Appendix E Delhi Sands Flower-loving Fly Habitat Report

Appendices

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Attn: Ms. Kara Kosel
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RE: Habitat conditions for Delhi Sands Flower-loving Fly on a 14.5-acre site, Fontana, San Bernardino County, CA.

To Whom It May Concern:

On behalf of the Chaffey Community College District, PlaceWorks has requested my evaluation of habitat suitability for the federally endangered Delhi Sands Flower-loving Fly (DSF, *Rhaphiomidas terminatus abdominalis*), on a 14.5-acre New Fontana Campus site in Fontana, California. This area is indicated on the attached maps, and is located on the east side of Sierra Avenue (Figure 1), approximately half way between Santa Ana Avenue and Jurupa Avenue, Fontana, Bernardino County, CA. For the purpose of this habitat assessment, I have evaluated site conditions for DSF suitability in terms of site characteristics on the basis of a detailed grading system I have developed and implemented since 2003.

Summary Conclusions: The entire study site is mapped with Delhi sands (Woodruff 1980) and is situated in a larger context with more extensive acreage (to the west) mapped with Delhi sands. The entire site supports ecological conditions rating as moderate quality DSF habitat.

Qualifications: Although I possess USFWS 10(a) permitting to survey for the federally endangered Delhi Sands Flower-loving Fly, such permitting is generally awarded to biologists only on the basis of a biologist's experience with and/or ability to identify adult DSF, such permitting not awarded on the basis of any real understanding of DSF biology, ecology, or habitat requirements. Traditionally, USFWS considered any land (within the known range of DSF) to have been mapped with Delhi Sands soils (Woodruff 1980) as subject to formal survey for the DSF. Thus, my additional qualifications in this regard include BS, MS, degrees in entomology, 45 years general entomological experience, thirty years experience with, research, and discoveries, in *Rhaphiomidas*, life history, biology, and ecology, such that I am now a leading expert in this narrow field of study.

Natural History of the DSF: DSF belongs to a genus of flies (*Rhaphiomidas*) commonly known as flower-loving flies (Cazier 1985). There are more than 30 species of these flies, distributed across the southwestern United States and northern Mexico. These flies are huge by the standards set by most flies, with size among the species ranging from approximately 1.5 centimeters up to 3 and even 4 centimeters, and are usually gray, tan, rust, or yellow in color. All species of *Rhaphiomidas* are associated with rather arid, sandy habitats, with most species living on dune systems of inland desert

valleys, rivers, deltas, and beach strands. A few species are found in sandy washes, alluvial benches, and remnant glacial moraines. Many species of these flies often hover before flowers in the manner of hummingbirds, using a long, thin, tubular proboscis (mouth-part), with which the flies probe for nectar; hence, a traditional name "giant flower-loving flies." Smaller flies of the family Apioceridae, once considered very closely related to *Rhaphiomidas* were formerly called "flower-loving flies."

The DSF is only known to occur in association with Delhi sand deposits and presumably occupied the once extensive dune system of the upper Santa Ana River Valley, including portions of what is now the City of Colton, west through portions of the City of Mira Loma, and south to the Santa Ana River. Today, DSF exists on only a few disjunct sites (USFWS 1997) within a radius of about 8 miles in southwestern San Bernardino and northwestern Riverside Counties (Colton, Rialto, Fontana, and Mira Loma). More than 95% of known DSF habitat was considered eliminated by development, agriculture, and other land management practices by 1993 (USFWS 1993; USFWS 1996 *in* Kingsley 1996); however, this proportion is now nearer 98 to 99% due to these ongoing processes. Many of the last remaining fragments of DSF habitat are currently under pressure by land management efforts such as heavy disking, irrigation, manure dumping, and gravel dumping. There is currently an estimated 1,200 acres of habitat that can support this species (USFWS 1997), but this estimate likely includes lands needing extensive habitat restoration.

The adult DSF flight period is typically August and September, when individual adults emerge, reproduce, and die. The adult life span of an individual DSF lasts for a few days and adults do not live beyond the flight period (Kiyani Environmental Consultants 1995). Adult DSF are highly mobile, agile fliers. Male DSF are frequently seen flying low through habitat, using apparently random, circuitous paths around and between shrubs in search of females. Such "cruising" behavior often covers areas on the scale of 1,000 square meters in the time span of a minute. Alternatively, male DSF are often seen flying about an open patch of ground (approximately 100 square meters) such as along a dirt path or dune blow-out area. Here, males may repetitively land and rest on an object (such as small dried plants) in the area, and such rests are interrupted by periods of patrolling flight (apparently territorial) about the spot. When alarmed, these insects tend to fly rapidly in more or less a straight line—often covering distances of 100 meters in less than 6 seconds. Adult DSF are known to nectar at flowers of California buckwheat (*Eriogonum fasciculatum*) and California croton (*Croton californica*).

