back to Jordan Gulch. This new channel flows adjacent to and under the road (through culverts) several times before emptying into a detention basin and draining further downstream. The highly engineered and developed nature of Jordan Gulch in this area makes it unsuitable for CRLF.

California bay trees dominate the extreme downstream end of Jordan Gulch near the historic area of the campus and the UCSC Farm. This part of the gulch lacks a defined bed and bank, and appears to function more as a swale than a creek. The bottom of the swale is vegetated with grasses and forbs and is deeply shaded. This area is unsuitable for frog breeding, but may provide potential aestivation and marginal foraging habitat along the banks in this section. Jordan Gulch marks the eastern-most edge of habitat that may be suitable for CRLF on campus. As described above, Jordan Gulch itself may be a barrier to CRLF movement. Where Jordan Gulch is not a barrier, other features such as Hagar Drive create a hazard or barrier to CRLF movement.

Moore Creek and College Eight Detention Basin

All of the known occurrences of CRLF on campus are associated with the Moore Creek drainage, so this drainage provides important habitat suitable for CRLF. The frog sightings were located along the creek between the Arboretum and the reach of Moore Creek adjacent to College Eight.

Moore Creek is divided into 3 branches, the western, middle, and eastern branch, which split at two confluences located immediately upstream of the Arboretum pond. In this area, the creek lacks a well-defined bed and bank, and the riparian corridor in this area is dominated by coyote brush (*Baccharis pilularis*) and willow (*Salix* spp.) scrub. Upstream of the confluence, the eastern branch is the largest creek, and is the closest and most easily accessible drainage for frogs dispersing from the Arboretum pond. Near Oakes Field, the eastern branch of Moore Creek transitions from willows and grassland into a grove of native buckeye trees (*Aesculus californica*), and then into redwood forest. This portion of the creek provides good non-breeding aquatic habitat for CRLF, including plunge pools and relatively slow moving water. However, the water in shaded reaches may be too cold for CRLF breeding (Margaret Fusari pers. comm.).

A series of 4 ponds constructed in the Natural Reserve in the early 1990s are located adjacent to the eastern branch of Moore Creek, approximately 1,500 feet upstream of the Arboretum pond. A piping system was also constructed to bring water from the creek into the upstream pond. The other 3 ponds are connected in sequence to the first pond by PVC pipes. Because the upper pond receives and

retains water for longer periods than the other ponds, the vegetation in this pond consists of aquatic species such as watercress (*Rorippa officinale*) and rushes (*Juncus* spp.). The second pond receives much less water, and therefore contains the dried remains of aquatic species, as well as upland species such as grasses and Himalayan blackberries (*Rubus discolor*). The third and fourth ponds seem to have been dry for quite some time, and are choked with upland species such as Italian thistle and wild oat.

CRLF were observed in these ponds in the past (Ecosystems West Consulting Group 2000, California Department of Fish and Game 2000, Margaret Fusari pers. comm.). At the time of our survey, the lower 3 ponds were dry and the upper pond contained 4–6 inches of water, providing marginal aquatic habitat for CRLF. The pipe system that conveys water from the creek to the ponds is frequently clogged, preventing water from reaching the downstream ponds. Frequent cleaning is needed to keep the pipes clear of debris.

The eastern branch of Moore Creek extends into Central Campus. Near Kresge College, the eastern branch of Moore Creek is not suitable for breeding CRLF because this area is most likely inaccessible to frogs (Ecosystems West Consulting Group 2000). Similar accessibility issues are present in the section of the drainage from Kresge College downstream to the University House. In this section, the eastern branch of Moore Creek travels for a fairly long distance underground, approximately 200 yards from the Performing Arts building to the University House. It is possible for frogs to travel over land between these points. However, several well-used trails and Meyer Drive traverse this area, all posing a substantial hazard, or possibly even a barrier, to frog movement along this section. In addition, this portion of the drainage is flanked on both sides by highly developed campus core areas, which probably hinder frog movement into or out of the drainage to the east and west. No CRLF have been found in the upper portions of this watershed. Because of the inaccessibility of these areas, it is unlikely that CRLF would be found in Moore Creek north of the reach adjacent to the student project ponds.

