FINAL

Del Dios Highlands Preserve
Vegetation Management Plan

Prepared for:

County of San Diego
Department of Parks and Recreation
5500 Overland Avenue, Suite 410
San Diego, California 92123
Contact: Jessica Norton

Prepared by:

DUDEK
605 Third Street
Encinitas, California 92024
Contact: Mike Huff

MAY 2011

Printed on 30% post-consumer recycled material.

TABLE OF CONTENTS

Section **Page No.**

1.0 INTRODUCTION....1
1.1 Purpose and Need 1
1.2 Site Location and Description 2
1.3 Vegetation Management Goals and Objectives 7

2.0 ENVIRONMENTAL RESOURCES....8
2.1 Biological Resources 9
2.1.1 Vegetation Communities 9
2.1.2 Sensitive Plant Species 9
2.1.3 Sensitive Animal Species 10
2.2 Cultural Resources 11

3.0 INVASIVE SPECIES MANAGEMENT 19
3.1 Target Invasive Species 23
3.1.1 High Priority Species 23
3.1.2 Moderate Priority Species 24
3.1.3 Low Priority Species 26
3.2 Removal Methods 28
3.2.1 Manual Removal 28
3.2.2 Mechanical Removal 28
3.2.3 Herbicides 29
3.2.4 Cut and Daub 29

4.0 HABITAT RESTORATION 29
4.1 Proposed Restoration Areas 30
4.2 Restoration Methods 30
4.2.1 Passive Restoration 30
4.2.2 Active Restoration 31

5.0 FIRE MANAGEMENT 33
5.1 Current Fire Management Practices 33
5.2 Fire Environment 34
5.2.1 Climate 35
5.2.2 Topography 36
5.2.3 Watershed Description 37
5.2.4 Fire History 37
5.2.5 Vegetation Dynamics and Fuel Loads 41

TABLE OF CONTENTS (CONTINUED)

Section **Page No.**

5.3 Fuel Management Methods 48
5.3.1 Grazing 51
5.3.2 Mowing 51
5.3.3 Herbicides 51
5.3.4 Prescribed Fire 51
5.3.5 Hand Tool or Mechanical Equipment Thinning 52
5.3.6 Fuel Breaks 52
5.4 Fire Response Plan 53
5.4.1 Fire Hazard and Current Fire Management Practices Evaluation 55
5.4.2 Primary Actions and Contacts for Wildfire Emergency 57
5.4.3 Roads/Access 58
5.4.4 Fuel Breaks 59
5.4.5 Emergency Staging Areas 60
5.4.6 Fire Hydrants 60
5.4.7 Other Water Sources 60

6.0 MANAGEMENT DIRECTIVES 61
6.1 Invasive Species Removal 61
6.2 Restoration 61
6.3 Fire Management 62

7.0 REFERENCES 68

APPENDICES

A Glossary of Terms and Acronyms
B Preserve Map with Access Gates and Transmission Line Locations
C Fire Behavior Modeling Results

TABLE OF CONTENTS (CONTINUED)

Page No.

LIST OF FIGURES

1 Regional Map 3
2 Site Location 5
3 Vegetation Communities/Habitats 13
4 Sensitive Plant Species Locations 15
5 Sensitive Animal Species Locations 17
6 Target Invasive Non-native Plant Species Locations and Potential Restoration Areas 21
7 Fire History Map 39
8 Fuels Distribution 45
9 Vegetation Management Units 49

LIST OF TABLES

1 Vegetation Communities 9
2 Sensitive Plant Species Known to Occur in the Del Dios Highlands Preserve 10
3 Sensitive Animal Species Known to Occur in the Del Dios Highlands Preserve 10
4 Del Dios Highlands Preserve Sensitive Cultural Sites 12
5 Non-native Perennial Plant Species at the Del Dios Highlands Preserve 19
6 Non-Native Annual Plant Species at the Del Dios Highlands Preserve 20
7 Removal Priority of Target Invasive Non-Native Species 23
8 Chaparral Seed Mix 31
9 Chaparral Container Plant Species 32
10 General Weather Conditions for the Del Dios Highlands Preserve 36
11 Quantity of Del Dios Highlands Preserve Wildfires 38
12 Fire Intervals for the Del Dios Highlands Preserve 38
13 Vegetation Communities and Associated Fuel Models for the Del Dios Highlands Preserve 41
14 Fuel Management Activities by VMU 65

INTENTIONALLY LEFT BLANK

1.0 INTRODUCTION

The Del Dios Highlands Preserve (Preserve) is an approximately 781.8-acre open space preserve located southwest of the City of Escondido, west of Del Dios Highway, and northwest of Lake Hodges, within an unincorporated area of San Diego County (County). The Preserve is owned by the County of San Diego Department of Parks and Recreation (DPR) and managed in accordance with a Resource Management Plan (RMP), including Area-Specific Management Directives (ASMDs), pursuant to the requirements of the County's Multiple Species Conservation Program (MSCP). The Preserve is included in both the South and North County MSCP preserve systems and contains valuable native habitats, as well as areas that have been marginally or severely impacted by invasive non-native plant species, human activities, wildfire, and post fire erosion.

The majority of the Preserve supports high quality native vegetation communities; however, invasive non-native plants are present in portions of the Preserve and are outcompeting native species and reducing the biological functions and values of these communities. In discrete locations, human disturbance has resulted in unvegetated areas, which are subject to erosion. Portions of the Preserve most recently burned during the 2007 Witch Fire, and the majority of the Preserve has burned during the recorded fire history period, some areas having burned over four times. Despite repeated fires, much of the vegetation on site is recovering, although some areas remain in a disturbed or semi-disturbed state.

1.1 Purpose and Need

The purpose of this Vegetation Management Plan (VMP) is to describe the current site conditions within the Del Dios Highlands Preserve and provide recommendations for vegetation management within the Preserve including: 1) invasive species management, 2) habitat restoration, and 3) fire management. While this VMP is intended to be a stand-alone document, the information and recommendations presented will be used by DPR to develop additional ASMDs to augment the existing Preserve RMP. In addition, the VMP provides fire response personnel with critical site information for emergency fire response within and immediately adjacent to the Preserve boundaries and identifies targeted fuel management actions that can be implemented as preventative measures.

The Invasive Species Management section of this VMP lists the non-native invasive plant species observed in the Preserve, identifies and prioritizes target species for removal, and outlines standard removal methods. The Habitat Restoration section of this VMP identifies potential restoration opportunities within the Preserve and outlines standard restoration methods. The Fire Management section of this VMP outlines a framework to address wildfire risk and enables environmental documentation of strategic fuels management that may be needed. The

framework includes discussion of fire prevention, suppression, and post-suppression fire-control activities within and adjacent to the Preserve.

The goals and objectives as well as the recommendations in this VMP are consistent with the County's MSCP and the County of San Diego Vegetation Management Report (County of San Diego 2009a), which addresses vegetation management criteria for wildland and urban areas of unincorporated San Diego County. It is anticipated that this VMP will be revised once every 5 years, as needed, in conjunction with anticipated Preserve RMP updates.

1.2 Site Location and Description

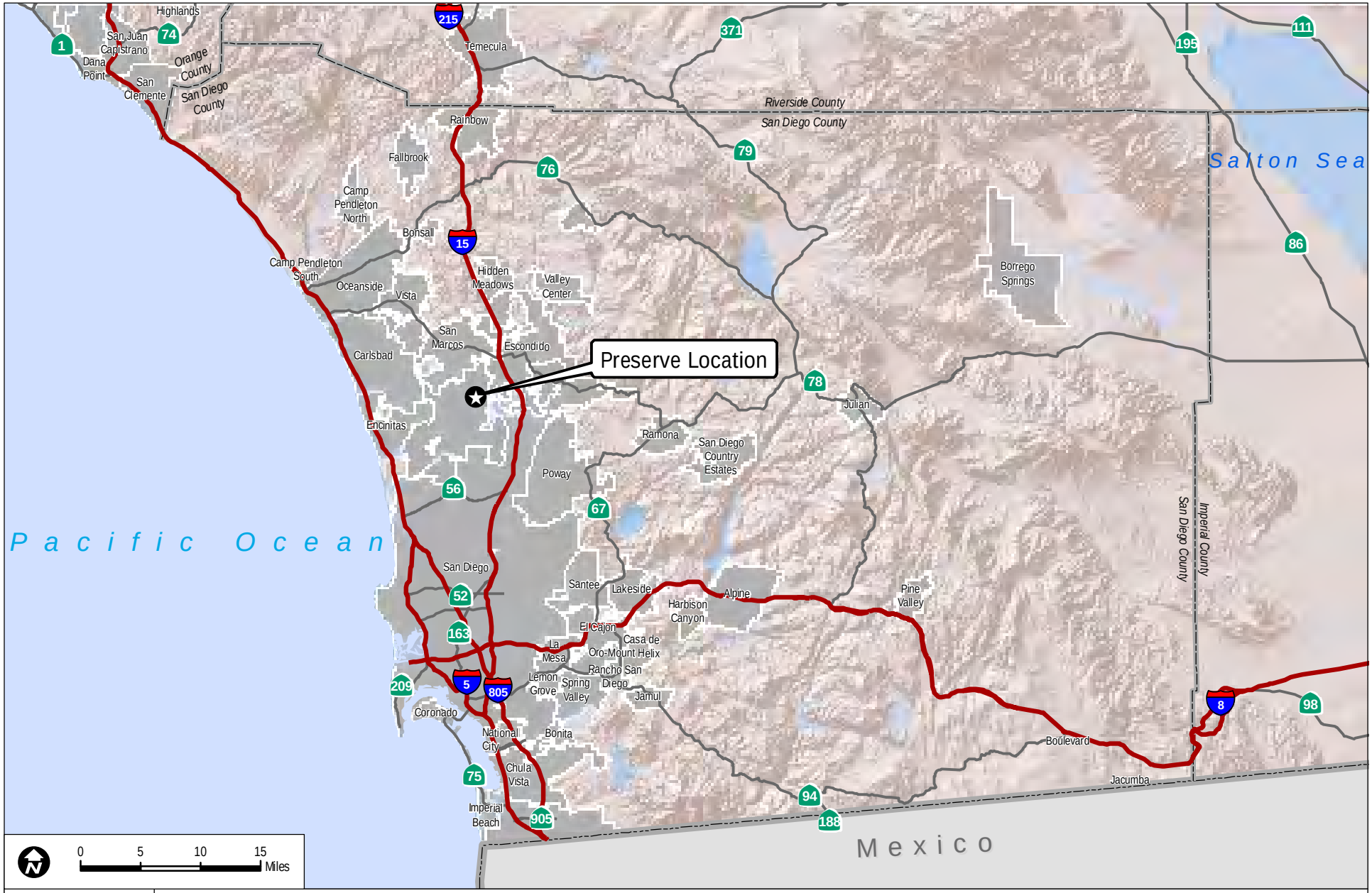
The approximately 781.8-acre Del Dios Highlands Preserve is located at 9860 Del Dios Highway, Escondido, California 92025. The Preserve is southwest of the City of Escondido, west of Del Dios Highway, and northwest of Lake Hodges, within an unincorporated area of San Diego County (Figure 1). The Preserve is mapped within the U.S. Geological Survey (USGS) 7.5-minute Escondido and Rancho Santa Fe quadrangles: Township 12 South, Range 2 West, Sections 6 and 31; Township 12 South, Range 3 West, Section 36; and Township 13 South, Range 2 West, Sections 6 and 7 (Figure 2).

The Preserve is composed of the following Assessor's Parcel Numbers (APNs):

238-020-34	270-010-02	270-030-07	272-060-01	679-140-11
238-020-36	270-010-03	270-030-15	272-161-03	679-140-16
238-020-37	270-010-04	270-030-17	272-161-04	
238-021-07	270-010-05	270-290-08		

The Preserve is bordered by low density, rural residential development to the north and south, Del Dios Highway to the east, and undeveloped land in the west, including the County's Escondido Creek Preserve, and the Elfin Forest Recreational Reserve and Olivenhain Reservoir, which are owned and managed by the Olivenhain Municipal Water District (OMWD). The Preserve is nearly contiguous, bisected only in the south by a graded, inaccessible extension of Mt. Israel Road and in the north by a designated multi-use trail, which also serves as an access road.

The southern portion of the Preserve is located within the North Metro-Lakeside-Jamul segment of the South County MSCP Subarea Plan, and the northern portion is located in the Harmony Grove Core Area of the draft North County MSCP Plan. The Preserve is located in the management district of one supervising park ranger, two park rangers, and three seasonal park attendants. There is currently no full-time, on-site manager, but patrols occur daily and more frequently on weekends and holidays.



DUDEK

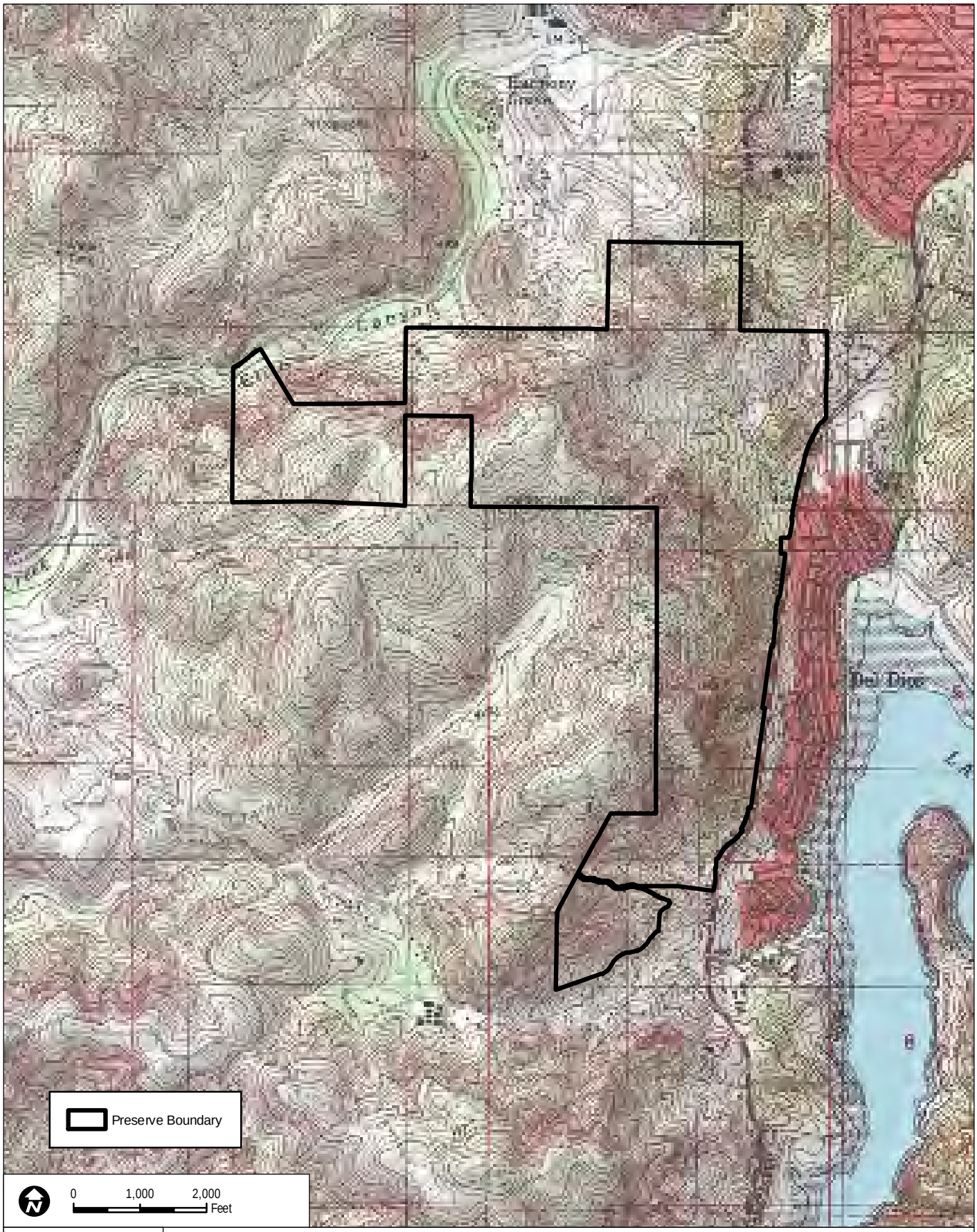
6680-1D

FIGURE 1

Regional Map

Final Del Dios Highlands Preserve - Vegetation Management Plan

INTENTIONALLY LEFT BLANK



DUDEK

6680-1D

SOURCE: USGS 7.5-Minute Series Quadrangle.

FIGURE 2

Site Location

Final Del Dios Highlands Preserve - Vegetation Management Plan

INTENTIONALLY LEFT BLANK

The Preserve consists primarily of southern mixed chaparral and is classified as a Very High Fire Hazard Severity Zone by the California Department of Forestry and Fire Protection (CAL FIRE) (FRAP 2011). The central portion of the Preserve is designated a local responsibility area (LRA), while the remaining portions to the north, south, and west are designated a state responsibility area (SRA). The Preserve lies within the service areas of the Rancho Santa Fe Fire Protection District (RSFFPD), Elfin Forest/Harmony Grove Fire Department (EF/HGFD), and Escondido Fire Department (EFD).

The Preserve is located in the coastal foothills of the Peninsular Ranges in northern San Diego County. The Preserve is composed of moderately to steeply sloping terrain, ranging in elevation from 146 meters (480 feet) above mean sea level (amsl) in the northwest portion along Escondido Creek to approximately 400 meters (1,300 feet) amsl in the west-central portion of the Preserve north of the Olivenhain Reservoir.

1.3 Vegetation Management Goals and Objectives

This VMP aims to develop management strategies consistent with those of the larger South and North County MSCP subarea plans and the Preserve RMP. To that end, the vegetation management goals for the Preserve are focused on environmental resource preservation and enhancement of existing native habitat. The vegetation management goals for the Preserve include:

- Ensure the long-term viability and sustainability of native ecosystem function and natural processes;
- Protect the existing biological and cultural resources from disturbance-causing, incompatible activities within and adjacent to the Preserve;
- Manage invasive non-native species to ensure native vegetation community and resource preservation;
- Restore and/or enhance the quality of degraded vegetation communities in a manner consistent with overall species or habitat preservation goals; and
- Develop fuel-load reduction methods that are consistent with overall Preserve management goals.

To achieve these long-term vegetation management goals for the Preserve, the following objectives have been formulated to achieve desired levels of resource protection and public and firefighter safety:

- Maximize native vegetation community quality;
- Identify and prioritize removal/control of invasive non-native plant species in the Preserve;

- Provide methods for removal/control of invasive non-native plant species;
- Address current and long-term vegetation community restoration needs;
- Minimize adverse impacts to sensitive and high-value habitats;
- Utilize available fuel and invasive non-native plant reduction techniques, such as grazing, mowing, herbicide application, and prescribed fire, consistent with Preserve goals for habitat preservation, enhancement, and restoration, and asset and cultural resource protection;
- Provide site information about fire behavior to local fire agencies, including RSFFPD, CAL FIRE San Diego Unit, EF/HGFD, and EFD, for inclusion in wildland pre-response plans;
- Establish vegetation management units (VMUs) based on topography or other clearly discernable landscape boundaries to facilitate fire management;
- Minimize likelihood of Preserve-wide, catastrophic wildfires;
- Identify wildland-urban interface (WUI) areas and associated fuel management goals with a dual role of preventing wildfire from impacting urban areas, as well as protecting Preserve lands from fire originating in urban areas;
- Provide education for local firefighting personnel regarding sensitive resources and overall management considerations associated with the Preserve;
- Provide local fire agencies maps of sensitive biological and cultural resources to be avoided to the maximum extent possible;
- Prepare Preserve maps depicting relevant fire management data, including property boundaries, topography, vegetation and fuel types, access, and other major features, such as roads and structures;
- Prepare fire restoration management guidelines for each VMU including discussion of prevention, suppression, and post-suppression activities; and
- Provide appropriate contact information to responding fire personnel in the event fire management activities may affect priority resources.

2.0 ENVIRONMENTAL RESOURCES

Baseline biological surveys of the Preserve were first conducted in 2007–2008 (TAIC 2008). In 2009–2010, DPR acquired several new parcels as additions to the Preserve, and baseline biological surveys of these newly acquired parcels were conducted in 2010–2011 (Dudek 2011). Field studies included vegetation mapping (including mapping invasive non-native plants), rare plant surveys, butterfly surveys, pitfall arrays, aquatic amphibian surveys, avian point counts, bat surveys, small mammal trapping, and tracking and camera stations. Brief descriptions of the

existing vegetation communities, sensitive plant and wildlife species, and cultural resources documented in the Preserve during the baseline surveys are provided below.

2.1 Biological Resources

2.1.1 Vegetation Communities

The predominant vegetation community within the Preserve is southern mixed chaparral; however, eight other vegetation communities and land cover types have been mapped within the Preserve including coast live oak woodland, southern coast live oak riparian forest, eucalyptus woodland, Diegan coastal sage scrub, non-native grassland, southern willow scrub, disturbed habitat, and urban/developed land (Table 1, Figure 3).

Table 1
Vegetation Communities

Vegetation Community/Land Cover	Acres	Percentage
Southern Mixed Chaparral[1]	728.5	93.2%
Coast Live Oak Woodland	15.1	1.9%
Disturbed Habitat	13.9	1.8%
Southern Coast Live Oak Riparian Forest	12.0	1.5%
Diegan Coastal Sage Scrub[2]	5.0	0.6%
Eucalyptus Woodland	3.1	0.4%
Urban/Developed	2.2	0.3%
Non-Native Grassland	1.2	0.2%
Southern Willow Scrub	0.7	0.1%
Total[3]	**781.7**	**100.0%**

[1] Includes 2.6 acres of disturbed southern mixed chaparral
[2] Includes 1.5 acres of disturbed Diegan coastal sage scrub
[3] Total differs from the 781.8-acre Preserve area due to rounding
Note: Vegetation Community descriptions based on Holland (1986), updated by Oberbaur (1996)

2.1.2 Sensitive Plant Species

Seven special-status plant species have been documented within the Preserve (TAIC 2008; Dudek 2011). Table 2 presents the sensitive plant species identified in the Preserve. Sensitive plant species locations are presented in Figure 4.

Table 2
Sensitive Plant Species Known to Occur in the Del Dios Highlands Preserve

Common Name	Scientific Name	Status
Brewer's calandrinia	*Calandrinia breweri*	CNPS List 4, County List D
San Diego (Palmer's) sagewort	*Artemisia palmeri*	CNPS List 4.2, County List D
Robinson's pepper-grass	*Lepidium virginicum* var. *robinsonii*	CNPS List 1B.2, County List A
Wart-stemmed ceanothus	*Ceanothus verrucosus*	CNPS List 2.2, County List B, MSCP Covered Species
Summer holly	*Comarostaphylis diversifolia* ssp. *diversifolia*	CNPS List 1B.2, County List A
Encinitas baccharis	*Baccharis vanessae*	Federally Threatened, State Endangered, CNPS List 1B.1, County List A, MSCP Covered Species
Ashy spike-moss	*Selaginella cinerascens*	CNPS List 4.1, County List B

2.1.3 Sensitive Animal Species

Overall, 42 special-status wildlife species were observed or detected within the Preserve (TAIC 2008; Dudek 2011) Table 3 presents the sensitive animal species observed in the Preserve. Sensitive animal species locations are also presented on Figure 5.

