CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

California Endangered Species Act

Status Review of
Lime Ridge Eriastrum (*Eriastrum ertterae*)

Report to the Fish and Game Commission

August 2023

Cover photo by Jeb McKay Bjerke (Alternative text: photograph of a small, slender, gray-green plant with linear leaves, and a single flower at the end of the stem that has white pollen and five small petal lobes that are white with lavender-colored streaks)

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LIST OF ABBREVIATIONS, ACRONYMS, AND TERMS

CEQA – California Environmental Quality Act
CESA – California Endangered Species Act
CNDDB – California Natural Diversity Database
Commission – California Fish and Game Commission
Department – California Department of Fish and Wildlife
et al. – "and others"
id. – "the same"
NEPA – National Environmental Policy Act
Occurrence – CNDDB Element Occurrence
ssp. – Subspecies
var. – Variety

EXECUTIVE SUMMARY

This Status Review is based on the best scientific information available to the California Department of Fish and Wildlife (Department) on Lime Ridge eriastrum (*Eriastrum ertterae* D. Gowen) and serves as the basis for the Department's recommendation to the California Fish and Game Commission (Commission) on whether to list the species as endangered under the California Endangered Species Act (CESA). On July 6, 2021, Christopher McCarron submitted a petition to the Commission requesting that Lime Ridge eriastrum be listed as an endangered species under CESA (Petition). At its public meeting on February 17, 2022, the Commission considered the Petition, and found sufficient information to indicate the petitioned action may be warranted. Lime Ridge eriastrum was designated a candidate species under CESA on March 4, 2022. This Status Review has also been independently peer reviewed by scientific experts.

Lime Ridge eriastrum is an inconspicuous annual plant with a distribution of five small groups of plants (colonies) that occupy a combined area of approximately 47 m^2 (500 ft^2). All known colonies are within Lime Ridge Open Space in Contra Costa County, in an area owned and managed by the City of Walnut Creek. Lime Ridge eriastrum is found within and adjacent to stands of shrubland chapparal plant communities on soils derived from sandstone rocks with limestone deposited from hot springs. The total number of Lime Ridge eriastrum plants (abundance) is very low, and recent annual censuses have documented between 155 and 1,297 plants.

Lime Ridge eriastrum is an extremely rare plant, which makes it vulnerable to extinction from even minor disturbances. Lime Ridge Open Space is a 496-ha (1,226-acre) park that is heavily used for recreation. Off-trail hiking, bicycle use, off-leash dog impacts, and horse traffic can damage plants and alter Lime Ridge eriastrum habitat. Wildfire management, including implementation of fire breaks, has the potential to eliminate colonies. Utility infrastructure is present near four of the five Lime Ridge eriastrum colonies. Maintenance of this infrastructure may have contributed to the loss of one colony and could impact additional colonies. Invasive plants are present at all Lime Ridge eriastrum colonies, and likely lower the ability of the species to survive and reproduce. Climate change is a threat to the species due to the species' low dispersal capacity, extremely small range, and unique soil requirements.

Scientific evidence available to the Department demonstrates that Lime Ridge eriastrum is in serious danger of becoming extinct throughout its range in the foreseeable future. The Department recommends that the Commission find the petitioned action to list Lime Ridge eriastrum as an endangered species under CESA to be warranted, and further recommends implementation of the management recommendations and recovery measures described in this Status Review.

INTRODUCTION

Petition Evaluation Process

A petition (Petition) to list Lime Ridge eriastrum (*Eriastrum ertterae* D. Gowen) as endangered under the California Endangered Species Act (CESA) was submitted to the California Fish and Game Commission (Commission) on July 6, 2021, by Christopher McCarron. The Petition was accompanied by a letter of endorsement by the California Native Plant Society as co-sponsor of the petition. Commission staff transmitted the petition to the California Department of Fish and Wildlife (Department) pursuant to Fish and Game Code section 2073 on July 15, 2021, and published a formal notice of receipt of the Petition on August 6, 2021 (Cal. Reg. Notice Register 2021, No. 32-Z, p. 1022). A petition to list or delist a species under CESA must include "information regarding the population trend, range, distribution, abundance, and life history of a species, the factors affecting the ability of the population to survive and reproduce, the degree and immediacy of the threat, the impact of existing management efforts, suggestions for future management, and the availability and sources of information. The petition shall also include information regarding the kind of habitat necessary for species survival, a detailed distribution map, and any other factors that the petitioner deems relevant" (Fish & G. Code, § 2072.3).

On November 10, 2021, the Department provided the Commission with its evaluation of the petition to assist the Commission in making a determination as to whether the petitioned action may be warranted based on the sufficiency of scientific information (Fish & G. Code, §§ 2073.5 & 2074.2; Cal. Code Regs., tit. 14, § 670.1, subds. (d) & (e)). By evaluating the information provided in the petition as submitted, and other relevant information the Department had possession of or received relating to each of the relevant categories, the Department recommended to the Commission that the petition be accepted.

At its scheduled public meeting on February 17, 2022, the Commission considered the petition, the Department's petition evaluation and recommendation, and comments received. The Commission found that sufficient information exists to indicate the petitioned action may be warranted and accepted the petition for consideration. Upon publication of the Commission's notice of findings, Lime Ridge eriastrum was designated a candidate species on March 4, 2022 (Cal. Reg. Notice Register 2022, No. 9-Z, p. 237).

Status Review Process

The Commission's action designating Lime Ridge eriastrum as a candidate species triggered the Department's process for conducting a status review to inform the Commission's decision on whether listing the species is warranted (Fish & G. Code, § 2074.6).

Following the Commission's action to designate Lime Ridge eriastrum a candidate species the Department notified affected and interested parties and solicited data and comments on the petitioned action pursuant to Fish and Game Code section 2074.4 (see also Cal. Code Regs., tit. 14, § 670.1, subd. (f)(2)). Comments on the petitioned action were invited via tribal notifications and a general notification, all dated July 8, 2022. These notifications were distributed to tribes, owners and managers of the land supporting Lime Ridge eriastrum, people familiar with Lime Ridge eriastrum, and other interested individuals and organizations. The Department received one response to the general notification, and this response is included in Appendix B of this report. The Department received one request for tribal consultation in response to a tribal notification and consulted with the requesting tribe on October 26, 2022.

At its scheduled public meeting on December 15, 2022, the Commission granted the Department a six-month extension to complete this Status Review and independent peer review.

The review process included independent peer review of the draft Status Review by members of the scientific/academic community considered to be experts on subjects relevant to this Status Review and possessing knowledge and expertise to critique the scientific validity of the Status Review contents. Independent experts that reviewed the Status Review are listed in Table 1, below. Appendix A contains the comments and suggested edits provided to the Department by peer reviewers, the Department's written response to this input, and any amendments made to the Status Review (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)(2)).

Table 1. Status review peer reviewers

Name	**Affiliation**
Dr. Sarah De Groot	Independent
Dr. Barbara Ertter	University and Jepson Herbaria, University of California
David Gowen	Independent

This Status Review is intended to provide the Commission with the most current information on Lime Ridge eriastrum and to serve as the basis for the Department's recommendation to the Commission on whether the petitioned action is warranted. This Status Review is not intended to be an exhaustive review of all published scientific literature relevant to Lime Ridge eriastrum and the subjects reviewed in this report; rather, it is intended to summarize the key points from the best scientific information available relevant to the status of the species. This Status Review also identifies habitat that may be essential to the continued existence of the species and

provides management recommendations for recovery of the species (Fish & G. Code, § 2074.6). Upon receipt by the Commission, this Status Review will be made available to the public for no less than 30-days prior to the Commission taking any action on the Petition.

BIOLOGY

Species Description

The following description of Lime Ridge eriastrum's physical appearance is based primarily on Gowen (2013), De Groot et al. (2015), and De Groot (2016). Lime Ridge eriastrum is an inconspicuous slender annual herb in the phlox family (Polemoniaceae). Lime Ridge eriastrum typically grows between 1.5 and 20 cm (0.6–7.9 in) tall, but sometimes grows as tall as 25 cm (9.8 in). Stems of Lime Ridge eriastrum are erect (upright), wiry, and are often unbranched, but sometimes branch above the base, and larger plants can have one side branch at the base. The leaves of Lime Ridge eriastrum are narrow and up to 3 cm (1.2 in) long with parallel edges (linear). The leaves on the upper stem sometimes have two additional short linear lobes at the base of the leaf. The stems and leaves of Lime Ridge eriastrum are light green with a surface of soft woolly hairs, but the stems can become reddish-brown with age as the hairs wear away. The leaves often have a reddish tip.

Lime Ridge eriastrum produces clusters of flowers (inflorescences) in compact heads at the ends of branches or along stems above the leaves (in leaf axils). Also contained within these heads are bracts (leaf-like structures), that are 5 to 19 mm (0.2–0.6 in) long and may have three lobes. There are 1 to 21 woolly heads per plant with each head measuring 5 to 7 mm (0.20–0.28 in) long and 2 to 7 mm (0.08–0.28 in) wide excluding tips of bracts. Each head typically contains 3 to 9 flowers, but heads along the stem may only contain one flower. The flowers of Lime Ridge eriastrum have five petals that are fused into a narrow corolla tube, with lobes at the end that are folded outward (a more or less salverform corolla). The corolla is white with a pale blue tint or blue streaks. Below the corolla is a whorl of five green sepals that are fused from their base up to two-thirds of their length. The flowers of Lime Ridge eriastrum are bisexual and have five male sexual parts called stamens that are mostly fused to the corolla. The anthers (the part of the stamens that include pollen) are positioned near the opening of the corolla but are not clearly exserted (protruding) and have cream-colored pollen. There is one female sexual part called a pistil that has three ovary chambers. Once pollinated, Lime Ridge eriastrum flowers can develop into dry fruits called capsules that are approximately 4 mm (0.16 in) long and 2 mm (0.08 in) wide. Each capsule is comprised of three fused ovary chambers, with each chamber containing two to four seeds.