The middle branch of Moore Creek is very short. The headwaters of this branch originate adjacent to the Oakes athletic field, and the creek joins the eastern branch at a confluence located approximately 1,100 feet to the south. The creek bed of the middle branch of Moore Creek is not well defined in its lower reaches, and exhibits some erosional features, such as headcutting in its upper reaches. The vegetation in the drainage consists of a grove of redwoods at its headwaters, coyote bush scrub in the middle reaches, and willow stands along the lowest reaches. Although it is possible for CRLF to move into this drainage, it retains water for very short periods after rain events, and does not provide aquatic habitat that would be suitable for sustaining frogs for any length of time. The western branch of Moore Creek flows parallel to Empire Grade from the College Eight detention pond down to a confluence just upstream of the Arboretum pond. The upstream reaches of this drainage are vegetated with oaks, coyote bush, Himalayan blackberries, and other scrub species. The lower reaches flow through grasslands, and then into willow stands as the topography flattens. This

branch of Moore Creek has experienced high levels of erosion since the construction of College Eight and Oakes College in the 1970s and 1980s, and as a result, exhibits gullies up to 15-feet deep.

The College Eight detention pond is located at the upstream end of the western branch of Moore Creek. At the time of this field survey, the detention pond was full of water and contained large amounts of emergent and riparian vegetation throughout the pond such as willows, sedges (*Carex* spp.), blackberry, grasses, and coyote bush (*Baccharis pilularis*). This pond provides suitable breeding habitat for CRLF because of the pond's depth, duration of ponding, dense vegetation, proximity to the Arboretum pond, and connection via the western branch of Moore Creek. Previous surveys of the site have not detected CRLF adults or larvae in this pond (Ecosystems West Consulting Group 2000; Environmental Assessment Group 2001; Mark Allaback pers. comm.).

Arboretum

The Arboretum maintains extensive collections of Austrailian, South Pacific, South African, native Californian, and other vegetation. Trees, shrubs, and other plants are cultivated and displayed as geographic or taxonomic groups for enjoyment or study. In addition to the maintained grounds, their facilities include mist houses, greenhouses, buildings for classrooms and administration, and a gift shop.

The Arboretum contains a large pond that was formed after the construction of a dam for water storage for the Cowell ranch in the late 1800's. The pond is located in the northwest portion of the Arboretum, near Empire Grade. The Arboretum pond is the only known breeding location for CRLF on campus (California Department of Fish and Game 2000). In addition, it is 1 of 5 active breeding ponds at the north edge of Santa Cruz. The pond is approximately 75 feet in diameter and contains dense emergent and woody vegetation such as willows, cottonwoods (*Populus fremontii*), and stands of bamboo. No bullfrogs or non-native fish have been found within the pond during recent surveys (Dawn Reis and Mark Allaback pers. comm.), although bullfrogs may have occurred in the pond in the past (Ray Collette pers. comm.). The pond dries near the end of summer, likely preventing these species from becoming established. A bullfrog was recently sighted in Moore Creek near Empire Grade (Dawn Reis pers. comm.), illustrating the danger that bullfrogs could invade the pond.

Mist houses are located adjacent to the pond, and provide refuge habitat for frogs as the pond dries in late summer. Several adult CRLF have been observed under benches in the mist houses (Dean Fitch, Margaret Fusari, Mark Allaback, Dawn Reis, and Ray Collette pers. comm.).

The Arboretum pond is the only source of CRLF that could move off-campus. CRLF could move from the pond in almost any direction, but movement to the north or south is most likely because the pond is located in the Moore Creek

drainage. Upstream of the pond, the 3 branches of Moore Creek provide suitable movement and aquatic non-breeding habitat. CRLF are known to occur downstream of the pond in the Moore Creek drainage at Antonelli Pond (1.9 miles away) and at the northern boundary of the UCSC Long Marine Laboratory property (2.6 miles away). Between these locations Moore Creek runs through dense residential development. However, the dense riparian cover of the creek could provide a suitable movement route for frogs to and from the Arboretum pond.

CRLF may also move between the Arboretum pond and the Cave Gulch/Wilder Creek drainage to the west. CRLF are known to occur in these drainages, and the habitat between these drainages is highly suitable for CRLF movement. The grassland between Empire Grade and Wilder Creek supports dense seasonal wetlands. Low-intensity cattle grazing maintains the vegetation in a moderate density and cropped condition, creating an easy dispersal route for frogs over the gradual topography. The only hazard to dispersal between the Arboretum pond and Wilder Creek is traffic on Empire Grade, unless frogs were able to move through the culvert at Moore Creek.

