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July 26, 2024

Via Email Only

Board of Supervisors
County of Lake
c/o Clerk of the Board
255 N. Forbes Street
Lakeport, CA 95453
clerkoftheboard@lakecountyca.gov

Re: Appeal of Planning Commission's Approval of Highland Farms Cannabis Farm
(UP 20-96) and Adoption of its Mitigated Negative Declaration (IS 20-116)

Dear Chairman Sabatier, Vice Chair Crandell, and Supervisors Simon, Green, and Psyka:

Somach Simmons & Dunn represents Thomas Lajcik and Margaux Kambara (Lajciks), owners and residents of the property at 6451 Ridge Road, Lakeport. On May 28, 2024, the Lajciks filed an appeal with Lake County (County) challenging the Planning Commission's approval of the Highland Farms Cannabis Farm (UP 20-96) (Project) and adoption of the associated Mitigated Negative Declaration (MND) (IS 20-116). This letter supplements and supports that appeal.

As explained in more detail below, the Lajciks are appealing the Planning Commission's approval of the Project because they have significant concerns about the Project's adverse impacts on the environment and community, in particular impacts to air quality, health, biological resources, noise, recreation, water supply, and traffic. The MND, in violation of the California Environmental Quality Act (CEQA) (Pub. Res. Code, § 21000 et seq.), does not accurately or adequately address these impacts. As such, an environmental impact report (EIR) is required. Moreover, as explained below, the Project violates the County's Cannabis Cultivation Ordinance, State Minimum Fire Safe Regulations, and Statewide Cannabis Cultivation General Order.

**The MND Fails to Identify, Assess, and Mitigate Significant
Environmental Impacts of the Project**

Since "CEQA's inception," the California Supreme Court has held that " 'the Legislature intended ... [C]EQA to be interpreted in such manner as to afford the fullest possible protection to the environment within the reasonable scope of the statutory language.' " (*Union of Medical Marijuana Patients, Inc. v. City of San Diego* (2019) 7 Cal.5th 1171, 1184, quoting *Friends of Mammoth v. Bd. of Supervisors* (1972) 8 Cal.3d 247,

259.) It is in this framework that CEQA requires a Lead Agency to identify the potentially significant environmental impacts of a project and avoid or mitigate those impacts, if feasible. (Cal. Code Regs., tit. 14 [CEQA Guidelines], §§ 15002, subd. (a), 15021, subd. (a).) The MND fails in this regard. As explained in detail in the Attachments to this letter, the MND does not identify, assess, and mitigate the following impacts:

- Serpentine Soils (see Attach. A): The Project site contains serpentine formations and soils that, when disturbed by Project construction and operation, will release naturally occurring asbestos into the air. This airborne asbestos will result in adverse health impacts to construction workers and the public. Asbestos in any form is a human carcinogen for which there is no safe level of human exposure. The part of the Project site that, with certainty, contains serpentine formations and soils¹ includes the portion of the site access road located on County-owned parcels that would connect the cultivation area to Highland Springs Road. This portion of the access road containing serpentine soils was not included in the analyses or studies performed for the MND, in violation of CEQA. CEQA requires that a Lead Agency fully analyze “the whole of an action, which has a potential for resulting in either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment” (CEQA Guidelines, § 15378, subd. (a); see also, e.g., *Tuolumne County Citizens for Responsible Growth, Inc. v. City of Sonoma* (2007) 155 Cal.App.4th 1214, 1222; *Assn. for a Cleaner Environment v. Yosemite Community College Dist.* (2004) 116 Cal.App.4th 629, 637.) Both the MND and Planning Commission Staff Report identify Project use of the County-owned portion of the access road and eventual roadway improvements. (Attach. A, ¶ B.) Yet, the MND fails to analyze impacts associated with those road improvements and future roadway use and further fails to provide necessary and feasible mitigation; it also omits any discussion of the many rules and regulations, including County policies, governing construction in and around serpentine soils. (*Id.*, ¶¶ D.2, G, H.3.) CEQA requires analysis of this physical change to the environment and does not allow piecemealed review of project components that are clearly connected, as occurs here—sequential activities that are “adopted by the same entity, ... cover activity in the same geographical area,” and “address the same subject matter,” with a “temporal connection.” (*POET, LLC v. State Air Resources Bd.* (2017) 12 Cal.App.5th 52, 75.)
- Special Status-Species (see Attach. B): The Project site contains several special-status plant species associated with serpentine habitat that will be destroyed or disrupted during Project construction and operation. The MND critically fails to conduct or prescribe protocol-level surveys for these special-status species and others that are likely to occur onsite, including the locally renowned Konocti manzanita. (Attach. B, ¶ C.1.) The MND also fails to discuss the many County policies intended to protect biological

¹ Evidence indicates that serpentine formations and soils exist on other portions of the Project site as well. (Attach. A, ¶ B.10.)

resources with which the Project would conflict (*id.*, ¶ F) and relies in significant part on data for a different project site and area (*id.*, ¶ E).

- Wetlands (see Attach. B): Several wetlands occur onsite, but no wetland delineation was performed. (Attach. B, ¶ D.1–3.) The biological surveys conducted for the Project occurred during a historic drought, when the boundaries of seasonal wetlands would have been difficult to determine. The MND’s mitigation for wetlands does not address these critical flaws. The MND also fails to acknowledge or abide by the recommendation of the Project biologist that no cultivation occur in areas where it is currently proposed because of the impossibility of avoiding wetlands and maintaining required setbacks. (*Id.*, ¶ D.4.)
- Groundwater/Water Supply (see Attach. B): The MND does not assess impacts on the nearest neighboring spring to the Project site, despite evidence that the Project’s wells will drawdown the aquifer and that there is groundwater connectivity to the neighboring spring. (Attach. B, ¶ G.)
- Cumulative Traffic and Roadway Safety (see Attach. C): In its comment letter on the Project, the Department of Cannabis Control (DCC) states that the MND should include a cumulative impacts analysis. The Project will increase traffic on Highland Springs Road and, when considered together with other nearby cannabis operations using Highland Springs Road, likely would create a significant cumulative impact. (Attach. C, ¶ B.) As well, Highland Springs Road currently contains several safety hazards that will be exacerbated by Project traffic. (*Id.*, ¶ C.)
- Noise (see Attach. D): Project construction noise could impact sensitive receptors at the adjacent Highland Springs Recreation Area. (Attach. D, ¶ E.3.) The MND does not recognize this potentially significant impact.
- Odor (see Attach. D): Project operation odor could impact sensitive receptors at the adjacent Highland Springs Recreation Area and Highland Springs Regional Park. (Attach. D, ¶ E.4–5.) The MND does not properly address this potentially significant impact or effectively mitigate it.
- Recreation (see Attach. D): Project construction and operation could impact recreational activities at the adjacent Highland Springs Recreation Area in a manner that in turn affects recreational facilities at other parks. (Attach. D, ¶ E.1–2.)

These analytical inadequacies violate CEQA’s requirement to provide information to “decision makers and the public about the potential, significant environmental effects of proposed activities” (CEQA Guidelines, § 15002, subd. (a)) and to avoid or mitigate those impacts, if feasible (*id.*, § 15021, subd. (a)). The MND also contains several other errors, omissions, and concerns that further diminish the document’s informational qualities. (See

Attach. I.) For example, the applicant publicly discussed connecting the Project site to Amber Ridge Court for use as emergency egress for the Project. (*Id.*, ¶ D; see also Attach. F, ¶¶ B.3-4.) This proposed emergency egress is not included as part of the Project in the MND, in violation of CEQA piecemealing law (discussed above). Consequently, it goes unanalyzed, despite its potential for resulting in additional impacts to wetlands and special-status species, as well as impacts associated with serpentine soils.

Feasible mitigation exists for these significant environmental impacts that would substantially lessen effects. The types of impacts associated with the Project are common to development in the region and elsewhere in California for which mitigation measures have been established and are regularly applied. Measures may include heightened dust control for construction in serpentine soils (Attach. A, ¶ D.2); paving roadways with serpentine soils to regulatory specifications (*id.*, ¶ F.1); avoidance or minimization of disturbance of special-status species and relocation or compensation if avoidance is infeasible (Attach. B, ¶¶ B.4, C.4); formally delineating wetlands and creating appropriate setbacks (*id.*, ¶ D.1); installing roadway safety signs and markings on Highland Springs Road (Attach. C, ¶ C); odor control measures (Attach. D, ¶ E.5); etc. This mitigation is required for the Project. CEQA requirements for mitigation are further discussed below.

An EIR Is Required

While a Lead Agency may prepare an MND when an initial study shows “that there is no substantial evidence, in light of the whole record before the agency, that the project may have a significant effect on the environment” (CEQA Guidelines, § 15070, subd. (a)), when a fair argument can be made that a project may have a significant effect on the environment, an EIR must be prepared, even if evidence to the contrary exists. (See, e.g., *Friends of College of San Mateo Gardens v. San Mateo County Community College Dist.* (2016) 1 Cal.5th 937, 957; *No Oil, Inc. v. Los Angeles* (1974) 13 Cal.3d 68, 75.) “ ‘The fair argument standard is a “low threshold” test for requiring the preparation of an EIR. It is a question of law, not fact, whether a fair argument exists, and the courts owe no deference to the lead agency’s determination.’ ” (*Protect Niles v. City of Fremont* (2018) 25 Cal.App.5th 1129, 1139, internal quotations omitted.)

Here, the “fair argument” standard is clearly met. The Project will result in numerous significant environmental effects that have gone unidentified and unanalyzed in the MND, summarized above. The Lajciks provide ample substantial evidence in the Attachments to this letter demonstrating the Project’s numerous additional significant environmental effects. Their evidence includes but is not limited to mapping, photographs, local expert input, local observations,² scientific and governmental support, information included in the MND’s own technical studies, etc.

² “ ‘Relevant personal observations of area residents on nontechnical subjects may qualify as substantial evidence for a fair argument.’ ” (*Protect Niles, supra*, 25 Cal.App.5th at p. 1139.)

Under the fair argument standard, “an agency is merely supposed to look to see if the record shows substantial evidence of a fair argument that there *may* be a significant effect. In other words, the agency is not to weigh the evidence to come to its own conclusion about whether there will be a significant effect.” An agency must find a “fair argument” if there is any substantial evidence to support that conclusion, even if there is competing substantial evidence in the record that the project will not have a significant environmental effect.

(*Historic Architecture Alliance v. City of Laguna Beach* (2023) 96 Cal.App.5th 186, 209, some internal quotations and citations omitted, emphasis added.) The Lajciks provide more than enough “evidence of a fair argument that there may be significant effect.” (*Ibid.*) No more is required.

The County as CEQA Lead Agency must provide “feasible mitigation measures” and/or “feasible alternatives” to “substantially lessen the significant environmental effects of such projects” (Pub. Res. Code, § 21002; CEQA Guidelines, §§ 15126.4, subd. (a)(1), 15126.6, subd. (a)), even if the impact remains significant after implementation (see, e.g., *Sierra Club v. County of Fresno* (2018) 6 Cal.5th 502, 523 [California Supreme Court holding that “[m]itigation measures ... must be at least partially effective, even if they cannot mitigate significant impacts to less than significant levels”]).) As explained above, feasible (and commonplace) mitigation exists to avoid or lessen the significant impacts of the Project. All mitigation must be timely (not deferred), fully enforceable through a legally binding instrument, and include clear performance standards for what any future mitigation must achieve. (CEQA Guidelines, § 15126.4, subd. (a).) As to Project alternatives, several exist, such as alternative locations, configurations, or reduced size, that could reduce significant environmental impacts and which the County must analyze. (See Attach. E.)

CEQA’s substantive mandate requires agencies to “refrain from approving projects for which there are feasible alternatives or mitigation measures” (*Mountain Lion Foundation v. Fish & Game Com.* (1997) 16 Cal.4th 105, 134) unless ... the agency makes specified findings and adopts a statement of overriding considerations ([Pub. Res. Code,] § 21081). (See *Cal. Bldg. Industry Assn. v. Bay Area Air Quality Management Dist.* (2015) 62 Cal.4th 369, 383; §§ 21002, 21002.1; Guidelines, § 15093.)

(*Preservation Action Council of San Jose v. City of San Jose* (2023) 91 Cal.App.5th 517, 535.) Here, feasible mitigation measures and alternatives exist for the Project that would reduce impacts, and the County must either apply them or make findings and adopt a statement of overriding considerations as to why they cannot.

CEQA further mandates a Lead Agency require an EIR and make findings of significance for projects that would, “in light of the whole record before the lead agency” (Pub. Res. Code, § 21082.2, subd. (d)) have “possible environmental effects that are individually limited but cumulatively considerable” and “cause substantial adverse effects on

human beings” (CEQA Guidelines, § 15065). Here, the Project would result in cumulatively considerable impacts (i.e., traffic and roadway safety) and adverse impacts to human health (i.e., airborne asbestos from serpentine soils), thus the County must require an EIR and make findings of significance.

Importantly, in addition to its comments on the MND’s inadequate cumulative analysis (discussed above), the DCC commented that the MND’s environmental and regulatory setting information, impact analysis, and mitigation are insufficient for its needs as a Responsible Agency under CEQA (see CEQA Guidelines, §§ 15096, 15381) when processing the annual cultivation licenses required by the Project. (Attach. I, ¶ A.) When a Responsible Agency finds a negative declaration inadequate for its purposes, it can require the preparation of a subsequent EIR, and may choose to do so in this instance, at the expense of the applicant. (CEQA Guidelines, § 15096, subd. (e)(3).) A Responsible Agency requiring preparation of an EIR “does not excuse a lead agency’s failure to prepare an EIR that complies with CEQA.” (*Habitat & Watershed Caretakers v. City of Santa Cruz* (2013) 213 Cal.App.4th 1277, 1299.)

Accordingly, CEQA *requires* that the County prepare an EIR for the Project that identifies and analyzes *all* significant environmental impacts and considers *all* feasible mitigation measures and alternatives that could lessen those impacts and make findings accordingly.

**The Project Violates a County Ordinance and State Regulations and Orders
and Therefore Cannot Be Approved**

The Project violates the following:

- Lake County Cannabis Cultivation Ordinance, Article 27, section 27.13:
 - Section 27.13(at)1.v prohibits cannabis cultivation within 1,000 feet of “Public Lands.” Evidence shows that the Highland Springs Regional Park is a public land within the scope of the Ordinance and is located within 1,000 feet of the Project’s cannabis cultivation, thereby violating the Ordinance. (See Attach. D.)
 - Section 27.13(aaa)4.i requires that the parcels on which cannabis processing facilities are located “front *and* have direct access to a paved State or County maintained road.” Evidence shows, however, that the parcel on which the Project’s processing facilities will be located does not “front” Highland Springs Road—several parcels separate it from the roadway. Nor may access be achievable because the portions of the County-owned parcels through which the applicant must traverse do not appear to allow Project access, and the MND does not analyze any other access as part of the Project in accordance with CEQA requirements (discussed above) that the whole of an action be considered. Consequently, neither criterion of the Ordinance is met. (See Attach. H.)

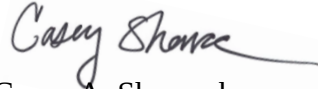
- State Minimum Fire Safe Regulations (see Attach. F): State Minimum Fire Safe Regulations mandate maximum roadway lengths for dead-end roads. Evidence shows that the Project's access road is a dead-end road subject to these Regulations and would exceed the maximum allowable length, thereby violating these Regulations.
- State Water Resources Control Board Cannabis Cultivation General Order (see Attach. G): The General Order requires all cannabis cultivation be setback 100 feet from seasonal wetlands. Evidence shows that the Project will violate this setback requirement on the northern parcel, thereby violating the General Order.

The County must uphold its ordinance and comply with state regulations and orders. It cannot approve a Project that violates these lawful rules.

The Project's environmental analysis violates CEQA. The Project itself violates a local ordinance and state regulation and order. The Lajciks therefore appeal the Planning Commission's approval of the Project and adoption of its MND and request that the Board of Supervisors vote to rescind. As nearby residents to the Project, the Lajciks will be amongst the many locals who would be adversely impacted by the Project. As a second-generation Lake County family, the Lajciks care deeply about their community and the local environment and firmly believe that this Project, as it is currently proposed, will detrimentally impact both.

If you have questions, please feel free to contact Casey Shorrock at (916) 449-7979 or cshorrock@somachlaw.com.

Very truly yours,



Casey A. Shorrock
Kelley M. Taber

Encs: Attachments A-I

Exhibits to Attachments

cc: Johanna DeLong, Assistant Clerk (johanna.delong@lakecountyca.gov)
Mary Claybon, Associate Planner (mary.claybon@lakecountyca.gov)

ATTACHMENT A

SERPENTINE FORMATIONS AND SOILS ON THE PROJECT SITE

A. The MND Incorrectly Claims that Serpentine Formations and Soils Do Not Exist on the Project Site

1. The California Environmental Quality Act (CEQA) Initial Study and Mitigated Negative Declaration (MND) for the Highland Farms cannabis farm (Project) incorrectly claims that the Project site and area do not contain “any identified areas of serpentine soils or ultramafic rock, and risk of asbestos exposure during construction is minimal.” (MND, pp. 23, 44.) In actuality, a large portion of the access road through County property that is included as part of the Project contains serpentine formations and soils, discussed below.

B. The Project Site Includes an Access Road through County-Owned Parcels, and the Access Road Contains Serpentine Formations and Soils

1. As its primary access, the Project would use an access road from the proposed cultivation area to Highland Springs Road. (MND, p. 4 [“The Property is accessed from Highland Springs Rd. by a private access roadway.”]; see also May 23, 2024, Planning Commission Staff Report [PC Staff Report], p. 7 [“The Property is accessed from Highland Springs Rd. by a private deeded access roadway.”].)

2. The Project would include road improvements (grading, graveling, etc.) on a “portion of a deeded access road (1,057 linear feet) that connects Highland Springs Rd. to the Property entrance (located across [County-owned] APNs 007-043-04 and 007-043-01)” (PC Staff Report, p. 6; MND, p. 3.)

3. These County-owned parcels (007-043-04 and 007-043-01) are a part of the Project site, specifically the portions containing the access road where road improvements would be made as part of the Project. (See MND, pp. 5 [listing “roadway improvements” as part the Project’s “Stage 2”], 6 [fig. 3, Stage 2 Site Plan, showing affected roadways including access road]; PC Staff Report, p. 6-7 [“A portion of the deeded access road (1,057 linear feet) that connects Highland Springs Rd. to the Property entrance (located across APNs 007-043-04 and 007-043-01) would be graded and improved”; “The Proposed Project also includes the improvement of the existing gravel access road.”].)

4. Within and around a portion of this access road and its right-of-way, where roadway use and construction would occur, serpentine formations and soils exist. The 2020 Biological Resources Assessment (BRA) prepared for the Project by Pinecrest Environmental Consulting (PEC) (see, e.g., MND, p. 28) states that “there is a small amount of serpentine mapped onsite in the far southeast corner near Highland Springs Road, and offsite to the northwest (Appendix F).” (BRA, pp. 9, 12, 13 [PDF file,¹ pp. 11,13, 14].) Appendix F of the

¹ Several biological assessments and studies were prepared for the Project and MND, which were combined by the County into one PDF file, apparently referred to in the collective in the MND and PC Staff Report as the Biological Assessment. These attachments provide citations to the page numbers for individual reports along with the corresponding PDF page number from that combined file.

BRA (p. 55 [PDF file, p. 56]) contains a Serpentine Soil Map showing serpentine formations near the entrance of Highland Springs Road within the two County parcels where road improvements for site access would occur.

5. Lake County's Parcel Viewer shows a large swath of serpentine soils across parcels 007-043-04 and 007-043-01, specifically overlapping the proposed location of access road construction and use included as part of the Project. See **Figure A1** below for a screenshot of the Viewer—the green areas represent the serpentine soils data layer.²

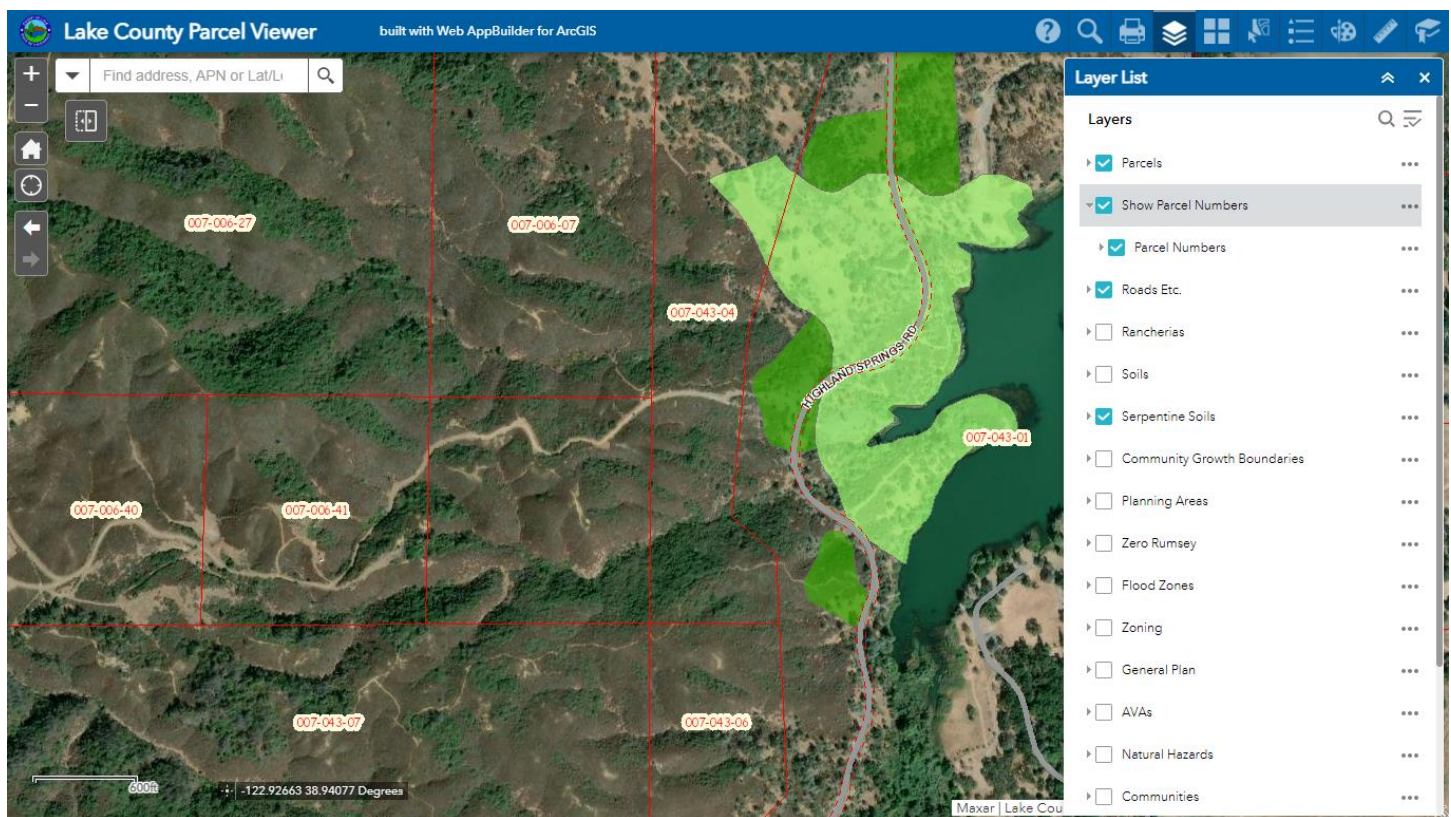


Figure A1: Lake County Parcel Viewer: Highland Springs Recreation Area map with serpentine soils overlay

6. Additional evidence exists of serpentine soils at this location. The 2022 Biological Memorandum (BM) prepared by AES-Montrose (AES) for the Project identifies that “[l]eather oak-chamise-Yerba Santa chaparral occurs within the Project Site where road improvements are proposed.” (BM, p. 8, fig. 3 [PDF file, p. 88].) Leather oak is one of the strongest indicator species for serpentine—indeed it primarily grows in the wild in only serpentine soils. (See, e.g., California Native Plant Society [CNPS] (2024), *Leather Oak*, *Quercus durata*, available online at [https://calscape.org/Quercus-durata-\(Leather-Oak\)](https://calscape.org/Quercus-durata-(Leather-Oak)),³ EXH-003 et seq.; *id.*, Marin Chapter (2024), December Plant of the Month, *Quercus durata*, *Leather*

² The Lake County Parcel Viewer is based on data from SSURGO (Soil Survey Geographic Database) from the U.S Department of Agriculture (USDA), Natural Resources Conservation Service.

³ Electronic copies of all online resources cited in appeal attachments are included as exhibits to the attachments, and exhibit page numbers are included herein with each citation (e.g., “EXH-###, et seq.”).

Oak, available online at <https://cnpsmarin.org/december-2012-plant-of-the-month/>, EXH-005 et seq.)

7. Furthermore, whiteleaf manzanita indicates the presence of serpentine soils and it also was identified on the privately owned parcels where road improvements are planned. (BM, p. 8 [PDF file, p. 88].)

8. More than half of the 1,057 linear feet of roadway located on County land to be improved and used by the Project crosses serpentine formations and soils. Appellants measured the distance of the access road on County property containing serpentine formations and soils using a measuring wheel and found that approximately 606 feet of the road crosses serpentine soils (see **Figure A2**).

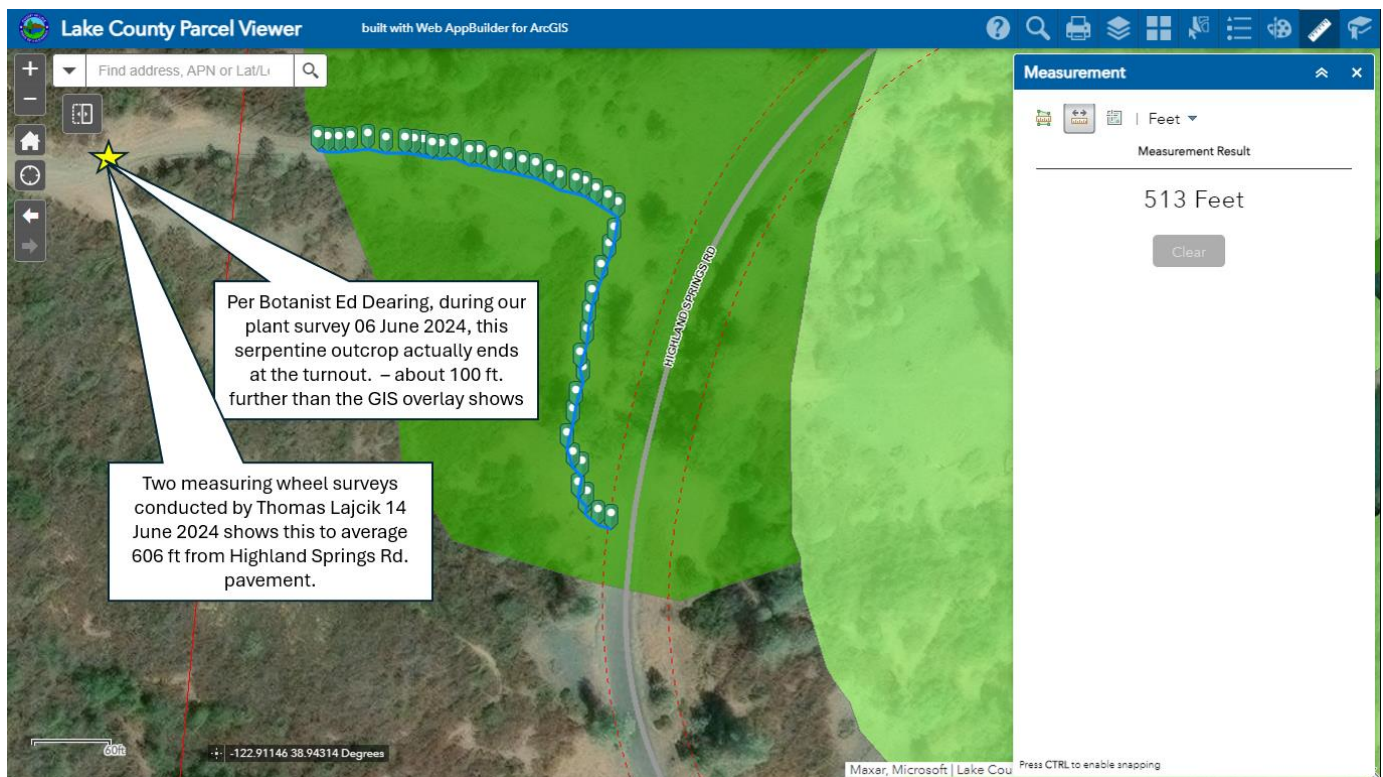


Figure A2: Access Roadway Measurements

9. This portion of the Project site also contains special-status species found in serpentine formations and soils that would be disturbed by the project, discussed in Attachment B.

10. Moreover, additional areas on the Project site likely contain serpentine soils. The biological reports prepared for the site improperly interpreted the USDA Soil Survey Maps. Soil survey maps referenced by PEC are generalizations of the major soil types in each area but do not include every type of soil within a particular sector. (See **Figure A3**, USDA Warning Message Describing Limitations of the Survey Maps.) USDA's warning states:

Warning: Soil Map may not be valid at this scale ... Mapping of soils is done at a particular scale. The soil surveys that comprise your AOI were mapped at 1:24,000. The design of map units and the level of detail shown in the resulting soil map are dependent on that map scale. Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale

Therefore, the absence of a soil type in a USDA soil map section does not mean that soil type will not be found in that section. PEC's misinterpretation of the information contributed to the erroneous conclusion that serpentine soils do not exist in the Project area. (See BRA, p. 9 [“There are no special soil types such as serpentine or hardpan in the vicinity of the proposed cultivation areas, although there is a small amount of serpentine mapped onsite in the far southeast corner near Highland Springs Road, and offsite to the northwest.”] [PDF file, p. 10].) Given that 108,000 cubic yards of material are planned to be disturbed in other areas that likely include serpentine soils, additional investigation is required. (PC Staff Report, p. 8.)

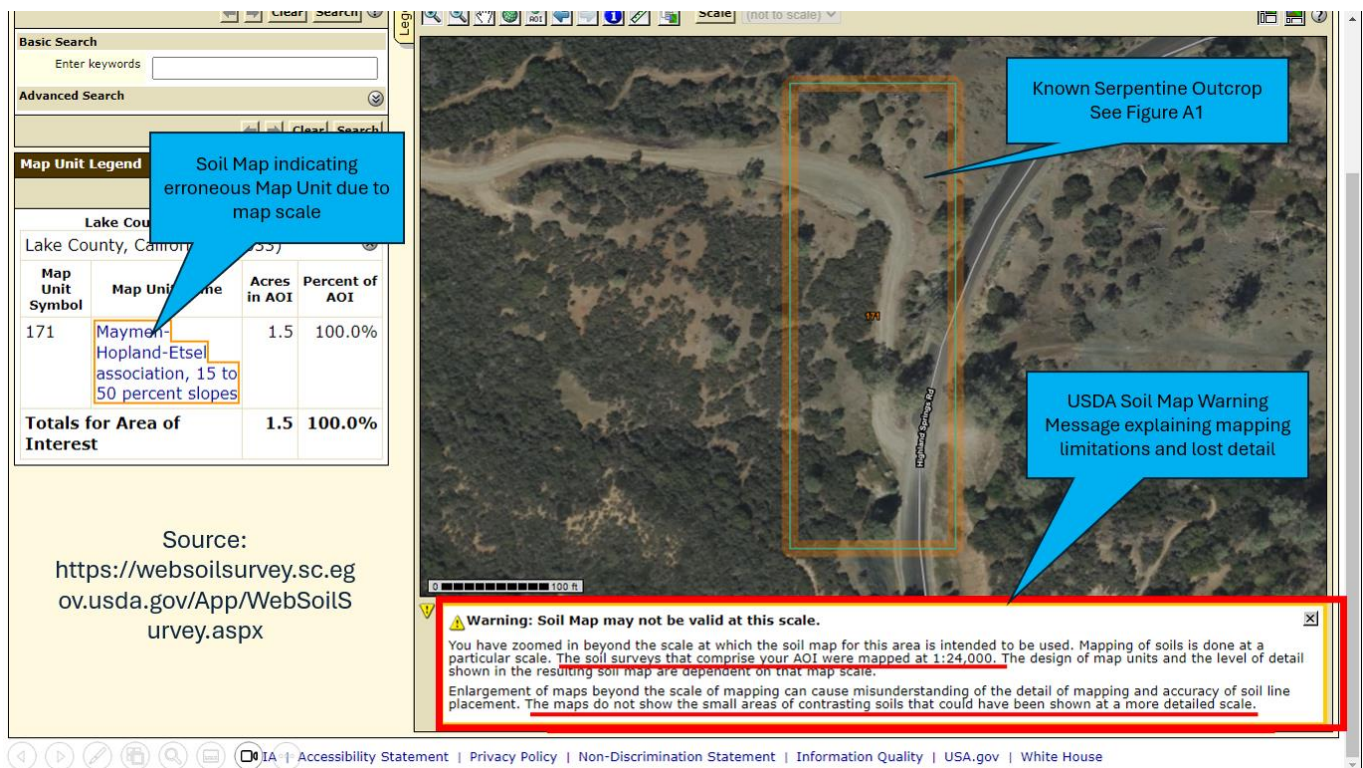


Figure A3: USDA Warning Message Describing Limitations of the Survey Maps

11. Despite the many discussions of serpentine soils throughout the MND and its biological studies (the word “serpentine” is included at least 76 times in the Project’s biological studies), not once was the existence of serpentine soils onsite identified and analyzed. At the Planning Commission hearing on the Project, the applicant’s consultant was adamant that there are no serpentine soils onsite and that the issue was extensively studied. Yet, overwhelming substantial evidence shows serpentine formations and soils indeed exist onsite. This is a major

oversight that calls into question the accuracy of the entirety of the biological resources analysis. It is a fatal flaw in the environmental review.

C. Project Construction and Operation Will Disturb Serpentine Formations and Soils

1. The Project would require extensive construction of the portion of the access roadway containing documented serpentine formations and soils.

a. “[G]rading would likely need to take place to upgrade a segment of the access road connecting Highland Springs Rd. to the property entrance, which is expected to have a cut volume of 6,167 cubic yards and a fill of 372 cubic yards.” (MND, p. 8.)

b. The access roadway would be graded, “with an approximate slope of 0% to a maximum of 15% ... [to be] 20 feet wide with unobstructed vertical clearance and 14 feet of unobstructed horizontal clearance at the gate.” (PC Staff Report, p. 7.) Further, “[a] 6-inch gravel layer would be added to the entire length for erosion and dust control.” (*Ibid.*)

2. Prior to completion of this work, which would occur during Stage 2 of the Project, planned for approximately two to three years after the onset of Project Stage 1 (MND, p. 4), the Project would result in up to 52 vehicle trips per day (MND, p. 24) across the unimproved, existing access road through County-owned property.

3. After completion of the Stage 2 access road improvements, those 52 daily vehicle trips would occur along the improved roadway.

D. Construction Impacts: Airborne Asbestos and Health Effects

1. The expansive improvements of the access roadway would result in disturbance of the serpentine formations and soils and associated special-status species, with significant adverse impacts.

2. Serpentine and ultramafic rock, when in dust form, contain significant quantities of naturally occurring asbestos. (See California Air Resources Board [CARB], *Naturally-Occurring Asbestos General Information*, available online at <https://ww2.arb.ca.gov/sites/default/files/classic/toxics/asbestos/general.pdf>, EXH-009 et seq.) The principal impact of disturbing serpentine rocks and soils is releasing toxic asbestos into the air. (*Ibid.*; MND, p. 23.) Asbestos is a known human carcinogen and cause of mesothelioma (membrane cancer) amongst other ailments such as asbestosis and lung cancer. (CARB, *Fact Sheet #1, Health Information on Asbestos*, available online at <https://ww2.arb.ca.gov/sites/default/files/classic/toxics/asbestos/1health.pdf>, EXH-011 et seq.; see also, Lake County Air Quality Management District [LCAQMD], et al., *Naturally Occurring Asbestos in Serpentine Soils Education Program*, available online at <https://ucanr.edu/sites/ucakecounty/files/64827.pdf>, EXH-013 et seq. [“20-plus years may pass before [asbestos-related] disease appears”].) Per the U.S. Environmental Protection Agency (EPA) and the State of California, there is no safe level of asbestos. (See Cal. Office of Environmental Health Hazard Assessment [OEHHA] (2000), *Asbestos Fact Sheet – Information on Health Risks from Exposures to Asbestos*, available online at <https://oehha.ca.gov/air/asbestos->

[fact-sheet-information-health-risks-exposures-asbestos](#), EXH-039 et seq.; see also, ABC News (2024), *EPA Bans Remaining Uses of Cancer-Causing Asbestos in the US*, available online at <https://abcnews.go.com/Politics/epa-bans-remaining-cancer-causing-asbestos-us/story?id=108248383>, EXH-041 et seq. [quoting EPA Administrator Michael Regan, “ ‘But the science is clear and settled,’ Regan added. ‘There is simply no safe level of exposure to asbestos.’ ”]; Occupational Safety and Health Administration [OSHA], *Asbestos*, available online at <https://www.osha.gov/asbestos>, EXH-045 et seq. [“There is no ‘safe’ level of asbestos fiber. Asbestos exposures as short in duration as a few days have caused mesothelioma in humans.”].)

Construction workers would be exposed to significant amounts of airborne asbestos during the “six to nine months” of roadway construction. (MND, p. 8.) Because there is no safe exposure to asbestos and exposure regularly results in significant health problems, including cancer, EPA and CARB suggest several measures to mitigate the dangerous inhalation of naturally occurring asbestos during construction. (See EPA (Mar. 2008), *Naturally Occurring Asbestos: Approaches for Reducing Exposure*, available online at https://archive.epa.gov/region9/toxic/web/pdf/noa_factsheet.pdf, EXH-049 et seq.; CARB, *Fact Sheet #3, Ways to Control Naturally-Occurring Asbestos Dust*, available online at <https://ww2.arb.ca.gov/sites/default/files/classic/toxics/asbestos/3control.pdf>, EXH-057 et seq.)

3. In response to the County’s Review for Sufficiency, LCAQMD, in an email from the County’s Air Quality Engineer to County Assistant Planner Mary Claybon dated September 7, 2023, stated: “The LCAQMD and the State of California Air Resources regulate surfacing and construction activities involving serpentine ... If serpentine is discovered or is present during the course of grading or construction, all work shall stop until an approved serpentine dust control plan is in place”

4. The public, especially recreationists in the adjacent Highland Springs Recreation Area (hikers, horseback riders, bicyclists, dog walkers, boaters, etc.) would be exposed to airborne asbestos during roadway construction (drivers on Highland Springs Road may also be exposed). Several hiking trails used by the public, including children, exist in the immediate vicinity of roadway construction. The Lone Pine Loop Trail in the Highland Springs Recreation Area is less than 100 feet from the access road as is the Lake Loop Trail. Other trails on or near the access road include the Loco Trail, which crosses the access road, and the Pine Loop Trail, which parallels the access road for approximately 800 feet. Parking turnouts for recreationists to access the western shore of Highland Springs Reservoir are directly across from the access road entrance (approx. 25 feet away) and the reservoir itself where recreationists boat and swim is just 500 feet away. (See Lake County Parcel Viewer; see also **Figure A4**, from the Highland Springs Trails GPS Mapping Project, June 2018.)

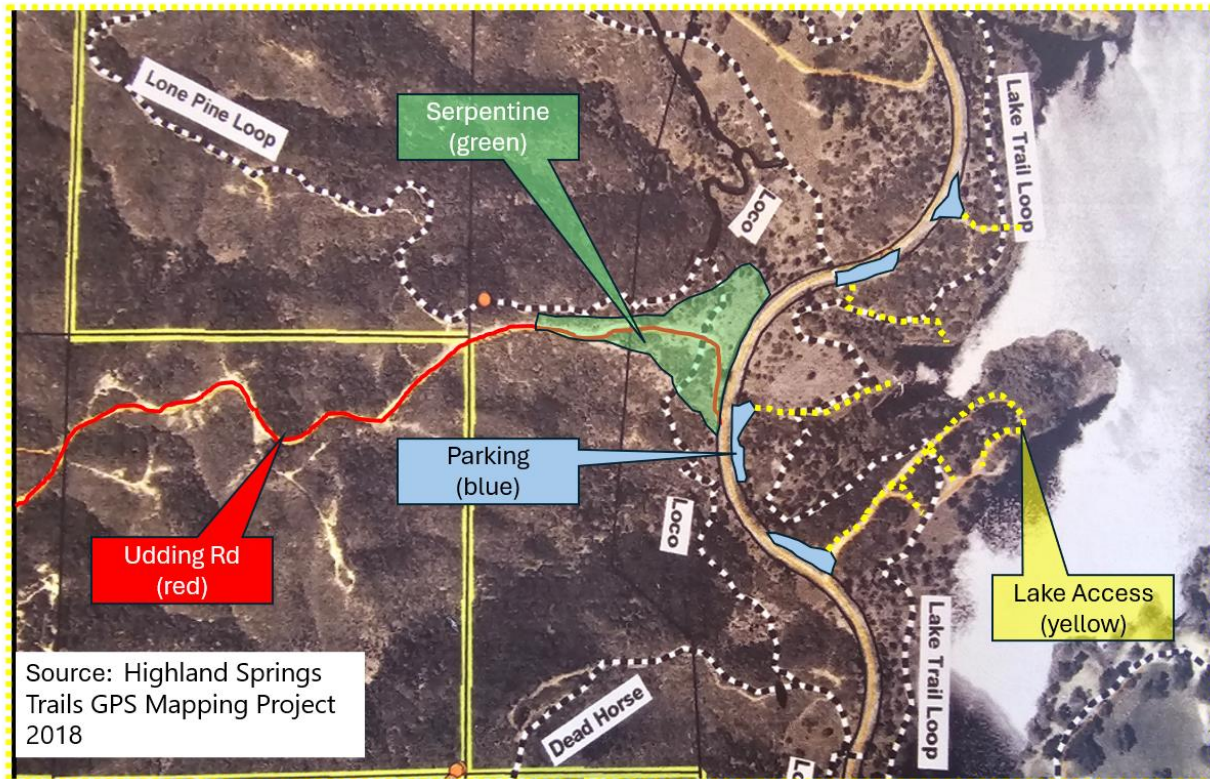


Figure A4: Trails and Parking near Serpentine Outcrop at Entrance to Project Site

5. This exposure could result in significant health problems for the public, including cancer, particularly in children who are more susceptible to the effects of asbestos exposure. (Lake County AQMD, *supra* ["Children Need Extra Protection [from naturally occurring asbestos]"]; University of California, Division of Agriculture and Natural Resources (Aug. 2009), *Facts about Serpentine Rock and Soil Containing Asbestos in California*, available at <https://anrcatalog.ucanr.edu/pdf/8399.pdf>, p. 3, EXH-059 et seq.)

6. Construction of access road improvements also would destroy or damage special-status plant species that are known to occur onsite and others that are commonly found in serpentine soils (discussed below).

E. Pre-Construction Impacts: Airborne Asbestos and Health Effects

1. The use of the unimproved, uncovered access road on County property for up to three years prior to roadway improvements would result in significant impacts and is prohibited without mitigation.

2. Use of the existing road would expose Project workers and the public (explained above) to daily excessive asbestos dust released by the 52 daily vehicle trips driving over serpentine formations and soils, in addition to the many large vehicles that will cross the roadway during construction of Stage 1 of the Project.

3. CARB prohibits the use of serpentine or ultramafic rock for unpaved surfacing in areas where public exposure may occur. (Cal. Code Regs., tit. 17, § 93106.) CARB also restricts

the percentage of serpentine allowed in surfacing material to 0.25 percent and requires dust control mitigation measures for roadways producing airborne asbestos. (*Id.*, §§ 93105, 93106.) Use of a public roadway, as would occur here, presumes public exposure. Recreationists at the adjacent Highland Springs Recreation Area and on other nearby trails (and to some extent passersby on Highland Springs Road) would be exposed to airborne asbestos from the serpentine laden roadway.

4. As well, the increased use of this access road would destroy or damage special-status plant species that are known to occur onsite and others that are commonly found in serpentine soils and may be present onsite (discussed above).

F. Operational Impacts: Airborne Asbestos and Health Effects

1. Mitigation Measure AQ-5 requiring some kind of sealed surface for the access roadway is inadequate. (MND, p. 24.) It does not account for the serpentine soils on the access road and the specialty requirements for properly sealing serpentine soils. Likewise for AQ-6, which allows graveling of some driveway and parking surfaces. Both measures must be reassessed in light of the serpentine formations and soils that are known to exist on the Project site.

2. CARB requires paving serpentine roadway surfaces located near paved public roadways (like Highland Springs Road) (see Cal. Code Regs., tit. 17, §§ 93105, 93106) and provides specific paving and sealing measures for maximum effectiveness (CARB, *Fact Sheet #3, supra*, EXH-057 et seq.). The MND does not demonstrate that the access road will be sealed to CARB standards for naturally occurring asbestos. There is no mitigation for this imminent significant impact.

3. Furthermore, regardless of roadway sealing, Project traffic likely would disturb serpentine rocks and soils still present in the roadway shoulder.

G. The Project Would Violate County General Plan Policies Related to Serpentine Dust

1. County General Plan Chapter 7, Health and Safety, includes three mandatory policies requiring dust control and inspection measures for construction and development in areas with naturally occurring asbestos: Policies HS-1.6 (Serpentine Dust Mitigation), HS-3.10 (Dust Suppression During Construction), and HS-3.11 (Asbestos Inspection During Construction).

2. The MND does not discuss these policies nor do mitigation or conditions of approval require that the applicant adhere to these policies. In fact, nothing in the record, from what Appellants have seen, even acknowledges the presence of serpentine soils onsite (see ¶ B.11 above). The County must ensure that the Project complies with these policies.

H. Additional Environmental Review Must Be Performed and Mitigation Provided to Lessen Significant Impacts

1. The County must perform additional environmental review that includes an accurate and robust discussion of the serpentine soils on the Project site that will be disturbed by the Project.

2. Another ground survey must be conducted on all affected parcels (County and privately owned) to investigate the presence of serpentine formations and soils and associated special-status species plants (see Attach. B).

a. The biological reports concluded that the parcels where these formations exist are outside of the scope of the assessment, but this is incorrect. (See, e.g., BRA, pp. 4 [PDF file, p. 5] [Table 1 listing only the privately owned parcels], 70 [Mar. 31, 2021 memorandum regarding early season plant survey for only two privately owned parcels]; BM, pp. 1 [PDF file, p. 81] [“Project Site refers only to those areas within the Subject Property with the potential to be impacted by the Proposed Project (i.e., Cultivation Areas, buildings, roadways improvement, graded areas, etc.) that total 27.7 acres”].) The record clearly demonstrates that the portions of the access road traversing County-owned parcels where serpentine formation and soils exist are a part of the Project site (PC Staff Report, p. 6 [“A portion of the access road (1,057 linear feet) that connects Highland Springs Rd. to the Property entrance (located across APNs 007-043-04 and 007-043-01) would be graded and improved in accordance with Public Resource [sic] Code (PRC) 4290 to provide adequate site access.”]).

3. Mitigation must be included to avoid the damaging impacts associated with disturbance of serpentine soils (discussed above) and to ensure that the access road is properly surfaced. The Project also must comply with all rules and regulations specific to asbestos, including County policies. (See, e.g., Cal. Code Regs., tit. 17, § 93105 [Asbestos Airborne Toxic Control Measure for Construction, Grading, Quarrying, and Surface Mining Operations]; *id.*, tit. 8, § 1529 [Asbestos].) These rules and regulations must be disclosed and discussed in the Project’s CEQA document.

4. Mitigation is also required to avoid or minimize impacts to special-status plant species that occur or could occur in these same areas. (See Attach. B.)

ATTACHMENT B

INACCURATE, INADEQUATE, AND INCOMPLETE BIOLOGY AND HYDROLOGY/WATER REPORTS RESULT IN FLAWED MND

The 2020 BRA and 2022 BM (see Attach. A) were prepared for the Project, as was a 2022 Technical Memorandum re. Bloom Survey Results (Bloom TM). The MND relies on these reports for its analysis of impacts to biological resources; however, as explained below, these reports and the MND are sometimes inaccurate and inadequate. Also, the MND fails to correctly report all of their meaningful findings.

A. The Biology Reports/MND Failed to Assess the Entirety of the Project Site

1. These biological studies performed for the Project included up to five field surveys, none of which appear to cover the County-owned parcels where the access road will be used and eventually improved (see Attach. A)⁴ and none of which included protocol-level species surveys. (See, e.g., MND, p. 3; BRA, p. 4 [PDF file, p. 5], BM, fig. 3 [PDF file, p. 84].) The varying studies, not all of which are correctly reflected in the MND, make it a challenge to easily determine what surveys were conducted and when/where they occurred. Accordingly, Appellants prepared the following chart to provide a summary of surveys allegedly performed on specific parcels with sensitive habitat and special—status species (Y = Yes, survey done; N = No, survey not done).