Table 3
Sensitive Animal Species Known to Occur in the Del Dios Highlands Preserve

Common Name	Scientific Name	Status (Federal/State/County/MSCP)[1]
Birds		
Coastal California gnatcatcher	*Polioptila californica californica*	FT/SSC/Group 1/MSCP
Cooper's hawk	*Accipiter cooperii*	–/SWL/Group 1/MSCP
Sharp-shinned hawk	*Accipiter striatus*	–/SWL/Group 1/–
Ferruginous hawk	*Buteo regalis*	–/SWL/Group 1/MSCP
Peregrine falcon	*Falco peregrinus*	–/SFP/Group 1/MSCP
Southern California rufous-crowned sparrow	*Aimophila ruficeps canescens*	–/SWL/Group 1/MSCP
Double-crested cormorant	*Phalacrocorax auritus*	–/SWL/Group 2/–
Western bluebird	*Sialia mexicana*	–/–/Group 2/MSCP
Bell's sage sparrow	*Amphispiza bell bellii*	–/SWL/Group 1/MSCP
Yellow warbler	*Dendroica petechia*	–/SSC/Group 2/–
Vaux's swift	*Chaetura vauxi*	–/SSC/–/–
Yellow-breasted chat	*Icteria virens*	–/SSC/Group 1/MSCP
White-faced ibis	*Plegadis chihi*	–/SWL/Group 1/MSCP
Common loon	*Gavia immer*	–/SSC/Group 2/–
Gadwall	*Anas strepera*	–/–/Group 2/–
Great blue heron	*Ardea herodias*	–/–/Group 2/–

Table 3 (Continued)

Common Name	Scientific Name	Status (Federal/State/County/MSCP)[1]
Red-shouldered hawk	*Buteo lineatus*	–/–/Group 1/–
Northern harrier	*Circus cyaneus*	–/SSC/Group 1/MSCP
Turkey vulture	*Cathartes aura*	–/–/Group 1/–
Barn owl	*Tyto alba*	–/–/Group 2/–
Mammals		
Western mastiff bat	*Eumops perotis*	–/SSC/Group 2/–
Western red bat	*Lasiurus blossevillii*	–/SSC/Group 2/–
Pocketed free-tailed bat	*Nyctinomops femorosaccus*	–/SSC/Group 2/–
San Diego desert woodrat	*Neotoma lepida intermedia*	–/SSC/Group 2/–
Southern mule deer	*Odocoileus hemionus fuliginata*	–/–/Group 2/MSCP
California pocket mouse	*Chaetodipus californicus*	–/SSC/Group 2/–
Northwestern San Diego pocket mouse	*Chaetodipus fallax fallax*	–/SSC/Group 2/–
Townsend's big-eared bat	*Corynorhinus townsendii*	–/SSC/Group 2/MSCP
Western yellow bat	*Lasiurus xanthinus*	–/SSC/–/–
San Diego black-tailed jackrabbit	*Lepus californicus bennettii*	–/SSC/Group 2/MSCP
Yuma myotis	*Myotis yumanensis*	–/–/Group 2/–
Big free-tailed bat	*Nyctinomops macrotis*	–/SSC/Group2/–
Mountain lion	*Felis concolor*	–/–/Group 2/MSCP
Herpetofauna		
Coast patch-nosed snake	*Salvadora hexalepis*	–/SSC/Group 2/–
Western spadefoot	*Spea hammondii*	–/SSC/Group 2/MSCP
Orange-throated whiptail	*Aspidoscelis hyperythra*	–/SSC/Group 2/MSCP
Red-diamond rattlesnake	*Crotalus ruber ruber*	–/SSC/Group 2/MSCP
Coast (Blainville's) horned lizard	*Phyrnosoma coronatum blainvillii*	–/SSC/Group 2/MSCP
Coastal western whiptail	*Aspidoscelis tigris stejnegeri*	–/–/Group 2/–
Rosy boa	*Charina trivirgata roseofusca*	–/–/Group 2/–
San Diego ringneck snake	*Diadophis punctatus similis*	–/–/Group 2/–
Two-striped garter snake	*Thamnophis hammondii*	–/SSC/Group 1/MSCP

[1] Status - Federal Designations
FT: Federally Threatened
State Designations
SSC: Species of Special Concern
SFP: State Fully Protected
SWL: State Watch List
County Designations
Group 1: Animals of high sensitivity (listed or specific natural history requirements)
Group 2: Animals declining, but not in immediate threat of extinction or extirpation
MSCP: Covered under the South and/or North County MSCP

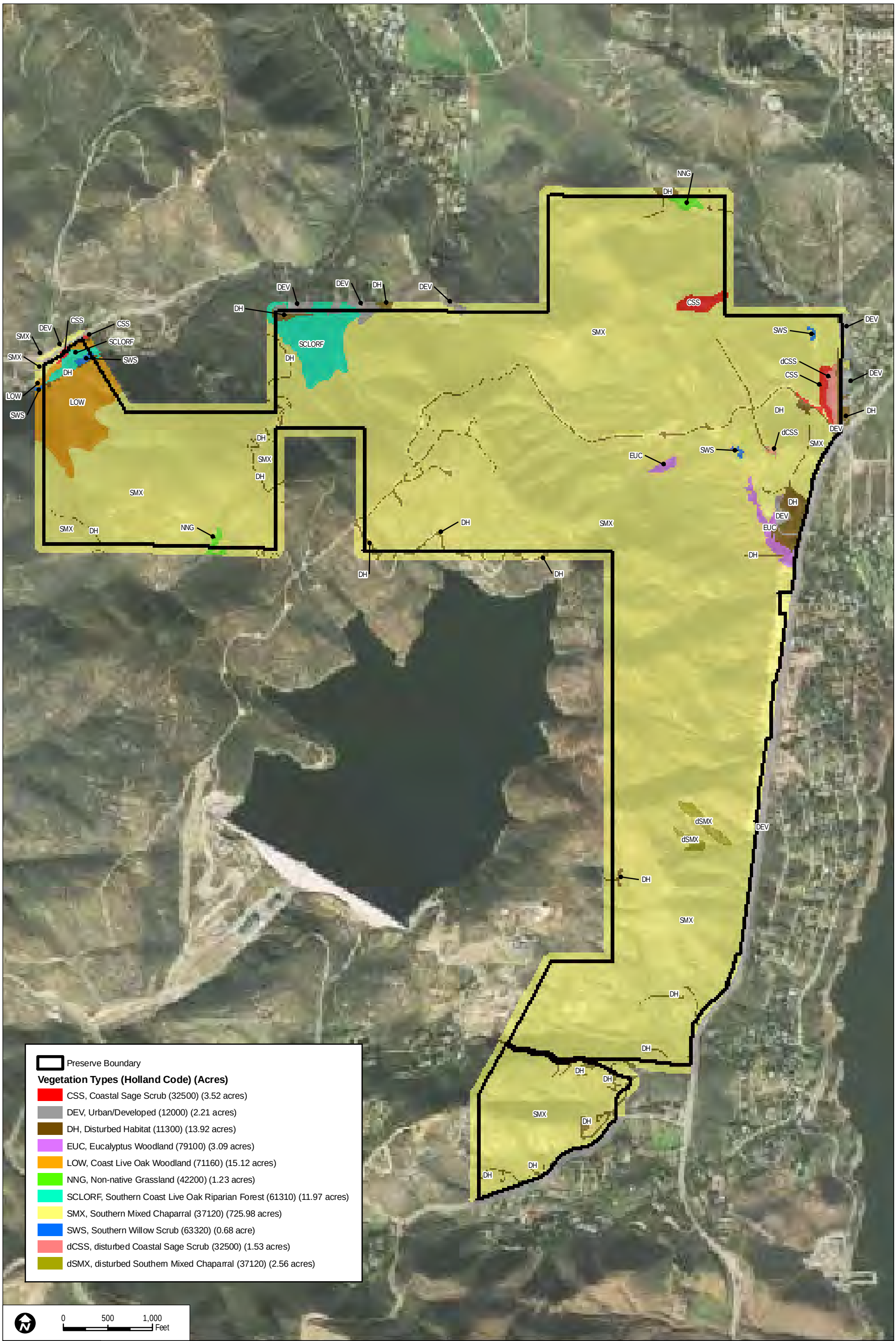
2.2 Cultural Resources

Nine significant or potentially significant cultural resources have been identified within the Preserve including modern rock art, a habitation site, ceramic/lithic scatters, a milling feature, a historic mine shaft, a historic trash scatter, and the historic Derbas Property (ASM 2008; 2011). These cultural resources are discussed in greater detail in the *Management Plan for*

Archaeological Resources within the Del Dios Highlands Preserve (ASM 2008) and the *Archaeological Survey Report for the Pascoe, Helix-Lambron, and Cielo Azul Parcel Additions to the Del Dios Highlands Preserve* (ASM 2011). Locations of documented cultural resources in the Preserve are presented in the confidential appendices included in these reports. Table 4 presents the sensitive cultural sites identified within the Preserve.

Table 4
Del Dios Highlands Preserve Sensitive Cultural Sites

Primary or Trinomial Site#	Description	Significance Evaluation
CA-SDI-12,047 (P-37-012047)	Prehistoric habitation site	Significant under California Environmental Quality Act (CEQA)
CA-SDI-13,646 (P-37-013646)	Historic mine shaft	Not evaluated – Considered significant under CEQA
CA-SDI-15,999	Prehistoric ceramic scatter	Not evaluated – Considered significant under CEQA
CA-SDI-19,062 (P-37-029812)	Historic Derbas property	Significant under CEQA
CA-SDI-19,063 (P-37-029814)	Prehistoric lithic scatter	Not evaluated – Considered significant under CEQA
CA-SDI-19,064 (P-37-029815)	Prehistoric lithic scatter	Not evaluated – Considered significant under CEQA
CA-SDI-20,157	Prehistoric milling feature	Not evaluated – Considered significant under CEQA
P-37-030076	Modern rock art	Not evaluated – Considered significant under CEQA
P-37-031725	Historic trash scatter	Not evaluated – Considered significant under CEQA



DUDEK

6680-1D

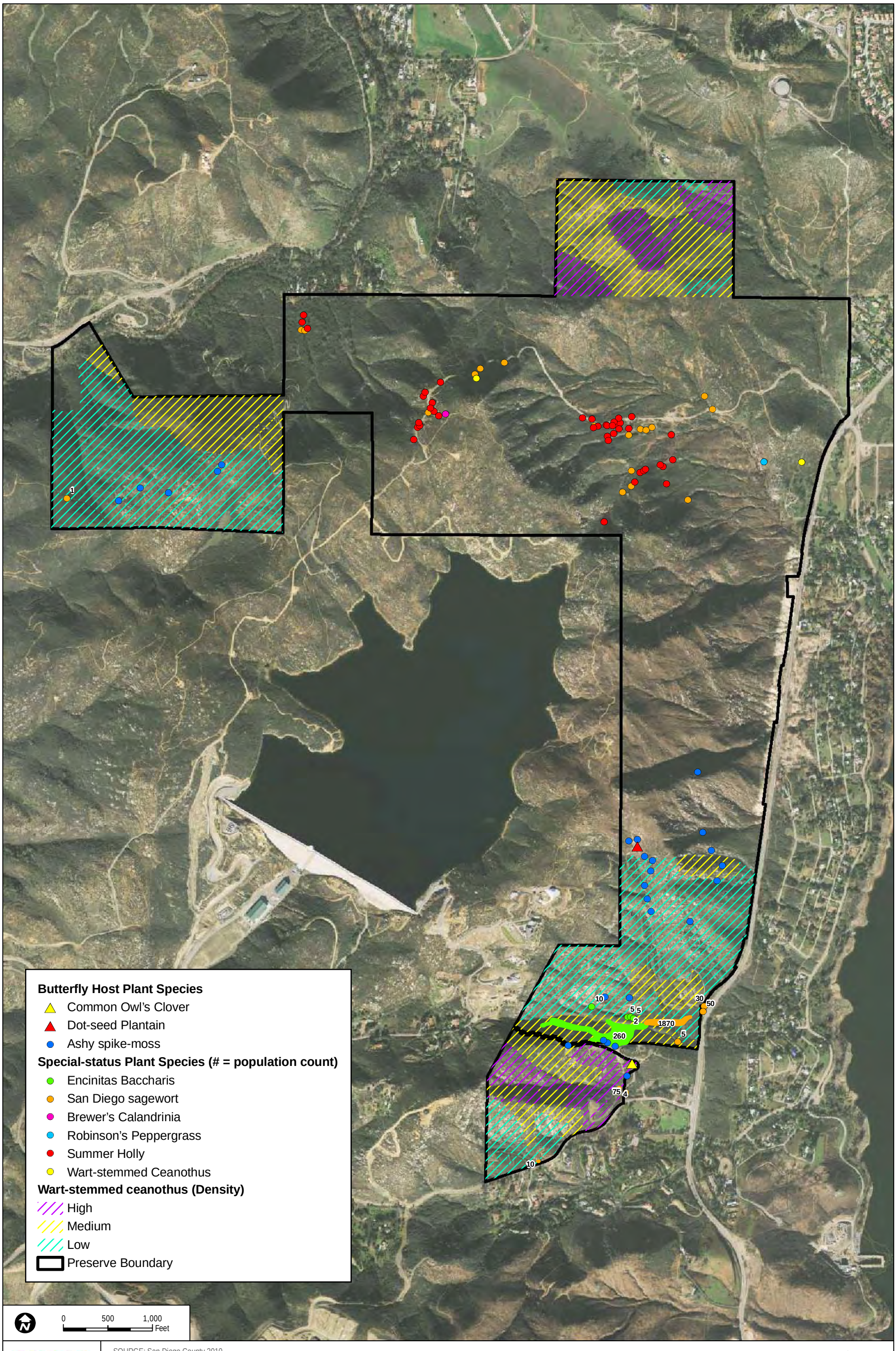
SOURCE: Digital Globe 2008

FIGURE 3

Vegetation Communities/Habitats

Final Del Dios Highlands Preserve - Vegetation Management Plan

INTENTIONALLY LEFT BLANK



DUDEK

6680-1D

SOURCE: San Diego County 2010
Digital Globe 2008
TAIC 2008

FIGURE 4

Sensitive Plant Species Locations

Final Del Dios Highlands Preserve - Vegetation Management Plan

INTENTIONALLY LEFT BLANK

Sensitive Bird Species Locations

- Bell's Sage Sparrow
- Barn Owl
- California Gnatcatcher
- Gadwall
- Red-shouldered Hawk
- Great Blue Heron
- Northern Harrier
- Common Loon
- Cooper's Hawk
- Double-crested Cormorant
- Ferruginous Hawk
- Peregrine Falcon
- Sharp-shinned Hawk
- So. Ca. Rufous-crowned Sparrow
- Vaux's Swift
- Western Bluebird
- Western Whiptail
- White-faced Ibis
- Yellow Warbler
- Yellow-breasted Chat

Sensitive Bat Species Locations

- Big Free-tailed Bat
- Pocketed Free-tailed Bat
- Townsend's Big-eared Bat
- Western Mastiff Bat
- Western Red Bat
- Western Yellow Bat
- Yuma Myotis

Sensitive Herpetofauna Species Locations

- Coast (Blainville's) horned lizard
- Northern Red-diamond Rattlesnake
- Orange-Throated Lizard
- Rosy Boa
- San Diego Ringneck Snake
- Two-striped Garter Snake
- Western Patched-Nosed Snake
- Western Spadefoot Toad

Sensitive Large Mammal Species Locations

- Mule Deer
- Mountain Lion scat

Sensitive Small Mammal Species Locations

- California Pocket Mouse
- San Diego Desert Woodrat
- Northwestern San Diego Pocket Mouse
- San Diego Black-tailed Jackrabbit

Wildlife Survey Locations

- Herp Array Location
- Herp Cover-board Location
- Large Mammal Camera Location
- Bat Survey Location
- Avian Survey Location
- Preserve Boundary

Data Location ID	Species
A	Pocketed Free-tailed Bat
A	Western Red Bat
B	Sage Sparrow
B	Rufous-crow ned Sparrow
C	Double-crested Cormorant
C	California Gnatcatcher
C	Sage Sparrow
D	California Pocket Mouse
D	San Diego Pocket Mouse
D	Desert Woodrat
E	Common Loon
E	Double-crested Cormorant
E	Sage Sparrow
E	Rufous-crow ned Sparrow
F	Sage Sparrow
F	Sharp-shinned Hawk
F	Rufous-crow ned Sparrow
G	Rufous-crow ned Sparrow
G	Sage Sparrow
H	Rufous-crow ned Sparrow
H	Sage Sparrow
I	Double-crested Cormorant
I	Rufous-crow ned Sparrow
I	Yellow Warbler
J	Double-crested Cormorant
J	Sharp-shinned Hawk
J	Ferruginours Hawk
J	Sage Sparrow
K	Coast (Blainsville's) Horned Lizard
K	Orange-throated Lizard
L	Coast (Blainsville's) Horned Lizard
L	Orange-throated Lizard
M	Double-crested Cormorant
M	Rufous-crow ned Sparrow
M	Yellow Warbler
N	Double-crested Cormorant
N	Rufous-crow ned Sparrow
N	Western Bluebird
N	Cooper's Hawk
N	Vaux's Swift
N	White-faced Ibis
O	San Diego Pocket Mouse
O	Desert Woodrat
P	California Pocket Mouse
P	San Diego Pocket Mouse
Q	Pocketed Free-tailed Bat
Q	Western Red Bat
R	Pocketed Free-tailed Bat
R	Western Red Bat
R	Western Mastiff Bat
S	Coast (Blainsville's) Horned Lizard
S	Orange-throated Lizard
S	Red Diamond Rattlesnake
S	Western Patched-nosed Snake
T	California Gnatcatcher
T	Double-crested Cormorant
U	San Diego Pocket Mouse
U	Desert Woodrat
V	California Pocket Mouse
V	San Diego Pocket Mouse
V	Desert Woodrat
W	San Diego Pocket Mouse
W	Desert Woodrat
X	Pocketed Free-tailed Bat
X	Western Red Bat
Y	California Pocket Mouse
Y	San Diego Pocket Mouse
Y	Desert Woodrat

0 500 1,000 Feet

DUDEK

6680-1D

SOURCE: Digital Globe 2008

FIGURE 5

Sensitive Animal Species Locations

Final Del Dios Highlands Preserve - Vegetation Management Plan

INTENTIONALLY LEFT BLANK

3.0 INVASIVE SPECIES MANAGEMENT

Because invasive non-native plant species can have significant impacts on native plant associations, ecosystem processes, and biodiversity, special management measures are needed for their removal and control. Non-native plants have few ecological controls on their population sizes, and they tend to thrive under conditions created by humans. They often exhibit aggressive growth, out-compete or otherwise harm sensitive species, and can alter natural fire regimes by increasing the frequency and intensity of wildfire (Bell 2009).

Eighteen invasive non-native plant species have been identified in the Preserve, including both perennial and annual species (TAIC 2008; Dudek 2011). The perennial non-native species within the Preserve include hottentot fig (*Carpobrotus edulis*), pampas grass (*Cortaderia selloana)*, tree tobacco (*Nicotiana glauca*), olive (*Olea europa*), fountain grass (*Pennisetum setaceum*), Peruvian peppertree (*Schinus molle*), sweet fennel (*Foeniculum vulgare*), tamarisk (*Tamarix ramosissima*), Mexican fan palm (*Washingtonia robusta*), and eucalyptus (*Eucalyptus* spp.). Table 5 lists the non-native perennial species and their associated California Invasive Plant Council (Cal-IPC) Inventory rating. Invasive plant species locations are shown on Figure 6.

Table 5
Non-native Perennial Plant Species at the Del Dios Highlands Preserve

Scientific Name	Common Name	Cal-IPC Rating*
Carpobrotus edulis	hottentot fig, iceplant	High
Cortaderia selloana	pampas grass	High
Eucalyptus spp.	Eucalyptus	Limited/Moderate
Foeniculum vulgare	Sweet fennel	High
Nicotiana glauca	Tree tobacco	Moderate
Olea europa	Olive	Limited
Pennisetum setaceum	Fountain grass	Moderate
Schinus molle	Peruvian peppertree	Limited
Tamarix ramosissima	Tamarisk	High
Washingtonia robusta	Mexican fan palm	Moderate**

***Source:** Cal-IPC (California Invasive Plant Inventory) Database, updated December 2010. Overall rating listed for southwest region, factoring impact, invasiveness, distribution, and documentation level.

Inventory Categories

High: Species have severe ecological impacts, are conducive to moderate to high rates of dispersal/establishment, and most are widely spread.

Moderate: Species have substantial and apparent, but generally not severe, ecological impacts, are conducive to moderate to high rates of dispersal, although establishment is generally dependent on ecological disturbance, and distribution may range from limited to widespread.

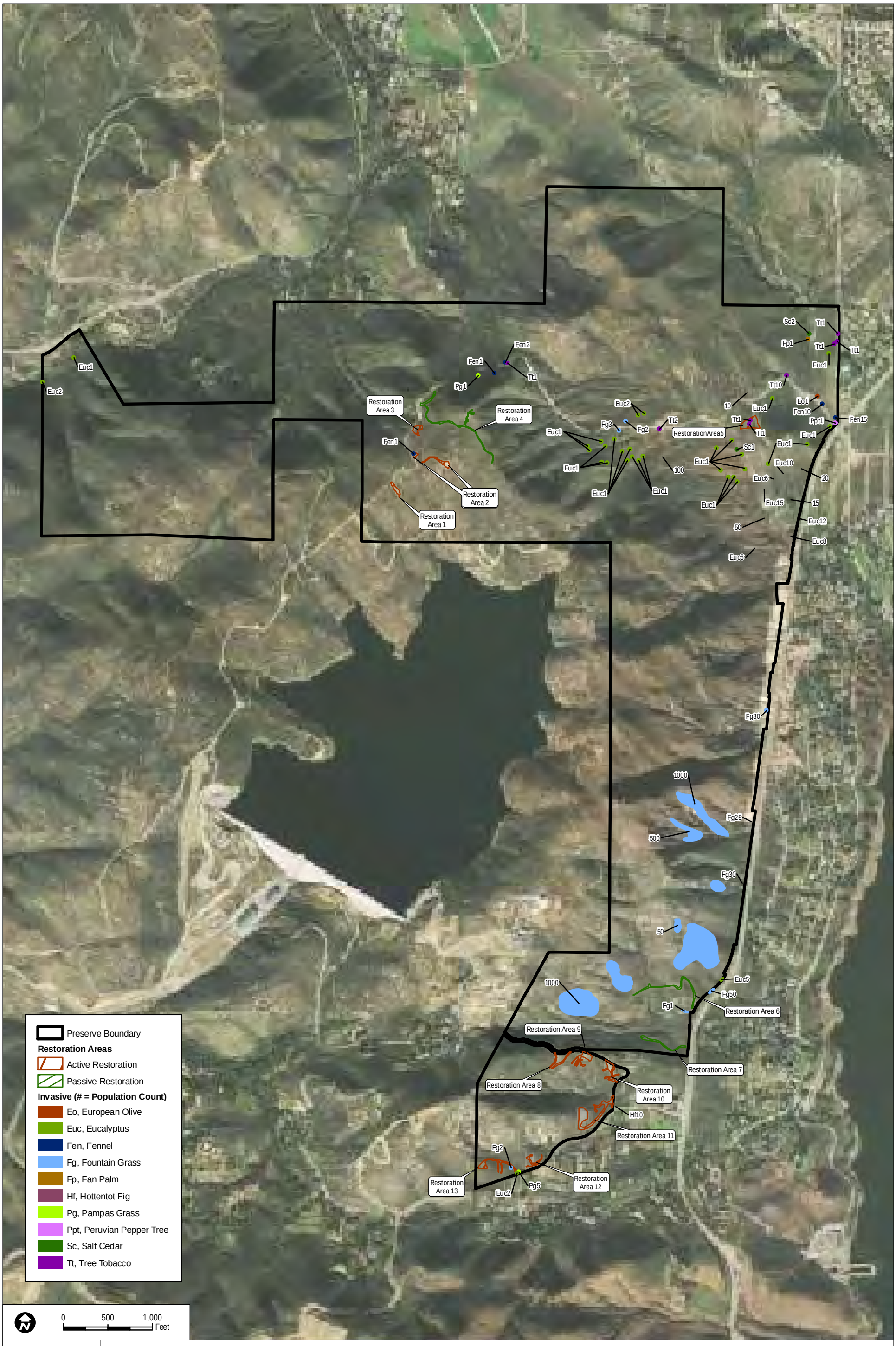
Limited: Species are invasive, but their ecological impacts are minor on a statewide level (or there was not enough information to justify a higher score), they have low to moderate rates of invasiveness, and are generally limited but may be locally persistent and problematic.

** Species has a CAL-IPC "Alert" status indicating significant potential for invading new ecosystems.

Ubiquitous non-native annuals are also present throughout the Preserve and comprise the majority of species in the non-native grassland on site, which is dominated by foxtail chess *(Bromus madritensis)*, wild oat (*Avena fatua*), tocalote (*Centaurea melitensis*), and shortpod mustard (*Hirschfeldia incana*). While non-native grassland consists primarily of non-native plant species, it is considered a natural vegetation community under the County's MSCP because it is a naturalized community that provides habitat for native and sensitive plants and animal species. Therefore, non-native grassland plant species are not included in this management plan for removal or control. Non-native annual plant species that are common to the Preserve are shown in Table 6.

Table 6
Non-Native Annual Plant Species at the Del Dios Highlands Preserve

Scientific Name	Common Name
Avena barbata; A. fatua	Wild oat
Brassica nigra	Black mustard
Bromus diandrus	Ripgut brome
Bromus hordeaceus	Soft brome
Bromus madritensis ssp. *rubens*	Foxtail chess
Centaurea melitensis	Star thistle
Erodium cicutarium	Redstem filaree
Hirschfeldia incana	Shortpod mustard



DUDEK

6680-1D

SOURCE: Digital Globe 2008

FIGURE 6

Target Invasive Non-Native Plant Species Locations and Potential Restoration Areas

Final Del Dios Highlands Preserve - Vegetation Management Plan

INTENTIONALLY LEFT BLANK

3.1 Target Invasive Species

Ten of the eighteen invasive non-native plant species observed within the Preserve have been identified as target species in need of removal and control. A removal priority ranking system was established for these target species to assist management efforts. The criteria used for assigning removal priority rankings for the invasive non-native species included an evaluation of the Cal-IPC rating, the current cover and distribution in the Preserve, the potential for invading sensitive habitat, and the potential for increasing fire intensity. These species and associated management/control recommendations are presented below along with a removal priority ranking. Table 7 summarizes this information. Species ranked as high priority are recommended for control as soon as possible; species ranked as moderate priority are recommended for control as soon as high priority species are under control; and species ranked as low priority are recommended for control after high and moderate priority species are under control.

Table 7
Removal Priority of Target Invasive Non-Native Species

Scientific Name	Common Name	Removal Priority
Eucalyptus spp.	Eucalyptus	High
Cortaderia selloana	Pampas grass	Moderate
Nicotiana glauca	Tree tobacco	Moderate
Pennisetum setaceum	Fountain grass	Moderate
Tamarix ramosissima	Tamarisk, salt cedar	Moderate
Washingtonia robusta	Mexican fan palm	Moderate
Carpobrotus edulis	Hottentot fig, iceplant	Low
Foeniculum vulgare	Sweet fennel	Low
Olea europa	Olive	Low
Schinus molle	Peruvian peppertree	Low

3.1.1 High Priority Species

Eucalyptus trees (*Eucalyptus* spp.)

Mainly located in an upland area in the northeastern portion of the Preserve, eucalyptus trees cover approximately 7.68 acres (Figure 6). The majority of the eucalyptus trees within the Preserve are blue gum (*Eucalyptus globulus*), with a few numbers of other eucalyptus species also present. Many of the eucalyptus trees were burned in the recent wildfire (2007) and are re-growing. There are also indications of control measures that have been implemented on some of the individuals, as evidenced by recent die-back of foliage. While the Cal-IPC inventory

categorizes Eucalyptus species as having overall ratings of "limited" or "moderate", they are ranked as a high priority for removal/control in the Preserve because of their tendency to displace native vegetation communities, the extent of their presence, and observed propagation of new saplings. In addition, this species is of concern for fire hazard since its physical characteristics (resin content) can increase fire intensity, transition ground fire to crown fires, and propagate spot fires through the dislodging of canopy material during windy conditions. Therefore, the best treatment for eucalyptus removal is through mechanical removal and herbicidal treatments. Eucalyptus trees may be cut and sprayed with the appropriate herbicide, or trees may be removed with the use of girdling and herbicidal treatment. Herbicides should be applied within the first 1 to 2 minutes following cutting. Trees can be girdled past the xylem/phloem and treated with an appropriate herbicide. Follow-up herbicidal treatment may be necessary since sucker growth may occur.