The only other aquatic feature in the Arboretum is a small, artificial, and temporary pond at the south end of the Arboretum within a eucalyptus grove (Figure 4). The pond forms each winter as water collects behind a berm that was built around the LPG site. During our site visit on December 14, 2001, minimal water had collected in the depression. On February 9, 2002, however, the pond had increased in size to 5 feet by 20 feet, and its depth had increased to approximately 4 inches. The water in this area collects at the base of the eucalyptus trees (*Eucalyptus* spp.), and supports a low density of rushes (*Juncus* spp.). Water in the pond was dark brown, indicating a high concentration of tannins and poor water quality for amphibians. The pond had dried completely by August 19 although the soil remained moist. The small size, poor water quality, and temporary nature of this pond make it unsuitable for either breeding or rearing habitat for CRLF. No CRLF have been documented at this site. Although unlikely, frogs may use this area for short periods of time as a resting site during dispersal.

Trees, shrubs, and other vegetation planted throughout the Arboretum are watered during the late spring and summer with a drip irrigation system. It is unknown whether this irrigation system affects the habitat for CRLF. It is unlikely that CRLF would travel overland during the hot and dry late-spring and summer when the irrigation system is operating. CRLF disperse on rainy nights during the wet season (U.S. Fish and Wildlife Service 1999).

Potential Movement Routes On Campus

CRLF are not limited in the direction that they can travel from the Arboretum. However, there are routes that we consider to have a higher likelihood of frogs traveling within them. We identified potential movement routes based upon the

location of known occurrences of CRL F on campus, the location of suitable aquatic sites, habitat quality, and the absence of barriers or hazards to dispersal.

We identified three sites that contained suitable aquatic habitat in Lower Campus: the Arboretum pond, College 8 detention basin, and the student project ponds, when they are filled with water. Riparian and upland habitat between these sites and the Arboretum pond were examined for movement suitability. We identified three routes with the highest likelihood to support frogs dispersing to and from the Arboretum pond:

- Along the east branch of Moore Creek, north of the Arboretum pond
- Along Moore Creek, south of the Arboretum pond, and
- Through Inclusion Area A, west of Empire Grade.

Frogs most likely travel north from the Arboretum pond along the east branch of Moore Creek. This branch is typically wet or moist along these reaches all year, providing high quality dispersal habitat. In addition, the student project ponds and plunge pools in the reach adjacent to Oakes College provide aquatic habitat for resting or foraging.

Travel south from the Arboretum pond is also likely along Lower Moore Creek. This area is densely vegetated and although not wet all year, provides shaded and moist dispersal habitat to off-campus areas that are known to support frogs. While on-campus travel through this part of the Arboretum is relatively safe, dispersing frogs would have to safely cross Empire Grade to move to off-campus habitat.

Frogs may also travel west into the wet Mima mound area within Inclusion Area A. This potential movement route does have a hazard to dispersal: frogs must cross Empire Grade to travel between the Arboretum pond and Inclusion Area A. Frogs may use this corridor to travel between the Arboretum pond and a suitable movement route off-campus in Wilder Creek.

The presence of major hazards or barriers to frog movement indicate where frogs most likely cannot travel on campus. These features include developed areas of campus adjacent to natural habitats such as the West Remote Parking Lot, College Eight, Oakes College, and Family Student housing, which are all located to the north of the Arboretum pond. Empire Grade poses a hazard to frogs trying to move to and from the west areas of campus or watersheds off campus. Movement to the south (except down Moore Creek) is highly unlikely because it abuts the urban development of the City of Santa Cruz. Movement to the eastern areas of Lower Campus are unlikely because of Hagar Drive, steep slopes of Jordan Gulch, the Village housing development, and the absence of aquatic habitat and/or a source population in the eastern part of Lower Campus.

Potential to Occur on Project Sites

Below are discussions of the potential for CRLF to occur in specific areas of Lower Campus: Inclusion Area D, the Farm and proposed replacement Farm plots, the ERC, and the EECC. These sites were chosen for focused analysis because projects are proposed on them.