APN	007-043-04	007-043-01	007-006-27	007-006-41	007-006-40	007-006-34	007-006-35	007-057-02	007-057-01
Habitat	Serpentine	Serpentine	Chaparral	Chaparral	Chaparral Grassland Wetland	Wetland/ Grassland	Wetland/ Grassland	Wetland/ Grassland	Chaparral
Planned Activity	Access Road.	Access Road	Access Road	Access Road	Access Rd Operations	Operations	Operations	Operations	Electrical Easement
Reconnaissance Survey PEC	N	N	Y	Y	Y	Y	Y	Y	Y
Reconnaissance Survey AES	N	N	Y	Y	Y	Y	Y	Y	Y
Protocol Level Plant Survey 1	N	N	N	N	N	PEC	PEC	N	N/A
Protocol Level Plant Survey 2	N	N	N	N	N	PEC	PEC	N	N/A
Protocol Level Plant Survey 3	N	N	N	N	AES	AES	AES	N	N/A
Protocol Level FYTL Survey 1	N/A	N/A	N/A	N/A	N	N	N	N	N/A
Protocol Level FYTL Survey 2	N/A	N/A	N/A	N/A	N	N	N	N	N/A
Protocol Level FYTL Survey 2	N/A	N/A	N/A	N/A	N	N	N	N	N/A

⁴ County Planner Mary Claybon stated, in a May 22, 2024 email to Appellants, that the “Biological Assessments occurred on parcels where cultivation areas are proposed.”

B. The Biology Reports/MND Failed to Assess Impacts to Special-Status Species Within Serpentine Habitat

1. As explained in Attachment A and just above, the MND and its biological reports did not assess the area of the Project site with serpentine formations and soils.

2. However, “many of these [serpentine] formations contain special-status plant species (Appendix C).” (BRA, p. 13 [PDF file, p. 14].) The BRA lists more than 28 special-status species that are found in serpentine habitats, including Lake County stonecrop (*Sedella leiocarpa*) and Lake County western flax (*Hesperolinon didymocarpum*) (BRA, appen. A, p. 36 [PDF file, p. 37]), both of which are considered federally and state designated endangered species.

3. “California’s [serpentine] soils support a very high proportion of the State’s rare plants.” (USDA (2005), *Serpentine Endemism In The California Flora: A Database Of Serpentine Affinity*, Madrono (vol. 52, No. 4, pp. 222–257), available online at https://www.fs.usda.gov/wildflowers/beauty/serpentes/center/documents/Safford_et_al_2005_Serpentine_Endemism.pdf, EXH-065 et seq.)

4. An out-of-season botanical survey performed by a local botanist and native plant expert identified several special-status species within these serpentine formations at the entrance to the Project site. (See map and photographs below, **Figures B1 to B6**.) These species were geo-tagged within the Project site, near or on the access road going through County property. Additionally, several other potential special status species have been identified that will require a flowering season study to confirm their rare plant status. Other special status species are known to exist on this formation and require a flowering season study for proper identification.

a. Ed Dearing is a local botanist and naturalist and member of CNPS (California Native Plant Society). He is an expert on native plants in California and, in particular, Lake County. For more than 50 years, Mr. Dearing has performed botanical surveys across the state. Upon County request, he conducted several botanical surveys, including surveys for Highland Springs Regional Park and Konocti Regional Park. He has led several botanical tours and hikes throughout Lake County for government agencies, botanical researchers, CNPS members, the Sierra Club, as well as plant and nature enthusiasts. Mr. Dearing has published several articles for CNPS showcasing flora in Lake County.

b. Karen Sullivan is a native plant specialist in Lake County and member of CNPS. She has collaborated with Ed Dearing for more than 30 years, collecting data on Lake County native plants, and working with Mr. Dearing on the Konocti Regional Park botanical survey and the Highland Springs botanical surveys. She also collaborated with Mr. Dearing on the botanical hikes and tours for the Sierra Club and Highland Springs Trail Volunteers. Ms. Sullivan and her colleague Kim Riley provided plant photos and their descriptions displayed at park visitor information kiosks in Highland Springs Recreation Area (aka Highland Springs Regional Park). She currently operates a native plant nursery, consults, and grows native plants in cooperation with the Lake County Resource Conservation District. Her experience as a state licensed nursery owner required her to accurately identify and label native plants. She is involved with the Tribal

Eco-restoration Alliance (TERA) and works with TERA to identify plants in Highland Springs Regional Park that are culturally important to tribal communities in the area.

In addition to extensive knowledge of native plants, Ms. Sullivan is a founding member of Highland Springs Trails Volunteers. Founded in the early 2000's, the group formed to recover trails and perform the GPS mapping of more than 30 miles of trails in Highland Springs Regional Park. Ms. Sullivan is also a founding member of Lake County Horse Council and at the request of Lake County Public Works Director Scott DeLeon, she and her colleague Kim Riley authored the 2010 Highland Springs Resource Management Plan for the County.

c. Ed Dearing and Karen Sullivan are very familiar with the serpentine outcrop at the entrance to the Project site (aka Udding Road). As early as 2009, Mr. Dearing identified several endangered species on the serpentine outcrop on Udding Road. Highland Springs Trail Volunteers re-routed the trail to protect the habitat.

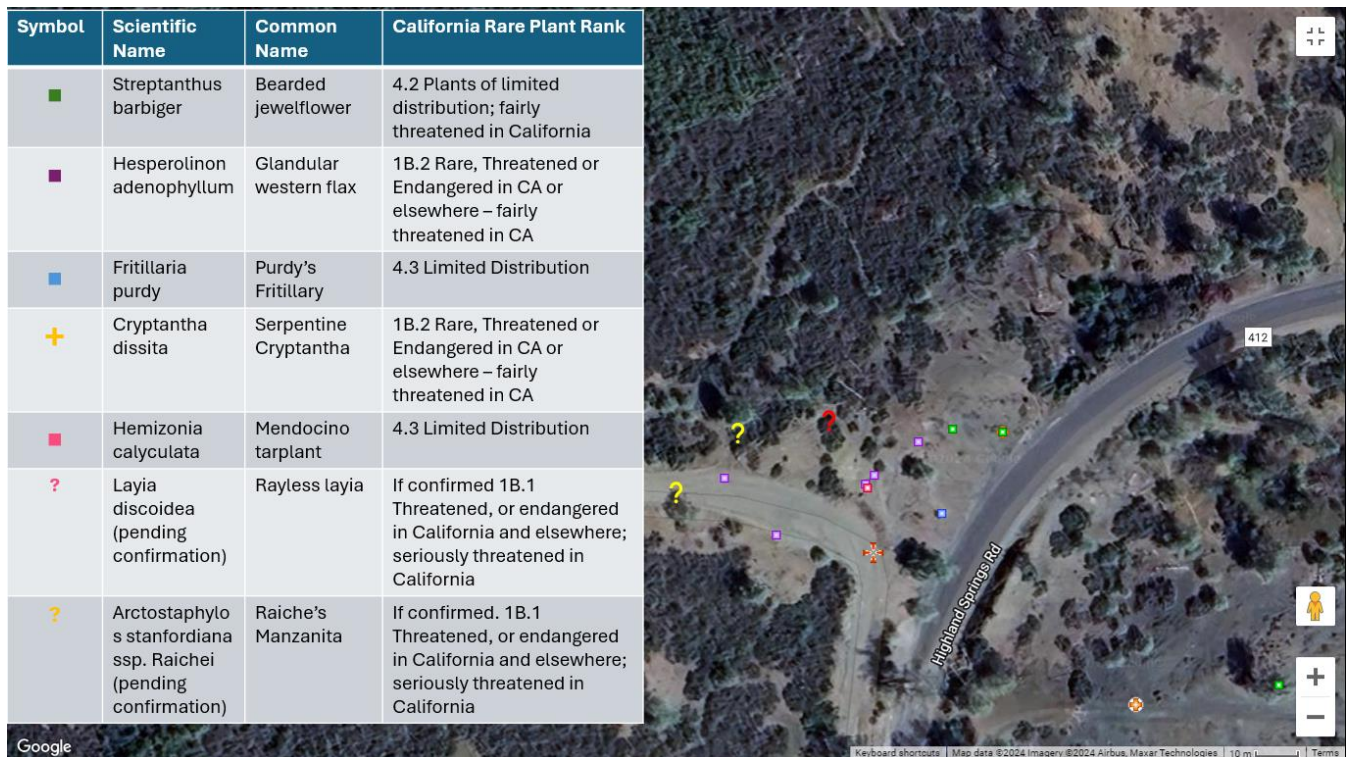


Figure B1: Map of geotagged special-status plant species on Project site



Streptanthus Barbiger (bearded jewelflower)
 Photo courtesy of Karen Sullivan.
 Found on Udding Rd. Serpentine Outcrop/Bluff.
 Number of occurrences: 51 -100

Figure B2: Streptanthus barbiger/bearded jewelflower on Project site

Calflora Observation Detail

[COMMENTS and CORRECTIONS: 0](#)

Plant Name [Cryptantha dissita](#)
Serpentine cryptantha

Observer Terrence Gosliner [PROFILE](#)

Date 2020-05-16

County Lake

Number of Plants 101 - 1000

[LOCATION CLOSEUP](#)

Elevation 465 meters

Location Description Highland Spring Reservoir

Calflora ID po157736

Added 2020-05-20 [Plant Observation Entry](#)

Updated 2020-05-21

Coordinates 38.943263, -122.910317

Location Quality HIGH (2)

Context [Other Plant Observations near this location](#)
[What Grows Here? near this location](#)

Like

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✓ Reference photo

Figure B3: Cryptantha dissita/serpentine cryptantha on Project site

CalfIora

Observation Detail

> COMMENTS and CORRECTIONS: 0

Plant Name

Hesperolinon adenophyllum
Glandular western flax

Observer

Thomas Lajcik [PROFILE](#)

Date

2024-06-10

County

Lake

Number of Plants

51 - 100

[LOCATION CLOSEUP](#)

Notes

In Udding rd. Identified by botanist Ed Dearing and native plant specialist Karen Sullivan

CalfIora ID

mg247158

Added

2024-06-10 [Plant Observation Entry](#)

Updated

2024-06-20

Coordinates

38.943195, -122.911359

Location Quality

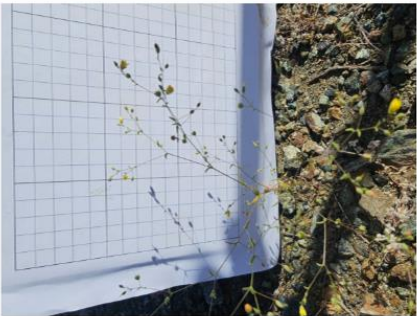
HIGH (1)

Error Radius

4.0 meters

Context

[Other Plant Observations](#) near this location
[What Grows Here?](#) near this location



Like

© 2024 Thomas Lajcik CC-BY-NC 4.0

California Observation Detail

> COMMENTS and CORRECTIONS: 0

Plant Name

[Fritillaria purdyi](#)
Purdy's fritillary

Observer

Karen Sullivan
[PROFILE](#)

Date

2024-03-20

County

Lake

Number of Plants

30

[LOCATION CLOSEUP](#)

Notes

Many on bluff bisected by Udding road off Highland Springs Road

Calflora ID

po266323

Added

2024-06-13
[Plant Observation Entry](#)

Coordinates

38.943090, -122.910482

Location Quality

HIGH (2)

Context

[Other Plant Observations near this location](#)
[What Grows Here? near this location](#)



Like

© 2024 Karen Sullivan CC-BY-NC 4.0
Fritillaria purdyi



Plant Name

[Hemizonia congesta ssp. calyculata](#)

Mendocino tarplant

Observer

Thomas Lajcik

[PROFILE](#)

Date

2024-06-10

County

Lake

Number of Plants

2 - 10

LOCATION CLOSEUP

Notes

Identified by botanist Ed Dearing and Native Plant specialist Karen Sullivan

Calflora ID

mg247154

Added

2024-06-10

[Plant Observation Entry](#)

Updated

2024-06-23

Coordinates

38.943145, -122.910685

Location Quality

HIGH (1)

Error Radius

3.7 meters

Context

[Other Plant Observations near this location](#)
[What Grows Here? near this location](#)



Like

© 2024 Thomas Lajcik CC-BY-NC 4.0

COMMENTS and CORRECTIONS: 0

Figure B6: *Hemizonia congesta* ssp. *calyculata*/mendocino tarplant on Project site

5. Mitigation is required to avoid or minimize disturbance to these special-status species that are protected by federal and state law. Measures should include protocol-level, pre-construction surveys to identify all species, buffers to avoid disturbance, relocation if avoidance is not feasible, or compensation for any species destroyed by Project construction or operation if relocation is not feasible. These are standard CEQA mitigation measures for special-status plant species.

C. The Biology Reports/MND Failed to Identify Potential Impacts to Other Special-Status Species

1. The AES BM failed to identify Konocti manzanita (*Arctostaphylos manzanita* ssp. *elegans*) on the site, despite its prevalence in the region and despite the parcels containing chaparral that hosts the species. (BM, p. 10 [PDF file, p. 90].) A protocol-level survey is required to determine if Konocti manzanita occurs onsite.

2. During the County's Review for Sufficiency, in an email from Lake County Community Development Resource Planning to Mary Claybon, dated August 29, 2023, Resource Planner Katherine Schaefer made the following recommendation as it pertains to the identification of special plant species Konocti Manzanita and *Quercus Dumosa* and the disturbance of chaparral: "The FMP indicates (pg. 17, 20) low brush/shrub removal will occur when necessary. The location should be identified so it is shown not to conflict with this finding" To date, the locations of the special-status species and the areas of disturbance have not been correlated.

ATTACH. B, p. 6

3. The BRA and MND failed to assess potential impacts to the Foothill yellow-legged frog, despite its native habitat type being present onsite (watercourses, wetlands). A protocol-level survey is required to determine if the Foothill yellow-legged frog or its habitat occurs onsite.

4. The MND states: “There are no observations of golden eagle within 10 miles of the Project Site.” (MND, p. 29.) However, in 2023 and 2024, golden eagles were observed directly north of the Project site and at the entrance to Highland Springs Road, as stated by members of the public at the Planning Commission hearing on the Project. An additional survey is required to assess potential for onsite occurrences of, or habitat for, this special-status species.

5. Mitigation is required to avoid or minimize disturbance to these special-status species that are protected by federal and state law. (See ¶ B.4 above.)

D. The Biology Reports/MND Fail to Protect Wetlands Because They Do Not Require a Wetland Delineation and Ignore Project Biologist Recommendations

1. Wetlands exist onsite. (BRA, pp. 9, 11, 13 [PDF file, pp. 5,12,14].) To comply with the Federal Clean Water Act (CWA), a “protocol-level wetland delineation must be performed to verify the precise extent of wetlands onsite.” (Comment letter from Redbud Audubon Society [Audubon Letter], p. 1.) A wetland delineation using U.S. Army Corps of Engineers (USACE) protocol is required to determine both the extent of the wetland and whether Project activities may impact wetlands subject to USACE and CWA jurisdiction. (Mar. 31, 2021, Memo. from PEC re. “Results of early-season special-status plant survey at Lake County APN 007-006-35 & 007-006-34,” p. 2 [PDF file, p. 71].)

2. Instead of a wetland delineation performed by and USACE-certified wetland delineation expert, a substandard survey was conducted for the Project site during extreme drought years—May 2021 and June 2022. (National Integrated Drought Information System [NIDIS] (2021), *Drought Status Update and 2020 Recap for California-Nevada*, available online at <https://www.drought.gov/drought-status-updates/drought-status-update-and-2020-recap-california-nevada>, EXH-101 et seq.; see also, California Department of Water Resources [DWR] (2022), *New Water Year Begins Amid Preparations for Continued Drought*, available online at <https://water.ca.gov/News/News-Releases/2022/Oct-22/New-Water-Year-Begins-Amid-Preparations-for-Continued-Drought>, EXH-105 et seq.) Conducting a survey during extreme drought years where seasonal wetlands would have shrunk considerably and where wetland and wetland boundary indicators are difficult to determine, and without the expertise of a certified wetland delineator, results in critically flawed analysis in the MND. (See, e.g., USACE (Jan. 1987), *Corps of Engineers Wetlands Delineation Manual*, pp. 5, 84–86, available online at <https://www.nae.usace.army.mil/Portals/74/docs/regulatory/JurisdictionalLimits/wlman87.pdf>, EXH-107 et seq. [seasonal wetlands requires specialty assessment during dry times]; State Water Resources Control Board [SWRCB] (Mar. 1, 2011), *Technical Memorandum No. 4: Wetland Identification and Delineation*, pp. 15–19, available online at https://www.waterboards.ca.gov/water_issues/programs/cwa401/docs/wrapp/techmemo4.pdf, EXH-117 et seq. [wetland conditions during dry seasons are difficult to resolve and require specialty assessment].)

3. The MND's wetland mitigation measure does not address this critical flaw. BIO-1 states, "prior to construction activities, a qualified biologist shall survey the potential seasonal wetland and Class II and III watercourses within 200 feet of the Project Site." (MND, p. 30.) This mitigation is inadequate. It does not include a protocol-level wetland delineation performed by a USACE-certified specialist. It does not contain adequate criteria for determining actual wetland boundaries during drought or require wetland assessments be made during the times of year when wetlands will be at their full capacity. Therefore, the mitigation's requirement for "setbacks from wetlands" is ineffective because those setbacks will be based on inaccurate, reduced wetland boundaries.

4. The County, furthermore, ignored the Project biologist's recommendation to not cultivate on the northern parcel, where a large portion of the Project will occur, because the 100-foot setbacks required in the MND would not ensure wetlands would not be impacted. Per the subsequent memorandum prepared by PEC on May 23, 2001 (pp. 1-2 [PDF file, pp. 75-76]), included as part of the BRA:

Due to the configuration of wetlands and watercourses onsite, we do not believe it is feasible to cultivate on the majority of the north parcel. The configuration of potential wetlands, and the existence of three branches of jurisdictional watercourse appear to preclude access to any potential cultivation areas on the north parcel without having to transit through wetlands or watercourses. Potential wetlands and watercourses shown in the original BA that are in the same hydrological drainage can be assumed to be connected even if they are not shown as such in the original BA, making access to any potential cultivation areas in the north parcel problematic ... In addition, State Water Quality Control Board Cannabis General Order requires 100-foot setbacks from wetlands, and it would be difficult to avoid any discharge of sediment into any setback area while grading the top of the two hills on the north parcel due to the small size of these potential cultivation areas. [See *Attachment G for more on this violation.*] In addition, there is a high diversity of native species on the tops of the hills, most of the native species diversity on the parcel is concentrated in these wetlands and hills ... Our recommendation is to limit cultivation to the south parcel and to restore the wetlands in the north parcel.

5. Moreover, the County claims, in response to comments made in the Audubon Letter, that the use of onsite groundwater would not impact onsite wetlands because the depth of the onsite well, in addition to setbacks, would ensure no impacts. The County, however, does not point to any evidence in the record supporting this inference. Wetlands are a "groundwater dependent ecosystem." (California Department of Fish and Wildlife [CDFW] (June 2019), *CDFW Groundwater Program, Fish & Wildlife Groundwater Planning Considerations, Freshwater Wetlands*, p. 3, available online at <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=170170&inline>, EXH-123 et seq.)

E. The Biology Reports Rely on Data for a Different Project Site

1. Despite several assurances by the applicant and the County that the documents were thoroughly reviewed by staff, legal and biological consultants, a simple look at the

documents shows that large portions of resource material relied upon by AES does not apply to the Project site but instead to a site in the mountains above Nice on the other side of Clear Lake. For example:

- AES Appendix A [PDF file, p. 103]: Letter from U.S. Fish and Wildlife Service (USFWS) re. consultation (p. 1) for “Project Name: =Artemis Farmz.” Artemis Farmz is located near Nice and Lucerne.
- AES Appendix A [PDF file, p. 106]: same USFWS consultation, “Approximate location of the project can be viewed in Google Maps: <https://www.google.com/maps/@39.12770485,-122.81968101299238,14z>” whereas this location shows Artemiz Farms near Nice.
- AES Appendix B [PDF file, p. 110]: National Wetlands Inventory Map showing Gilbert Creek, which is located in the mountains behind Nice near Artemis Farmz.
- AES Appendix C [PDF file, p. 112]: USDA National Resources Conservation Service (NRCS) Custom Soil Map showing Gilbert Creek near Artemiz Farms.
- AES Appendix C [PDF file, p. 120]: USDA NRCS Custom Soil Resource Report showing map of Gilbert Creek near Artemiz Farms.

F. The Project Would Conflict with County General Plan Policies Intended to Protect Biological Resources

1. County General Plan Chapter 9, Open Space, Conservation and Recreation, includes several mandatory policies limiting development in environmentally sensitive areas and near or on sensitive habit and sensitive-status species: Policies OSC-1.1 (Protection of Rare and Endangered Species), OSC-1.2 (Development in Environmentally Sensitive Areas), OSC-1.9 (Open Space Buffers), OSC-1.15 (Protect Natural Resources).

2. The Project would conflict with these policies, yet the MND does not discuss these policies or the Project’s inherent conflict with them, despite the initial study question requiring such a discussion. (MND, pp. 28 [“Would the project: ... conflict with any local policies or ordinances protecting biological resources ... ?”], 33 [no discussion].) The MND also does not offer mitigation for remedying these policy conflicts.

G. The Hydrology Study and Water Availability Analysis Are Incomplete

1. A Hydrology Study and Water Availability Analysis (WAA) were prepared for the Project. (See MND, pp. 15, 49.) Neither assessed impacts to the neighboring spring nearest to the Project site. This is a critical omission given that the Project will drawdown the aquifer up to 15 feet (MND, p. 49), and evidence exists that there is connectivity to a neighboring spring, discussed below.

2. At the Planning Commission hearing, the applicant’s civil engineer stated that surface water feeds springs and, because the Project is not diverting surface water, it is not affecting springs. However, this is inaccurate logic. A neighbor submitted a written comment to the County prior to the hearing, and made the same comment at the hearing, that his perennial spring, upon which for decades he relies for his livelihood, went dry during the last months of the last year of the historic drought. His spring is fed by both surface water *and* groundwater.

The WAA relies on the ability of surface water to recharge groundwater through precipitation (primarily rainfall) for enough quantity of groundwater to serve the Project. (WAA, pp. 5–8.) However, during drought years, groundwater recharge is reduced and water table levels become low. (See, e.g., Lake County’s *Drought Management Plan Update* (Apr. 12, 2021), p. 1.) If there is not enough groundwater recharge, and as a result water tables get too low, then there may not be enough water in the aquifer to support the Project and maintain necessary flows in neighboring springs.

3. Indeed, *any* aquifer drawdown may impact the availability of spring water on adjacent properties. This impact must be evaluated. The WAA fails to look at this impact entirely, despite the fact that the neighboring spring at issue is within the Project’s cumulative impact area (see WAA, enc. A) and despite the assumed connectivity between the aquifer and the spring (discussed above).

4. The WAA also does not appear to account for the slope of the terrain and overall basin topography and runoff when calculating groundwater recharge and absorption (see **Figure G1**).

5. The WAA estimates that cannabis cultivation and process will require 22.7 acre-feet per year, to be derived from a groundwater well. (PC Staff Report, p. 12.) Much of this water would be required during summer months and during dry years, when area groundwater-fed spring flows are reduced or stop altogether. This potentially critical issue needs to be investigated and addressed in the MND.

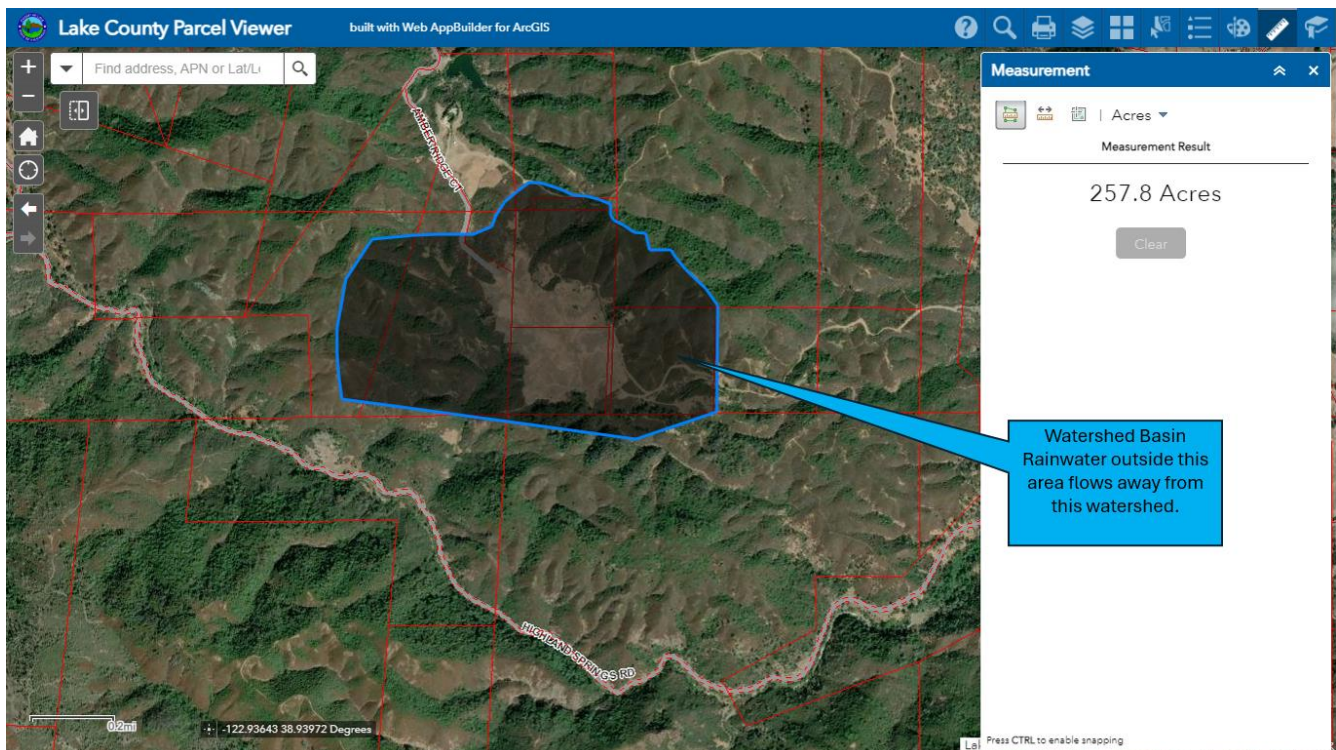


Figure G1: Approximate watershed basin in proximity to the Project wells

ATTACHMENT C

INADEQUATE AND INACCURATE CUMULATIVE IMPACTS ANALYSIS

A. Department of Cannabis Control Requests Cumulative Impacts Analysis

1. In its letter dated May 7, 2024, the Department of Cannabis Control (DCC) comments:

The IS/MND would be improved by acknowledging and analyzing the potential for cumulative impacts resulting from the Project coupled with other commercial cannabis business projects being processed by the County and any other reasonably foreseeable projects in Lake County that could contribute to cumulative impacts similar to those of the Project.

(DCC Letter, p. 3.) The topics that the DCC regards as important to cumulatively consider include, but are not limited to:

- cumulative impacts from groundwater diversion on the health of the underlying aquifer, including impacts on other users and impacts on stream-related resources connected to the aquifer;
- cumulative impacts related to noise;
- cumulative impacts related to transportation; and
- cumulative impacts related to air quality and objectionable odors.”

(*Ibid.*)

2. We agree with DCC that the MND must consider, at least, these impacts in a cumulative setting. Attachment D discusses Project-related noise and odor impacts, and Attachment B discusses Project-related groundwater impacts. Below we discuss cumulative traffic impacts.

B. Cumulative Traffic Impacts

1. Per the MND, page 70, Figures 12 and 13, show five other cannabis operations using Highland Springs Road for access to their sites. The cumulative projects in the area include but are not limited to the following:

Permit Number	Project	Address
MUP 21-13	Delux CA LLC	1209 Vernal Drive
MUP 19-15	Wellness I	6751 Ridge Rd.
MUP 22-11	Wellness Ranch II	6751 Ridge Rd.
MUP 20-57	WFPS	6051 Ridge Rd.
MUP 20-96	Highland Farms	7522 Highland Springs Rd.
MUP 20-82	BG Property Management	9200 Highland Springs Rd.

2. The Project will contribute to significant cumulative traffic impacts that are unacknowledged in the MND, as explained below. Already, there has been a dramatic increase in traffic on Highland Springs Road since cannabis operations started. In addition to increased passenger automotive traffic, there is a large increase in heavy trucks and trucks towing trailers on Highland Springs Road. These trucks are wide and take up more of the road than passenger cars and cannot slow down or turn as quickly.

3. The cumulative effect of this traffic in conjunction with Project traffic will negatively impact access to recreational areas, which contravenes County planning directives and economic goals for tourism, which seek to increase tourism and its associated economy—not decrease it. The Draft Lake County Parks, Recreation, & Trails Master Plan promotes a goal reflecting community vision: “Identify and create parks, ... trails with regional destination allure to attract visitors to Lake County to bolster the local economy.” (Master Plan, pp. iii, 2.7.) Continuing, the Master Plan observes, “Lake County is experiencing increased tourism, which should be considered when imagining the future of parks, recreation, and trails.” (*Id.*, p. 2-3.)

The Master Plan references the economic development potential of County parks, including Highland Springs Recreation Area, which translates to more visitors to County parks:

- “There is significant resident interest in experiencing nature and getting close to the water for nature-focused activities. This is also a key driver for tourism in Lake County.” (Master Plan, pp. 3.18, C-17.)
- “Many communities are seeking to grow their outdoor recreation and tourism economy, invest in their downtowns, and conserve natural lands. Outdoor recreation is a major potential source for growing the local economy. Encouraging activities that foster environmentally friendly community development, includes: Creating or expanding trail networks to attract overnight visitors and new businesses and foster use by local residents.” (Master Plan, p. A-28.)

4. The addition of Highland Farms traffic of 52 trips per day will increase vehicle trips on Highland Springs Road in a manner that will increase the cumulative effect of cannabis operations and create a potentially significant cumulative impact that requires analysis. Below is a table demonstrating the increase.

Permit Number	Project	Address	Trips per day	Peak Hour Trips
MUP 21-13	Delux CA LLC	1209 Vernal Dr.	6	
MUP 19-15	Wellness I	6751 Ridge Rd.	4	
MUP 22-11	Wellness Ranch II	6751 Ridge Rd.	8	
MUP 20-57	WFPS	6051 Ridge Rd.	24	41
MUP 20-96	Highland Farms	7522 Highland Springs Rd.	52	
MUP 20-82	BG Property Management	9200 Highland Springs Rd.	30	40
		Totals	124	152

Moreover, the MND misleadingly compares the Project’s traffic on Highland Springs Road to traffic on State Route 29. (MND, p. 60.) This comparison is inapposite. State Route 29 is more

than 4.25 miles from the Project and, as a major arterial roadway through the County, can handle traffic increases. Highland Springs Road, however, is a much narrower, curvier, rural roadway that cannot safely handle the same traffic increases as State Route 29. Comparing the two roadways presents a false equivalency that hides the actual impact of the Project.

C. Cumulative Roadway Safety Concerns

1. Furthermore, the portion of Highland Springs Road that will be used by Project traffic currently lacks several basic safety features, making the road unsafe for motorists and recreationists trying to enjoy Highland Springs Recreation Area. The cumulative effect of the additional traffic from the cannabis operation increases the risk to an already dangerous situation. These include the following.

a. No speed limit signs on the entire length of Highland Springs Road. Other roads, including those less travelled, branching off State Highway 29 have speed limit signs, yet Highland Springs Road lacks this basic safety feature. (See **Figure C1.**) Signage should be installed.

Roads intersecting CA-29 between Highland Springs Rd. and Kelseyville

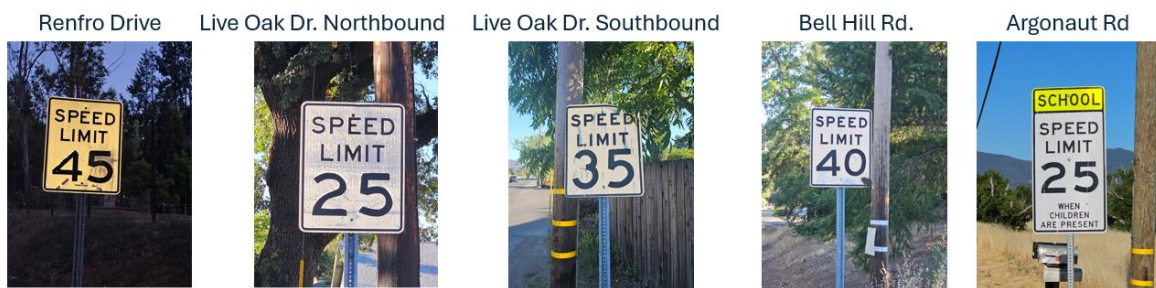


Figure C1: Posted speed limit signs on other nearby roads connected to State Hwy 29

b. Highland Springs Road, as it goes through Highland Springs Recreation Area, has little or no shoulder and no shoulder markings. Recreationists walk, ride bicycles, and horseback ride on the road. While East Highland Springs Road has centerline markings identifying it as a two-lane road and signage advising drivers that pedestrians and equestrians are on the road, Highland Springs Road has no centerline markings or signage. Similarly, while northbound motorists leaving the park see caution signage for tractors on the road, there is no caution signage for southbound motorists entering the park advising motorists that recreationists are on the road. (See **Figure C2.**) Signage should be installed.

East Highland Springs Rd. Signage and Caution Signage Upon Exiting the Park



Caution sign near mile 4.28 Northbound Highland Springs Rd. (exiting the park)



East Highland Springs Rd. advising motorists of Equestrian and Pedestrian traffic



East Highland Springs Rd. asking motorists to drive slow



East Highland Rd. with double-yellow centerline marking

Figure C2: East Highland Springs Road signage

c. The two-mile paved portion of Highland Springs Road within Highland Springs Recreation Area and the approximately four-mile unpaved portion of the road between Highland Springs Recreation Area and the County line has several blind curves. There is no signage cautioning drivers of this hazard. (See **Figure C3.**) Signage should be installed.

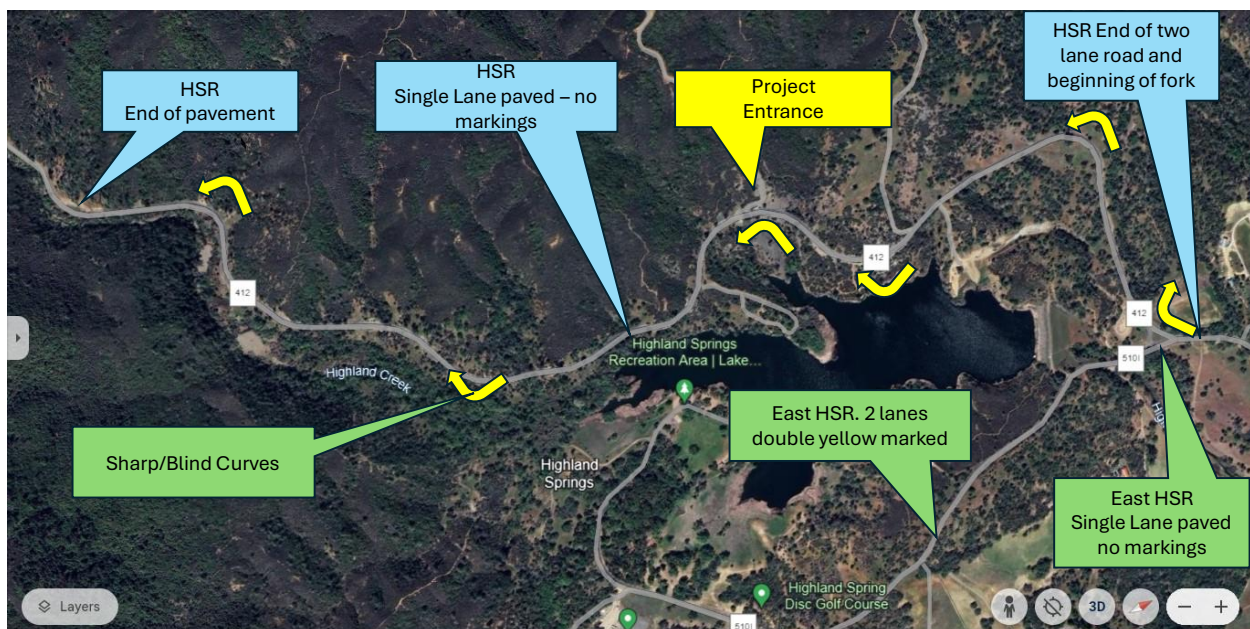


Figure C3: Aerial view of single lane paved portion of Highland Springs Road

d. The two-mile paved portion of Highland Springs Road, within Highland Springs Recreation Area above the reservoir between mile markers MM 4.29 and MM6.37, does not meet state width requirements for a two-lane road. (See California Department of Transportation [Caltrans] (2020), *Highway Design Manual*, § 301.1, available online at <https://dot.ca.gov/-/media/dot-media/programs/design/documents/>

[hdm-complete-12312020a11y.pdf](#), EXH-129 et seq. [“For conventional State highways with posted speeds less than or equal to 40 miles per hour and AADTT (truck volume) less than 250 per lane that are in urban, city or town centers (rural main streets), the minimum lane width shall be 11 feet. The preferred lane width is 12 feet.”].) (See **Figure C4**.) Additionally, it lacks markings to suggest to a driver that they are on a two-lane road. Markings should be installed. However, if proper markings are added, the road width will be further narrowed and not comply with Caltrans requirements, be more dangerous, and potentially require a reduction in speed to mitigate safety issues.

Consequently, drivers from either direction regularly drive over the center of the road as if on a single lane road, dangerously facing oncoming traffic head on. Lack of speed limit signs, narrow shoulders, sharp/blind curves and no lane markings create known traffic safety risks. (See Federal Highway Administration, *Mitigation Strategies for Design Exceptions*, available online at https://safety.fhwa.dot.gov/geometric/pubs/mitigationstrategies/chapter3/3_lanewidth.cfm EXH-177 et seq. [discusses an increase in lane-departures on narrow roads and roads with narrow shoulders].)

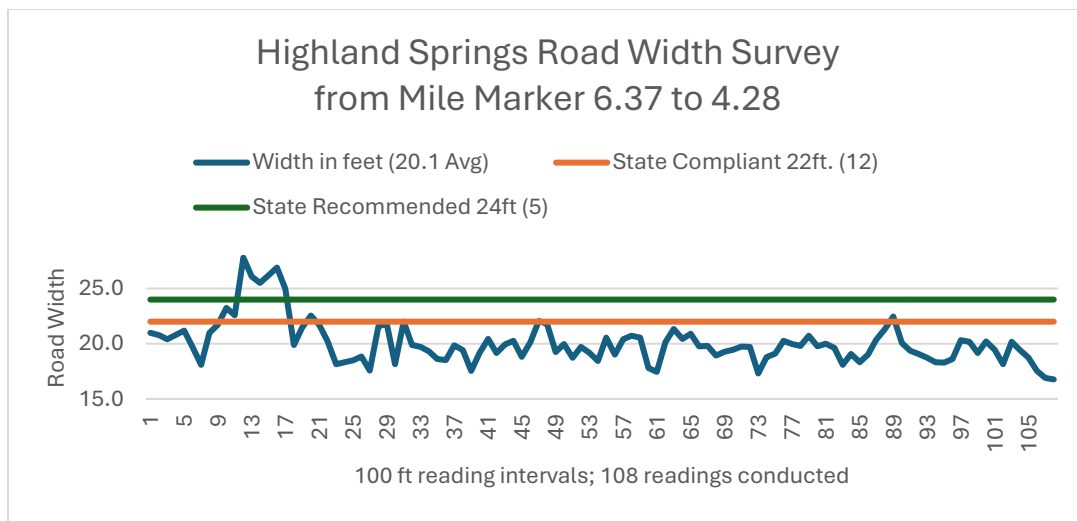


Figure C4: Highland Springs Road width survey

e. The fork that splits East Highland Springs Road from Highland Springs Road is particularly confusing and dangerous. (See **Figures C5** and **C6**.) It is an unusual convergence of three single lane roads using three different forks in close proximity. Drivers going downhill on Highland Springs Road cannot see drivers going uphill due to the sharp curve blocking the view. Simultaneously, drivers going downhill on Highland Springs Road must cross oncoming traffic going to Highland Springs Recreation Area’s main entrance. Also, drivers exiting from the main entrance must merge with drivers going downhill from Highland Springs Road. There is no signage or lane markings to help drivers safely negotiate the intersection. (See **Figure C6**.) Signage and lane markings should be installed, at a minimum, although a junction redesign likely would be the necessary solution to sufficiently mitigate safety impacts.



Figure C5: Aerial view of Highland Springs Road transition from two to one-lane

Highland Springs Road (HSR) and East Highland Springs Road (East HSR) Intersection near mile marker 4.28

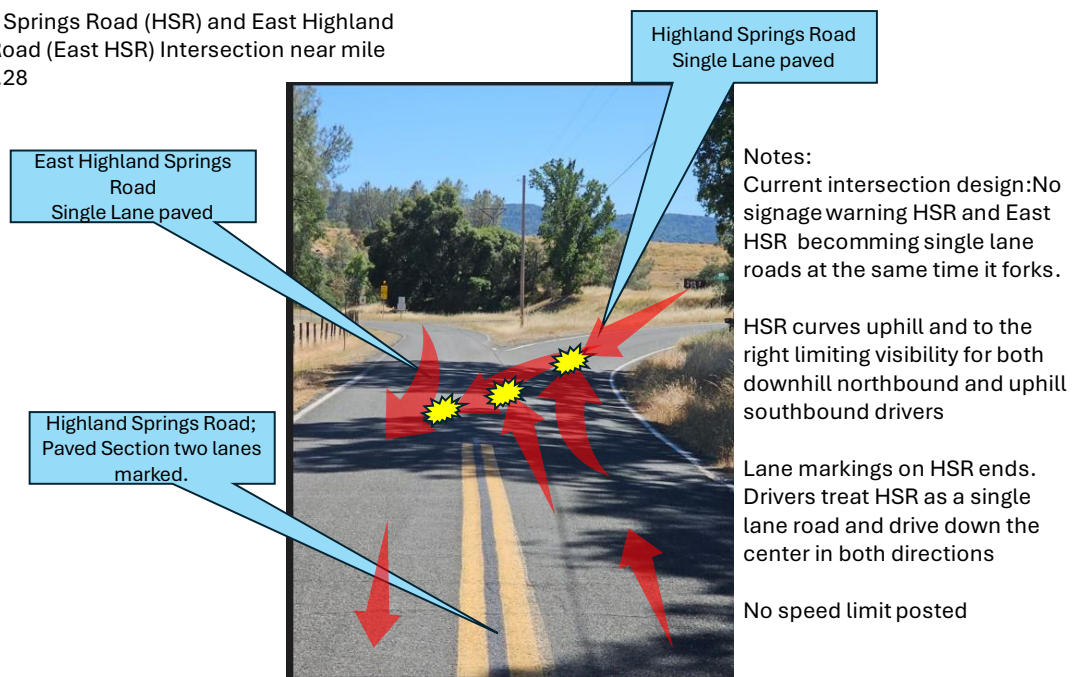


Figure C6: Roadway view of Highland Springs Road transition from two- to one-lane

- D. The Project's permit should be denied until the County properly addresses the traffic safety deficiencies on Highland Springs Road and the cumulative effects of the increased traffic from cannabis growers and park goers.

ATTACHMENT D

INADEQUATE SETBACK FROM PUBLIC LANDS AND VIOLATION OF COUNTY CANNABIS CULTIVATION ORDINANCE

A. Lake County Cannabis Cultivation Ordinance Prohibits Commercial Cannabis Cultivation within 1,000 Feet of Public Lands

1. Lake County Zoning Ordinance Article 27, section 27.13(at)1.v (p. 27-120) states: “Commercial cannabis cultivation is prohibited within a [sic] 1,000 feet of ... Public lands”

2. This prohibition was approved as part of the 2019 Commercial Cannabis Cultivation Ordinance No. 3084.

B. Public Lands Include State and Public Parks Per County Ordinance

1. County Ordinance No. 3096 updated the definition of Public Lands subject to this prohibition to include all state and county parks:

Public lands, where, because of development or other actions, it is clear that the public is invited to use such locations as places of recreation and other destination activities, including but not limited to, hiking, birdwatching, equestrian activities, and camping. Additionally, all State and County parks are public lands. (See also **Figure D1.**)

BOARD OF SUPERVISORS, COUNTY OF LAKE, STATE OF CALIFORNIA
ORDINANCE NO. 3096
AN ORDINANCE AMENDING ARTICLES 27 AND 68 OF CHAPTER TWENTY-ONE
OF THE LAKE COUNTY CODE TO CLARIFY THE DEFINITION OF PUBLIC LANDS
IN REGARD TO COMMERCIAL CANNABIS CULTIVATION

WHEREAS, property setbacks have many benefits both aesthetically and functionally, including the benefit to the general public that setbacks will generally encourage outdoor activities in public areas; and

WHEREAS, the term “public lands” is presently susceptible to a very broad definition for purposes of setback limitations relating to commercial cannabis cultivation areas; and

WHEREAS, since not all public land is usable to the public for purposes of recreation and other destination activities, it is the desire of this Board of Supervisors to clarify the definition of public lands as it relates to commercial cannabis cultivation setback limitations..

NOW THEREFORE, THE BOARD OF SUPERVISORS OF THE COUNTY OF LAKE ORDAINS AS FOLLOWS:

Section One: Section 21-27.11, subsection (at) 1.v.c. of Chapter 21 of the Lake County

Code is hereby amended to read as follows:

“v. Commercial Cannabis Cultivation Exclusion Areas

Commercial cannabis cultivation is prohibited within 1000 feet of the following areas or uses . . .

c. Public lands, where, because of development or other actions, it is clear that the public is invited to use such locations as places of recreation and other destination activities, including but not limited to, hiking, bird-watching, equestrian activities, and camping. **Additionally, all State and County parks are public lands.”**

Section Two: Section 21-68.4 (p) of Chapter 21 of the Lake County Code is hereby amended to add the following definition:

“68.4 Words and phrases . . .

(p) DEFINITIONS P . . .

31. Public Lands. For purposes of setback limitations on commercial cannabis cultivation, lands where, because of development or other actions, it is clear that the public is invited to use such locations as places of recreation and other destination activities, including but not limited to hiking, bird-watching, equestrian activities, and camping. **All State and County parks are public lands.”**

Section Three: The Board of Supervisors finds this ordinance is not a project for purposes of the California Environmental Quality Act because it has no potential for resulting in a significant environmental effect.

Section Four: All ordinances or parts of ordinances or resolutions or parts of resolutions in conflict herewith are hereby repealed to the extent of such conflict and no further.

Section Five: This ordinance shall take effect on the 10 day ~~of~~ September, 2020, and before the expiration of fifteen days after its passage, it shall be published at least once in a newspaper of general circulation printed and published in the County of Lake.

The foregoing ordinance was introduced before the Board of Supervisors on 4th day of August, 2020, and passed by the following vote on the 11th day of August, 2020

AYES: Supervisor Sabatier, Crandell, Scott, Brown, and Simon

NOES:None

ABSENT OR NOT VOTING: None

COUNTY OF LAKE

Carol J. Huchingson
Chair, Board of Supervisors

ATTEST: CAROL J. HUCHINGSON
Clerk of the Board

By: Anita L. Grant
APPROVED AS TO FORM:
ANITA L. GRANT
County Counsel
By: Anita L. Grant



Figure D1: Ordinance No. 3096

C. Highland Springs Recreation Area Adjacent to the Project Site Is a Public Park and Therefore a Public Land Subject to the 1,000-Foot Prohibition

1. County parcel 007-043-07, adjoining the applicant's cultivation sites, is part of Highland Springs Recreation Area (aka Highland Springs Regional Park or Highland Springs Park)—a regional public park owned by the Lake County Watershed Protection District, a political subdivision of the state, and managed by the Lake County Water Resources Department, a division of the County. The County refers to it as a park on its website (see <https://www.lakecountyca.gov/Facilities/Facility/Details/Highland-Springs-Park-66>). Being a State or County park is sufficient for the land to be defined as “public land” per County Ordinance No. 3096 and for the 1,000-foot setback for cannabis cultivation to apply.