3.1.2 Moderate Priority Species

Pampas grass (*Cortaderia selloano*)

Pampas grass is a large, clumping grass, about 6–8 feet (1.8–2.4 meters) tall. It is an aggressive spreading, ornamental species that produces significant amounts of biomass, which is extremely flammable, thus increasing the potential for fire ignition and/or spread. This species produces an abundance of seed, which is light, and can be windblown into the surrounding areas. The Cal-IPC inventory categorizes pampas grass as having an overall rating of "high"; however, it is ranked as a moderate priority for removal/control within the Preserve because of its limited distribution and location within upland habitat (as opposed to riparian habitat) where it is less likely to spread rapidly. This species was observed within southern mixed chaparral in the north-central portion of the Preserve, and in a disturbed area along a roadway at the southern end of the Preserve, totaling approximately 150 square feet (Figure 6). Treatment and removal of pampas grass involves either hand digging or pulling/winching plants out of the ground. If complete removal of the plant is not feasible, it may be cut to near the ground surface and treated with an appropriate herbicide. Treatment is recommended to occur prior to seed-set, and if viable seed is present at the time of treatment, plumes should be carefully cut and bagged to prevent seed spread.

Tree tobacco (*Nicotiana glauca*)

Tree tobacco is an invasive tree/shrub that was first introduced in California as an ornamental, but has escaped and frequently colonizes areas of soil disturbance in a variety of upland habitats. It is a prolific seed producer and has a high rate of spread. The Cal-IPC inventory categorizes tree tobacco as having an overall rating of "moderate", and it is ranked as a moderate priority for

removal/control within the Preserve because of the species tendency to establish in disturbed areas and its limited presence in established habitat. Approximately 600 square feet of tree tobacco was observed in the Preserve, located in the northeastern corner in or near areas of disturbance (Figure 6). Mechanical removal is recommended, with an appropriate herbicide applied to remaining stump and plant parts. Follow-up treatments may be necessary.

Fountain grass (*Pennisetum setaceum*)

Fountain grass is a smaller clumping grass that has spread in large part due to its popularity as an ornamental plant. This species possesses a low ability to displace well-established native upland vegetation communities and will primarily colonize disturbed areas, or areas of naturally occurring sparse vegetation, such as sandy/rocky outcroppings on slopes. Fountain grass is well-adapted to fire and can increase in density following a burn. A total of 5.42 acres of fountain grass has been mapped within the eastern and southeastern portions of the Preserve (Figure 6). The Cal-IPC inventory categorizes fountain grass as having an overall rating of "moderate", and it is ranked as a moderate priority for removal/control within the Preserve due to its high abundance within portions of the Preserve, but limited ability to displace established habitats. Recommended control for this species includes treatment with an appropriate herbicide prior to the development of mature seed heads. Should control not occur prior to maturation of seed, it is recommended that the seed heads be removed, bagged, and disposed of off site, with the remaining grass bunch receiving an herbicide treatment. Since the majority of the fountain grass stands occurring in the Preserve are located on steep, sparsely vegetated slopes, herbicide treatment would be preferable to hand-pulling due to soil disturbance.

Tamarisk (*Tamarix ramosissima*)

Tamarisk (also known as salt cedar) is a shrub or tree typically found along waterways, drainages and riparian areas. It is associated with dramatic changes in geomorphology, groundwater availability, soil chemistry, fire frequency, plant community composition, and native wildlife diversity. Tamarisk presents the greatest risk of reducing habitat quality within riparian areas, which are limited in presence within the Preserve. Tamarisk was observed within drainages in the northeastern portion of the Preserve, with a footprint of approximately 350 square feet (Figure 6). The Cal-IPC inventory categorizes tamarisk as having an overall rating of "high"; however, it is ranked as a moderate priority for control within the Preserve because of its limited extent within the Preserve, and because the drainage in which it occurs contains well-established riparian habitat. Because tamarisk is a sizable plant, it can be controlled by mechanical methods. Application of an appropriate herbicide is recommended for remaining stumps and plant parts since root fragments can regenerate. Removed invasive plants should be properly disposed of at

off-site facilities. The area from which tamarisk would be removed is potentially appropriate for replanting with other native riparian plant species.

Mexican Fan Palm (*Washingtonia robusta*)

Mexican fan palm is a species of palm tree commonly used for landscaping, which has become invasive in riparian areas, orchards, and landscaped areas. It is known to create monotypic stands in riparian areas, and dead fronds of the tree can create a fire hazard. It can spread into native vegetation communities through seeds being washed downstream in drainages, or birds dispersing seeds into areas with sufficient soil moisture for the palm to germinate and establish. The Cal-IPC inventory categorizes Mexican fan palm as having an overall rating of "moderate" and designates is as an Alert species, indicating it has significant potential to invade new ecosystems. This species is ranked as a moderate priority for removal/control within the Preserve due to its potential for additional colonization within the drainage and its limited distribution. One occurrence of Mexican fan palm was observed growing in a drainage area in the northeast corner of the Preserve (Figure 6). Control for this tree may include mechanical removal and treatment of the stump with an appropriate herbicide. Alternatively, the palm may be drilled, injected with an appropriate herbicide, and left in place to die if removal is not desired. Complete mechanical removal would be preferable from a fire management perspective since this would reduce the available deadwood fuel load present.

3.1.3 Low Priority Species

Hottentot fig (*Carpobrotus edulis*)

Hottentot fig (also known as iceplant) is a succulent shrub that was introduced as an ornamental plant. Hottentot fig spreads laterally over the ground as nodes on the plant produce roots, which establish and support continued lateral spreading. This species has been known to invade native areas adjacent to where it is planted and "carpet" over existing plants. The dense mats it creates also increase soil organic matter over time, allowing new non-native species to invade. Control of this species can be difficult because even small stem fragments can regenerate into a new plant. This species has colonized less than 300 square feet adjacent to Mt. Israel Road in the southeastern part of the Preserve (Figure 6). The Cal-IPC inventory categorizes hottentot fig as having an overall rating of "high"; however, it is ranked as a low priority for removal/control within the Preserve due to its limited distribution and the disturbed nature of the habitat surrounding its location. Recommendations for control include hand removal and disposal of plant material off site, with follow-up hand removal or herbicide treatments for resprouts.

Olive (*Olea europa*)

This non-native species of olive tree is commonly grown as a crop in California. This species is a concern due to the potential of spread from orchards, but while it is a major invasive in Australia, it does not appear to be spreading in California. One occurrence of olive was observed growing near the Preserve entrance and parking area off of Del Dios Highway in the northeastern corner of the site (Figure 6). The Cal-IPC inventory categorizes olive as having an overall rating of "limited", and it is ranked as a low priority for removal/control within the Preserve due to its limited distribution and low potential to colonize the surrounding area. Recommended control of this species may include mechanical removal and treatment of the stump with an appropriate herbicide.

Peruvian peppertree (Schinus molle)

Peruvian peppertree is an ornamental tree that can invade into natural areas with suitable soil moisture through shoot sprout or seed dispersal by birds or stream flows in drainages; however, it is reported as only mildly invasive. One occurrence of this species was observed near the Preserve entrance and staging area off the Del Dios Highway in the northeastern portion of the Preserve (Figure 6). The Cal-IPC inventory categorizes Peruvian peppertree as having an overall rating of "limited", and it is ranked as a low priority for removal/control within the Preserve due to its limited distribution and low potential to colonize the surrounding area. Recommended control methods include mechanical removal and application of an appropriate herbicide to remaining stump and plant parts. Follow-up herbicide control may be required.

Sweet Fennel (*Foeniculum vulgare*)

Sweet fennel is a perennial herb common throughout the state. It can drastically alter the composition and structure of many plant communities, including grasslands, coastal scrub, riparian, and wetland communities. In addition, it can also alter fire regimes, creating an intense, fast-moving fire. Sweet fennel was observed next to a dirt road within southern mixed chaparral in the north-central part of the Preserve, and along the entrance road off of Del Dios Highway in the northeastern portion of the Preserve (Figure 6). Approximately 400 square feet of this species was observed in total. The Cal-IPC inventory categorizes fennel as having an overall rating of "high"; however, it is ranked as a moderate priority for removal/control in the Preserve due to its limited extent. Recommended control methods include cutting the plants close to the ground and treatment with an appropriate herbicide. Control should be performed prior to seed-set; however, if viable seed is present at the time of control, seed heads should be bagged and disposed of appropriately off site. Follow-up herbicide applications may be necessary for control.

3.2 Removal Methods

The selection of the appropriate removal methodology should be determined with consideration of many variables, including the time of year, severity of infestation, the presence of sensitive plants and wildlife, the degree of intermixing of invasive species with sensitive native habitats, access, and proximity to surface water. The U.S. Army Corps of Engineers and CDFG should be consulted regarding potential permitting requirements if invasive removal will occur in waterways or wetlands under their jurisdiction. General recommendations for the Preserve are provided below.

3.2.1 Manual Removal

Manual vegetation removal (e.g., hand pulling, grubbing, and hoeing) is a low-impact method of controlling non-native species within a focused area dominated by native vegetation. Due to the perennial nature of the target invasive plant species, their size, and difficulty of control, manual vegetation removal has limited application within the Preserve. Appropriate applications for manual removal are for small occurrences of annual weeds and seedlings of perennial species when complete removal of the root system is possible. More mature perennial plants will limit the ability for manual removal based on their size and root mass. Manual removal should be incorporated where herbicide application alone is inadequate, or where proximity of sensitive plant species prevents safe application (e.g., overspray or drifting of herbicides). In accordance with Implementation Measure B.2.1 of the Resource Management Plan for the Preserve (County of San Diego 2009b), it is anticipated that DPR park rangers will routinely pull weeds or remove non-native plant species in early stages of growth when found along trails and will coordinate with volunteer groups to remove non-native plant species at locations identified during invasive plant surveys and monitoring. All removed non-native plant material that is feasible (portions of trees may be too large to remove without significant effort or impact) should be disposed of properly off site.

3.2.2 Mechanical Removal

Mechanical removal may be necessary for control of some larger target invasive species, such as eucalyptus, fan palms, pampas grass, and tamarisk, and is recommended to be combined with herbicide application. Cutting and removal of the aboveground plant material can be conducted with chainsaws and/or hand saws. The resulting material should be chipped and hauled off site. Subsequent application of herbicides should follow product guidelines for safe transport, storage, and application. Stumps remaining on site after cutting and herbicide application are not recommended for removal or grinding, but should be left to decompose in place.

3.2.3 Herbicides

The application of herbicides to control target invasive species may be used on its own or as a secondary treatment following manual or mechanical removal for controlling sprout growth and regeneration. Herbicide application is recommended following removal of all target invasive tree species and other perennial species with the ability to regenerate root fragments when removal of all plant material is not feasible. Herbicide use should be limited to localized applications rather than foliar applications to eliminate the possibility of drift and impacts to neighboring desirable species. A wide range of herbicides are available for such types of treatment. Herbicide labels and material safety data sheets (MSDS) list susceptible target plant species and provide proper direction in the use and handling of the products. Herbicides should be applied by state licensed applicators.

3.2.4 Cut and Daub

Cut and daub treatment is recommended for larger invasive plants to control regrowth and kill the portion of the plant remaining belowground. Cut and daub involves the cutting of invasive plant stalks and then the direct application of an appropriate herbicide directly to the freshly cut stump. Other related methods include drill and fill where holes are drilled into the trunk of a tree and herbicide is injected; or the glove method, where an herbicide-soaked glove is used to apply directly to plant foliage or freshly cut stumps. It is critical that the herbicide treatment occur immediately after the plants are severed so that the herbicide is carried into the plant tissue. If enough time elapses to allow the cut surface of the severed plant to dry out, a fresh cut should be made prior to herbicide application.

4.0 HABITAT RESTORATION

The goal of habitat restoration is to reestablish or enhance the biological functions and values of vegetation communities that have been degraded by either human or natural causes. Restoration methods range from active revegetation (involving soil preparation and planting), to passive management (involving weed control and allowing time for natural recruitment to occur). Active restoration may assist the recovery of an area that has been disturbed and is showing difficulty in recovering. Any proposed restoration activity should utilize current, accepted techniques and avoid/minimize impacts to sensitive species or native vegetation communities. Any proposed revegetation activities should use only local native species. The purpose of restoration within the Preserve is to reclaim native vegetation community acreage lost or compromised due to human or other induced disturbance involving the clearing or grading of native vegetation. Restoring disturbed areas will provide an overall increase of acreage of native vegetation, connectivity of existing native vegetation, and erosion control in

areas of disturbance. Restoration of these areas is important to the integrity of the surrounding vegetation communities, as cleared areas can provide opportunity for non-native species to colonize (many non-native annuals are flashy fuels that can increase fire danger), provide opportunity for erosion by exposing the soil surface, reduce acreage of native vegetation communities, and sever connectivity among vegetation communities.

4.1 Proposed Restoration Areas

The Preserve is generally composed of high-quality native vegetation communities, and habitat restoration opportunities are limited within the Preserve. Within the Preserve, 3.8 acres of disturbed habitat are proposed for restoration, which primarily include old dirt road spurs and graded turnarounds. These are located in the north-central and southeastern portions of the site, among southern mixed chaparral, as shown in Figure 3. These are areas that were graded at various times in the past, and are no longer necessary for through-traffic, turn-outs, equipment storage, or access to specific locations. Some of these graded dirt road spurs are located on steep terrain and show signs of erosion, due in part to a lack of vegetation cover.

4.2 Restoration Methods

Two methods of restoration are proposed for the disturbed areas within the Preserve: (1) passive restoration, and (2) active restoration. Restoration areas are shown on Figure 6, numbered 1–13.

4.2.1 Passive Restoration

Passive restoration involves performing weed and erosion control, as needed, in disturbed areas where natural recruitment of native plant species is actively occurring. These restoration areas are numbered 4, 6, and 7, on Figure 6. Grading has occurred in the past in these areas, but they are currently recruiting native southern mixed chaparral species found in the adjacent vegetation communities. Since the process of recruitment and establishment of native plant species has already begun, no soil disturbance (e.g., ripping, tilling, grading) or other soil preparation is recommended. Based on individual site conditions, erosion control measures and weed control should be conducted where necessary. Erosion control features will help to limit further erosion and soil loss and, if installed correctly, will capture sediments that can create areas for native plants to establish. Passive restoration areas should be maintained weed free to allow native recruitment to continue until the area is reincorporated back into southern mixed chaparral. Should natural recruitment slow or stop over time, seed application and/or container plants could be incorporated.

4.2.2 Active Restoration

Active restoration involves soil preparation and planting of disturbed or degraded areas where native vegetation recruitment is not actively occurring. Active restoration is recommended on cleared areas that are not showing significant natural recruitment of native plant species, and/or that are degraded from erosion. These areas are numbered 1-3, 5, and 8-13 on Figure 6. These areas should be prepared prior to planting by ripping the soil, incorporating organic matter, and recontouring to natural contours. Appropriate erosion control measures should be installed after site preparation activities to limit further erosion and soil loss. Upon completion of site preparation activities, native seed and container plants could be installed. Weed control should be performed regularly to allow container plants to establish and transition the area to southern mixed chaparral.

Preparation of the soil should begin with ripping to loosen the soil surface layer and disrupt existing erosional/drainage features on sloped sites. It is recommended that the sites are ripped to a depth greater than 12 inches and amended with organic matter to assist in creating soil structure to reduce settling. Ripping a soil without incorporation of organic matter provides only temporary and marginal initial increase in infiltration capacity and soil structure improvement, and soil settlement and surface sealing can occur and reduce or negate any positive gains to soil structure (Luce 1997). No fertilizer is recommended for addition to the amendments since this can favor establishment of faster growing, annual non-natives. The final ripping/tilling pattern should avoid having the "rows" parallel to the fall line of the slope to reduce the presence of microtopography, which may assist formation of rill or gully erosion.

Following ripping and any necessary recontouring, seed and/or container plants could be installed. Plant materials should be native species from San Diego County, originating within 25 miles from the site. Tables 8 and 9 provide a seed mix and plant palette for areas of active restoration. These are native species that are common to the southern mixed chaparral found in the Preserve. Quantities, rates, and composition should be determined on an individual basis, based on the existing plant composition around the restoration sites. Additional native species appropriate to the adjacent vegetation community may be added as appropriate.

Table 8
Chaparral Seed Mix

Scientific Name	Common Name	% Purity	% Germination	Pounds/Acre
Achnatherum coronatum	Giant needlegrass	70	40	2
Adenostoma fasciculatum	Chamise	90	20	4
Baccharis sarothroides	Desert broom	5	40	0.5
Ceanothus tomentosus var. olivaceus	Woolly leaf ceanothus	95	65	2

Table 8 (Continued)

Scientific Name	Common Name	% Purity	% Germination	Pounds/Acre
Eriogonum fasciculatum	California buckwheat	10	65	4
Eriophyllum confertifolium	Golden yarrow	30	50	0.1
Eschscholzia californica	California poppy	98	75	0.5
Hazardia squarrosa	Sawtooth goldenbush	10	20	2
Helianthemum scoparium	Rock rushrose	95	60	0.5
Lasthenia californica	California goldfields	50	60	0.5
Lessingia filaginifolia	Sand aster	2	4	2
Lotus scoparius	Deerweed	95	40	0.5
Lupinus bicolor	Pygmy lupine	98	80	2
Malacothamnus fasciculata	Chaparral mallow	15	60	4
Malosma laurina	Laurel sumac	95	60	0.5
Mimulus aurantiacus puniceus	Sticky monkeyflower	2	60	0.5
Nassella lepida	Foothill needlegrass	90	60	2
Plantago erecta	Dot seed plantain	98	75	1
Rhamnus crocea	Spiny redberry	90	40	3
Rhus integrifolia	Lemonade berry	90	60	4
Salvia mellifera	Black sage	70	50	1
Vulpia microstachys	Small fescue	90	80	1
Xylococcus bicolor	Mission manzanita	90	40	4
			Total	**41.6**

Table 9
Chaparral Container Plant Species

Scientific Name	Common Name	Average Spacing, Feet on Center
Adenostoma fasciculatum	Chamise	4
Baccharis sarothroides	Desert broom	4
Ceanothus tomentosus var. *olivaceus*	Woolly leaf ceanothus	5
Ceanothus verrucosus	Wart-stemmed ceanothus	5
Eriogonum fasciculatum	California buckwheat	4
Hazardia squarrosa	Sawtooth goldenbush	4
Malacothamnus fasciculata	Chaparral mallow	6
Malosma laurina	Laurel sumac	8
Mimulus aurantiacus puniceus	Sticky monkeyflower	5
Rhamnus crocea	Spiny redberry	5
Rhus integrifolia	Lemonade berry	8
Salvia mellifera	Black sage	5
Xylococcus bicolor	Mission manzanita	5

Because the potential restoration areas are not easily accessible and lack an irrigation system to help in establishing plants, restoration should prioritize seed application over container plant installation.

Chaparral species are challenging to establish from seed due to natural seed inhibitors. Therefore, the recommended seed mix includes pioneer species that should help establish vegetative cover until climax species are eventually recruited (Table 8). Seed application should occur prior to the onset of the winter rainy season to take advantage of the full growing season. An effective seed application technique would be to hand broadcast seed, rake into the soil, and cover with a fine mulch seed topper at approximately 1/4-inch depth. The fine mulch seed topper helps protect the seed from getting eaten by birds and rodents, and also helps keep the soil moist during the rainy season.

If container plants are installed, they should be installed in the fall at the onset of the rainy season. Without supplemental irrigation, installation of container plants will likely have limited success. Standard planting procedures should be employed for installing container plants. All container plants should be checked for viability and general health prior to installation. Holes approximately twice the size of the root ball of the plant should be dug using a shovel, post hole digger, or power auger. Holes should be filled with water and allowed to drain immediately prior to planting. Backfill soil containing amendments (such as a fertilizer tab, or equivalent), as directed by the project's biologist, should be placed in every planting hole following soaking, and container plants should be installed so that the top of the root ball is at grade or slightly above grade. Plants should be monitored for signs of stress or mortality. In the months following planting, and especially if dryer than average conditions exist, periodic hand watering may be necessary to help establish the plants. Many native southern mixed chaparral species are evergreen, and are adapted to seasonal drought conditions. Chaparral species that can be planted from container stock are included in Table 9.

5.0 FIRE MANAGEMENT

5.1 Current Fire Management Practices

Currently, fire management practices in the Preserve include maintenance of fuel modification zones and defensible space as follows:

- 30-foot fuel modification zone along the entire northeastern border where the Preserve abuts residential development. (This fuel modification zone on the Preserve provides the adjacent residences a 100-foot buffer as measured from the residential structures.)
- 30-foot fuel modification zone from the right-of-way of Del Dios Highway along the entire eastern border of the Preserve.
- 30-foot fuel modification zone from the right-of-way of Mt. Israel Road along the southern border of the Preserve.
- 30-foot fuel modification zone around the perimeter of the staging area.

Additionally, there are other activities associated with fire management that are implemented on the Preserve. These activities are related to emergency response and access. Among them are:

- In the event of a fire, the main entrance road and designated multi-use trail that extends from Del Dios Highway through the northern portion of the Preserve serves as an access road. Roads and trails have been successfully used for fire containment in large fires (e.g., Witch Fire 2007), and the Preserve trail provides the opportunity for access and fire operations.
- The existing trail/access road is maintained, as needed, to remove fuels and to maintain a 10- to 20-foot-wide travel surface.
- Waterbars occurring along the primary trail/access road are designed and maintained for consistency with emergency vehicle travel – although the number of waterbars and the need for fire apparatus to slow significantly would hinder access.
- Locks from RSFFPD, EF/HGFD, and EFD have been placed on all Preserve gates on site. Coordination with CAL FIRE, RSFFPD, EF/HGFD, and EFD continues.

An analysis of the fire environment has been conducted as part of this VMP. This analysis, presented in the following sections, provides the basis for evaluation of existing fire management practices and their adequacy for meeting Preserve goals and providing for public safety.

5.2 Fire Environment

Several factors comprise the fire environment. Fires can occur in any environment where conditions are conducive to ignition and fire movement. The three major components of fire environment are climate, topography, and vegetation/fuels. The state of each of these components and their interaction with each other determine the potential characteristics and behavior of a fire at any given moment. Understanding these existing conditions is necessary to understanding the potential for fire within and around the Preserve.

Wildfires are a regular and natural occurrence in most of Southern California. However, increasing numbers of fires and acres burned annually has been experienced over the last decade. These wildfires are mostly human-caused, suggesting that the historic fire interval has been artificially affected across large areas. In addition, wildfire suppression efforts over the last several decades may have aided in the accumulation of fuels in some natural communities (Minnich 1983; Minnich and Chou 1997) resulting in larger and more intense wildfires. Large wildfires have had, and will continue to have, a substantial and recurring role in native California landscapes (Keeley and Fotheringham 2003), in part because (1) native landscapes become highly flammable each fall, (2) the climate in the region has been characterized by fire

climatologists as the worst fire climate in the United States (Keeley 2004) with Santa Ana winds occurring during autumn after a 6-month drought period each year, and (3) ignitions via anthropogenic sources have increased or are increasing in many wildland or WUI areas.

Based on available information and an understanding of the fire environment of the region, it is expected that large wildfires will occur again and will burn within the Del Dios Highlands Preserve.

5.2.1 Climate

As with most of Southern California, the Preserve area is influenced to a certain extent by the Pacific Ocean and is frequently under the influence of a seasonal, migratory, subtropical high-pressure cell known as the Pacific High. Typical of a Mediterranean climate, wetter winters and dry summers, with mild seasonal changes, generally characterize the Southern California region. This climate pattern is occasionally interrupted by extreme periods of hot weather, winter storms, or dry, easterly Santa Ana winds.

Additionally, the local vegetation and the seasonal drying produce climatic conditions that result in fuel-driven wildfires and fire-associated climatic changes. This type of condition is referred to as a plume-dominated wildfire. Plume-dominated wildfires are fires where the energy produced by the fire in conjunction with atmospheric instability creates significant convective forces and increased winds. Such fires are extremely unpredictable, spread in various directions simultaneously, and exhibit extreme fire behavior. These fires are extremely dangerous and are often large in size.

The inland location of the Preserve affects the degree of influence of the Pacific Ocean, resulting in less regulated temperatures. The average high temperature for this area is approximately 77.7º Fahrenheit (F), with higher temperatures in summer and early fall (July through October) averaging between 87°F and 89°F. A record high temperature of 107°F at the nearby Summer Creek weather station was recorded on September 27, 2010, although this extreme temperature is rarely approached. The mean precipitation for the area is 15.1 inches per year, with the majority of rainfall concentrated in the months of December (1.78 inch), January (3.37 inches), February (3.16 inches), and March (3.30 inches).

The prevailing wind pattern is from the west, but the presence of the Pacific Ocean causes a diurnal wind pattern known as the land/sea breeze system. During the day, winds are typically from the west–southwest (sea), and at night, winds are from the northeast (land). During the summer season, the diurnal winds can be slightly stronger than the winds during the winter season due to greater pressure gradient forces. Surface winds can also be influenced locally by topography and slope variations. On the Preserve, the varied topography may affect wind velocity and patterns. The highest wind velocities are typically associated with downslope, canyon, and Santa Ana winds.