Inclusion Area D

Inclusion Area D is a 28-acre site that consists mostly of a dense cover of non-native grassland and ruderal upland habitat dominated by rattlesnake grass and wild oats. The southern half of the site, however, contains a relatively high density and diversity of native grasses and herbs such as California oat grass and purple needlegrass. Approximately 1.7-acres of the site is covered by a bare area containing large rock piles. There was no aquatic habitat on the site at the time of the survey. However, 2 wet areas approximately ¼-acre in size were observed in 1999 and 2000 in the middle of the site (Ecosystems West 2000). These sites were identified as seeps and as potential upland habitat for CRLF. During our field surveys, the soil moisture and vegetation at these sites was no different than the surrounding area. UCSC is currently monitoring groundwater at these sites with peizometers. In most years, the sites are noticeably wet for a few months after winter rains cease, retaining moist soils and supporting wetland vegetation (Reed 1988; Nolan, Zinn, and Associates 2002; Chris Aldecoa and Richard Arnold pers. comm., 2002). At the time of this survey, the sites did not provide any additional habitat value to CRLF beyond the adjacent upland areas. The wetter conditions of these sites observed in previous years would likely provide better upland habitat for CRLF, but at no time would these sites provide suitable breeding habitat for CRLF.

Inclusion Area D provides marginal upland aestivation habitat for CRLF. Small mammal burrows (probably northern pocket gopher [*Thomomys talpoides]*) occur on Inclusion Area D at a low to moderate density, providing suitable aestivation sites. However, the thick cover of thatch from the non-native grasses and lack of nearby aquatic features reduces the suitability of these burrows. Because better quality aestivation habitat is available closer to the known breeding site (i.e., the Arboretum pond), it is unlikely that CRLF are using Inclusion Area D for aestivation.

Inclusion Area D is approximately 1,500 feet from the Arboretum pond. Because CRLF have been known to disperse up to 3 miles from breeding sites (Ecosystems West 2000, Rathbun and Schneider 2001), it possible that dispersing frogs may travel through Inclusion Area D. However, this area is not along a likely dispersal corridor because it is not located between aquatic habitats. Furthermore, there are serious hazards or barriers to CRLF dispersal around Inclusion Area D. For example, the area forms the edge of urbanization that leads into the City of Santa Cruz (to the south and east of the site).

A portion of the UCSC Farm (4.3 acres) is located in the northernmost portion of Inclusion Area D. This area is planted in row crops and is irrigated through the dry summer months. It is unknown whether the irrigation attracts frogs, although it does provide some moisture during the summer. Farm activities do not present a barrier or serious hazard to frogs. However, there is no suitable aquatic habitat to the east of this area (see discussion of Jordan Gulch below). In addition, there are no verified sightings of frogs on the Farm.

In summary, there is no evidence that CRLF currently use Inclusion Area D, although they may use it infrequently. There is no breeding or foraging habitat on the site, and aestivation habitat is marginal. Inclusion Area D does not function as a movement route because of barriers and hazards to dispersal around the site. It effectively functions as a dead-end for frogs that may find their way into the area.

Farm and Farm Plots

The UCSC Farm covers approximately 25 acres and operates a year-round organic agricultural, research, and teaching facility east of the Arboretum. The Farm consists of teaching buildings, storage and other work-related buildings, and fields of row crops. The distance between the Farm and the Arboretum pond is approximately 1,100 feet. As with other upland areas that occur near the Arboretum pond, it is possible that CRLF move through the Farm on rainy nights during the wet season. There are no barriers to CRLF movement on the Farm. Agricultural operations at the farm are generally low-intensity and not mechanized, so they would not present a hazard to CRLF dispersal.

UCSC Farm personnel irrigate their fields during the summer. As with the Arboretum, it is unknown how this irrigation affects the use of the site by CRLF. It is unlikely that frogs would move 1,100 feet in upland habitat during the dry season. In addition, there are no suitable aquatic sites for CRLF between the Farm and the Arboretum pond that could serve as “stepping stones” to the Farm. Although several frogs have been reported in the Farm, there has never been a confirmed sighting of CRLF at the Farm.

On the eastern edge of the Farm there is a concrete-lined ornamental pond approximately 10 feet in diameter. This pond is fenced and contains some aquatic and emergent vegetation. Although it offers aquatic habitat for CRLF, it is unlikely that frogs would use the site because of the lack of upland cover, the small size of the pond, its close proximity to high levels of human activity, and distance from the Arboretum pond (approximately 2,000 feet).