D. The Project Is Sited Within 1,000 Feet of Public Lands—Highland Springs Regional Park—and Therefore Violates the Prohibition

1. The Lake County Parcel Viewer shows County parcel 007-043-007, part of the Highland Springs Recreation Area, adjoining several of the parcels within the Project site, including parcels 007-006-34, 007-006-35, and 007-046-040. (See **Figure D2.**) The vast majority of the proposed cannabis operation is proposed to take place on those three parcels, and a large portion would take place within the 1,000-foot setback zone. (See **Figure D3.**)

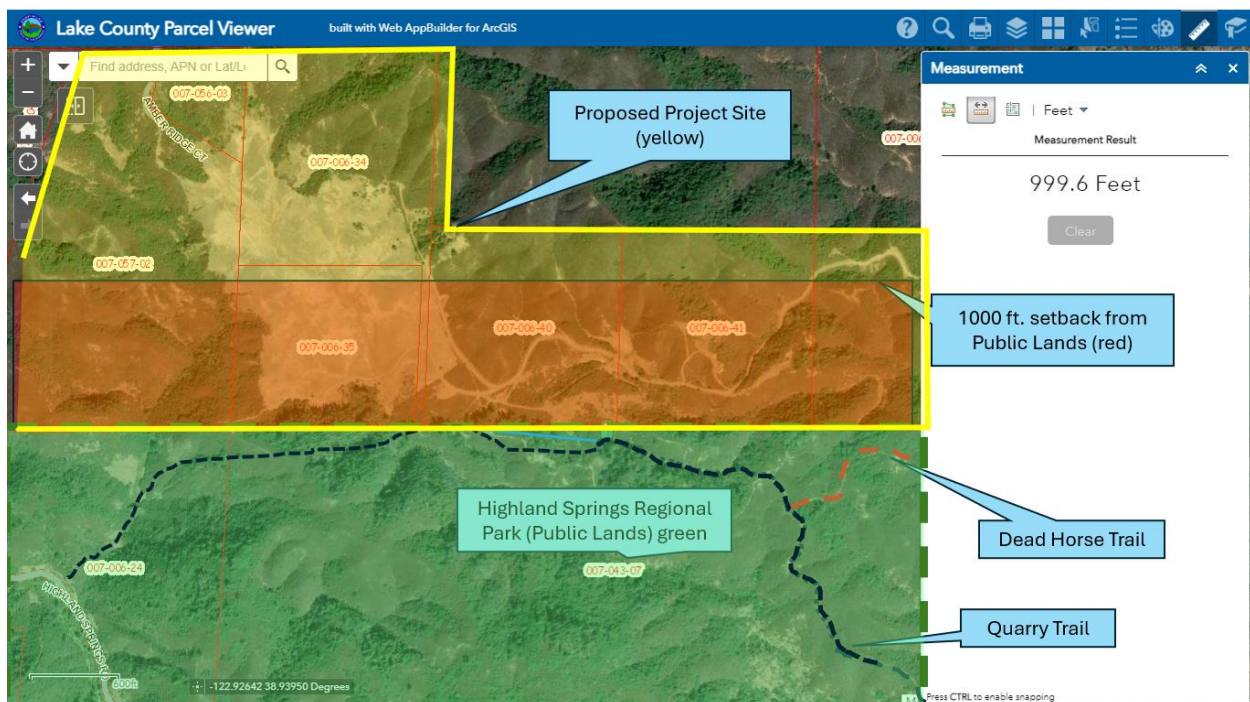


Figure D2: Lake County Parcel Viewer 1,000-foot setback overlay

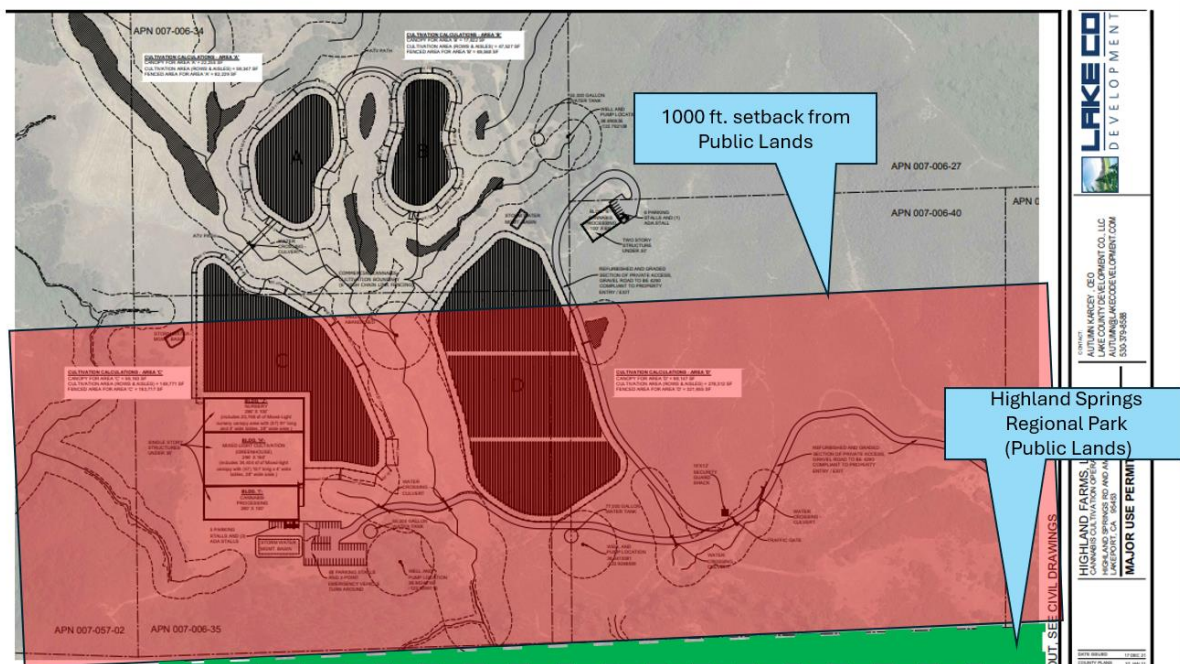


Figure D3: Site Plan with 1,000-foot setback overlay

2. Accordingly, the Project violates the County’s prohibition of siting cannabis cultivation within 1,000 feet of public lands.

E. Placing the Project Within 1,000 Feet of Public Lands Would Cause Potential Significant Environmental Effects

Impacts to Recreation and Recreational Facilities

1. As indicated in County Ordinance No. 3096, Clarification of Definition of Public Lands regarding Commercial Cannabis Cultivation, inadequate setbacks from cannabis cultivation can discourage the use of nearby public lands, which may result in the increased use of other public lands and associated accelerated deterioration of facilities at those other public lands.

2. Highland Springs Regional Park has a long-standing trail network that parallels the Project’s southern property line—namely the Quarry Trail and the Dead Horse Trail. The Quarry Trail runs within a few feet of the Project’s property line for nearly the entire width of the cultivation area. The County promotes the use of these trails in its brochures. The trails have been part of the approved KRT (Konocti Regional Trails) Master Plan for decades and are also part of the Draft Lake County Parks, Recreation and Trails Master Plan to interconnect trails from Highland Springs Road to Middletown. (See **Figures D4** through **D7** below.)



Figure D4: Highland Springs Regional Park Trail System Proposal (2004)

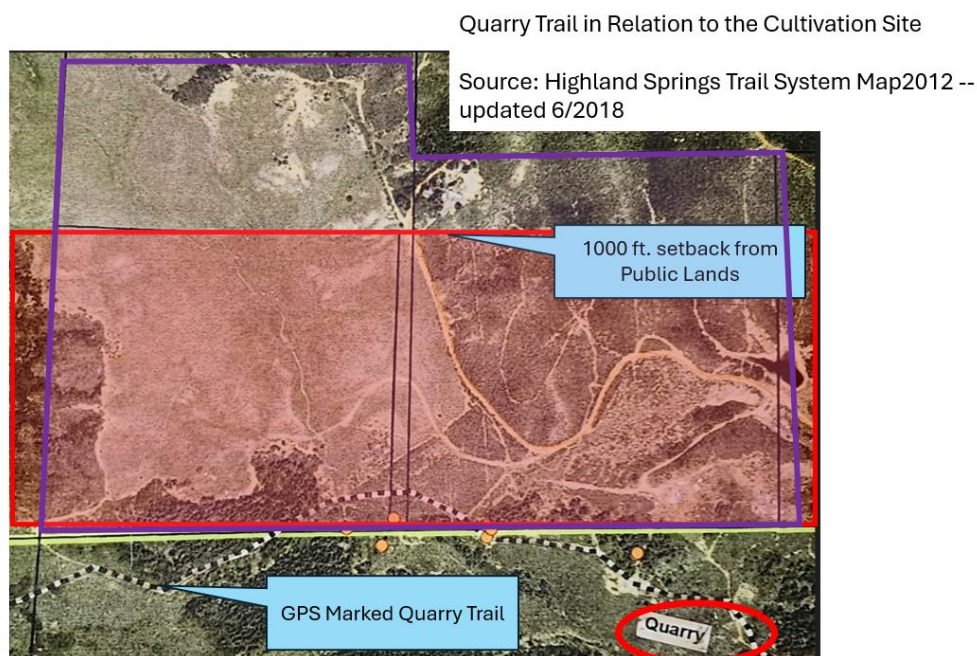


Figure D5: Highland Springs Regional Park Trail System Map (2012 - Updated 2018)

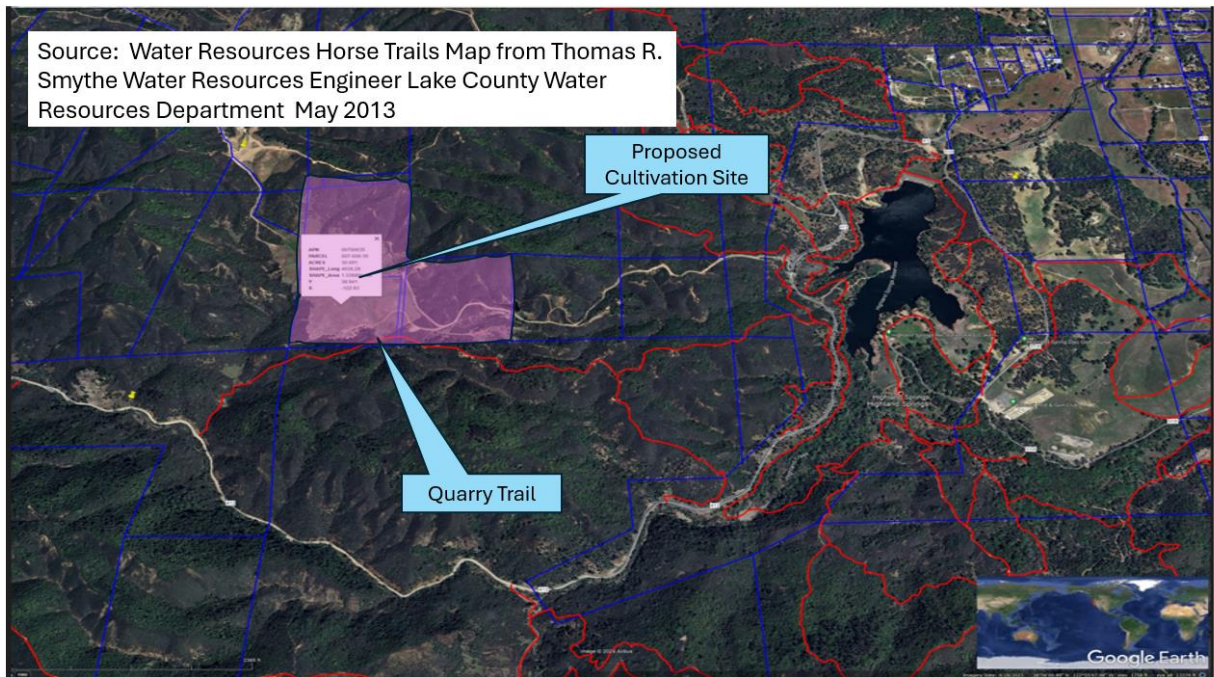
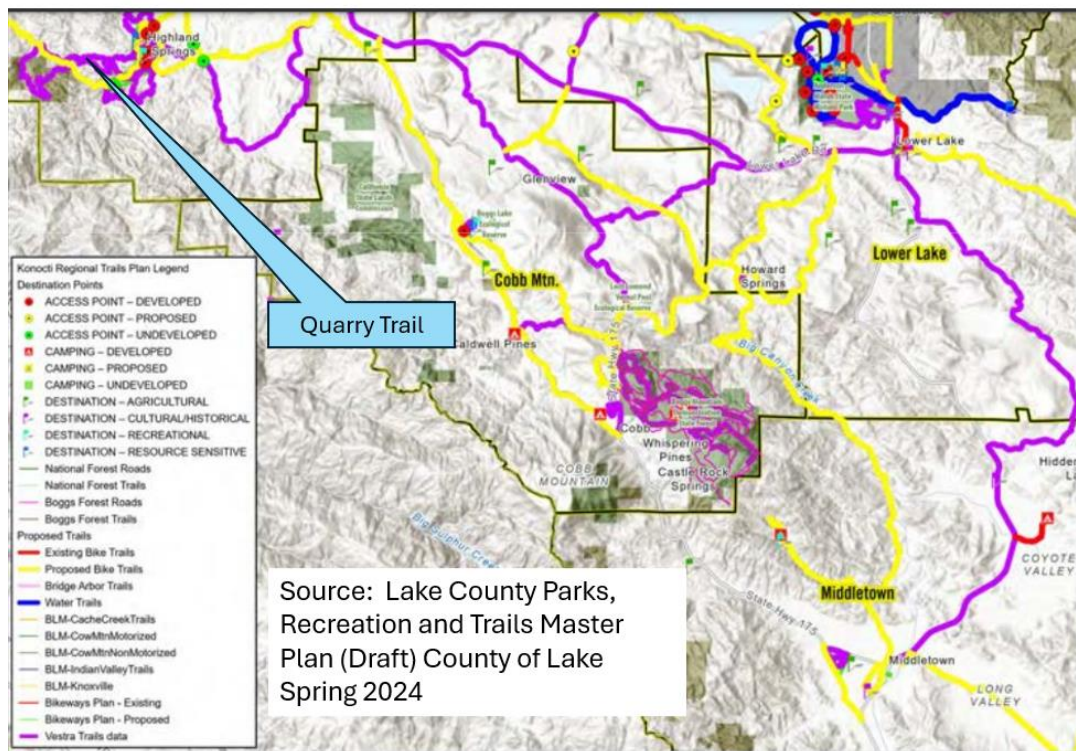


Figure D6: Lake County Water Resources Horse Trails Map (2013), from Thomas Smythe, former County Water Resources Director



Source: CPAD, 2022, Lake County GIS, CDBW, ESRI

Planned Konocti Regional Trails Plan Network



Figure: D7: Draft Lake County Parks, Recreation and Trails Master Plan (2024)

Noise Impacts

3. Noise during Project construction may result in significant impacts to recreationists at the adjacent Highland Springs Recreation Area and Highland Springs Regional Park. The MND inaccurately states that “there are no sensitive noise receptors within one mile of the Project site.” (MND, p. 55.) However, recreational park users are ordinarily considered sensitive receptors, and the County considers parks sensitive receptors.⁵ A park and park users occur within a mile of the Project site—actually, within 20 feet of proposed roadway construction. The MND does not include a construction noise study or any quantified analysis demonstrating what noise levels might be like at these public parks during Project construction, nor does it offer adequate mitigation to reduce the variety of construction noise that would occur.

Odor Impacts

4. The MND acknowledges that odor may be a problem, even claiming the Project includes an Air Quality Management Plan to address it (discussed below), but then fails to properly analyze potential odor effects on recreationists at the adjacent Highland Springs Recreation Area and fails to explain exactly how the Plan will address odor impacts. (MND, pp. 26–27.) Large-scale cannabis cultivation is known to produce strong and far-reaching odors, from both the plants themselves, especially during flowering, and from products, like manure, used in cultivation. (See, e.g., Processing Magazine (Oct. 28, 2022), *Cannabis is here to stay, its unpleasant odors are not*, available at <https://www.processingmagazine.com/material-handling-dry-wet/filtration-separation/article/21282544/cannabis-is-here-to-stay-its-unpleasant-odors-are-not>, EXH-183 et seq.)

5. The MND includes no odor-control mitigation measures and states only that “Potential odors would be minimized, as the processing facilities would be equipped with air circulation fans, passive carbon filtration, windscreens, and native vegetation maintenance to mask odors from cannabis cultivation and processing.” (MND, p. 27.) Supposedly the Project includes an “Air Quality Management Plan” (*ibid.*) yet there is no legally binding mechanism to ensure its preparation—no mitigation measure or condition of approval requires it. It does not even appear in the project description as part of the Project. Nor does the MND state anywhere what will be in this Plan and how it will effectively mitigate and manage odor issues associated with cannabis cultivation. The applicant’s Farm Management Plan (p. 22) states that “Outdoor odors will be managed by planting fragrant native flowering vegetation surrounding the cultivation area” However, this strategy is fundamentally flawed since the native plants in the area, fragrant or otherwise, flower in the spring before cannabis cultivation odors are at their strongest. And, again, there is no legally binding mechanism to enforce this measure.

⁵ County Planner Mary Claybon stated, in a May 22, 2024, email to Appellants that: “Sensitive receptors have been determined as hospital facilities, schools, *parks*, playgrounds by the Planning Commission” (emphasis added).

ATTACHMENT E

INADEQUATE PROJECT ALTERNATIVES

A. The County Fails to Analyze Project Alternatives that Could Avoid or Substantially Lessen Significant Project Impacts

Alternative Locations

1. The Project could be located on another site farther removed from a public recreational area thereby avoiding impacts (e.g., serpentine dust, noise, odor) to the sensitive receptors at that adjacent Highland Springs Recreation Area and avoiding impacts to recreation in general. (See Attach. D.)

2. The Project could be located on a site outside an area identified as containing serpentine formations and soils thereby avoiding impacts associated with disruption of serpentine soils and airborne asbestos. (See Attach. A.)

3. The Project could be located on a site that does not contain wetlands, or at least does not contain wetlands in such close proximity to Project facilities, thereby avoiding impacts associated with disturbing wetlands. (See Attach. B.)

4. Possible alternative sites could include those sites where other applicants have withdrawn or closed their applications. See table below of closed and withdrawn cannabis sites.

Project Number	Project Name	Cultivation Address	City	Grow_Type	Canopy SQFT	Canopy_Acreage
MUP 19-30	Emerald Fire Ranch	2210 Ladder Ridge Rd	Upper Lake	Mixed-light	22000	0.5
MUP 20-09	Llamas Farms II	23290 Morgan Valley Rd	Lower Lake	Mixed-light	5400	0.1
MUP 20-14	Action Cannabis	11996 Spruce Grove Rd	Lower Lake	Mixed-light	7500	0.2
MUP 20-29	Palmerin, Daniel	10295 Bachelor Valley Rd	Witter Springs	Mixed-light	2500	0.1
MUP 22-09	Green Diamond	10095 Kelsey Creek Dr	Kelseyville	Outdoor	38800	0.9
UP 19-16	LDM Operations	22811 Morgan Valley Rd	Lower Lake	Outdoor	22500	0.5
UP 19-17	Releaf Pharm	23485 Morgan Valley Rd	Lower Lake	Outdoor	29906	0.7
UP 20-07	Ambiland Farms	26364 18N 34	Lake Pillsbury	Outdoor	23488	0.5
UP 20-10	Empire Valley Organics	5615 Scotts Valley Rd	Lakeport	Outdoor	42000	1.0

Project Number	Project Name	Cultivation Address	City	Grow_Type	Canopy SQFT	Canopy_Acreage
UP 20-16	Ora Del Ranch	3600 Dessie Dr	Lakeport	Outdoor	304920	7.0
UP 20-28	Airport Cannabis	4440 George Rd	Lakeport	Outdoor	133620	3.1
UP 20-29	Llamas Farms I	20276 Morgan Valley Rd	Lower Lake	Outdoor	103344	2.4
UP 20-34	LC5029, LLC	9514 Glenhaven Dr	Glenhaven	Outdoor	19364	0.4
UP 20-38	Red Hill Farm	11990 Bottle Rock Rd	Kelseyville	Outdoor	68500	1.6
UP 20-42	Green Lantern Earth Med. Ranch, LLC	23515 Morgan Valley Rd	Lower Lake	Outdoor	43560	1.0
UP 20-44	Double Golden Eagle, LLC	822 Watertrough Rd	Clearlake Oaks	Outdoor	83820	1.9
UP 20-45	Blue Lakes Organics	10680 Schuette Rd	Upper Lake	Outdoor	20000	0.5
UP 20-48	HiCann	23320 Shady Grove Rd	Middletown	Outdoor	248800	5.7
UP 20-52	R & L Farming, LLC	7525 Zeno Rd	Lakeport	Outdoor	22400	0.5
UP 20-55	Eubanks, Kent	21626 My Way	Middletown	Outdoor	53560	1.2
UP 20-63	Canvas Farms	11739 Spruce Grove Rd	Lower Lake	Outdoor	87120	2.0
UP 20-64	Rocky Creek Farms	21262 Morgan Valley Rd	Lower Lake	Outdoor	43560	1.0
UP 20-65	Cannabisco Farms	23523 Morgan Valley Rd	Lower Lake	Outdoor	132000	3.0
UP 20-70	Sierra Vista Farm	25598 Jerusalem Grade	Lower Lake	Outdoor	43560	1.0
UP 20-76	Lee Farms	8255 S Hwy 29	Lower Lake	Outdoor	43560	1.0
UP 20-87	Gaston Ag. Co.	22182 Jerusalem Grade	Lower Lake	Outdoor	300000	6.9
UP 20-89	Green Lake Exotic Cannabis	3152 Scotts Creek Rd	Lakeport	Outdoor	87000	2.0

Project Number	Project Name	Cultivation Address	City	Grow_Type	Canopy SQFT	Canopy_Acreage
UP 20-99	Red Hills RHRP2, LLC (Kultivate LLC)	7765 South State Hwy 29	Kelseyville	Outdoor	0	0.0
UP 21-08	Paradise Valley Farms	26233 Jerusalem Grade	Middletown	Outdoor	2731163	62.7
UP 21-22	High Valley Stoney Farms	11315 High Valley Rd	Clearlake Oaks	Outdoor	1176120	27.0
UP 21-23	Tharp II	7560 Hwy 29	Kelseyville	Outdoor	125120	2.9
UP 21-26	Voight Nadora LLC	550 Voigt Rd Lakeport	lakeport	Mixed-light	43874	1.0
UP 21-43	Aero Acres	750 Sky Park Dr	Lakeport	N/A	0	0.0
UP 21-45	Davis Seigler Springs North	10075 Seigler Springs North Rd	Kelseyville	Mixed-light	3080	0.1
UP 21-47	Mount Fire 29	8159 S State Hwy 29	Lower Lake	Mixed-light	43416	1.0
UP 21-50	Rocky Mountain Farms, Inc	9310 Rocky Creek Rd	Lower Lake	Outdoor	1305866	30.0
UP 21-51	Morgan Valley Ag	25900 Morgan Valley Rd	Lower Lake	Outdooor	174240	4.0
UP 21-54	Rocking PT Farms	8275 N Hwy 29	Lakeport	Outdoor	479160	11.0
UP 21-56	Lakeview Organics (Lakeview Organics Corporation)	8265 N State Hwy 29	Upper Lake 95485	Outdoor	43920	1.0
UP 21-57	Steelhead Gardens	4965 Steelhead Drive	Kelseyville	Mixed-light	87120	2.0
UP 22-01	Highland Oasis Nursery	21700 Morgan Valley Rd	Lower Lake	Outdoor	65560	1.5
UP 22-05	Kultivate, LLC/ Lakes Own (UP 19-06 expansion)	13200 Seigler Canyon Rd	Lower Lake	Outdoor	246438	5.7
UP 22-10	Fisherman Pharms	1849 Clover Valley Rd	Upper Lake	Outdoor	91120	2.1

Reduced Size or Alternate Configuration Alternatives

5. The Project could be reduced in size to avoid or reduce drawdown impacts to the aquifer, and potentially on nearby wells, associated with supplying groundwater to a large-scale cannabis cultivation operation (see Attach. B). Its configuration could be altered to avoid development and cultivation on the north parcel (see Attach. G). A reduced size or alternate configuration could better avoid impacts to the many onsite wetlands (see Attachs. B & G).

ATTACHMENT F

VIOLATION OF STATE MINIMUM FIRE SAFE REGULATIONS

A. State Minimum Fire Safe Regulations Require Dead-End Roads on the Project Site to Stay Within Certain Lengths

1. Title 14, division 1.5, chapter 7, section 1273.08 of the California Code of Regulations, promulgated pursuant to Legislative mandate in Public Resources Code section 4290, requires dead-end roads on parcels zoned for 20 acres or more within a Very High Fire Severity Zone in a State Responsibility Area to not exceed 5,280 feet, as part of State Minimum Fire Safe Regulations. (See also Cal. Code Regs., tit. 14, § 1270.02, subd. (a).)

2. The Project site is located within a Very High Fire Severity Zone in a State Responsibility Area (MND, p. 45) and zoned primarily as RL (Rural Lands) with minimum allowable parcel sizes of 20 acres (see Lake County Zoning Ordinance, art. 7, § 7.12).

B. The Project's Access Road Is a Dead-End Road and Would Exceed the Allowable Length, Therefore Violating State Minimum Fire Safe Regulations

1. Access to the property will be achieved by a portion of the access road on County property (1,057 feet) connecting Highland Springs Road to the property entrance and the additional 6,500-foot-long private access roadway—totaling approximately 7,500 feet of roadway. (PC Staff Report, p. 6.)

2. The MND incorrectly states that the access road connects to Amber Ridge Court (aka Amber Ridge Road). (MND, p. 59.) Per the Lake County Parcel Viewer, Amber Ridge Court does not connect to the access road. More than 2,000 feet of wetland and grassland separate the two roads. (See **Figure F1**.)

3. There are no documented plans to connect the two roads. The applicant's site plan only depicts "ATV paths" inside the grassland/wetland areas. (See **Figure F2**.) The majority of these paths are contained inside secured cultivation areas. (See **Figure F2**.) Nothing in the record demonstrates that the access road will be connected to Amber Ridge Court in a manner that precludes it from being considered a dead-end road. Indeed, the applicant has publicly acknowledged that the Project site is *not* connected to Amber Ridge Court in as much as the applicant has discussed connecting it for emergency egress (see below).

4. At the Planning Commission hearing, the applicant stated that it wants to connect the parcel to Amber Ridge Court for emergency egress. However, this emergency egress is not discussed as part of the Project in the MND or PC Staff Report, and it would be problematic. To achieve secondary egress to the nearest non-dead-end road, Highland Springs Road, from Amber Ridge Court, the applicant would have to traverse through Donovan Valley on Amber Ridge Court, Vernal Drive, and Ridge Road. Each of these roads themselves do not meet State Minimum Fire Safe Regulations. They do not meet the requirements for road width (Cal. Code Regs., tit. 14, § 1273.01, subds. a, b), road grade (*id.*, § 1273.03, subds. a, b) or road radius (*id.*, § 1273.04). Neither the applicant nor County have shared any plans to make the required improvements to these other roads.

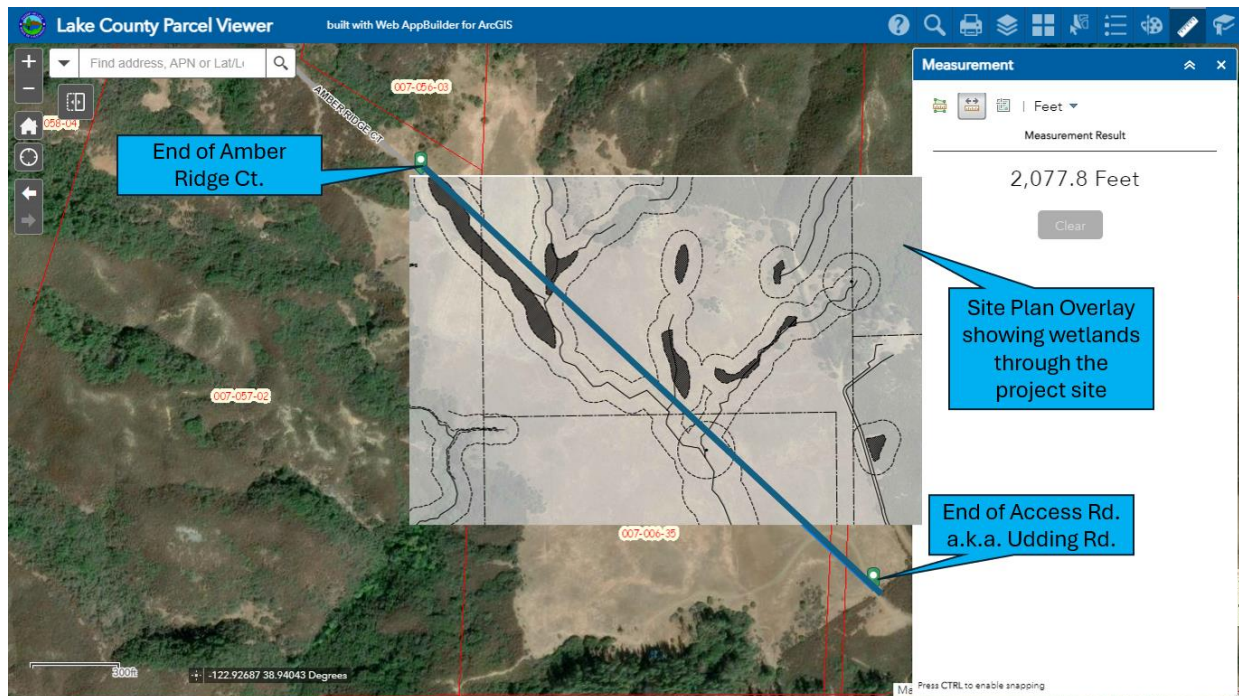


Figure F1: Lake County Parcel Viewer showing wetlands between Amber Ridge Court and the access road

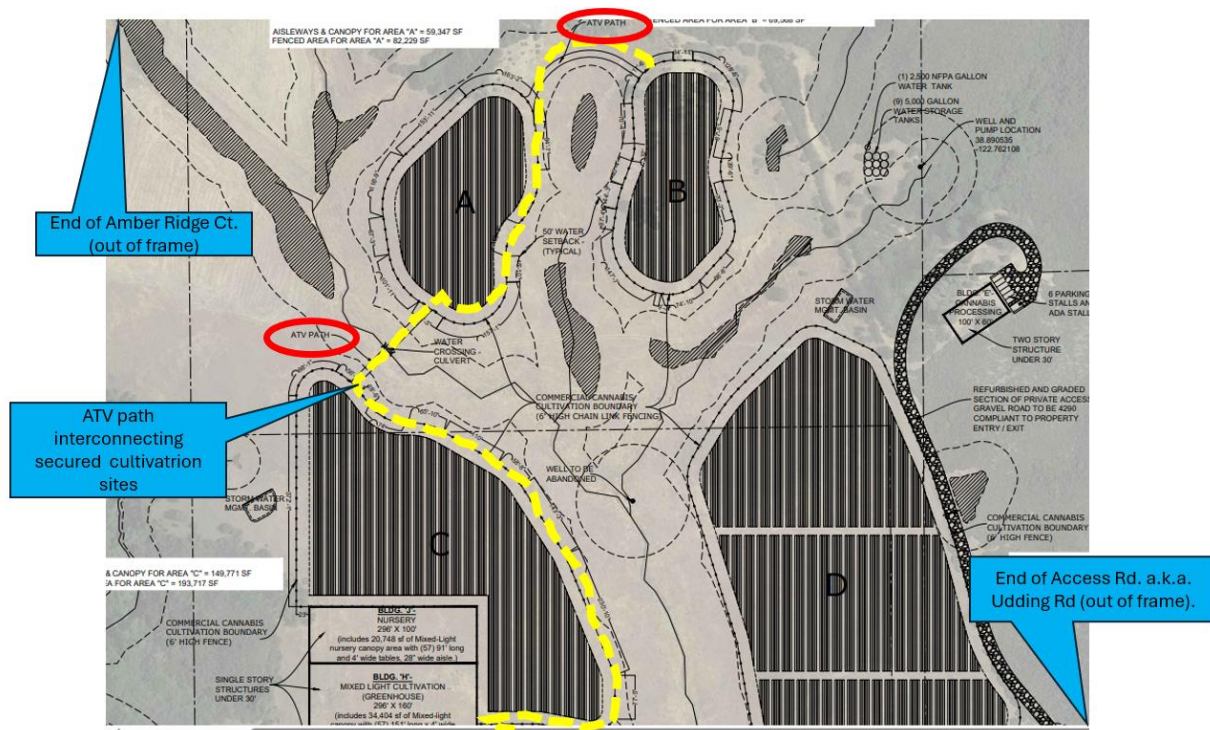


Figure F2: Proposed Project Site Plan – Depicting Vehicular Paths

5. Until connected to Amber Ridge Court, the private access road is considered a dead-end road. Accordingly, the Project would violate title 14, division 1.5, chapter 7, section 1273.08 of the California Code of Regulations.

ATTACHMENT G

VIOLATION OF STATE CANNABIS CULTIVATION GENERAL ORDER

A. The Project Violates the SWRCB Cannabis Cultivation General Order

1. The SWRCB Cannabis Cultivation General Order (adopted Nov. 7, 2023), Cannabis Cultivation Policy Attachment A, Definitions and Requirements for Cannabis Cultivation, mandate a 100-foot setback from intermittent (i.e., seasonal) wetlands. (SWRCB, *General Order*, Attach. A, p. 28 [General Requirement No. 37], available online at https://www.waterboards.ca.gov/water_issues/programs/cannabis/docs/cannabis_attach_a_clean_version.pdf, EXH-193 et seq.)
2. However, as explained above in Attachment B, paragraph D.4, the Project biologist established that the Project would not be able to adhere to setback requirements because “it would be difficult to avoid any discharge of sediment into any setback area while grading the top of the two hills on the north parcel due to the small size of these potential cultivation area.”
3. The biologist went on to recommend that Project cultivation be limited to the south parcel only and that wetlands on the north parcel be restored. This Project change did not occur.
4. Additional evidence demonstrates that wetland boundaries were underestimated (see Attach. B), therefore, any setbacks from these boundaries prescribed in MND Mitigation Measure BIO-1 would be even more inadequate than assumed by the Project biologist.
5. Consequently, the Project cannot adhere to the 100-foot setback requirement of the state Cannabis Cultivation General Order and will violate the Order.

ATTACHMENT H

INCORRECT AND UNVERIFIED EASEMENTS AND VIOLATION OF COUNTY CANNABIS CULTIVATION ORDINANCE

A. The Correct Easements Required for Site Access Have Not Been Identified or Verified

1. As stated in the PC Staff Report: “two easements [must] be verified ... an access easement through adjacent parcel identified as (APN 007-043-04) ... [and a] “second easements [] identified as a roadway and utility easement on parcels (APN 007-056-01, 007-056-02, and 007-056-06).”

2. To our knowledge, the scope of these easements has not been verified, and the use proposed for the Project does not appear to be within the scope of at least one.

3. Per the County’s Request for Review for Sufficiency form (Attach. 13 of the PC Staff Report): “ACCESS: Any site where cannabis activity is permitted shall have access to a public road *or a recorded easement* that allows for but not limited to, delivery trucks, emergency vehicles, sheriff and other law enforcement officers, and government employees who are responsible for inspection or enforcement actions” (PC Staff Report, p. 15, emphasis added.)

4. To acquire access to the nearest public road, Highland Springs Road, the project must utilize an access roadway that traverses two County-owned parcels, APN 007-043-01 and APN 007-043-04 (see Attach. A). The County, however, has only provided what appears to be incorrect easement information on County-owned parcel 007-043-04. The County has not yet provided easement information for parcel 007-043-01.

5. As background, the portion of the Project’s proposed access road traversing County-owned parcels is located in the southwest portion of Section 30 of County Parcel Map Book 7. (See **Figure H1**.)

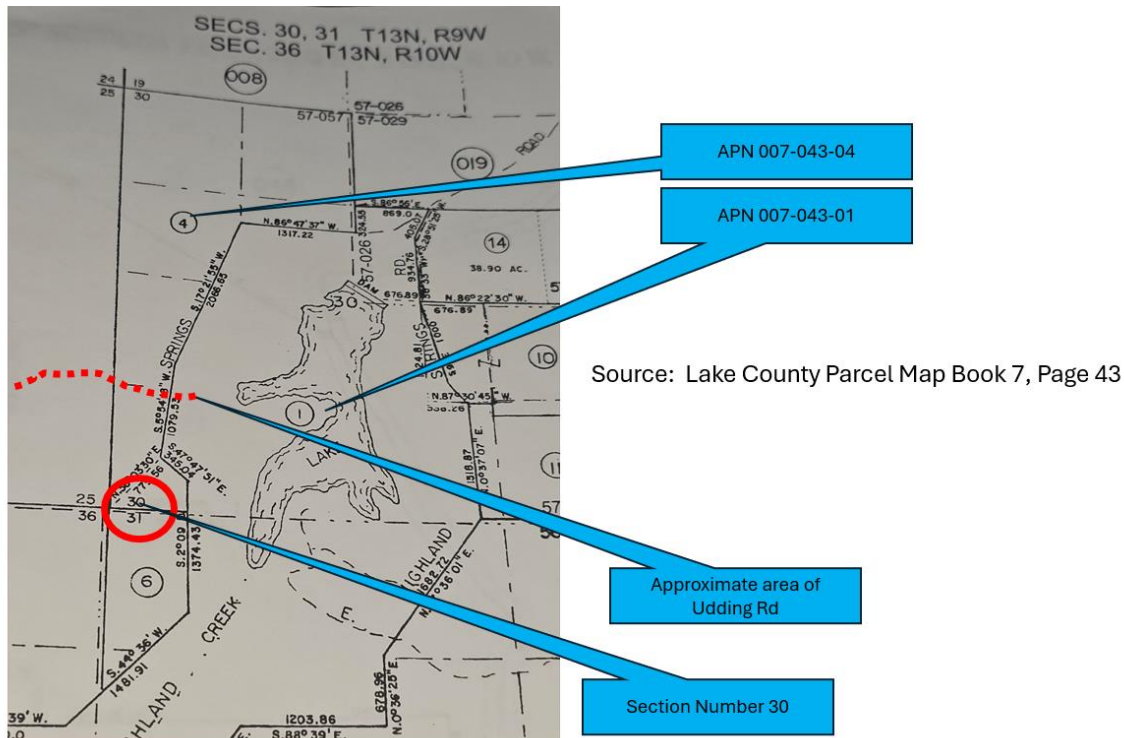


Figure H1: Lake County Parcel Map Book 7, Section 30

6. The “Woods Easement,” supposedly applicable to APN 007-043-04 (see PC Staff Report, p. 15), however, describes different areas altogether. The deed that contains the Woods Easement describes areas located on the other side of Highland Springs Reservoir, in map Sections and Section areas not related to the Project’s access road, in what is now in the area of the gun range and equestrian center. For example (emphasis added):

- “... All that part of the Southwest quarter of the *Southwest quarter of Section 29 ...* .”
- and all that part of the *Southeast quarter of the Southeast quarter of Section 30*, and all that part of the Northwest quarter of *Section 32 ...* .”
- “... all in Township 13 North, Range 9 West, M.D.B.&M., more particularly described as follows: TRACT 1. BEGINNING at a point within the Southwest quarter of the Southwest quarter of said *Section 29 ...* .”
- “... Tract 11. A parcel of land in the South half of the Southwest quarter of *Section 29*, Township 13 North ... and the North half of the Northwest quarter of *Section 32 ...* .”
- “... 100 feet to the center of Adobe Creek thence down the center of Adobe Creek” Adobe Creek is on the other side of the lake from the Project site.

As explained just above, the portion of the Project’s proposed access road traversing County-owned parcels is located in the far southwest corner of Section 30, *not* the southeast quarter of Section 30 and not in Sections 29 and 32, covered by the Woods Easement.

Figures H2 and H3 show relevant portions of the Woods Easement deed. **Figure H4** shows the

approximate outermost boundaries of the Woods Easement parcel, and **Figure H5** shows Lake County Parcel Map Book 7, Sections 29 and 32, implicated in the Woods Easement.

Reference
to
Sections
29, 30 and
32

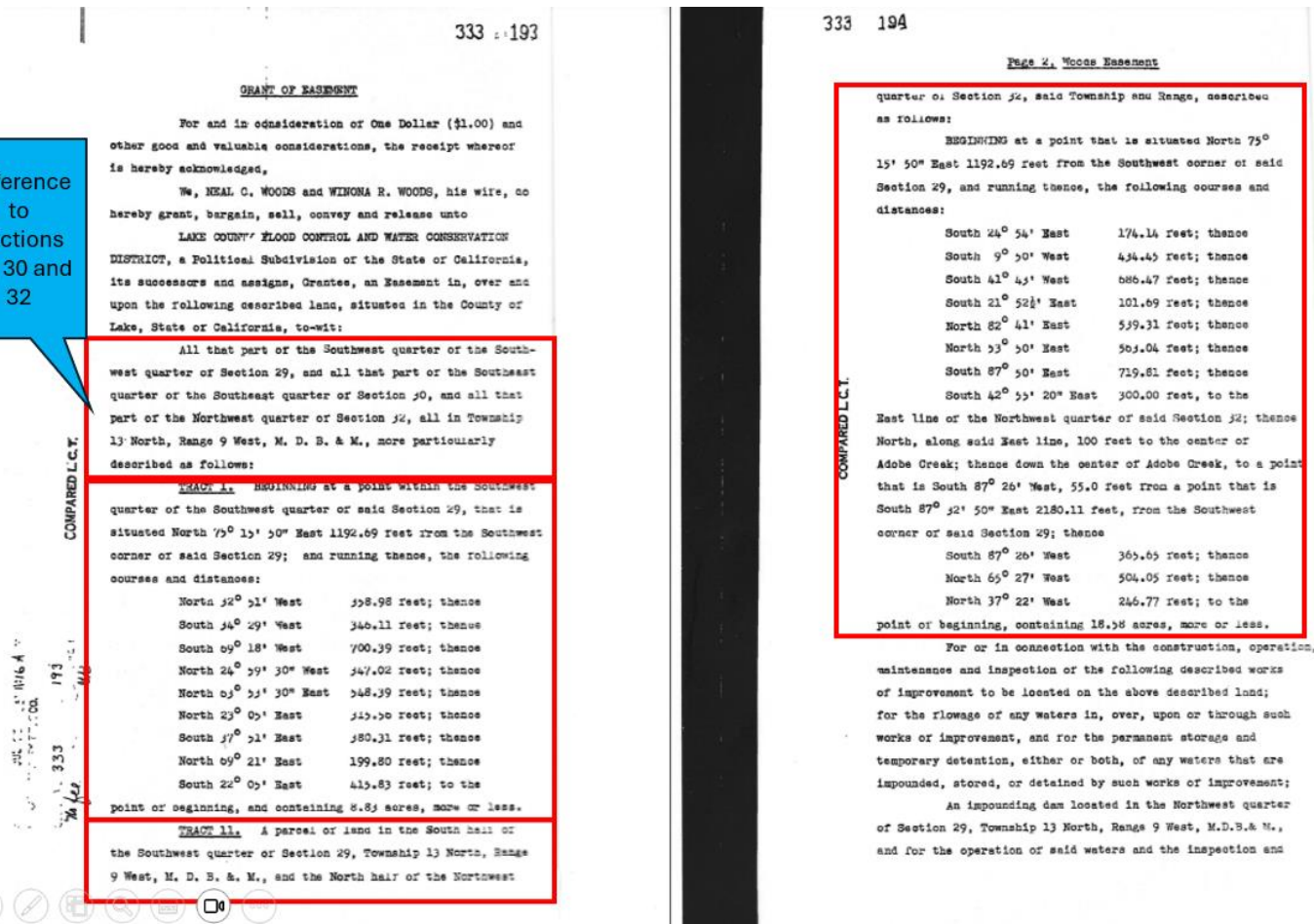


Figure H2: Woods Easement, Book 333, pp. 193 and 194

Page 3. Woods Easement

maintenance of said area to be flooded.

1. In the event construction of the above described works of improvement is not commenced within one year from the date hereof, the rights and privileges herein granted shall at once revert to and become the property of the Grantors, their heirs and assigns.

2. This Easement includes the right of ingress and egress at any time over and upon the above described land of the Grantors, and any other land of the Grantors adjoining said land.

3. There is reserved to the Grantors, their heirs and assigns, the right and privilege to use the above described land of the Grantors, at any time, and in any manner, and for any purpose, not inconsistent with the full use and enjoyment by the Grantee, its successors and assigns, of the rights and privileges herein granted.

4. The rights and privileges herein granted are subject to all easements, rights of way, mineral reservations, or other rights now outstanding in third parties.

5. The Grantee is responsible for operating and maintaining the above described works of improvement.

6. Special Provisions: None.

TO HAVE AND TO HOLD the aforesaid Easement in, over and upon the above described land of the Grantors, with all the rights privileges and appurtenances thereto belonging or in any wise appertaining, unto the Grantee, its successors and assigns, forever.

IN WITNESS WHEREOF, the Grantors have executed this instrument, on the 1 day of June 1966.

Willard D. Hansen
WITNESS

CHAL

Neal C. Woods
Grantors

STATE OF CALIFORNIA 333 196

County of Lake On this 1st day of June 1966 before me, a Notary Public in and for the County of Lake, State of California, duly commissioned and sworn, known to me to be the person whose name is subscribed to the within instrument as deponent therein, who, being by me duly sworn, depose and said: that he residing at the County of Lake State of California that he as deponent and saw NEAL C. WOODS and WINONA R. WOODS, his wife (personally known to him to be the person described in, and who executed the said within instrument as part leg thereto), sign, seal, and deliver the same, that the said NEAL C. WOODS and WINONA R. WOODS duly acknowledged in the presence of said officer, that they executed the same and that the said officer, thereupon, and at the request of said NEAL C. WOODS and WINONA R. WOODS, subscribed his name to the same as deponent IN WITNESS WHEREOF I have hereunto set my hand and official seal in the County of Lake the day and year in this certificate first above written.

Notary Public in and for the County of Lake State of California
My Commission Expires 10-20-63

Figure H3: Woods Easement, Book 333, pp. 195 and 196

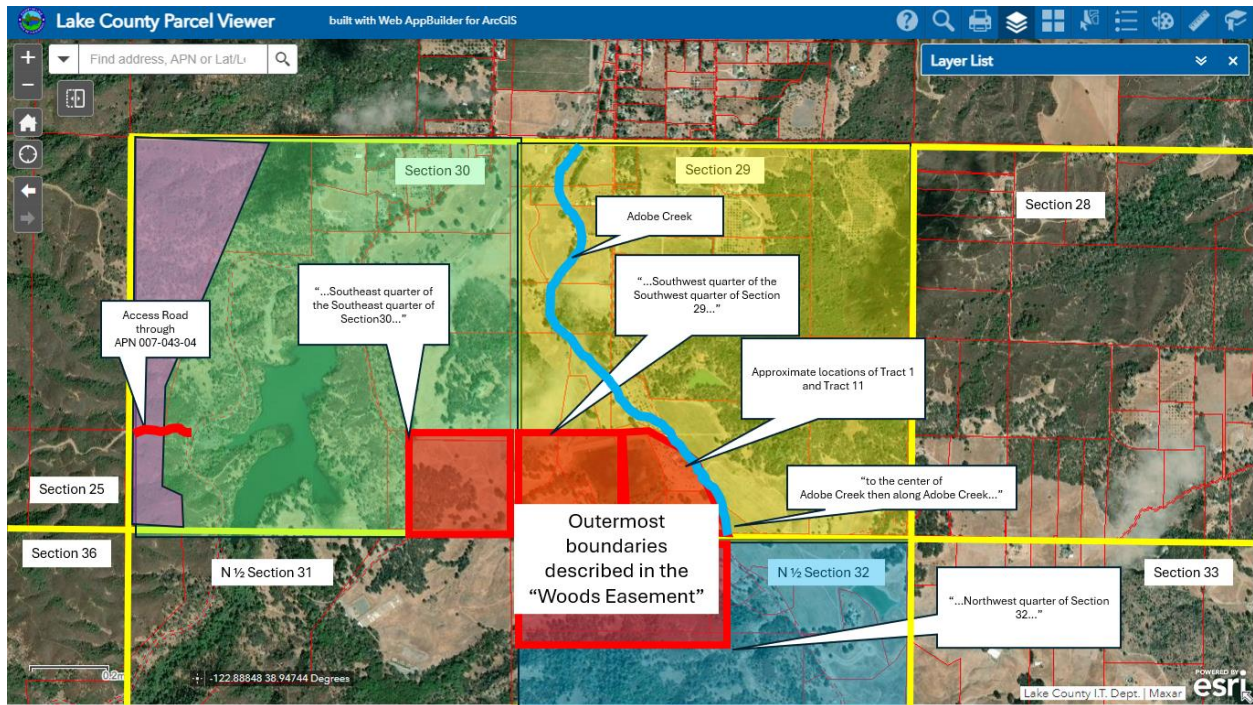


Figure H4: Outermost Boundaries of the Woods Easement

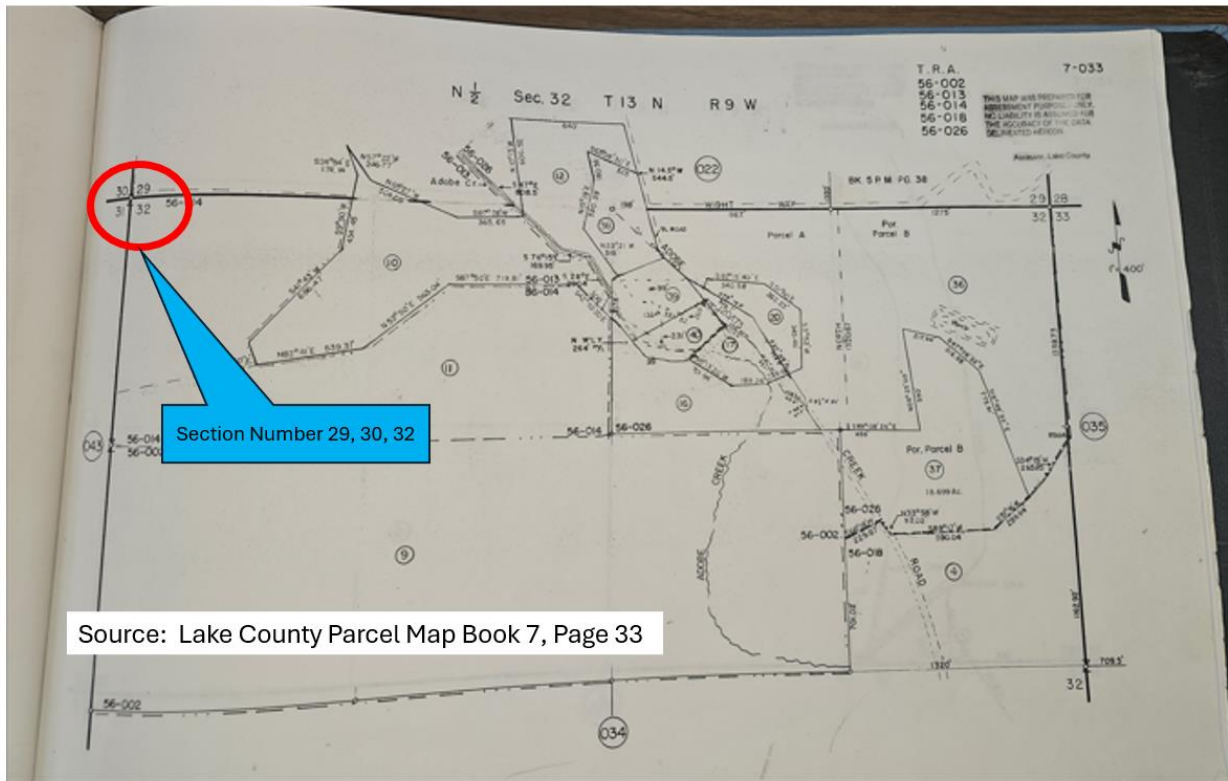


Figure H5: Lake County Parcel Map Book 7, Sections 29 and 32

7. Research of Lake County records found no deeded easements for APN 007-043-04 and only a PG&E utility easement for APN 007-043-01 that applies to an extension of the utility easement next to East Highland Springs Road. Thus, the Woods Easement is not applicable to the Project, and there does not appear to be any other easements that would allow the Project's use of the access road as currently described in the MND and PC Staff Report.