The fire season in Southern California typically starts in June, as vegetation begins to dry out after winter and spring rains, and typically ends in October, although fire weather may be present year-round (Schroeder and Buck 1970). The highest fire danger for this area coincides with the Santa Ana winds. Santa Ana wind conditions are a reversal of the prevailing southwesterly winds that usually occur on a region-wide basis during late summer and early fall. They are dry, warm winds that flow from the higher desert elevations in the north through the mountain passes and canyons. As they converge through the canyons, their velocities increase. Consequently, peak velocities are highest at the mouths of canyons and dissipate as they spread across valley floors.

General weather conditions for the region were derived from the Summer Creek weather station[1] and are presented in Table 10. Additional weather variables were analyzed to determine extreme fire weather conditions, specifically, 97th percentile wind and fuel moisture conditions to be used in the fire behavior modeling efforts conducted for the Preserve. The fire weather variables and an analysis of fire behavior for the Preserve are presented in Section 5.0 and Appendix C.

Table 10
General Weather Conditions for the Del Dios Highlands Preserve

Season	Wind Speed (mph)		Air Temp. (°F)			Humidity (%)			Avg. Monthly Precipitation (in.)
	Avg.	Max.	Avg.	Max.	Min.	Avg.	Max.	Min.	
Summer (6/21–9/21)	8.7	15.0	73	106	55	59	88	8	0.06
Fall (9/22–12/20)	7.1	24.0	63	107*	38	56	95	6	0.66
Winter (12/21–3/19)	7.8	32.0	56	84	36	54	92	4	2.77
Spring (3/20–6/20)	9.6	17.0	64	96	44	60	88	8	1.54

* The high temperature of 107°F occurred on September 27, 2010.

5.2.2 Topography

The topography of the Preserve includes moderate and steep slopes with elevation ranges from approximately 480 to 1,300 feet amsl. Primary ridgelines extend north-south while smaller ridges associated with drainages on the face of the east-facing slope tend to be east-west trending. Elevations generally rise from the east to the west and from the north to the south with the exception of small drainages that occur on the northeast facing slopes above Del Dios Highway and in the northernmost portion of the Preserve. The northwestern portion of the Preserve is situated within San Elijo Canyon and is characterized by steep, primarily north- and northwest-facing slopes that form the southern canyon rim. Escondido Creek flows through the bottom of San Elijo Canyon, adjacent to Harmony Grove Road. The canyons and drainages characterizing this area contain the steepest

[1] The Summer Creek station is located in Escondido, approximately 1.3 miles northeast of the Preserve. The following summarizes the location and available data ranges for the Summer Creek weather station: Latitude: 33.096; Longitude: -117.116; Elevation: 820 feet; Data years: 2006 to 2011.

slopes observed on the Preserve, with slope gradients reaching 140% (approximately 55°) in some areas. A topographic feature that may present a fire spread facilitator is the "saddle" located in the northern portion of the property. The saddle is southeast/northwest trending, so is not wind aligned, but slope is favorable and wind funneling may occur due to local terrain.

5.2.3 Watershed Description

The northwestern portion of the Preserve is located within the Carlsbad Watershed, and the southwestern portion is within the San Dieguito Watershed. A series of east-west trending ridgelines intersect in multiple locations and help define drainage across the Preserve. Typically, precipitation drains east to the San Dieguito River, north to Escondido Creek, or south and west to the Mt. Israel Reservoir (Olivenhain Reservoir). The north-south trending backbone ridge in the Preserve influences the majority of drainage to the east to Lake Hodges and then down the San Dieguito River. The San Dieguito River flows southwest, ultimately draining into the Pacific Ocean approximately 8 miles from the Preserve.

5.2.4 Fire History

Fire history is an important component in understanding fire frequency, fire type, significant ignition sources, and vulnerable areas. The topography, vegetation, and climatic conditions associated with the Preserve combine to create a unique situation capable of supporting large-scale, high-intensity wildfires, such as the Witch Creek Fire in 2007. The history of wildfires on the Preserve is graphically portrayed in Figure 7.

Based on historical fire perimeter data (FRAP 2011)[2], nearly all of the Preserve has burned at least once during the recorded data period, with fires occurring in 1919, 1943, 1980, 1985, 1990, 1997, and 2007. Some areas of the Preserve have burned as many as four times dating to 1919. Table 11 presents the quantity of times the Preserve has burned by land area (acreage).

[2] Based on polygon geographic information system (GIS) data from CAL FIRE's Fire and Resource Assessment Program (FRAP), which includes data from CAL FIRE, U.S. Department of Agriculture Forest Service Region 5, Bureau of Land Management, National Park Service, Contract Counties and other agencies. The data set is a comprehensive fire perimeter GIS layer for public and private lands throughout the state and covers fires 10 acres and greater between 1878 and 2008.

Table 11
Quantity of Del Dios Highlands Preserve Wildfires

Quantity of Times Burned*	Acreage	Percentage
0	2.53	0.3
1	491.50	62.9
2	116.29	14.9
3	151.39	19.4
4	20.15	2.6
Total	**781.86**	**100.0**

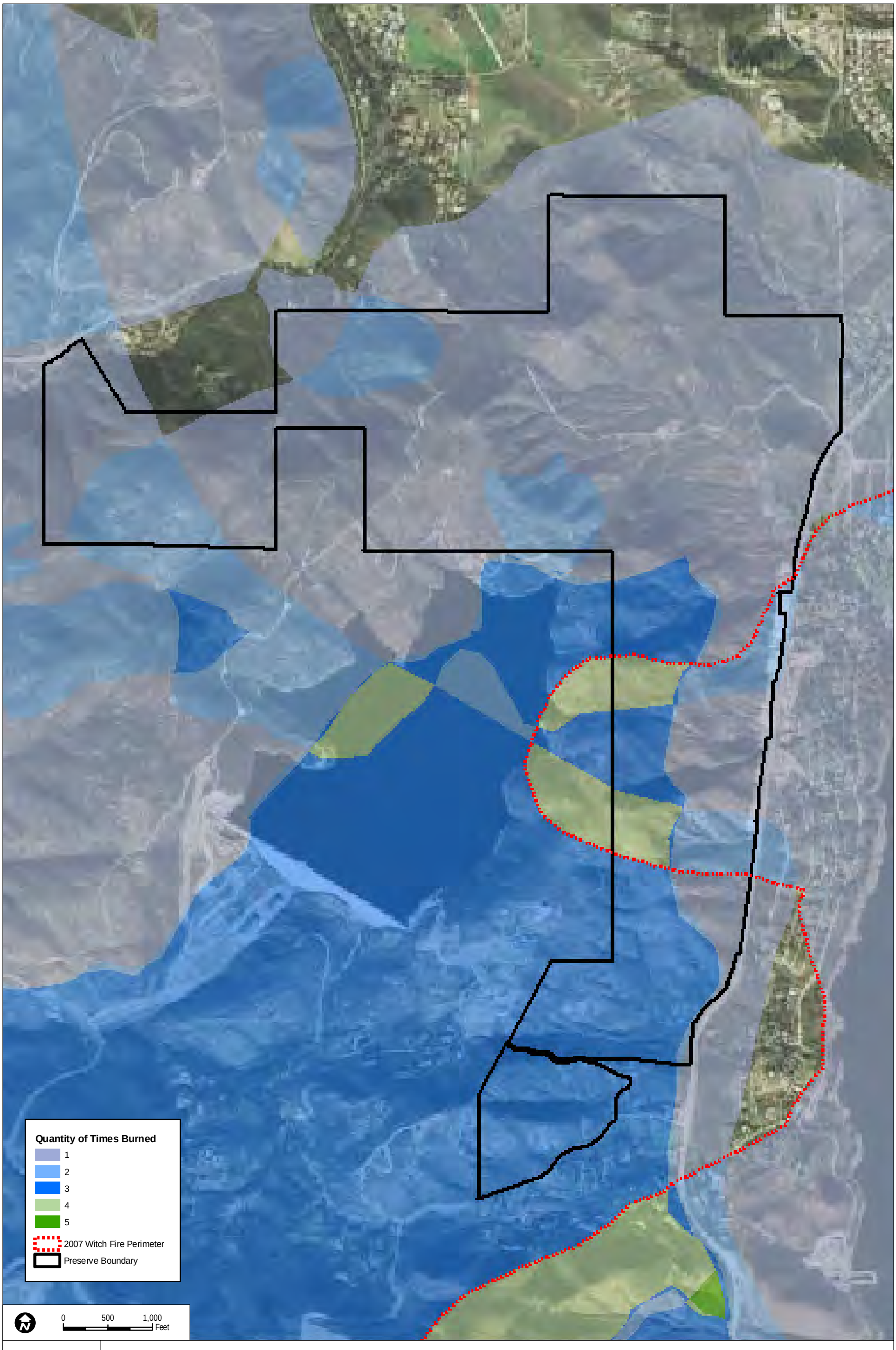
*FRAP 2011

Based on an analysis of this fire history data set, specifically the years in which the fires burned, the average interval between wildfires on the Preserve was calculated at 15 years with intervals ranging between 5 and 37 years. Based on this analysis, it is expected that the Del Dios Highlands Preserve would be subject to wildfire occurrence every 15 years, with the realistic possibility of shorter interval occurrences. Table 12 presents the fire interval data for the Preserve.

Table 12
Fire Intervals for the Del Dios Highlands Preserve

Fire Year*	Fire Name	Interval (years)	Acreage Burned on Preserve	Percent of Preserve Burned**
1919	Unnamed Fire	N/A	172.55	22.1
1943	Unnamed Fire	24	220.88	28.3
1980	Elfin Fire	37	34.68	4.4
1985	Israel Fire	5	24.84	3.2
1990	Paint Fire	5	175.87	22.5
1997	Del Dios Fire	7	534.47	68.4
2007	Witch Fire	10	95.58	12.2

*FRAP 2011
**Based on total Preserve acreage of 781.8



DUDEK

SOURCE: SanGIS 2007; Digital Globe 2008; FRAP 2011

FIGURE 7

Fire History Map

6680-1D

INTENTIONALLY LEFT BLANK

Based on an analysis of the fire history, vegetation age classes on the Preserve vary depending on the extent and location of fire-free periods. Specifically, over 65% of the vegetation on the Preserve is 13 years old, burning most recently in the 1997 Del Dios Fire. The remaining vegetation on site is a mixture of age classes, including: 3-year-old vegetation resulting from the 2007 Witch Fire (12.2%); 20-year-old vegetation resulting from the 1990 Paint Fire (14.5%); 30-year-old vegetation resulting from the 1980 Elfin Fire (1.3%); 67-year-old vegetation resulting from the unnamed 1943 fire (6.3%); and vegetation older than 100 years (0.3%), which has not burned during the recorded fire history period. While younger vegetation is generally considered less susceptible to fire than the older vegetation, all vegetation is capable of igniting and carrying fire, especially during extreme weather (Red Flag Warning Conditions) and over time, the younger age vegetation will become more susceptible to fire ignition and spread.

5.2.5 Vegetation Dynamics and Fuel Loads

Utilizing site vegetation maps, field evaluations were conducted to evaluate fuel loading and classify vegetation types into fuel models (Anderson 1982; Scott and Burgan 2005; Weise and Regelbrugge 1997). Fuel model assignments are presented in Table 13 by vegetation type and are graphically presented in Figure 8. Certain vegetation types increase fire hazard based on plant physiology (resin content), biological function (flowering, retention of dead plant material), and/or physical structure (leaf size, branching patterns). Specifically, the following chaparral and sage scrub species found throughout the majority of the Preserve are considered to exhibit higher potential hazard based on such criteria: coastal sagebrush (*Artemisia californica*), chamise, California buckwheat, and black sage.

In addition, non-native invasive plants can increase the frequency of fires by providing more continuous fuels that are more easily ignited (Brooks et al. 2004). Invasive plants also present hazards when located adjacent to neighboring structures or within fuel modification zones that are meant to provide defensible space. Non-native invasive species of the greatest concern within the Preserve include tamarisk, pampas grass, sweet fennel, and eucalyptus (Figure 6).

Table 13
Vegetation Communities and Associated Fuel Models for the Del Dios Highlands Preserve

Vegetation Community/Land Cover	Fuel Model	Acres	Percentage
Coast Live Oak Woodland	9	15.1	1.9
Diegan Coastal Sage Scrub	SCAL18	5.0	0.6
Disturbed Habitat	1	13.9	1.8
Eucalyptus Woodland	TU5	3.1	0.4
Non-native Grassland	1	1.2	0.2
Southern Coast Live Oak Riparian Forest	8	12.0	1.5

Table 13 (Continued)

Vegetation Community/Land Cover	Fuel Model	Acres	Percentage
Southern Mixed Chaparral	SH7	728.5	93.2
Southern Willow Scrub	8	0.7	0.1
Urban/Developed	98	2.2	0.3
	Total	**781.8**	**100.0**

Vegetation Dynamics

Vegetation plays a significant role in fire behavior and is an important component of the fire behavior models discussed in this report. A critical factor to consider is the dynamic nature of vegetation communities. Fire presence and absence at varying cycles or regimes affect plant community succession, or the natural sequential replacement of vegetation types over time. Succession of plant communities, most notably the gradual conversion of shrublands to grasslands in areas with high fire frequencies and short intervals between fires, and grasslands to shrublands in areas with fire exclusion or long fire-free periods, is highly dependent on fire characteristics, including intensity, duration, and return interval. Additionally, encroachment of non-native plant species from residential landscaping into wildland areas is already occurring and is expected to continue based on the proximity of ornamental landscaping to open space. Consequently, routine maintenance of the fuel reduction areas/defensible space zones, and establishment of defensible space zones in some areas, is needed to maintain reduced hazard conditions.

Biomass and associated fuel loading will increase over time, assuming that disturbance or fuel reduction efforts are not realized. Depending on factors such as fire exclusion activities, mechanical treatments, and prescribed burning, among others, the current vegetation composition and density will continue to change, either through increased volume and the establishment of non-native species or the continued degradation of scrublands and persistence of annual grasses.

The Preserve is dominated by southern mixed chaparral, with scattered patches of coastal sage scrub and grassland, as well as isolated oak woodland stands. It should be noted that chaparral and sage are not susceptible to annual burning, but grass cover can burn yearly (Minnich and Scott 2005). Lack of disturbance such as fire and grazing will, over time, allow shrub cover to establish in areas currently dominated by grass cover. Shrub cover, although less likely to burn in the first 20 years during typical weather conditions, will burn under extreme fire events (Moritz 2003). Once established, the shrub cover will increase in volume, and following approximately 20 years, the hazard will increase corresponding with fuel age (Keeley 2005; Moritz et al. 2004). Additionally, as previously mentioned, encroachment of non-native plants into open space areas

is likely based on the proximity of ornamental landscaping to undeveloped open space land, in many cases increasing the fuel load and likelihood for higher intensity fire.

As with the changes in vegetative cover in grassland habitats over time, changes in the chaparral, woodland, and forest types will also occur with the lack of disturbance. Chaparral stands will continue to accumulate biomass and volume, often retaining dead plant material within individual component shrubs. Oak woodland cover types tend to limit ground fuel accumulation with age. Canopy closure serves to "shade-out" understory plants, resulting in mature oak woodland characterized by a dense canopy layer and an understory consisting primarily of leaf and twig litter. Hardwood stands vary in species composition with disturbance, but maintain typically consistent shrub and tree cover with associated ladder fuels allowing the potential for canopy fire spread.

Southern Mixed Chaparral Fire Effects

Southern mixed chaparral communities cover the majority of the Preserve (728.5 acres). This vegetation type typically ranges from 1–3 meters (3 to 10 feet) in height with little herbaceous understory in mature stands. Chaparral vegetation communities have developed post-fire reproductive strategies intended to survive stand-replacing wildfires. Specifically, component plant species can be classified as obligate sprouters, obligate seeders, or facultative seeders. Obligate sprouters reproduce via root systems that survive after a fire (e.g., toyon), while obligate seeders rely solely on seedling establishment for survival (e.g., ceanothus, Manzanita) (Conrad 1987). Facultative seeders are those chaparral species that stump sprout and regenerate via seed following fire (e.g., chamise) (Conrad 1987).

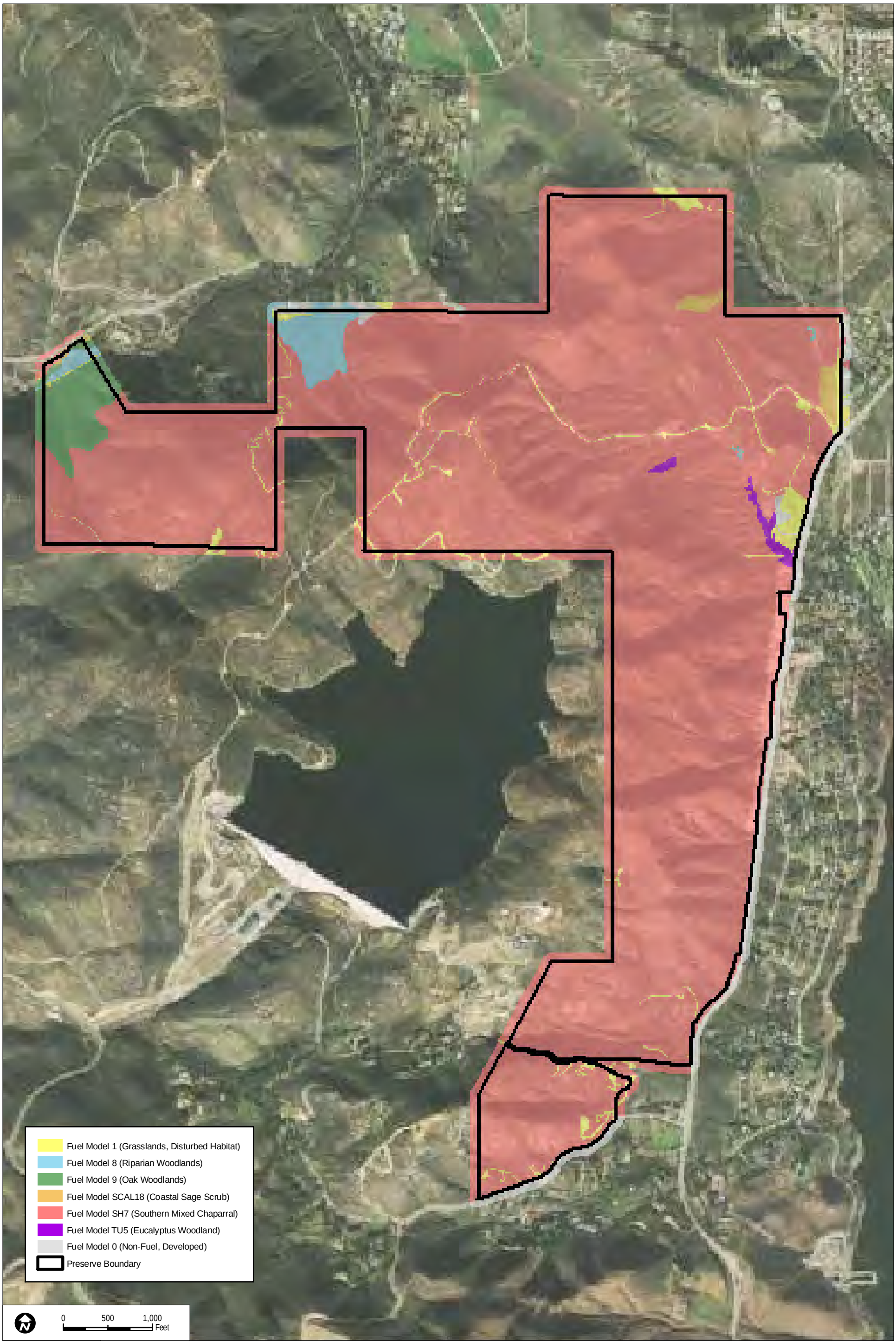
Current fire frequency in chaparral communities averages between 20 and 30 years (Keeley and Keeley 1988), although historic fire frequency is likely in the range of 50–100+ years (Conard and Weise 1998). The shortening of fire-free periods in chaparral has been affected by increases in ignition sources due to the proximity of chaparral communities to developed/urban areas. Fires in chaparral typically consume all aboveground vegetation. In the first year following fire, there is typically abundant herbaceous vegetative growth, although by the fifth post-fire year, shrub cover dominates the site (Keeley and Keeley 1988). In general, vegetation/fuel volume in chaparral will increase in the years following fire, with the rate of biomass increase leveling out between 20 and 40 years, depending on numerous site-specific variables (Conard and Weise 1998).

Diegan Coastal Sage Scrub Fire Effects

Diegan coastal sage scrub occupies 5.0 acres within the Preserve. Following fire, typical sage scrub succession includes a predominance of annual herbs during the first year. Non-native

species may dominate a landscape after wildfire due to their success in establishing quickly and outcompeting many native species. Non-native species tend to decline in subsequent years without fire or other disturbances as shrubs establish and attain greater cover. Perennial herb understory species, which may grow from resprouts, show low recruitment from the soil seed bank. Unlike herbaceous annuals, the overall diversity of perennial understory herbs remains constant the first few years following fire. New species continue to become established in recovering sage scrub, reaching a peak at 5–10 years after a fire. After the peak in species diversity, there is a general decline in perennial understory herb species, possibly attributable to shading effects from dominant shrubs (Wills 2000; Keeley and Keeley 1984).

Lack of fire will allow shrub cover to return to burn areas over time. Recovering shrub cover is less likely to burn in the first 20 years during typical weather conditions, but it will burn under extreme fire events (Moritz 2003). The Preserve's vegetation age is variable, with the majority of vegetation being 13 years old (65%) at the time of this report. Shrub cover will continue to increase in volume, and within approximately 7 years, the fire hazard will increase corresponding with fuel age (Keeley 2005). Changes in land use will also affect the vegetation distribution pattern. For example, the encroachment of non-native plants is likely based on the proximity of residential development and ornamental landscaping to the Preserve.



DUDEK

SOURCE: Digital Globe 2008

FIGURE 8

Fuels Distribution

6680-1D

Final Del Dios Highlands Preserve - Vegetation Management Plan

INTENTIONALLY LEFT BLANK

Grassland Fire Effects

Annual grassland responses to fire are varied. A review and analysis of the response to burning and grazing of California grasslands indicates that prescribed burning temporarily reduces non-native annual grasses, but also results in increased non-native and native forbs (Rice 2005; Bainbridge and D'Antonio 2003; D'Antonio et al. 2003). These studies indicate that single prescribed burns often decrease non-native annual grasses, but they recover by the third year in the absence of additional disturbance. Grazing or follow-up burns hinder the recovery of non-native annual grasses and maintain forb cover.

One effect that appears to be fairly common among non-native grasses is that lower-intensity grassland fires rarely damage seeds on or near the soil surface (Daubenmire 1968). Since seeds on the soil surface are not generally exposed to high enough temperatures to cause mortality in a grassland environment, burn timing is most effective after desirable species have dispersed their seeds, but when target invasive species have their seed heads directly exposed to flames (DiTomaso et al. 2006). For management purposes, non-native grassland burning must be timed appropriately so that the target seeds are consumed, resulting in decreased reestablishment of non-natives and reduced competition for annual forbs.

Live Oak Woodland and Forest Effects

Oak woodland and forest communities (coast live oak woodland and southern coast live oak riparian forest) cover 3.4 acres of the Preserve. Coast live oak trees are very fire resistant, with fire adaptations including evergreen leaves, thick bark, and post-fire sprouting from surviving tissue. Fire intensity affects individual tree survival, with the amount and extent of trunk char and canopy consumption playing a critical role in survival and response (Plumb and Gomez 1983). Following burning, coast live oaks sprout from the main trunk and upper crown even after severe burning (Plumb and McDonald 1981). Post-fire recovery of coast live oak woodlands is dependent on fire intensity, and fall fire damage is typically more severe than that occurring earlier in the year (Plumb and Gomez 1983). While the thick bark of mature coast live oak trees minimizes the effects of heat exposure from wildfire, seedlings and acorns are much more susceptible to mortality, even following low-intensity fires (Lawson, Zedler, and Sieger 1997). Recovery of coast live oaks may take up to 3 years, so post-fire cutting of affected trees should be postponed to verify whether re-sprouting will occur (Plumb and Gomez 1983).