Both of the alternative sites for the new farm plots proposed to replace the ones located on Inclusion Area D are located adjacent to the eastern boundary of the Farm. As with other portions of the Farm, it is possible for CRLF to travel through these areas during the wet season. However, during the dry season, it is even less likely for frogs to occur in these proposed farm plots because they are

even further from the Arboretum pond (approximately 2,000 feet), and because they are located to the east of the heavily used Farm classrooms, administration, and operational buildings.

Emergency Response Center

As described above, the ERC will be constructed in 2 of 3 proposed locations in the Lower Campus area: adjacent to Barn G, in an equipment storage barn northeast of the intersection of Bay and High Streets, or on the LPG site along Empire Grade (see Figure 3).

The proposed ERC sites in or near the barns do not provide suitable habitat for CRLF because they are located at the urban edge of campus and are not located along potential movement routes or near suitable aquatic habitats.

The LPG site is approximately 100-feet by 200-feet, paved, and fenced. The site is currently being used for storage of equipment and debris. The site does not provide any suitable natural habitat for CRLF. However, CRLF have been known to seek refuge in or under buildings or debris piles (U.S. Fish and Wildlife Service 2002). Although unlikely, the debris piles on the LPG site may provide temporary refuge to CRLF dispersing from the Arboretum pond approximately 2,000 feet away.

The LPG site is separated from the Arboretum by a berm approximately 10 feet high and 20 feet wide. Water has collected on the east side of the berm, forming a temporary pond in a eucalyptus grove. This pond is part of the Arboretum (i.e., not part of the LPG site) and is discussed in the "Arboretum" section above.

Early Education and Care Center

Vegetation on the proposed EECC site (located directly south of Family Student Housing) includes non-native grasses that are mowed on a regular basis and a small grove of redwood and coast live oak (*Quercus agrifolia*) trees. The site contains potential upland habitat for CRLF but no breeding habitat. The site is approximately 2,700 feet upslope from the Arboretum pond, the nearest known breeding site of CRLF, and separated from the pond by the busy Heller Drive. The site is located at the southern edge of the developed campus core, so there is no suitable CRLF frog habitat beyond the site to the north. Because of the site's distance from the Arboretum pond, separation by Heller Drive (a hazard to dispersal), and location at the edge of the developed campus core, it is highly unlikely that frogs would occur at the proposed EECC site.

Approximately 450 to 500 feet from the site and across Heller Drive is the College Eight detention pond. This pond has been identified as potential breeding habitat for CRLF. CLRF have not been detected at the pond, despite previous surveys there. Even if frogs were to use the detention pond in the

future, the suitability of the EECC site for CRLF would not change, and developing the EECC would not change the suitability of the College Eight detention ponds. To reach the EECC site, frogs using the detention pond would still face the major hazard of Heller Drive. The travel routes from the detention pond down Moore Creek or through the adjacent meadow are much more suitable because they contain fewer hazards and are more direct routes to suitable breeding sites and abundant upland aestivation sites downslope.

Known Occurrences Near Campus

The nearest observation of CRLF off-campus is approximately 0.4 mile northwest of North Campus, west of Empire Grade (Ecosystems West Consulting Group 2000). Two adult CRLF were found in a small pool below a culvert along Adams Creek, a tributary to Wilder Creek, in 1993.

All other known locations of CRLF are south and southwest of the campus at least 1 mile away. The closest locations of breeding populations of frogs are located between 1 and 1.8 miles west of UCSC at 2 agricultural ponds in Wilder Ranch State Park, at an agricultural pond near Highway 1 and the Granite Rock sand quarry, and at a pond located in the Granite Rock sand quarry.

Observations of non-breeding CRLF have been recorded between 1.3 and 2 miles from UCSC, including: Antonelli Pond, a pond at Natural Bridges State Park, Wilder Creek and Lagoon, Younger Lagoon, Old Dairy Gulch Lagoon, at the northern boundary of UCSC Long Marine Lab, and along Highway 1 between Granite Rock sand quarry and Moore Creek (roadkill).