8. The County must ensure that proper access to the Project's operations through County-owned parcels 007-043-01 and 007-043-04 is in place. The County must discuss this access accurately in public information associated with the Project. If new easements are required for Project access to Highland Springs Road and roadway improvements, then those easements must be discussed as part of the Project in any CEQA document prepared for the Project.

B. The Project Violates County Ordinance Article 27 on Cannabis Cultivation

1. County Ordinance Article 27 (§ 27.13(aaa)4.i, p. 27-165) states: "The parcel where the processor activity is located shall [1] front *and* [2] have direct access to a paved State or County maintained road" Both criteria must be met to comply with the Ordinance.

2. The parcel on which the Project's cannabis processing facilities will operate (APN 007-006-35) does not front Highland Springs Road, which is the only paved state or County maintained road that could feasibly be used by the Project.

3. Nor is direct access to Highland Springs Road obtainable at this juncture. To gain access to Highland Springs Road, the Project *must* rely on an access road that traverses County-owned parcels 007-043-01 and 007-043-04, and there must be appropriate easements and permissions in place that allow for this use. However, as explained above, no such easements exist and none are proposed as part of the Project.

4. Accordingly, the Project as it is currently designed does not and cannot comply with either criterion of the Ordinance.

ATTACHMENT I

MISCELLANEOUS OTHER MND ERRORS, OMISSIONS, AND CONCERNS

A. As stated by the DCC in its comment letter on the Project (dated May 7, 2024), the MND's "regulatory setting, environmental setting, impact analysis and methodology" all require more substantial evidence "to support all impacts conclusions in the checklist, including the sources relied upon to make conclusions." (DCC Letter, p. 2.) The DCC also commented that "[i]n several instances throughout the document, mitigation measures are not sufficiently specific to establish how such measures would minimize significant adverse impacts as a result of Proposed Project activities." (*Ibid.*) Additionally, per the DCC, the MND's project description required more detail. (*Ibid.*) The DCC is the state agency charged with overseeing cannabis operations and a Responsible Agency under CEQA informing the County that the MND's project description, environmental analysis, and mitigation are insufficient under CEQA. (*Id.*, p. 1.) The DCC further asserts that, without amendments, it cannot rely on the MND for its CEQA needs as a Responsible Agency when processing the "annual cultivation licenses from DCC" required by the Project.

B. The MND, in its "Project Location(s)" section (p. 1), fails to identify the County-owned parcels upon which a large portion of the access road will be constructed and used. This is a problematic omission because it confuses the scope of the Project site, which clearly involves those parcels. (See Attach. A.)

C. The MND fails to identify the full zoning designations for the affected parcels, labeling them all as "RL-Rural Lands" (p. 1) and omitting the remainder zoning identification, i.e., RL-WW (Waterway) and RL-B5. This is a problematic omission because these specialized zoning districts come with additional restrictions that require discussion and design consideration. For example, parcels 007-006-27 and 007-057-02 are zoned WW, which prohibits development activity within riparian corridors. (See Lake County Zoning Ordinance, art. 37, § 37.4.)

D. As explained in Attachment F, paragraph B.4, the applicant has publicly stated that it wants to connect the parcel to Amber Ridge Court for emergency egress. This emergency egress is a foreseeable part of the Project (given the applicant's public admission) and must be included as part of the Project and analyzed accordingly. Use of the roadways required for this emergency egress (Amber Ridge Court, Vernal Drive, and Ridge Road) may have impacts not already considered, such as to wetlands and sensitive species (see Attach. B) or associated with serpentine formations and soils (see Attach. A).

E. The MND fails to discuss the emerging data demonstrating the alarming levels of pesticides found in legal cannabis products. A recent investigation showed that more than half of the legal cannabis products tested had "concentrations of pesticides either above levels the state allows or at levels that exceed federal standards for tobacco." (Los Angeles Times (June 14, 2024), *The dirty secret of legal weed*, available online at <https://www.latimes.com/0000018f-cfbf-dd1e-a39f-efbff2500000-123>, EXH-199 et seq.) "The contaminants include chemicals tied to cancer, liver failure, thyroid disease and genetic and neurologic harm to users and unborn children ... Some individual products contained as many as two dozen pesticides." (*Ibid.*) The

MND does not discuss the application of pesticides and it does not list and discuss all the statutes, rules, and regulations that apply to the use of pesticides in cannabis cultivation. Nor does it offer mitigation to minimize pesticide impacts that might (and apparently will) occur, in spite of rules and regulations.

F. The MND states: “The Proposed Project would not change the overall undeveloped nature of the Property and does not include development of approximately 96% of the undeveloped habitat on the Property.” (MND, p. 29). This statement is misleading because it does not account for disturbance to nearly 100% of the grassland/wetland area and sensitive serpentine habitat, where many special-status species either occur or could occur.

Exhibits to Attachments

Add to plant list +

Print

75 photos

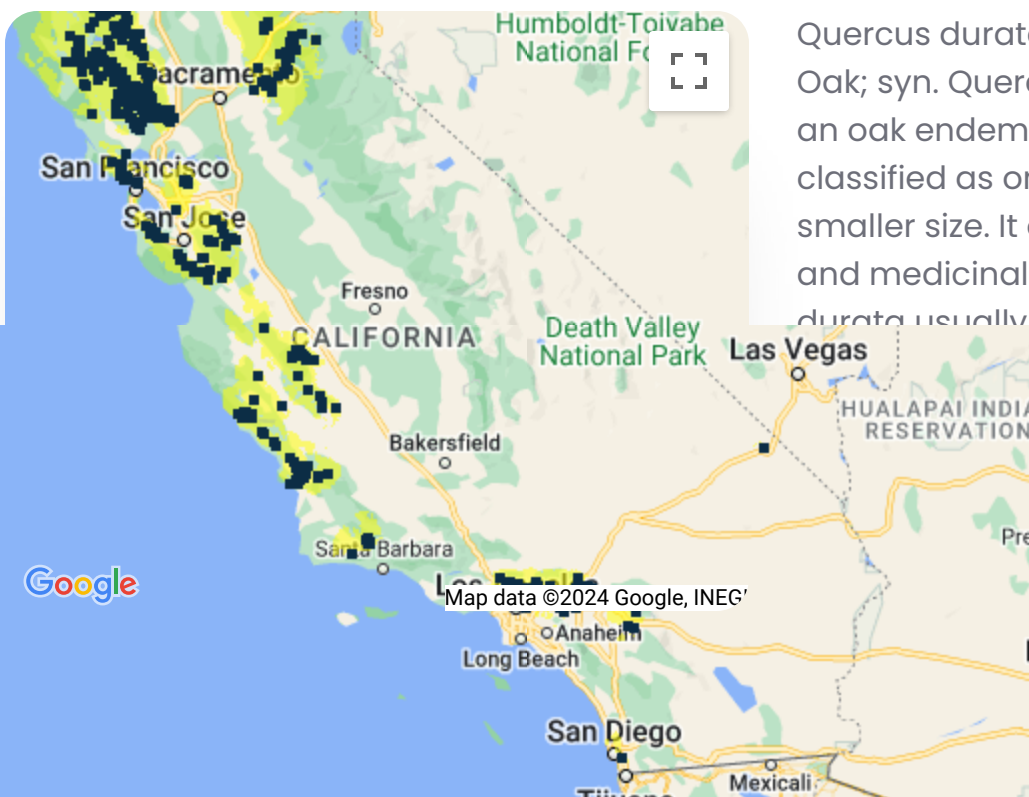
Leather Oak

Quercus durata

Carried by 6 nurseries

[View Availability at Nursery](#)

Estimated plant range



Plant description

Quercus durata (California Scrub Oak, Leather Oak; syn. *Quercus dumosa revoluta* Sarg.) is an oak endemic to California. This plant is classified as one of the shrub oaks due to its smaller size. It often used as an urban tree and medicinal plant. In the wild, *Quercus durata* usually grows in serpentine soils, often in the chaparral of the Coast Range from San Luis Obispo to San Luis Obispo. Existing populations in the Sierras of the San Gabriel Mountains. CNPS has identified a San Gabriel population to be a distinct variety. In the garden this plant does not require special fine soil and can tolerate drought and clay-rich soil. It is best adapted to relatively

EXH-003

December Plant of the Month

Quercus durata, Leather Oak

by Doreen Smith

Leather oak, *Quercus durata*, is common and nearly always found on serpentine-derived soils. In Marin this scrub oak grows in the chaparral of Mt. Tamalpais, Big Rock Ridge and Mt. Burdell.

“Our other scrub oak, *Quercus berberidifolia*, is very uncommon here, not on serpentine, and only easily discovered near Gold Grade fire-road halfway up the San Pedro Mountain behind Dominican University, San Rafael.

Photos by Vernon and Doreen Smith



Quercus durata var. durata – (leather oak)



Quercus durata var. durata – (leather oak)



Quercus berberidifolia – (scrub oak)

The California Native Plant Society is a non-profit organization dedicated to the conservation of California native plants and their natural habitats, and to increasing the understanding, appreciation, and horticultural use of native plants.

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[Newsletter](#) [Volunteer](#) [Donate](#) [Store](#)

Sign up for our monthly newsletter



Naturally-Occurring Asbestos General Information

- Asbestos is a term used for several types of naturally-occurring fibrous minerals found in many parts of California. The most common type of asbestos is chrysotile, but other types are also found in California. Serpentine rock often contains chrysotile asbestos. Serpentine rock, and its parent material, ultramafic rock, is abundant in the Sierra foothills, the Klamath Mountains, and Coast Ranges. Serpentine rock is typically grayish-green to bluish-black in color and may have a shiny appearance.
- Asbestos is commonly found in ultramafic rock, including serpentine, and near fault zones. The amount of asbestos that is typically present in these rocks range from less than 1% up to about 25%, and sometimes more. Asbestos is released from ultramafic and serpentine rock when it is broken or crushed. This can happen when cars drive over unpaved roads or driveways, which are surfaced with these rocks, when land is graded for building purposes, or at quarrying operations. It is also released naturally through weathering and erosion. Once released from the rock, asbestos can become airborne and may stay in the air for long periods.
- All types of asbestos are hazardous and may cause lung disease and cancer. Health risks to people are dependent upon their exposure to asbestos. The longer a person is exposed to asbestos and the greater the intensity of the exposure, the greater the chances for a health problem. Asbestos-related disease, such as lung cancer, may not occur for decades after breathing asbestos fibers. Cigarette smoking increases the risk of lung cancer from asbestos exposure.
- Other sources of asbestos are in manufactured products. The most common sources are heat-resistant insulators, cement, furnace or pipe coverings, inert filler material, fireproof gloves and clothing, and brake linings. Asbestos has been used in the United States since the early 1900's; however, asbestos is no longer allowed as a constituent in most home products and materials. Many older buildings, schools, and homes still have asbestos containing products. Therefore, laws are in place to protect citizens when these buildings are renovated or demolished.
- There are many laws pertaining to asbestos. The California Air Resources Board (CARB) adopted two statewide control measures, which prohibits the use of serpentine or ultramafic rock for unpaved surfacing and controls dust emissions from construction, grading, and surface mining in areas with these rocks. There may be additional or more stringent laws concerning asbestos in your area - please contact your local air pollution control district for further information.

For further information, please see the following fact sheets:

[Fact Sheet #1: Health Information on Asbestos](#)

[Fact Sheet #2: School Advisory for Naturally-Occurring Asbestos](#)

[Fact Sheet #3: Ways to Control Naturally-Occurring Asbestos Dust](#)

[Fact Sheet #4: Naturally Occurring Asbestos around Your Home](#)

[Fact Sheet #5: Monitoring for Asbestos](#)

Where can I find more information on California's regulation?

For additional information, please visit [CARB's asbestos webpage](#).



California
Environmental
Protection
Agency

**Air
Resources
Board**

1001 I St.
Sacramento, CA
(916) 322-2990

Contacts:

*General
Information:*
Jerry Martin
(916) 322-2990

*Health
Information:*
Jim Aguila
(916) 322-8283

*Control
Information:*
Richard Boyd
(916) 322-8285

*Monitoring
Information:*
Jeff Cook
(916) 322-3726

*Indoor
Asbestos:
Information:*
Dorothy Shimer
(916) 327-8693

Fact Sheet #1

Health Information on Asbestos

Asbestos is classified as a known human carcinogen by State, federal, and international agencies. It was identified by the Air Resources Board (ARB) as a toxic air contaminant in 1986.

“ Asbestos minerals belong to either the serpentine mineral group or the amphibole mineral group. The most common type of asbestos found in California is chrysotile, a serpentine mineral; other types include tremolite asbestos and actinolite asbestos which are amphibole minerals. State and federal health officials consider all types of asbestos to be hazardous. No safe asbestos exposure level has been established for residential areas.

“ The risk of disease depends upon the intensity and duration of exposure. Exposure to low levels of asbestos for short periods of time poses minimal risk. Asbestos fibers can penetrate body tissues and remain in the lungs and the tissue lining of the lungs and abdominal cavity. The fibers that remain in the body are thought to be responsible for asbestos-related diseases. The illnesses caused by asbestos may not be observed for twenty or more years.

“ The most common serious diseases caused by asbestos are listed below:

Asbestosis: Asbestosis is a non-cancerous lung disease related to diffuse fibrous scarring of the lungs. This disease has occurred in people heavily exposed to asbestos in the workplace and in household contacts of asbestos workers. Asbestosis can cause progressive shortness of breath and coughing.

Lung cancer: Lung cancer is a relatively common form of cancer which has been linked to smoking and a variety of occupational exposures. Cigarette smoking significantly increases the risk of lung cancer for those people exposed to asbestos.

Mesothelioma: Mesothelioma is a rare cancer of the thin membranes lining the lungs, chest, and abdominal cavity. Almost all cases are linked to prior occupational asbestos exposure.

“ Most of the information on health effects comes from studies of people who were regularly exposed to high levels of asbestos in the workplace. Workplace exposures are higher and much more likely to cause disease than non-workplace exposures.

“ Questions regarding health effects should be directed to your local air pollution control district, Mr. Jim Aguila of the ARB staff at (916) 322-8283, or Dr. Melanie Marty of the Office of Environmental Health Hazard Assessment at (510) 622-3154.

Naturally-Occurring Asbestos in Serpentine Soils Education Program

*Rachel Elkins and Julie Frazell,
University of California Cooperative Extension*

A Joint Project of

**Lake County Air Quality
Management District**

and

**University of California
Cooperative Extension**



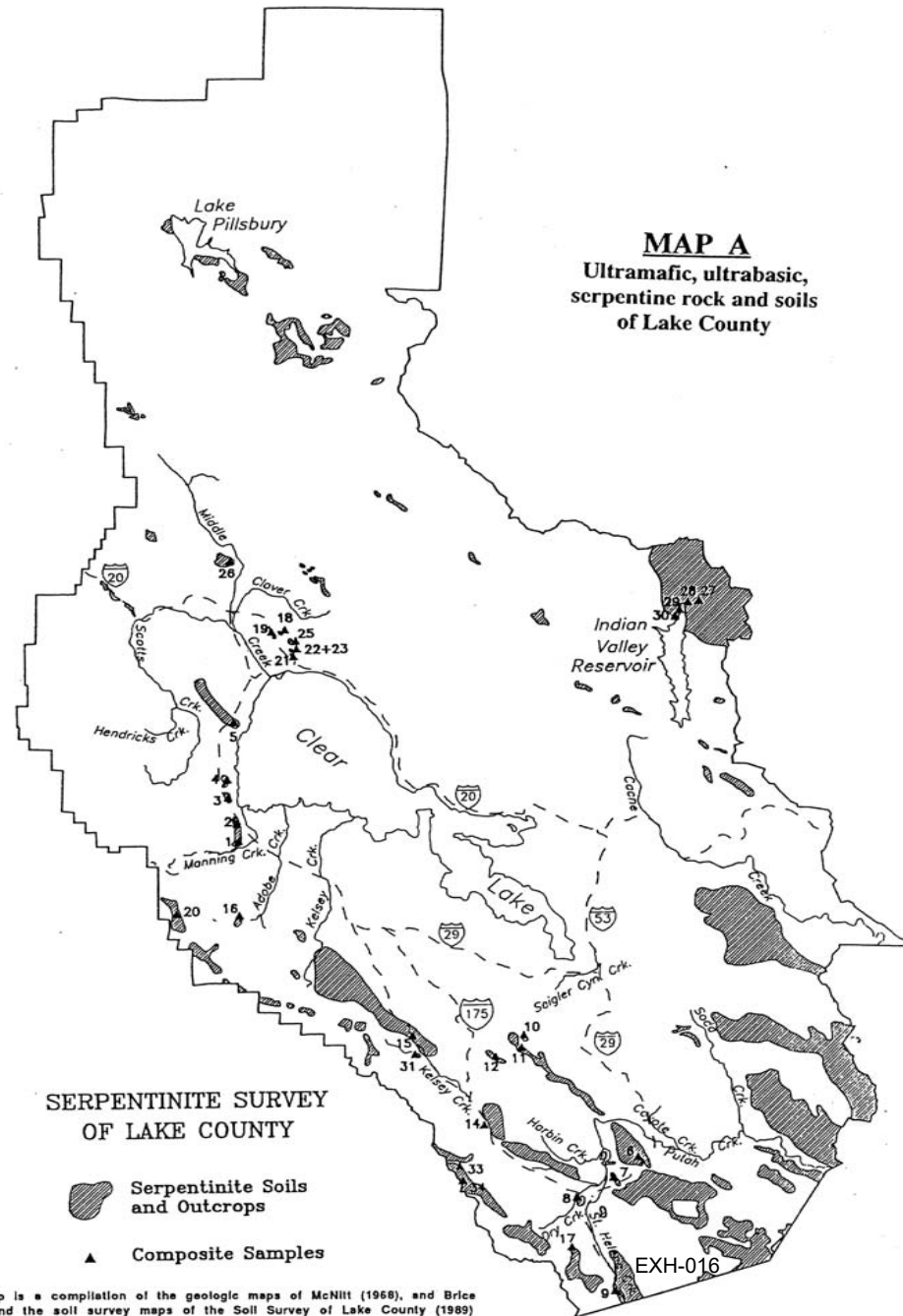
Discussing
**Community Concerns About
Asbestos-Containing
Rock or Soil**

~Community Concern~

**The Possible Risk of Disease
Associated With Repeated
Exposure to
Asbestos-Containing
Rocky-Soils or Dust**

Mapped Serpentine Areas in Lake County

Source: Lake County AQMD



What Is Serpentine ?

- California's state rock
- Contains fibers, also know as asbestos
- Asbestos can have health consequences



How to Recognize Serpentine



Greenish-gray in color with a waxy appearance.

Soils contain 10 % or more rock.



Martin Street, Lakeport

Campbell Hill, Lakeport



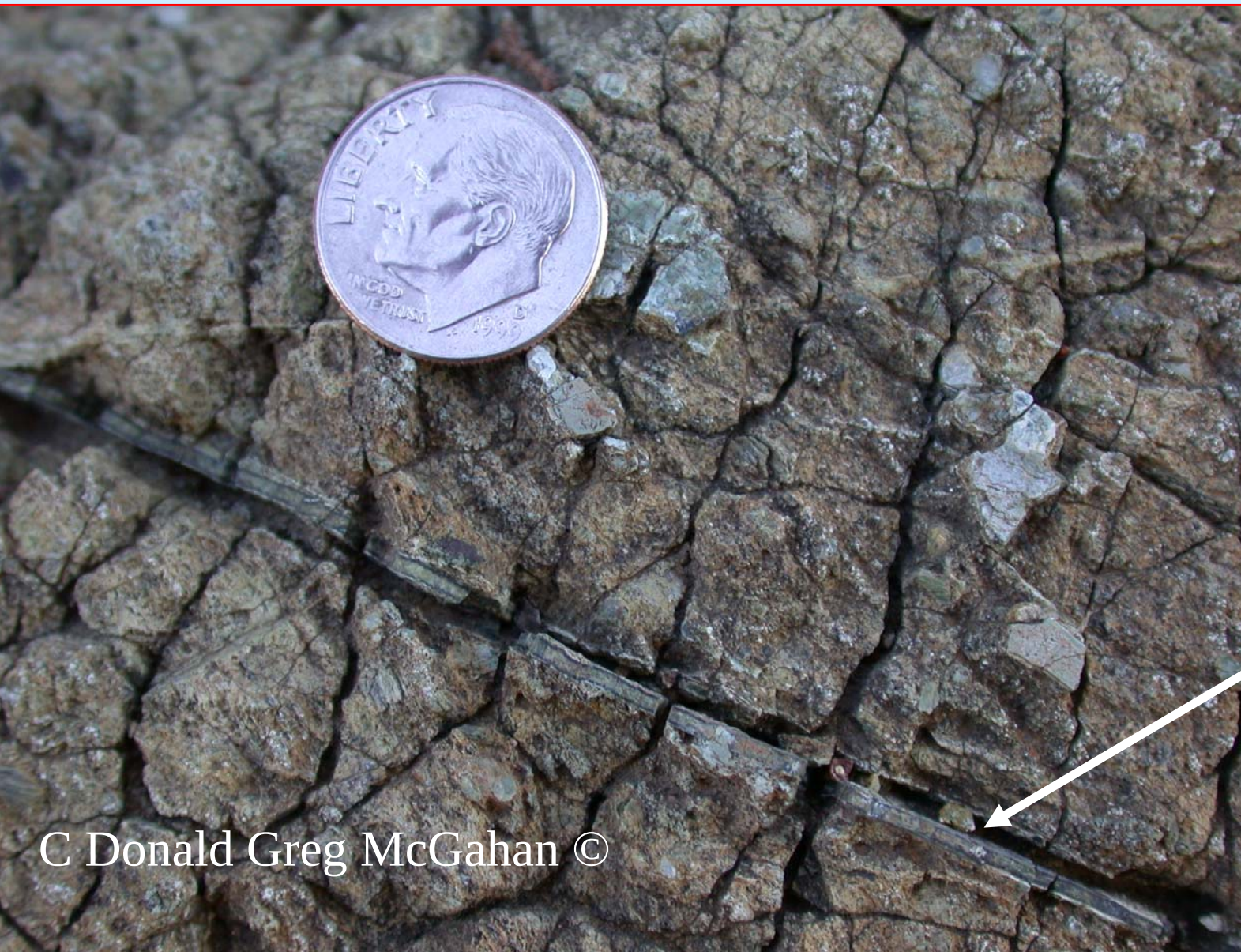
Photographs Courtesy of Lake County AQMD

Unique Shrubby or Stunted Vegetation



UC Davis – McLaughlin Reserve

Asbestiform-particles contained in Serpentinite

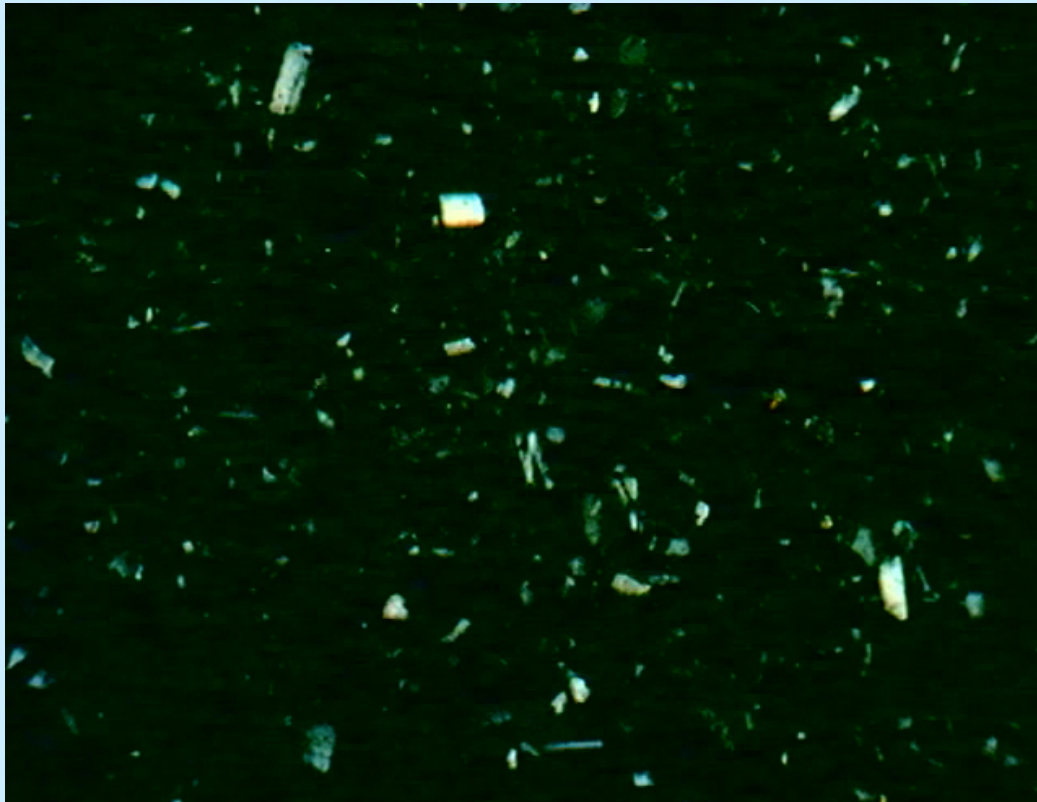


**Chrysotile
asbestos**

C Donald Greg McGahan ©

EXH-021

Asbestos is a General Term for Several Types of Naturally-Occurring Fibrous Minerals

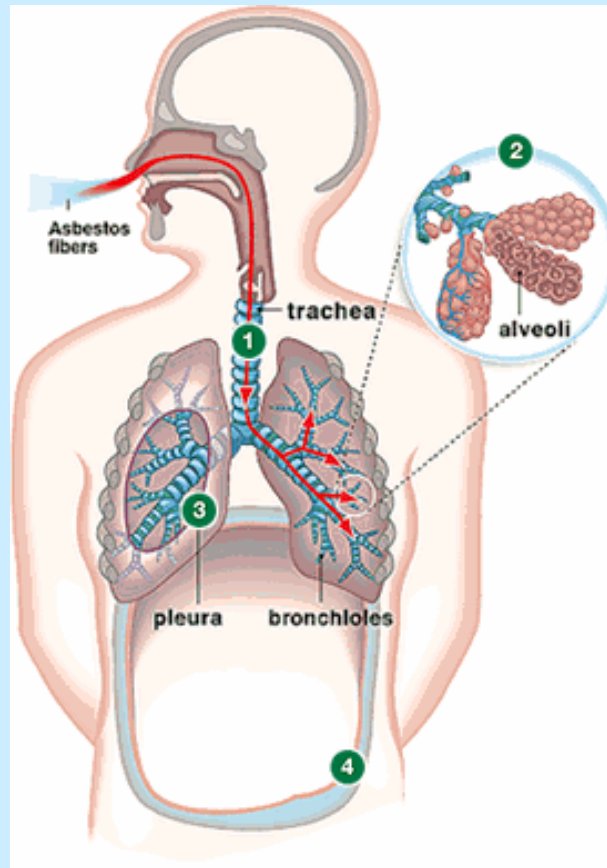


EXH-022

Source: Lake County AQMD - Serpentine / Chrysotile Asbestos, Polarized Light 200 sieve, 100x, 1.550HD

How Could Asbestos Fibers Affect My Health?

If inhaled or swallowed fibers may result in disease

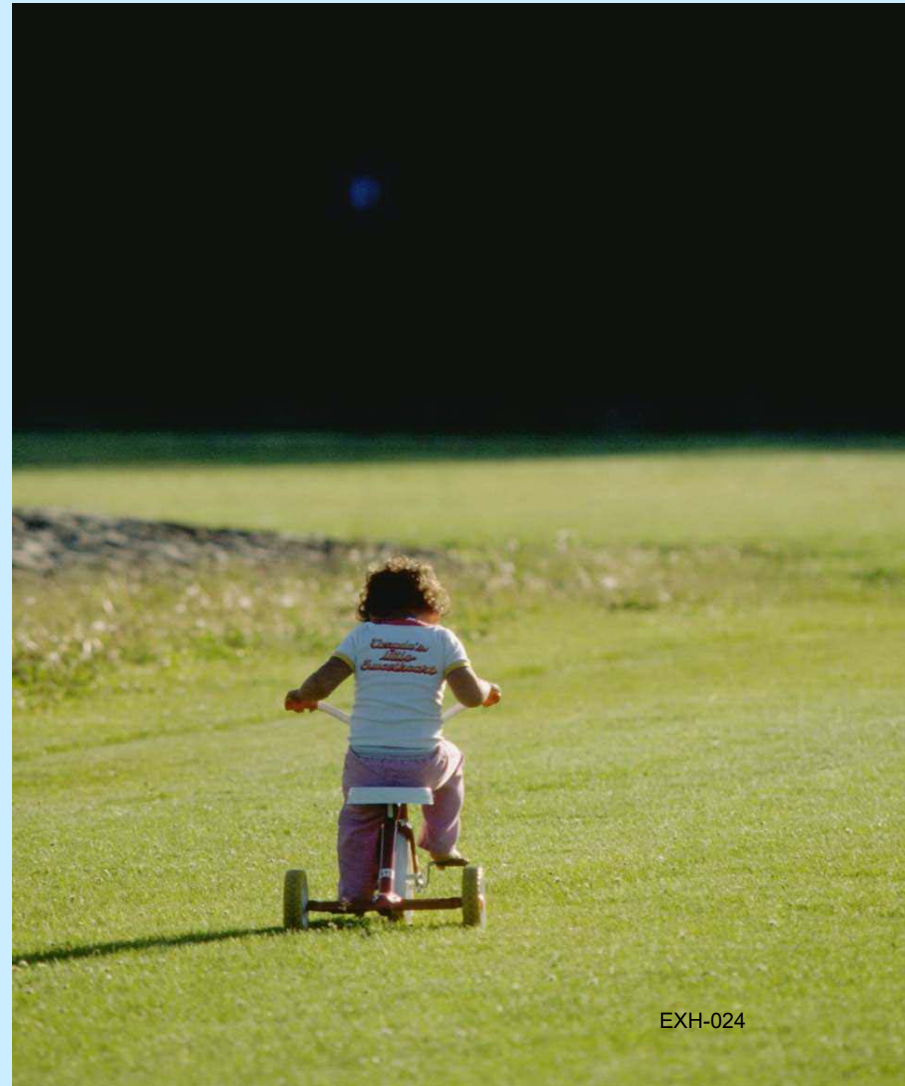


Smoking increases the chance of lung cancer

20-plus years may pass before disease appears.

Children Need Extra Protection

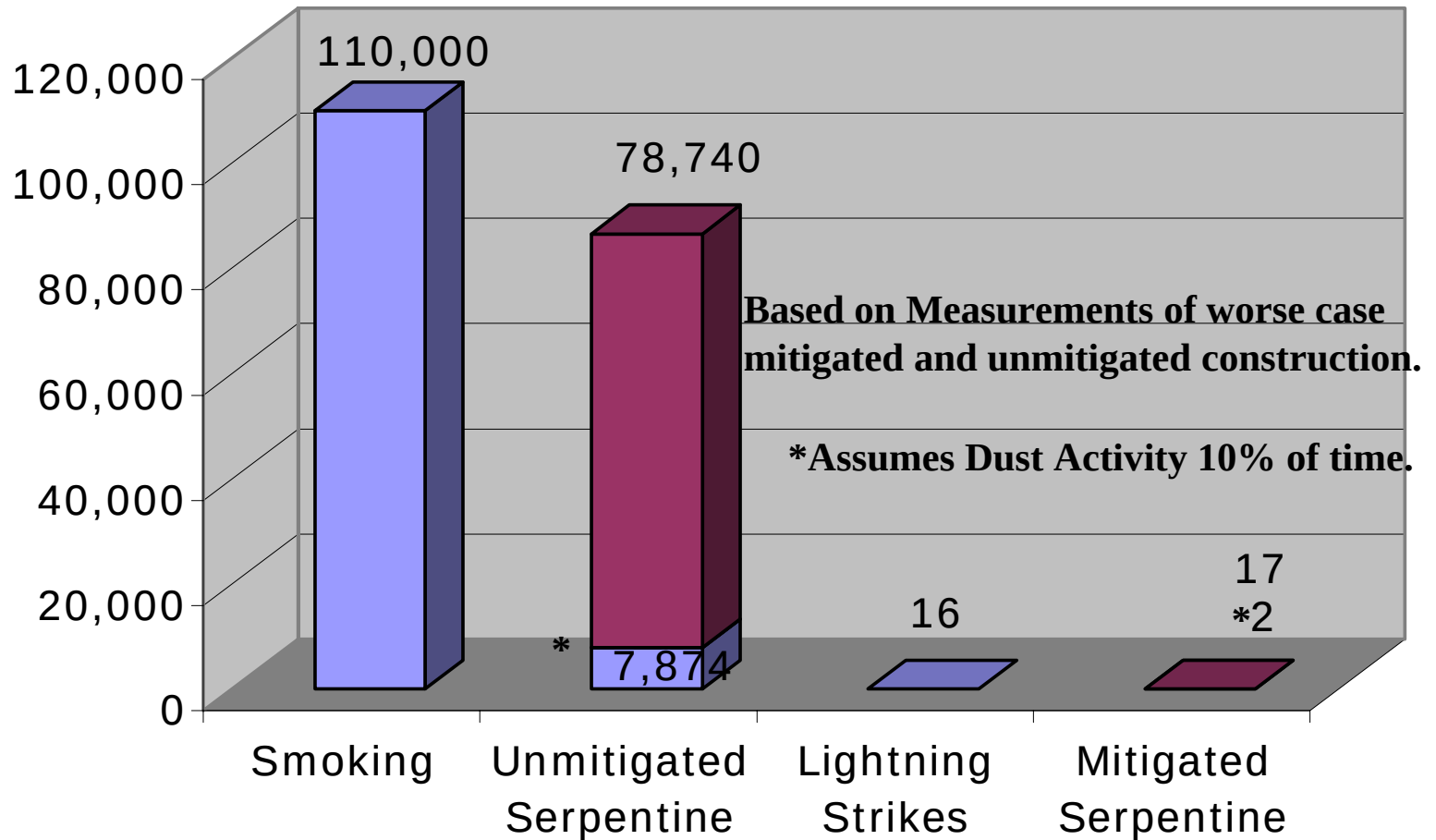
- Have a higher breathing rate
- Spend more time playing outside
- Reduce exposure now to reduce possible disease in 20 or more years



Any Exposure to Asbestos Fibers Involves Some Risk of Disease

- The more fibers you are exposed to, the higher the risk of disease.
- The fibers that remain in the body are thought to be responsible for asbestos-related disease.
- Reducing exposure will reduce risk of disease.

Deaths/Cancers Per Million Population Exposed (70 year lifespan of exposure)



If Asbestos-Containing
Serpentine Soils or Rock is
Located on Your Property:

**Reduce Activities
Which Create Visible Dust**

Outdoor Activities That Generate Dust When Soil is Dry

- Trenching
- Grading
- Plowing
- Rototilling
- Leaf Blowers
- Digging

Practice Proper Dust Controls With All Outdoor Activities

- Pre-soak ground thoroughly
- Use water to clean walkways
- Landscape exposed areas
- Remove exposed shoes or clothing before entering the house

Stabilize the Soil to Reduce Dust and Natural Weathering

Cover serpentine landscapes with:

- ✓ Serpentine tolerant plants
- ✓ 3-6 inches of organic mulch
- ✓ 3-6 inches of asbestos free soil



How Fibers May Enter The Home

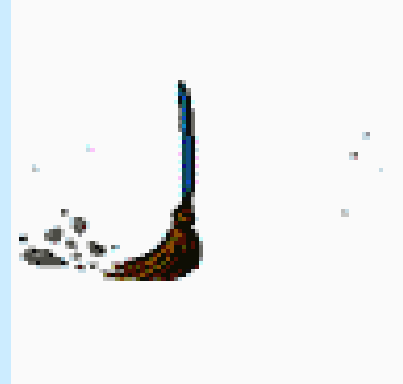
- Asbestos fibers settle on shoes and clothes and can be tracked into the home.
- Fibers can be transferred to others by pets.



Indoor Activities Which May Spread Asbestos Fibers in the Home

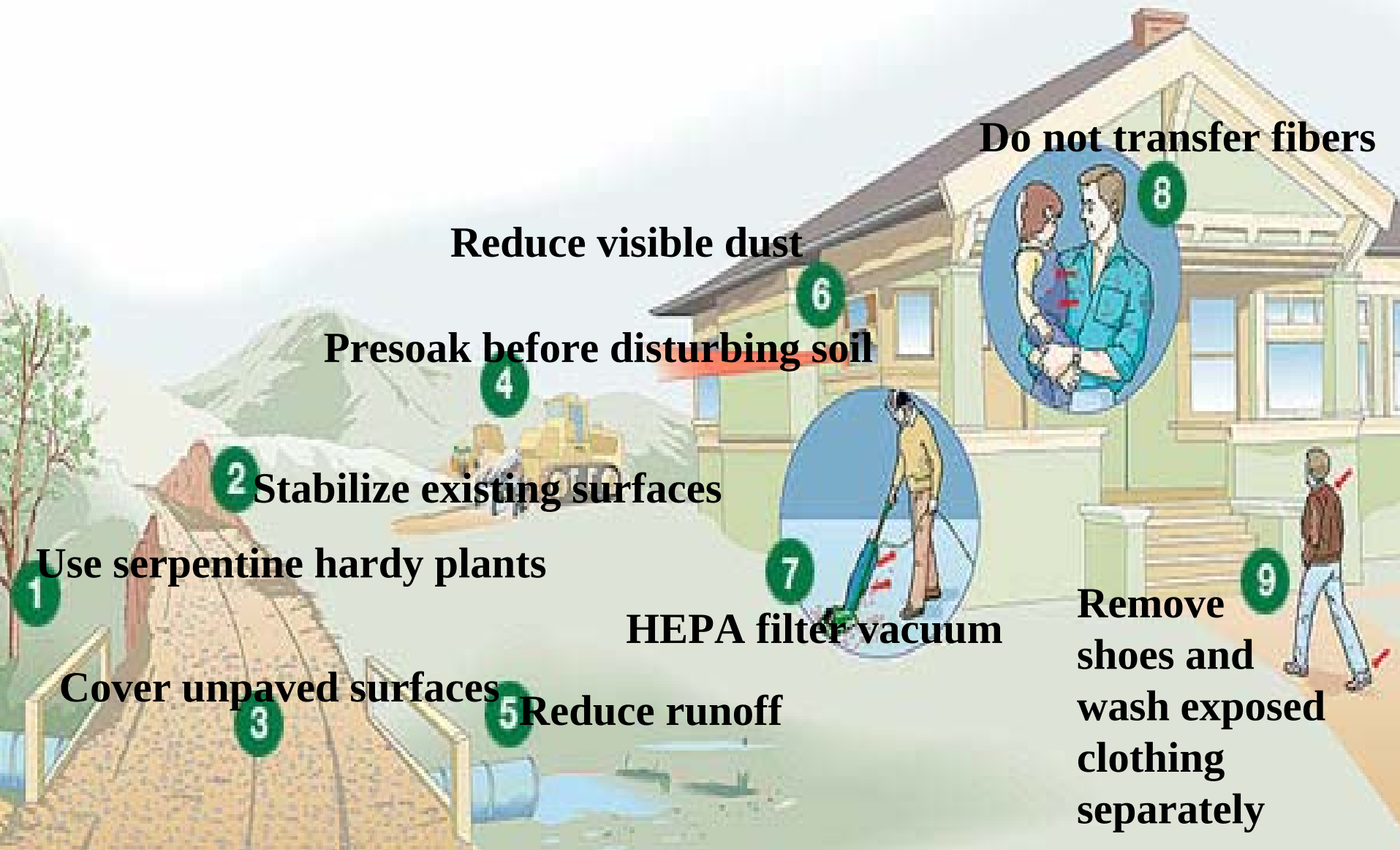
Take care when:

- Sweeping
- Vacuuming
- Dry Cloth Dusting
- Feather Dusters



Ways To Reduce the Spread of Fibers in the Home

- Damp cloth dusting
- Washable area rugs
- HEPA filter vacuum
- Damp mop
- Wash exposed clothing separately



**Just as sun screen has become
commonly used to reduce our
risk of skin cancer**

**Reducing visible dust will
reduce our risk of disease
associated with asbestos-
containing dust**

Acknowledgments

- California Air Resources Board
- Lake County Air Quality Management District
- University of California Cooperative Extension
- California Geological Survey
- UC Davis McLaughlin Reserve

A photograph of a rocky landscape with numerous purple flowers, likely California poppies, growing among the rocks and dry grass. The flowers are in various stages of bloom, with some fully open and others as buds. The rocks are dark and jagged, and the background is filled with dry, brownish grass and more rocks.

Thank You

Photograph Courtesy of Lake County AQMD

EXL-037



Asbestos Fact Sheet - Information on Health Risks from Exposures to Asbestos

May 8, 2000

Asbestos is the common name for a group of naturally occurring fibrous silicate minerals that can separate into thin but strong and durable fibers. The principal forms of asbestos include chrysotile, crocidolite, amosite, tremolite, actinolite, and anthophyllite. All but chrysotile are classified as amphiboles, which tend to have a thin, needle-like appearance. Chrysotile breaks into curly fibers. Asbestos deposits are located in many parts of California and are commonly associated with serpentine.

- Asbestos is classified as a known human carcinogen by State, Federal, and International agencies. Asbestos was identified as a Toxic Air Contaminant in 1986 by the Air Resources Board.
- Asbestos fibers can cause health problems if inhaled. When asbestos fibers become airborne, they can be inhaled deep into the lung. Many fibers deposited in the lung are retained there for long periods of time, others may be translocated to other parts of the body (e.g., the lining of the lung and abdomen), and others are completely cleared, albeit slowly. The fibers can cause chronic local inflammation and disrupt orderly cell division, both of which can facilitate the development of asbestosis and cancer. Thus, inhalation of asbestos fibers can initiate a chain of events resulting in cancer or other asbestos-related illness, which may not become apparent for years, even long after the exposure has ended.
- Most of the information on health effects comes from studies of workers exposed regularly to high levels of asbestos. In occupational settings all forms of asbestos have been shown to cause asbestosis, lung cancer and mesothelioma. Asbestosis is a noncancerous lung disease involving diffuse fibrotic scarring of the lungs. Persons with asbestosis can experience progressive shortness of breath. Lung cancer is associated with asbestos exposures; cigarette smoking and asbestos exposure multiply the risk of lung cancer beyond that caused by exposure to either of these materials separately. Mesothelioma is an incurable cancer of the lining of the chest cavity and abdomen.
- People have been exposed to asbestos by living with asbestos workers or living in the vicinity of asbestos mines and factories. People exposed to asbestos in such non-occupational settings have also had asbestos-related diseases including cancer. While most asbestos-associated cancers are related to the intensity and duration of exposure, reports in medical journals have linked some mesotheliomas to short exposure periods, on the order of months. Even in these cases, however, usually many years (20 years or more) elapse between the time of initial exposure to asbestos and the development of mesothelioma. In addition, there are reports of markedly elevated mesothelioma rates in populations living in areas in Greece, Turkey and New Caledonia with substantial quantities of tremolite in soil, particularly among individuals who used tremolite asbestos to whitewash their homes, resulting in substantial exposure. These populations had ongoing low-level as well as episodic high-level exposures to tremolite.
- There are some data that indicate amphibole forms of asbestos are more potent than chrysotile in inducing mesothelioma (but equipotent in inducing lung cancer). However, the data do not allow conclusive statements in this regard. Chrysotile and tremolite forms frequently occur together. Since many factors impact the potency of asbestos, the quantification of risk is inexact and at the present time all forms of asbestos are treated in risk assessment as equally potent carcinogens for both lung cancer and mesothelioma.
- Asbestos was used in many household and building products in the past. In part because of this indiscriminate dispersal of asbestos in the human environment in past years, it is common to find hundreds of thousands to millions of fibers in human lungs. Generally those with heavy exposures have greater asbestos lung burdens. For example, lung tissue taken from patients with mesothelioma often contains over a million fibers per gram of tissue.

- "Background" rates of mesothelioma for the general population in the United States with minimal exposure to asbestos are about 1 to 2 cases per 1 million people , though in communities in which there has been substantial occupational exposure such rates may be several-fold higher. Background rates for lung cancer are higher mostly due to smoking. Asbestosis is generally associated with occupational exposures but nonoccupational exposures, particularly to household contacts of people working in the industry, have resulted in asbestosis.
- For individuals living in areas of naturally occurring asbestos, there are many potential pathways for airborne exposure. Exposures to soil dust containing asbestos can occur under a variety of scenarios, including children playing in the dirt, dust raised from unpaved roads and driveways covered with crushed serpentine, uncontrolled quarry emissions, grading and construction associated with development of new housing, gardening and other human activities. For homes built on asbestos outcroppings, asbestos can be tracked into the home and can also enter as fibers suspended in outdoor air. Once such fibers are indoors, they can be resuspended by normal household activities, such as vacuuming (as many fibers will simply pass through vacuum cleaner bags).
- The general public exposed to low levels of asbestos may be at elevated risk (e.g., above background rates) of lung cancer and mesothelioma. The risk is proportional to the cumulative inhaled dose (number of fibers), and also increases with the time since first exposure. Although there are a number of factors that influence the disease-causing potency of any given asbestos, such as fiber length and width, fiber type, and fiber chemistry, all forms are carcinogens, and exposure should be minimized. The Air Resources Board has additional information on asbestos including ways to reduce exposure on its web page at <http://www.arb.ca.gov/toxics/Asbestos/general.htm>

Chemical Reference

Asbestos

Cal EPA

- > Air Resources Board
- > Cal Recycle
- > Department of Pesticide Regulation
- > Department of Toxic Substances Control
- > State Water Resources Control Board

Alerts

- > Amber Alert
- > Cal Alerts
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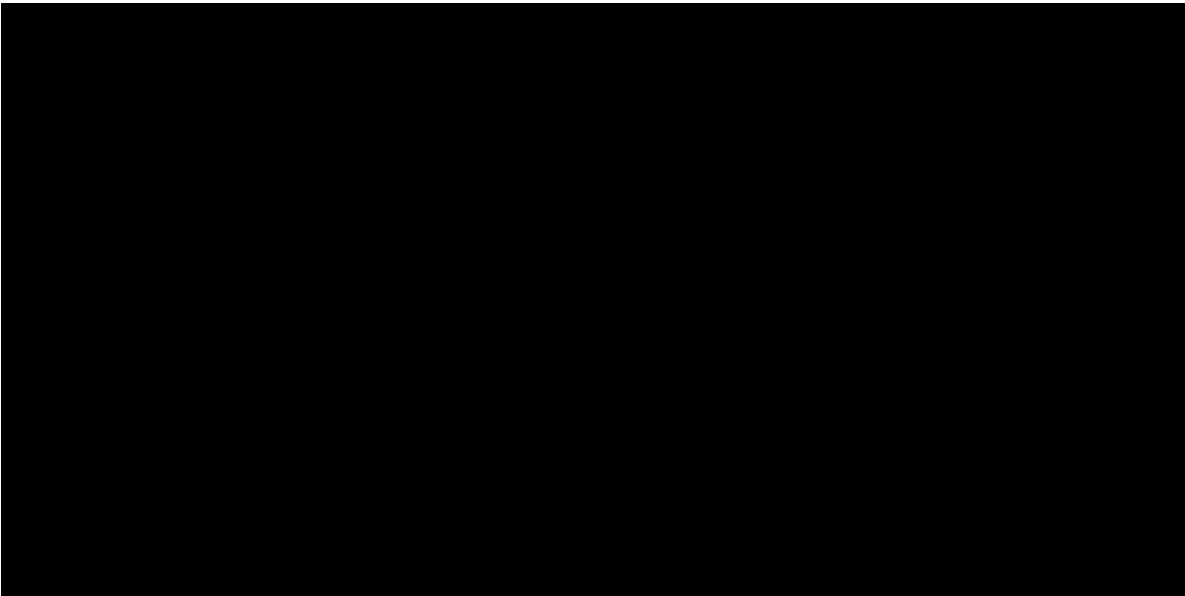
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EPA bans remaining uses of cancer-causing asbestos in the US

The agency enacted a partial ban in 1989, but some uses have remained.