As with coastal sage and chaparral, decreases in fire frequency in coast live oak woodlands and forests favors woodland/forest expansion into neighboring grassland (Callaway and Davis 1993). Fire behavior in oak woodlands and forests is typically much less intense than wildfires burning in chaparral and sage scrub communities. Low, compacted leaf litter understory, canopy shading

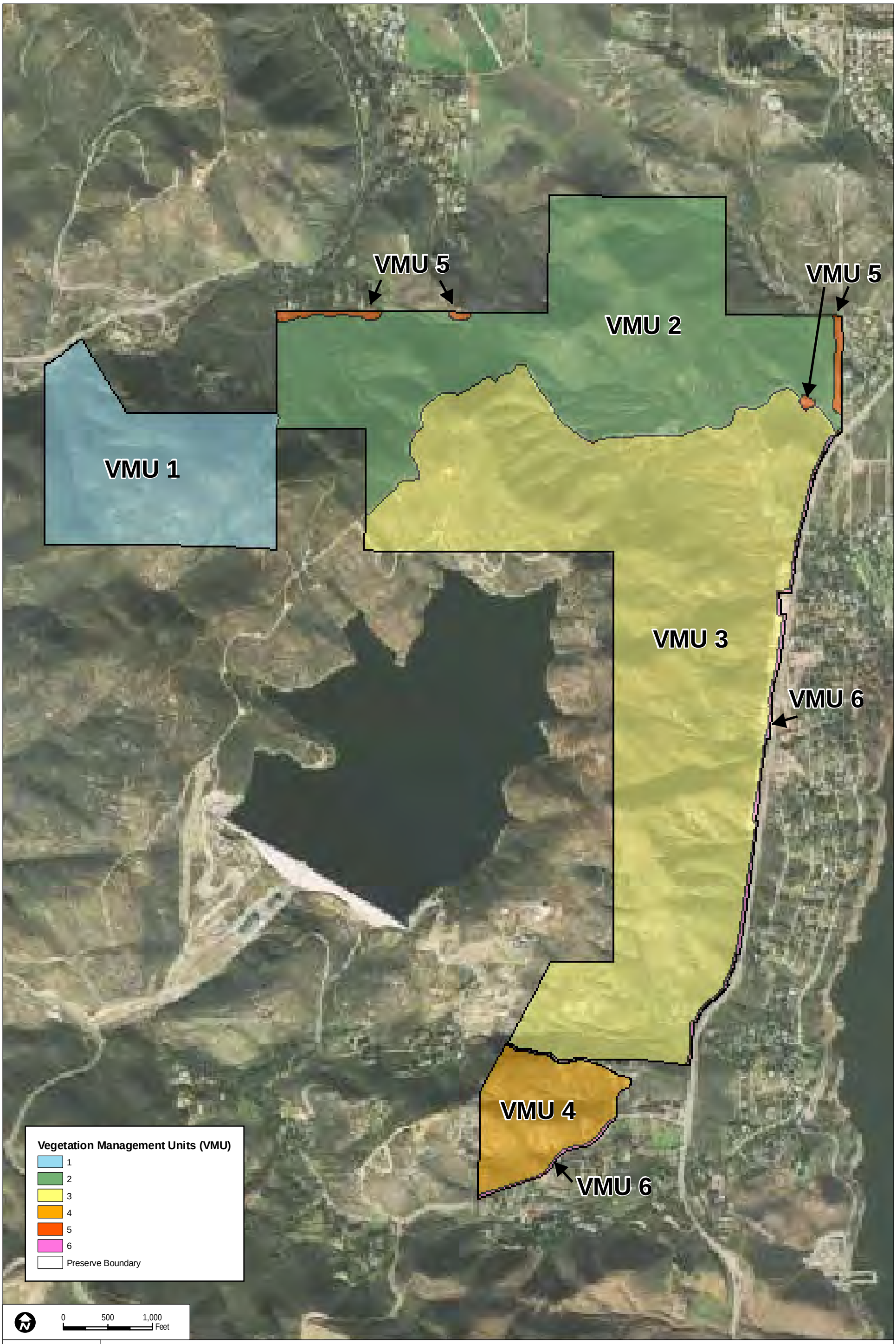
of ground fuels, and wind velocity reduction resulting from tree canopies significantly reduce the intensity and spread rates of surface fires in oak woodland and forest vegetation types. Transition from ground to canopy fire increases fire intensity, spotting, and tree mortality potential.

Fire Behavior

Fire behavior modeling provides reasonably accurate representations of how wildfire would move through available fuels in high-fire hazard areas. Fire behavior calculations are based on site-specific fuel characteristics supported by fire science research that analyzes heat transfer related to specific fire behavior. Current and accepted fire research data from several programs that specialize in the study of wildland fire were utilized for the completion of this analysis for the Preserve. To objectively predict flame lengths and intensities, the FlamMap fire behavior fuel modeling system was applied using predominant fuel characteristics from representative fuel models observed on the Preserve. In addition to fuels data, topographic and weather data were utilized in developing fire behavior models for two separate weather conditions: summer (onshore flow) and fall (offshore flow). Results of fire behavior modeling efforts for the Preserve are presented in Appendix C.

5.3 Fuel Management Methods

Successful fire management requires preplanning and utilization of fire prevention techniques and strategies. As the majority of the preserve has been fire-free for over 13 years (88%), management of fuels is an important component of overall Preserve management. To that end, VMUs, based on topography or other clearly discernable landscape boundaries, have been delineated on the Preserve to assist with fuel management planning. Figure 9 illustrates the VMU boundaries. VMU specific fuel reduction recommendations are provided in Section 6.3. A list of general fuel management methods and their suitability for use in the Preserve are discussed as follows.



DUDEK

6680-1D

SOURCE: Digital Globe 2008

FIGURE 9

Vegetation Management Units

Final Del Dios Highlands Preserve - Vegetation Management Plan

INTENTIONALLY LEFT BLANK

5.3.1 Grazing

Grazing is an effective fuel reduction method and can be compatible with Preserve management goals. Focused grazing is a feasible alternative on this Preserve, but it would need to be highly managed to avoid introducing and spreading non-native species, overgrazing, or escape grazing. Currently there is no pressing need to introduce grazing. However, the method should remain in the management toolbox for specific applications adjacent to highly sensitive habitats, adjacent roadways, and potentially in areas that are considered fuel modification zones.

5.3.2 Mowing

Mowing is one of the most common and successful methods for reducing fuel loads, and it is compatible with Preserve management goals, but is of limited use in rocky and rugged terrain. Mowing is a feasible option for the Preserve to meet roadside fuel modification guidelines. However, annual mowing may convert shrub dominated areas to grasslands over time. Therefore, mowing should be conducted in late spring after weedy annuals have stopped growing, but have not yet produced viable seed (Bell 2009).

5.3.3 Herbicides

Chemical means to control fuels/non-native plants is an effective method, but one that has a negative connotation, potential toxicity for humans and wildlife, and can affect water quality. Focused chemical selection and application minimizes the detrimental effects and makes the use of chemicals, such as glyphosate and other selective chemicals, a feasible alternative.

5.3.4 Prescribed Fire

Prescribed fire occurs in two forms: (1) natural fire, occurring primarily through lightning strikes that are then allowed to burn, and (2) intentional, managed fires. Natural fires are rare in San Diego County due to a general lack of lightning. However, natural fires may occur, and if allowed to burn as part of a fire plan, would then be considered a prescribed fire. Although considered unlikely, if natural fire occurs on the Preserve and the fire is determined to pose no threat to life or high-value resources, the fire may be allowed to burn if it meets fire authority objectives. If unsafe conditions exist (e.g., high winds, low humidity, high temperature) and, without suppression, it has a high likelihood of burning into areas of fire exclusion or is threatening valuable resources on or off site, then assertive suppression would be pursued.

Intentionally managed fires are planned ignitions for purposes of reducing fuels primarily for public safety or habitat improvement, are regulated by all applicable laws, and are managed by CAL FIRE's Vegetation Management Program. Where prescribed burning is feasible, it shall be

conducted under permit from CAL FIRE or under contract with CAL FIRE under the statewide Vegetation Management Program.

Prescribed fire on the Preserve is not currently considered a high priority for fuel management on the Preserve in respect to the other treatment options included in this VMP. However, future conditions may warrant the use of prescribed fire as a fire hazard reduction or habitat modification technique. Prescribed fire can only be implemented by CAL FIRE, or a similar fire authority with experience and certifications to conduct burns, and requires the preparation and approval of a prescribed burn plan prior to implementation. Burning objectives shall adhere to those included in the 2009 County of San Diego Vegetation Management Report, specifically:

> Prescribed burns will generally be utilized in strategic locations when the surrounding land has few residences or a fire can be easily controlled because of topographic or other features. Again, the use of fire as a management tool will be considered specific to ecosystem management objectives. Strategic fuels treatments would be located to provide the most effective potential for reducing catastrophic fire. The potential for promoting vegetation health could be factored into decisions on locating strategic fuel treatments.

5.3.5 Hand Tool or Mechanical Equipment Thinning

Thinning can reduce fuel continuity and loading by selective removal of dead and dying, overly dense, horizontal and vertical bunches and non-natives. This type of fuel reduction is most useful in the interface and intermix areas around high-value resources, such as residences. Adjacent residences would have to maintain their own defensible space off site, but on site extensions are provided by the Preserve. Thinning is recommended to occur on an annual basis prior to June for fuel modification areas associated with off-site residences or other habitable structures. Thinning is appropriate anywhere in the Preserve where insect or disease outbreaks and frost or drought kill occurs, resulting in dense, dead vegetation.

5.3.6 Fuel Breaks

Fuel breaks provide areas of removed fuels that play an important role in helping contain wildfires. The local fire departments and CAL FIRE attempt to minimize impacts to sensitive resources when fighting fires in wildlands, when possible; and where feasible, fires are allowed to run to natural breaks including trails and roads. These locations then serve as a defensive position for fighting the fire. The existing multi-use trail/access road through the Preserve and fuel modification zones generally meet the anticipated fuel break requirements for the Preserve.

5.4 Fire Response Plan

The RSFFPD, CAL FIRE, EF/HGFD, and EFD are the primary responders to the Preserve. It is expected that CAL FIRE and RSFFPD would be the primary agencies involved in wildland fire suppression on the Preserve, with assistance from the EF/HGFD. It is expected that the EFD will focus primarily on structural protection, assisting in wildland fire suppression as necessary. Given the location of the primary access to the Preserve on Del Dios Highway, initial attack on wildland fires in EF/HGFD jurisdiction will likely be by RSFFPD since they are capable of reaching the Preserve more quickly. In this case, EF/HGFD will also respond. These fire agencies, as well as the other agencies that would respond via automatic or mutual aid, are extremely qualified and experienced in responding to wildfires in this area.

The RSFFPD has prepared wildland pre-response plans with tactical worksheets for high-value assets at risk for most of their jurisdictional WUI areas, including the Preserve. The response plans are customized for fast viewing, quick hazard recognition, and actions to be taken during wildfire emergencies. Pertinent information provided in this VMP will be shared with the RSFFPD to be included in their wildland pre-response plans for the Preserve.

CAL FIRE provides response to wildfires in the SRA, including the Preserve, and the RSFFPD and EF/HGFD provide response to structure fires, wildfire, and medical and associated emergencies in the LRA. EFD primarily provides structural protection on the perimeter of the Preserve. CAL FIRE has a vast arsenal of firefighting personnel and apparatus throughout the County that can be called upon for responding to wildfires within or in the vicinity of the Preserve, including:

- Air tankers
- Helicopters
- Airtactical aircraft (AA)
- Various engine types
- Crew transports
- Bulldozers
- Communications centers.

CAL FIRE utilizes three levels of dispatch and response based upon weather conditions and time of year. The three levels are:

- Low – includes two engines with three personnel each

- Medium – includes three engines (type III) with three personnel each, one battalion chief, one mid-sized bulldozer, one type III helicopter, and one 16-person hand crew
- High – includes five engines with three personnel each, one battalion chief, two medium bulldozers, one AA, two air tankers, and one type III helicopter.

Dispatch levels are based on weather conditions. Low dispatch occurs during the winter months from November through May. Medium and high dispatch occurs during the normally declared fire season, June through October. There is some variation in the timing of the dispatch levels, based entirely on weather.

RSFFPD currently employs the following firefighting apparatus with associated firefighting personnel:

- Structure protection type I pumpers
- Type III brush engines
- 1 water tender
- Command vehicles.

EF/HGFD currently employs the following firefighting apparatus with associated firefighting personnel:

- 27 volunteers and two paid staff provide year-round fulltime service
- Type I structure engines
- Type III wildland engines
- Ambulance
- Command vehicles
- Utility vehicle.

EFD currently employs the following firefighting apparatus with associated firefighting personnel:

- 112 personnel
- Structure protection type I pumpers
- Type III brush engines
- Ladder trucks
- Command vehicles.

Fire Response

This VMP stresses the need for firefighting response to minimize impacts to natural resources, when possible, by using preplanned fire suppression tactics and actions within the boundary of the Preserve. Fire suppression is considered the top priority across the Preserve due to the shortened fire return interval realized over the last 20 to 25 years.

Fire suppression air support with fire retardant drops may be a component of responses to the entire Preserve for achieving goals and objectives, especially under conditions that would accelerate wildfire spread. Under extreme conditions, or at night, air support may not be available, and in these situations, response categories may become secondary to public safety. Fires occurring within open space areas have demonstrated the potential to move through the preserve into urban areas, consequently overwhelming available fire resources.

Response to a fire within the Preserve could potentially include the use of existing access roads for firefighting personnel, type I engines (limited to paved roadways just outside the Preserve), type III engines, fire crews, air attack and fire retardant, helicopters, and air tankers. Fire suppression actions may include one or more of the following: direct attack with engines, fire crews, helicopters, and firing operations, according to the wildland pre-response plans that RSFFPD has prepared for its District. Line construction activities within the Preserve would be best carried out by hand crews. Dozers/road graders may be activated but should not be put into operation on the Preserve itself unless necessary for improving existing roads for engine access or constructing a line or secondary line for preservation of high-value resources, including plant and animal species, habitats, people, or property.

There is an existing access road/trail that may be utilized for fire containment efforts by fire agency personnel including using the road as a fuel break or as an anchor point from which to conduct operations. However, these roads are not wide enough to provide acceptable fire spread slowing during wind driven wildfires. Otherwise, a graded extension of Mt. Israel Place bisects the southern portion of the Preserve; however, while it may slow fire spread under moderate conditions, it is not maintained and is inaccessible for firefighting equipment.

5.4.1 Fire Hazard and Current Fire Management Practices Evaluation

Based on site-specific data analysis, discussions with fire agencies responsible for fire suppression, and fire behavior modeling results, the Preserve includes an ongoing fire hazard that can result in significant fire intensity and spread during extreme weather events. This section presents a discussion of fire hazard situations for the Preserve. This information was collected during initial

site analysis and reviews of project data, fire behavior modeling results, and high-resolution aerial imagery and was integrated into the preparation of this document and associated recommendations.

1. Based on topography, vegetation, and fire history of the region, a large conflagration during Santa Ana wind conditions will likely enter the Preserve from the east, traveling down the San Dieguito River valley, as seen in the 2007 Witch Fire. Fires during typical onshore wind patterns are likely to enter the site from either the adjacent WUI or from open space areas south or west of the Preserve.
2. A WUI threat exists along the western, northern, and eastern boundaries of the Preserve. Residential development is most dense along the western boundary, with lower density rural-residential development along the northern and eastern boundaries.
3. Potential ignitions include a variety of residential related sources including structure fire, hot works, and yard machines, among others. Ignition sources not associated with residential development include vehicular associated ignitions (e.g., car fire, catalytic converter, tossed cigarette) along the adjacent roads. Additional nonresidential ignition sources include electrical transmission lines near and on the Preserve and arson.
4. Wildfires fueled by Santa Ana winds may move rapidly across the Preserve. Grassland, sage scrub, and chaparral fuels will be the predominant carriers of fire across the site with flame lengths in the chaparral fuels exceeding 20 feet. Steep slopes with even steeper walled drainages typify the topography of the Preserve. Fires in grassland fuels will be fast-moving ground fires with lower flame lengths (less than 20 feet), while those in chaparral or sage scrub fuels will move more slowly, but produce greater flame lengths (greater than 20 feet) and associated heat output (in excess of 5,000 British thermal units).
5. A fire originating in a structure within approximately a 1-mile radius of the Preserve could result in burning embers landing within the Preserve before they decay to the point of being unable to ignite fuels, potentially resulting in vegetation ignition if there is a receptive fuel bed.

Based on current roadways, firefighting may be difficult on the Preserve due to roads that are not designed to accommodate typical responding fire apparatus. Although there are several ways to access the Preserve, circulation throughout the Preserve under wildfire conditions is precarious and potentially dangerous due to narrow and steep roads with varying levels of traction and numerous waterbars, and vegetation and terrain that can result in significant fire intensity and irregular spread. Air attack will be an important component but may not be available or usable, depending on the extent of the fire event and/or the time of day and weather conditions.

The catastrophic wildfire threat for the Preserve is extreme when severe fire weather occurs, which will coincide with Red Flag Warning periods. Red Flag Warnings are declared by the National Weather Service. The Preserve is located in Fire Weather Zone 250, San Diego County Inland Valleys. Accordingly, Red Flag Warnings are issued when humidity is 15% or lower (for at least 6 hours) and sustained winds are 25 miles per hour (mph) (with gusts greater than or equal to 35 mph) (National Weather Service, San Diego Office 2011).

Beyond these provisions, fire management practices are restricted to response and tactical suppression efforts associated with wildfires originating on or burning onto the Preserve. No active fire or fuels management plans are currently employed on site.

5.4.2 Primary Actions and Contacts for Wildfire Emergency

The following persons/agencies should be contacted in the event of a wildfire on the Preserve or for information regarding fire management activities.

CAL FIRE
San Diego Unit
Emergency: 911
Non-Emergency - Unit Chief, El Cajon: 619.590.3100
Website: http://www.fire.ca.gov/

Rancho Santa Fe Fire Protection District (RSFFPD):
Emergency: 911
Non-Emergency - Fire Marshal: 858.756.3006
Website: http://www.rsf-fire.org/

Elfin Forest/Harmony Grove Fire Department (EF/HGFD)
Emergency: 911
Non-Emergency - Fire Chief: 760.744.2186
Website: http://www.eff-fire.org/

City of Escondido Fire Department (EFD)
Emergency: 911
Non-Emergency – Fire Marshal: 760.839.4495
Website: http://www.ci.escondido.ca.us/fire/

5.4.3 Roads/Access

Road access in the Preserve is relatively limited due to terrain. However, primary access to the Preserve is via a designated multi-use trail, which also serves as an access road. This 1.5-mile trail/access road originates at the main entrance and staging area of the Preserve off Del Dios Highway in the east and bisects the north-central portion of the Preserve, ultimately providing a western connection to the adjacent Elfin Forest Recreational Reserve trail system and an OMWD maintenance road. There are existing vehicle gates at both the eastern and western ends of the trail/access road.

In addition, there are several access points that provide limited access to the Preserve, including the following:

- Sewer Outfall Easement Road Access: Access to the northwestern-most parcel of the Preserve (Cielo Azul) is available along Mt. Israel Truck Trail via a 20-foot City of Escondido sewer outfall easement south of Escondido Creek, which serves as an access road and informal trail. This access road passes through private property and the adjacent Escondido Creek Preserve before reaching Cielo Azul.

- Mt. Israel Road Access: Access is available along the north side of Mt. Israel Road, approximately 800 feet west of Del Dios Highway. The gated dirt access road at this point is located at the Preserve boundary, and much of the road is off site. Vehicular access to the Preserve is limited at this location. Another access point is located along the north side of Mt. Israel Road, approximately 2,200 feet west of Del Dios Highway. This access point also provides limited vehicular access to the Preserve.

- Del Dios Highway Access: Access to the Preserve is limited along Del Dios Highway, with the exception of the primary Preserve access road. Other points of entry include:

    - An old dirt road cut 1,200 feet north of the intersection of Del Dios Highway and Mt. Israel Road). Road condition is poor, vehicular access is very limited.

    - A power line access road approximately 250 feet south of the intersection of Del Dios Highway and Elm Lane. Vehicular access is limited.

    - A degraded asphalt driveway located on the west side of the intersection of Del Dios Highway and Elm Lane (former driveway of Derbas property). Access at this point is gated. Vehicular access is approximately 500 feet to the former structure location.

- Private Road Access: Access to the northern portion of the Preserve is via a private road easement originating on Country Club Drive (approximately 1,400 feet south of Harmony Grove Road).

Access via roads, trails, and access gates is presented in Appendix B.

From a fire suppression perspective, access is limited to the multi-use trail/access road off Del Dios Highway where the main entrance and staging area are located. This road is not likely to be used during a wildfire emergency due to the narrow width, lack of roadside fuel modification, steep terrain, numerous waterbars, and lack of turnarounds. To improve or maintain the potential for firefighting crews to enter the Preserve during wildfire, the following road maintenance or improvements within the Preserve would be needed:

- Knox padlocks on all gates: Maintain Knox padlocks where they currently exist and install Knox padlocks on access gates that do not currently have Knox padlocks.
- Increase the width of all dirt roads to be used for emergency fire access to at least 16 feet; continue to maintain the current multi-use trail/access road at a minimum 16-foot width.
- Maintain water bars/erosion features to be consistent with fire apparatus limitations. Should new waterbars/erosion features be necessary, they should be consistent with fire apparatus limitations.
- Provide a minimum of 20 feet of fuel modification on both sides of roadways.
- Provide turnarounds meeting fire apparatus requirements.

The firefighting access improvements discussed above will be evaluated by DPR staff for consistency with overall Preserve goals and prioritized appropriately, based on the level of benefit versus potential Preserve impacts and cost. It may be determined during a fire event that even with roadway improvements, firefighters would not enter the Preserve due to the low probability that a wind-driven fire can be controlled and the related high risk to personnel and equipment. If that is the case, then access improvements would be focused on maintaining current accessibility.

5.4.4 Fuel Breaks

The existing multi-use trail/access road through the Preserve and the existing fuel modification zones along the Preserve boundary adjacent to residential residences currently serve as fuel breaks. Based on the topography of the Preserve and the potential for related impacts, it is not recommended that additional breaks be created at this time. However, the need for fuel breaks is dependent on the specific conditions of a fire. If new fire breaks are required, the location should

be coordinated with the Incident Command team where possible. The Incident Command team includes the district park manager and fire agency staff with access to location information on sensitive biological and cultural resources that should be avoided, if possible.

5.4.5 Emergency Staging Areas

Due to the terrain and fuels, it is not anticipated that fire response staging areas will be situated on the Preserve other than potentially at the existing Preserve entrance/staging area off Del Dios Highway during pre-attack events. Staging areas, important for incident command and to organize, plan, and implement firefighting strategies, typically cause higher ground disturbance from personnel, vehicles, and equipment in confined areas. Staging areas for fires that affect the Preserve will likely occur off site in well-defended, lower hazard areas.

5.4.6 Fire Hydrants

No fire hydrants are located on the Preserve. Fire hydrants are located within adjacent residential development areas and on the periphery of the Preserve along existing roadways, primarily in the residential developments to the north and west along Del Dios Highway. Fire hydrant locations are not consistent in the surrounding semirural area. The closest hydrants to the primary Preserve entrance on Del Dios Highway are located at the intersection of Willowbrook Street and Del Dios Highway and at the intersection of Lake Drive and Via Rancho Parkway. Wildland fire response to the Preserve will include a water tender as the primary water supply. Fire hydrants may be utilized during a fire event to refill engines, as necessary.

5.4.7 Other Water Sources

Other water sources which may be available during a wildfire event within the Preserve include the following:

- Lake Hodges, approximately 0.8 mile from the Preserve staging area and no more than approximately 1 mile from the furthest reaches of the Preserve, provides helicopter dipping access.
- The Olivenhain Reservoir, directly adjacent and less than approximately one-tenth of a mile and no more than seven-tenths of a mile from the Preserve staging area, is a source for helicopter dipping.

6.0 MANAGEMENT DIRECTIVES

This section provides recommendations for vegetation management within the Preserve, including management directives specifically related to invasive species management, habitat restoration, and fire management.

6.1 Invasive Species Removal

The following short-term management directives address high priority invasive species removal while longer-term management directives consider invasive species for their risk of reducing vegetation community quality over time.

Management Directive Invasive 1 – Remove and Control High Priority Invasive Non-native Species. Remove aggressive, invasive non-native plant species and those with a high fire hazard within the Preserve, such as eucalyptus, as soon as possible.

Management Directive Invasive 2 – Identify and Pursue Funding for Long-term Invasive Non-native Plant Control. Coordinate with other agencies, non-profit organizations, and/or volunteer groups in order to seek funding and implement invasive, non-native plant removal projects for moderate and low priority non-native species within the Preserve.

Management Directive Invasive 3 – Conduct Invasive Non-native Species Monitoring. Continue to monitor other identified non-native species within the Preserve to determine whether removal efforts are warranted in order to maintain and/or improve the quality of the existing native vegetation communities on site.

Management Directive Invasive 4 – Educational Outreach. Prepare and implement an invasive non-native plant species educational outreach program/materials to reduce use of these plants by adjacent property owners.

6.2 Restoration

The primary management directives for native vegetation community restoration include:

Management Directive Restoration 1 – Restore Native Vegetation Community Quality and Function. Restore the identified degraded areas to reestablish and/or enhance the biological functions and values of native vegetation communities in these areas.

1A – Passive Restoration. Perform weed and erosion control as needed in disturbed areas where natural recruitment of native plant species is actively occurring, as described in Section 4.2.1.

1B – Active Restoration. Conduct soil preparation and native planting of disturbed or degraded areas where native vegetation recruitment is not actively occurring, as described in Section 4.2.2.

Management Directive Restoration 2 – Address Long-term Restoration Needs. Restoration activities should occur following landscape-changing disturbances that remove, damage, degrade, or alter the existing native vegetation communities. Restoration methods will be customized to the Preserve, based on the type of disturbance, and will require preparation and implementation of a restoration plan. Restoration will incorporate active revegetation, including:

- Native vegetation community establishment/creation;
- Native vegetation community enhancement;
- Removal of invasive plants when they are young;
- Application of herbicides, pesticides and fertilizers if needed; and
- Application of supplemental irrigation if needed.

Management Directive Restoration 3 – Monitor Invasive Non-native Plant Removal Sites. Continue to monitor invasive species removal sites to ensure that passive natural recruitment is successfully occurring in these areas.

Management Directive Restoration 4 – Monitor Native Vegetation Community Quality. Continue to monitor the quality of native vegetation communities throughout the Preserve using comparative vegetation mapping over time and evaluation of potential type conversions.

Management Directive Restoration 5 – Monitor Pests and Disease. Monitor the presence of disease or pest levels to determine outbreaks and prescribe an active treatment, as appropriate.

6.3 Fire Management

The long-term strategic fire management plan considers strategic fire prevention activities, fire suppression with regard to fire effects on habitat, and post-fire monitoring and rehabilitation. The long-term strategic fire plan for the Preserve must prioritize public safety while meeting habitat management goals. Management directives are as follows.

Management Directive Fire 1 – Fire Suppression: Fire suppression, in combination with other management methods in targeted Preserve habitat management areas, is the priority for the Preserve. Lengthening the fire return cycle to an optimal frequency will require fuel

reduction experiments, research, monitoring, and analysis as part of the overall management approach. The optimal fire frequency in southern mixed chaparral may be from 50 to 100 years or more (Conard and Weise 1998). It may be difficult to achieve the longer fire return intervals given the current and projected ignition sources that may affect the Preserve. However, results of site data analysis will more firmly establish the optimal return intervals to meet habitat goals, or if additional steps need to be implemented, to lengthen the return of fire.