Movement Routes Off-Campus

Records of known occurrences of CRLF near campus indicate that several populations of CRLF persist in areas west of campus. These nearby populations are associated with Lower Moore Creek, Cave Gulch, and Wilder Creek. Because of the lack of development between the watersheds and the close proximity of the creek corridors near campus, it is likely that CRLF move between these watersheds and the breeding habitat at the Arboretum pond by traveling through upland habitat in Inclusion Area A and the adjacent Campus Resource Lands. These upland areas contain mima mound and swale topography which remains wet during the winter and spring months, providing moisture for frogs moving through these areas. The movement of frogs between watersheds ensures that genetic flow is maintained between these populations, which in turn increases their likelihood of persistence in the future.

The only hazard to dispersal between the Lower Moore Creek, Cave Gulch, and Wilder Creek watersheds to the west of campus and the population at the Arboretum pond is Empire Grade. However, even with the presence of this

hazard, it is likely that some frogs are able to safely disperse using this movement corridor. Movement of frogs is not possible to the south and east of campus because of the barriers formed by highly developed urban areas adjacent to campus, and because of the lack of aquatic habitat in those areas. In addition, there are no known locations of CRLF to the south or east of campus for many miles.

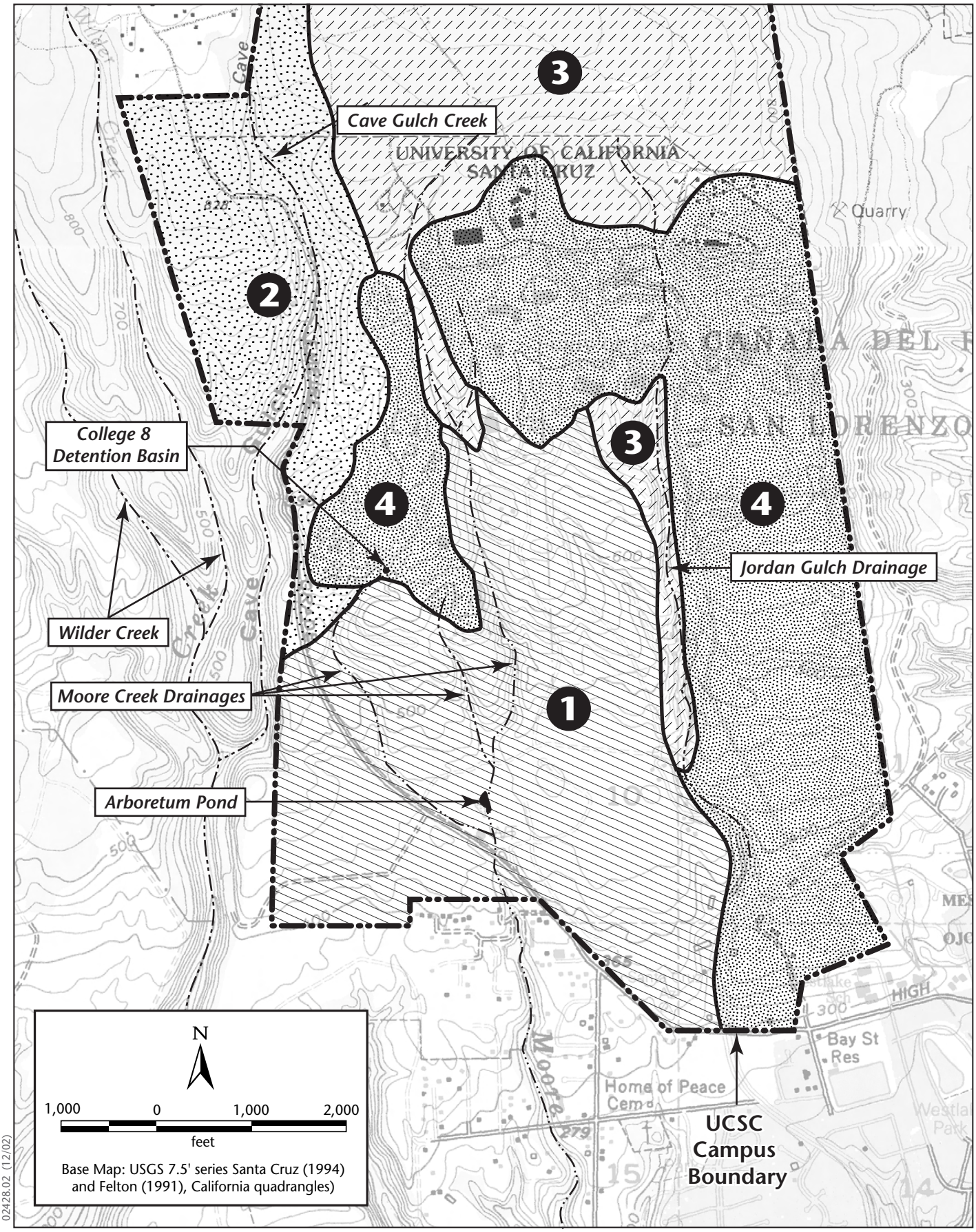
Comparison with Previous California Red-Legged Frog Habitat Assessments