Taxonomy

Lime Ridge eriastrum is a member of the phlox family (Polemoniaceae) and is in the genus *Eriastrum*, which consists of 18 species that are all endemic to (only known from) western North America (De Groot et al. 2015). Species currently within the genus *Eriastrum* have previously been placed in other genera, including *Hugelia*, *Gilia*, and *Navarretia* (Bentham 1833, 1845, Brand 1907, Wooton and Standley 1913, De Groot 2016). The phylogenetic relationships within the genus *Eriastrum*, and the genetic diversity of Lime Ridge eriastrum are not well understood.

Traditional ecological knowledge may exist for Lime Ridge eriastrum; however, the earliest record of the species known to the Department is a collection by Dr. Barbara Ertter and Tony Morosco in 1998. They were unable to identify the specimen to species when it was collected because it was already dried, however the features that were present (e.g., seed number per locule) were incompatible with any known species of *Eriastrum* in the East Bay (CCH1 2022, Ertter pers comm 2023 in Appendix A). David Gowen, the species author, observed the species in the field in 2003 and later determined through fieldwork, morphological analysis, and common garden experiments that it was a new, undescribed species (Gowen 2013). Lime Ridge eriastrum was formally described in 2013 and named to honor Dr. Ertter, a botanist and the taxon's first collector (Gowen 2013). The original description of Lime Ridge eriastrum was based on a collection by David Gowen on July 1, 2005, from "Lime Ridge Open Space, south of the summit near power line area." This collection corresponds with Colony B as described in the Range and Distribution section of this Status Review (Gowen 2013, CCH1 2022, The vPlants Project 2022).

Range and Distribution

Range is the general geographical area in which an organism occurs. For purposes of CESA and this Status Review, the range is the species' California range (*Cal. Forestry Assn. v. Cal. Fish and Game Com.* (2007) 156 Cal.App.4th 1535, 1551). Distribution describes the actual sites where individuals and populations of the species occur within the species' range.

Range

The range of Lime Ridge eriastrum is very small. It is only found within Lime Ridge Open Space, which is a 496-ha (1,226-acre) park within the City of Walnut Creek in Contra Costa County, California (Figure 1). Lime Ridge Open Space is on a dominant ridge leading to Mount Diablo, and is within the Pine Creek watershed, which drains into Suisun Bay and the Pacific Ocean. Lime Ridge eriastrum has been found from approximately 190 to 300 m in elevation (625 to 1,000 ft) and is within the Central California Coast ecoregion (USDA 2017). The species may

have evolved as a specialist on the once more extensive area of calcium-rich substrates at and near the former quarry at Lime Ridge Open Space. This area may have represented the original range of Lime Ridge eriastrum.

Distribution

Lime Ridge eriastrum's distribution consists of five small groupings of plants (colonies) within Lime Ridge Open Space (Table 2). The combined area of these colonies is approximately 47 m^2 (500 ft^2), which is an area that is smaller than four average vehicle parking spaces.

Populations of many rare plants in California, including Lime Ridge eriastrum, are tracked within the Department's California Natural Diversity Database (CNDDB). The CNDDB documents plant taxa, animal taxa, and natural communities that are of conservation concern within California and refers to these taxa as "elements." An "element occurrence" is a location record for a site which contains an individual, population, nest site, den, or stand of a special status element. Populations, individuals, or colonies that are located within 0.4 km (0.25 mi) of each other generally constitute a single element occurrence, sometimes with multiple "parts" (Bittman 2001). In some instances, parts of a single element occurrence could be separated by topography or other landscape and habitat characteristics, but regardless of the circumstances, all parts or populations that are within 0.4 km (0.25 mi) of each other are grouped into the same element occurrence in the CNDDB.

There are two element occurrences of Lime Ridge eriastrum. The two element occurrences are separated by approximately 0.72 km (0.45 mi). For the purposes of this Status Review, different parts of each element occurrence are identified as lettered colonies for easier reference. Lime Ridge eriastrum element occurrence #1 includes Colonies B-E, and element occurrence #2 consists of only Colony A (see Table 2). Department staff discovered Colony E during surveys in 2023, and there may be additional undiscovered colonies of Lime Ridge eriastrum.

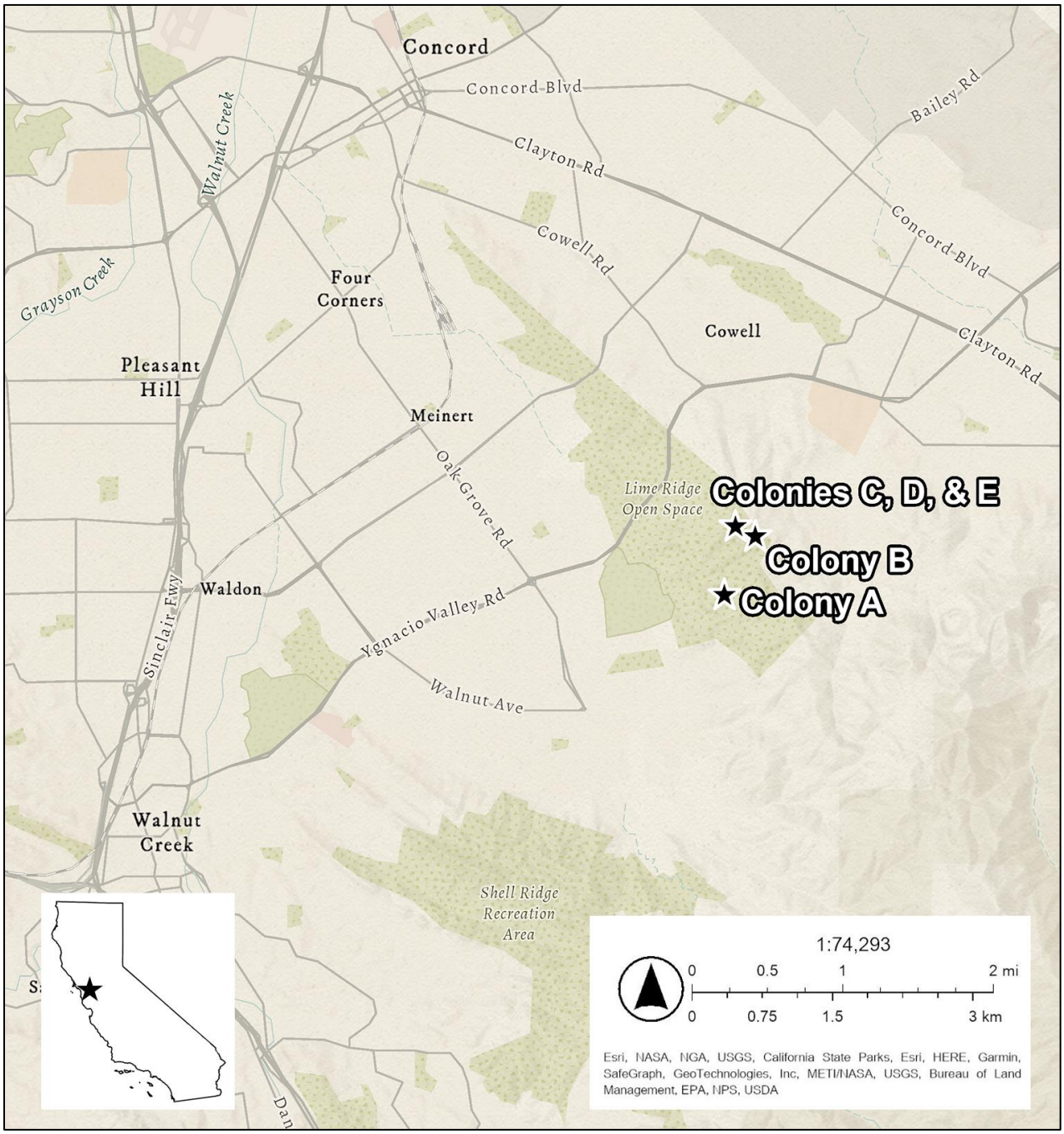

Figure 1. Distribution of Lime Ridge Eriastrum in California

Table 2: Known colonies of Lime Ridge eriastrum

Colony Name	CNDDB Element Occurrence Number	Colony Status	Estimated Area Occupied (m^2)
A	2	Plants observed in 2023	35
B	1	Plants last observed in 2018, colony may be extirpated	<1 (in 2009)
C	1	Plants observed in 2023	2
D	1	Plants observed in 2023	5
E	1	Plants observed in 2023	5
Total			**47**

Life History

There is very little information available on the life history and ecological relationships of Lime Ridge eriastrum. Lime Ridge eriastrum is an annual plant, meaning it completes its life cycle within one growing season. Annual plants begin their life cycle with the germination of seeds that have persisted in the soil from previous generations. Lime Ridge eriastrum seeds germinate sometime during the rainy season which begins in late fall and continues into the spring. No germination tests have been conducted on Lime Ridge eriastrum; however, Gowen (pers comm 2023 in Appendix A) has grown species of annual *Eriastrum*, including Lime Ridge eriastrum and reports that it germinates and grows readily. Gowen (pers comm 2023 in Appendix A) also reports that no treatment of seeds was required and germination was high for young seeds (1+ years old), but after perhaps 5 years, seeds did not germinate, and apparently were either not viable, or required a method to break dormancy. Germination tests on other annual *Eriastrum* species by California Botanical Garden (2021) found that those species were able to germinate without any of the physical or chemical treatments that are sometimes required to break seed dormancy in other plant species. These results increase the likelihood that Lime Ridge eriastrum seeds also do not require any specialized treatments to germinate.