The DSF, like other *Rhaphiomidas* species, appears to have, at a minimum, an annual life cycle (because of the annual flight). However, it has been widely believed that the underground larval/pupal stage may persist for additional years, depending upon various environmental factors such as annual rainfall, food availability, and weather conditions during the flight season (many desert *Rhaphiomidas* species do not appear after a drought year and, often, substantial flights occur only sporadically over the years). Though it has long been known that *Rhaphiomidas* larvae develop underground, until recently the specific biology (larval biology, habits, and food requirements) were not known for any *Rhaphiomidas* species. In 2003, an extensive excavation in known habitat of the San Joaquin Valley giant flower-loving fly (*Rhaphiomidas trochilus*) (Osborne and Ballmer 2014) recovered very large and strange looking fly larvae, inferred as *Rhaphiomidas* and later confirmed to be those of *Rhaphiomidas trochilus* based on DNA analysis. The biology of *R. trochilus* is likely informative of *Rhaphiomidas* species in general and DSF in particular. Based on observations of captive *R. trochilus* larvae (Osborne and Ballmer 2014), it is reasonable to conclude that they are mobile opportunistic predators of soft-bodied, sand-inhabiting insects. Larvae from Sand Ridge,

Kern County, California, were maintained in captivity for several months, during which they burrowed actively through sand maintained with slight moisture content (similar to the damp sand where they were found). They fed on larvae of a scarab beetle (Scarabaeidae) and an unidentified bee fly (Diptera: Bombyliidae), which were also recovered from Sand Ridge, and larvae of paper wasps (*Polistes* sp.), which were removed from their nests and buried in the sand. Captive larvae grew and molted after feeding; but, when not fed for extended periods of time, they molted again, losing weight and size in the process. Some larvae were observed to repeat the growth and "shrinkage" cycle multiple times. One larva survived about 17 months in captivity when it was captured 9 months after the most recent flight season and was at least 2 years old at time of death. This larva molted four times while undergoing five cycles of growth and shrinkage driven by variable food availability. Its final dry weight was slightly smaller than the typical dry weight of an adult male *R. trochilus*. The ability of *R. trochilus* larvae to molt down during times of scarce food resources could allow an extended and indeterminate larval growth period, but with maturation and appearance of adults always during summer months. This may also explain the common observations that populations of various *Rhaphiomidas* species apparently exhibit little or no adult emergence in some years (especially years of below normal precipitation).

The brief adult life span and active, random search mate-locating behavior of DSF males (typical of all *Rhaphiomidas* species) indicates that relatively high population density and/or nearly synchronous adult emergence are likely crucial to survival of populations. Protracted *Rhaphiomidas* larval biology and staggered (across years) adult emergence must enhance population momentum and cross generational gene flow, and the requirement of abundant and diverse insect prey on which larvae develop—all explain why DSF populations appear as long-term entities (persisting for decades) associated with ecologically intact dune habitats. This also explains why some populations, even though small numbers of adults emerge during flight seasons, eventually fail. These doomed "ghost populations" dwindle down to extinction after overall ecological health of habitat is compromised by various forms of ecological diminishment—ever increasing portions of habitat developed, agricultural use, incessant recreational vehicle use, annual disking of the vegetation community and upper soil column, encroachment of exotic plants, etc.

DSF Habitat Characteristics: DSF is typically found in areas of unconsolidated sandy soils (Delhi series) supporting an open community of native and exotic plant species. Dominant plants are commonly California buckwheat (*Eriogonum fasciculatum*), California croton (*Croton californicus*), telegraph weed (*Heterotheca grandiflora*), annual burweed (*Ambrosia acanthicarpa*) and deerweed (*Acmespon glaber*) but many exotic species often dominate on DSF habitat as well. DSF have been found in habitats that do not support these dominant plant species, and plant species composition may not be directly relevant to larval development (due to the predatory biology of DSF larvae). Erroneous habitat evaluations are often based on absence of these plant species and a false assumption that DSF is dependent on them, while these plant species are only indicative of relative disturbance on a site. Since larvae develop deep under the soil, disking of a site does not directly affect the DSF in the larval stage (though it may impact pupae if disking is undertaken in the month or so before that adult flight season) and they commonly emerge above highly disturbed soil conditions. Adult DSF are anecdotally believed to nectar at flowers of California buckwheat and California croton, though such a habit is rare at best and not yet documented. Many other plant species are common, including Thurber's eriogonum (*Eriogonum thurberi*), autumn vinegar weed (*Lessingia glandulifera*), and sapphire eriastrum (*Eriastrum sapphirinum*). Nonnative plant species also occur in DSF habitat (and incidentally, virtually