Management Directive Fire 2 – Maintain Required Fuel Modification Zones. Annually maintain, and extend where necessary, the fuel modification zones along the Preserve boundaries that are extensions of off-site residential structure fuel modification zones (Figure 9; VMU 5), as identified in Table 14.

Management Directive Fire 3 – Delineate Fuel Modification Areas. Install and maintain inconspicuous fuel modification extent markers for all fuel modification zones (Figure 9; VMU 5) to minimize additional thinning outside intended area.

Management Directive Fire 4 – Provide for Suitable Emergency Fire Access. Per local fire agency recommendations, improve road access for fire emergencies by maintaining and widening (in some stretches) the primary multi-use trail/access road to 16 feet, and providing fuel modification along this trail/access road (30 feet each side where possible)

Management Directive Fire 5 – Access Data Sharing. Maintain local fire agency gate locks and report any notice of removed or missing locks to the appropriate fire agency. Signs should be installed indicating access limitations and extents (map form) and provide road quality to local fire responders. This information will be included in their wildland pre-response plans, resulting in more efficient responses. Information readily accessible by responders not familiar with the area, such as out of County or out of state responders, will improve firefighter safety.

Management Directive Fire 6 – Control Illegal Access. Continue to restrict off-highway vehicles and shooting access. These are potential ignition sources that must be managed through restricting access (e.g., use of fence, gates, signage) and by establishing a high profile presence of park ranger staff.

Management Directive Fire 7 – Educational Outreach. Private property owners in the interface or intermix (located adjacent to the Preserve) should be encouraged to play an active role in reducing the potential fire hazard. It will also be beneficial if the public understands the management actions occurring on the Preserve, such as grazing, mowing, and herbicides, as applicable. As such, this VMP recommends a concerted effort to reach property owners who are situated in locations that may be affected by wildfire on the

Preserve or whose properties and actions may serve as Preserve ignition sources. Educational material can be customized for these homeowners to include discussion of the importance of the Preserve. Standard measures for implementing a 100-foot fuel modification/defensible space zone can be provided from materials available from CAL FIRE and from the County of San Diego Department of Planning and Land Use[3]. As part of the public education program, private property owners should be encouraged to participate as "eyes on the Preserve" to help curb illegal access and report potential problems.

Management Directive Fire 8 – Reduce Ignition Sources: Ignition sources are present on and adjacent to the Preserve. The high voltage electrical transmission lines that cross the Preserve present potential ignition sources. Adjacent sources include roadways with vehicular travel, especially Del Dios Highway, adjacent residences, and recreational users, among many others. As such, it is not possible to remove all sources of ignition. Rather, reducing the potential spread of wildfire onto or throughout the Preserve is recommended. Fuel modification buffers on the Preserve edges near existing homes are provided in some instances, but will need to be provided for all adjacent ignition sources such that the source has 30-100 feet of fuel modification with half the fuel as an unmodified vegetation stand. Similarly, fuel reduction (especially non-native trees) beneath the transmission lines, as appropriate, and along utility line access roadways/trails will reduce the likelihood of ignitions and fire spread from the line or from vehicles on the access roads.

Management Directive Fire 9 – Conduct Recommended Fuels Management. Conduct fuels management using the identified VMUs, as feasible, and as presented in Table 14. Table 14 provides a summary of the high-value resource areas acknowledged for the Preserve and the associated fire prevention strategy recommended for achieving long-term management goals.

Management Directive Fire 10 – Post-fire Management and Erosion Control. Provide controls following fire events to stabilize soils in the burn area and minimize potential for erosion. Erosion control best management practices (BMPs), such as mechanical rehabilitation treatments, including straw mulch, hay bales, and jute rolls, should be in place as soon as possible after a fire and prior to the onset of the winter rainy season. Care should be taken to select and inspect these materials so they are not a source of invasive non-native plants. The use of certified weed-free hay is good policy (Bell 2009).

[3] Available on-line at http://www.fire.ca.gov/cdfbofdb/pdfs/4291finalguidelines2_23_06.pdf and http://www.sdcounty.ca.gov/dplu/fire_resistant.html

Table 14
Fuel Management Activities by VMU

VMU	Sensitive Resources	Fuel Reduction Practice
1	Sensitive Animal Species: Cooper's hawk Gadwall Great blue heron Pocketed free-tailed bat Red-shouldered hawk San Diego black-tailed jackrabbit San Diego ringneck snake Two-striped garter snake Western red bat Western spadefoot toad Western whiptail Yellow warbler Yuma myotis Sensitive Plant Species: San Diego (Palmer's) sagewort Wart-stemmed ceanothus Ashy spike-moss Cultural Sites: SDI-20,157	VMU 1 consists primarily of southern mixed chaparral, with coast live oak woodland and other riparian areas in the northwest corner of the VMU. Chaparral is predominantly 13 years in age, while the oak woodland/riparian portion is 67 + years old. Access to VMU 1 is limited. Primary access to this area is from Harmony Grove Road. Secondary access is possible via the easement access road off Mt. Israel Truck Trail and spur roads and trails accessed via the primary Preserve access road. Steep terrain in this VMU also limits access and the amount of thinning that would be possible Consequently, fuel treatment in VMU 1 should be limited to invasive species removal. Strategic understory shrub thinning/crown raising may be implemented along the chaparral-oak woodland interface to minimize the potential for crown fire occurrence in the oak woodland/riparian zone. Further, dead fuel removal and invasive species removal should be conducted along the northwest edge of VMU 1 where it abuts Harmony Grove Road to minimize the likelihood of ignitions. Thinning/vegetation reduction may be necessary to reduce potential for catastrophic fire near sensitive species locations. Sensitive species locations should be flagged and avoided to the maximum extent possible. Vegetation should be removed via manual methods in these areas. The prehistoric milling feature within VMU 1 is susceptible to exfoliation off the surface of the bedrock during fire events, depending on fire intensity. This site should be avoided and protected with an appropriate buffer during thinning/fuel reduction efforts. If access to the site is necessary to control non-native species or to remove dead/dying vegetation, vegetation should be removed via manual methods. Any ground disturbance should be monitored by a County-approved archaeological and Native American monitor.
2	Sensitive Animal Species: Barn owl Bell's sage sparrow Big free-tailed bat California pocket mouse Coast horned lizard Desert woodrat Double-crested cormorant Northern red-diamond rattlesnake Northwestern San Diego pocket mouse Orange-throated whiptail Pocketed free-tailed bat	VMU 2 consists primarily of southern mixed chaparral that is 13 years in age. An area of southern coast live oak riparian forest is located in the northwest corner of the VMU. Fuel treatment in VMU 2 should be limited to invasive species removal given the relatively young chaparral age and post-fire plant community recovery. Strategic understory shrub thinning/crown raising may be implemented along the chaparral-oak woodland interface to minimize the potential for crown fire occurrence in the oak woodland/riparian zone, which is adjacent to residences and associated VMU 5. Reduction of fires through strategic mowing/fuel reduction is recommended along the primary Preserve access road (south

Table 14 (Continued)

VMU	Sensitive Resources	Fuel Reduction Practice
	Red diamond rattlesnake Rufous-crowned sparrow Western red bat Western yellow bat Yellow warbler Yellow-breasted chat Yuma myotis <u>Sensitive Plant Species:</u> San Diego (Palmer's) sagewort Summer holly Wart-stemmed ceanothus	edge of VMU 2). This road dividing VMU 2 and VMU 3 should be maintained free of vegetation to effectively maintain a north-south fire break. Thinning/vegetation reduction may be necessary to reduce potential for catastrophic fire near sensitive species locations. Sensitive species locations should be flagged and avoided to the maximum extent possible. Vegetation should be removed via manual methods in these areas.
3	<u>Sensitive Animal Species:</u> Bell's sage sparrow Big free-tailed bat California gnatcatcher California pocket mouse Coast horned lizard Common loon Cooper's hawk Desert woodrat Double-crested cormorant Ferruginous hawk Mule deer Northwestern San Diego pocket mouse Orange-throated whiptail Peregrine falcon Pocketed free-tailed bat Red diamond rattlesnake Rosy boa Rufous-crowned sparrow Sharp-shinned hawk Townsend's big-eared bat Western mastiff bat Western patched-nosed snake Western red bat Western spadefoot Yuma myotis <u>Sensitive Plant Species:</u> Encinitas baccharis San Diego (Palmer's) sagewort Wart-stemmed ceanothus Summer holly	VMU 3 consists almost entirely of southern mixed chaparral, with some small isolated areas of eucalyptus woodland. Age classes in chaparral communities for VMU 3 range between 3, 13, and 20 years old, with a small area of 67-year-old vegetation. Access to the northern portion of the VMU is via the primary Preserve access road. Steep terrain limits access to the remaining portions of the VMU and limits the amount of thinning that would be possible. Grazing is not applicable due to the limited extent of grasslands. Minimizing fire spread during wildfire will be a key component to habitat enhancement in this VMU. Timed prescribed fire could be used on a long-term basis to strategically reduce fuel loads. Reduction of fires through strategic mowing/fuel reduction is recommended along the primary Preserve access road (north edge of VMU 3). This road dividing VMU 2 and VMU 3 should be maintained free of vegetation to effectively maintain a north-south fire break. Thinning/vegetation reduction may be necessary to reduce potential for catastrophic fire near sensitive species locations. Sensitive species locations should be flagged and avoided to the maximum extent possible. Vegetation should be removed via manual methods in these areas. Two of the cultural sites (historic Derbas property and modern rock art site) within VMU 3 may be altered or destroyed by wildfire, depending on fire intensity. All cultural locations should be avoided and protected with an appropriate buffer during thinning/fuel reduction efforts. If access to cultural sites is necessary to control exotic species or to remove dead/dying vegetation, vegetation should be removed via manual methods. Any ground disturbance should be monitored by a County-approved archaeological and Native American monitor..

Table 14 (Continued)

VMU	Sensitive Resources	Fuel Reduction Practice
	Brewer's calandrinia Robinson's peppergrass Ashy spike-moss <u>Cultural Sites:</u> SDI-12,047 SDI-13,646 SDI-15,999 SDI-19,062 SDI-19,063 SDI-19,064 P-37-030076 P-37-031725	
4	<u>Sensitive Animal Species:</u> California gnatcatcher Northern harrier Pocketed free-tailed bat Western yellow bat Yuma myotis <u>Sensitive Plant Species:</u> San Diego (Palmer's) sagewort Wart-stemmed ceanothus Ashy spike-moss	VMU 4 consists entirely of southern mixed chaparral that is 20 years old. It is an isolated VMU, segregated from the remaining Preserve by a previously graded extension of Mt. Israel Road (Mt. Israel Place). Mt. Israel Road bounds the southern edge of VMU 4 and access is limited to a gate on the north side of Mt. Israel Road, approximately 800 feet west of its intersection with Del Dios Highway. Access is limited to steep, non-maintained trails and old road cuts. Due to limited access, steep topography, and proximity to ignition sources, vegetation management activity in VMU 4 should be limited to invasive species or dead fuel removal, primarily along the southern boundary at Mt. Israel Rd. Thinning/vegetation reduction may be necessary to reduce potential for catastrophic fire near sensitive species locations. Sensitive species locations should be flagged and avoided to the maximum extent possible. Vegetation should be removed via manual methods in these areas. There are no known significant cultural resources within VMU 4.
5 (WUI Fuel Modification Zones)	Residences <u>Sensitive Animal Species:</u> Cooper's hawk Double-crested cormorant Rufous-crowned sparrow Vaux's swift Western bluebird White-faced ibis	This zone is characterized by the adjacent residential development in limited locations in the north and northeast portions of the Preserve. Additionally, VMU 5 includes the 30-foot maintained buffer surrounding the staging area along the primary Preserve access road, 550 feet northwest of the intersection of Del Dios Highway and Date Lane. Fuel reduction by manual thinning, mowing, and non-native removal should be conducted routinely to minimize fire spread and ignition potential from residential development. Thinning/vegetation reduction may be necessary near sensitive species locations. Sensitive species locations should be flagged and avoided to the maximum extent possible. Vegetation should

Table 14 (Continued)

VMU	Sensitive Resources	Fuel Reduction Practice
		be removed via manual methods in these areas. There are no known significant cultural resources within VMU 5.
6 (Del Dios Highway and Mt. Israel Road Roadside Buffer)	Sensitive Plant Species: San Diego (Palmer's) sagewort Wart-stemmed ceanothus	This zone exists along the eastern and southern edges of the Preserve and consists of a 30-foot-wide fuel modification area adjacent to Del Dios Highway and Mt. Israel Road. Fuel reduction by manual thinning, mowing, and non-native plant removal should be conducted routinely to minimize fire spread and ignition potential from Del Dios Highway and Mt. Israel Road. There are no known significant cultural resources within VMU 6.

7.0 REFERENCES

Anderson, Hal E. 1982. Aids to Determining Fuel Models for Estimating Fire Behavior. USDA Forest Service Gen. Tech. Report INT-122. Intermountain Forest and Range Experiment Station, Ogden, UT.

ASM (ASM Affiliates Inc.) 2008. *Management Plan for Archaeological Resources within the Del Dios Highlands Preserve, San Diego County*. Prepared for the County of San Diego Department of Parks and Recreation, San Diego, California. November 2008.

ASM. 2011. *Archaeological Survey Report for the Pascoe, Helix-Lambron, and Cielo Azul Parcel Additions to the Del Dios Highlands Preserve, San Diego County, California*. Prepared for the County of San Diego Department of Parks and Recreation. San Diego, California. February 2011.

Bainbridge, S. and C.M. D'Antonio. 2003. "Prescribed fire for controlling exotics in the California grassland: factors influencing success." In Proceedings of Invasive plants in natural and managed systems: linking science and management [in conjunction with the] 7th International Conference on the Ecology and Management of Alien Plant Invasions. Fort Lauderdale, FL.

BehavePlus. 2009. Missoula, MT: U.S. Department of Agriculture Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

Bell, C.E. 2009. "Invasive Plants and Wildfires in Southern California." University of California, Division of Agriculture and Natural Resources, Publication No. 8397. August 2009.

Brooks, M.L, C.M. D'Antonio, D.M. Richardson, J.B. , D.M., Grace, J.E. Keeley, J.M. DiTomaso, R.J. Hobbs, M. Pellant, D. Pyke. 2004. "Effects of Invasive Alien Plants on Fire Regimes." *BioScience* 54(7):677–688.

Cal-IPC (California Invasive Plant Council). 2010. "California Invasive Plant Inventory Database." Berkley, California: California Invasive Plant Council. December 2010.

Callaway, R.M. and Davis, F.W. 1993. "Vegetation dynamics, fire, and the physical environment in coastal central California." Ecology. 74(5): 1567–1578.

Conard, S.G. and Weise, D.R. 1998. "Management of fire regime, fuels, and fire effects in southern California chaparral: lessons from the past and thoughts for the future." Edited by Teresa L. Pruden and Leonard A. Brennan. In *Fire in ecosystem management: shifting the paradigm from suppression to prescription*, 342–350. Tall Timbers Fire.

Conrad, C.E. 1987. *Common shrubs of chaparral and associated ecosystems of Southern California*. General technical report PSW-99. Berkeley, California: U.S. Department of Agriculture, Pacific Southwest Forest and Range Experiment Station.

County of San Diego. 1997. *Multiple Species Conservation Program: County of San Diego Subarea Plan*. County of San Diego Department of Planning and Land Use. October 1997.

County of San Diego. 2009a. *County of San Diego Vegetation Management Report: A Report on Vegetation Management in the Unincorporated Area of San Diego County*. County of San Diego Department of Planning and Land Use.

County of San Diego. 2009b. *Resource Management Plan for Del Dios Highlands Preserve San Diego County.* County of San Diego Department of Parks and Recreation. June 2009.

County of San Diego. 2010. *County of San Diego Guidelines for Determining Significance and Report Format and Content Requirements, Wildland Fire and Fire Protection*. Land Use and Environment Group. Second Revision August 31, 2010.

D'Antonio, C., S. Bainbridge, C. Kennedy, J.W. Bartolome, and S. Reynolds. 2003. "Ecology and restoration of California grasslands with special emphasis on the influence of fire and grazing on native grassland species." Unpublished manuscript; University of California, Berkeley.

Daubenmire, R. 1968. "Ecology of fire in grasslands." *Advances in Ecol. Res.* 5:209–266.

Davey Resource Group. 2006. *William Heise Park Vegetation Management Plan*. County of San Diego Department of Parks and Recreation. 51 p.

DiTomaso, J.M., and D.W. Johnson (eds.). 2006. "The Use of Fire as a Tool for Controlling Invasive Plants." Cal-IPC Publication 2006-01. Berkley, CA: California Invasive Plant Council.

Dudek. 2011. *Baseline Biodiversity Survey for the Pascoe, Helix-Lambron and Cielo Azul Parcel Additions to the Del Dios Highlands Preserve*. Prepared for the County of San Diego Department of Parks and Recreation. San Diego, California. May 2011.

Finney, M.A. 2004. FlamMap 3.0. Missoula, MT: USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

FireFamily Plus. 2007. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

FRAP (Fire and Resource Assessment Program). 2011. California Department of Forestry and Fire Protection. Accessed January 18, 2011. http://frap.cdf.ca.gov/.

Holland, R.F. 1986. "Preliminary descriptions of the terrestrial natural communities of California." Nongame-Heritage Program, California Department of Fish and Game.

Keeley, J.E. 2004. "Invasive plants and fire management in California Mediterranean-climate ecosystems." Edited by M. Arianoutsou. *In 10th MEDECOS-International Conference on Ecology, Conservation Management*. Rhodes, Greece.

Keeley, J.E. 2005. "Fire history of the San Francisco East Bay region and implications for landscape patterns." *International Journal of Wildland Fire* 14:285–296. http://www.werc.usgs.gov/seki/pdfs/K2005_East%20Bay%20Fire%20History_IJWF.pdf.

Keeley, J.E. and C.J. Fotheringham. 2003. "Impact of past, present, and future fire regimes on North American Mediterranean shrublands." Edited by T.T. Veblem, W.L. Baker, G. Montenegro, and T.W. Swetnam. *In Fire and climatic change in temperate ecosystems of the western Americas*. New York, NY: Springer-Verlag, 218–262.

Keeley, J.E. and S.C. Keeley 1984. "Postfire recovery of California Coastal Sage Scrub." *The American Midland Naturalist* 111(1):105–117.

Keeley, J.E. and S.C. Keeley, 1988. Chapter 6. "Chaparral." Edited by M.G. Barbour and W.D. Billings. *In North American terrestrial vegetation*. Cambridge, Massachusetts: Cambridge University Press, 165–207.

Lawson, D.M., Zedler, P.H., and Seiger, L.A. 1997. "Mortality and growth rates of seedlings and saplings of Quercus agrifolia and Quercus engelmannii: 1990-1995." Edited by Norman H. Pillsbury, Jared Verner, William D. Tietje, technical coordinators. *In Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues.* March 19–22, 1996, San Luis Obispo, California. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 642–645.

Luce, C. H., 1997. "Effectiveness of Road Ripping in Restoring Infiltration Capacity of Forest Roads. *Restoration Ecology* 5(3):265–270.

Minnich, Richard A. 1983. "Fire Mosaics in Southern California and Northern Baja California. Science." *New Series* 219(4590):1287–1294.

Minnich, R.A. and Scott, T.A. 2005. "Wildland fire and the conservation of coastal sage scrub." Accessed April 28, 2005. http://ecoregion.ucr.edu/review/cssfirex.pdf.

Minnich R.A. and Y.H. Chou. 1997. "Wildland fire patch dynamics in the chaparral of Southern California and northern Baja California." *International Journal of Wildland Fire* **7**:221–48.

Moritz, M.A. 2003. "Spatiotemporal Analysis of Controls on Shrubland Fire Regimes: Age Dependency and Fire Hazard." *Ecology* 84(2):351–361.

Moritz, Max A., Jon E Keeley, Edward A Johnson, and Andrew A Schaffner. 2004. "Testing a basic assumption of shrubland fire management: how important is fuel age?" *Front Ecol Environ* 2(2):67–72.

National Weather Service, San Diego Office. 2011. San Diego National Weather Service Office: Watch, Warning, and Advisory Criteria Quick Reference.

Oberbauer, T. 1996. *Terrestrial Vegetation Communities in San Diego County Based on Holland's Descriptions.* San Diego, California: San Diego Association of Governments.

Plumb, T.R. and McDonald, P.M. 1981. *Oak management in California*. Gen. Tech. Rep. PSW-54. Berkeley, California: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station.

Plumb, T.R. and Gomez, A.P. 1983. *Five southern California oaks: identification and postfire management.* Gen. Tech. Rep. PSW-71. Berkeley, California: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station.

RAWS (Remote Automated Weather Station). 2010. Weather data. Accessed March 11, 2010. http://www.fs.fed.us/raws/.

Rice, Peter M. 2005. "Fire as a tool for controlling nonnative invasive plants." Bozeman, Montana: Center for Invasive Plant Management. www.weedcenter.org/management/tools.htm#burning.

Rothermel, R.C. 1991. *Predicting Behavior and Size of Crown Fires in the Northern Rocky Mountains.* Research Paper INT-438. Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment.

Schroeder, Mark J. and Charles J. Buck. 1970. "Fire weather." U.S. Department of Agriculture, Agric. Handbook 360.

Scott, Joe H. and Robert E. Burgan. 2005. *Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model.* Gen. Tech. Rep. RMRS-GTR-153. Fort Collins, Colorado: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

TAIC (Technology Associates International Corporation). 2008. *Biological Diversity Baseline Report for the Del Dios Highlands Preserve, County of San Diego*. Prepared for the County of San Diego Department of Parks and Recreation. San Diego, California. November 2008.

Weise, D.R. and J. Regelbrugge. 1997. "Recent chaparral fuel modeling efforts." Prescribed Fire and Effects Research Unit, Riverside Fire Laboratory, Pacific Southwest Research Station.

Wills, R. 2000. "Effective fire planning for California native grasslands." Open-File Report 00-62. Sacramento, California: U.S. Geological Survey.

APPENDIX A

Glossary of Terms and Acronyms/Abbreviations

Glossary of Terms, Acronyms, and Abbreviations

Acronyms and Abbreviations

Acronym	Definition
amsl	Above Mean Sea Level
APN	Assessor's Parcel
ASMD	Area Specific Management Directives
BMP	Best Management Practices
CAL FIRE	California Department of Forestry and Fire Protection
Cal-IPC	California Invasive Plant Council
CDFG	California Department of Fish and Game
CNPS	California Native Plant Society
CRPR	California Rare Plant Rank
CEQA	California Environmental Quality Act
DPR	County of San Diego Department of Parks and Recreation
EFD	Escondido Fire Department
EF/HGFD	Elfin Forest/Harmony Grove Fire Department
FRAP	Fire and Resource Assessment Program
GIS	Geographic Information System
LRA	Local Responsibility Area
MSCP	Multiple Species Conservation Program
MSDS	Material Safety Data Sheets
OMWD	Olivenhain Municipal Water District
RMP	Resource Management Plan
RSFFPD	Rancho Santa Fe Fire Protection District
SFP	State Fully Protected
SRA	State Responsibility Area
SSC	Species of Special Concern

SWL	State Watch List
USGS	U.S. Geological Survey
VMP	Vegetation Management Plan
VMU	Vegetation Management Unit
WUI	Wildland –Urban Interface

Terms

BehavePlus: Fire behavior prediction and fuel modeling computer program designed to model fire behavior characteristics based on fuel, weather, and topographic inputs. Model outputs include flame length values, fire spotting potential, and rate of fire spread.

Brush: A collective term that refers to stands of vegetation dominated by shrubby, woody plants or low-growing trees; usually of a vegetation type undesirable for livestock or timber management.

Brush Fire: A fire burning in vegetation that is predominantly shrubs, brush, and scrub growth.

Burning Conditions: The state of the combined factors of the environment that affect fire behavior in a specified fuel type.

Canopy: The stratum containing the crowns of the tallest vegetation present (living or dead), usually above 20 feet.

Closure: Legal restriction, but not necessarily elimination, of specified activities such as smoking, camping, or entry that might cause fires in a given area.

Combustible: Any material that, in the form in which it is used and under the conditions anticipated, will ignite and burn.

Conflagration: A raging, destructive fire. Often used to describe a fire burning under extreme fire weather. The term is also used when a wildland fire burns into a WUI, destroying structures.

Crown Fire: A fire that advances from top-to-top of trees or shrubs more or less independent of a surface fire.

Defensible Space: An area either natural or man-made where material capable of allowing a fire to spread unchecked has been treated, cleared, or modified to slow the rate and intensity of

advancing wildfire. This will create an area for housing increased emergency fire equipment, for evacuating or sheltering civilians in place, and a point for fire suppression to occur.

***Duff*:** The layer of decomposing organic materials lying below the litter layer of freshly fallen twigs, needles and leaves and immediately above the mineral soil.

Exposure: (1) Property that may be endangered by a fire burning in another structure or by a wildfire; (2) Direction in which a slope faces, usually with respect to cardinal directions; (3) The general surroundings of a site with special reference to its openness to winds.

Extreme Fire: A level of fire behavior characteristics that ordinarily precludes methods of direct control. One or more of the following is usually involved: high rates of spread, prolific crowning and/or spotting, presence of fire whirls, a strong convection column. Predictability is difficult because such fires often exercise some degree of influence on their environments and behave erratically, sometimes dangerously.

Fine Fuels: Fast-drying dead fuels that are less than 0.025-inch in diameter and are generally characterized by a comparatively high surface area to volume ratio. These fuels (grass, leaves, needles, etc.) ignite readily and are consumed rapidly by fire when dry.

Fire Behavior: The manner in which a fire reacts to the influences of fuel, weather, and topography.