By [Kelly Livingston](#)

March 18, 2024, 2:06 PM



EPA announces ban on remaining uses of asbestos

The announcement comes as part of President Joe Biden's Cancer Moonshot initiative, which is using fe...

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The Environmental Protection Agency on Monday announced a United States ban on the ongoing use of chrysotile asbestos -- a carcinogen that the agency estimates is linked to more than 40,000 U.S. deaths each year.

The announcement comes as part of President Joe Biden's [Cancer Moonshot](#) initiative, which is using federal resources to make progress on cancer research and treatment.

"While the use of asbestos in the United States has been declining for decades, the use of chrysotile asbestos has continued to this day. Because of its resistance to heat, fire and electrical conduction, it has remained in use for a variety of construction and industrial products," EPA Administrator Michael Regan said in a Monday press call.

"But the science is clear and settled," Regan added. "There is simply no safe level of exposure to asbestos."

Chrysotile asbestos is the only known form of asbestos currently used in or imported to the U.S. Exposure to asbestos can cause lung cancer, mesothelioma, ovarian cancer and other health issues, Regan said. It is also linked to more than 40,000 deaths in the U.S. each year, according to the EPA.

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"Asbestos has harmed people across the country for decades, and under President Biden's leadership, we are taking decisive action to ban its use and advance this administration's historic environmental justice agenda," White House Council on Environmental Quality Chair Brenda Mallory said in a news release. "This action marks a major step to improve chemical safety after decades of inadequate protections, helping advance President Biden's Cancer Moonshot goal to end cancer as we know it."

The EPA previously tried to ban asbestos in most products under the Toxic Substances Control Act in 1989, but the U.S. Fifth Circuit Court of Appeals ruled the ban could apply only to products that would use asbestos for the first time. Continued use of asbestos in existing products was permitted.

Asbestos is currently used in the U.S. in products such as brake linings and gaskets in cars and in the production of chlorine.



An asbestos danger sign is seen in front of the three row houses that were heavily damaged by fire, Jul...

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Monday's ban is the first the EPA has issued for existing chemical use since Congress [updated the Toxic Substances Control Act in 2016](#), which changed the process for evaluating and addressing safety concerns.

"The failed asbestos ban from over 30 years ago was the reason why we needed to rewrite TSCA. And why Congress did so with almost unanimous support in 2016," said Michal Freedhoff, assistant administrator for the Office of Chemical Safety and Pollution Prevention. "Today's rule is important for public health, but it's also a symbol of how the new law can and must be used to protect people."

MORE: Biden set to issue executive order on women's health→

Regan called the ban a "sign of what's to come."

"The Biden administration is transforming the way EPA is using the new chemical safety law to do what it was meant to do -- protect people from toxic chemicals," he said.

The EPA has set compliance deadlines for the ban to transition away from different uses of chrysotile asbestos, attempting to provide a reasonable transition period while discontinuing the use of asbestos in each product as soon as possible, the agency said.

"At EPA, protecting public health and the environment is our privilege and our greatest responsibility," Regan said. "And today's rule is a major step forward in helping us to achieve our goals."



Occupational Safety and Health Administration

Asbestos

Overview

What is asbestos?

Asbestos is the name given to a group of naturally occurring minerals that are resistant to heat and corrosion. Asbestos has been used in products, such as insulation for pipes (steam lines for example), floor tiles, building materials, and in vehicle brakes and clutches. Asbestos includes the mineral fibers chrysotile, amosite, crocidolite, tremolite, anthophyllite, actinolite and any of these materials that have been chemically treated or altered. Heavy exposures tend to occur in the construction industry and in ship repair, particularly during the removal of asbestos materials due to renovation, repairs, or demolition. Workers are also likely to be exposed during the manufacture of asbestos products (such as textiles, friction products, insulation, and other building materials) and during automotive brake and clutch repair work.

What are the hazards of asbestos?

Asbestos is well recognized as a health hazard and its use is now highly regulated by both OSHA and EPA. Asbestos fibers associated with these health risks are too small to be seen with the naked eye. Breathing asbestos fibers can cause a buildup of scar-like tissue in the lungs called asbestosis and result in loss of lung function that often progresses to disability and death. Asbestos also causes cancer of the lung and other diseases such as mesothelioma of the pleura which is a fatal malignant tumor of the membrane lining the cavity of the lung or stomach. Epidemiologic evidence

has increasingly shown that all asbestos fiber types, including the most commonly used form of asbestos, chrysotile, causes mesothelioma in humans.^{1,2,3}

What can be done to reduce the hazards of asbestos?

Worker exposure to asbestos hazards are addressed in specific OSHA standards for the construction industry, general industry and shipyard employment sectors. These standards reduce the risk to workers by requiring that employers provide personal exposure monitoring to assess the risk and hazard awareness training for operations where there is any potential exposure to asbestos. Airborne levels of asbestos are never to exceed legal worker exposure limits. There is no "safe" level of asbestos exposure for any type of asbestos fiber.^{4,5} Asbestos exposures as short in duration as a few days have caused mesothelioma in humans.^{4,5,6,7} Every occupational exposure to asbestos can cause injury of disease; every occupational exposure to asbestos contributes to the risk of getting an asbestos related disease.⁸ Where there is exposure, employers are required to further protect workers by establishing regulated areas, controlling certain work practices and instituting engineering controls to reduce the airborne levels. The employer is required to ensure exposure is reduced by using administrative controls and provide for the wearing of personal protective equipment. Medical monitoring of workers is also required when legal limits and exposure times are exceeded.

Hazards

Provides references that describe health hazards of asbestos and how to recognize them.

[More »](#)

Evaluating and Controlling Exposure

Provides assistance for evaluating and controlling asbestos exposures.

[More »](#)

Construction

Provides information specific to asbestos in construction.

[More »](#)

Standards

Asbestos is addressed in specific OSHA standards for general industry, maritime, and construction.

[More »](#)

Additional Resources

Provides links and references to additional resources related to asbestos.

[More »](#)

¹ "[Asbestos \(Chrysotile, Amosite, Crocidolite, Tremolite, Actinolite, and Anthophyllite\).](#)"

World Health Organization (WHO), International Agency for Research on Cancer (IARC) Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 100C, 2012.

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Naturally Occurring Asbestos: Approaches for Reducing Exposure

Purpose and Intended Audience

This fact sheet provides an overview of approaches for reducing exposures to naturally occurring asbestos (NOA). It is intended to make general information about management options available to state and local government officials, project managers, and environmental professionals. The information should serve as a starting point for identifying current NOA management practices. In general, selecting an appropriate approach to reduce NOA exposure should be determined on a location-specific basis.

NOA management approaches can reduce but may not completely eliminate potential exposures to naturally occurring asbestos.

Information contained in this fact sheet was obtained from the currently available literature, including state and local government publications. To obtain more information on NOA management approaches, including their performance and frequency of use, refer to the resources provided at the end of this fact sheet.

Naturally Occurring Asbestos

NOA occurs in rocks and soil as a result of natural geological processes. Natural weathering and human activities may disturb NOA-bearing rock or soil and release mineral fibers into the air, which pose a greater potential for human exposure by inhalation.

The U.S. Geological Survey (USGS) has an ongoing project to map the locations of historical asbestos mines, former asbestos exploration prospects, and natural asbestos occurrences. At least 35 states have reported NOA locations. To locate NOA areas in a specific part of the country, begin by consulting the USGS reports (see below) and contact a state geologist.

U.S. Geological Survey	• Eastern United States http://pubs.usgs.gov/of/2005/1189/ • Central United States http://pubs.usgs.gov/of/2006/1211/ • Rocky Mountain States http://pubs.usgs.gov/of/2007/1182/ • Southwestern United States http://pubs.usgs.gov/of/2008/1095/
California Geological Survey	Asbestos Reports, Maps, and Guidelines for Geologic Investigations • http://www.conservation.ca.gov/cgs/minerals/hazardous_minerals/asbestos/Pages/Index.aspx

This fact sheet is intended solely to provide general information on approaches that may be useful when addressing naturally occurring asbestos (NOA). It is not intended, nor can it be relied upon, to create any rights enforceable by any party, including any party in litigation with the United States. EPA considers NOA to be in an altered form if it has been disturbed by human activity; NOA is not considered to be altered if modified solely through naturally occurring processes or phenomena, from a location where it is naturally found. This fact sheet may be revised periodically without public notice. Use or mention of trade names does not constitute endorsement or recommendation for use.

In this fact sheet, NOA does not refer to commercially processed, asbestos-containing material, such as insulation and fire protection in buildings or automobile brake linings. Information about commercial asbestos-containing products is available in other publications, including the resources mentioned on EPA's asbestos Web page <http://www.epa.gov/asbestos>.

Approaches for Mitigating Exposures to NOA

The following general approaches to mitigate inhalation exposures to NOA are aimed at reducing NOA releases from rock or soil into the air:

- Leave NOA material in place and undisturbed
- Cover or cap NOA material
- Limit dust generating activities
- Excavate and dispose of NOA material

Depending on the situation, a combination of engineering controls, work practices, and institutional (administrative) controls may be needed to implement an approach and reduce potential exposures to NOA. Selecting an approach depends on factors including:

- Accessibility of NOA (ground surface vs. below ground surface)
- Types of activities that disturb NOA (construction project vs. gardening)
- Climate and weather conditions
- Current and future land uses
- Technical and administrative feasibility of the approach

Approaches for reducing NOA exposure are similar to practices used for asbestos-containing materials in commercial applications.

Typical engineering controls involve the use of covers and caps, vegetation, fencing, landscaping, and in some conditions, the application of water to suppress dust. Local factors, such as climate, influence the extent to which these approaches are implemented. For example, areas with dry or windy conditions may need more dust control than those with humid or less windy conditions.

Common work practices include limiting activities on NOA-containing areas, reducing driving speed on unpaved roads that may contain NOA, and cleaning vehicles driven over NOA. For example, during road construction or maintenance activities on unpaved areas where NOA is present, the Asbestos Airborne Toxics Control Measure (ATCM) for Construction, Grading, Quarrying, and Surface Mining Operations of the California Air Resources Board (ARB) requires that vehicle speeds not exceed 15 miles per hour.¹ Worker health and safety measures that include respiratory protection may be warranted. For information, consult with Occupational Safety and Health Administration Asbestos Standards for the General Industry and Asbestos Standards for the Construction Industry (<http://www.osha.gov/SLTC/asbestos/hazards.html>).

Examples of Engineering and Work Practices that Reduce Exposure to NOA

Excavation, Grading, or Utility Work at Construction Projects	• Wet road surfaces with water using trucks, hoses, or sprinklers¹ • Wet piles of excavated material and cover them with tarps, plastic sheeting, or other items¹ • Continuously mist the work area¹ • Install wind barriers around the work area¹ • Clean or decontaminate equipment and vehicles to ensure that no equipment or workers track soil out of the work area (a gravel pad, tire shaker, or wheel wash system may be used to clear soil from vehicles)¹ • Wet the work area using a spray system attached directly to rock cutting or drilling equipment, such as a fine-mist sprayer or a variable-rate fogger nozzle (similar to those used in fire fighting)² • Excavate utility trenches to an adequate depth and backfill them with clean soil so that future repair work will not need excavation into potential NOA-containing materials³ • When transporting NOA-containing materials, avoid overloading trucks; keep the material below the top of each truck compartment and cover material with a tarp⁴ • Limit personnel and vehicle access to the work area⁵ • Identify NOA-containing areas with signs² • Reduce driving speed¹ • Reduce drilling or excavating speeds⁶ • Excavate during periods of calm or low winds¹
Roads and Parking Areas (unpaved and gravel roads)	• Cover roads with non-NOA-containing rock, chemical sealants or dust suppressants, chip seals, limestone aggregate, petroleum sealants, or asphalt cement paving^{1, 7, 8} • Wet road surfaces with water¹ • Install windbreaks or berms¹ • Reduce driving speed¹ • Avoid dusty areas, especially in windy conditions¹

Around Communities (playgrounds, ball fields, pathways, and gardens)

- Cover areas of rock and soil with clean soil, rock, vegetation, or other material (see next section, General Considerations for Using Covers or Caps)^{3, 9}
- Pave over unpaved walkways, driveways, or roadways containing NOA^{1, 10}
- Landscape areas with vegetation, such as NOA-tolerant plants, and add a layer of organic mulch or NOA-free soil. Water plants often until they are established to minimize erosion⁹
- Water garden areas before digging⁹
- Keep windows and doors closed on windy days and during periods when nearby rock or soil may be disturbed, such as during construction⁹
- Limit track-in by using entryway (door) mats, and wipe down pets before they enter buildings to reduce the amount of soil tracked indoors^{4, 9}
- Allow children to play in outdoor areas only if the area has a ground covering, such as wood chips, mulch, sand, pea gravel, grass, asphalt, shredded rubber, or rubber mats⁴
- Relocate outdoor activities to areas that do not contain NOA (walk, run, hike, and bike only on paved trails)⁴
- Avoid dusty areas, especially in windy conditions¹¹

General Considerations for Using Covers or Caps

One of the most common engineering controls is to place a cover system over the NOA. Cover materials may include clean soil or rock, concrete, chemical sealants or dust suppressants, chip seals, limestone aggregate, petroleum sealants, asphalt paving, geotextiles, wood chips, mulch, sand, pea gravel, shredded rubber, rubber mats, and vegetation.

The complexity of cover systems can vary from simple (e.g., a single soil layer) to complex (e.g., multiple layers of varying materials). Several factors, including cover material properties and site characteristics, affect the type of cover system appropriate for a particular area.

The availability of materials may influence the type of cover used. Materials that are readily available and close to the NOA area may be more desirable and cost effective than materials found farther away. For example, artificial turf and other imported materials may be more expensive than locally available soils. The cover material will likely need to be assessed for NOA or other undesirable constituents. Expected lifetime, maintenance, and monitoring requirements also affect the cost of covers.

The slope of the NOA area may influence the type and thickness of the cover material used. For example, steep slopes may need vegetation or shotcrete (concrete or mortar sprayed onto a surface with a pressurized hose) to promote slope stabilization. Steep slopes typically have a higher potential for erosion and therefore may demand thicker cover material.

The thickness of the cover material should provide a safety factor sufficient to ensure that airborne releases will not occur. Thicker covers may be needed in areas where there is a significant potential for erosion. The surface of a cover should protect against erosion by wind and rain. Materials used for erosion control typically include a layer of topsoil and vegetation. In areas where adequate vegetation is not possible, gravel, admixtures, or riprap may be used for the surface layer. The thickness of the cover may also depend on the presence of other cover components, such as irrigation lines.

A geotextile, which is a geosynthetic material made of polymer fabric, may be placed below the cover material to mark the presence of NOA and serve as an erosional indicator. Geotextiles also can provide protection, reinforcement, drainage, and separation when applied to the soil surface or between layers of materials. The California Department of Toxic Substances Control (DTSC) recommends that landscaped areas and play fields at schools include a geotextile marker covered by sufficient cover material to provide an effective barrier to reduce NOA exposures.³ Placement of geotextile markers will demand additional time and expertise.

Long-Term Management Approaches

For long-term management of areas with NOA, institutional controls (ICs) and a maintenance plan may be desirable. In areas where NOA poses potential health concerns, local and state government officials should consider providing educational material to supplement engineering approaches for reducing exposures to NOA. The Agency for Toxic Substances and Disease Registry has developed a fact sheet about asbestos and NOA for the general public entitled “Asbestos and Health: Frequently Asked Questions.”⁴

Institutional Controls

Generally, ICs are administrative or legal mechanisms that are designed to help minimize the potential for human exposure to contamination. They also protect the integrity of the engineering measures. ICs are generally divided into four categories:

For additional information about ICs, refer to the Land Use Controls Web site at <http://www.lucs.org>

- *Government controls* include laws and permits (such as local zoning laws and permits required for excavating or digging). Work that may disturb NOA-containing soil may require government approval and may be subject to local or state construction guidelines. In California, the ATCM of the California ARB requires owners and operators to notify the local air quality management district within one business day of discovering NOA, serpentine mineral, or ultramafic rock in an area to be disturbed by construction, grading, quarrying, or surface mining operations.¹ In Virginia, the Fairfax County Health Department requires a compliance plan that includes air monitoring to ensure effective dust control during construction in areas containing NOA.²
- *Proprietary controls* include property use restrictions based on private property laws, such as land use easements or covenants.
- *Enforcement tools* include legally binding documents that require individuals or companies to conduct or prohibit specific actions.
- *Informational devices* include deed notices, public advisories, and other measures (such as warning signs and worker health and safety awareness training) that alert and educate people about an area.

Maintenance Plan

A maintenance plan can help ensure that engineering controls and work practices remain effective. In California, for example, DTSC and school districts enter into an agreement to develop and implement an approved long-term operation and maintenance plan under DTSC oversight. These plans generally contain information about the following topics:³

- Building locations, utility line locations, and the thickness of cover material across the area
- Routine inspections

- Maintenance work, including erosion and storm water control
- Procedures for repairing cover damage
- Monitoring activities, such as perimeter or personal air monitoring
- Reporting format and frequency
- Restrictions on future activities that may expose NOA
- Management of imported soil and future excavation or trenching activities

Additional Information

- Agency for Toxic Substances and Disease Registry - <http://www.atsdr.cdc.gov/NOA>
- California Air Resources Board - <http://www.arb.ca.gov/toxics/asbestos/asbestos.htm>
- El Dorado County, California - <http://www.co.el-dorado.ca.us/emd/apcd/asbestos.html>
- Fairfax County, Virginia - <http://www.fairfaxcounty.gov/hd/asb>
- Sacramento County, California - <http://www.airquality.org/compliance/asbestosNaturallyOccurring.shtml>
- U.S. Environmental Protection Agency - <http://www.epa.gov/asbestos/pubs/clean.html>

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List of Acronyms

ARB	Air Resources Board
ATCM	Airborne Toxic Control Measure
DTSC	Department of Toxic Substances Control
ICs	institutional controls
NOA	naturally occurring asbestos
USGS	U.S. Geological Survey



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Fact Sheet #3 Ways to Control Naturally-Occurring Asbestos Dust

“ Shown below are ways to control asbestos dust from construction projects and roadways. These control actions will not eliminate asbestos, but offer options to reduce release of airborne asbestos fibers from various activities.

Construction Projects and Roadways

Dust Source	Mitigation Measure	Application Frequency	Relative Effectiveness ¹
Excavation	Water wetting	as needed	2-3
	Excavate during calm periods	when possible	1
Mobile Construction Equipment	Water wetting of roads surfaces	as needed	2-3
	Rinse vehicles / equipment	as needed	3
	Wet loads of excavated material	each load	3
	Cover loads of excavated material	each load	2-3
	Wet and cover loads	each load	4
Exposed Ultramafic or Serpentine Areas	Water wetting	as needed	3-4
	Cover with 6 to 12 inches of non-asbestos material	end of project	4
	Wind breaks / berms	where needed	1-2
	Chemical sealants / dust suppressants	3 mos. - 1 yr.	3
	Vegetative reclamation	end of project	3
	Asphalt cement paving	as needed	4
Roads	Water wetting	as needed	3-4
	Speed control	always	1-3
	Wind breaks / berms	where needed	1-2
	Cover with 2 to 4 inches of non-asbestos rock	as needed	3-4
	Chemical sealants / dust suppressants	3 mos. - 1 yr.	2-3
	Single-coat chip/seal	as needed	4
	Triple-coat chip/seal	as needed	4
	Petroleum sealants	as needed	4
	Asphalt cement paving	as needed	4

1. Subjective rating where: 1 = least effective, and 4 = most effective

Facts about Serpentine Rock and Soil Containing Asbestos in California

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What is Serpentine?

The term “serpentine” refers to a group of minerals that make up serpentinite rock. “Serpentine” and “serpentinite,” however, are often used interchangeably. Serpentinite is a metamorphic rock formed when water and rock are exposed to low temperatures (about 400 to 600 °C) and metamorphic processes (high pressures) within the earth's crust. Serpentinite is a type of ultramafic rock, consisting predominantly of magnesium silicate and iron oxide minerals.

Most ultramafic rocks, including serpentinite, contain naturally occurring asbestos (NOA) particles (fig. 1), microscopic needlelike particles of asbestos or asbestos-like fibers. The term “NOA” also refers to a group of relatively common fibrous minerals in rock (U.S. Geological Survey 2007). NOA minerals include chrysotile and fibrous forms of five amphiboles. These forms include a complex group of widely distributed magnesium-iron silicates (rock-forming minerals), crocidolite, amosite, anthophyllite, actinolite, and tremolite. The most common NOA particle in ultramafic rocks is chrysotile.



NOA particles are a known human health risk. Asbestos has been classified as a carcinogen by state, federal, and international agencies. If serpentinite or ultramafic rock is located on your property or was used to construct your driveway or walkways, there is a risk of asbestos exposure where you live.

HOW TO RECOGNIZE SERPENTINE LANDSCAPES

Serpentine is California's state rock. The state contains over 1,988 square miles (3,200 sq. km) of serpentinite outcrops, and it is present in 42 of the 58 counties. It has a distinctive greenish-gray to bluish-black color and may have a waxy

Figure 1. Serpentine rock with veins of NOA. Source: U.S. EPA Naturally Occurring Asbestos Web site, <http://www.epa.gov/asbestos/pubs/clean.html>.



Figure 2. Serpentine bedrock exposed from road construction. Source: Doug Gearhart, Lake County Air Quality Management District.

or shiny appearance (fig. 2). Soils derived from serpentine support distinctive grasslands and chaparrals in many parts of central and northern California, especially in the Coast Ranges, the Klamath Mountains, and the Sierra foothills. Serpentine and ultramafic landscapes are best recognized by the stark contrast their vegetation type and density present compared with adjacent areas. Soils derived from serpentine and ultramafic rock support vegetation with low vigor and increased patchiness; they also contain more endemic species than do adjacent areas with soils derived from other rock types. Vegetation growing in soils derived from serpentine is often sparse or stunted because of low levels of calcium and high levels of magnesium, resulting in calcium deficiencies.

WHAT ARE THE HEALTH CONCERNS?

People may inhale or swallow dust containing asbestos fibers. These fibers can cause cancer and other diseases by remaining in the lungs or traveling to the lining of the lungs or the abdominal cavity. Twenty or more years may pass before symptoms of asbestos-related disease are observed. The two most common forms of cancer caused by long-term exposure to asbestos fibers are lung cancer and mesothelioma, a rare cancer

of the lining surrounding the lung, stomach, or heart. While smokers have an increased risk of lung cancer when exposed to asbestos, nonsmokers are also susceptible, and both groups are equally susceptible to mesothelioma.

NO “SAFE” LEVEL OF EXPOSURE TO ASBESTOS HAS BEEN ESTABLISHED

Any exposure to asbestos fibers involves some risk of disease. The level of risk depends on how often and to what degree one is exposed to asbestos fibers. No one knows how many fibers are needed to cause lung cancer or other diseases. Heavy and frequent occupational exposures are more likely to cause disease than are nonoccupational exposures; however, a lifetime of exposure to low levels is also recognized as a potential hazard.

Environmental health scientists have suggested that children have a higher risk of exposure than adults in the same environment due to their faster breathing rates, time spent outdoors, and greater time for disease to develop.

HOW ARE PEOPLE EXPOSED TO ASBESTOS FIBERS?

Individual asbestos fibers are so tiny they can be seen only with a microscope. Once disturbed, they may settle on the soil surface or become airborne. The risk associated with NOA particles in soils formed from serpentine or other rocks containing NOA is unclear. Soils contain a variety of aggregating agents such as organic matter, clay, iron oxides, and calcium carbonate. These constituents bind individual particles including NOAs into larger aggregates, which cannot be suspended in the atmosphere as dust and are less likely to reach the vulnerable areas of the lung. Soil disturbances that destroy soil aggregates and liberate individual particles or expose the parent rock to the atmosphere may increase the risk of exposure to NOA particles. Natural means and routine human activity that can expose or release dust that contains asbestos fibers may include

- disturbing dry soils, which can create dust that contains asbestos fibers
- exposing asbestos fibers to the soil surface by erosion from wind and water or through natural land movement
- storm water runoff, which can concentrate fibers that may become airborne when dried

- any form of mechanical exposure or disturbance of serpentinite bedrock

IMPROVEMENT OF EXISTING CONTROL MEASURES

On July 20, 2000, the California Air Resources Board (ARB) strengthened its asbestos airborne toxic control measures by eliminating the use of asbestos-containing serpentine rock for surfacing operations, such as road covering or landscaping. Dr. Alan Lloyd, ARB chairman, stated, “This amendment improves the existing control measure and better protects the public from the cancer-causing effects of asbestos-laden dust from gravel roads, parking lots and landscaping” (California Air Resources Board 2000).

LIVING WITH SERPENTINE SOILS

Soils that form from serpentinite are an important natural resource in California. They support a wide range of unique and rare plant and animal life. Taking simple, common-sense precautions helps reduce the risk to residents who have serpentine soils or rock on their property. Serpentine soils or rock should be left undisturbed and stabilized to reduce exposing or releasing fibers into the environment. As long as fibers remain bound in rock or soil, they pose very little health threat.

HOW CAN YOU AS A HOMEOWNER REDUCE YOUR EXPOSURE TO ASBESTOS DUST?

Avoid the following outdoor activities when serpentine soil is dry and dusty:

- rototilling, digging, jackhammering, grading, or plowing
- using leaf blowers
- driving on unpaved roads or driveways
- riding horses or moving livestock
- construction or renovation activities that disturb the soil, such as pool installation

To control dust around your home, always

- presoak dry ground thoroughly before disturbing the soil
- use water to clean sidewalks and driveways
- avoid using (pave them over, if necessary) unpaved walkways, driveways, or roadways that may have asbestos-containing rock or soil

Landscaping can reduce exposure of asbestos fibers:

- To reduce natural erosion and dust, cover serpentine soil with a layer of organic mulch or asbestos-free soil 3 to 6 inches (7.5 to 15 cm) thick. Plant gardens and yards with serpentine-tolerant plants (see ANR Publication 8400, *Trees and Shrubs for Northern California Serpentine Landscapes*, <http://anrcatalog.ucdavis.edu/pdf/8400.pdf>).
- Provide adequate water until plants are well established.
- Keep heavily-trafficked areas moist.

Prevent fibers from entering the home:

- Asbestos fibers can be tracked into the home on shoes. Remove and clean shoes before entering the house.
- Fibers can settle on clothing. Wash exposed clothing separately from nonexposed clothing.
- Asbestos fibers can be transferred to family members by pets. Keeping pets in yards with grass or shrubs planted over bare soil can lower contact with soil and reduce tracking into the home. Where this is not possible, wash pets with running water from a hose following contact with bare soils.

If asbestos fibers may have been brought into the home:

- Avoid
 - dry-cloth dusting or feather dusting
 - sweeping or vacuuming
- Replace with
 - damp-cloth dusting or wet mopping
 - washable area rugs
 - HEPA filter vacuum.

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SERPENTINE ENDEMISM IN THE CALIFORNIA FLORA:
A DATABASE OF SERPENTINE AFFINITY

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ABSTRACT

We present a summary of a database documenting levels of affinity to ultramafic (“serpentine”) substrates for taxa in the California flora, USA. We constructed our database through an extensive literature search, expert opinion, field observations, and intensive use of accession records at key herbaria. We developed a semi-quantitative methodology for determining levels of serpentine affinity (strictly endemic, broadly endemic, strong “indicator”, etc.) in the California flora. In this contribution, we provide a list of taxa having high affinity to ultramafic/serpentine substrates in California, and present information on rarity, geographic distribution, taxonomy, and lifeform. Of species endemic to California, 12.5% are restricted to ultramafic substrates. Most of these taxa come from a half-dozen plant families, and from only one or two genera within each family. The North Coast and Klamath Ranges support more serpentine endemics than the rest of the State combined. 15% of all plant taxa listed as threatened or endangered in California show some degree of association with ultramafic substrates. Information in our database should prove valuable to efforts in ecology, floristics, biosystematics, conservation, and land management.

Key Words: serpentine, ultramafic, California, endemism, diversity.

INTRODUCTION

Ultramafic rocks, often called “serpentine” by ecologists, botanists and pedologists, underlie more than 6000 km² of the land area of the State of California (Harrison et al. 2000). The edges of continental plates often include bands of these vestiges of oceanic mantle rock, accreted during the geologic process of subduction, and later uplifted and exposed during mountain building and subsequent erosion. Ultramafic rocks and the soils that develop on them are characterized by critically low levels of most principal plant nutrients (N, P, K, Ca), and exceptionally high levels of Mg and Fe and a suite of toxic trace elements including Cr, Ni, and Co. Outcrops of ultramafic rocks support high numbers of edaphic-endemic taxa throughout the world (Brooks 1987). The California serpentine flora is the richest in the temperate zone, and consists of hundreds of species and subspecies that are largely or entirely confined to ultramafic substrates.

Serpentine endemism is a key feature of the diversity of the California flora (Raven and Axelrod 1978; Kruckeberg 2002). Of about 1410 full species endemic to the State (Hickman 1993), Kruckeberg (1984) estimated that about 180 were endemic to serpentine. If these numbers are at least approximately correct, then about 13% of the plant species endemic to California are serpentine endemics. This is a remarkably high number when one considers that only 1.5% of the State is under-

lain by ultramafic rocks (6000 km²/406,280 km²). In addition, because they tend to have small geographic ranges and because many of them occur in the rapidly urbanizing San Francisco Bay Area, serpentine endemics are overrepresented among the state’s rare, sensitive, and listed plant taxa (Skinner and Pavlik 1994). The ecology of California’s serpentine plants has been extensively studied at the University of California’s Sedgwick Ranch Reserve (e.g., Seabloom et al. 2003; Gram et al. 2004) and McLaughlin Reserve (e.g., Harrison et al. 2003; Safford and Harrison 2004) and Stanford University’s Jasper Ridge Reserve (e.g., McNaughton 1968; Huenneke et al. 1990; Hobbs and Mooney 1991).

Botanists have relied for two decades on the monograph by Arthur Kruckeberg (1984) for most of their information on Californian serpentine-endemic plant taxa. Since then, publication of the Jepson Manual (Hickman 1993), and a proliferation of new botanical research and name changes have left this list in need of updating. Our initial aim was to modify Kruckeberg’s (1984) list, primarily using information from Hickman (1993), to use in our research on diversity patterns (Harrison et al. 2000, 2004). However, it soon became clear that we would have to expand and intensify our search for the best available information. Complicating this effort, plants show a continuum in degrees of serpentine restriction, and are sometimes more restrict-

ed in some parts of their geographic ranges than others, thus contributing to inconsistencies among reports from different sources. This led us to adopt a semi-quantitative procedure for scoring plant taxa on their reported degree of serpentine affinity.

In this contribution, we present a summary of our current database of serpentine affinity in the California flora. The database was constructed via an extensive literature search, expert opinion, field observations, web research, and intensive use of accession records at key herbaria. It provides data on levels of serpentine endemism, rarity, geographic distribution, taxonomy, and lifeform.

METHODOLOGY

We began by conducting a database search of the electronic Jepson Manual (Hickman 1993) maintained by the Jepson Herbarium at the University of California-Berkeley (UC-JEPS 2004a). The database was queried for all taxa with “serpentine”, “ultramafic”, or related (e.g., “asbestos soils”) references in the habitat description. Taxa containing “non-serpentine” in the description were removed afterward. We cross-checked the 391 serpentine-related taxa found in the Jepson Manual with Kruckeberg (1984), who listed those taxa he believed to be endemic to ultramafic substrates in California, and those that were either local or regional “serpentine indicators” (i.e., nonendemic taxa whose distributions are nonetheless skewed toward occurrences on ultramafics). Taxonomic updates in the Jepson Manual (Hickman 1993) were applied to the Kruckeberg list (which included 377 taxa after these revisions), and then those taxa not on the Jepson-derived list were added to our database. This resulted in a list of 529 taxa; of these, 287 were not shared between the two sources. We then added to the list a number of taxa that we considered to be likely endemics or indicators but which were not indicated as such by either Kruckeberg (1984) or the Jepson Manual (1993). Finally, published literature (e.g., Meinke and Zika 1992; Nelson and Nelson 2004; Baldwin 1999 and 2001; Barkley 1999; Porter and Johnson 2000; Zika et al. 1998) and the online Jepson Interchange Jepson Flora Project (UC-JEPS 2004b) were consulted for taxonomic revisions and taxa newly described since the publication of the Jepson Manual.

To score the affinity of taxa to ultramafic substrates, we adopted a modification of Kruckeberg’s measures of ultramafic “fidelity”. In his Appendix C, Kruckeberg (1984) used two or three “+”s to signify increasing levels of endemism: three “+”s were attached to taxa with 95–100% of their occurrences found on ultramafics, two “+”s signified taxa with 85–94% fidelity. In his Appendix D, Kruckeberg used one or two exclamation marks (“!”s) to signify increasing levels of fidelity to ultramafic substrates among supposed nonendemic “indicator” taxa. In both appendices, question

marks (“?”) were attached to those taxa for which more information was necessary to confidently assign their status. Some of the “tentative” endemics were included in the indicator appendix as well, thus these taxa occur twice in Kruckeberg’s lists. We combined Kruckeberg’s two scales, and added two levels to yield six levels of ultramafic affinity, where 6 represents a “strict endemic” ($\geq 95\%$ of occurrences on ultramafics), and successively lower values signify lower affinity to the substrate (5 = 85–94% of occurrences; 4 = 75–84%; 3 = 65–74%; 2 = 55–64%; 1 = 45–54%). By this definition, “1” thus represents a species found about half of the time on serpentine. We consider scores between 1 and 2 to indicate “weak indicators”, and a score of about 1 to mean an “indifferent” taxon. The Kruckeberg fidelity scale crosswalks to ours in the following fashion: “+++” = 6; “++” = 5; “!!” = 3; one “!” = 2. Those taxa which occurred in both Kruckeberg’s endemic and indicator tables had their two scores averaged: these all fell between “3” and “4” on our scale. For example, *Cupressus macnabiana* was rated “+++” in Kruckeberg’s Appendix C (i.e., “6” on our scale), and “!!” [i.e., “2” in our scale] in Appendix D; these were averaged to “4” on our scale.

We attached our categorical levels of ultramafic affinity to all of the species in our hybrid Jepson-Kruckeberg database. In the case of the Kruckeberg taxa, we simply cross-walked the Kruckeberg fidelity codes to our scale as described above, making some adjustments based on more recent taxonomic revisions and combinations. In the case of the Jepson Manual taxa, we were forced to interpret the language used in habitat descriptions to determine levels of affinity. We used the following interpretations of description language to assign affinities: a “6” was assigned where the habitat description categorically stated “serpentine” or “ultramafic” (a “5” if there was some indication that this restriction was not absolute); a “4” was assigned where the modifiers “generally” or “usually serpentine” were used; “especially” or “often” equaled “3”; “sometimes” or “occasionally” equaled “1”. In a few cases, affinity levels were assigned based on ancillary information in the habitat and/or range description rather than on explicit statement of serpentine affinity.

We then conducted a broad survey of the literature, regional botanical experts, and herbaria records to obtain as many sources as possible for each taxon in our database, and to add to the database any taxa we might have overlooked. We manually consulted every species description in a variety of regional and local floras (Clifton 2001; Ertter and Bowerman 2004; Howell 1970; McMin 1939; Oswald 2002; Smith and Wheeler 1992), and guidebooks to rare and sensitive taxa (Hanson 1999; Hoover et al. 1993; Jimerson et al. 1995; McCarten 1988; McCarten and Rogers 1991; Nakamura and Nelson 2001; Trinity SIPS 2001; USFWS 1998).

We also consulted the CalFlora Online Species Database (CalFlora 2004), and the California Native Plant Society Online Inventory of Rare and Endangered Plants (CNPS 2004). We added columns to our database for each source, and gave scores (1–6, as described above) to each taxon for which a habitat description suggested an ultramafic affinity. Information on serpentine affinity in the CalFlora database is limited to taxa from the Sierra Nevada and to rare taxa statewide, and does not include sufficient information to determine degree of affinity (A. Dennis, personal communication). CalFlora was therefore not treated as a typical “source”, and CalFlora serpentine taxa were simply given a score of 0.5 to be added later to the sum of scores when final ultramafic affinities were calculated (see below). The California Natural Diversity Database (CNDDB) was not searched, as we consulted all of the primary resources originally used to build CNDDB, and the CNPS Online Inventory (see above) is updated from the same contemporary sources as CNDDB.

We calculated preliminary mean affinities for taxa in our database by summing the scores across source columns and adding the CalFlora score (if present), then dividing by the number of sources (not including CalFlora) for the taxon in question. We also calculated the number of sources, the median score, and the standard deviation and standard error of the scores for each taxon. We then sent the database to approximately 40 state and regional experts for their review and input, and asked them to score serpentine affinity using the 1–6 scale for taxa with which they were familiar. These individuals included botanists employed by federal and state land management agencies, universities, museums, non-governmental organizations, and private consulting firms. We received 17 substantive replies, and incorporated their input into an updated database.

The next step was to ensure that we had at least three sources of serpentine affinity for each taxon in our database; given the great differences between the Jepson Manual and Kruckeberg’s list, we felt a third opinion was important. We focused on those taxa for which we had less than three sources, as well as those with high variability in scores. We began by consulting the habitat descriptions in Munz and Keck (1968) for every taxon in our database with less than three sources. We then turned to Herbaria accession records. We searched the online “SMASCH” accession databases of the UC and Jepson Herbariums at UC-Berkeley at (UC-JEPS 2004c) for all taxa with one or two sources, and for all taxa with affinity-score standard deviations ≥ 1.0 (a total of 548 taxa). For any Northern California taxa remaining with less than three sources and/or high variability, we then searched the online accession database of the Biological Sciences Herbarium at Chico State University (CSU-BSH 2004; a total of 164 taxa were searched).

In our online accession database research, we followed the following protocol:

1. We began with the most recent accession records and worked backwards, as habitat descriptions before the mid 1970’s usually lack sufficiently detailed information on substrate and location.

2. We consulted the habitat description for each record. If the description included enough information to determine the substrate, we noted whether it was ultramafic or non-ultramafic. We did not count multiple accession records from the same collecting trip and location as different records.

3. On the average, about $\frac{1}{3}$ of the accession records consulted had sufficient information to determine if a collection had been made on ultramafics or not. Not all of these determinations were made simply based on the collector’s habitat description. For example, many California counties do not contain outcrops of ultramafic rocks (e.g., Los Angeles, San Diego, San Bernardino, Modoc). Collections from these counties were coded as “nonserpentine” even where habitat descriptions were missing. Also, collections from well-known collecting locations on ultramafics (e.g., Blue Banks in Glenn County, Red Butte in Siskiyou County, or the mouth of 18-Mile Creek on the Middle Fork Smith River, Del Norte County) were coded as “serpentine” even where habitat descriptions were missing. Finally, where we had trouble getting a sufficient number of records with habitat descriptions, or where it was otherwise critical to get more information, we used location information in the accession record (where it existed) to do further research. We used TOPO! Software (National Geographic Maps 2000) to locate coordinates or named locations and then consulted geological maps (ranging from 1:250,000 to 1:25,000) to determine if the location was on an ultramafic outcrop. Only those occurrences which could be confidently assigned to ultramafics were identified as such.

4. We continued until we had recorded habitat information from at least 10% of the total accession records for the species in question. Our minimum was 10 records, unless there were fewer than 10 records with habitat descriptions and reasonably locatable site information (286/548 taxa had fewer than 10). Our maximum was usually 20, although we went beyond 20 in some cases.

5. We summarized the accession record results for each taxon by dividing the total number of records with sufficient habitat or location information to determine substrate by the number of records recording serpentine/ultramafics, and then multiplied the result by 100 to get a percentage. We then cross-walked the percent value to our scale of ultramafic affinity: 95–100% of records on ultramafics = 6; 85–94% = 5; 75–84% = 4; 65–74% = 3; 55–64% = 2; 45–54% = 1; 35–44% = 0.75; 25–34% = 0.5; 15–24% = 0.25; >0–14% = 0.1; 0 = 0.

Finally, T. Nelson and S. Carothers also used the

Humboldt State University Herbarium to provide information to us on a number of under-documented taxa from Northwestern California.

In our accession records research, we necessarily assumed that: (1) the taxon itself was correctly identified on the accession record; (2) the substrate was correctly identified by the collector; and (3) ultramafic substrates were neither more nor less likely to be identified correctly (or at all) than other substrates. The last assumption is probably flawed, as serpentine and other “charismatic” substrates—given their close connection to plant endemic taxa and their relative ease of identification—are almost certainly more likely to be identified than “normal” substrates. This could theoretically lead to accession records “overstating” the degree of a taxon’s affinity to ultramafic substrates. In practice, however, we found that the accession records were generally somewhat more conservative than our literature sources vis-à-vis the serpentine affinities of the taxa in our database.

Our final database included 18 columns of information sources for serpentine affinity, plus a column for CalFlora. We summed these affinity values and took their mean (not including CalFlora in the denominator). We also calculated the mean without CalFlora, the median, the standard deviation, and the standard error. We identified each taxon by taxonomic category (pteridophyte, gymnosperm, dicot or monocot), and by lifeform (annual forb, perennial forb, annual graminoid, perennial graminoid, shrub, tree). For rare taxa, we added the rarity rating from the California Native Plant Society Online Database of Rare and Endangered Plants (version 6.04d, 11-12-2004). The following information was also added to the complete database: geographic distribution in California for each taxon (by Jepson Manual geographic subdivisions); elevational range (from Hickman 1993); the geographic distribution of, and number of species of the genus of each taxon (from Mabberly 1996); and the common name (from Hickman 1993, and the Natural Resource Conservation Service PLANTS online database [USDA-NRCS 2005]). Aside from a summary of the geographic distribution, this information is not presented in the current paper, but is available on request from the first author, as are the affinity values calculated for each source.

RESULTS

A summary table of the current database is presented in Appendix 1. Appendix 1 includes 669 taxa, ranging in affinity from 6.25 to 1.00 (some values exceed 6 because they were identified as serpentine taxa in the CalFlora Database). Our full database includes 698 taxa, 29 of which have mean serpentine affinities of < 1 ; we did not include these taxa in the current paper. The greatest number of sources we located for any single taxon was nine (four taxa). We found eight sources for eight taxa

and seven sources for 19 taxa; 587 taxa had between three and six sources. Eighty-one taxa had fewer than three sources (77 with two, three with one). Somewhat more than half of the taxa (387) in our original list had standard deviations for serpentine affinities > 1.0 .

Since our serpentine affinities are calculated as the means of multiple sources, our values fall on a continuous scale, rather than in categories. Given this, we recognized taxa with mean affinities > 5.5 as “strict endemics” (analogous to Kruckeberg’s “+++”, or taxa with $> 95\%$ of their occurrences on ultramafics), and taxa with mean affinities > 4.5 and < 5.5 as “broad endemics” (analogous to Kruckeberg’s “++”, taxa with about 85–94% of their occurrences on ultramafics). Using these definitions, 164 taxa are strict endemics, while 82 taxa are broad endemics, for a total of 246 endemic taxa; 176 of these are full species. Among the remaining taxa, 123 are “strong serpentine indicators” (Kruckeberg 1984), with scores ranging from 2.5 to 3.4 (about 65–74% of their occurrences on ultramafics); 150 are “weak indicators”, falling between 1.5 and 2.4 on our scale (± 55 –64% of their occurrences on ultramafics); and 79 fall in a gray area between weak indicators and indifferent taxa (between 1.0 and 1.4 on our scale, or about 50–54% of occurrences. Seventy-one taxa have affinity scores between 3.5 and 4.4 (about 75–84% of their occurrences on ultramafics), and thus represent the transition from strong indicators to broad endemics.

Six families account for more than half of all the endemics: Asteraceae, Liliaceae, Brassicaceae, Polygonaceae, Scrophulariaceae, and Apiaceae (Table 1). The 20 most important plant families among the serpentine endemics are shown in Fig. 1, with the percentage of the serpentine endemic flora that they contribute, as well as the percentage of the total California endemic flora that they contribute. Families that proportionally contribute more to the serpentine endemic flora than to the California endemic flora include Liliaceae, Brassicaceae, Polygonaceae, Linaceae and Caryophyllaceae. Families whose level of endemism is much lower on serpentine than it is statewide include Fabaceae, Poaceae, Boraginaceae, and Rosaceae (Fig. 1).

The most diverse genera in our list of serpentine endemics are *Streptanthus* (Brassicaceae) and *Eriogonum* (Polygonaceae), followed by *Hesperolimon* (Linaceae) and *Arctostaphylos* (Ericaceae) (Table 2). There are 21 genera with at least four taxa among the endemics. These represent 14 plant families, with Asteraceae (four genera among the endemics), Liliaceae (three genera), Scrophulariaceae (two genera) and Brassicaceae (two genera) the only families with multiple genera in the list. Figure 2 compares the contribution of these genera to the serpentine endemic flora with their contribution to the California endemic flora. All but five or six of these genera have a greater level of endemism to serpentine than they have within the State as a

TABLE 1. NUMBERS OF SERPENTINE ENDEMIC AND NEAR ENDEMIC TAXA, BY FAMILY. ¹ Strict endemics. ² Strict endemics plus broad endemics. ³ Strict and broad endemics plus "near endemic" taxa (taxa transitional from strong indicators to broad endemics).

Family	Serpentine affinity score			Total taxa
	≥5.5 ¹	≥4.5 ²	≥3.5 ³	
Asteraceae	26	37	45	106
Liliaceae	15	28	37	85
Brassicaceae	21	26	31	46
Polygonaceae	10	17	19	39
Scrophulariaceae	9	14	18	37
Apiaceae	7	10	13	32
Linaceae	8	9	9	14
Ericaceae	5	8	10	15
Polemoniaceae	6	7	8	18
Caryophyllaceae	5	7	8	18
Fabaceae	4	7	10	24
Lamiaceae	4	6	10	17
Crassulaceae	5	5	7	13
Rhamnaceae	4	5	6	14
Campanulaceae	3	5	8	12
Onagraceae	3	5	7	12
Hydrophyllaceae	4	4	8	15
Rubiaceae	3	4	4	8
Convolvulaceae	1	4	5	6
Cyperaceae	1	4	5	8
Poaceae	1	3	3	19
Portulacaceae	0	3	5	16
Boraginaceae	2	2	3	10
Gentianaceae	2	2	2	3
Iridaceae	2	2	2	4
Malvaceae	2	2	2	5
Salicaceae	2	2	2	3
Garryaceae	1	2	2	2
Rosaceae	1	2	5	10
Cupressaceae	0	2	3	6
Violaceae	0	2	3	7
Asclepiadaceae	1	1	1	1
Berberidaceae	1	1	1	4
Dryopteridaceae	1	1	1	2
Fagaceae	1	1	1	3
Lentibulariaceae	1	1	1	1
Papaveraceae	1	1	1	5
Ranunculaceae	1	1	3	6
Orchidaceae	0	1	1	3
Pteridaceae	0	1	1	4
Verbenaceae	0	1	1	1
Cistaceae	0	0	0	1
Orobanchaceae	0	0	0	1
Pinaceae	0	0	1	6
Plantaginaceae	0	0	0	1
Polygalaceae	0	0	0	1
Primulaceae	0	0	0	1
Sarraceniacae	0	0	1	1
Saxifragaceae	0	0	1	2
Sterculiaceae	0	0	0	1
Totals	164	246	315	669

whole. These genera include *Streptanthus*, *Hesperolinon*, *Lomatium* and *Minuartia*. Only one genus (*Phacelia*) contributes less to the serpentine endemic flora than it does to the State as a whole; *Arc-*

tostaphylos contributes a similar percentage to both floras (Fig. 2).

Of the taxa in our database, there are 532 dicots (of which 204 are endemic), 119 monocots (38 endemics), 12 gymnosperms (2 endemics) and six pteridophytes (2 endemics). 207 taxa are annual forbs (of which 71 are endemics, including 7 of 14 that can also be perennial/biennial), 383 are perennial forbs (150 endemics, including the 7 "annuals" and 6 taxa which can also be shrubs), 24 are perennial graminoids (7 endemics), 64 are shrubs (23 endemics, including 6 taxa shared with the perennial forbs and 1 which assumes both tree and shrub forms), and 12 are trees (2 endemics) (Appendix 1). Of the endemic perennial forbs, 24 are bulb plants (all Liliaceae), 17 are rhizomatous (from ten different Families), three are hemiparasites (Scrophulariaceae), and one is carnivorous (Lentibulariaceae) (Appendix 1).

Using Kruckeberg's (1984) physiographic provinces of California (which correspond more or less to major geographic subdivisions mapped in the Jepson Manual (Hickman 1993)), we found the following geographic distribution of serpentine endemic taxa (Fig. 3): The North Coast, considered *in toto* (i.e., the Jepson Manual's NCo and NCoR subregions (Hickman 1993)), supports approximately 118 serpentine endemics, with 49 of these restricted to that area. The Klamath Region (Jepson Manual subregion KR), supports 98 endemic taxa, with 54 restricted to that area (including taxa also found in neighboring SW Oregon). The San Francisco Bay Area (Jepson Manual subregion SnFrB plus the sections of NCo and CCo bordering it) supports about 51 endemics, with 24 found only there. The South Coast Ranges, including the Channel Islands and the Santa Ana Mountains (i.e., Jepson Manual subregions CCo, SCoR plus the few ultramafic outcrops that occur in the Jepson SW Region), support 43 total endemics with 24 restricted to that area. The Sierra Nevada (Jepson Manual region SN) support 38 total serpentine endemic taxa, with 21 taxa restricted to the Range (Fig. 3).