Lime Ridge eriastrum has been observed flowering as early as late April (cover photo taken April 18, 2022) and as late as early July (CCH1 2022), though flowering typically occurs from late May until mid to late June (McCarron 2021). There have been no studies on pollinator interactions with Lime Ridge eriastrum, so little is known about its pollination requirements. Pollinator syndromes describe floral traits that are thought to be associated with types of pollination, including by wind, water, or different groups of animals. These pollinator syndromes can be used to formulate hypotheses about a species' most likely pollination. Lime Ridge eriastrum has small upright flowers with light-colored tube-like corollas that have blue nectar guide-like streaks, and these flowers are open during the day. These traits most closely

resemble the pollinator syndromes associated with pollination by bees and long-tongued bee flies (Waser and Ollerton 2006, Rosas-Guerrero et al. 2014). Although these predictions have risks, researchers can often predict pollinators with high accuracy even when basing predictions on only a few traits (Fenster et al. 2004, Ollerton et al. 2009, Dellinger 2020).

Pollinator interactions have been documented for five members of the *Eriastrum* genus. Subspecies of giant eriastrum (*E. densifolium*) appear to be generalists that can take advantage of a diverse guild of pollinators including bees, bee flies, and hummingbirds (Grant and Grant 1965, Munoz 1991, Dorsett et al. 2001, Jones et al. 2020). Desert woollystar (*E. eremicum*) appears to be primarily pollinated by bee flies though various insect visitors have been observed, yellow-flowered eriastrum (*E. luteum*) appears to be primarily pollinated by bees and bee flies, sapphire eriastrum (*E. sapphirinum*) appears to be primarily pollinated by bees, and Wilcox's eriastrum (*E. wilcoxii*) is speculated to be self-pollinated (Grant and Grant 1965). Gowen (pers comm 2023 in Appendix A) also speculated that Lime Ridge eriastrum may be self-pollinated because like Wilcox's eriastrum, the species has very short stamens and doesn't have showy flowers, which contrasts with other *Eriastrum* species that have longer stamens and showier flowers.

After pollination, Lime Ridge eriastrum fruits develop and seeds are produced. Fruits are reported to develop in late June to mid July (McCarron 2021). Lime Ridge eriastrum dispersal mechanisms are unknown; its fruits and seeds do not appear to have any specialized features for dispersal (Gowen 2013, De Groot 2016). With no obvious dispersal agents or mechanisms other than gravity, the dispersal ability of Lime Ridge eriastrum seeds appears to be low, which likely limits the potential for colonization of unoccupied habitat. Lime Ridge eriastrum is an annual plant, and the plants die after producing seeds. Plants become desiccated and can break apart during the warm summer months, and populations of Lime Ridge eriastrum may be nearly undetectable for most of the year. After dispersing from the plants, seeds likely remain on or in the soil during the relatively hot and dry summer months, until the fall rains trigger germination. Seeds that don't germinate the following fall may possibly remain in the soil, but it is unknown how many years seeds are capable of surviving in the soil seed bank.

Similar-looking Plants

There are few records of other *Eriastrum* species in Contra Costa County or in the eastern San Francisco Bay Area, so Lime Ridge eriastrum is unlikely to be confused with other species of *Eriastrum* in these areas. De Groot (2016) constructed a key to *Eriastrum,* with Lime Ridge eriastrum distinguished from other species by having all of the following traits: (1) stamens exserted 0.5 mm or less beyond the corolla sinuses (area between the corolla lobes) or included just within the sinuses, (2) anthers mostly 1 mm long or shorter, (3) generally more than 1

ovule/seed in each ovary/fruit chamber, (4) corollas 3.7 to 7 mm long, (5) upper stems, leaves, and bracts not markedly glandular; (6) leaf primary axis about 0.5–0.75 mm wide, and (7) anther stalks (filaments) that are 1.3 mm long or longer. Gowen (2013) reported that Lime Ridge eriastrum looks most similar to Hoover's eriastrum (*E. hooveri*); however, Hoover's eriastrum occurs 160 km (100 mi) or more away from Lime Ridge eriastrum populations, and Hoover's eriastrum has slightly shorter corollas and anther filaments. Three other species or subspecies of *Eriastrum* have been documented in the San Francisco Bay Area. Many-flowered eriastrum (*E. pluriflorum* subsp. *pluriflorum*) is only known from historical collections in the San Francisco Bay Area and has more exserted stamens and much larger and darker blue corollas than Lime Ridge eriastrum. Abram's eriastrum (*E. abramsii*) and Tracy's eriastrum (*E. tracyi*) are documented in the San Francisco Bay Area, but they don't occur on Lime Ridge. Abram's eriastrum occurs in two very small populations in Contra Costa County, one just east of Mt. Diablo (approx. 9 km (5.6 mi) from Lime Ridge) and one slightly southeast of Mt. Diablo (approx. 16 km (9.9 mi) from Lime Ridge) (Gowen pers comm 2023 in Appendix A). Additionally, Abram's eriastrum and Tracy's eriastrum generally only have one seed in each of their fruit chambers compared with the two to four seeds per fruit chamber of Lime Ridge eriastrum.

Leaves and stems of narrowleaf cottonrose (*Logfia gallica*) in the sunflower family (Asteraceae) look superficially similar to Lime Ridge eriastrum, but the two species are easily distinguished by flower morphology. Additionally, leaves of narrowleaf cottonrose do not have lobes, while leaves of Lime Ridge eriastrum are sometimes 3-lobed at their base. Stems and leaves of Lime Ridge eriastrum are also generally more slender and more rigid than those of narrowleaf cottonrose.

HABITAT THAT MAY BE ESSENTIAL TO THE CONTINUED EXISTENCE OF THE SPECIES

Habitat for plants can often be described in terms of the other species they are found in association with (vegetation), the geology and soils in the areas they grow, and the climate, hydrology, and other factors that support the species' survival and reproduction. Although a few species of *Eriastrum* can be widespread and prolific, most *Eriastrum* species are uncommon plants found in a narrow range of soil and other environmental conditions and with little competing vegetation (Gowen pers comm 2023 in Appendix A). Lime Ridge eriastrum habitat is found in fine sandy soil in openings within or on the edges of chaparral, in mostly bare areas (Figure 2). The Department's preliminary identification of the habitat that may be essential to the continued existence of Lime Ridge eriastrum includes the habitat that fits the general descriptions provided below. This includes all existing colonies of Lime Ridge eriastrum, and areas of Lime Ridge Open Space that are currently unoccupied by the species, but that are likely to be suitable for the species now or may be suitable for the species in the future.

Geology and Soils

Geology (rocks, minerals), geomorphology (landforms, topography, physical processes), and soils are important factors contributing to the diversity, distribution, and habitat of plants (Brilha et al. 2018, Hulshof and Spasojevic 2020). Lime Ridge eriastrum occurs only on Lime Ridge (a ridge located within Lime Ridge Open Space), and the unique geology of the area is likely an essential component of the habitat of the species. Lime Ridge is predominately composed of sandstone called the Domingene Formation (Graymer et al. 1994, 2006; Dibblee and Minch 2006), with deposits of calcium carbonate (lime), hence the name Lime Ridge. The Domingene Formation was made from deposits associated with rivers, estuaries, and tidal influence approximately 48 million years ago during the middle part of the Eocene geological epoch (Sullivan and Sullivan 2012). The Domingene Formation is found north of Mount Diablo and extends east into the Sacramento Basin (Sullivan and Sullivan 2012). The Lime Ridge area is also characterized by the presence of travertine, which is limestone that was deposited from hot spring waters percolating calcium carbonate through sandstone. The travertine at Lime Ridge likely formed in a more recent geologic time. Prior to extensive mining, the travertine rock at Lime Ridge was reported to have covered an area approximately 2.5 mi (4 km) long and 0.5 mi (0.8 km) wide, with a varying thickness of up to 20 ft (6 m)(Lyon 1997, Perazzo 2015). There have not been any studies of the mineral composition of soil in areas where Lime Ridge eriastrum is found, but it occurs in distinctly light-colored patches of bare soil, presumably light due to the presence of lime. Thus, the presence of decomposed travertine rock may be an important aspect of Lime Ridge eriastrum habitat. There are smaller localized areas of calcium-rich substrates on Domingene Formation sandstone at Black Diamond Mines Regional Preserve in Contra Costa County, however Lime Ridge eriastrum was not found in these areas during Department surveys in 2023.

Soils supporting Lime ridge eriastrum are generally barren of significant vegetation and are light tan in color, which could be expected for calcareous soils weathered from rock containing limestone (travertine). The Natural Resources Conservation Services' soil map for the area where Lime Ridge eriastrum grows includes rock outcrops and soil classified as Briones loamy sand, 30 to 50 percent slopes (Soil Survey Staff 2022). The Briones series consists of somewhat excessively drained, moderately deep soils over sandstone in uplands occurring on hills at elevations of 152 to 304 m (500–1,000 ft) underlain by soft to firm coarse-grained sandstone (Soil Survey Staff 2022). Runoff is medium to rapid, with rapid permeability of the soil, except in sandstone, where the permeability is slow or very slow. McCarron (2021) reports that Lime Ridge eriastrum populations occur on compacted, fine sandy soils with low nutrients and low organic matter content.

Figure 2. Photographs of Lime Ridge eriastrum habitat at portions of Colony A (left image) and Colony C (right image). Pink pin flags are locations of Lime Ridge eriastrum plants on June 19, 2020. Department photos by Jeb McKay Bjerke.

Vegetation

The Department uses *A Manual of California Vegetation* (Sawyer et al. 2009, CNPS 2023a) to classify vegetation within California. Vegetation alliances and associations are vegetation classification categories that describe repeating patterns of plants communities across a landscape, with an alliance classifying vegetation at a broader scale than an association. The vegetation at Lime Ridge has not yet been classified or mapped so the specific vegetation alliances and associations that Lime Ridge eriastrum occurs in are currently undescribed. However, the Department does have other information that indicates the dominant vegetation at Lime Ridge includes chaparral, oak woodland, grassland and herbaceous vegetation. The individual plant species found near Lime Ridge eriastrum are also discussed in this section.