Fire Department: Any regularly organized fire department, fire protection district or fire company regularly charged with the responsibility of providing fire protection to the jurisdiction.

Fire Front: That part of a fire within which continuous flaming combustion is taking place. Unless otherwise specified, it is assumed to be the leading edge of the fire perimeter.

Fire Hazard: A fuel complex, defined by volume, type condition, arrangement, and location, that determines the degree of ease of ignition and of resistance to control.

Fire Hydrant: A valved connection on a piped water supply system having one or more outlets that is used to supply hose and fire department pumpers with water.

Fire Prevention: Activities, including education, engineering, enforcement, and administration that are directed at reducing the number of wildfires, the costs of suppression, and fire-caused damage to resources and property.

Fire Protection: The actions taken to limit the adverse environmental, social, political and economic effects of fire. Protection is relative, not absolute.

***Fire Regime**:* Periodicity and pattern of naturally occurring fires in a particular area or vegetative type, described in terms of frequency, biological severity, and area of extent.

Fire Retardant: Any substance, except plain water, that by chemical or physical action reduces flammability of fuels or slows their rate of combustion.

Fire Season: (1) Period(s) of the year during which wildland fires are likely to occur, spread, and affect resource values sufficient to warrant organized fire management activities; (2) A legally enacted time during which burning activities are regulated by state or local authority.

Fire Storm: Violent convection caused by a large continuous area of intense fire. Often characterized by destructively violent surface indrafts, near and beyond the perimeter, and sometimes by tornado-like whirls.

Fire Triangle: Instructional aid in which the sides of a triangle are used to represent the three factors (oxygen, heat, fuel) necessary for combustion and flame production; removal of any of the three factors causes flame production to cease.

Fire Weather: Weather conditions which influence fire starts, fire behavior or fire suppression.

Fire Whirl: Spinning vortex column of ascending hot air and gases rising from a fire and carrying aloft smoke, debris, and flame. Fire whirls range in size from less than 1 foot to over 500 feet in diameter. Large fire whirls have the intensity of a small tornado.

Firebrand: Any source of heat, natural or human made, capable of igniting wildland fuels. Flaming or glowing fuel particles that can be carried naturally by wind, convection currents, or gravity into unburned fuels. Examples include leaves, pine cones, glowing charcoal, and sparks.

Firebreak: A natural or constructed barrier used to stop or check fires that may occur, or to provide a control line from which to work.

Firefighter: A person who is trained and proficient in the components of structural or wildland fire.

Flame: A mass of gas undergoing rapid combustion, generally accompanied by evolution of sensible heat and incandescence.

Flammability: The relative ease with which fuels ignite and burn regardless of the quantity of the fuels.

Fuel Break: An area, strategically located for fighting anticipated fires, where the native vegetation has been permanently modified or replaced so that fires burning into it can be more

easily controlled. Fuel breaks divide fire-prone areas into smaller areas for easier fire control and to provide access for firefighting.

Fuel Loading: The volume of fuel in a given area generally expressed in tons per acre.

Fuel Model: Simulated fuel complex for which all fuel descriptors required for the solution of a mathematical rate of spread model have been specified.

Fuel Modification: Any manipulation or removal of fuels to reduce the likelihood of ignition or the resistance to fire control.

Fuel Modification Zone: A strip of land, typically 100 feet wide or more, between an improved property and wildlands, where combustible vegetation has been removed, thinned, or modified and may be partially or totally replaced with approved drought-tolerant, fire-resistant and/or irrigated plants to provide an acceptable level of risk from vegetation fires. Fuel modification reduces radiant and convective heat, thereby reducing the amount of heat exposure on the roadway or structure and providing fire suppression forces a safer area in which to take action.

Fuels: All combustible material within the WUI or intermix, including vegetation and structures.

Hazard: The degree of flammability of the fuels once a fire starts. This includes the fuel (type, arrangement, volume and condition), topography and weather.

High Value Resource: High Value Resources are natural or man-made resources, including plant and animal species, cultural resources, and residences that form the basis for fire management planning on the Preserve.

Ignition Time: Time between application of an ignition source and self-sustained combustion of fuel.

Invasive Plant Species: A plant species that is not native to the region and has demonstrated the ability to aggressively outcompete native plant species that would normally colonize a given area.

Ladder Fuels: Fuels that provide vertical continuity allowing fire to carry from surface fuels into the crowns of trees or shrubs with relative ease.

Overstory: That portion of the trees in a forest that forms the upper or uppermost layer.

Peak Fire Season: That period of the year during which fires are expected to ignite most readily, to burn with greater than average intensity, and to create damages at an unacceptable level.

Prescribed Burning: Controlled application of fire to wildland fuels in either their natural or modified state, under specified environmental conditions, which allows the fire to be confined to a predetermined area, and to produce the fire behavior and fire characteristics required to attain planned fire treatment and resource management objectives.

Prescribed Fire: A fire burning within prescription. This fire may result from either planned or unplanned ignitions.

Red Flag Warning Conditions: A **Red Flag Warning** is a forecast warning issued by the United States National Weather Service to inform area firefighting and land management agencies that conditions are ideal for wildland fire ignition and propagation. After drought conditions, and when humidity is very low, and especially when high or erratic winds that may include lightning are a factor, the Red Flag Warning becomes a critical statement for firefighting agencies, which often alter their staffing and equipment resources dramatically to accommodate the forecast risk.

Responsibility Area: That area for which a particular fire protection organization has the primary responsibility for attacking an uncontrolled fire and for directing the suppression action. Such responsibility may develop through law, contract, or personal interest of the fire protection agent. Several agencies or entities may have some basic responsibilities without being known as the fire organization having direct protection responsibility.

Restoration (*of native vegetation communities*): The act of restoring ecological functions and values of vegetation communities that have been adversely affected by human- or nature-induced impacts, causing decrease in ecological functions and values.

Sensitive Species: A plant or animal species with a special status listing from federal, state or local regulatory agencies.

Slope: The variation of terrain from the horizontal; the number of feet rise or fall per 100 feet measured horizontally, expressed as a percentage.

Smoke: (1) The visible products of combustion rising above a fire; (2) Term used when reporting a fire or probable fire in its initial stages.

Spotting: The ignition of unburned fuels ahead of the fire front as a result of ignition by firebrands. Spotting enhances the spread of wildfires.

Structure Fire: Fire originating in and burning any part of all of any building, shelter, or other structure.

Suppression: The most aggressive fire protection strategy, it leads to the total extinguishment of a fire.

Surface Fuel: Fuels lying on or near the surface of the ground, consisting of leaf and needle litter, dead branch material, downed logs, bark, tree cones, and low stature living plants.

Tree Crown: The primary and secondary branches growing out from the main stem, together with twigs and foliage.

Uncontrolled Fire: Any fire that threatens to destroy life, property, or natural resources and that (a) is not burning within the confines of firebreaks or (b) is burning with such intensity that it could not be readily extinguished with ordinary, commonly available tools.

Understory: Low-growing vegetation (herbaceous, brush or reproduction) growing under a stand of trees. Also, that portion of trees in a forest stand below the overstory.

Urban Interface: Any area where wildland fuels threaten to ignite combustible homes and structures.

Vegetation Management Unit: Delineated Preserve unit based on topography, vegetation or other features used for internal invasive species, restoration, and fire management planning.

Weed: A plant species that interferes with a desired management objective. This term does not denote the native or non-native status of a plant species. Both native and non-native plants have the ability to interfere, depending on the objective (i.e., native cattails can be considered a weed for flood control management objectives).

Wildfire: An unplanned and uncontrolled fire spreading through vegetative fuels, at times involving structures.

Wildland: An area in which development is essentially nonexistent, except for roads, railroads, power lines, and similar transportation facilities. Structures, if any, are widely scattered.

Wildland Fire: Any fire occurring on the wildlands, regardless of ignition source, damages or benefits.

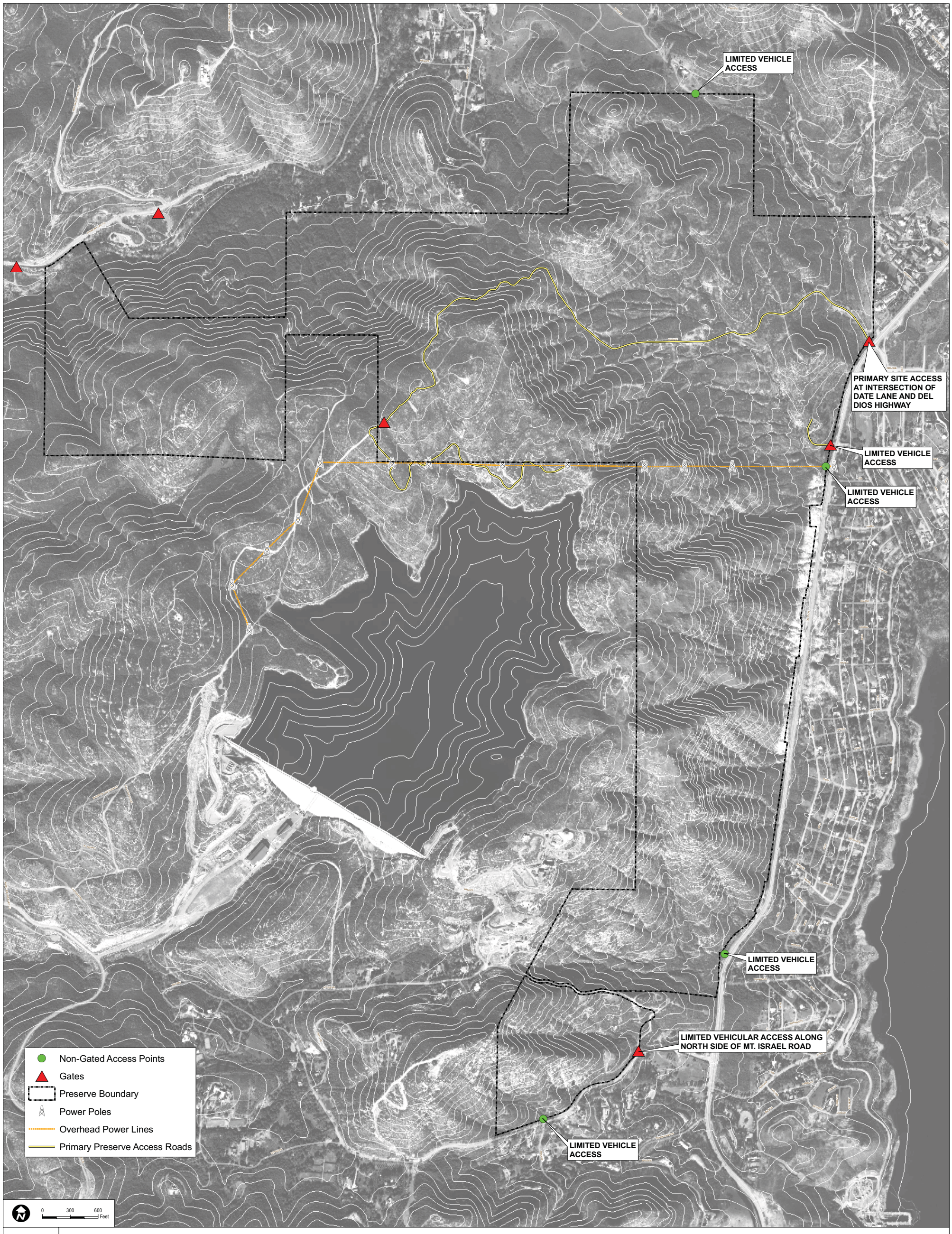
Wildland-Urban Interface (WUI): The area where structures and other human developments meet or intermingle with undeveloped wildland (as defined in the County Fire Code, County Consolidated Fire Code and County Building Code).

Sources: www.firewise.org and County of San Diego Guidelines for Determining Significance and Report Format and Content Requirements, Wildland Fire and Fire Protection (2010).

INTENTIONALLY LEFT BLANK

APPENDIX B

Preserve Map with Access Gates and Transmission Line Locations



DUDEK

6680-1D

SOURCE: Digital Globe 2008

APPENDIX B

Preserve Map with Access Gates, Transmission Line Location, and Vegetation Management Units

APPENDIX C

Fire Behavior Modeling Results

APPENDIX C
Fire Behavior Modeling Results

FUELS CLASSIFICATION

Reliable estimates of fire behavior must consider the relationship of fuels to the fire environment and the variations in these fuels. Natural fuels are made up of the various components of vegetation, both live and dead, that occur on a site. The type and quantity will depend upon the soil, climate, geographic features, and the fire history of the site. The major fuel groups of grass, shrub, trees, and slash are defined by their constituent types and quantities of litter and duff layers, dead woody material, grasses and forbs, shrubs, regeneration, and trees. Fire behavior can be predicted largely by analyzing the characteristics of these fuels. Fire behavior is affected by seven principal fuel characteristics: fuel loading, size and shape, compactness, horizontal continuity, vertical arrangement, moisture content and chemical properties.

All vegetation is considered fuel. All vegetation will burn; however, some species require more heat in order to ignite and propagate flame. The moisture content of vegetation is an important component; dry vegetation will ignite more rapidly, whereas green vegetation must lose its moisture before it will ignite. Consequently, shrubland vegetation with high oil content (above 6%) will burn more quickly and hotter than vegetation with high leaf moisture levels and low oil content levels. More than 90% of the flaming front of a wildfire is composed of fuel less than 0.5 inch in diameter and is consumed in minutes. Fuels larger than 1 inch in diameter are termed "residual" fuel and may require several hours to burn out. This larger fuel does not contribute to the forward rate of spread of the fire. The following factors describe the relationship between vegetation characteristics that affect fire behavior:

Fuel loading is defined as the oven dry weight of fuels in a given area, usually expressed in tons per acre. Natural fuel loading varies greatly by vegetative or fuel types in addition to the different size classes of fuel particles. Vegetation types can be rated as light, moderate, or heavy. Each rating is an estimate of the dead or live surface fuels that are less than 3 inches in diameter. Although specific measurements were not taken, based on the vegetation types identified in the cursory survey of the Del Dios Highlands (Preserve), the different vegetation types can generally be assigned a moderate to high rating.

> Measuring the intensity, force, and destructive potential of wildfire is accomplished by observing flame lengths produced by burning vegetation. A direct relationship exists between the amount of energy released during burning (per second) and the length of flame generated. The standard for measuring energy release in the United States is the British Thermal Unit (BTU). One BTU is defined as the amount of energy required to increase the temperature of 1 pound of water 1°F (a standard kitchen match or candle flame is approximately one BTU).

Size and shape affect the surface area to volume ratio of fuels. Small fuels have a greater surface area to volume ratio than larger fuels. Dead fuels are separated into four size classes: (1) grasses, litter, or duff less than 0.25-inch diameter; (2) twigs and small stems 0.25– to 1-inch diameter; (3) branches 1- to 3-inch diameter; and (4) large stems and branches greater than 3-inch diameter. The fine fuels less than 0.25 inch in diameter are most important for fire behavior analysis because their ignition time is less, and their fuel moisture content changes rapidly. This characteristic is typical for the grasses that were identified within and adjacent to the Preserve.

> The arrangement, size, and surface area of vegetative fuels play an important role in fire behavior and spread potential. Dense, concentrated biomass may burn evenly; however, when overall size decreases and surface area increases (as seen in native shrub stands), burning patterns change, resulting in faster ignition and spread. Live shrubland and grassland vegetation generally exhibit high surface to volume ratios. Standing grass, coastal sage scrub, and chaparral have high surface area to volume ratios, whereas forest litter and chipped or cut biomass exhibit very low surface to volume ratios.

Compactness, or spacing between fuel particles, affects the rate of combustion. For example, fuel particles that are closely compacted have less surface area exposed and less air circulation between particles and thus are slower to combust. The thick duff layer found underneath a mixed forest is an example of a tightly compacted fuel, whereas the open, dead branches on sagebrush or chaparral are considered a loosely compacted fuel. With the exception of the on-site oak woodlands, the fuels on the Preserve are loosely spaced with adequate air circulation required to carry a fire.

Horizontal continuity is the extent of horizontal distribution of fuels at various levels or planes. The vegetative types within various portions of the Preserve were analyzed for horizontal continuity and vertical arrangement. Fuels are either rated as uniform or patchy. Uniform fuels are evenly distributed and occur in a continuous, non-interrupted cover across the landscape. Patchy fuels are not continuous.

Vertical arrangement is defined as the relative heights of fuels above the ground, as well as their vertical continuity. Both of these vegetation characteristics influence the ability of fire to reach various fuel levels or strata. Vegetation of various heights that can transport fire from the low-level brush to tree canopies is called a fuel ladder and may create what is called a “crown fire.” When tall grasses and shrubs grow around trees with low hanging branches, the result is a fuel ladder. When a ground fire climbs the fuel ladder into the crowns of trees, it can spread canopy to canopy, creating higher fire intensity and firebrands.

Fuel moisture content is defined as the amount of water in fuels. The moisture content of plant materials plays a major role in the ignition, development, and spread of fires. Fuel moisture controls the current flammability of fuels both living and dead. During the most active growing periods of spring, the moisture content of plant foliage may be quite high. As the season progresses, a plant's moisture content declines until late summer or early fall when the plant becomes dormant or completely dies. Fine fuels, less than 0.25 inch thick, are most responsible for the spread of fire and have highly variable fuel moisture contents depending on the relative humidity of the air. Live fuel moisture content during the peak fire season (October through December) is estimated to be 60% to 80% in the drier open areas. This can potentially drop to less than 60% under extreme, dry wildfire conditions.

> There are two types of fuel moisture values to consider: (1) dead fuel moisture, with measurements of 1-, 10-, 100-, and 1,000-hour time-lag; and (2) live fuel moisture.

Dead fuel moisture percentages are determined by temperature, aspect, time of day, relative humidity, and time of year. One-hour time-lag fuel is less than 0.5 inch thick, 10-hour time-lag fuel is between 0.5 inch and 1 inch thick, 100-hour time-lag fuel is between 1 and 3 inches thick, and 1,000-hour time-lag fuel is greater than 3 inches thick. One-hour time-lag fuel can reach equilibrium with the surrounding atmosphere in 1 hour, or within minutes when air temperature exceeds 80°F and relative humidity is below 25%. One-hour time-lag fuel moisture may be calculated using a set of tables that reference time of day, month, aspect, slope, temperature, and relative humidity. Ten-hour, 100-hour, and 1,000-hour time-lag fuel can take up to 10 hours, 100 hours, or 1,000 hours to reach equilibrium with the surrounding atmosphere, respectively. In Southern California, 1-hour, 10-hour, and 100-hour time-lag fuels are usually given equal value. One thousand hour time-lag fuel, which occurs in more heavily wooded environments (i.e., timber), is generally used in measuring drought effects. Forests are considered "critical" when 1,000-hour fuel measurements are less than 15% (as a frame of references, kiln-dried wood moisture averages 22%).

> Despite variations in the topography and disturbance history of the Preserve, vegetative cover is classified into four main types: grass, chaparral, coastal sage scrub, and woodland. Frequent fires have created low-volume fuel beds throughout much of the Preserve. Although most fuels occur in the 1-hour size class, pockets of 10- and 100-hour fuels can be found, primarily in the woodland vegetation types on site.

Live fuel moisture is described as the moisture in leaves and woody portions of a plant. Field measurements of live fuel moistures are calculated by cutting small branches (less than 3 inches in diameter), weighing the branch, placing it in a low- temperature oven for 12 hours, removing

the branch, and weighing it again. The difference in weight is the loss of moisture in the leaves and woody portion of the branch. Consequently, live fuel moisture may exceed 100% of the dry weight of the plant. Live fuel moisture is the highest in the spring and early summer, and the lowest in late summer, fall, and early winter. This measurement is a valuable tool in predicting wildfire potential for a general area.

> Chaparral and coastal sage scrub are common Southern California vegetation types found in many upland locations and generally have reduced fuel moisture levels. Conversely, riparian vegetation, including willow (*Salix* spp.), coast live oak (*Quercus agrifolia*), and mulefat (*Baccharis salicifolia*), has higher leaf moisture values than vegetation growing in drier, more xeric sites. The importance of fuel moisture in examining fire hazard is that higher moisture levels ultimately require higher BTU output to ignite or sustain ignition. Consequently, fuel arrangement, along with fuel chemical/moisture content, plays an important role in wildfire combustion, spread, and heat output. Fuel moisture is a significant component, as vegetation requires external heat and energy to reduce moisture levels before it will ignite. High winds, low relative humidity, and/or high temperatures begin the process of removing fuel moisture, thus allowing vegetation to ignite and burn more rapidly. Consequently, lower fuel moisture values, including both dead and live fuel moistures, result in increased fire intensity. Moisture-laden fuels inhibit complete combustion while simultaneously producing excessive smoke output.

Fuel chemical properties include the presence of volatile substances such as oils, resins, wax, and pitch. These also affect the rate of combustion. Chaparral and sage scrub vegetation have high amounts of these volatile substances that contribute to rapid rates of spread and high fire intensities.

> Oil and moisture contents vary between fuels and fluctuate depending on the time of year. For example, black sage may have an oil content approaching 20% of its weight in dry summer or autumn months, but, in the spring, when sufficient groundwater is available, moisture content values can exceed 300%. When stressed during extreme dry weather conditions, numerous chaparral and coastal sage scrub species may react explosively when moisture falls below 60%, whereas larger shrubs may require higher energy to sustain ignition.

FUEL MODELS

All nine fuels characteristics are descriptors that help define the 13 standard fuel models (Anderson 1982), the more recently developed 40 fuel models (Scott and Burgan 2005), and five

custom fuel models developed for Southern California (Weise and Regelbrugge 1997). Six fuel models (models 1, 8, 9, SCAL 18, SH7, and TU5) were used in the FlamMap analysis for the Preserve and are required inputs for the mathematical fire spread computations. Additionally, one non-burnable model (model 98) was utilized to represent non-fuel areas (e.g. roads)). Table 1 provides details of the six fuel models used in the analysis conducted for Preserve.

Table 1
Fuel Model Characteristics

Fuel Model	Description	Tons/acre; Btu/lb	Fuel Bed Depth (Feet)
1	Short grass	0.7 tons/acre; 8,000 Btu/lb	1.0
8	Closed timber litter	5.0 tons/acre; 8,000 Btu/lb	0.2
9	Hardwood litter	3.5 tons/acre; 8,000 Btu/lb	0.2
SCAL18	Sage/buckwheat	9.7 tons/acre; 9,200 Btu/lb	3.0
SH7	Very high load dry scrub	14.4 tons/acre; 8,000 Btu/lb	6.0
TU5	Very high load, dry climate timber-shrub	14.0 tons/acre; 8,000 Btu/lb	1.0

WILDLAND FIRE BEHAVIOR MODELING

Fire behavior was analyzed for the Preserve site using FlamMap fire behavior modeling software and local topographic, fuels, and weather data. The FlamMap output data provide an indication of how vegetative fuels will burn under specific fuel, weather, and topographical conditions. The FlamMap (version 3.0) fire behavior software package (Finney 2004) is a geographic information system (GIS)-driven computer program that incorporates fuels, weather, and topography data in generating static fire behavior outputs, including values associated with flame length, rate of spread, and fireline intensity. It is a flexible system that can be adapted to a variety of specific wildland fire planning and management needs.

The calculations that result from FlamMap are based on the BehavePlus Fire Modeling System algorithms but result in a geographically distinct data set based on GIS inputs. FlamMap model outputs allow wildland resource managers to predict rate of spread, fireline intensity, and flame length, which provide important insights about the characteristics of wildfire spread within and adjacent to high-value areas, whether residential structures or preserved sensitive habitats. Each of the input variables used in FlamMap remain constant at each location, meaning that the input variables are applied consistently to each grid cell and the fire behavior at one grid cell does not impact that at a neighboring grid cell. Essentially, the model presents a "snapshot" in time and does not account for temporal changes in fire behavior or the movement of fire across the landscape. As such, the results of the models contained herein should be utilized as valuable

information sources and tools to prioritize fuel treatment options rather than an exact representation of how a fire would behave on the Preserve.

The basic assumptions and limitations of FlamMap are:

- The fire model output describes fire behavior only in the flaming front. The primary driving forces in the predictive calculations are the dead fuels less than 0.25 inch in diameter. These are the fine fuels that carry fire. Fuels greater than 1 inch in diameter have little effect to carry fire, and fuels greater than 3 inches in diameter have no effect.

- The model bases calculations and descriptions on a wildfire spreading through surface fuels that are within 6 feet of the ground and contiguous to the ground. Surface fuels are often classified as grass, brush, litter, or slash.

- The software assumes that weather is uniform. However, because wildfires almost always burn under non-uniform conditions, length of projection period and choice of fuel must be carefully considered to obtain useful predictions.

- The FlamMap fire behavior computer modeling system provides the average length of the flames, which is a key element for determining defensible space distances for minimizing structure ignition.

Fuel models used in the FlamMap analysis are classified into four groups based upon fuel loading (tons/acre), fuel height, and surface to volume ratio. Fuel model classifications were made during field analysis and in conjunction with available vegetation maps of the Reserve. The following list of fuel types describes the classification of fuel models based on vegetation type:

- Grasses Fuel, Models 1 through 3. These models represent the fast moving, light, flashy fuels found in grassland landscapes.

- Brush Fuel, Models 4 through 7, SCAL 14 through 18. These models are designed to represent the higher-intensity chaparral and sage scrub dominated landscapes.

- Timber Fuel, Models 8 through 10. Timber models are selected to represent the riparian woodland or ornamental forested landscapes.

- Logging Slash, Fuel Models 11 through 13. These models are used to represent slash; none were utilized for the Preserve.