Habitat for CRLF was assessed on campus as early as 1988 in conjunction with the Long-Range Development Plan (University of California, Santa Cruz 1988). However, since CRLF were not listed at that time, the riparian habitat was described in terms of general amphibian use. Surveys and assessments for CRLF have also been conducted for specific projects (e.g., Environmental Assessment Group 2000). The next campus-wide assessment of CRLF habitat was done in 2000 (Ecosystems West Consulting Group 2000). This study divided the campus into 4 zones, based upon the likelihood of CRLF to occur. Zone 1 had the highest potential for frog occurrence; Zone 4 had the lowest potential. Large areas of campus designated as Zones 3 or 4 were considered to have no or very low potential for CRLF habitat. No definitions of the zones were provided in the report, which has caused some confusion. We developed the following definitions based upon a review of the report and discussions with Ecosystems West Consulting Group Staff (Dawn Reis, pers. comm.).

- Zone 1: Areas of known or suitable breeding habitat and suitable upland habitat with no substantial barriers or hazards to dispersal.
- Zone 2: Potential area for transient or dispersing CRLF due to the presence of aquatic habitat and the location along dispersal corridor between known occurrences.
- Zone 3: Areas where aquatic sites are present but CRLF are unlikely to occur due to the distance from known breeding sites, partial barriers or hazards to dispersal, or lack of dispersal corridors.
- Zone 4: Areas where CRLF are least likely to occur due to the lack of any aquatic habitat and the existence of substantial barriers or hazards to dispersal.

Changes to Zone 1 in Lower Campus

The results of our survey were used to refine the boundary of the area designated as most suitable for CRLF (Zone 1) and surveyed during this habitat assessment (see Study Area, Figure 2). Boundary changes were made along the eastern, northern, and southern boundaries of Zone 1 (Figure 5). Boundary lines were not changed in areas north of the Study Area, but are included in Figure 5 for



Jones & Stokes

Figure 5
Revised Zones of Likelihood of Occurrence of California Red-Legged Frogs

reference and continuity. Highly developed areas of the campus core were changed to Zone 4 (lowest likelihood for CRLF occurrence) because these areas lacked aquatic habitat, exhibited a high degree of disturbance and human activity, and presented hazards and barriers to frog movement. Other boundary changes were made based on the presence of hazards and barriers to CRLF dispersal that limit or exclude frog movement beyond them. As a result of these changes, the area potentially most suitable for CRLF (Zone 1) is approximately 10% smaller than drawn in 2000.

It is important to note that habitat in Zone 1 represents varying degrees of suitability for CRLF. As discussed in this assessment, habitat immediately surrounding the Arboretum pond is highly suitable for CRLF aestivation and movement, as is habitat along Moore Creek and between the Arboretum pond and Wilder Creek (a likely movement route). However, other areas within Zone 1 are much less suitable for CRLF because of their distance from the Arboretum pond or other factors such as topography, vegetation, burrow density, or the presence of barriers or hazards to dispersal. In general, the value of upland habitat for CRLF decreases with increasing distance from known breeding sites or other aquatic sites. When determining the probability of a site within Zone 1 to support CRLF, site-specific factors should be considered and evaluated in the context of all potential habitat for CRLF in the Lower Campus of UCSC.

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Appendix A

California Red-Legged Frog Ecology

Ecology

Status and Range

The California Red-Legged Frog (CRLF) is listed as "threatened" under the federal Endangered Species Act (ESA) and meets requirements as a "rare, threatened, or endangered species" under CEQA.