Much of the chaparral vegetation at Lime Ridge would likely be placed in the chamise and black sage (*Adenostoma fasciculatum-Salvia mellifera*) shrubland alliance, with the rare shrub Mt. Diablo manzanita (*Arctostaphylos auriculata*) as a component of the vegetation in some areas. The oak woodlands present would likely fit the blue oak (*Quercus douglasii*) forest and woodland alliance. There are large continuous areas dominated by herbaceous vegetation at Lime Ridge Open Space, including highly disturbed terrain that was previously used as a limestone quarry, and more natural terrain that is dominated by non-native plant species. These herbaceous stands would fit into the broader vegetation community of California Annual

and Perennial Grassland macro group and are likely within a matrix consisting of the Mediterranean California naturalized annual and perennial grassland group, the California annual herb/grass group, and the California perennial grassland group with several finer alliance and association distinctions within each of those groups. Lime Ridge eriastrum is found underneath shrubs, or adjacent to shrubs in small areas of sparse herbaceous vegetation that appear to be transition zones between stands of chaparral and stands of oak woodland. All known Lime Ridge eriastrum habitat appears to have chaparral immediately to the south or west, and oak woodland occurring a short distance away to the north or east.

Though vegetative cover is generally very low in the immediate vicinity of where Lime Ridge eriastrum grows, Department staff have observed the species growing underneath black sage. Lime Ridge eriastrum often co-occurs with the small, herbaceous hollyleaf navarretia (*Navarretia atractyloides*), which appears to have similar habitat and therefore may be an indicator of habitat for Lime Ridge eriastrum (McCarron 2021). Native plants that occur in the same vicinity as Lime Ridge eriastrum include coastal sagebrush (*Artemisia californica*), sand pygmy weed (*Crassula connata*), and thymeleaf mesamint (*Pogogyne serpylloides*). Non-native plants that occur in the same vicinity as Lime Ridge eriastrum include the annual forbs tocalote (*Centaurea melitensis*), scarlet pimpernel (*Lysimachia arvensis*), and narrowleaf cottonrose (*Logfia gallica*), and the annual grasses red brome (*Bromus rubens*), ripgut brome (*Bromus diandrus*), silvery hairgrass (*Aira caryophyllea*), soft chess brome (*Bromus hordeaceus*), hare barley (*Hordeum murinum* subsp. *leporinum*), and nit grass (*Gastridium phleoides*) (McCarron 2021, Department observation 2022). In addition, unidentified leafy liverworts and lichen were observed growing at Colony A, and cryptobiotic soil crust has been observed near Lime Ridge eriastrum colonies (Department observation 2022).

Several plants with a California Rare Plant Rank have been observed at various locations on Lime Ridge including big tarplant (*Blepharizonia plumosa*), Hall's bushmallow (*Malacothamnus hallii*), Jepson's coyote thistle (*Eryngium jepsonii*), Lime Ridge navarretia (*Navarretia gowenii*), Mt. Diablo fairy lantern (*Calochortus pulchellus*), Mt. Diablo helianthella (*Helianthella castanea*), and Mt. Diablo manzanita (CNDDB 2023).

Climate and Hydrology

Lime Ridge eriastrum occurs in a Mediterranean climate, which consists of cool, wet winters and warm, dry summers (Kottek et al. 2006). Climate in the San Francisco Bay Area is influenced by regional topography, oceanic currents, fog exposure, and onshore winds. Temperatures tend to be cooler with smaller fluctuations between highs and lows near the ocean, and warmer with larger fluctuations between highs and lows inland. Although precipitation in Lime Ridge eriastrum habitat may occur in any month of the year, over 95 percent of the precipitation falls

from October to May, which is typical for much of California. Between 1895 and 2021, the modeled average annual precipitation within the Parameter-elevation Regressions on Independent Slopes Model (PRISM) Climate Group 4 km grid cell containing Lime Ridge was approximately 42 cm (16.4 in). Precipitation can vary dramatically from month to month, and year to year. Precipitation in Lime Ridge eriastrum habitat occurs mainly as rain; however, snowfall and hail have been documented to occur infrequently. Based on models for the period between 1895 and 2021 the coldest month of the year at Lime Ridge is typically January, which had an average low temperature of approximately 3.2°C (37.8°F) (PRISM Climate Group 2023). The hottest month of the year is typically July when Lime Ridge eriastrum plants are dispersing seeds, dying, or dead. Because the species occurs near the tops of slopes that likely drain quickly and have little influence from groundwater, Lime Ridge eriastrum is highly dependent on precipitation to complete its life cycle.

Wildfire

Lime Ridge would have been historically subject to periodic wildfire, but the effects of wildfire on Lime Ridge eriastrum plants and seeds in the soil seed bank are unknown. In the past, wildfire may have resulted in positive and/or negative responses in Lime Ridge eriastrum populations, and these responses may have been influenced by the frequency and severity of wildfire. Other species in the Polemoniaceae family grow in abundance following wildfire, and it is possible that a low-intensity fire when plants are dormant would create more open habitat and less competition, which may be beneficial for the species (De Groot pers comm 2023 in Appendix A). Ash from fire could also add nutrients to the soil, which may have a negative effect on the species, either directly, or by promoting invasive weeds. The chamise and black sage shrubland alliance is the most common vegetation type near Lime Ridge eriastrum colonies, and this vegetation experiences high to very high severity and intensity fires, with a historical fire return interval of approximately 30 to 60 years (CNPS 2023a). Chamise recovers well following fire, but black sage is more sensitive to fire (CNPS 2023a).

There is little information on the historical wildfire history of Lime Ridge, and California Department of Forestry and Fire Protection records do not have any records of wildfire at Lime Ridge Open Space; however, brush fires that are less than 12 ha (30 ac) and grass fires that are less than 121 ha (300 ac) are not included in this dataset (CAL FIRE 2023). Nevertheless, several fires affecting Lime Ridge Open Space are documented via news stories and aerial imagery such as a 19 ha (48 ac) grass fire in 2002, a 21 ha (53 ac) grass fire in 2003, a 8 ha (20 ac) grass fire in 2005, a nearly 120 ha (300 ac) grass fire in 2018, and a 0.4 ha (1 ac) fire in 2021 (East Bay Times 2005, The Pioneer 2018, Bay City News 2021, Google 2023). The 2018 grass fire burned the chaparral north of the summit at Lime Ridge and came within 10 m Colony D (McCarron 2021).

POPULATION TRENDS AND ABUNDANCE

For the purposes of this Status Review, abundance is defined as the number of individuals that are present overall. The available information indicates that the abundance of Lime Ridge eriastrum is very low. There are only two element occurrences (consisting of five known colonies) of Lime Ridge eriastrum and each colony consists of very few plants (Table 3). Gowen (2013) reported the total abundance of Lime Ridge eriastrum to be "several hundred to possibly a thousand plants" annually depending on rainfall patterns. Recent annual censuses have documented between 155 and 1,297 plants.

Table 3: Abundance of Lime Ridge eriastrum

Colony Name	CNDDB Element Occurrence	Number of Plants Prior to 2018	Number of Plants in 2018	Number of Plants in 2019	Number of Plants in 2020	Number of Plants in 2022	Number of Plants in 2023
A	2	No data	1147	No data	130	700	81
B	1	"a few hundred"	1	0	0	0	0
C	1	No data	93	No data	25	15	33
D	1	No data	56	No data	0	15	5
E	1	No data	No data	No data	No data	No data	152
Total		**Unknown**	**1297**	**Unknown**	**155**	**730**	**271**

The Department has very little information on Lime Ridge eriastrum population trends. Nevertheless, the Department speculates that there has likely been an overall decline in the abundance of Lime Ridge eriastrum since the mid-1800s due to impacts from historical mining activity, invasive plant species, and other impacts at Lime Ridge. Although records prior to 1903 are scarce, mining of limestone in Contra Costa County began perhaps as early as 1851 (Perazzo 2015). Lime Ridge eriastrum has a specialized habitat, and mining for limestone and sandstone disturbed a large portion (half or more) of the area at Lime Ridge that may have been suitable for the species in the past. Furthermore, any lime-rich substrates in the vicinity of Lime Ridge Open Space that may have supported the species in the past may have also been converted to housing developments. Furthermore, while disturbances such as mining may have created areas that could perhaps be utilized by Lime Ridge eriastrum were seeds transported to them, there are no records of the species persisting in mine tailings or areas that were subject to historical mining impacts. Although historical or biological data is unavailable, is it reasonable to conclude based on habitat conditions that at least some of the area disturbed by mining and related activities previously supported Lime Ridge eriastrum populations, and mining disturbance therefore contributed to a population decline sometime between the mid-1800s and mid-1900s. Mining at Lime Ridge reportedly ceased in 1946 (Lyon 1997, Perazzo 2015).

Lime Ridge eriastrum population counts are limited, with survey data only available from 2018 (McCarron 2021), 2020, and 2022 (CDFW 2020, 2022). The Department recognizes that populations of annual plants can have high inter-annual variability, making it difficult to detect population trends. The germination rate of annual plants can vary from season to season based on environmental conditions, and therefore observed annual plant population sizes can fluctuate significantly from year to year. Inconsistent population monitoring further confounds efforts to understand population trends. Populations of annual plants can be observed when plants grow during a portion of the year, but for species with a persistent soil seed bank, the true population size is the number of viable seeds, which is cryptic and difficult to estimate. Based on the available information, Colonies A, C, and D have survived from 2018 to 2023, although the number of plants that germinated and survived was highest in 2018, and lower in 2020, 2022, and 2023. David Gowen, the species author, reported Colony B consisted of "a few hundred" plants prior to 2018 (Gowen 2013). A portion of Colony B is along a trail that was rerouted, likely in 2016. The equipment and amount of soil disruption that occurred for the trail rerouting at Colony B in unknown. Colony B has not been observed since 2018, when a single plant was seen. The cause of Colony B's decline may be a result of recreational land use of the area (specifically trail re-routing), utility infrastructure management activities, and piling of cut vegetation to deter the use of unauthorized trails. Evidence is mounting that Colony B may be extirpated, however seeds of Lime Ridge eriastrum may still exist in the soil seed bank, and recent drought may have suppressed germination and survival at all colonies, so plants could still be observed at Colony B in the future. Colony E was discovered by Department staff during surveys in 2023, and trend information is therefore not yet available for this colony.