FLAMMAP FUEL MODEL INPUTS

FlamMap software requires a minimum of 5 input files that represent field conditions in the study area, including elevation, slope, aspect, fuel model, and canopy cover. Each of these files was created as a raster geographic information system (GIS) file in Arc View 9.3.1 software, exported as an ASCII grid file, then utilized in creating a FARSITE Landscape file that served as the base for the FlamMap runs. The resolution of each grid file and associated ASCII file that was used in the models described herein is 3 meters, based on available digital elevation models (DEMs). In addition to the Landscape file, wind and weather data are incorporated into the model inputs. The output files chosen for each of the modeling runs included flame length (feet) and fireline intensity (BTU/ft/sec). Figures B-1 through B-4 depict the results of each of the four modeling runs and exhibit each of these output variables.

The following provides a description of the input and output variables used in processing the FlamMap models. In addition, data sources are cited and any assumptions made during the modeling process are described.

1. ***Elevation.*** Elevation data were derived from a 3 meter resolution Interferometric Synthetic Aperture Radar (IfSAR) measurement for coastal Southern California, acquired from the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center. This data were utilized to create an elevation grid file, using units of feet above mean sea level. The elevation data are a necessary input file for FlamMap runs and are necessary for adiabatic (i.e., a process that happens without loss or gain of heat) adjustment of temperature and humidity and for conversion of fire spread between horizontal and slope distances (Finney 2004).
2. ***Slope.*** Using Spatial Analyst tools, a slope grid file was generated from the elevation grid file. Slope measurements are represented in percent of inclination from horizontal. The slope input file is necessary for computing slope effects on fire spread and solar radiance (Finney 2004).
3. ***Aspect.*** Using Spatial Analyst tools, an aspect grid file was generated from the elevation grid. Aspect values are presented in azimuth degrees and are important in determining solar exposure.
4. ***Fuel Model.*** Vegetation coverage data in the form of a GIS shapefile were used in this analysis to create a fuel model file. Derived from Dudek's vegetation mapping data, the vegetation types were classified according to existing National Forest Fire Laboratory (NFFL) and BehavePlus fuel models, and the data file was converted to a grid file for inclusion in FlamMap modeling. Table 2 presents the vegetation and associated fuel type classifications for the Preserve.

5. ***Canopy Cover.*** Canopy cover is a required file for FlamMap operations. It is necessary for computing shading and wind reduction factors for all fuel models. Canopy cover is the horizontal percentage of the ground surface that is covered by tree crowns. Canopy cover is measured as the horizontal fraction of the ground that is covered directly overhead by tree canopy. Crown closure refers to the ecological condition of relative tree crown density. Stands can be said to be "closed" to recruitment of canopy trees but still only have 40% or 50% canopy cover (Finney 2004). Coverage units can be categories (0–4) or percentage values (0–100). Table 2 presents canopy cover assignments for each vegetation type/fuel model

Table 2
Fuel Models and Associated Canopy Cover Values

Vegetation Community/Land Cover	Fuel Model	Canopy Cover Value
Coast Live Oak Woodland	9	3
Diegan Coastal Sage Scrub	SCAL18	0
Disturbed Habitat	1	0
Eucalyptus Woodland	TU5	3
Non-native Grassland	1	0
Southern Coast Live Oak Riparian Forest	8	3
Southern Mixed Chaparral	SH7	0
Southern Willow Scrub	8	2
Urban/Developed	98	0

Weather

In order to utilize weather and fuel moisture variables for the Preserve, data from the Ammo Dump Remote Automated Weather Station (RAWS) was analyzed. While data from the Sweetwater weather station was used to evaluate temperature and precipitation for the Preserve, utilization of RAWS data is necessary for fire behavior modeling as it includes data for fuel moisture conditions (unavailable from the Sweetwater weather station). As of the date of this report, no RAWS are located on the Preserve property. The Ammo Dump RAWS is located approximately 23 miles to the northwest of the Preserve and is located in a similar inland position as the Preserve. While the Valley Center RAWS is located closer to the Preserve, it is more than 10 miles further inland, and is placed at an elevation approximately 400 feet higher than the Preserve. The following summarizes the location and available data ranges for the Ammo Dump RAWS:

- Latitude: 33.381389
- Longitude: -117.285556

- Elevation: 1,068 feet
- Data years: 2001 to 2010.

Wind and weather data are a required component to fire behavior modeling efforts. The Ammo Dump RAWS data was processed with the FireFamily Plus v. 4.0.2 (FireFamily Plus 2007) software package to determine summer (50th percentile) and fall (97th percentile) weather conditions to be incorporated into the Initial Fuel Moisture file used as an input in FlamMap. Wind direction and wind speed values for the two FlamMap runs were manually entered during the data input phase. All other weather data were held constant for each of the FlamMap runs. Table 3 summarizes weather and fuel moisture data inputs used for both summer and fall weather conditions.

Table 3
FlamMap Weather Input Variables

Model Variable	50th Percentile Weather	97th Percentile Weather (w/ Max. Wind)
1 h fuel moisture	7%	2%
10 h fuel moisture	9%	3%
100 h fuel moisture	16%	8%
Live herbaceous moisture	60%	30%
Live woody moisture	90%	60%
20 ft wind speed (mph)	10 mph	50 mph (maximum observed Fall wind speed)
Wind direction	225 degrees	45 degrees
Slope steepness	Variable by location	Variable by location

mph = miles per hour

FlamMap Fuel Model Outputs

Two output grid files were generated for each of the two FlamMap runs, and include representations of flame length (feet) and fireline intensity (BTU/feet/second), as shown in Figures B-1 through B-4. The aforementioned fire behavior variables are an important component in understanding fire risk and fire agency response capabilities. Flame length, the length of the flame of a spreading surface fire within the flaming front, is measured from midway in the active flaming combustion zone to the average tip of the flames (Andrews, Bevins, and Seli 2004). It is a somewhat subjective and non-scientific measure of fire behavior, but is extremely important to fireline personnel in evaluating fireline intensity and is worth considering as an important fire variable (Rothermel 1991). Fireline intensity is a measure of heat output from the flaming front, and also affects the potential for a surface fire to transition to a crown fire and is another important variable in initial attack and fire suppression efforts. The information in Table 4 presents an interpretation of these fire behavior variables as related to fire suppression efforts.

Table 4
Fire Suppression Interpretation

Flame Length (feet)	Fireline Intensity (Btu/ft/s)	Interpretations
Under 4	Under 100	Fires can generally be attacked at the head or flanks by persons using hand tools. Hand line should hold the fire.
4 to 8	100 to 500	Fires are too intense for direct attack on the head by persons using hand tools. Hand line cannot be relied on to hold the fire. Equipment such as dozers, pumpers, and retardant aircraft can be effective.
8 to 11	500 to 1000	Fires may present serious control problems—torching out, crowning, and spotting. Control efforts at the fire head will probably be ineffective.
Over 11	Over 1000	Crowning, spotting, and major fire runs are probable. Control efforts at head of fire are ineffective.

Source: BehavePlus 3.0.2 fire behavior modeling program (Andrews, Bevins, and Seli 2004)

The fire behavior analysis results for the Preserve vary depending on fuel type. As FlamMap utilizes site-specific digital terrain data (including slope, vegetation, aspect, and elevation data) slight variations in predicted flame length and fireline intensity values can be observed based on fluctuations of these attributes across the landscape. As presented, wildfire behavior in each of the fuel types varies depending on weather conditions. Given the climatic, vegetation, and topographic characteristics along with the fire history and fire behavior modeling results discussed in this VMP, the Preserve is determined to be vulnerable to wildfire starting in, burning onto, or spotting onto the site. Based on this information, adjacent residential development, and the fire history of the area, it is expected that wildfires will occur on the Preserve in the future.

Under extreme fall weather conditions (97th percentile fuel moistures and maximum recorded wind speeds of 50 miles per hour), fire can move rapidly through the site's fuels. Worst-case flame lengths were calculated at approximately 48 feet in chaparral vegetation types and approximately 41 feet in sage scrub vegetation on slopes exceeding 50% throughout the Preserve. Spread rates on site may exceed 8 miles per hour in dry flashy fuels (grasses and scrub) under extreme weather and slope conditions. Finally, under extreme weather and wind conditions, fireline intensity values may exceed 24,000 Btu/feet/second limiting the options for fire response personnel and emphasizing the importance of fuel modification and defensible space for adjacent residences.

It should be noted that the modeling results depict values based on inputs to the FlamMap system. Variations in weather or pockets of different fuel types are not accounted for in this analysis. Additionally, the scale of analysis (3 square meters) limits fine-scale analysis and interpretation. Model results should be used as a basis for planning only, as actual fire behavior for a given location will be affected by many factors, including unique weather patterns, small-scale topographic variations, or changing vegetation patterns that could not be obtained for this analysis.

REFERENCES

Anderson, H.E. 1982. *Aids to Determining Fuel Models for Estimating Fire Behavior.* U.S. Department of Agriculture (USDA), Forest Service, General Technical Report INT-122. Intermountain Forest and Range Experiment Station: Ogden, UT.

Andrews, Patricia L., Collin D. Bevins, and Robert C. Seli. 2004. BehavePlus fire modeling system, version 3.0: User's Guide. Gen. Tech. Rep. RMRS-GTR-106 Ogden, UT: Department of Agriculture, Forest Service, Rocky Mountain Research Station. 132p.

DigitalGlobe. 2008. Graphical data for Figures C-1 through C-4.

Finney, M.A. 2004. FlamMap 3.0. USDA, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory: Missoula, MT.

Dudek. 2009. Vegetation Mapping. Preserve Geodatabase for Vegetation Communities. Unpublished data.

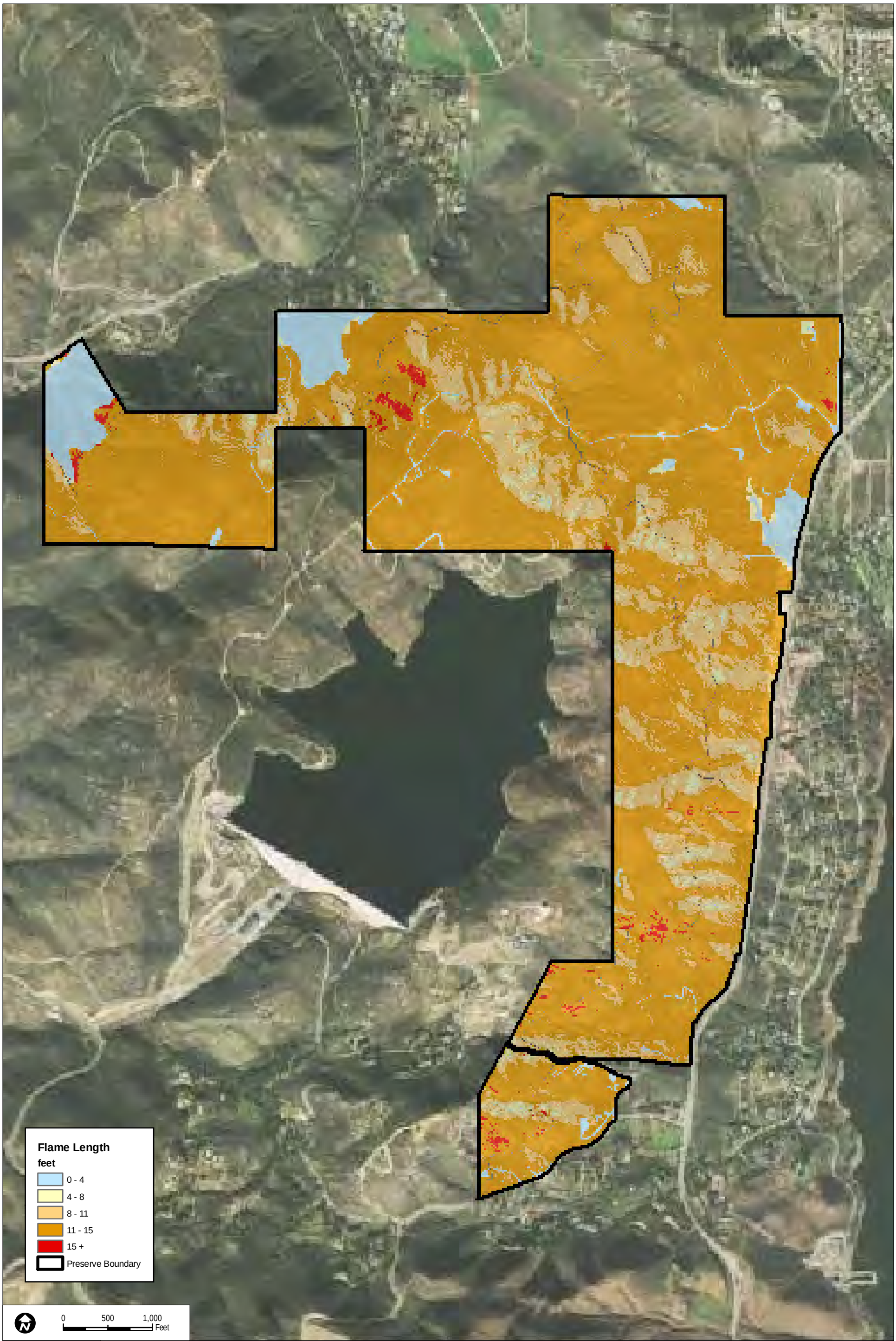
Rothermel, Richard C. 1991. Predicting behavior and size of crown fires in the northern Rocky Mountains. Research Paper INT-438. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station.

SanGIS (San Diego Geographic Information System). 2007. Graphical data for Figures C-1 through C-4.

Scott, J.H. and R.E. Burgan. 2005. *Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model*. USDA, Forest Service, General Technical Report RMRS-GTR-153. Rocky Mountain Research Station: Fort Collins, CO. 72 p.

Weise, D.R. and J. Regelbrugge. 1997. *Recent chaparral fuel modeling efforts*. Prescribed Fire and Effects Research Unit, Riverside Fire Laboratory, Pacific Southwest Research Station. 5 p.

INTENTIONALLY LEFT BLANK



DUDEK

6680-1D

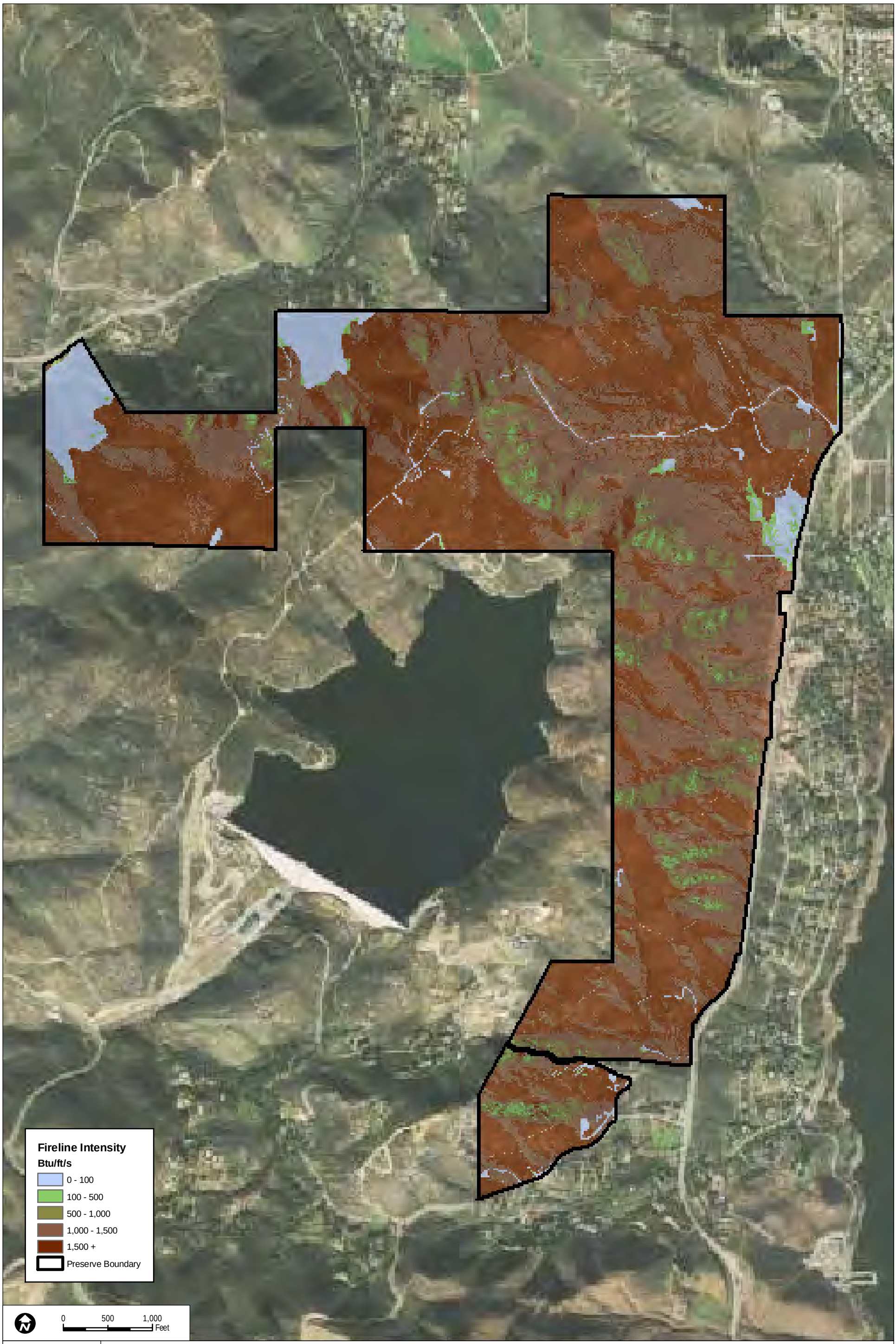
SOURCE: Digital Globe 2008

APPENDIX C-1

Flame Length, Summer Fire

Final Del Dios Highlands Preserve - Vegetation Management Plan

INTENTIONALLY LEFT BLANK



DUDEK

6680-1D

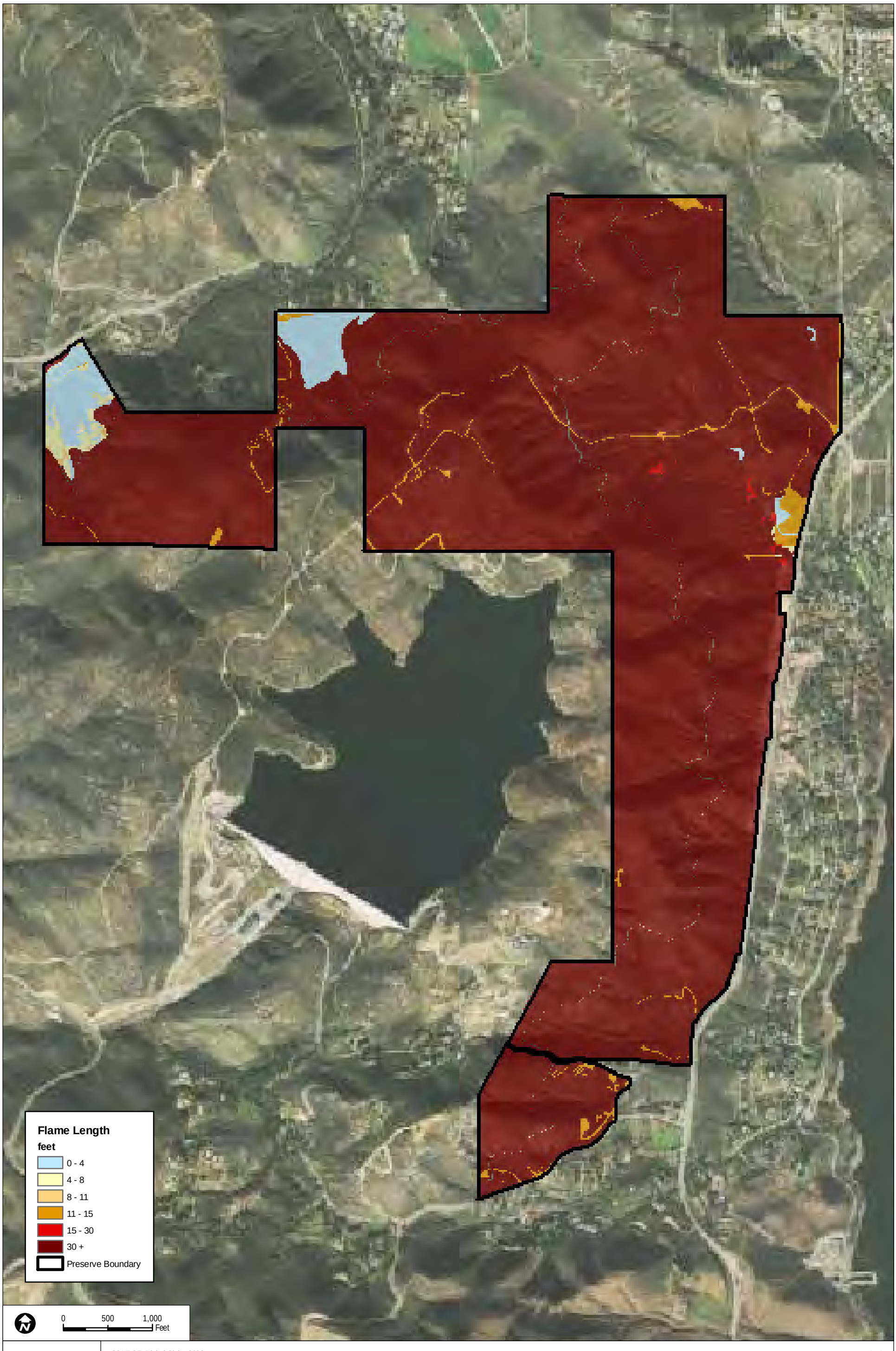
SOURCE: Digital Globe 2008

APPENDIX C-2

Fireline Intensity, Summer Fire

Final Del Dios Highlands Preserve - Vegetation Management Plan

INTENTIONALLY LEFT BLANK



DUDEK

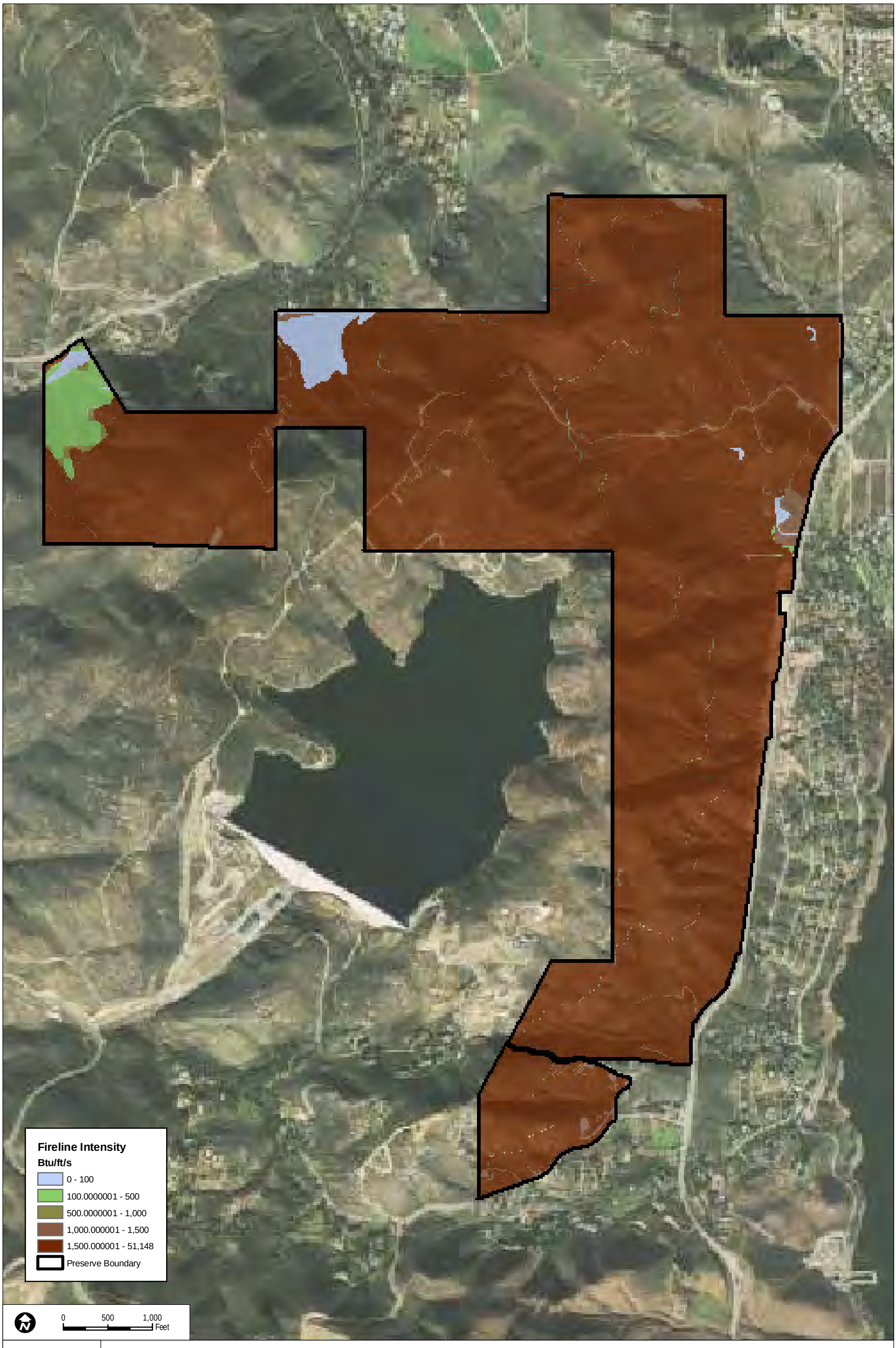
6680-1D

SOURCE: Digital Globe 2008

APPENDIX C-3

Flame Length, Fall Fire

INTENTIONALLY LEFT BLANK



DUDEK

6680-1D

SOURCE: Digital Globe 2008

APPENDIX C-4

Fireline Intensity, Fall Fire

INTENTIONALLY LEFT BLANK