Of the 669 taxa in our database, 295 are listed as "rare" or "uncommon" by the California Native Plant Society (CNPS) (Appendix 1). These include 194 of the 246 taxa that we consider to be either strict or broad serpentine endemics. One serpentine endemic taxon, *Arctostaphylos hookeri* subsp. *franciscana*, is extinct in the wild and survives only in cultivation. Of the 295 rare or uncommon taxa, 154 are on CNPS List 1b, which lists plants considered threatened or endangered by either the State or Federal governments, as well as unlisted plants which CNPS considers rare enough to warrant listing; 111 of these List 1b plants are serpentine endemics by our definition. Nine taxa (seven endemics) from Appendix 1 are on CNPS list 2, which contains plant taxa that are rare in California but are not restricted completely to the State; all of these taxa are either State listed and threatened or endangered,

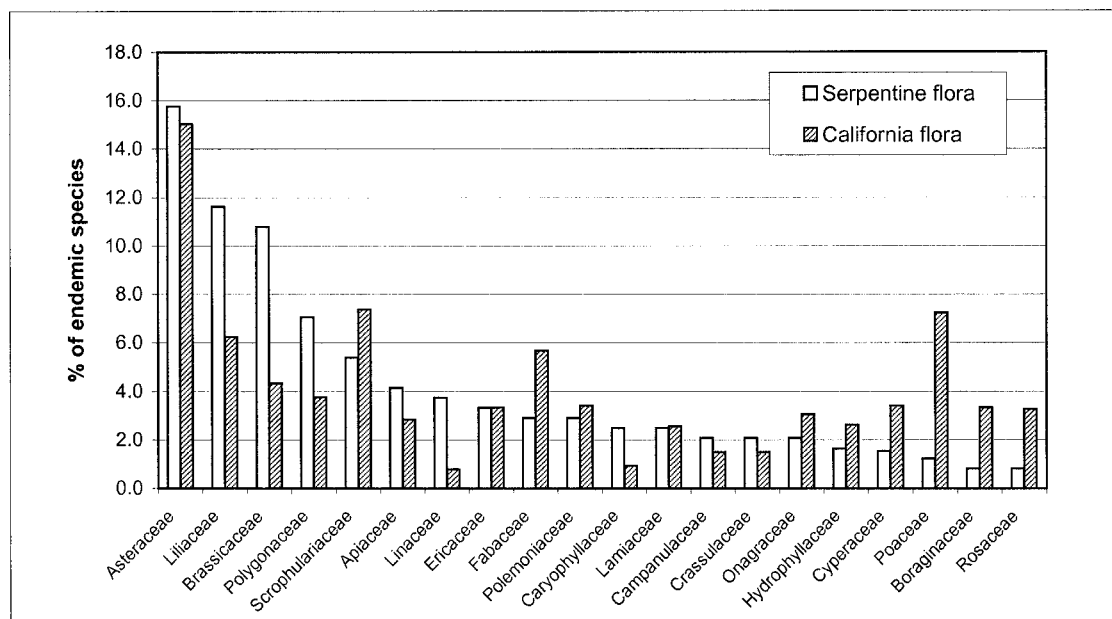


FIG. 1. The twenty most important plant families of serpentine endemic plants (i.e., including strict and broad serpentine endemics), with the percentage of endemic species they contribute to the serpentine endemic flora in California, and to the California endemic flora as a whole.

or are eligible for listing. Eight taxa (four endemics) in Appendix 1 are found on CNPS list 3, which lists uncommon taxa for which more information is required. Of taxa in Appendix 1, 123 (71 endemics) are on CNPS list 4, which contains taxa of "limited distribution or infrequent throughout a broader area in California".

TABLE 2. GENERA WITH MORE THAN THREE TAXA ENDEMIC TO SERPENTINE.

Genus	Family	Endemic taxa
<i>Streptanthus</i>	Brassicaceae	18
<i>Eriogonum</i>	Polygonaceae	14
<i>Hesperolinon</i>	Linaceae	9
<i>Arctostaphylos</i>	Ericaceae	8
<i>Allium</i>	Liliaceae	7
<i>Lomatium</i>	Apiaceae	7
<i>Packera (Senecio)</i>	Asteraceae	6
<i>Calochortus</i>	Liliaceae	5
<i>Cordylanthus</i>	Scrophulariaceae	5
<i>Arabis</i>	Brassicaceae	4
<i>Calystegia</i>	Convolvulaceae	4
<i>Carex</i>	Cyperaceae	4
<i>Castilleja</i>	Scrophulariaceae	4
<i>Cirsium</i>	Asteraceae	4
<i>Erigeron</i>	Asteraceae	4
<i>Fritillaria</i>	Liliaceae	4
<i>Galium</i>	Rubiaceae	4
<i>Lessingia</i>	Asteraceae	4
<i>Minuartia</i>	Caryophyllaceae	4
<i>Monardella</i>	Lamiaceae	4
<i>Phacelia</i>	Hydrophyllaceae	4

DISCUSSION

In 1984, Kruckeberg estimated that the serpentine endemic flora of California numbered approximately 220 taxa (about 180 full species), and that a further 230 taxa were sufficiently associated with ultramafics to be "indicators" of the substrate. Thus, Kruckeberg believed that about 450 taxa were associated with serpentine in California. Although our results suggest that the number of serpentine-associated taxa is closer to 670, they also suggest that Kruckeberg's (1984) estimate of the number of full-species endemics was remarkably accurate (180 vs. 176). As Kruckeberg's numbers also suggested, serpentine endemics therefore comprise approximately 12.5% (176/1410) of the plant species endemic to California. Based on numbers from the Jepson Manual (Hickman 1993; R. Moe personal communication), the percentage of serpentine endemics among California endemic species, subspecies and varieties is about 11.4% (246/2153).

Kruckeberg's (1984) estimates of endemics by California geographic region are somewhat less accurate than his statewide estimate (see Fig. 3), but Kruckeberg's data sources in the 1970's and early 1980's were extremely limited compared to ours. As did Kruckeberg, we found that the North Coast Ranges support more serpentine endemics plants than any other geographic region, but that the Klamath Ranges (and adjoining SW Oregon) support many more restricted endemics than Kruckeberg thought was the case (54 vs. 30). Kruckeberg's estimates for the numbers of restricted endemics in

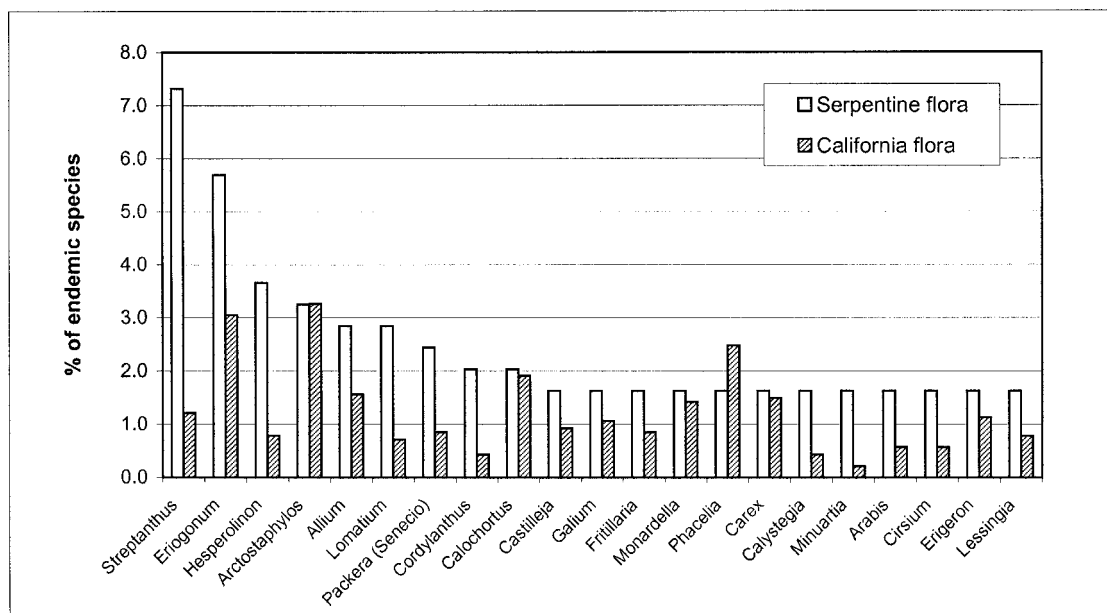


FIG. 2. The twenty-one most important genera of serpentine endemic plants (i.e., including strict and broad serpentine endemics), with the percentage of endemic species they contribute to the serpentine endemic flora in California, and to the California endemic flora as a whole.

the North Coast Ranges and the Bay Area are very similar to our numbers (Fig. 3), but he overestimated the number of endemics in the South Coast Ranges (36 vs. 24). Kruckeberg estimated that either 13 or 16 (depending on whether one goes by the text or the tables in Appendix E) endemic taxa were restricted to the Sierra Nevada; we found 21 taxa thus restricted.

Reasons for differences between our numbers and Kruckeberg's (1984) are many, but belong to two broad categories. The primary reason is quality and quantity of information. In many cases, Kruckeberg's information had to come through his own field experience, or through hard copy herbarium records, which—before the late 1970's—were no-

toriously uninformative when it came to habitat description. In contrast, many data sources we accessed were available electronically and could be queried and retrieved remotely.

The other principal reason for difference is the inevitable discoveries and taxonomic reorganizations that occur over a 20-year period. Kruckeberg's work came before publication of the Jepson Manual (Hickman 1993), which contained many significant changes in California plant taxonomy. A considerable number of serpentine endemic taxa in the Jepson Manual were wholly unknown to Kruckeberg in 1984. Examples include *Calochortus raichei* S. Farwig & V. Girard, *Minuartia stolonifera* T. W. Nelson & J. P. Nelson, *Perideridia bacigalupii* Chuang & Constance, and *Monardella stebbinsii* Hardham & J. Bartel. Since the Manual's publication, there have been further changes (e.g., Barkley 1999; Baldwin 1999; Porter and Johnson 2000). Serpentine endemic taxa named since publication of the Jepson Manual include *Harmonia guggolziorum* B. G. Baldwin, *Carex serpentinicola* P. F. Zika, and *Silene serpentinicola* T. W. Nelson & J. P. Nelson.

As a null hypothesis, one might expect that the distribution of endemic plant taxa across plant families and genera on California serpentes would more or less mirror the distribution of endemics in the State as a whole. Our data demonstrate that this assumption is incorrect at both taxonomic levels, but the root of this difference seems to be largely at the level of genus. A number of families contribute a much higher proportion of the serpentine

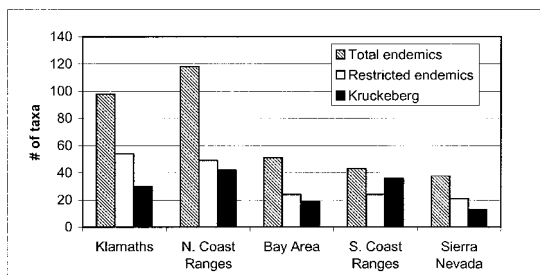


FIG. 3. Geographic distribution of serpentine endemic taxa in California. "Total endemics" includes all California serpentine endemic taxa present in a given region; "restricted endemics" includes only those taxa restricted to a given region; black bars represent Kruckeberg's (1984) estimates of restricted endemics.

TABLE 3. EXAMPLES OF “REGIONAL” SERPENTINE INDICATORS, *SENSU* KRUCKEBERG (1984). ¹ CA = California, KL = Klamath Ranges, NC = North Coast Ranges, BA = San Francisco Bay Area, SC = South Coast Ranges, SN = Sierra Nevada.

Taxon	Distribution ¹	Comments ¹
<i>Allium amplexans</i>	CA	SC—broad endemic; Northern CA—weak indicator at best
<i>Aspidotis densa</i>	CA	Marin County—broad endemic; rest of NC—weak to strong indicator; KL—broad endemic to strong indicator, depending on locality; rest of CA—strong indicator
<i>Festuca californica</i>	CA	Northern SN and KL—strong indicator to broad endemic; NC—primarily weak indicator; rest of CA—indifferent
<i>Lupinus onustus</i>	KL, SN	KL—broad endemic; SN—indifferent (mostly non-ultramafic)
<i>Pinus attenuata</i>	CA	Mendocino County and neighboring NC—broad endemic; rest of NC and SC—strong indicator; KL—weak indicator; SN—weak indicator to indifferent
<i>Pinus jeffreyi</i>	KL, NC, SC, SN	KL and NC— $\pm$ strict endemic; Westslope of northern SN—strong indicator; rest of CA—indifferent
<i>Quercus vaccinifolia</i>	KL, NC, SN	Mendocino County and neighboring NC—broad endemic; Northern NC and KL—weak indicator; SN—indifferent
<i>Sedum obtusatum</i> ssp. <i>obtusatum</i>	KL, SN	KL and NC— $\pm$ broad endemic; SN—weak indicator or indifferent
<i>Stachys pycnantha</i>	CA	Marin County—broad endemic to strong indicator; Northern SN—very weak indicator; rest of CA—weak indicator or indifferent
<i>Viola douglasii</i>	CA	Plumas County—endemic; NC—strong indicator; rest of CA—indifferent

endemic flora than they do of the California endemic flora (Fig. 1), but our database shows that most of these “anomalies” are due to one or two genera within those families (see Fig. 2). Examples include *Fritillaria* and *Allium* in Liliaceae, *Minuartia* in Caryophyllaceae, *Streptanthus* and *Arabis* in Brassicaceae, *Hesperolinon* in Linaceae, and *Eriogonum* in Polygonaceae. Many of these genera are well-known as foci of neoendemism (i.e., genera with groups of actively and rapidly speciating taxa) (Raven and Axelrod 1978). It is interesting that such prominent California plant families like Scrophulariaceae, Hydrophyllaceae, Boraginaceae, Onagraceae and Polemoniaceae are underrepresented on serpentine substrates. Certain highly diverse genera in California are also proportionally underrepresented as serpentine endemics (e.g., *Clarkia*, *Phacelia*, *Ceanothus*, *Gilia*, and *Mimulus*).

As we constructed our database, taxa with high variability in serpentine affinity scores were tagged for further research (e.g., through accession records; see Methodology) so that we might be able to discern taxa that truly varied geographically in their affinities from taxa that simply suffered from inadequate or faulty information. The former were called “regional indicators” by Kruckeberg (1984), i.e., taxa that are considered serpentine endemics or indicators in one part of their range but show less or no affinity for ultramafic substrates in other parts of their range. In his Appendix D, Kruckeberg (1984) tried to summarize where the different regional indicators he had identified occurred on ultramafics. We refer the reader to Kruckeberg (1984) for details on these taxa (most of which also occur in our database), but most regional indicators in our database can be recognized by searching for taxa with: (1) relatively wide geographic distributions,

(2) lower mean serpentine affinity scores, and (3) high standard deviations in their affinity scores. Table 3 lists ten examples of regional indicator taxa in our database.

Some of the variability in our serpentine affinity scores is thus due to geographic variation in affinities, but some is also due to inadequate, statistically biased, or even faulty information from our sources. We attempted to offset these sources of variability by including as many sources as possible in our database (and by using accession records), but were not successful in all cases. We consider any taxon with a standard deviation in affinity score > 1.5 , or having fewer than three sources, as being in “need of further research”; this includes about a third of the taxa in our database. Examples of such taxa include: *Lupinus lapidicola*—called a strict serpentine endemic by Kruckeberg (1984) and a strong serpentine indicator by CNPS (2004), and with 2/2 accession records in SMASCH with ultramafic habitat descriptions, but stated as occurring only on granites by the Jepson Manual (Hickman 1993) and Munz and Keck (1973); *Phacelia phacelioides*—Kruckeberg (1984) and V. Yadon (personal communication) believe this is a strict endemic, but the Jepson Manual is mute on the subject, and only 1/3 accession records in SMASCH are on ultramafics (but the two nonserpentine locations may have misidentified geology given the location); and *Allium lacunosum* var. *lacunosum*—both the Jepson Manual and Kruckeberg rate this as a strict endemic, Munz and Keck score it a strong indicator, but SMASCH has only 1/6 records on ultramafics.

Some species had surprising levels of ultramafic affinity. For example, our database includes a number of taxa that we personally have only rarely seen

on serpentine (e.g., *Lathyrus vestitus* var. *vestitus*, *Apiastrum angustifolium*, *Emmenanthe penduliflora* var. *penduliflora*). It also includes other taxa which we would have characterized as being clearly indifferent to ultramafic substrates, but which scored higher based on our sources (e.g., *Adenostoma fasciculatum*, *Pinus balfouriana* ssp. *balfouriana*). As noted above, some of these “discrepancies” may be due to inadequate or biased data—the ultramafic affinity of these types of taxa will drop as we collect more information. Many of these surprising affinities are probably real however, and they are simply a sign of our limited knowledge of the relationships between California plant life and ultramafic substrates.

In accession records, and in the literature, botanists and ecologists frequently misidentified basic rock types. For example, in accession records we found a number of examples of peridotite being called “volcanics” or even “sandstones”. We also found multiple examples, in accession records as well as in the literature, of gabbro and other basic intrusive rocks being misidentified as ultramafics. Gabbro and “basic” rocks are “mafic” in composition—that is to say, they usually contain visible feldspars and they are geochemically distinct from ultramafic rocks. For example, the average alkali-gabbro contains 4–5 times as much Na as peridotite, 5–10 times as much P, 3–4 times as much K and Ca, and about 1/3 as much Mg (Ehlers and Blatt 1982). The famous gabbro outcrops of Eldorado County (Pine Hill) or San Diego County are therefore *not* ultramafic, even though the effect of the substrate on plant physiognomy and community composition may appear similar. A number of species in our database appear to be primarily, if not exclusively gabbro endemics, but we lacked sufficient information to remove them from our list. These include *Acanthomintha ilicifolia*, *Fremontodendron californicum* ssp. *decumbens*, and *Calochortus weedii* var. *vestitus*.

As has been frequently noted (Mason 1946a, b; Raven and Axelrod 1978; Kruckeberg 1984, 2002; Skinner and Pavlik 1994; McCarten 1997), California’s ultramafic soils support a very high proportion of the State’s rare plants. Based on our database, almost 11% (111/1021) of California’s rare plant taxa are either broadly or strictly restricted to ultramafic substrates; 15% of List 1b taxa (154/1021) show high affinity for ultramafic substrates (i.e., they are endemics or indicators). In northwestern California, 15% of plant taxa managed as “sensitive” by the Forest Service are serpentine endemics, and fully 30% are closely associated with ultramafics (J. K. Nelson and L. Hoover personal communication). In 2002, Kruckeberg wrote that “preservation of serpentine habitats in California is spotty, inadequate, and largely coincidental”. Given the great importance of ultramafic substrates to the richness and distinctiveness of the California flora, the conservation of these unique habitats

should be a high priority for land management agencies and private conservation organizations throughout the State.

Our database of serpentine affinity updates, and expands on the widely-used tables of serpentine endemic and “indicator” taxa published in 1984 by Art Kruckeberg in his classic monograph on California serpentine ecology. Our data are also a quantitative synthesis of the qualitative (and usually incomplete) allusions to serpentine affinity contained in habitat descriptions in California floras and flora databases, including Munz and Keck (1973), Hickman (1993), Oswald (2002), the online CalFlora Database (CalFlora 2004), and the California Native Plant Society Online Inventory of Rare and Endangered Plants (CNPS 2004). Our data on serpentine endemism should prove valuable to efforts in ecology, biosystematics (Baldwin 1995), conservation, and land management. In particular, we hope that our database will help us better understand the nature and degree of serpentine endemism in the California flora, and we hope it will spur the collection of additional, critical information necessary for conserving the rare plants and habitats of ultramafic substrates.

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APPENDIX 1. PLANT TAXA WITH HIGH AFFINITY TO ULTRAMAFIC SUBSTRATES IN CALIFORNIA. Ordered by family and taxon. ¹ Names as in Hickman (1993); names in parentheses are based on more recent revisions (see text for sources). ² Affinity: SE = strict endemic, BE = broad endemic, BE/SI = broad endemic/strong indicator, SI = strong indicator, WI = weak indicator, WI/IN = weak indicator/indifferent. ³ Mean affinity score, including information from CalFlora. ⁴ Sum of all affinity scores, including CalFlora. ⁵ Median of affinity scores. ⁶ Standard deviation of affinity scores. ⁷ Standard error of affinity scores. ⁸ California Native Plant Society rarity codes, from CNPS Inventory of Rare and Endangered Plants of California, 11-2004. ⁹ Geographic distribution: KL = Klamath Ranges, NC = North Coast Ranges, BA = San Francisco Bay Area, SC = South Coast Ranges, SN = Sierra Nevada. ¹⁰ Taxonomic category. ¹¹ carn = carnivorous, cesp = cespitose, hemipar = hemiparasitic, paras = parasitic, rhiz = rhizomatous. See text for more information.

Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Angelica tomentosa</i>	Apiaceae	SI	2.7	8	3	3.0	1.5	0.9		1	1		1		Dicot	Perennial forb
<i>Apiastrum angustifolium</i>	Apiaceae	WI	1.5	7.6	5	0.1	2.5	1.1		1	1	1	1		Dicot	Annual forb
<i>Ligusticum californicum</i>	Apiaceae	WI/IN	1.4	5.75	4	1.4	1.3	0.7		1	1			1	Dicot	Perennial forb
<i>Lomatium ciliolatum</i>	Apiaceae	SE	6.0	18	3	6.0	0.0	0.0			1	1	1		Dicot	Perennial forb
<i>Lomatium congdonii</i>	Apiaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b					1	Dicot	Perennial forb
<i>Lomatium dasycarpum</i> ssp. <i>dasycarpum</i>	Apiaceae	BE/SI	3.6	21.5	6	3.5	1.9	0.8			1	1	1		Dicot	Perennial forb
<i>Lomatium engelmannii</i>	Apiaceae	SE	5.8	34.5	6	6.0	0.8	0.3	4	1	1				Dicot	Perennial forb
<i>Lomatium hooveri</i>	Apiaceae	SE	5.9	29.5	5	6.0	0.4	0.2	4		1				Dicot	Perennial forb
<i>Lomatium howellii</i>	Apiaceae	SE	6.1	24.5	4	6.0	0.0	0.0	4	1					Dicot	Perennial forb
<i>Lomatium macrocarpum</i>	Apiaceae	SI	2.7	8	3	3.0	0.6	0.3		1	1	1	1	1	Dicot	Perennial forb
<i>Lomatium marginatum</i>	Apiaceae	BE	5.0	25	5	6.0	1.4	0.6		1	1			1	Dicot	Perennial forb
<i>Lomatium observatorium</i>	Apiaceae	WI/IN	1.4	2.75	2	1.4	0.9	0.6				1	1		Dicot	Perennial forb
<i>Lomatium parvifolium</i>	Apiaceae	SI	3.3	13	4	3.0	2.3	1.1	4				1		Dicot	Perennial forb
<i>Lomatium repostum</i>	Apiaceae	SI	3.2	12.6	4	3.0	2.4	1.2	4		1				Dicot	Perennial forb
<i>Lomatium tracyi</i>	Apiaceae	SE	6.1	42.5	7	6.0	0.0	0.0	4	1	1				Dicot	Perennial forb
<i>Lomatium triternatum</i> var. <i>triternatum</i>	Apiaceae	SI	2.8	11	4	2.0	2.4	1.2		1	1				Dicot	Perennial forb
<i>Lomatium utriculatum</i>	Apiaceae	WI	1.7	8.5	5	1.0	1.4	0.6		1	1	1	1	1	Dicot	Perennial forb
<i>Perideridia bacigalupii</i>	Apiaceae	BE	4.6	23	5	6.0	2.4	1.1	4					1	Dicot	Perennial forb
<i>Perideridia kelloggii</i>	Apiaceae	WI	2.1	10.6	5	2.0	2.0	0.9			1	1	1	1	Dicot	Perennial forb
<i>Perideridia leptocarpa</i>	Apiaceae	SE	5.6	22.5	4	6.0	1.0	0.5	4	1					Dicot	Perennial forb
<i>Perideridia oregana</i>	Apiaceae	WI	1.7	5	3	1.0	1.2	0.7		1	1	1	1		Dicot	Perennial forb
<i>Perideridia pringlei</i>	Apiaceae	BE/SI	3.7	18.5	5	3.0	2.3	1.0	4				1		Dicot	Perennial forb
<i>Sanicula bipinnatifida</i>	Apiaceae	WI	1.8	7.1	4	2.0	1.5	0.7		1	1	1	1	1	Dicot	Perennial forb
<i>Sanicula hoffmannii</i>	Apiaceae	WI	1.8	3.5	2	1.5	2.1	1.5	4				1		Dicot	Perennial forb
<i>Sanicula maritima</i>	Apiaceae	WI	2.3	4.5	2	2.0	0.0	0.0	1b			1	1		Dicot	Perennial forb
<i>Sanicula peckiana</i>	Apiaceae	BE	5.3	26.5	5	6.0	1.3	0.6	4	1					Dicot	Perennial forb
<i>Sanicula tracyi</i>	Apiaceae	WI	2.1	8.5	4	1.0	2.6	1.3			1				Dicot	Perennial forb
<i>Sanicula tuberosa</i>	Apiaceae	WI/IN	1.3	3.75	3	1.0	0.7	0.4			1		1	1	Dicot	Perennial forb
<i>Tauschia glauca</i>	Apiaceae	BE/SI	3.5	10.5	3	3.0	0.6	0.3	4		1				Dicot	Perennial forb
<i>Tauschia hartwegii</i>	Apiaceae	WI/IN	1.3	4	3	1.0	1.5	0.9				1	1	1	Dicot	Perennial forb
<i>Tauschia howellii</i>	Apiaceae	WI	2.3	7	3	1.0	3.2	1.9		1					Dicot	Perennial forb
<i>Tauschia kelloggii</i>	Apiaceae	SI	2.6	12.75	5	2.0	2.2	1.0			1		1	1	Dicot	Perennial forb

APPENDIX 1. CONTINUED.

Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Asclepias solanoana</i>	Asclepiadaceae	SE	6.0	42	7	6.0	0.0	0.0	4		1				Dicot	Perennial forb
<i>Agoseris heterophylla</i>	Asteraceae	WI/IN	1.4	4.1	3	1.0	1.5	0.9		1	1	1	1	1	Dicot	Annual forb
<i>Ancistrocarphus filagineus</i>	Asteraceae	SI	3.3	13	4	3.0	0.5	0.3		1	1	1	1	1	Dicot	Annual forb
<i>Antennaria argentea</i>	Asteraceae	WI	1.9	7.75	4	0.8	2.7	1.4		1	1				Dicot	Perennial forb
<i>Antennaria suffrutescens</i>	Asteraceae	SE	5.6	22.5	4	6.0	1.0	0.5	4	1	1				Dicot	Perennial forb
<i>Arnica cernua</i>	Asteraceae	SE	6.1	24.5	4	6.0	0.0	0.0	4	1					Dicot	Perennial forb (rhiz.)
<i>Arnica spathulata</i>	Asteraceae	SE	5.5	16.5	3	6.0	1.2	0.7	4	1					Dicot	Perennial forb (rhiz.)
<i>Aster oregonensis</i>	Asteraceae	WI/IN	1.1	3.25	3	1.0	0.9	0.5		1	1			1	Dicot	Perennial forb
<i>Balsamorhiza macrolepis</i> var. <i>macrolepis</i>	Asteraceae	SI	2.5	15	6	2.0	1.1	0.5	1b			1		1	Dicot	Perennial forb
<i>Balsamorhiza sericea</i>	Asteraceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b	1					Dicot	Perennial forb
<i>Brickellia greenei</i>	Asteraceae	BE/SI	3.7	11	3	4.0	0.6	0.3		1	1			1	Dicot	Perennial forb
<i>Cacaliopsis nardosmia</i>	Asteraceae	WI/IN	1.3	4	3	2.0	1.2	0.7		1	1				Dicot	Perennial forb
<i>Calycadenia multiglandulosa</i>	Asteraceae	SI	3.1	15.5	5	3.0	1.2	0.6			1	1	1	1	Dicot	Annual forb
<i>Calycadenia oppositifolia</i>	Asteraceae	SI	2.6	18	7	2.0	1.6	0.6	1b					1	Dicot	Annual forb
<i>Calycadenia pauciflora</i>	Asteraceae	BE	5.3	21	4	5.5	1.0	0.5			1				Dicot	Annual forb
<i>Calycadenia truncata</i>	Asteraceae	WI	2.1	12.5	6	2.5	1.1	0.5		1	1	1	1	1	Dicot	Annual forb
<i>Chaenactis glabriuscula</i> var. <i>glabriuscula</i>	Asteraceae	WI	1.7	5.1	3	2.0	1.5	0.9				1	1	1	Dicot	Perennial forb
<i>Chaenactis glabriuscula</i> var. <i>heterocarpha</i>	Asteraceae	SI	2.5	10	4	2.5	0.6	0.3			1	1	1	1	Dicot	Annual forb
<i>Chaenactis suffrutescens</i>	Asteraceae	SE	6.1	30.5	5	6.0	0.0	0.0	1b	1					Dicot	Perennial forb
<i>Chrysothamnus nauseosus</i> ssp. <i>consimilis</i>	Asteraceae	WI	1.8	8.85	5	2.0	1.5	0.7		1	1			1	Dicot	Shrub
<i>Cirsium andrewsii</i>	Asteraceae	WI	1.7	5	3	2.0	0.9	0.5	1b			1			Dicot	Perennial forb
<i>Cirsium cymosum</i>	Asteraceae	SI	3.0	12	4	2.0	2.0	1.0		1	1	1	1	1	Dicot	Perennial forb
<i>Cirsium douglasii</i> var. <i>breweri</i>	Asteraceae	SI	3.0	12	4	3.0	1.6	0.8		1	1			1	Dicot	Perennial forb
<i>Cirsium fontinale</i> var. <i>campylon</i>	Asteraceae	SE	5.9	29.5	5	6.0	0.4	0.2	1b			1	1		Dicot	Perennial forb
<i>Cirsium fontinale</i> var. <i>fontinale</i>	Asteraceae	SE	6.1	30.5	5	6.0	0.0	0.0	1b			1	1		Dicot	Perennial forb
<i>Cirsium fontinale</i> var. <i>obispoense</i>	Asteraceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b				1		Dicot	Perennial forb
<i>Cirsium hydrophilum</i> var. <i>vaseyi</i>	Asteraceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b		1	1			Dicot	Perennial forb
<i>Cirsium remotifolium</i>	Asteraceae	WI/IN	1.0	3.1	3	1.0	1.0	0.5		1	1	1			Dicot	Perennial forb
<i>Coreopsis stillmanii</i>	Asteraceae	SI	2.7	8	3	3.0	0.6	0.3			1		1	1	Dicot	Annual forb
<i>Crepis pleurocarpa</i>	Asteraceae	WI	2.0	10	5	2.0	0.7	0.3		1	1			1	Dicot	Perennial forb
<i>Ericameria arborescens</i>	Asteraceae	WI/IN	1.3	4	3	1.0	1.5	0.9		1	1		1	1	Dicot	Shrub
<i>Ericameria greenei</i>	Asteraceae	WI	2.0	8.1	4	1.5	2.1	1.1		1	1			1	Dicot	Shrub
<i>Ericameria ophitidis</i>	Asteraceae	SE	5.5	38.5	7	6.0	1.0	0.4	4	1	1				Dicot	Shrub

Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Erigeron angustatus</i>	Asteraceae	SE	5.7	28.5	5	6.0	0.9	0.4	1b		1				Dicot	Perennial forb
<i>Erigeron bloomeri</i> var. <i>nudatus</i>	Asteraceae	SE	6.2	18.5	3	6.0	0.0	0.0	2	1					Dicot	Perennial forb
<i>Erigeron cervinus</i>	Asteraceae	SI	3.3	10	3	4.0	3.1	1.8		1					Dicot	Perennial forb (rhiz.)
<i>Erigeron decumbens</i> var. <i>robustior</i>	Asteraceae	WI	1.5	4.5	3	2.0	1.2	0.7	4		1				Dicot	Perennial forb
<i>Erigeron foliosus</i> var. <i>confinis</i>	Asteraceae	BE/SI	3.7	11	3	3.0	1.2	0.7		1					Dicot	Perennial forb
<i>Erigeron lassenianus</i> var. <i>deficiens</i>	Asteraceae	WI	1.7	5	3	2.0	1.5	0.9						1	Dicot	Perennial forb
<i>Erigeron petrophilus</i> var. <i>sierrensis</i>	Asteraceae	BE	4.8	28.5	6	6.0	2.1	0.8	4					1	Dicot	Perennial forb (rhiz.)
<i>Erigeron petrophilus</i> var. <i>viscidulus</i>	Asteraceae	WI	2.4	9.5	4	2.0	0.5	0.3	4	1					Dicot	Perennial forb (rhiz.)
<i>Erigeron reductus</i>	Asteraceae	WI	2.0	8	4	2.0	1.6	0.8		1	1			1	Dicot	Perennial forb
<i>Erigeron serpentinus</i>	Asteraceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b		1				Dicot	Perennial forb
<i>Eriophyllum confertiflorum</i> var. <i>tanacetiflorum</i>	Asteraceae	WI	1.9	3.75	2	1.9	1.6	1.1						1	Dicot	Shrub
<i>Eriophyllum jepsonii</i>	Asteraceae	BE/SI	3.5	17.5	5	3.0	1.5	0.7	4			1	1		Dicot	Shrub
<i>Eriophyllum lanatum</i> var. <i>achillaeoides</i>	Asteraceae	WI	2.3	7	3	2.0	0.6	0.3		1	1	1	1	1	Dicot	Shrub
<i>Eriophyllum lanatum</i> var. <i>lanceolatum</i>	Asteraceae	WI	1.7	5	3	2.0	1.5	0.9		1	1				Dicot	Shrub
<i>Eriophyllum latilobum</i>	Asteraceae	SE	5.5	16.5	3	6.0	1.2	0.7	1b			1	1		Dicot	Shrub
<i>Grindelia hirsutula</i> var. <i>davyi</i>	Asteraceae	WI	1.8	5.25	3	2.0	1.4	0.8			1			1	Dicot	Perennial forb
<i>Grindelia hirsutula</i> var. <i>hirsutula</i>	Asteraceae	WI/IN	1.2	3.6	3	1.0	1.0	0.5				1	1		Dicot	Perennial forb
<i>Grindelia hirsutula</i> var. <i>maritima</i>	Asteraceae	WI	1.7	5	3	2.0	0.9	0.5	1b			1			Dicot	Perennial forb
<i>Gutierrezia californica</i>	Asteraceae	WI	1.8	5.25	3	2.0	1.4	0.8			1	1	1		Dicot	Perennial forb, Shrub
<i>Harmonia guggolziorum</i>	Asteraceae	SE	6.0	18	3	6.0	0.0	0.0	1b		1				Dicot	Annual forb
<i>Hazardia stenolepis</i>	Asteraceae	WI	2.0	6.1	3	3.0	1.7	1.0					1		Dicot	Shrub (stem succulent)
<i>Hazardia whitneyi</i> var. <i>discoidea</i>	Asteraceae	WI	1.9	5.75	3	2.0	1.1	0.7		1					Dicot	Perennial forb, Shrub
<i>Hazardia whitneyi</i> var. <i>whitneyi</i>	Asteraceae	WI/IN	1.0	2	2	1.0	1.4	1.0						1	Dicot	Perennial forb, Shrub
<i>Helenium bigelovii</i>	Asteraceae	SI	2.9	11.5	4	2.5	2.3	1.2		1	1		1	1	Dicot	Perennial forb
<i>Helianthus exilis</i>	Asteraceae	SE	5.7	45.5	8	6.0	1.1	0.4	4	1	1		1	1	Dicot	Annual, Perennial forb

APPENDIX 1. CONTINUED.

Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Hemizonia congesta</i> ssp. <i>calyculata</i>	Asteraceae	WI	1.5	4.5	3	2.0	1.2	0.7	4		1				Dicot	Annual forb
<i>Hemizonia congesta</i> ssp. <i>congesta</i>	Asteraceae	WI/IN	1.3	4	3	2.0	1.2	0.7			1	1	1		Dicot	Annual forb
<i>Hemizonia congesta</i> ssp. <i>tracyi</i>	Asteraceae	WI	1.8	5.25	3	2.0	0.7	0.4	4		1				Dicot	Annual forb
<i>Hemizonia halliana</i>	Asteraceae	SI	3.0	12	4	3.0	2.4	1.2					1		Dicot	Annual forb
<i>Hesperervax sparsiflora</i> var. <i>sparsiflora</i>	Asteraceae	WI	1.8	7.25	4	1.5	1.6	0.8			1	1	1		Dicot	Annual forb
<i>Heterotheca oregona</i> var. <i>oregona</i>	Asteraceae	WI	2.0	6	3	3.0	1.7	1.0		1	1		1		Dicot	Perennial forb
<i>Hieracium bolanderi</i>	Asteraceae	BE/SI	3.8	15	4	4.5	2.6	1.3		1	1				Dicot	Perennial forb
<i>Hieracium greenei</i>	Asteraceae	WI	2.2	6.5	3	3.0	1.4	0.8		1	1				Dicot	Perennial forb
<i>Lagophylla glandulosa</i>	Asteraceae	WI	2.0	6.1	3	3.0	1.7	1.0			1			1	Dicot	Annual forb
<i>Lagophylla minor</i>	Asteraceae	BE	4.7	23.5	5	5.0	1.7	0.7			1			1	Dicot	Annual forb
<i>Layia discoidea</i>	Asteraceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b				1		Dicot	Annual forb
<i>Layia jonesii</i>	Asteraceae	BE/SI	3.5	10.5	3	3.0	0.6	0.3	1b				1		Dicot	Annual forb
<i>Layia septentrionalis</i>	Asteraceae	SI	3.2	19	6	3.5	1.4	0.6	1b		1				Dicot	Annual forb
<i>Lessingia arachnoidea</i>	Asteraceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b			1			Dicot	Annual forb
<i>Lessingia filaginifolia</i> var. <i>californica</i>	Asteraceae	WI/IN	1.3	4	3	1.0	1.5	0.9		1	1	1	1	1	Dicot	Perennial forb, Shrub
<i>Lessingia hololeuca</i>	Asteraceae	SI	2.5	7.5	3	3.0	1.2	0.7	3		1	1			Dicot	Annual forb
<i>Lessingia micradenia</i> var. <i>glabrata</i>	Asteraceae	BE	5.1	30.5	6	5.5	1.3	0.5	1b			1			Dicot	Annual forb
<i>Lessingia micradenia</i> var. <i>micradenia</i>	Asteraceae	BE	5.3	31.5	6	5.5	1.0	0.4	1b			1			Dicot	Annual forb
<i>Lessingia nemaclada</i>	Asteraceae	WI	2.0	6	3	2.0	1.0	0.6		1	1	1	1	1	Dicot	Annual forb
<i>Lessingia occidentalis</i>	Asteraceae	BE/SI	4.1	16.5	4	4.0	1.8	0.9	4				1		Dicot	Annual forb
<i>Lessingia ramulosa</i>	Asteraceae	BE	5.4	27	5	6.0	1.3	0.6			1			1	Dicot	Annual forb
<i>Luina hypoleuca</i>	Asteraceae	WI/IN	1.4	4.25	3	2.0	1.0	0.6		1	1	1			Dicot	Perennial forb
<i>Madia doris-nilesiae</i> (= <i>Harmonia</i> d.)	Asteraceae	BE	5.4	32.5	6	5.5	0.8	0.3	1b	1					Dicot	Annual forb
<i>Madia exigua</i>	Asteraceae	WI	1.8	7.25	4	2.0	1.4	0.7		1	1	1	1	1	Dicot	Annual forb
<i>Madia hallii</i> (= <i>Harmonia</i> h.)	Asteraceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b		1				Dicot	Annual forb
<i>Madia stebbinsii</i> (= <i>Harmonia</i> s.)	Asteraceae	SE	6.1	42.5	7	6.0	0.0	0.0	1b		1				Dicot	Annual forb
<i>Malacothrix clevelandii</i>	Asteraceae	SI	3.0	9.1	3	3.0	3.0	1.7		1	1	1	1	1	Dicot	Annual forb
<i>Malacothrix floccifera</i>	Asteraceae	WI	2.1	6.25	3	3.0	1.6	0.9		1	1	1	1	1	Dicot	Annual forb
<i>Micropus amphibolus</i>	Asteraceae	WI	2.4	7.25	3	1.0	3.1	1.8			1	1	1		Dicot	Annual forb
<i>Microseris douglasii</i>	Asteraceae	WI/IN	1.3	4	3	1.0	0.6	0.3			1	1	1	1	Dicot	Annual forb
<i>Monolopia gracilens</i>	Asteraceae	WI	2.4	4.75	2	2.4	2.3	1.6				1	1		Dicot	Annual forb
<i>Pentachaeta bellidiflora</i>	Asteraceae	WI	2.4	7.25	3	3.0	1.3	0.8	1b			1			Dicot	Annual forb

Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Pyrrocoma racemosa</i> var. <i>congesta</i>	Asteraceae	SE	6.2	18.5	3	6.0	0.0	0.0	2	1					Dicot	Perennial forb
<i>Pyrrocoma racemosa</i> var. <i>pinetorum</i>	Asteraceae	BE/SI	4.0	16	4	4.5	2.4	1.2		1					Dicot	Perennial forb
<i>Pyrrocoma racemosa</i> var. <i>racemosa</i>	Asteraceae	WI	1.7	5	3	1.0	2.1	1.2			1	1	1		Dicot	Perennial forb
<i>Raillardella pringlei</i>	Asteraceae	SE	6.0	30	5	6.0	0.0	0.0	1b	1					Dicot	Perennial forb
<i>Rigiopappus leptocladus</i>	Asteraceae	WI	1.9	7.5	4	2.0	1.3	0.7		1	1	1	1	1	Dicot	Annual forb
<i>Rudbeckia californica</i> var. <i>glauca</i>	Asteraceae	BE	5.3	21	4	6.0	1.5	0.8		1	1				Dicot	Perennial forb
<i>Senecio clevelandii</i> var. <i>clevelandii</i> (= <i>Packera</i> c. v. c.)	Asteraceae	SE	5.8	46.5	8	6.0	0.7	0.3	4		1				Dicot	Perennial forb
<i>Senecio clevelandii</i> var. <i>heterophyllus</i> (= <i>Packera</i> c. v. h.)	Asteraceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b					1	Dicot	Perennial forb
<i>Senecio eurycephalus</i> var. <i>eurycephalus</i> (= <i>Packera eurycephala</i> var. <i>eurycephala</i>)	Asteraceae	BE/SI	3.8	15	4	3.0	1.5	0.8		1	1				Dicot	Perennial forb
<i>Senecio eurycephalus</i> var. <i>lewisrosei</i> (= <i>Packera eurycephala</i> var. <i>lewisrosei</i>)	Asteraceae	SE	5.8	40.5	7	6.0	0.8	0.3	1b					1	Dicot	Perennial forb
<i>Senecio greenei</i> (= <i>Packera</i> g.)	Asteraceae	BE	5.3	32	6	6.0	1.6	0.7		1	1				Dicot	Perennial forb
<i>Senecio layneae</i> (= <i>Packera</i> l.)	Asteraceae	BE	4.9	29.5	6	5.0	1.3	0.5	1b					1	Dicot	Perennial forb
<i>Senecio macounii</i> (= <i>Packera</i> m.)	Asteraceae	BE	5.1	20.5	4	6.0	2.0	1.0	4	1					Dicot	Perennial forb
<i>Solidago guiradonis</i>	Asteraceae	SE	6.2	18.5	3	6.0	0.0	0.0	4				1		Dicot	Perennial forb
<i>Solidago multiradiata</i>	Asteraceae	WI/IN	1.1	2.1	2	1.1	1.3	1.0		1				1	Dicot	Perennial forb
<i>Stebbinsoseris decipiens</i>	Asteraceae	WI	1.8	5.5	3	2.0	0.6	0.3	1b			1	1		Dicot	Annual forb
<i>Wyethia bolanderi</i>	Asteraceae	WI	1.5	3	2	1.5	0.7	0.5						1	Dicot	Perennial forb
<i>Berberis aquifolium</i> var. <i>aquifolium</i>	Berberidaceae	WI	1.6	4.75	3	1.0	1.2	0.7		1	1			1	Dicot	Shrub
<i>Berberis aquifolium</i> var. <i>repens</i>	Berberidaceae	WI	1.7	5	3	1.0	1.2	0.7		1	1			1	Dicot	Shrub
<i>Vancouveria chrysantha</i>	Berberidaceae	SE	6.2	18.5	3	6.0	0.0	0.0	4	1	1				Dicot	Perennial forb (rhiz.)
<i>Vancouveria planipetala</i>	Berberidaceae	WI	1.7	5	3	1.0	1.2	0.7		1	1	1	1		Dicot	Perennial forb (rhiz.)
<i>Cryptantha clevelandii</i> var. <i>dissita</i>	Boraginaceae	BE/SI	4.4	17.5	4	4.5	2.1	1.0	1b		1				Dicot	Annual forb
<i>Cryptantha excavata</i>	Boraginaceae	WI	1.5	3	2	1.5	2.1	1.5			1				Dicot	Annual forb

Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Cryptantha flaccida</i>	Boraginaceae	WI	1.6	4.75	3	2.0	0.7	0.4		1	1	1	1	1	Dicot	Annual forb
<i>Cryptantha hispidula</i>	Boraginaceae	SE	6.0	24	4	6.0	0.0	0.0		1	1				Dicot	Annual forb
<i>Cryptantha intermedia</i>	Boraginaceae	WI/IN	1.4	4.1	3	1.0	1.5	0.9		1	1	1	1	1	Dicot	Annual forb
<i>Cryptantha mariposae</i>	Boraginaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b					1	Dicot	Annual forb
<i>Cryptantha milobakeri</i>	Boraginaceae	SI	3.3	9.75	3	3.0	2.6	1.5		1	1			1	Dicot	Annual forb
<i>Cryptantha sobolifera</i>	Boraginaceae	WI/IN	1.4	4.1	3	1.0	1.5	0.9		1				1	Dicot	Perennial forb
<i>Hackelia bella</i>	Boraginaceae	WI/IN	1.3	4	3	1.0	1.5	0.9		1	1				Dicot	Perennial forb
<i>Pectocarya pusilla</i>	Boraginaceae	WI/IN	1.3	2.5	2	1.3	1.1	0.8		1	1	1	1	1	Dicot	Annual forb
<i>Arabis aculeolata</i>	Brassicaceae	SE	6.1	24.5	4	6.0	0.0	0.0	2	1					Dicot	Perennial forb
<i>Arabis constancei</i>	Brassicaceae	SE	5.9	41.5	7	6.0	0.4	0.1	1b					1	Dicot	Perennial forb
<i>Arabis koehleri</i> var. <i>stipitata</i>	Brassicaceae	SE	5.5	16.5	3	6.0	1.2	0.7	1b	1					Dicot	Perennial forb
<i>Arabis macdonaldiana</i>	Brassicaceae	BE	5.4	32.5	6	6.0	1.0	0.4	1b	1	1				Dicot	Perennial forb
<i>Arabis oregana</i>	Brassicaceae	BE/SI	3.8	11.5	3	3.0	2.1	1.2	4	1	1				Dicot	Perennial forb
<i>Arabis subpinnatifida</i>	Brassicaceae	SI	3.2	16	5	3.0	1.6	0.7		1	1				Dicot	Perennial forb
<i>Arabis suffrutescens</i> var. <i>horizontalis</i>	Brassicaceae	BE/SI	3.9	27	7	3.0	1.6	0.6			1			1	Dicot	Perennial forb
<i>Arabis suffrutescens</i> var. <i>suffrutescens</i>	Brassicaceae	SI	2.9	17.5	6	2.5	1.9	0.8		1				1	Dicot	Perennial forb
<i>Cardamine californica</i> var. <i>cuneata</i>	Brassicaceae	WI	1.9	3.75	2	1.9	1.6	1.1					1		Dicot	Perennial forb (rhiz.)
<i>Cardamine nuttallii</i> var. <i>gemmata</i>	Brassicaceae	BE	5.2	15.5	3	5.0	1.0	0.6	1b	1					Dicot	Perennial forb (rhiz.)
<i>Cardamine pachystigma</i> var. <i>dissectifolia</i>	Brassicaceae	BE	5.4	48.5	9	6.0	1.0	0.3	3		1			1	Dicot	Perennial forb (rhiz.)
<i>Cardamine pachystigma</i> var. <i>pachystigma</i>	Brassicaceae	WI	2.0	6	3	2.0	1.0	0.6			1			1	Dicot	Perennial forb (rhiz.)
<i>Caulanthus amplexicaulis</i> var. <i>barbarae</i>	Brassicaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b				1		Dicot	Annual forb
<i>Draba aureola</i>	Brassicaceae	SI	2.7	8	3	3.0	0.6	0.3	1b	1					Dicot	Perennial forb
<i>Draba carnosula</i>	Brassicaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b	1					Dicot	Perennial forb
<i>Draba howellii</i>	Brassicaceae	WI/IN	1.4	4.25	3	1.0	1.4	0.8		1					Dicot	Perennial forb
<i>Erysimum franciscanum</i>	Brassicaceae	SI	3.0	9	3	3.0	0.0	0.0	4		1	1	1		Dicot	Perennial forb
<i>Guillenia flavescens</i>	Brassicaceae	WI	2.3	9.25	4	2.5	1.6	0.8			1	1	1		Dicot	Annual forb
<i>Streptanthus albidus</i> ssp. <i>albidus</i>	Brassicaceae	BE	5.3	31.5	6	6.0	1.3	0.5	1b			1	1		Dicot	Annual forb
<i>Streptanthus albidus</i> ssp. <i>peramoenus</i>	Brassicaceae	BE/SI	4.3	34.5	8	4.5	1.9	0.7	1b			1	1		Dicot	Annual forb
<i>Streptanthus barbatus</i>	Brassicaceae	SE	5.6	28	5	6.0	0.5	0.2		1					Dicot	Perennial forb
<i>Streptanthus barbiger</i>	Brassicaceae	SE	6.0	24	4	6.0	0.0	0.0	4		1				Dicot	Annual forb
<i>Streptanthus batrachopus</i>	Brassicaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b		1	1			Dicot	Annual forb

Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Streptanthus brachiatus</i> var. <i>brachiatus</i>	Brassicaceae	SE	5.6	22.5	4	6.0	1.0	0.5	1b		1				Dicot	Annual, Perennial forb
<i>Streptanthus brachiatus</i> var. <i>hoffmanii</i>	Brassicaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b		1				Dicot	Annual, Perennial forb
<i>Streptanthus breweri</i> var. <i>breweri</i>	Brassicaceae	SE	5.7	40	7	6.0	0.8	0.3		1	1	1	1		Dicot	Annual forb
<i>Streptanthus breweri</i> var. <i>hesperidus</i>	Brassicaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b		1				Dicot	Annual forb
<i>Streptanthus drepanoides</i>	Brassicaceae	SE	6.1	36.5	6	6.0	0.0	0.0	4	1	1			1	Dicot	Annual forb
<i>Streptanthus glandulosus</i> ssp. <i>glandulosus</i>	Brassicaceae	WI	1.9	5.75	3	2.0	1.1	0.7			1	1	1		Dicot	Annual forb
<i>Streptanthus glandulosus</i> ssp. <i>pulchellus</i>	Brassicaceae	BE	4.9	24.5	5	6.0	1.8	0.8	1b		1	1			Dicot	Annual forb
<i>Streptanthus glandulosus</i> ssp. <i>secundus</i>	Brassicaceae	SI	3.3	20	6	3.0	1.5	0.6			1	1			Dicot	Annual forb
<i>Streptanthus glandulosus</i> ssp. <i>secundus</i> var. <i>hoffmanii</i>	Brassicaceae	SI	3.0	3	1	3.0	—	—	1b		1				Dicot	Annual forb
<i>Streptanthus howellii</i>	Brassicaceae	SE	6.1	30.5	5	6.0	0.0	0.0	1b	1					Dicot	Perennial forb
<i>Streptanthus insignis</i> ssp. <i>insignis</i>	Brassicaceae	BE/SI	4.0	20	5	4.0	2.4	1.1					1		Dicot	Annual forb
<i>Streptanthus insignis</i> ssp. <i>lyonii</i>	Brassicaceae	SI	3.3	16.5	5	2.0	2.7	1.2	1b				1		Dicot	Annual forb
<i>Streptanthus morrisonii</i> ssp. <i>elatus</i>	Brassicaceae	SE	6.1	30.5	5	6.0	0.0	0.0	1b		1				Dicot	Annual, Perennial forb
<i>Streptanthus morrisonii</i> ssp. <i>hirtiflorus</i>	Brassicaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b		1				Dicot	Annual, Perennial forb
<i>Streptanthus morrisonii</i> ssp. <i>kruckebergii</i>	Brassicaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b		1				Dicot	Annual, Perennial forb
<i>Streptanthus morrisonii</i> ssp. <i>morrisonii</i>	Brassicaceae	SE	6.1	30.5	5	6.0	0.0	0.0	1b		1				Dicot	Annual, Perennial forb
<i>Streptanthus niger</i>	Brassicaceae	SE	6.1	30.5	5	6.0	0.0	0.0	1b		1	1			Dicot	Annual forb
<i>Streptanthus polygaloides</i>	Brassicaceae	SE	5.7	28.5	5	6.0	0.9	0.4						1	Dicot	Annual forb
<i>Streptanthus tortuosus</i> var. <i>suffrutescens</i>	Brassicaceae	WI	1.6	8.2	5	2.0	1.6	0.7			1		1	1	Dicot	Annual, Perennial forb

APPENDIX 1. CONTINUED.