In summary, the abundance of Lime Ridge eriastrum is very low, and although population trends for annual plants are difficult to discern, there is information to suggest that the population has declined since the 19th century due in part to mining. More recently, one of the five colonies of Lime Ridge eriastrum has not been seen since 2018 and may be extirpated. Due to the small number of Lime Ridge eriastrum individuals occurring in only five colonies, the loss of any of these colonies, or the loss of a significant portion of one of these colonies, would represent the loss of a significant portion of the species' total range.

FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE

Vulnerability of Small Populations

Lime Ridge eriastrum is an extremely rare plant, which makes it highly vulnerable to extinction. Species with small ranges tend to be more vulnerable to extinction from disturbances, environmental changes, random events, and other threats than species with large ranges (Purvis et al. 2000, Harris and Pimm 2007, Gaston and Fuller 2009, Pimm 2009, Newbold et al.

2018, Enquist et al. 2019, Silva et al. 2019, Staude et al. 2020). Population size and trends are also important predictors for extinction risk (Shaffer 1981, Pimm et al. 1988, O'Grady et al. 2004). Species with high abundance can suffer substantial losses and remain viable, but species with low abundance cannot. The abundance of Lime Ridge eriastrum is very low and the species occupies a combined area that is smaller than the size of four vehicle parking spaces. For species this rare, even minor disturbances could result in extirpation of a colony or extinction of the species. One of five Lime Ridge eriastrum colonies is declining (and may already be extirpated) due to disturbances from recreational land use of the area and management activities. Chance events such as high erosion, drought, fire, or human activity could result in the loss of all or a significant portion of a Lime Ridge eriastrum colony. Adverse environmental conditions that could result in seed germination without subsequent growth and reproduction could also deplete the soil seed bank and threaten the long-term persistence of Lime Ridge eriastrum populations.

Species with large populations that occupy large environmentally variable regions generally have higher genetic diversity than species restricted to smaller areas. These more widespread species can therefore avoid many genetic problems that occur in smaller populations (Ellstrand and Elam 1993, Reed 2005, Hobohm 2014). Plant populations with low genetic diversity are unlikely to go through rapid evolutionary adaptation or migrate to more suitable locations to persist in the face of climate change. Populations with less genetic variability are also less likely to have traits that are beneficial under changing conditions, decreasing the likelihood of persistence in their current range (Hoffmann and Sgro 2011, Stotz et al. 2021). The genetic diversity of Lime Ridge eriastrum is not well understood, however the species' small range and low abundance suggest that it may have low genetic diversity, which may negatively affect its ability to survive and reproduce.

Lime Ridge eriastrum's small range and low abundance is a significant factor influencing the ability of the species to survive and reproduce.

Recreational Land Use

Recreational land use is a primary threat to all colonies of Lime Ridge eriastrum. As described in the Distribution section of this Status Review, all known colonies of Lime Ridge eriastrum occur within Lime Ridge Open Space, which is managed by the City of Walnut Creek's Open Space Division. Recreational land use impacts Lime Ridge eriastrum through hiker, dog, bicycle, and horse traffic, and these activities can trample plants and disturb habitat. These impacts can create soil conditions that are too compacted, crumbly, or disturbed to support the species, or can disrupt important soil processes or microorganisms. Maintenance activities related to recreational land use can also negatively impact the species, such as through piling of brush on

populations to deter unauthorized trail use. Most trails at Lime Ridge Open Space are identified for use by hikers, dogs, bicycles, and horses, although some trails do not allow bicycles or dogs, and one trial is hiker-only (City of Walnut Creek n.d.). Despite restrictions that bicycles at Lime Ridge Open Space remain on fire roads that are at least eight feet wide, websites and online digital services (e.g., Strava, Trailforks, and YouTube) provide evidence that bicycle use and other recreational activity occurs outside of authorized trails. In addition to trampling of plants, bicycle riders illegally clear brush to build trails, and move soil to construct unsanctioned bicycle jumps and ramps. Off leash dog damage may include digging, defecating, and urination in sensitive habitat areas. This unauthorized recreational use has the potential to negatively impact Lime Ridge eriastrum plants and habitat. Due to the vulnerability of small populations discussed above, such activities have the potential to eliminate colonies, and contribute to the extinction of the species.

Colony A is the farthest colony from an officially maintained trail, and therefore may be at a lesser risk from recreational impacts compared with the other colonies. Nevertheless, a seldom-used unofficial use trail passes through Colony A and trampling of Lime Ridge eriastrum could occasionally occur. Evidence of unauthorized bicycle use was not observed by the Department at Colony A in 2020 or 2022, but bicycle use is a possibility in the future.

Colony B occurs within and adjacent to a heavily used designated trail. This trail is identified for use by hikers and horses on the Lime Ridge Open Space trail map, but websites and digital services indicate that it is frequently used by bicycles. The heavy use of this trail likely means that trampling of Lime Ridge eriastrum frequently occurs and may have contributed to the decline of Colony B. An additional factor that may have contributed to the decline of Colony B was the placement of cut vegetation on top of the colony by Pacific Gas & Electric (PG&E), a private energy company that provides gas and electric services in the area. This vegetation was cut for utility right-of-way management (as discussed further in the Utility Right-of-way Management section of this Status Review), but the cut vegetation appears to have also been used to block access to an unauthorized trail pathway.

Colony C is about 30 m (100 ft) from a heavily used designated trail. This trail is identified for use by hikers and horses on the Lime Ridge Open Space trail map, but websites and digital services indicate that it is frequently used by bicycles. An unofficial use trail passes approximately 5 m (16 ft) from Colony C and appears to be used somewhat regularly, perhaps due to its proximity to an official trail. This area may have also been used as an unofficial bicycle route in the past.

Colony D is near a summit on Lime Ridge that has a bench and is heavily used by hikers and bicycle riders. A road (not accessible to public automobile traffic) extends a short distance to

the west of the summit in the general direction of Colony D, but a fence has been installed to deter travel in this direction past where the road ends. Nevertheless, it is possible to go around this fence, and the road likely encourages some people to go west from the summit and continue exploring in that direction.

Colony E is within two meters of a wide dirt road heavily used by hikers and bicycle riders, and the road is also used for motor vehicles with access to Lime Ridge Open Space. Colony E is likely occasionally trampled by hikers and bicycle riders who step off of the road, and Colony E could also be used as a vehicle turnout.

In summary, Colony A is at a relatively low but persistent risk from recreational land use and Colonies B and E are at a persistent high risk of impact from recreational land use. It appears that the area in the immediate vicinity of Colony C and to a slightly lesser extent in the vicinity of Colony D are occasionally used by hikers and bicycle riders and trampling of Lime Ridge eriastrum at these colonies therefore occasionally occurs. Colonies C and D are at high risk of impact from recreational use due to their proximity to trails, and due to the risk that these areas could be used more intensively as unauthorized bicycle routes in the future. Recreational land use is a significant ongoing threat to the continued existence of Lime Ridge eriastrum and may have already led to extirpation of one of the five known colonies.

Response to Wildfire

As described in the Wildfire section of this Status Review, Lime Ridge eriastrum would have been historically subject to periodic wildfire events, and fire continues to occur in the area. While the effects of wildfire on Lime Ridge eriastrum are unknown and could be both positive and negative, human response to wildfire is a threat to the species, particularly implementation of bulldozer lines. Lime Ridge eriastrum colonies are extremely small, and a single bulldozer line is wide enough to eliminate any one of the known colonies. Colonies are particularly vulnerable to impacts from wildfire response activities because they occur on ridges and near the tops of slopes, which are areas that are likely to be selected for use as fuel breaks and fire lines. Additionally, wildfire response at Lime Ridge Open Space and the surrounding area is likely to be aggressive due to the proximity of Lime Ridge Open Space to extensive residential development. Response to wildfire is an ongoing threat to the species.

Utility Right-of-way Management

An underground natural gas transmission pipeline and an overhead power transmission line pass through Lime Ridge Open Space. A project to install an underground power transmission line as a replacement for the existing overhead power transmission line was implemented in 2022. The utility infrastructure is owned and/or operated by PG&E. Based on the general

mapping of natural gas transmission pipelines that is available online (PG&E 2023), the gas pipeline at Lime Ridge Open Space passes horizontally within 2 m (7 ft) of Colony C and within 12 m (39 ft) of Colony D. Any disturbance of the ground surface above this gas pipeline (e.g., disturbance related to maintenance) could affect the ability of the species to survive and reproduce and could lead to the extirpation of one or both of these colonies. Colony E is within two meters of a wide dirt road that is used for trucks and utility vehicles with access to Lime Ridge Open Space. Trucks and utility vehicles were observed by Department staff using areas similar to Colony E as pullouts on March 16, 2023. Colony E is at high risk of trampling impacts from trucks and utility vehicles. Additionally, a transmission tower is in the immediate vicinity of Colony B, with a portion of the colony within 15 m (49 ft) of the tower. Vegetation management around the tower, and the piling of cut vegetation may have contributed to the decline and possible extirpation of Colony B. If Colony B is still extant, ground disturbance related to maintenance of this tower, conversion of the power transmission lines to underground lines, or the removal of the tower could lead to Colony B's extirpation. Moving the power transmission lines at Lime Ridge Open Space underground will likely reduce the need for PG&E to manage vegetation within transmission line right-of-ways, which may reduce the long-term risk to Lime Ridge eriastrum, so long as the current colonies remain extant after such activities. Nevertheless, maintenance of these underground lines in the future could affect the ability of Lime Ridge eriastrum to survive and reproduce if the activities involve disturbance of the soil near where the species occurs. Ground disturbing activities can also increase risk of impacts to the species from non-native plant species, as discussed in the Invasive Plants section of this Status Review.