The historical range of CRLF extended along the coast from the vicinity of Point Reyes National Seashore, Marin County, and inland from Redding, Shasta County, southward to northwestern Baja California, Mexico (Jennings and Hayes 1986, Hayes and Kremples 1986). The current distribution of this species includes only isolated localities in the Sierra Nevada and northern Coast and Northern Traverse Ranges. It is still common in the San Francisco Bay Area and along the central coast. It is now believed to be extirpated from the southern Traverse and Peninsular ranges (U.S. Fish and Wildlife Service 2000).

Life History

California red-legged frogs breed from November through April (Storer 1925, U.S. Fish and Wildlife Service 2000). Males usually appear at the breeding sites 2 to 4 weeks before females. Females are attracted to calling males. Females lay egg masses containing about 2,000 to 5,000 eggs, which hatch in 6 to 14 days, depending on water temperatures (U.S. Fish and Wildlife Service 2000). Larvae metamorphose in 3.5 to 7 months, typically between July and September (Storer 1925, Wright and Wright 1949, U.S. Fish and Wildlife Service 2000). Sexual maturity is usually attained by males at 2 years of age and females at 3 years of age.

Adult CRLF can live 8 to 10 years (Jennings et al. 1993), but the average life span is probably much lower (Scott pers. comm. in U.S. Fish and Wildlife Service 2000). Most mortality occurs during the tadpole stage (Licht 1974). No long-term studies have been conducted on the population dynamics of CLRF.

Habitat and Distribution

Distribution of CRLF among breeding, non-reproductive aquatic and upland habitats is often determined by variations in climate and variations in requisites for each life stage (USFWS 2000). In general, however, CRLF habitat contains permanent or ephemeral water sources with emergent and/or submerged vegetation, riparian areas, and upland habitats (Ecosystems West 2000, USFWS 2000).

Typically, breeding habitat for the CRLF includes deep pools and backwaters within streams and creeks, ponds, and low salinity (<4.5 parts per trillion) areas within lagoons and estuaries (USFWS 2000). The most suitable habitats are deep (>0.7 meters), still or slow-moving water bodies that contain dense, shrubby riparian or emergent vegetation (USFWS 2000). Even better habitats are pools that dry in the late summer, thereby allowing CRLF to metamorphose but preventing predators, such as mosquito fish (*Gambusia affina*) and bullfrogs (*Rana catesbeiana*), from becoming established.

Non-breeding habitat for CRLF may include permanent or ephemeral creeks, ponds, seeps, and other wetland features. These water sources should be large enough to allow frogs to escape predators by jumping to the center of the pool, and/or contain enough cover and moisture to support frogs seeking refuge.

Both adult and juvenile frogs use non-breeding habitat. Adult frogs move between breeding and non-breeding habitat during the breeding season, and seek refuge in non-breeding habitats as the ponds dry in late spring and summer. Intense competition from adult frogs within breeding ponds makes the presence of non-breeding habitat especially important for juvenile frogs. Reis (1999) found juvenile CRLF most often in shallow aquatic habitats with limited shoreline and/or emergent vegetation. More open vegetation structure may provide juveniles with small breaks in the vegetation for basking and foraging, while retaining adjacent refuge and/or cover (Jennings and Hayes 1988, Ecosystems West 2000).

During dry periods, CRLF are seldom found far from water. However, during wet weather, individuals may make overland excursions through upland habitats over distances up to 3 miles (Ecosystems West 2000). These dispersal movements are generally straight-line, point-to-point migrations rather than migrations that follow specific habitat corridors (Ecosystems West 2000, Rathbun and Schneider 2001). Dispersal distances are believed to depend on the availability of suitable habitat and prevailing environmental conditions. Very little is known about how CRLF use upland habitats during these periods.

During summer, CLRF often disperse from their breeding habitat to forage and seek summer habitat, if water is not available (U.S. Fish and Wildlife Service 2000). This habitat may include shelter under boulders, rocks, logs, industrial debris, agricultural drains, watering troughs, abandoned sheds, and hay-ricks. They will also use small mammal burrows, incised stream channels, and areas with moist leaf litter (Jennings and Hayes 1994; U.S. Fish and Wildlife Service

1996, 2000). This summer movement behavior, however, has not been observed in all CRLF populations studied.

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