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Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Streptanthus tortuosus</i> var. <i>tortuosus</i>	Brassicaceae	WI/IN	1.4	4.25	3	2.0	1.0	0.6			1	1		1	Dicot	Annual, Perennial forb
<i>Thelypodium brachycarpum</i>	Brassicaceae	SI	3.3	10	3	3.0	0.6	0.3	4	1	1				Dicot	Annual, Perennial forb
<i>Thlaspi californicum</i>	Brassicaceae	SE	6.1	30.5	5	6.0	0.0	0.0	1b		1				Dicot	Perennial forb
<i>Thlaspi montanum</i> var. <i>montanum</i>	Brassicaceae	BE/SI	4.4	22	5	4.0	1.5	0.7		1	1				Dicot	Perennial forb
<i>Campanula angustiflora</i>	Campanulaceae	BE/SI	3.9	19.25	5	4.0	2.4	1.1			1	1			Dicot	Annual forb
<i>Campanula exigua</i>	Campanulaceae	BE/SI	3.9	19.5	5	4.0	1.5	0.7	1b			1	1		Dicot	Annual forb
<i>Campanula griffinii</i>	Campanulaceae	SE	6.0	18	3	6.0	0.0	0.0			1	1	1		Dicot	Annual forb
<i>Campanula rotundifolia</i>	Campanulaceae	BE	5.0	15	3	6.0	1.7	1.0		1					Dicot	Perennial forb
<i>Campanula scabrella</i>	Campanulaceae	SI	2.5	10	4	2.5	1.3	0.6	4	1					Dicot	Perennial forb (rhiz.)
<i>Campanula sharsmithiae</i>	Campanulaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b			1	1		Dicot	Annual forb
<i>Campanula wilkinsiana</i>	Campanulaceae	WI/IN	1.0	5	5	0.0	1.7	0.8		1					Dicot	Perennial forb (rhiz.)
<i>Githopsis diffusa</i> ssp. <i>candida</i>	Campanulaceae	WI/IN	1.0	2	2	1.0	1.4	1.0					1		Dicot	Annual forb
<i>Githopsis pulchella</i> ssp. <i>campestris</i>	Campanulaceae	WI	1.6	3.25	2	1.6	1.9	1.4						1	Dicot	Annual forb
<i>Githopsis pulchella</i> ssp. <i>pulchella</i> var. <i>glabra</i>	Campanulaceae	BE/SI	3.8	19	5	3.0	2.0	0.9						1	Dicot	Annual forb
<i>Githopsis pulchella</i> ssp. <i>serpentinicola</i>	Campanulaceae	BE	5.3	21	4	5.5	1.0	0.5	4					1	Dicot	Annual forb
<i>Nemacladus montanus</i>	Campanulaceae	SE	6.0	18	3	6.0	0.0	0.0			1	1	1		Dicot	Annual forb
<i>Arenaria kingii</i> var. <i>glabrescens</i>	Caryophyllaceae	WI/IN	1.4	4.1	3	2.0	1.1	0.6						1	Dicot	Perennial forb
<i>Cerastium arvense</i>	Caryophyllaceae	WI	2.1	8.5	4	0.9	2.6	1.3		1	1	1	1	1	Dicot	Perennial forb
<i>Minuartia californica</i>	Caryophyllaceae	WI	1.7	5	3	2.0	1.5	0.9		1	1	1	1	1	Dicot	Annual forb
<i>Minuartia cismontana</i> (new taxon)	Caryophyllaceae	WI	1.8	3.5	2	1.8	1.8	1.3		1	1	1	1	1	Dicot	Annual, Perennial forb
<i>Minuartia decumbens</i>	Caryophyllaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b	1	1				Dicot	Perennial forb
<i>Minuartia douglasii</i>	Caryophyllaceae	SI	3.0	15	5	3.0	0.7	0.3		1	1	1	1	1	Dicot	Annual forb
<i>Minuartia howellii</i>	Caryophyllaceae	SE	5.7	28.5	5	6.0	0.9	0.4	1b	1					Dicot	Perennial forb
<i>Minuartia nuttallii</i> ssp. <i>gregaria</i>	Caryophyllaceae	SI	3.2	16	5	3.0	1.9	0.9		1	1				Dicot	Perennial forb
<i>Minuartia rosei</i>	Caryophyllaceae	SE	6.1	30.5	5	6.0	0.0	0.0	4	1	1				Dicot	Perennial forb
<i>Minuartia stolonifera</i>	Caryophyllaceae	SE	6.1	30.5	5	6.0	0.0	0.0	1b	1					Dicot	Perennial forb
<i>Moehringia macrophylla</i>	Caryophyllaceae	SI	2.7	8	3	3.0	0.6	0.3		1	1	1	1	1	Dicot	Perennial forb
<i>Silene antirrhina</i>	Caryophyllaceae	WI/IN	1.1	3.25	3	1.0	0.9	0.5		1	1	1	1	1	Dicot	Annual forb

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Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Silene campanulata</i> ssp. <i>campanulata</i>	Caryophyllaceae	BE	5.3	31.5	6	5.5	1.0	0.4	4	1	1				Dicot	Perennial forb
<i>Silene campanulata</i> ssp. <i>glandulosa</i>	Caryophyllaceae	BE/SI	3.8	19	5	3.0	1.3	0.6		1	1				Dicot	Perennial forb
<i>Silene grayi</i>	Caryophyllaceae	WI	1.8	5.5	3	2.0	1.3	0.7		1					Dicot	Perennial forb
<i>Silene hookeri</i> ssp. <i>bolanderi</i>	Caryophyllaceae	BE	4.5	18	4	4.5	1.7	0.9		1	1				Dicot	Perennial forb
<i>Silene hookeri</i> ssp. <i>hookeri</i>	Caryophyllaceae	SI	3.0	12	4	2.5	2.2	1.1		1	1				Dicot	Perennial forb
<i>Silene serpentinicola</i> (new taxon)	Caryophyllaceae	SE	6.0	6	1	6.0	—	—		1					Dicot	Perennial forb (rhiz.)
<i>Helianthemum suffrutescens</i> (in <i>H. scoparium</i> in Jepson)	Cistaceae	WI/IN	1.0	2	2	1.0	1.4	1.0	3					1	Dicot	Shrub
<i>Calystegia collina</i> ssp. <i>collina</i>	Convolvulaceae	BE	4.7	33	7	6.0	1.6	0.6			1	1			Dicot	Perennial forb
<i>Calystegia collina</i> ssp. <i>oxyphylla</i>	Convolvulaceae	SE	5.6	33.5	6	6.0	1.2	0.5	4		1				Dicot	Perennial forb
<i>Calystegia collina</i> ssp. <i>tridactylosa</i>	Convolvulaceae	BE	4.5	18	4	4.5	1.7	0.9			1				Dicot	Perennial forb
<i>Calystegia collina</i> ssp. <i>venusta</i>	Convolvulaceae	BE	4.9	24.5	5	5.0	1.3	0.6	4				1		Dicot	Perennial forb
<i>Calystegia malacophylla</i>	Convolvulaceae	WI	1.5	4.5	3	1.0	1.3	0.8				1	1	1	Dicot	Perennial forb
<i>Convolvulus simulans</i>	Convolvulaceae	BE/SI	3.7	14.75	4	4.0	2.4	1.2	4			1	1		Dicot	Annual forb
<i>Dudleya abramsii</i> ssp. <i>bettinae</i>	Crassulaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b				1		Dicot	Perennial forb
<i>Dudleya abramsii</i> ssp. <i>murina</i>	Crassulaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b				1		Dicot	Perennial forb
<i>Dudleya blochmaniae</i> ssp. <i>blochmaniae</i>	Crassulaceae	SI	3.2	9.5	3	3.0	0.0	0.0	1b				1		Dicot	Perennial forb
<i>Dudleya setchellii</i>	Crassulaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b			1	1		Dicot	Perennial forb
<i>Parvisedum pentandrum</i>	Crassulaceae	WI	2.0	8.1	4	1.5	2.1	1.1			1	1	1		Dicot	Annual forb
<i>Parvisedum pumilum</i>	Crassulaceae	WI	1.7	5.1	3	2.0	1.5	0.9			1			1	Dicot	Annual forb
<i>Sedum albomarginatum</i>	Crassulaceae	SE	6.1	42.5	7	6.0	0.0	0.0	1b					1	Dicot	Perennial forb
<i>Sedum eastwoodiae</i>	Crassulaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b		1				Dicot	Perennial forb
<i>Sedum laxum</i> ssp. <i>flavidum</i>	Crassulaceae	SI	3.1	18.5	6	3.0	0.6	0.3	4	1	1				Dicot	Perennial forb
<i>Sedum laxum</i> ssp. <i>heckneri</i>	Crassulaceae	BE/SI	3.5	10.5	3	3.0	0.6	0.3	4	1	1				Dicot	Perennial forb
<i>Sedum laxum</i> ssp. <i>laxum</i>	Crassulaceae	BE/SI	4.0	16	4	3.5	1.4	0.7		1	1				Dicot	Perennial forb
<i>Sedum obtusatum</i> ssp. <i>obtusatum</i>	Crassulaceae	SI	3.2	16	5	3.0	2.2	1.0		1				1	Dicot	Perennial forb (rhiz.)
<i>Sedum radiatum</i>	Crassulaceae	WI	2.0	6	3	2.0	2.0	1.2		1	1	1	1	1	Dicot	Annual forb
<i>Calocedrus decurrens</i>	Cupressaceae	SI	3.0	9	3	3.0	0.0	0.0		1	1	1	1	1	Gymnosp.	Tree
<i>Cupressus bakeri</i>	Cupressaceae	SI	2.6	13	5	3.0	0.5	0.2	4	1				1	Gymnosp.	Tree
<i>Cupressus lawsoniana</i>	Cupressaceae	SI	3.0	15	5	3.0	0.7	0.3		1	1				Gymnosp.	Tree
<i>Cupressus macnabiana</i>	Cupressaceae	BE	4.7	28	6	4.5	1.2	0.5			1			1	Gymnosp.	Tree
<i>Cupressus sargentii</i>	Cupressaceae	BE	4.9	34	7	5.0	1.2	0.5			1	1	1		Gymnosp.	Tree
<i>Juniperus communis</i> var. <i>jackii</i>	Cupressaceae	BE/SI	4.0	8	2	4.0	2.8	2.0		1					Gymnosp.	Shrub

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Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Carex amplexans</i>	Cyperaceae	SI	2.6	10.5	4	2.3	2.9	1.4						1	Monocot	Perennial gram. (cesp.)
<i>Carex brainerdii</i>	Cyperaceae	WI/IN	1.4	4.25	3	2.0	1.0	0.6		1	1		1	1	Monocot	Perennial gram. (rhiz.)
<i>Carex gigas</i>	Cyperaceae	BE	4.5	22.5	5	4.0	1.7	0.7	4	1				1	Monocot	Perennial gram. (rhiz.)
<i>Carex mendocinensis</i>	Cyperaceae	BE/SI	3.8	23	6	3.5	1.2	0.5		1	1			1	Monocot	Perennial gram. (cesp.)
<i>Carex obispoensis</i>	Cyperaceae	BE	4.9	24.5	5	6.0	1.6	0.7	1b				1		Monocot	Perennial gram. (cesp.)
<i>Carex serpentinicola</i> (new taxon)	Cyperaceae	SE	5.5	11	2	5.5	0.7	0.5	2	1					Monocot	Perennial gram. (rhiz.)
<i>Carex serratodens</i>	Cyperaceae	BE	4.9	39	8	5.0	1.1	0.4			1	1	1	1	Monocot	Perennial gram. (cesp.)
<i>Carex spissa</i>	Cyperaceae	SI	2.8	8.25	3	2.0	2.9	1.7					1		Monocot	Perennial gram. (rhiz.)
<i>Polystichum lemmonii</i>	Dryopteridaceae	SE	6.0	24	4	6.0	0.0	0.0		1	1			1	Pteridoph.	Perennial forb (rhiz.)
<i>Polystichum scopulinum</i>	Dryopteridaceae	WI	1.7	5.1	3	2.0	1.5	0.9		1	1			1	Pteridoph.	Perennial forb (rhiz.)
<i>Arctostaphylos bakeri</i> ssp. <i>bakeri</i>	Ericaceae	SE	5.5	27.5	5	6.0	1.3	0.6	1b		1				Dicot	Shrub
<i>Arctostaphylos bakeri</i> ssp. <i>sublaevis</i>	Ericaceae	SE	6.3	12.5	2	6.0	0.0	0.0	1b		1				Dicot	Shrub
<i>Arctostaphylos canescens</i> ssp. <i>sonomensis</i>	Ericaceae	SI	2.5	12.5	5	3.0	1.5	0.7	1b	1	1				Dicot	Shrub
<i>Arctostaphylos hispidula</i>	Ericaceae	BE	4.5	22.5	5	4.0	1.1	0.5	4	1	1				Dicot	Shrub
<i>Arctostaphylos hookeri</i> ssp. <i>franciscana</i>	Ericaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1a			1	1		Dicot	Shrub
<i>Arctostaphylos hookeri</i> ssp. <i>montana</i>	Ericaceae	BE	4.9	19.5	4	4.5	1.0	0.5	1b			1	1		Dicot	Shrub
<i>Arctostaphylos hookeri</i> ssp. <i>ravenii</i>	Ericaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b			1	1		Dicot	Shrub

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Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Arctostaphylos klamathensis</i>	Ericaceae	BE/SI	3.9	19.5	5	4.0	1.8	0.8	1b	1					Dicot	Shrub
<i>Arctostaphylos nortensis</i>	Ericaceae	SI	2.8	5.5	2	2.5	0.7	0.5	4	1					Dicot	Shrub
<i>Arctostaphylos obispoensis</i>	Ericaceae	SE	5.7	28.5	5	6.0	0.9	0.4	4				1		Dicot	Shrub
<i>Arctostaphylos stanfordiana</i> ssp. <i>raichei</i>	Ericaceae	SI	2.6	10.5	4	3.0	1.7	0.9	1b		1				Dicot	Shrub
<i>Arctostaphylos viscida</i> ssp. <i>pulchella</i>	Ericaceae	BE	5.0	25	5	5.0	1.0	0.4		1	1				Dicot	Shrub
<i>Arctostaphylos viscida</i> ssp. <i>viscida</i>	Ericaceae	WI	2.2	10.75	5	3.0	1.2	0.5		1				1	Dicot	Shrub
<i>Pyrola picta</i> ssp. <i>dentata</i>	Ericaceae	WI	2.0	6	3	3.0	1.7	1.0		1	1				Dicot	Perennial forb (rhiz.)
<i>Vaccinium coccineum</i>	Ericaceae	BE/SI	3.5	3.5	1	3.0	—	—	3	1					Dicot	Shrub
<i>Astragalus breweri</i>	Fabaceae	SI	3.2	15.75	5	3.0	2.0	0.9	4		1	1			Dicot	Annual forb
<i>Astragalus clarianus</i> (<i>claranus</i>)	Fabaceae	SI	3.0	6	2	3.0	0.0	0.0	1b		1				Dicot	Annual forb
<i>Astragalus clevelandii</i>	Fabaceae	SE	6.1	24.5	4	6.0	0.0	0.0	4		1		1		Dicot	Perennial forb
<i>Astragalus curtipes</i>	Fabaceae	WI	1.8	3.5	2	1.8	1.8	1.3					1		Dicot	Perennial forb
<i>Astragalus macrodon</i>	Fabaceae	WI/IN	1.3	3.75	3	1.0	0.7	0.4	4				1		Dicot	Perennial forb
<i>Astragalus rattanii</i> var. <i>jepsonianus</i>	Fabaceae	BE/SI	4.3	25.5	6	4.0	1.2	0.5	1b		1				Dicot	Annual forb
<i>Astragalus whitneyi</i> var. <i>siskiyouensis</i>	Fabaceae	BE	4.6	23	5	5.0	1.1	0.5		1	1				Dicot	Perennial forb
<i>Hoita strobilina</i>	Fabaceae	SI	2.5	5	2	2.5	2.1	1.5	1b			1			Dicot	Perennial forb
<i>Lathyrus biflorus</i>	Fabaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b		1				Dicot	Perennial forb
<i>Lathyrus delnorticus</i>	Fabaceae	BE	5.3	10.5	2	5.0	1.4	1.0	4	1					Dicot	Perennial forb
<i>Lathyrus vestitus</i> var. <i>vestitus</i>	Fabaceae	WI	1.8	7.2	4	0.6	2.8	1.4			1	1	1		Dicot	Perennial forb
<i>Lotus junceus</i> var. <i>junceus</i>	Fabaceae	WI	1.5	3	2	1.5	0.7	0.5					1		Dicot	Perennial forb
<i>Lupinus constancei</i>	Fabaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b		1				Dicot	Perennial forb
<i>Lupinus lapidicola</i>	Fabaceae	SI	3.0	15	5	3.0	3.0	1.3	4	1	1				Dicot	Perennial forb
<i>Lupinus onustus</i>	Fabaceae	SI	3.1	15.25	5	3.0	2.9	1.3		1				1	Dicot	Perennial forb
<i>Lupinus spectabilis</i>	Fabaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b					1	Dicot	Annual forb
<i>Pediomelum californicum</i>	Fabaceae	BE/SI	4.4	21.75	5	6.0	2.4	1.1			1	1	1		Dicot	Perennial forb
<i>Trifolium amoenum</i>	Fabaceae	WI/IN	1.3	2.5	2	1.0	1.4	1.0	1b		1	1			Dicot	Annual forb
<i>Trifolium fucatum</i>	Fabaceae	WI/IN	1.3	4	3	1.0	0.6	0.3			1		1		Dicot	Annual forb
<i>Trifolium gracilentum</i> var. <i>gracilentum</i>	Fabaceae	WI/IN	1.0	3.1	3	1.0	1.0	0.5		1	1	1	1	1	Dicot	Annual forb
<i>Trifolium longipes</i> var. <i>elmeri</i>	Fabaceae	BE	5.3	21	4	6.0	1.5	0.8		1	1				Dicot	Perennial forb
<i>Trifolium longipes</i> var. <i>oreganum</i>	Fabaceae	BE/SI	4.0	12	3	4.0	2.0	1.2		1	1				Dicot	Perennial forb
<i>Trifolium microcephalum</i>	Fabaceae	WI/IN	1.4	7	5	1.0	1.1	0.5		1	1			1	Dicot	Annual forb
<i>Trifolium willdenovii</i>	Fabaceae	WI/IN	1.3	4	3	1.0	0.6	0.3		1	1	1	1	1	Dicot	Annual forb

APPENDIX 1. CONTINUED.

Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Lithocarpus densiflorus</i> var. <i>echinoides</i>	Fagaceae	SI	2.5	12.25	5	1.0	2.5	1.1		1				1	Dicot	Shrub
<i>Quercus durata</i> var. <i>durata</i>	Fagaceae	SE	5.8	40.5	7	6.0	0.8	0.3			1	1	1	1	Dicot	Shrub
<i>Quercus vaccinifolia</i>	Fagaceae	SI	2.5	12.25	5	2.0	2.2	1.0		1	1			1	Dicot	Shrub
<i>Garrya buxifolia</i>	Garryaceae	SE	5.8	29	5	6.0	0.4	0.2		1	1				Dicot	Shrub
<i>Garrya congdonii</i>	Garryaceae	BE	5.0	30	6	5.5	1.3	0.5		1	1	1		1	Dicot	Shrub
<i>Centaurium tricanthum</i>	Gentianaceae	SE	5.5	11	2	5.5	0.7	0.5			1	1			Dicot	Annual forb
<i>Gentiana setigera</i>	Gentianaceae	SE	5.8	17.5	3	6.0	0.3	0.2		1	1				Dicot	Perennial forb
<i>Swertia fastigiata</i>	Gentianaceae	WI	1.5	3	2	1.5	2.1	1.5		1					Dicot	Perennial forb
<i>Emmenanthe penduliflora</i> var. <i>penduliflora</i>	Hydrophyllaceae	WI	1.8	7	4	2.0	0.5	0.3			1	1	1	1	Dicot	Annual forb
<i>Emmenanthe penduliflora</i> var. <i>rosea</i>	Hydrophyllaceae	BE/SI	4.3	17	4	4.5	1.7	0.9				1	1		Dicot	Annual forb
<i>Phacelia breweri</i>	Hydrophyllaceae	SE	5.5	11	2	5.5	0.7	0.5				1	1		Dicot	Annual forb
<i>Phacelia californica</i>	Hydrophyllaceae	WI/IN	1.4	4.25	3	1.0	1.4	0.8			1	1	1		Dicot	Perennial forb
<i>Phacelia corymbosa</i>	Hydrophyllaceae	SE	5.5	33	6	6.0	0.8	0.3		1	1				Dicot	Perennial forb
<i>Phacelia dalesiana</i>	Hydrophyllaceae	SE	6.1	30.5	5	6.0	0.0	0.0	4	1					Dicot	Perennial forb
<i>Phacelia distans</i>	Hydrophyllaceae	WI/IN	1.1	2.1	2	1.1	1.3	1.0			1	1	1		Dicot	Annual forb
<i>Phacelia divaricata</i>	Hydrophyllaceae	WI	2.3	7	3	3.0	1.2	0.7			1	1	1		Dicot	Annual forb
<i>Phacelia egea</i>	Hydrophyllaceae	WI	2.1	6.25	3	3.0	1.6	0.9		1	1	1	1	1	Dicot	Perennial forb
<i>Phacelia greenei</i>	Hydrophyllaceae	SE	6.1	36.5	6	6.0	0.0	0.0	1b	1					Dicot	Annual forb
<i>Phacelia imbricata</i> ssp. <i>imbricata</i>	Hydrophyllaceae	WI	1.7	5	3	1.0	1.2	0.7			1	1	1	1	Dicot	Perennial forb
<i>Phacelia leonis</i>	Hydrophyllaceae	BE/SI	3.9	27.5	7	4.0	1.1	0.4	1b	1					Dicot	Annual forb
<i>Phacelia phacelioides</i>	Hydrophyllaceae	BE/SI	4.2	12.5	3	6.0	3.2	1.8				1	1		Dicot	Annual forb
<i>Phacelia pringlei</i>	Hydrophyllaceae	BE/SI	4.0	12	3	4.0	1.0	0.6		1					Dicot	Annual forb
<i>Phacelia purpusii</i>	Hydrophyllaceae	WI/IN	1.1	2.1	2	1.1	1.3	1.0						1	Dicot	Annual forb
<i>Iris bracteata</i>	Iridaceae	SE	5.8	11.5	2	5.5	0.7	0.5	3	1					Monocot	Perennial forb (rhiz.)
<i>Iris innominata</i>	Iridaceae	SE	5.8	11.5	2	5.5	0.7	0.5	4	1	1				Monocot	Perennial forb (rhiz.)
<i>Iris macrosiphon</i>	Iridaceae	WI/IN	1.1	3.25	3	1.0	0.9	0.5			1	1		1	Monocot	Perennial forb (rhiz.)
<i>Iris tenuissima</i> ssp. <i>purdyiformis</i>	Iridaceae	WI	1.5	3	2	1.5	2.1	1.5		1				1	Monocot	Perennial forb (rhiz.)
<i>Acanthomintha duttonii</i>	Lamiaceae	SE	6.1	30.5	5	6.0	0.0	0.0	1b			1	1		Dicot	Annual forb
<i>Acanthomintha ilicifolia</i>	Lamiaceae	WI/IN	1.3	3	3	0.0	1.7	1.0					1		Dicot	Annual forb
<i>Acanthomintha lanceolata</i>	Lamiaceae	SI	3.4	16.75	5	3.0	2.1	0.9	4			1	1		Dicot	Annual forb
<i>Acanthomintha obovata</i> ssp. <i>obovata</i>	Lamiaceae	BE/SI	3.5	10.5	3	3.0	2.5	1.5	4				1		Dicot	Annual forb

Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Monardella antonina</i> ssp. <i>benitensis</i>	Lamiaceae	SE	6.1	24.5	4	6.0	0.0	0.0	4				1		Dicot	Perennial forb (rhiz.)
<i>Monardella douglasii</i> ssp. <i>douglasii</i>	Lamiaceae	SI	3.0	6	2	3.0	1.4	1.0			1	1	1		Dicot	Annual forb
<i>Monardella follettii</i>	Lamiaceae	SE	5.8	34.5	6	6.0	0.8	0.3	1b					1	Dicot	Shrub
<i>Monardella palmeri</i>	Lamiaceae	BE	4.8	28.5	6	6.0	2.2	0.9	1b				1		Dicot	Perennial forb (rhiz.)
<i>Monardella purpurea</i>	Lamiaceae	BE/SI	4.4	22	5	6.0	2.3	1.0		1	1	1	1		Dicot	Perennial forb
<i>Monardella sheltonii</i>	Lamiaceae	SI	3.0	18	6	3.0	1.7	0.7		1	1			1	Dicot	Perennial forb
<i>Monardella stebbinsii</i>	Lamiaceae	SE	6.1	30.5	5	6.0	0.0	0.0	1b					1	Dicot	Perennial forb (rhiz.)
<i>Monardella viridis</i> ssp. <i>viridis</i>	Lamiaceae	BE/SI	4.3	17	4	4.5	2.1	1.0			1				Dicot	Perennial forb
<i>Salvia sonomensis</i>	Lamiaceae	WI	1.6	9.5	6	1.5	1.3	0.5		1	1	1	1	1	Dicot	Shrub
<i>Scutellaria antirrhinoides</i>	Lamiaceae	WI	2.3	11.5	5	3.0	1.5	0.7		1	1			1	Dicot	Perennial forb
<i>Stachys pycnantha</i>	Lamiaceae	WI	2.2	11	5	1.0	2.4	1.1		1	1	1	1	1	Dicot	Perennial forb
<i>Trichostema laxum</i>	Lamiaceae	BE/SI	4.0	16	4	4.5	2.4	1.2		1	1				Dicot	Annual forb
<i>Trichostema rubisepalum</i>	Lamiaceae	BE	5.4	21.5	4	6.0	1.5	0.8	4		1		1	1	Dicot	Annual forb
<i>Pinguicula vulgaris</i> ssp. <i>macroceras</i>	Lentibulariaceae	SE	6.2	18.5	3	6.0	0.0	0.0	2	1					Dicot	Perennial forb (carn.)
<i>Allium acuminatum</i>	Liliaceae	WI	1.5	4.5	3	2.0	0.9	0.5		1	1	1			Monocot	Perennial forb (bulb)
<i>Allium amplexans</i>	Liliaceae	WI	2.3	11.25	5	2.0	2.2	1.0		1	1	1	1	1	Monocot	Perennial forb (bulb)
<i>Allium bolanderi</i> var. <i>bolanderi</i>	Liliaceae	WI/IN	1.1	4.5	4	1.0	0.6	0.3		1	1	1			Monocot	Perennial forb (bulb)
<i>Allium bolanderi</i> var. <i>mirabile</i>	Liliaceae	WI	2.0	4	2	2.0	0.0	0.0		1	1				Monocot	Perennial forb (bulb)
<i>Allium cratericola</i>	Liliaceae	SI	2.6	15.75	6	2.5	1.9	0.8		1	1			1	Monocot	Perennial forb (bulb)
<i>Allium crispum</i>	Liliaceae	WI/IN	1.3	3.75	3	1.0	0.7	0.4				1	1		Monocot	Perennial forb (bulb)
<i>Allium diabloense</i>	Liliaceae	SE	6.0	18	3	6.0	0.0	0.0					1		Monocot	Perennial forb (bulb)
<i>Allium falcifolium</i>	Liliaceae	BE/SI	4.2	38	9	4.0	1.6	0.5		1	1	1			Monocot	Perennial forb (bulb)
<i>Allium fimbriatum</i> var. <i>purdyi</i>	Liliaceae	BE	5.4	21.5	4	6.0	1.5	0.8	4		1				Monocot	Perennial forb (bulb)
<i>Allium hoffmanii</i>	Liliaceae	SE	6.1	30.5	5	6.0	0.0	0.0	4	1	1				Monocot	Perennial forb (bulb)
<i>Allium howellii</i> var. <i>sanbenitense</i>	Liliaceae	BE/SI	4.0	12	3	4.0	1.0	0.6					1		Monocot	Perennial forb (bulb)

APPENDIX 1. CONTINUED.

Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Allium jepsonii</i>	Liliaceae	BE	5.4	37.5	7	6.0	1.0	0.4	1b					1	Monocot	Perennial forb (bulb)
<i>Allium lacunosum</i> var. <i>lacunosum</i>	Liliaceae	BE/SI	3.8	15.25	4	4.5	2.8	1.4				1	1		Monocot	Perennial forb (bulb)
<i>Allium lacunosum</i> var. <i>micranthum</i>	Liliaceae	BE/SI	4.3	13	3	6.0	2.9	1.7					1		Monocot	Perennial forb (bulb)
<i>Allium membranaceum</i>	Liliaceae	WI/IN	1.3	4	3	1.0	1.5	0.9		1				1	Monocot	Perennial forb (bulb)
<i>Allium obtusum</i> var. <i>conspicuum</i>	Liliaceae	WI/IN	1.0	2	2	1.0	1.4	1.0						1	Monocot	Perennial forb (bulb)
<i>Allium peninsulare</i> var. <i>franciscanum</i>	Liliaceae	WI	1.8	3.5	2	1.8	1.8	1.3	1b			1	1		Monocot	Perennial forb (bulb)
<i>Allium sanbornii</i> var. <i>congdonii</i>	Liliaceae	SE	5.6	22.5	4	6.0	1.0	0.5	4					1	Monocot	Perennial forb (bulb)
<i>Allium sanbornii</i> var. <i>sanbornii</i>	Liliaceae	SI	3.4	27	8	3.5	2.2	0.8	4					1	Monocot	Perennial forb (bulb)
<i>Allium serra</i>	Liliaceae	SI	2.6	10.5	4	3.0	1.5	0.7			1	1	1		Monocot	Perennial forb (bulb)
<i>Allium sharsmithiae</i>	Liliaceae	BE	5.1	20.5	4	6.0	2.0	1.0	1b			1	1		Monocot	Perennial forb (bulb)
<i>Allium siskiyouense</i>	Liliaceae	SI	2.8	14	5	2.0	1.8	0.8	4	1	1				Monocot	Perennial forb (bulb)
<i>Allium tuolumnense</i>	Liliaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b					1	Monocot	Perennial forb (bulb)
<i>Allium unifolium</i>	Liliaceae	WI/IN	1.0	3	3	1.0	1.0	0.6			1	1	1		Monocot	Perennial forb (bulb)
<i>Brodiaea californica</i> var. <i>californica</i>	Liliaceae	WI/IN	1.1	4.5	4	1.3	1.0	0.5			1			1	Monocot	Perennial forb
<i>Brodiaea californica</i> var. <i>leptandra</i>	Liliaceae	WI	2.0	4	2	2.0	1.4	1.0			1				Monocot	Perennial forb
<i>Brodiaea coronaria</i> ssp. <i>coronaria</i>	Liliaceae	WI/IN	1.0	2	2	1.0	1.4	1.0		1	1			1	Monocot	Perennial forb
<i>Brodiaea coronaria</i> ssp. <i>rosea</i>	Liliaceae	SE	5.5	27.5	5	6.0	1.3	0.6	1b		1				Monocot	Perennial forb
<i>Brodiaea pallida</i>	Liliaceae	BE	4.9	19.5	4	5.0	1.5	0.8	1b					1	Monocot	Perennial forb
<i>Brodiaea purdyi</i>	Liliaceae	WI	2.2	11	5	2.0	0.8	0.4						1	Monocot	Perennial forb
<i>Brodiaea stellaris</i>	Liliaceae	SE	6.0	18	3	6.0	0.0	0.0			1				Monocot	Perennial forb
<i>Calochortus clavatus</i> var. <i>clavatus</i>	Liliaceae	BE	4.5	13.5	3	4.0	0.6	0.3	4				1		Monocot	Perennial forb (bulb)
<i>Calochortus coeruleus</i> var. <i>fimbriatus</i>	Liliaceae	WI	1.5	4.5	3	1.0	1.3	0.8		1	1			1	Monocot	Perennial forb (bulb)
<i>Calochortus elegans</i> var. <i>nanus</i>	Liliaceae	WI	2.0	4	2	2.0	1.4	1.0		1					Monocot	Perennial forb (bulb)

Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Calochortus greenii</i>	Liliaceae	SE	6.0	12	2	6.0	0.0	0.0		1					Monocot	Perennial forb (bulb)
<i>Calochortus nudus</i>	Liliaceae	WI	2.1	8.5	4	2.5	1.2	0.6		1				1	Monocot	Perennial forb (bulb)
<i>Calochortus obispoensis</i>	Liliaceae	BE	5.4	21.5	4	6.0	1.5	0.8	1b				1		Monocot	Perennial forb (bulb)
<i>Calochortus raichei</i>	Liliaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b		1				Monocot	Perennial forb (bulb)
<i>Calochortus tiburonensis</i>	Liliaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b		1	1			Monocot	Perennial forb (bulb)
<i>Calochortus umbellatus</i>	Liliaceae	SI	2.9	14.5	5	3.0	1.1	0.5	4		1	1			Monocot	Perennial forb (bulb)
<i>Calochortus uniflorus</i>	Liliaceae	WI	1.7	5	3	1.0	1.2	0.7		1	1	1	1		Monocot	Perennial forb (bulb)
<i>Calochortus vestae</i>	Liliaceae	WI	2.0	6	3	2.0	1.0	0.6		1	1				Monocot	Perennial forb (bulb)
<i>Calochortus weedii</i> var. <i>vestus</i>	Liliaceae	WI/IN	1.0	3	3	0.0	1.7	1.0	1b				1		Monocot	Perennial forb (bulb)
<i>Chlorogalum angustifolium</i>	Liliaceae	WI	2.4	9.5	4	1.8	2.8	1.4			1			1	Monocot	Perennial forb (bulb)
<i>Chlorogalum grandiflorum</i>	Liliaceae	BE	5.2	26	5	6.0	1.1	0.5	1b					1	Monocot	Perennial forb (bulb)
<i>Chlorogalum pomeridianum</i> var. <i>minus</i>	Liliaceae	SE	6.1	30.5	5	6.0	0.0	0.0	1b		1	1	1		Monocot	Perennial forb (bulb)
<i>Chlorogalum purpureum</i> var. <i>reductum</i>	Liliaceae	SE	5.5	16.5	3	6.0	1.2	0.7	1b				1		Monocot	Perennial forb (bulb)
<i>Erythronium californicum</i>	Liliaceae	SI	2.7	8	3	2.0	2.1	1.2		1	1				Monocot	Perennial forb (bulb)
<i>Erythronium citrinum</i> var. <i>citrinum</i>	Liliaceae	BE/SI	4.3	21.5	5	4.0	0.4	0.2	4	1					Monocot	Perennial forb (bulb)
<i>Erythronium citrinum</i> var. <i>roderickii</i>	Liliaceae	BE	4.7	37.5	8	4.5	1.4	0.5	1b	1					Monocot	Perennial forb (bulb)
<i>Erythronium helenae</i>	Liliaceae	BE	4.5	18	4	4.5	1.7	0.9	4		1				Monocot	Perennial forb (bulb)
<i>Erythronium hendersonii</i>	Liliaceae	SI	2.5	5	2	2.5	3.5	2.5		1					Monocot	Perennial forb (bulb)
<i>Erythronium howellii</i>	Liliaceae	WI	2.3	7	3	2.0	2.5	1.5	1b	1					Monocot	Perennial forb (bulb)
<i>Erythronium multiscapoideum</i>	Liliaceae	SI	3.0	15	5	2.0	1.7	0.8						1	Monocot	Perennial forb (bulb)
<i>Erythronium purpurascens</i>	Liliaceae	WI/IN	1.0	2	2	1.0	1.4	1.0						1	Monocot	Perennial forb (bulb)

APPENDIX 1. CONTINUED.

Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Erythronium tuolumnense</i>	Liliaceae	SI	2.5	5	2	2.5	3.5	2.5						1	Monocot	Perennial forb (bulb)
<i>Fritillaria affinis</i> var. <i>affinis</i>	Liliaceae	WI	2.0	6	3	2.0	0.0	0.0		1	1	1		1	Monocot	Perennial forb (bulb)
<i>Fritillaria agrestis</i>	Liliaceae	SI	2.7	13.25	5	2.0	1.6	0.7	4		1	1	1	1	Monocot	Perennial forb (bulb)
<i>Fritillaria biflora</i> var. <i>biflora</i>	Liliaceae	WI	2.3	9	4	2.5	1.7	0.9			1	1	1		Monocot	Perennial forb (bulb)
<i>Fritillaria biflora</i> var. <i>ineziana</i>	Liliaceae	BE	5.4	21.5	4	6.0	1.5	0.8	1b			1			Monocot	Perennial forb (bulb)
<i>Fritillaria eastwoodiae</i>	Liliaceae	WI	2.3	13.5	6	2.0	0.4	0.2	3					1	Monocot	Perennial forb (bulb)
<i>Fritillaria falcata</i>	Liliaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b			1	1		Monocot	Perennial forb (bulb)
<i>Fritillaria glauca</i>	Liliaceae	BE/SI	4.3	17.25	4	5.5	2.7	1.4		1	1				Monocot	Perennial forb (bulb)
<i>Fritillaria liliacea</i>	Liliaceae	WI	1.8	7	4	1.5	1.1	0.6	1b			1	1		Monocot	Perennial forb (bulb)
<i>Fritillaria pluriflora</i>	Liliaceae	WI	2.4	9.5	4	2.5	1.5	0.7			1			1	Monocot	Perennial forb (bulb)
<i>Fritillaria purdyi</i>	Liliaceae	BE	4.5	31.5	7	4.0	1.8	0.7	4	1	1				Monocot	Perennial forb (bulb)
<i>Fritillaria recurva</i> var. <i>coccinea</i>	Liliaceae	SI	2.7	8	3	2.0	3.1	1.8			1				Monocot	Perennial forb (bulb)
<i>Fritillaria recurva</i> var. <i>recurva</i>	Liliaceae	SI	2.7	8	3	3.0	0.6	0.3		1	1			1	Monocot	Perennial forb (bulb)
<i>Fritillaria viridea</i>	Liliaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b				1		Monocot	Perennial forb (bulb)
<i>Hastingsia alba</i>	Liliaceae	SI	3.4	17	5	3.0	1.5	0.7		1	1			1	Monocot	Perennial forb (bulb)
<i>Hastingsia serpentinicola</i>	Liliaceae	SE	6.0	18	3	6.0	0.0	0.0		1	1				Monocot	Perennial forb (bulb)
<i>Lilium bolanderi</i>	Liliaceae	SE	6.2	18.5	3	6.0	0.0	0.0	4	1					Monocot	Perennial forb (bulb)
<i>Lilium kelloggii</i>	Liliaceae	SI	2.5	10	4	2.0	1.9	1.0		1	1				Monocot	Perennial forb (bulb)
<i>Lilium rubescens</i>	Liliaceae	WI	2.0	9.75	5	2.0	1.4	0.6	4	1	1	1			Monocot	Perennial forb (bulb)
<i>Lilium washingtonianum</i> ssp. <i>purpurascens</i>	Liliaceae	BE/SI	3.5	10.5	3	3.0	2.5	1.5	4	1					Monocot	Perennial forb (bulb)
<i>Muilla maritima</i>	Liliaceae	WI	2.0	6	3	2.0	1.0	0.6			1	1	1	1	Monocot	Perennial forb (bulb)
<i>Odontostomum hartwegii</i>	Liliaceae	SI	2.7	8	3	3.0	0.6	0.3			1			1	Monocot	Perennial forb (bulb)
<i>Triteleia bridgesii</i>	Liliaceae	SI	3.3	13	4	3.5	1.7	0.9		1	1			1	Monocot	Perennial forb (bulb)

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										KL	NC	BA	SC	SN		
<i>Triteleia crocea</i> var. <i>crocea</i>	Liliaceae	SI	3.3	10	3	3.0	2.5	1.5	4	1					Monocot	Perennial forb
<i>Triteleia crocea</i> var. <i>modesta</i>	Liliaceae	BE	4.5	22.5	5	4.0	1.5	0.7	4	1					Monocot	Perennial forb
<i>Triteleia ixioides</i> ssp. <i>cookii</i>	Liliaceae	BE	4.5	13.5	3	6.0	2.9	1.7	1b				1		Monocot	Perennial forb
<i>Triteleia peduncularis</i>	Liliaceae	BE/SI	3.8	19	5	3.0	2.2	1.0		1	1	1	1		Monocot	Perennial forb
<i>Xerophyllum tenax</i>	Liliaceae	WI	1.6	8	5	1.0	0.9	0.4		1	1	1	1	1	Monocot	Perennial forb (rhiz.)
<i>Zigadenus micranthus</i> var. <i>fontanus</i>	Liliaceae	BE/SI	3.8	23	6	4.0	0.8	0.3	4		1	1	1		Monocot	Perennial forb (bulb)
<i>Zigadenus paniculatus</i>	Liliaceae	WI	1.6	4.75	3	2.0	0.7	0.4		1	1			1	Monocot	Perennial forb (bulb)
<i>Hesperolinon adenophyllum</i>	Linaceae	SE	5.7	28.5	5	6.0	0.9	0.4	1b		1				Dicot	Annual forb
<i>Hesperolinon bicarpellatum</i>	Linaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b		1				Dicot	Annual forb
<i>Hesperolinon breweri</i>	Linaceae	SI	2.5	10	4	2.5	1.5	0.7	1b		1	1			Dicot	Annual forb
<i>Hesperolinon californicum</i>	Linaceae	SI	2.8	8.5	3	3.0	0.6	0.3			1	1	1	1	Dicot	Annual forb
<i>Hesperolinon clevelandii</i>	Linaceae	WI	2.0	8	4	2.0	1.8	0.9			1	1			Dicot	Annual forb
<i>Hesperolinon congestum</i>	Linaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b		1	1			Dicot	Annual forb
<i>Hesperolinon didymocarpum</i>	Linaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b		1				Dicot	Annual forb
<i>Hesperolinon disjunctum</i>	Linaceae	SE	6.0	18	3	6.0	0.0	0.0			1	1	1		Dicot	Annual forb
<i>Hesperolinon drymarioides</i>	Linaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b		1				Dicot	Annual forb
<i>Hesperolinon micranthum</i>	Linaceae	WI	2.4	11.75	5	3.0	1.0	0.4		1	1	1	1	1	Dicot	Annual forb
<i>Hesperolinon serpentinum</i>	Linaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b		1				Dicot	Annual forb
<i>Hesperolinon spergulinum</i>	Linaceae	BE	4.7	14	3	6.0	2.3	1.3			1	1			Dicot	Annual forb
<i>Hesperolinon tehamense</i>	Linaceae	SE	5.8	34.5	6	6.0	0.8	0.3	1b		1				Dicot	Annual forb
<i>Linum lewisii</i>	Linaceae	WI/IN	1.3	4	3	1.0	1.5	0.9		1	1	1	1	1	Dicot	Perennial forb
<i>Sidalcea diploscypha</i>	Malvaceae	SI	2.6	13	5	3.0	2.3	1.0			1	1	1	1	Dicot	Annual forb
<i>Sidalcea hartwegii</i>	Malvaceae	WI	1.6	4.75	3	2.0	0.7	0.4			1			1	Dicot	Annual forb
<i>Sidalcea hickmanii</i> ssp. <i>anomala</i>	Malvaceae	SE	5.6	22.5	4	6.0	1.0	0.5	1b				1		Dicot	Perennial forb
<i>Sidalcea hickmanii</i> ssp. <i>viridis</i>	Malvaceae	SE	6.3	12.5	2	6.0	0.0	0.0	1b		1	1			Dicot	Perennial forb
<i>Sidalcea keckii</i>	Malvaceae	SI	3.0	6	2	3.0	2.8	2.0	1b					1	Dicot	Annual forb
<i>Camissonia benitensis</i>	Onagraceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b				1		Dicot	Annual forb
<i>Camissonia lacustris</i>	Onagraceae	SI	3.0	9	3	3.0	3.0	1.7			1			1	Dicot	Annual forb
<i>Clarkia arcuata</i>	Onagraceae	WI	2.3	7	3	2.0	0.6	0.3						1	Dicot	Annual forb
<i>Clarkia biloba</i> ssp. <i>biloba</i>	Onagraceae	WI/IN	1.4	2.75	2	1.4	0.9	0.6				1		1	Dicot	Annual forb
<i>Clarkia breweri</i>	Onagraceae	BE/SI	3.8	11.5	3	3.0	2.1	1.2	4			1	1		Dicot	Annual forb
<i>Clarkia franciscana</i>	Onagraceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b			1	1		Dicot	Annual forb
<i>Clarkia gracilis</i> ssp. <i>albicaulis</i>	Onagraceae	WI	2.2	6.5	3	2.0	1.0	0.6	1b					1	Dicot	Annual forb
<i>Clarkia gracilis</i> ssp. <i>tracyi</i>	Onagraceae	BE	5.0	25	5	5.0	1.0	0.4	4		1				Dicot	Annual forb
<i>Epilobium minutum</i>	Onagraceae	WI	2.0	6	3	2.0	1.0	0.6		1	1	1	1	1	Dicot	Annual forb
<i>Epilobium oreganum</i>	Onagraceae	BE/SI	3.8	23	6	4.0	2.2	0.9		1	1				Dicot	Perennial forb

APPENDIX 1. CONTINUED.