Invasive Plants

Non-native species are those that did not naturally occur in an area but that have become established and continue to reproduce in the wild. Invasive species are non-native species that have been determined to cause negative impacts to the environment or economy. Invasive species are often cited as the second greatest threat to biodiversity behind habitat loss (Wilcove et al. 1998, Mack et al. 2000, Pimentel et al. 2004) and North America has accumulated the largest number of naturalized, non-native plants in the world (van Kleunen et al. 2015). Many studies hypothesize or suggest that competition with invasive plants is the process responsible for observed impacts to biodiversity; however, invasive plants may impact native plants in a variety of ways (Levine et al. 2003). Invasive plants may threaten native populations through competition for light, water, or nutrients; deposition of harmful biochemicals to soil; alteration of soil chemistry (e.g., pH, salinity); thatch accumulation that inhibits seed germination and seedling recruitment; changes in fire frequency; disruptions to pollination or seed-dispersal mutualisms; changes in soil microorganisms; diseases; or other mechanisms. The magnitude of impact from invasive plants depends on the characteristics of

the invading species and the characteristics of the location being invaded (Gaertner et al. 2009, Fried et al. 2014). Invasive plants may also influence native species' colonization rates, leading to declines in local biodiversity over longer timescales (Yurkonis and Meiners 2004).

Red brome has been evaluated by the California Invasive Plant Council to cause severe ecological impacts. Red brome is abundant throughout central Contra Costa County and has been observed at and near Lime Ridge eriastrum populations (California Invasive Plant Council 2023). Ripgut brome and hare barley have also been observed at and near Lime Ridge eriastrum populations and have high abundance in central Contra Costa County (California Invasive Plant Council 2023). Tocalote has been observed at and near Lime Ridge eriastrum populations, has medium abundance in central Contra Costa County, and is spreading in this area (California Invasive Plant Council 2023). Tocalote, ripgut brome, and hare barley are all reported by the California Invasive Plant Council to cause ecological impacts, although the combined impacts from these species are less severe than those caused by red brome. There are many other species of plants that are not native to the region of California where Lime Ridge eriastrum occurs, but that have become established and continue to reproduce and spread in the region (Baldwin et al. 2012).

The Department is not aware of any studies examining the effects of non-native plant species on Lime Ridge eriastrum, but invasive plant species, especially invasive annual grasses, often negatively affect native plant species in California. Lime Ridge eriastrum is a relatively short plant (1.5–20 cm (0.6–7.9 in)) that occupies somewhat barren areas, and therefore may be particularly susceptible to the effects of competition from invasive and non-native plants, including the plants identified in the preceding paragraph. Other species of *Eriastrum* are also reported to be poor competitors with invasive plants, perhaps because germination, growth, and flowering for many *Eriastrum* species takes place slightly later than many co-occurring plant species, which may give these co-occurring species a competitive advantage (De Groot pers comm 2023 in Appendix A). Bare areas often occupied by *Eriastrum* species may, however, be less suitable for invasion due to soil, land use, hydrologic, or other factors. Biological soil crusts may also play a role in whether an area is invaded or not.

Infestations of tocalote have been shown to reduce the reproductive capacity of California endangered plant species Lyon's pentachaeta (*Pentachaeta lyonia*) (Moroney et al. 2011), and San Diego thornmint (*Acanthomintha ilicifolia*)(Bauder and Sakrison 1999), and may do the same for Lime Ridge eriastrum. Dense stands of tocalote have been observed at Lime Ridge eriastrum Colonies C and D meaning these colonies may be experiencing negative impacts from this invasive species. *Bromus* species (e.g., red brome and ripgut brome) have also been observed at Lime Ridge eriastrum colonies and are species known for invading and dominating

vast areas of the western United States, displacing native species, and increasing the frequency and extent of wildfire (Germino et al. 2016).

Many areas of California are exposed to low levels of anthropogenic atmospheric nitrogen deposition from pollution, with interspersed hotspots of elevated deposition downwind of large and expanding metropolitan centers (e.g., the San Francisco Bay Area), and downwind of large agricultural operations (Fenn et al. 2010). Increased nutrient availability through nitrogen deposition has been shown to be a contributor to the abundance and spread of invasive plant species in some environments in California, particularly in low productivity ecosystems (Pardo et al. 2011, Bytnerowicz et al. 2015, Rao et al. 2015); however, the significance of these effects on the ecosystems at Lime Ridge Open Space is still unknown.

Climate Change

It is unequivocal that human influence has warmed the atmosphere, ocean, and land, resulting in widespread and rapid changes in the atmosphere, ocean, cryosphere, and biosphere (IPCC 2014, 2021). Global surface temperature will continue to increase until at least the mid-21st century under all emissions scenarios considered by the Intergovernmental Panel on Climate Change, and global warming of 1.5°C and 2°C (2.7°F and 3.6°F) will be exceeded during the 21st century unless deep reductions in emissions occur in the coming decades (Schwalm et al. 2020, IPCC 2021). While projected changes in climate may benefit some species, experimental and empirical evidence indicates that climate change negatively impacts a high proportion of species and natural systems across the globe (Parmesan and Yohe 2003, Parmesan 2006, Scheffers et al. 2016, IPCC 2022), is increasing extinction risk (Warren et al. 2011, Nic Lughadha et al. 2020), and has already caused local extinction of some species (Wiens 2016). Biodiversity hotspots, such as California chaparral and woodlands, are expected to be especially vulnerable to climate change because their endemic species have smaller geographic ranges (Sandel et al. 2011, Brown et al. 2020, Manes et al. 2021, IPCC 2022). California's physical and biological systems have already been affected by climate change (Iknayan and Beissinger 2018, California Office of Environmental Health Hazard Assessment 2018, Riddell et al. 2019). According to the California Global Warming Solutions Act of 2006, climate change is now considered one of the greatest threats to California's ecosystems, and over the 21st century, climate change will alter the fundamental character, production, and distribution of ecosystems in California and elsewhere (California Energy Commission 2009, Shaw et al. 2011, Notaro et al. 2012, Garfin et al. 2013, Bedsworth et al. 2018). Climate change is a major challenge to the conservation of California's biological resources, and it will amplify existing threats and create new threats to natural systems.

Studies indicate that by the end of the 21st century California's climate will be considerably warmer than it is today, precipitation will become more variable, droughts will become more frequent, heavy precipitation events will become more intense, more winter precipitation will fall as rain instead of snow, snowpack will melt earlier in the year, and snowpack will be diminished (Hayhoe et al. 2004, Leung et al. 2004, Mote et al. 2005, Knowles et al. 2006, Garfin et al. 2013, Bedsworth et al. 2018, He et al. 2018). California is also vulnerable to climate fluctuations because it derives a large percentage of its water supply from a small number of large winter storms. These storms arise from "atmospheric rivers" which are long and narrow corridors of enhanced water vapor that are often associated with a low-level jet stream of an extratropical cyclone (Dettinger 2011, Dettinger et al. 2011). Within the San Francisco Bay Area, where Lime Ridge eriastrum occurs, average annual maximum temperature has increased by 0.95 °C (1.7°F) from 1950 to 2005, and warming will continue in the future with inland areas more severely affected (Ackerly et al. 2018). Fog and ocean influence have a strong effect on the climate of the San Francisco Bay Area. There is some evidence that the amount of fog in the San Francisco Bay Area has already decreased, but the effect of climate change on fog and sea breeze is still poorly understood (Ackerly et al. 2018).

Species distribution models can be used to predict effects of global climate change on the future range and distribution of species (Elith and Leathwick 2009) and may also identify areas where species may persist despite the effects of climate change (climate change refugia) (Barrows et al. 2020), though model error can be high and should be reported. To date, no species distribution models have been developed for Lime Ridge eriastrum.

The Department does not have any data on the extent to which predicted climate changes will affect the demographics of Lime Ridge eriastrum (e.g., seed production and mortality) in the foreseeable future. As an annual plant, Lime Ridge eriastrum may have some resilience to increased summer aridity and temperatures because the species persists as seeds in the soil during the hottest and driest portions of the year. However, during the winter and spring growing season, Lime Ridge eriastrum will likely be sensitive to increases in temperatures and the intensity of droughts.

Department staff assessed the vulnerability of Lime Ridge eriastrum to climate change using the NatureServe Climate Change Vulnerability Index (CCVI) Version 3.02 (Young et al. 2016, CDFW 2023). The CCVI is a rapid means of estimating a plant or animal species' relative vulnerability to climate change. The CCVI analyzes exposure to local climate change within a species' range and assesses indirect climate change effects and the species sensitivity and adaptive capacity to provide a qualitative assessment of how the abundance and/or range extent of the species may change due to climate change. The results of the CCVI indicated that Lime Ridge eriastrum has a climate change vulnerability index value of highly vulnerable, indicating that "abundance

and/or range extent within geographical area assessed likely to decrease significantly by 2050" with a moderate confidence level. Factors contributing to this vulnerability assessment included low dispersal capacity, very small range, and restriction to an area with uncommon geological features.

EXISTING MANAGEMENT

Regulatory Status and Legal Protections

Some local, state, and federal laws apply to activities undertaken in California that may provide Lime Ridge eriastrum and its habitat some level of protection from development and other human activities. A discussion of some of the local, state, and federal laws that are applicable is provided below; however, the following is not an exhaustive list of all laws that may provide protection to Lime Ridge eriastrum.

In general, the highest level of regulatory protection that Lime Ridge eriastrum has received so far has been the result of the species being designated a candidate under CESA on March 4, 2022, which prohibits take of the species during the candidacy period and typically requires take to be minimized and fully mitigated to Department standards. Absent the protections of CESA, other federal, state, and local laws and regulations may provide limited avoidance, minimization, and mitigation of impacts for the species, with protection or mitigation of impacts often only required when a controlling agency or project proponent determines it is feasible to do so.