everywhere). DSF habitat also supports other associated insects such as flies and wasps considered as indicator species – *Apiocera convergens, Apiocera chrysolasia, Ligyra gozophylax*, *Campsomeris tolteca*, *Trielis alcione*, and *Nemomydas pantherinus.* Over 350 insect species have been found on one DSF site, and DSF habitat is typically marked by high abundance and diversity of predatory and parasitic insect groups including many highly specialized families of flies, wasps, bees, beetles, and antlions. The Delhi Sands community is one of California's unique natural communities containing an array of native plants and animals, some of which are found nowhere else. One plant species, Pringle's monardella, (*Monardella pringlei*) is already presumed extinct, as no living individuals have been observed in many years. Several species of insects and some vertebrates, which inhabit the Delhi Sands dunes system, are as endangered as the DSF, but no one has yet petitioned to have them officially declared Endangered. These include the convergent flower-loving fly *Apiocera convergens*, a newly discovered species of Jerusalem cricket, (*Stenopelmatus* sp.), a new species of camel cricket (*Ceuthophilus* sp.) and an endemic subspecies of butterfly *Apodemia mormo nigrescens* (Emmel and Emmel 1998). The other apiocerid fly (*Apiocera chrysolasia*), although known from approximately six general localities, is only common within the Delhi sands. Finally, it is worth noting that although habitats may be rated to be suitable for DSF, populations of this species have become increasingly rare – hence its listing as federally protected. The likelihood of finding new population sites on undeveloped lands within its former range is remotely small and presence/absence surveys are formally undertaken in order to enable documentation and mitigation for any populations that remain to be destroyed.

Methods: On December 13, 2021, I visited the study area in order to investigate habitat suitability for the DSF. I have reviewed soil maps covering the subject site, prepared by the California Department of Agriculture (Woodruff 1980, Figure 2). Aerial imagery covering the site, dating from 1993 to 2021 (Google Earth) was reviewed in order to gain an understanding of land use regimens in recent years. Photographs were taken of the site (Figures 3-6) along with field notes on vegetation soil conditions. I examined the subject site to rate its potential (Osborne 2003, Osborne et al. 2003) to support DSF, the rating based on the following scale of 1 to 5, with 5 being the best quality and most suitable habitat in my judgment:

1. Developed areas, non-Delhi sands soils with high clay, silt, and/or gravel content. Delhi sands extensively and deeply covered by dumping of exotic soils, rubble, trash, manure, or organic debris. *Unsuitable.*

2. Delhi sands are present but the soil characteristics include a predominance of exotic soils such as alluvial materials, or predominance of other foreign contamination as gravels, manure, or organic debris. Severe and frequent disturbance (such as a maintenance yard or high use roadbed). *Very Low Quality.*

3. Moderately contaminated Delhi sands. Delhi sands with moderate to high disturbance (such as annual disking). Sufficient Delhi Sands are present to prevent soil compaction (related to contamination by foreign soils). Some sandy soils exposed on the surface due to fossorial animal activity. *Low Quality.*

4. Abundant clean Delhi Sands with little or no foreign soils (such as alluvial material) present. Moderate abundance of exposed sands on the soil surface. Low vegetative cover. Evidence of moderate degree of fossorial animal activity by vertebrates and invertebrates. May represent high quality habitat with mild or superficial disturbance. *Moderate Quality*

5. Sand dune habitat with clean Delhi Sands. High abundance of exposed sands on the soil surface. Low vegetative cover. Evidence (soil surface often gives under foot) of high degree of fossorial animal activity by vertebrates and invertebrates. Sand associated plant and arthropod species may be abundant and vegetation species composition is often indicative of low disturbance. *High Quality*

It should be noted that habitat qualities often vary spatially within a site so that conditions on a site fall within a range of qualities. Further, overall habitat quality is affected by the overall habitat area on a site, such that very small areas diminish the overall habitat value of a site. Habitat conditions rated from *Very Low Quality* up to *High Quality*, are formally considered as representing *Suitable* conditions for the DSF. Use of this habitat rating system is somewhat subjective and best undertaken by a biologist who has extensive experience with *Rhaphiomidas* species. It must be noted that these ratings do not infer or imply actual occupancy by DSF, only relative potential to harbor the species, and relative conservation value of the land should DSF be found.