Federal

Lime Ridge eriastrum is not federally-listed and has no regulatory protection under the federal Endangered Species Act (16 U.S.C. §§ 1531-1544).

State

Lime Ridge eriastrum was designated a candidate species under CESA on March 4, 2022. During candidacy, CESA prohibits the import, export, take, possession, purchase, or sale of Lime Ridge eriastrum, or any part or product of Lime Ridge eriastrum, except as otherwise provided, such as through a permit or agreement issued by the Department under the authority of the Fish and Game Code (Fish & G. Code, § 2080 et seq.). For example, the Department may issue permits that allow the incidental take of listed and candidate species if the take is minimized and fully mitigated, the activity will not jeopardize the continued existence of the species, and other conditions are met (*id*. at § 2081, subd. (b)). The Department may also authorize the take and possession of listed and candidate species for scientific, educational, or management

purposes (*id*. at § 2081, subd. (a)). Furthermore, the Department may issue a Safe Harbor Agreement to authorize incidental take of listed or candidate species if a landowner provides a net conservation benefit to the species, implements practices to avoid or minimize incidental take, establishes a monitoring program, and meets other program conditions (*id*. at § 2089.2 et seq.). Finally, the Department may authorize take associated with routine and ongoing agricultural activities through Voluntary Local Programs if management practices avoid and minimize take to the maximum extent practicable, as supported by the best scientific information for both agricultural and conservation practices, among other conditions (*id*. at § 2086).

State and local agencies must conduct environmental review under the California Environmental Quality Act (CEQA) for discretionary projects proposed to be carried out or approved by the public agency unless the agency properly determines the project is exempt from CEQA (Pub. Resources Code, § 21080). If a project has the potential to substantially reduce the habitat, decrease the number, or restrict the range of any rare, threatened, or endangered species, the lead agency must make a finding that the project will have a significant effect on the environment and prepare an environmental impact report (EIR) or mitigated negative declaration as appropriate before proceeding with or approving the project (Cal. Code Regs., tit. 14, §§ 15065(a)(1), 15070, and 15380). An agency cannot approve or carry out any project for which the EIR identifies one or more significant effects on the environment unless it makes one or more of the following findings: (1) changes have been required in or incorporated into the project that avoid the significant environmental effects or mitigate them to a less than significant level; (2) those changes are in the responsibility and jurisdiction of another agency and have been, or can and should be, adopted by that other agency; or (3) specific economic, legal, social, technological, or other considerations make infeasible the mitigation measures or alternatives identified in the environmental impact report (Pub. Resources Code, § 21081; Cal. Code Regs., tit. 14, §§ 15091 and 15093). For (3), the agency must make a statement of overriding considerations finding that the overriding benefits of the project outweigh the significant effects on the environment. CEQA establishes a duty for public agencies to avoid or minimize such significant negative effects where feasible (Cal. Code regs., tit. 14, § 15021). Impacts to Lime Ridge eriastrum, as a CESA-candidate species, should be identified, evaluated, disclosed, and mitigated or justified under the Biological Resources section of an environmental document prepared pursuant to CEQA.

Local

Lime Ridge Open Space is owned by both the City of Walnut Creek and the City of Concord, and the area is managed by the City of Walnut Creek as recreational open space, which provides the area with substantial protection from development and many other destructive land uses. The

Walnut Creek Hillside/Open Space Protection Ordinance of 1991 states that the intent of the people of the City of Walnut Creek is to protect the remaining open space resources within and adjacent to the City, and a goal within the City's 2025 General Plan is to maintain and enhance open space lands. The portions of Lime Ridge Open Space that support Lime Ridge eriastrum are zoned by the City of Walnut Creek as open space/recreation which significantly limits the types of land use allowed in these areas (Walnut Creek Municipal Code Section 10-2.2.1401). Walnut Creek Municipal Code Title 11-1.516 specifies that bicycles may not be used on a single-track hiking or horseback trail unless specifically posted as open to bicycle use. It also specifies that bicycles may not be used in any open space area, including but not limited to, open space hillsides, valleys, creeks, creek beds, drainage areas, and ridgetops unless specifically posted as open to bicycle use. Dogs are not allowed south of Ygnacio Valley Road in the Lime Ridge Open Space area, where the primary habitat areas for Lime Ridge eriastrum exist, yet are allowed elsewhere on the adjacent hiking trails. Leash rules vary therein, yet the City of Walnut Creek's website recommends leashing dogs at all times.

Nonregulatory Status

Species that are not listed under CESA or the federal ESA may nevertheless be rare or at risk of extinction and nonprofit organizations often assign such species a nonregulatory status, sometimes in collaboration with a government agency. Impacts to species that have a nonregulatory status may sometimes be analyzed and mitigated under CEQA and NEPA, even if the species are not listed under CESA or the federal ESA.

Natural Heritage Program Ranking

All natural heritage programs, such as the CNDDB, use the same ranking methodology originally developed by The Nature Conservancy and now maintained by NatureServe. This ranking methodology consists of a global rank describing the rank for a given taxon over its entire distribution, and a subnational rank describing the rank for the taxon over its state distribution. Both global and subnational ranks reflect a combination of rarity, threat, and trend factors. The ranking methodology uses a standardized calculator that uses available information to assign a numeric score or range of scores to the taxon, with lower scores indicating that a taxon is more vulnerable to extinction, and higher scores indicating that a taxon is more stable (Faber-Langendoen et al. 2012). The rank calculation process begins with an initial rank score based on rarity and threats, with rarity (multiplied by 0.7) factored more heavily into the calculator than threats (multiplied by 0.3). The combined rarity and threat rank is then either raised or lowered based on trends. When there is a negative trend, the rank score is lowered, and when there is a positive trend the rank score is raised. Short-term trends are factored more heavily into the calculator than long-term trends. The rank calculator assesses extinction risk for a species using

a period of 10 years or 3 generations, whichever is longer, up to a maximum of 100 years (Faber-Langendoen et al. 2012).

Lime Ridge eriastrum has been assigned a global rank of G1 and subnational rank of S1 indicating that it is "Critically imperiled; at very high risk of extinction or elimination due to very restricted range, very few populations or occurrences, very steep declines, very severe threats, or other factors." Natural heritage ranking does not provide any regulatory protections but is often considered during the CEQA process (Hammerson et al. 2008).

California Rare Plant Rank

The California Native Plant Society works in collaboration with botanical experts throughout the state, including Department biologists, to assign rare and endangered plants a California Rare Plant Rank reflective of their status. Lime Ridge eriastrum has a California Rare Plant Rank of 1B.1, which indicates that it is rare, threatened, or endangered throughout its range and seriously threatened in California (CNPS 2023b).

Management Efforts

No federal or state recovery or management plans currently exist for the benefit of Lime Ridge eriastrum. The California Native Plant Society East Bay Chapter (2008) prepared draft interim management guidelines for Lime Ridge Open Space botanical resources which emphasized avoiding impacts to areas with Lime Ridge eriastrum. Fencing, signs, and other deterrents have been installed to minimize off-trail travel in some parts of Lime Ridge Open Space, but it is unknown how frequently they are inspected and maintained. In addition, 139 Lime Ridge eriastrum seeds were collected from Colony B on July 25, 2008, and these seeds are held in conservation storage at University of California Botanical Garden at Berkeley (2022).

SCIENTIFIC DETERMINATIONS REGARDING THE STATUS OF LIME RIDGE ERIASTRUM IN CALIFORNIA

CESA directs the Department to prepare a status review regarding the status of Lime Ridge eriastrum based upon the best scientific information available to the Department (Fish & G. Code, § 2074.6). The preceding sections of this status review describe the best scientific information available on Lime Ridge eriastrum's biology, habitat, population trends and abundance, and factors affecting the ability of the species to survive and reproduce.

CESA's implementing regulations identify key factors that are relevant to the Department's analyses. Specifically, a "species shall be listed as endangered or threatened ... if the Commission determines that its continued existence is in serious danger or is threatened by any

one or any combination of the following factors: 1. Present or threatened modification or destruction of its habitat; 2. Overexploitation; 3. Predation; 4. Competition; 5. Disease; or 6. Other natural occurrences or human-related activities" (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A)). The section below specifically addresses these factors as laid out in the California Code of Regulations and, for each factor, considers the significance of the threats to the continued existence of Lime Ridge eriastrum.

Present or Threatened Modification or Destruction of Habitat

Lime Ridge eriastrum habitat could be negatively impacted by several factors discussed under the Factors Affecting the Ability to Survive and Reproduce section of this Status Review. These factors include the direct and indirect effects of recreational land use, responses to wildfire, utility right-of-way management invasive plants, and climate change. Some of these factors are interconnected and cumulative, and because Lime Ridge eriastrum is an extremely rare plant it is at risk of extinction from even minor modification or destruction of habitat and other impacts.

Recreational land use, responses to wildfire, and utility right-of-way management have the potential to result in direct mortality of Lime Ridge eriastrum plants and to modify and/or destroy its specialized habitat. Because Lime Ridge eriastrum is such an extremely rare plant, the impacts from recreational land use and response to wildfire are significant threats to the species and have the potential to result in the species extinction within the foreseeable future. Threats from recreational land use and response to wildfire are present, and persistent, at all Lime Ridge eriastrum colonies. Utility right-of-way management is also a threat to the species, but this factor does not threaten Colony A, and the natural gas pipeline and power transmission lines at Lime Ridge Open Space are buried underground, so the risk to Colonies B-D may be somewhat less than the risks posed by recreational land use and wildfire response. Management of utility infrastructure alone is unlikely to cause extinction of the species unless this management requires disruption of the surrounding ground surface.

Invasive and non-native plant species are an indirect threat to all Lime Ridge eriastrum colonies by potentially degrading habitat that would otherwise be suitable for Lime Ridge eriastrium, which may reduce the ability of the species to survive and reproduce. Climate change is also a threat to all Lime Ridge eriastrum colonies, but the Department does not have any data on the extent to which predicted climate changes will affect the demographics of the species (e.g., seed production and mortality) in the foreseeable future.