Results: The field investigation found abundant clean Delhi sands throughout the site (with exception of two small areas of imported soils, rubble, and a concrete pad) and (in spite of the recently disked condition of most of the site) plant species associated with DSF habitat and Delhi sands including *Heterotheca grandiflora*, *Eriogonum gracile*, and *Ambrosia acanthicarpa.* Department of Agriculture, Soil Conservation Service map (Woodruff 1980) and associated web based resources (https://casoilresource.lawr.ucdavis.edu/gmap/) show all portions of the study site mapped with Delhi fine sand soils (Figure 2). Until recently, additional undeveloped areas with Delhi sands have bounded the site to the west (being graded at the time of this field investigation). Google Earth satellite images show that since 1993, the entire site has remained relatively unchanged, with remnant orchard trees, open fields, and a Eucalyptus windbreak along the northern boundary of the site. Three residences with driveways and walkways existed prior to this year (an area of approximately 0.7 acres which would have rated as unsuitable for DSF prior to removal of the residences sometime in the last year). Thus the site is rated as *Moderate* habitat for DSF. DSF populations existed 2.3 km NE of the site (Osborne 2000), and 1 km NE under conditions similar to current conditions on the subject site (Osborne 2004) but these have been subsequently destroyed by development. The nearest (known) extant DSF population is located 3.2 km southwest of the site at the foot of the Jurupa Mountains.

Conclusions and Recommendations: On the basis of my experience, conditions on the site represent *Suitable* conditions of moderate quality for DSF. Extensive Delhi sands, the presence (until recently) of additional areas of Delhi sands adjacent to the west, and the presence of the site of plant species indicative of ecological communities typical of Delhi sands all indicate the potential for DSF. I do not rate the site as High quality DSF habitat due to the fact that most of it appears to be disked periodically and most of the site supports predominantly exotic grassland – while high quality habitat would have a more open aspect of soil exposure and dominance of native plant species associated with the sands. Approximately 0.7 acres of the site on the northeastern portion recently had developed structures and their removal has opened the sands to potential exploitation by DSF had other sand associated species. The removal has been so recent that DSF quality in this area would be rated as lower quality for the time being. In addition, 0.2 acres of the site (southern portion) have areas with a concrete pad as well as piles or concrete rubble and exotic soils – representing a small fraction of the site not suitable for DSF, though in the larger context of site conditions, this small area has little effect on overall habitat suitability.

Interim General Survey Guidelines for the DSF, suggested by the USFWS (1996) typically recommend protocol surveys for DSF where undeveloped Delhi sands occur. Surveys are conducted for at least two consecutive years from July 1 to September 20. Prior to ground improvements on these sites, Presence/Absence Surveys for DSF are recommended (USFWS 1996). Particular USFWS policies regarding the longevity of valid negative survey results for DSF should be noted owing to their implications for project delays: In going forward with project development, it is important to understand that after two years with negative survey results for DSF, if the site is not developed during the interim months before the next subsequent DSF flight season, it is currently USFWS policy to consider the previously determined DSF absent status as void, and the USFWS then recommends continued DSF surveys in order to maintain current assessments as to presence or absence. If, after two years with negative results, a survey is not conducted during one or more subsequent summer seasons, then USFWS has required a full repeat of two years of survey before negative results are again accepted. As a consequence, some projects, not yet having completed planning or obtained grading permits, have undertaken DSF surveys over several consecutive years in order to keep the negative results current!

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Respectfully submitted,

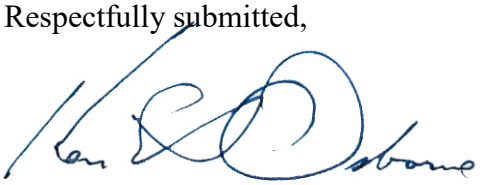

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Figure 1. Aerial image showing the vicinity of the study site (outlined in blue, shaded yellow).

Figure 2. Soils map for the vicinity of the study site (highlighted and outlined in blue): Yellow lines separate soil types: TuB = Tujunga gravely alluvial soils; Db = Delhi sands.

Figure 3. Photograph of exposed Delhi sands with dried stalks of *Heterotheca* (indicative of DSF habitat quality) on the western portion of the study site, view looking west. All this habitat is suitable for potential DSF.

Figure 4. Photograph of a *Eucalyptus* windbreak on the northern edge of the study site (left) with exposed Delhi sands throughout the area. All this habitat is suitable for potential DSF. View looks east along the northern border of the site.

Figure 5. Photograph of exposed Delhi sands (gopher mounds) over open fields with remnant trunks of orchard trees (pecan) in a diagonal view looking northeast across the study site. All this habitat is suitable for potential DSF.

Figure 6. Photograph of exposed Delhi sands with Jimson weed (white flowers) on the southeastern portion of the study site, view looking east onto Sierra Avenue. This habitat is suitable for potential DSF.