Overexploitation

The Department does not have any information suggesting that overexploitation of Lime Ridge eriastrum is a threat to the species.

Predation

The Department has little information about herbivory and predation affecting Lime Ridge eriastrum and did not observe evidence of herbivory or predation impacts during site visits in 2020 or 2022. Seasonal cattle grazing has been reported to take place in a small area of central Lime Ridge Open Space (City of Walnut Creek 2015), but Department staff did not observe any recent evidence of cattle grazing at Lime Ridge eriastrum colonies during site visits in 2020 or 2022. The Department does not have any information suggesting that herbivory or predation of Lime Ridge eriastrum is a threat to the species.

Competition

Invasive and non-native plant species are a direct threat to all Lime Ridge eriastrum colonies because they have the potential to outcompete Lime Ridge eriastrum plants. Negative impacts from invasive species will likely increase in the future as invasive plants spread and increase in abundance.

Disease

The Department does not have any information suggesting that disease is a threat to Lime Ridge eriastrum.

Other Natural Occurrences or Human-related Activities

The extreme rarity of Lime Ridge eriastrum makes it inherently vulnerable to extinction even if the other the other threat factors discussed in this status review are not considered. The vulnerability of small populations is a serious, pervasive, and persistent threat to this species.

SUMMARY OF KEY FINDINGS

Lime Ridge eriastrum is a small and inconspicuous annual plant that only occurs at Lime Ridge Open Space in Contra Costa County. Lime Ridge eriastrum is found within and near stands of chapparal on sandy soils derived from sandstone rocks that also contain limestone deposited from hot springs. The species distribution is five small colonies that occupy a combined area of approximately 47 m^2 (500 ft^2). The total number of Lime Ridge eriastrum plants (abundance) is very low, and recent annual censuses have documented between 155 and 1,297 plants.

The extreme rarity of Lime Ridge eriastrum makes it highly vulnerable to extinction from even minor disturbances. Lime Ridge eriastrum is restricted to Lime Ridge Open Space, which is owned and managed by the City of Walnut Creek and heavily used for recreation. Off-trail hiker, bicycle, and horse traffic can trample plants and alter Lime Ridge eriastrum habitat. Colonies of Lime Ridge eriastrum occur on ridges and near the tops of slopes increasing the likelihood that bulldozing for wildfire response could destroy populations. Utility infrastructure is present near four of the five Lime Ridge eriastrum colonies. Management of this infrastructure may have contributed to the loss of one colony and could negatively impact additional colonies in the future. Invasive plants are present at all Lime Ridge eriastrum colonies, and likely lower the ability of the species to survive and reproduce. Climate change is a threat to the species due to the species' low dispersal capacity, very small range, and unique soil requirements. Some of these threat factors are interconnected and cumulative.

Some local, state, and federal laws apply to activities undertaken in California that may provide Lime Ridge eriastrum and its habitat some level of protection from development and other human activities. The local laws and zoning currently protect Lime Ridge Open Space from land development. However, no recovery or management plans currently exist for the benefit of Lime Ridge eriastrum, and the species has received little scientific, management, and conservation attention.

RECOMMENDATION TO COMMISSION FOR PETITIONED ACTION

CESA requires the Department to prepare this report regarding the status of Lime Ridge eriastrum in California based upon the best scientific information available to the Department (Fish & G. Code, § 2074.6). CESA also requires the Department to indicate in this Status Review whether the petitioned action is warranted (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)). Based on the criteria described above, the best scientific information available to the Department indicates that Lime Ridge eriastrum is in serious danger of becoming extinct in all or a significant portion of its range due to one or more causes including the vulnerability of small populations, recreational land use, wildfire response, utility right-of-way management, invasive plants, and climate change.

The Department recommends that the Commission find the petitioned action to list Lime Ridge eriastrum as an endangered species to be warranted.

PROTECTION AFFORDED BY LISTING

It is the policy of the state to conserve, protect, restore, and enhance any endangered or any threatened species and its habitat (Fish & G. Code, § 2052). If Lime Ridge eriastrum is listed under CESA, unauthorized "take" of Lime Ridge eriastrum would be prohibited, and the

conservation, protection, and enhancement of the species and its habitat would be an issue of statewide concern. Under CESA, "take" is defined as hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill (Id., § 86). Any person violating the take prohibition would be punishable under state law. The Fish and Game Code provides the Department with related authority to authorize "take" under certain circumstances (Id., §§ 2081, 2081.1, 2086, 2087, 2089.6, 2089.10 and 2835). As authorized through an incidental take permit, however, impacts of the take of an endangered or threatened species caused by the activity must be minimized and fully mitigated according to state standards.

Protection of Lime Ridge eriastrum could also occur with required public agency environmental review under CEQA. CEQA requires affected public agencies to analyze and disclose project-related environmental effects, including potentially significant impacts on endangered, threatened, and rare special status species. For example, under CEQA's "substantive mandate," state and local agencies in California must avoid or substantially lessen significant environmental effects to the extent feasible. Impacts to species that are of conservation concern may be analyzed and mitigated under CEQA even if the species are not listed; however, in common practice, potential impacts to listed species are examined more closely in CEQA documents than potential impacts to unlisted species. State listing, in this respect, and required consultation with the Department during state and local agency environmental review under CEQA, may benefit Lime Ridge eriastrum.

If Lime Ridge eriastrum is listed under CESA, it may also increase the likelihood that state and federal land and resource management agencies will allocate funds towards protection and recovery actions. CESA listing of Lime Ridge eriastrum could also increase public awareness of the conservation needs of the species and could lead to an increased interest in scientific research on the species.

MANAGEMENT RECOMMENDATIONS AND RECOVERY MEASURES

CESA directs the Department to include in its Status Review recommended management activities and other recommendations for recovery of Lime Ridge eriastrum (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).). Department staff generated the following list of recommended management actions based on recommendations from researchers, non-profit organizations, and other interested parties.

Recovery of Lime Ridge eriastrum is dependent on careful management of Lime Ridge Open Space, and pro-active efforts to expand and enhance Lime Ridge eriastrum colonies and establish new self-sustaining colonies. There is very little quantitative, scientific data on Lime Ridge eriastrum, so studies designed to provide data on the species, and the factors that affect the potential for it to survive and reproduce are necessary for species recovery.

1. Impact avoidance through cooperation

1a. Meet regularly with relevant parties such as the City of Walnut Creek, the mountain biking community, equestrian groups, PG&E, wildfire control districts, and others to exchange information and foster trust and cooperation.

1b. Ensure that all wildfire management activities avoid habitat disturbance to Lime Ridge eriastrum colonies and surrounding habitats.

1c. Enforce laws and regulations that protect Lime Ridge eriastrum and the habitat on which it depends.

2. Monitor colonies and habitat to prevent and respond to impacts

2a. Implement annual population monitoring of colonies and conduct demographic assessments.

2b. Survey for additional Lime Ridge eriastrum colonies at Lime Ridge Open Space and elsewhere in areas with appropriate habitat to ensure they are protected. Use information on environmental parameters associated with the species to develop a species distribution model for Lime Ridge eriastrum to identify possible habitat in the current Lime Ridge eriastrum range and the surrounding region. Survey areas that the model identifies as habitat to find new occurrences, validate the model, and repeat this approach as an iterative process.

2c. Monitor the areas around all colonies regularly for negative impacts during the species' growing season and intervene promptly to prevent or minimize any impacts. This includes protection from direct disturbances such as recreation- and utility-related damage to plants and habitat, prompt response to the creation of unauthorized trails, and early detection of other problems.

2d. Monitor invasive species populations at Lime Ridge eriastrum colonies and implement control measures if necessary, while avoiding impacts to Lime Ridge eriastrum.

3. Conduct scientific studies to inform management

3a. Conduct habitat assessments to determine the environmental parameters that appear to be associated with Lime Ridge eriastrum presence and year-to-year abundance, and how habitat disturbances (e.g. fire, invasive plants, and climate variation) affect the species.

3b. Conduct a study to determine how fire affects Lime Ridge eriastrum, particularly whether it may enhance seed germination.

3c. Conduct life history assessments to determine which, if any, life stages of Lime Ridge eriastrum are most vulnerable. Focus management activities on protecting the species at the identified life stages to improve its rates of survival and reproduction. Conduct life history assessments to investigate germination, seedling survival, flowering, pollination, fruit production, seed dispersal, and seed longevity.

3d. Conduct ecological assessments to determine the degree and nature of Lime Ridge eriastrum's relationships with other organisms, including native and non-native species and cryptobiotic soil crusts.

3e. Conduct a population genetics analysis to evaluate if the species is at risk due to low genetic diversity or other genetic problems, and to inform any future reintroduction efforts. Conduct a genetic study of Lime Ridge eriastrum's relationships with other taxa in the genus.

3f. Conduct a soil seed bank analysis at colonies to determine the presence and abundance of Lime Ridge eriastrum seeds, particularly at Colony B where no plants have been observed for several years.

4. Expand and enhance colonies

4a. Collect seed from all Lime Ridge eriastrum colonies for long-term conservation storage, and future enhancement and expansion of colonies. Ensure that seed collected from existing colonies does not impact the survival of those colonies. Ensure that Lime Ridge eriastrum seed is stored at accredited seed banking institutions. Test viability of collected seeds.

4b. Develop Lime Ridge eriastrum propagation techniques.

4c. Plan and implement an experimental propagation and outplanting project in an effort to establish new colonies and provide population redundancy to prevent extinction of Lime Ridge eriastrum.

4d. Protect any additional populations of Lime Ridge eriastrum that are established or discovered from habitat destruction.

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APPENDIX A: SCIENTIFIC PEER REVIEW

APPENDIX B: COMMENTS FROM AFFECTED AND INTERESTED PARTIES ON THE PETITIONED ACTION