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Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Epilobium rigidum</i>	Onagraceae	BE	5.1	20.5	4	6.0	2.0	1.0	4	1					Dicot	Perennial forb
<i>Epilobium siskiyouense</i>	Onagraceae	SE	5.5	38.5	7	6.0	1.0	0.4	1b	1					Dicot	Perennial forb
<i>Cypripedium californicum</i>	Orchidaceae	BE	4.5	40.5	9	4.0	1.3	0.4	4	1	1	1		1	Monocot	Perennial forb (bulb)
<i>Cypripedium fasciculatum</i>	Orchidaceae	SI	2.5	12.25	5	2.0	1.6	0.7	4	1	1	1		1	Monocot	Perennial forb (bulb)
<i>Piperia candida</i>	Orchidaceae	WI/IN	1.2	3.5	3	1.0	1.0	0.6	4	1	1	1			Monocot	Perennial forb (bulb)
<i>Orobanche valida</i> ssp. <i>howellii</i>	Orobanchaceae	SI	3.4	13.5	4	3.0	1.3	0.6	4		1				Dicot	Perennial forb (paras.)
<i>Dicentra chrysantha</i>	Papaveraceae	WI/IN	1.1	3.25	3	1.0	0.9	0.5		1	1	1	1	1	Dicot	Perennial forb
<i>Dicentra formosa</i> ssp. <i>oregana</i>	Papaveraceae	SE	5.6	22.5	4	6.0	1.0	0.5	4	1					Dicot	Perennial forb
<i>Dicentra pauciflora</i>	Papaveraceae	WI	2.2	6.5	3	3.0	1.4	0.8		1				1	Dicot	Perennial forb
<i>Eschscholzia hypocoides</i>	Papaveraceae	SI	2.6	7.75	3	1.0	3.1	1.8	4				1		Dicot	Annual forb
<i>Platystemon californicus</i>	Papaveraceae	WI	1.7	5	3	2.0	0.6	0.3		1	1	1	1	1	Dicot	Annual forb
<i>Picea breweriana</i>	Pinaceae	WI	2.2	6.5	3	3.0	1.4	0.8		1					Gymnosp.	Tree
<i>Pinus attenuata</i>	Pinaceae	SI	2.5	12.6	5	3.0	2.4	1.1		1	1	1	1	1	Gymnosp.	Tree
<i>Pinus balfouriana</i> ssp. <i>balfouriana</i>	Pinaceae	BE/SI	4.3	26	6	4.0	1.5	0.6		1					Gymnosp.	Tree
<i>Pinus coulteri</i>	Pinaceae	WI/IN	1.3	4	3	1.0	1.5	0.9				1	1		Gymnosp.	Tree
<i>Pinus jeffreyi</i>	Pinaceae	SI	2.7	8	3	3.0	0.6	0.3		1	1			1	Gymnosp.	Tree
<i>Pinus sabiniana</i>	Pinaceae	WI/IN	1.4	4.25	3	1.0	1.4	0.8		1	1	1	1	1	Gymnosp.	Tree
<i>Plantago erecta</i>	Plantaginaceae	WI/IN	1.0	3	3	1.0	1.0	0.6		1	1	1	1	1	Dicot	Annual forb
<i>Achnatherum lemmonii</i> var. <i>pubescens</i>	Poaceae	BE	4.8	14.5	3	6.0	2.3	1.3	3	1	1				Monocot	Perennial gram. (cesp.)
<i>Achnatherum nelsonii</i> var. <i>dorei</i>	Poaceae	WI/IN	1.0	2	2	1.0	1.4	1.0						1	Monocot	Perennial gram. (cesp.)
<i>Achnatherum stillmanii</i>	Poaceae	WI/IN	1.1	2.1	2	1.1	1.3	1.0						1	Monocot	Perennial gram. (cesp.)
<i>Agrostis microphylla</i>	Poaceae	WI/IN	1.1	4.25	4	1.1	1.1	0.5			1	1	1		Monocot	Annual gram.
<i>Bromus laevipes</i>	Poaceae	WI	1.7	65	3	2.0	0.6	0.3		1	1	1	1	1	Monocot	Perennial gram. (cesp.)
<i>Calamagrostis foliosa</i>	Poaceae	WI	1.7	5	3	2.0	1.5	0.9			1				Monocot	Perennial gram. (rhiz.)
<i>Calamagrostis ophitidis</i>	Poaceae	SE	6.1	24.5	4	6.0	0.0	0.0	4		1	1			Monocot	Perennial gram. (rhiz.)

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Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Calamagrostis stricta</i> ssp. <i>inexpansa</i>	Poaceae	WI	1.5	3	2	1.5	2.1	1.5		1	1	1	1	1	Monocot	Perennial gram. (cesp.)
<i>Danthonia californica</i> var. <i>californica</i>	Poaceae	SI	3.3	13	4	3.0	2.2	1.1		1	1	1	1	1	Monocot	Perennial gram. (cesp.)
<i>Elymus trachycaulus</i> ssp. <i>trachycaulus</i>	Poaceae	WI	1.6	3.1	2	1.6	2.1	1.5		1	1	1	1	1	Monocot	Perennial gram. (cesp.)
<i>Festuca californica</i>	Poaceae	WI	2.4	11.75	5	2.0	1.6	0.7		1	1	1	1	1	Monocot	Perennial gram. (cesp.)
<i>Festuca idahoensis</i>	Poaceae	WI/IN	1.3	5.25	4	1.0	1.2	0.6		1	1	1	1	1	Monocot	Perennial gram. (cesp.)
<i>Hordeum brachyantherum</i> ssp. <i>californicum</i>	Poaceae	SI	3.1	9.25	3	3.0	2.9	1.7		1	1	1	1	1	Monocot	Perennial gram. (cesp.)
<i>Melica geyeri</i>	Poaceae	WI/IN	1.2	6	5	1.0	0.4	0.2		1	1		1	1	Monocot	Perennial gram. (cesp.)
<i>Poa piperi</i>	Poaceae	BE	5.4	21.5	4	5.5	1.0	0.5	4	1					Monocot	Perennial gram. (rhiz.)
<i>Poa rhizomata</i>	Poaceae	WI	1.8	3.5	2	1.5	2.1	1.5	4	1					Monocot	Perennial gram. (rhiz.)
<i>Poa tenerrima</i>	Poaceae	SI	3.3	13	4	3.0	1.3	0.6				1	1	1	Monocot	Perennial gram. (cesp.)
<i>Scribneria bolanderi</i>	Poaceae	WI	1.7	5.1	3	1.0	2.0	1.2		1	1	1	1	1	Monocot	Annual gram.
<i>Vulpia microstachys</i> var. <i>microstachys</i>	Poaceae	WI	2.3	9.1	4	2.0	2.0	1.0		1	1	1	1	1	Monocot	Annual gram.
<i>Collomia diversifolia</i>	Polemoniaceae	SE	5.6	33.5	6	6.0	1.2	0.5	4		1	1			Dicot	Annual forb
<i>Collomia tinctoria</i>	Polemoniaceae	WI	1.8	7.1	4	2.0	1.5	0.7		1	1			1	Dicot	Annual forb
<i>Gilia capitata</i> ssp. <i>capitata</i>	Polemoniaceae	WI	1.6	4.75	3	1.0	1.2	0.7		1	1				Dicot	Annual, Perennial forb
<i>Gilia sinistra</i> ssp. <i>pinnatisecta</i>	Polemoniaceae	BE/SI	3.8	19	5	3.0	2.2	1.0	4		1				Dicot	Annual, Perennial forb

Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Gilia sinistra</i> ssp. <i>sinistra</i>	Polemoniaceae	SI	2.5	7.5	3	3.0	1.8	1.0		1	1			1	Dicot	Annual forb
<i>Linanthus ambiguus</i>	Polemoniaceae	SE	5.8	17.5	3	6.0	0.6	0.3	4			1	1		Dicot	Annual forb
<i>Linanthus bolanderi</i>	Polemoniaceae	WI/IN	1.3	2.5	2	1.3	1.1	0.8			1	1		1	Dicot	Annual forb
<i>Linanthus dichotomus</i>	Polemoniaceae	SI	2.5	12.35	5	3.0	2.4	1.1		1	1	1	1	1	Dicot	Annual forb
<i>Linanthus latisectus</i> (= <i>Leptosiphon</i> la.)	Polemoniaceae	WI	2.0	6	3	2.0	0.0	0.0			1				Dicot	Annual forb
<i>Linanthus liniflorus</i> (= <i>Leptosiphon</i> li.)	Polemoniaceae	WI	1.6	6.25	4	1.5	1.2	0.6		1	1	1	1	1	Dicot	Annual forb
<i>Linanthus nuttallii</i> ssp. <i>howellii</i> (= <i>Leptosiphon</i> n. s. h.)	Polemoniaceae	BE	5.3	31.5	6	6.0	1.3	0.5	1b		1				Dicot	Perennial forb
<i>Navarretia heterodoxa</i>	Polemoniaceae	SI	2.8	14	5	3.0	2.4	1.1				1			Dicot	Annual forb
<i>Navarretia jaredii</i>	Polemoniaceae	SE	5.9	23.5	4	6.0	0.5	0.3	4				1		Dicot	Annual forb
<i>Navarretia jepsonii</i>	Polemoniaceae	SE	5.6	22.5	4	5.5	0.6	0.3	4		1				Dicot	Annual forb
<i>Navarretia pubescens</i>	Polemoniaceae	WI	2.0	6	3	2.0	1.0	0.6			1	1	1	1	Dicot	Annual forb
<i>Navarretia rosulata</i>	Polemoniaceae	SE	6.0	18	3	6.0	0.0	0.0	1b		1	1			Dicot	Annual forb
<i>Phlox hirsuta</i>	Polemoniaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b	1					Dicot	Perennial forb
<i>Polemonium chartaceum</i>	Polemoniaceae	WI	1.6	8.1	5	2.0	1.5	0.7	1b	1				1	Dicot	Perennial forb
<i>Polygala cornuta</i> var. <i>cornuta</i>	Polygalaceae	WI	2.3	9	4	2.0	1.3	0.6		1				1	Dicot	Perennial forb, Shrub
<i>Chorizanthe breweri</i>	Polygonaceae	BE	5.4	21.5	4	5.5	1.0	0.5	1b				1		Dicot	Annual forb
<i>Chorizanthe palmeri</i>	Polygonaceae	BE	4.9	24.5	5	6.0	1.6	0.7	4				1		Dicot	Annual forb
<i>Chorizanthe uniaristata</i>	Polygonaceae	SI	2.7	10.75	4	2.5	2.0	1.0					1	1	Dicot	Annual, Perennial forb
<i>Chorizanthe ventricosa</i>	Polygonaceae	BE	5.3	16	3	6.0	1.2	0.7	4				1		Dicot	Annual forb
<i>Eriogonum alpinum</i>	Polygonaceae	SE	6.1	30.5	5	6.0	0.0	0.0	1b	1					Dicot	Perennial forb
<i>Eriogonum argillosum</i>	Polygonaceae	SI	3.1	12.5	4	3.0	2.6	1.3	4			1	1		Dicot	Annual forb
<i>Eriogonum compositum</i> var. <i>compositum</i>	Polygonaceae	WI	1.7	5.1	3	2.0	1.5	0.9		1	1				Dicot	Perennial forb
<i>Eriogonum congdonii</i>	Polygonaceae	BE	5.1	35.5	7	6.0	1.7	0.7	4	1					Dicot	Shrub
<i>Eriogonum covilleianum</i>	Polygonaceae	SI	3.0	12	4	3.0	1.6	0.8					1		Dicot	Annual forb
<i>Eriogonum dasyanthemum</i>	Polygonaceae	SI	3.0	6	2	3.0	1.4	1.0			1				Dicot	Annual forb
<i>Eriogonum diclinum</i>	Polygonaceae	SI	3.2	9.5	3	3.0	3.0	1.7	4	1					Dicot	Perennial forb
<i>Eriogonum elatum</i> var. <i>villosum</i>	Polygonaceae	SI	3.3	13	4	3.5	3.2	1.6		1				1	Dicot	Perennial forb
<i>Eriogonum hirtellum</i>	Polygonaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b	1					Dicot	Perennial forb (rhiz.)
<i>Eriogonum hirtiflorum</i>	Polygonaceae	SI	3.3	13	4	3.5	3.2	1.6		1	1	1	1	1	Dicot	Annual forb
<i>Eriogonum kelloggii</i>	Polygonaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b		1				Dicot	Perennial forb
<i>Eriogonum libertini</i>	Polygonaceae	SE	6.1	36.5	6	6.0	0.0	0.0	4	1	1				Dicot	Perennial forb
<i>Eriogonum luteolum</i> var. <i>caninum</i>	Polygonaceae	SE	5.5	27.5	5	6.0	0.9	0.4	3		1	1			Dicot	Annual forb

Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Eriogonum luteolum</i> var. <i>luteolum</i>	Polygonaceae	BE/SI	3.8	15	4	3.0	1.5	0.8		1	1	1		1	Dicot	Annual forb
<i>Eriogonum nervulosum</i>	Polygonaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b		1				Dicot	Perennial forb (rhiz.)
<i>Eriogonum nudum</i> var. <i>indictum</i>	Polygonaceae	WI	1.5	4.5	3	1.0	0.6	0.3	4				1		Dicot	Perennial forb
<i>Eriogonum nudum</i> var. <i>oblongifolium</i>	Polygonaceae	WI	2.0	6	3	2.0	0.0	0.0		1	1			1	Dicot	Perennial forb
<i>Eriogonum pendulum</i>	Polygonaceae	SE	6.2	18.5	3	6.0	0.0	0.0	2	1					Dicot	Perennial forb
<i>Eriogonum pyrolifolium</i>	Polygonaceae	WI/IN	1.0	3	3	0.0	1.7	1.0		1				1	Dicot	Perennial forb
<i>Eriogonum siskiyouense</i>	Polygonaceae	BE	5.4	32.5	6	6.0	1.2	0.5	4	1					Dicot	Perennial forb
<i>Eriogonum strictum</i> var. <i>greenei</i>	Polygonaceae	SE	5.9	29.5	5	6.0	0.4	0.2	4	1	1				Dicot	Perennial forb
<i>Eriogonum strictum</i> var. <i>proliferum</i>	Polygonaceae	SE	6.0	24	4	6.0	0.0	0.0		1	1			1	Dicot	Perennial forb
<i>Eriogonum ternatum</i>	Polygonaceae	SE	6.2	18.5	3	6.0	0.0	0.0	4	1	1				Dicot	Perennial forb
<i>Eriogonum trichopes</i> var. <i>hooveri</i>	Polygonaceae	SI	3.3	10	3	3.0	2.5	1.5					1		Dicot	Annual forb
<i>Eriogonum tripodum</i>	Polygonaceae	BE	5.3	26.5	5	6.0	1.3	0.6	4		1			1	Dicot	Shrub
<i>Eriogonum umbellatum</i> var. <i>argus</i>	Polygonaceae	SI	3.0	12	4	3.5	1.4	0.7		1	1				Dicot	Perennial forb
<i>Eriogonum umbellatum</i> var. <i>bahiiforme</i>	Polygonaceae	BE/SI	3.5	21	6	3.0	1.2	0.5	4		1	1	1		Dicot	Perennial forb
<i>Eriogonum umbellatum</i> var. <i>goodmanii</i>	Polygonaceae	SI	3.3	10	3	3.0	2.5	1.5		1					Dicot	Perennial forb
<i>Eriogonum umbellatum</i> var. <i>humistratum</i>	Polygonaceae	BE	4.5	27.25	6	5.0	2.1	0.8	4	1	1				Dicot	Perennial forb
<i>Eriogonum umbellatum</i> var. <i>speciosum</i>	Polygonaceae	BE/SI	4.2	21	5	4.0	1.3	0.6		1				1	Dicot	Perennial forb
<i>Eriogonum ursinum</i>	Polygonaceae	WI/IN	1.1	2.25	2	1.1	1.2	0.9		1				1	Dicot	Perennial forb
<i>Eriogonum vimineum</i>	Polygonaceae	WI/IN	1.0	3	3	1.0	0.0	0.0		1				1	Dicot	Annual forb
<i>Polygonum douglasii</i> ssp. <i>majus</i>	Polygonaceae	WI	1.5	4.5	3	2.0	0.9	0.5		1				1	Dicot	Annual forb
<i>Polygonum douglasii</i> ssp. <i>spergulariiforme</i>	Polygonaceae	SI	3.0	18.25	6	2.5	2.1	0.9		1	1	1		1	Dicot	Annual forb
<i>Systemotheca vortriedei</i>	Polygonaceae	SI	3.1	12.25	4	2.5	2.2	1.1	4				1		Dicot	Annual forb
<i>Calyptidium quadripetalum</i>	Portulacaceae	BE	4.6	27.5	6	4.0	1.2	0.5	4		1				Dicot	Annual forb
<i>Calyptidium umbellatum</i>	Portulacaceae	WI/IN	1.3	4	3	1.0	1.5	0.9		1	1	1		1	Dicot	Perennial forb
<i>Claytonia exigua</i> ssp. <i>exigua</i>	Portulacaceae	SI	3.4	24	7	3.0	1.1	0.4		1	1	1	1	1	Dicot	Annual forb
<i>Claytonia exigua</i> ssp. <i>glauca</i>	Portulacaceae	BE/SI	3.6	18	5	3.0	1.3	0.6		1	1	1	1		Dicot	Annual forb
<i>Claytonia gypsophiloides</i>	Portulacaceae	SI	3.1	15.5	5	3.0	0.2	0.1			1	1	1		Dicot	Annual forb

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Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Claytonia saxosa</i>	Portulacaceae	BE/SI	4.4	21.75	5	5.0	2.2	1.0		1	1				Dicot	Annual forb
<i>Lewisia cantelovii</i>	Portulacaceae	WI/IN	1.0	6	6	1.0	1.1	0.4	1b	1				1	Dicot	Perennial forb
<i>Lewisia cotyledon</i> var. <i>cotyledon</i>	Portulacaceae	WI	2.0	6	3	3.0	1.7	1.0		1					Dicot	Perennial forb
<i>Lewisia cotyledon</i> var. <i>heckneri</i>	Portulacaceae	WI/IN	1.0	4	4	0.5	1.4	0.7		1					Dicot	Perennial forb
<i>Lewisia cotyledon</i> var. <i>howellii</i>	Portulacaceae	WI/IN	1.3	4	3	1.0	1.5	0.9		1					Dicot	Perennial forb
<i>Lewisia leana</i>	Portulacaceae	SI	3.0	6	2	3.0	0.0	0.0		1	1			1	Dicot	Perennial forb
<i>Lewisia nevadensis</i>	Portulacaceae	WI	1.7	5	3	2.0	1.5	0.9		1	1			1	Dicot	Perennial forb
<i>Lewisia oppositifolia</i>	Portulacaceae	BE	5.3	21	4	6.0	1.5	0.8		1					Dicot	Perennial forb
<i>Lewisia rediviva</i>	Portulacaceae	WI/IN	1.4	7	5	1.0	1.1	0.5		1	1	1	1	1	Dicot	Perennial forb
<i>Lewisia stebbinsii</i>	Portulacaceae	BE	4.7	14	3	6.0	2.3	1.3	1b		1				Dicot	Perennial forb
<i>Lewisia triphylla</i>	Portulacaceae	WI	1.7	5	3	2.0	1.5	0.9		1	1			1	Dicot	Perennial forb
<i>Dodecatheon clevelandii</i> ssp. <i>patulum</i>	Primulaceae	SI	3.0	9	3	3.0	0.0	0.0				1	1	1	Dicot	Perennial forb
<i>Adiantum aleuticum</i>	Pteridaceae	WI	2.4	11.75	5	2.0	1.2	0.5		1	1	1	1	1	Pteridoph.	Perennial forb
<i>Aspidotis carlotta-halliae</i>	Pteridaceae	BE	5.3	26.5	5	6.0	1.1	0.5	4			1	1		Pteridoph.	Perennial forb (rhiz.)
<i>Aspidotis densa</i>	Pteridaceae	SI	3.4	31	9	3.0	1.2	0.4		1	1	1	1	1	Pteridoph.	Perennial forb
<i>Pellaea brachyptera</i>	Pteridaceae	WI	1.5	4.5	3	2.0	0.9	0.5		1	1			1	Pteridoph.	Perennial forb
<i>Anemone drummondii</i>	Ranunculaceae	WI	2.3	6.75	3	2.0	1.6	0.9		1				1	Dicot	Perennial forb
<i>Aquilegia eximia</i>	Ranunculaceae	BE/SI	4.2	25	6	3.5	1.5	0.6			1	1	1		Dicot	Perennial forb
<i>Delphinium hesperium</i> ssp. <i>hesperium</i>	Ranunculaceae	SI	2.7	8	3	3.0	0.6	0.3		1	1	1			Dicot	Perennial forb
<i>Delphinium nuttallianum</i>	Ranunculaceae	WI/IN	1.4	4.1	3	1.0	1.5	0.9		1				1	Dicot	Perennial forb
<i>Delphinium parryi</i> ssp. <i>eastwoodiae</i>	Ranunculaceae	BE/SI	3.7	11	3	4.0	2.5	1.5					1		Dicot	Perennial forb
<i>Delphinium uliginosum</i>	Ranunculaceae	SE	5.7	28.5	5	6.0	0.9	0.4	4		1				Dicot	Perennial forb
<i>Ceanothus confusus</i>	Rhamnaceae	WI/IN	1.3	2.5	2	1.3	1.1	0.8	1b		1				Dicot	Shrub
<i>Ceanothus cuneatus</i> var. <i>cuneatus</i>	Rhamnaceae	WI	1.5	6.1	4	1.5	1.3	0.6		1	1	1	1	1	Dicot	Shrub
<i>Ceanothus divergens</i>	Rhamnaceae	WI	2.0	4	2	2.0	1.4	1.0	1b		1				Dicot	Shrub
<i>Ceanothus ferrisae</i>	Rhamnaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b			1			Dicot	Shrub
<i>Ceanothus foliosus</i> var. <i>medius</i>	Rhamnaceae	BE/SI	4.0	12	3	3.0	1.7	1.0				1	1		Dicot	Shrub
<i>Ceanothus jepsonii</i>	Rhamnaceae	SE	6.0	18	3	6.0	0.0	0.0			1	1			Dicot	Shrub
<i>Ceanothus masonii</i>	Rhamnaceae	SI	3.3	6.5	2	3.0	4.2	3.0	1b			1			Dicot	Shrub
<i>Ceanothus papillosus</i> var. <i>roweanus</i>	Rhamnaceae	WI	1.5	3	2	1.5	2.1	1.5					1		Dicot	Shrub
<i>Ceanothus pumilus</i>	Rhamnaceae	SE	5.7	28.5	5	6.0	0.9	0.4		1	1				Dicot	Shrub
<i>Ceanothus roderickii</i>	Rhamnaceae	WI	1.7	5	3	2.0	1.5	0.9	1b					1	Dicot	Shrub
<i>Ceanothus sonomensis</i>	Rhamnaceae	WI/IN	1.3	4	3	2.0	1.2	0.7	1b			1			Dicot	Shrub

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Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Rhamnus californica</i> ssp. <i>occidentalis</i>	Rhamnaceae	SE	6.0	24	4	6.0	0.0	0.0		1	1			1	Dicot	Shrub
<i>Rhamnus tomentella</i> ssp. <i>crassifolia</i>	Rhamnaceae	BE	4.8	19	4	6.0	2.5	1.3		1	1				Dicot	Shrub
<i>Rhamnus tomentella</i> ssp. <i>tomentella</i>	Rhamnaceae	WI	1.5	6	4	0.8	1.7	0.8		1	1	1	1	1	Dicot	Shrub
<i>Adenostoma fasciculatum</i>	Rosaceae	WI/IN	1.3	5.2	4	1.1	1.4	0.7			1	1	1	1	Dicot	Shrub
<i>Holodiscus discolor</i>	Rosaceae	WI/IN	1.0	3	3	1.0	1.0	0.6		1	1	1	1	1	Dicot	Shrub
<i>Horkelia congesta</i> ssp. <i>nemorosa</i>	Rosaceae	BE/SI	3.8	7.5	2	3.5	0.7	0.5	2	1					Dicot	Perennial forb
<i>Horkelia daucifolia</i>	Rosaceae	BE/SI	3.8	15	4	3.0	1.5	0.8		1	1				Dicot	Perennial forb
<i>Horkelia sericata</i>	Rosaceae	SE	5.6	22.5	4	6.0	1.0	0.5	4	1					Dicot	Perennial forb
<i>Horkelia tridentata</i> ssp. <i>flavescens</i>	Rosaceae	SI	3.0	9	3	2.0	1.7	1.0		1	1			1	Dicot	Perennial forb
<i>Ivesia gordonii</i>	Rosaceae	WI	1.6	3.25	2	1.6	1.9	1.4		1	1			1	Dicot	Perennial forb
<i>Ivesia pickeringii</i>	Rosaceae	BE	5.4	32.5	6	6.0	1.0	0.4	1b	1					Dicot	Perennial forb
<i>Potentilla cristae</i>	Rosaceae	SI	3.1	12.5	4	3.0	0.0	0.0	1b	1					Dicot	Perennial forb
<i>Sanguisorba officinalis</i>	Rosaceae	BE/SI	4.2	12.5	3	3.0	1.7	1.0	2	1	1				Dicot	Perennial forb (rhiz.)
<i>Galium ambiguum</i> var. <i>ambiguum</i>	Rubiaceae	SI	3.3	10	3	3.0	2.5	1.5			1			1	Dicot	Perennial forb
<i>Galium ambiguum</i> var. <i>siskiyouense</i>	Rubiaceae	SE	5.5	27.5	5	6.0	0.9	0.4		1	1				Dicot	Perennial forb
<i>Galium andrewsii</i> ssp. <i>andrewsii</i>	Rubiaceae	SI	3.2	16	5	3.0	1.9	0.9			1	1	1		Dicot	Perennial forb
<i>Galium andrewsii</i> ssp. <i>gatense</i>	Rubiaceae	BE	5.1	20.5	4	5.0	0.8	0.4	4			1	1		Dicot	Perennial forb
<i>Galium andrewsii</i> ssp. <i>intermedium</i>	Rubiaceae	WI/IN	1.4	2.75	2	1.4	0.9	0.6					1		Dicot	Perennial forb
<i>Galium clementis</i>	Rubiaceae	WI/IN	1.0	2	2	1.0	1.4	1.0	1b				1		Dicot	Perennial forb
<i>Galium hardhamiae</i>	Rubiaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b				1		Dicot	Perennial forb
<i>Galium serpenticum</i> ssp. <i>scotticum</i>	Rubiaceae	SE	5.9	29.5	5	6.0	0.4	0.2	1b	1					Dicot	Perennial forb
<i>Salix breweri</i>	Salicaceae	SE	6.0	30	5	6.0	0.0	0.0			1	1	1		Dicot	Shrub
<i>Salix delnortensis</i>	Salicaceae	SE	6.2	18.5	3	6.0	0.0	0.0	4	1					Dicot	Shrub
<i>Salix sitchensis</i>	Salicaceae	WI	1.6	4.75	3	1.0	1.2	0.7		1	1	1	1		Dicot	Tree, shrub
<i>Darlingtonia californica</i>	Sarraceniaceae	BE/SI	4.1	32.5	8	4.0	1.4	0.5	4	1				1	Dicot	Perennial forb (carn.)
<i>Parnassia californica</i>	Saxifragaceae	WI	2.0	6	3	2.0	0.0	0.0		1	1		1	1	Dicot	Perennial forb
<i>Saxifraga howellii</i>	Saxifragaceae	BE/SI	3.8	7.5	2	3.5	2.1	1.5	4	1					Dicot	Perennial forb
<i>Antirrhinum cornutum</i>	Scrophulariaceae	WI	2.2	11	5	2.0	0.8	0.4			1				Dicot	Annual forb
<i>Antirrhinum leptaleum</i>	Scrophulariaceae	WI	1.6	3.1	2	1.6	2.1	1.5						1	Dicot	Annual forb

Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Antirrhinum subcordatum</i>	Scrophulariaceae	BE/SI	4.3	21.5	5	4.0	1.8	0.8	4		1				Dicot	Annual forb
<i>Antirrhinum vexillo-calyculatum</i>	Scrophulariaceae	SI	2.5	20	8	2.5	1.3	0.5		1	1	1	1	1	Dicot	Annual forb
<i>Antirrhinum virga</i>	Scrophulariaceae	SI	2.8	8.5	3	3.0	0.6	0.3	4		1				Dicot	Perennial forb
<i>Castilleja affinis</i> ssp. <i>neglecta</i>	Scrophulariaceae	SE	6.1	30.5	5	6.0	0.0	0.0	1b		1	1			Dicot	Perennial forb (hemipar.)
<i>Castilleja foliolosa</i>	Scrophulariaceae	WI	2.3	9	4	2.5	1.0	0.5			1	1	1	1	Dicot	Perennial forb, Shrub
<i>Castilleja hispida</i> ssp. <i>brevilobata</i>	Scrophulariaceae	SE	6.2	18.5	3	6.0	0.0	0.0	4	1					Dicot	Perennial forb (hemipar.)
<i>Castilleja miniata</i> ssp. <i>elata</i>	Scrophulariaceae	BE	4.6	27.5	6	4.5	1.4	0.6	2	1					Dicot	Perennial forb (hemipar.)
<i>Castilleja minor</i> ssp. <i>spiralis</i>	Scrophulariaceae	SI	3.3	16.5	5	3.0	2.6	1.2			1	1	1	1	Dicot	Annual forb (hemipar.)
<i>Castilleja pruinosa</i>	Scrophulariaceae	SI	3.2	15.75	5	3.0	1.9	0.8		1	1			1	Dicot	Perennial forb (hemipar.)
<i>Castilleja rubicundula</i> ssp. <i>lithospermoides</i>	Scrophulariaceae	WI	2.4	9.75	4	2.0	1.8	0.9			1				Dicot	Annual forb (hemipar.)
<i>Castilleja rubicundula</i> ssp. <i>rubicundula</i>	Scrophulariaceae	SE	5.6	28	5	6.0	0.9	0.4	1b		1				Dicot	Annual forb (hemipar.)
<i>Collinsia greenii</i>	Scrophulariaceae	BE	5.2	31	6	6.0	1.3	0.5		1	1				Dicot	Annual forb
<i>Collinsia multicolor</i>	Scrophulariaceae	WI/IN	1.1	2.25	2	1.1	1.2	0.9	1b		1	1			Dicot	Annual forb
<i>Collinsia sparsiflora</i>	Scrophulariaceae	WI	1.7	5	3	1.0	1.2	0.7		1	1	1	1	1	Dicot	Annual forb
<i>Cordylanthus nidularius</i>	Scrophulariaceae	SE	6.2	18.5	3	6.0	0.0	0.0	1b			1	1		Dicot	Annual forb (hemipar.)
<i>Cordylanthus pilosus</i> var. <i>pilosus</i>	Scrophulariaceae	SI	2.5	10	4	2.5	0.6	0.3			1	1			Dicot	Annual forb (hemipar.)
<i>Cordylanthus pringlei</i>	Scrophulariaceae	SE	5.6	28	5	6.0	0.9	0.4			1				Dicot	Annual forb (hemipar.)
<i>Cordylanthus tenuis</i> ssp. <i>brunneus</i>	Scrophulariaceae	BE	5.1	25.5	5	5.0	1.0	0.4	4		1				Dicot	Annual forb (hemipar.)
<i>Cordylanthus tenuis</i> ssp. <i>capillaris</i>	Scrophulariaceae	SE	6.1	24.5	4	6.0	0.0	0.0	1b		1				Dicot	Annual forb (hemipar.)
<i>Cordylanthus tenuis</i> ssp. <i>tenuis</i>	Scrophulariaceae	WI	2.3	9	4	2.0	0.5	0.3						1	Dicot	Annual forb (hemipar.)
<i>Cordylanthus tenuis</i> ssp. <i>viscidus</i>	Scrophulariaceae	BE	4.5	27	6	4.5	1.4	0.6		1	1			1	Dicot	Annual forb (hemipar.)
<i>Keckiella lemmonii</i>	Scrophulariaceae	WI/IN	1.1	3.25	3	1.0	0.9	0.5		1	1			1	Dicot	Shrub
<i>Mimulus douglasii</i>	Scrophulariaceae	SI	2.7	13.5	5	3.0	0.5	0.2		1	1	1	1	1	Dicot	Annual forb
<i>Mimulus glaucescens</i>	Scrophulariaceae	BE/SI	3.8	18.75	5	4.0	2.1	0.9	4					1	Dicot	Annual forb
<i>Mimulus layneae</i> (including <i>M. brachiatus</i>)	Scrophulariaceae	SI	2.9	14.25	5	3.0	1.2	0.5		1	1			1	Dicot	Annual forb

APPENDIX 1. CONTINUED.

Taxon ¹	Family	Aff ²	Mean ³	Sum ⁴	Sources	Med. ⁵	SD ⁶	SE ⁷	Rarity ⁸	Geog. Dist. ⁹					Tax. Cat. ¹⁰	Lifeform ¹¹
										KL	NC	BA	SC	SN		
<i>Mimulus nudatus</i>	Scrophulariaceae	SE	5.6	33.5	6	6.0	1.2	0.5	4		1				Dicot	Annual forb
<i>Mimulus primuloides</i> ssp. <i>linearifolius</i>	Scrophulariaceae	BE/SI	4.0	16	4	4.5	2.4	1.2		1					Dicot	Perennial forb (rhiz.)
<i>Orthocarpus pachystachyus</i>	Scrophulariaceae	SE	6.0	18	3	6.0	0.0	0.0		1					Dicot	Annual forb (hemipar.)
<i>Pedicularis howellii</i>	Scrophulariaceae	SI	2.5	7.5	3	3.0	1.2	0.7	4	1					Dicot	Perennial forb (hemipar.)
<i>Penstemon azureus</i> var. <i>azureus</i>	Scrophulariaceae	SI	2.7	8	3	3.0	0.6	0.3		1	1			1	Dicot	Perennial forb
<i>Penstemon filiformis</i>	Scrophulariaceae	BE	5.0	30	6	5.5	1.3	0.5		1					Dicot	Perennial forb
<i>Penstemon parvulus</i>	Scrophulariaceae	BE/SI	3.7	11	3	4.0	0.6	0.3		1				1	Dicot	Perennial forb
<i>Penstemon purpusii</i>	Scrophulariaceae	SI	2.8	11	4	2.0	2.4	1.2		1	1				Dicot	Perennial forb
<i>Triphysaria floribunda</i>	Scrophulariaceae	WI	2.3	6.75	3	2.0	1.9	1.1	1b		1	1	1		Dicot	Annual forb
<i>Veronica copelandii</i>	Scrophulariaceae	SE	6.1	24.5	4	6.0	0.0	0.0	4	1					Dicot	Perennial forb
<i>Fremontodendron californicum</i> ssp. <i>decumbens</i>	Sterculiaceae	BE/SI	2.0	8	4	1.5	2.4	1.2	1b					1	Dicot	Shrub
<i>Verbena californica</i>	Verbenaceae	BE	4.8	14.5	3	4.0	1.2	0.7	1b					1	Dicot	Perennial forb
<i>Viola cuneata</i>	Violaceae	BE	5.2	31	6	6.0	1.3	0.5		1	1				Dicot	Perennial forb
<i>Viola douglasii</i>	Violaceae	SI	2.8	13.75	5	2.0	2.0	0.9		1	1	1	1	1	Dicot	Perennial forb
<i>Viola hallii</i>	Violaceae	BE/SI	4.0	16	4	4.0	2.3	1.2		1	1				Dicot	Perennial forb
<i>Viola lobata</i> ssp. <i>lobata</i>	Violaceae	WI	2.3	11.35	5	2.0	2.4	1.1		1	1			1	Dicot	Perennial forb (rhiz.)
<i>Viola ocellata</i>	Violaceae	SI	2.5	12.5	5	3.0	0.9	0.4		1	1	1	1		Dicot	Perennial forb
<i>Viola primulifolia</i> ssp. <i>occidentalis</i>	Violaceae	BE	5.1	25.5	5	6.0	1.4	0.6	1b	1					Dicot	Perennial forb (rhiz.)
<i>Viola purpurea</i> ssp. <i>integrifolia</i>	Violaceae	WI/IN	1.3	4	3	2.0	1.2	0.7		1	1			1	Dicot	Perennial forb



Drought.gov

National Integrated Drought Information System

Drought Status Update and 2020 Recap for California-Nevada

Date Issued: January 5, 2021

DEWS Regions: California Nevada

States: California, Nevada

Update Status: NIDIS and its partners will issue future drought updates as conditions evolve.

2020 closes and 2021 begins with rain and snow chipping away at some regional drought conditions. **Key Points**

- California and Nevada saw drought expand and worsen in 2020 as dry conditions built over the last year. Below-average precipitation, including a weak monsoon, and above-normal temperatures and evaporative demand intensified drought conditions and brought a record-breaking wildfire season. Benefits of spring wetness in the southern part of the region have diminished with a dry fall.
- Recent storms have brought some rain to Southern California and increased the Sierra snowpack, but the water year precipitation deficits and snow drought remains.
- Forecasts indicate storms in early and mid-January, potentially leading to some drought improvements in northern California, but less so in Nevada and southern California.
- The La Niña pattern that developed in the tropical Pacific in Autumn 2020 remains firmly in place. Over the historical record, La Niña tilts odds toward wetter water years in the Pacific Northwest and drier water years in the Southwest U.S. There is large uncertainty in the northern parts of California and Nevada.
- The next 3-4 months remain to see if conditions improve, but overcoming deficits that have accumulated in California and Nevada will require substantial wetness, and preparation for another sub-par water year should be seriously considered, especially in the driest areas.
- This update includes data as of January 4, 2021.

U.S. Drought Monitor Conditions: California-Nevada | December 29, 2020

States Affected by Moderate to Exceptional (D1 - D4) Drought:

95% of California is experiencing Moderate to Exceptional Drought (D1-D4)

33.75% of California is experiencing Extreme to Exceptional Drought (D3-D4)

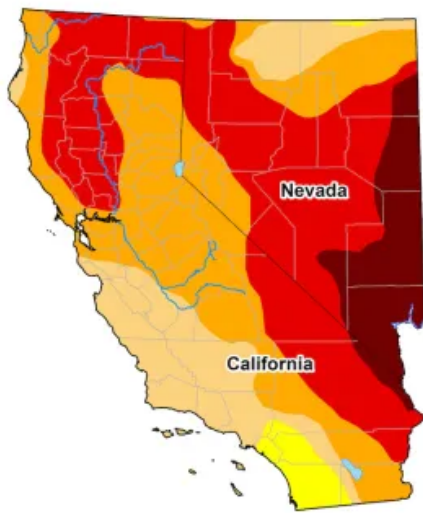
99.7% of Nevada is experiencing Moderate to Exceptional Drought (D1-D4)

24% of Nevada is experiencing Exceptional Drought (D4)

Populations Affected by Drought:

30.5 Million **2.7 Million**

people in California are in Moderate to Exceptional (D1 - D4) Drought people in Nevada are in Moderate to Exceptional (D1 - D4) Drought



U.S. Drought Monitor for CA/NV for December 29, 2020.
Source: <https://droughtmonitor.unl.edu/>.

95%

of CA is in Moderate to
Exceptional Drought (D1-D4)

99.7%

of NV is in Moderate to
Exceptional Drought (D1-D4)

10%-30%

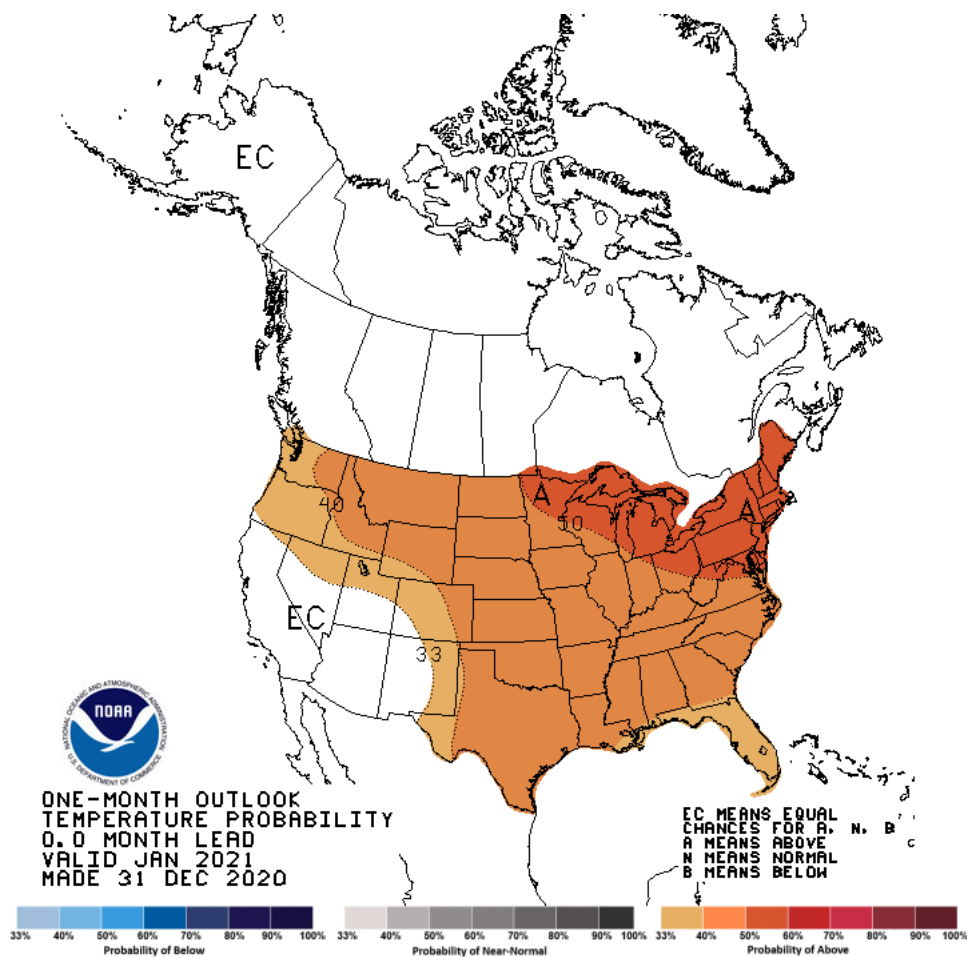
odds of reaching normal
precipitation for Water Year
2021

4 million

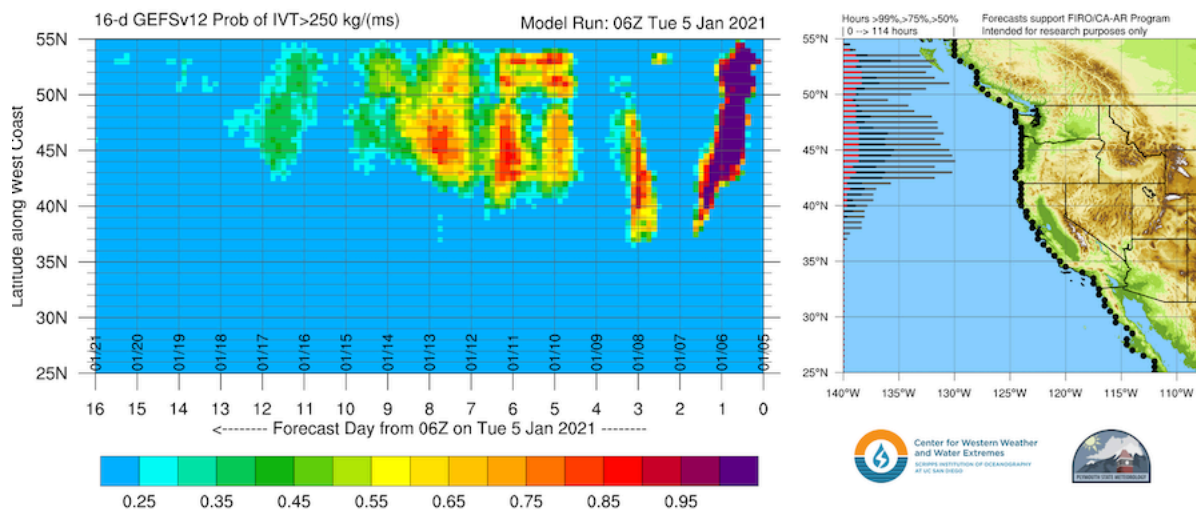
acres burned in CA due to
wildfires, as of early October
2020

2020 Recap

- January and February 2020 were dry to record dry in several areas (central CA and northern CA-NV). Wetness only returned in spring to parts of the southern part of the region.
- Last year's monsoon produced little precipitation and much above-normal summer temperatures, including August records.
- Conditions led to intensified drought conditions, high evaporative demand, and a record-breaking wildfire season. Over [4 million acres burned in California](https://www.fire.ca.gov/incidents/2020/) (<https://www.fire.ca.gov/incidents/2020/>) as of early October.



January Precipitation Outlook (top) and Temperature Outlook (bottom). A = chances of above-normal; EC= equal chances of above, below, normal; B = chances of below-normal. Source: NOAA NWS Climate Prediction Center (https://www.cpc.ncep.noaa.gov/products/predictions/long_range/seasonal.php?lead=1). How do I interpret these graphics? (https://cnap.sio.ucsd.edu/wp-content/uploads/sites/430/2017/02/CNAP_S2S_TwoPager_FINAL.pdf)



CW3E's atmospheric river landfall tool shows the probability (i.e. percentage of ensemble members) that show atmospheric river (AR) conditions along the U.S. West Coast. In the next week there is a high probability that Northern coastal CA will experience AR conditions bringing much needed precipitation to the region. See <https://cw3e.ucsd.edu/iwv-and-ivt-forecasts/> (<https://cw3e.ucsd.edu/iwv-and-ivt-forecasts/>) for more information and forecast products.

Drought Early Warning Resources

Observations & Monitoring

- U.S. Drought Portal (<https://www.drought.gov/>): Snow Drought Current Conditions Update ([/topics/snow-drought](https://www.drought.gov/topics/snow-drought)) (launched December 17)
- U.S. Drought Monitor (<https://droughtmonitor.unl.edu/>)
- California State Climatologist (<https://water.ca.gov/Programs/Flood-Management/Flood-Data/Climatology-and-Meteorology>), California Exchange Center (<https://cdec.water.ca.gov/>),

- Nevada State Climatologist (<https://extension.unr.edu/climate/>)
- National Drought Mitigation Center: Condition Monitoring Observer Reports (CMOR) (<https://droughtimpacts.unl.edu/ConditionMonitoringObservations.aspx>) and Drought Impacts Reporter (<https://droughtreporter.unl.edu/map/>)
- Western Regional Climate Center (<https://wrcc.dri.edu/>) (http://r20.rs6.net/tn.jsp?f=0018WQxkBS9L_dh7Lb0J3fhft6K9TiltjIRtZRTCPp1ebFiCmBJdYQ_RiHesdbIhoLNUgvAdhdwN42wC8PZu6-bU9dtrhZ-hFsGzcseoh_UF9oMYfyCrsm8_cZkcPwNGq9mlbkWjQQsoUo=&c=PaiBvurUs9e_X6WKR95pjUZ-spE784QqnRTmigjgw0aJtSre1kv_A==&ch=l-sdoF-aQLpBpqwywJJhsuAle4rQn03BCugB91kElvS0NKfGWe2hMw==) (Past ENSO strength/precipitation figures (https://wrcc.dri.edu/Climate/soi_precip.php))
- WestWide Drought Tracker (<https://wrcc.dri.edu/wwdt/>)
- Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS) (<https://www.cocorahs.org/>)
- California-Nevada Applications Program (<https://cnap.ucsd.edu/>) Resources: Water Storage Tracking (https://cnap.ucsd.edu/storage_in_sierra_ucrb/), UCLA Drought Monitor (http://www.hydro.ucla.edu/SurfaceWaterGroup/forecast/monitor_ca/index.html), Precipitation Tracking (<http://cirrus.ucsd.edu/~pierce/sdprecip/>)
- Climate Engine (<http://climateengine.org/>)
- Great Basin Dashboard (<https://gbdash.dri.edu/>)
- U.S. Water Watcher (<https://climatetoolbox.org/tool/Historical-Water-Watcher>)

Predictions & Forecasting

- Weather Forecasts: Your Local National Weather Service office (<https://www.weather.gov/srh/nws/offices>), NOAA NWS California-Nevada River Forecast Center (<https://www.cnrfc.noaa.gov/>) (streamflows)
- Subseasonal-to-seasonal (two weeks to three months): NOAA NWS Climate Prediction Center (<https://www.cpc.ncep.noaa.gov/>), ENSO (<https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/enso.shtml>), ENSO Blog (<https://www.climate.gov/news-features/departments/enso-blog>)
- 1-month Evaporative Demand Drought Index (EDDI) Forecasts (<https://www.ncdc.noaa.gov/temp-and-precip/drought/recovery/eddi>)
- Experimental Forecasts from the Center for Western Weather and Water Extremes (<https://cw3e.ucsd.edu/>) Precipitation Forecasts (https://cw3e.ucsd.edu/precipitation_forecasts/), including:
 - Odds of Reaching Normal Water Year Precipitation (<https://cw3e.ucsd.edu/odds-of-normal-water-year-precipitation/>)
 - Atmospheric River Forecast Products (<https://cw3e.ucsd.edu/iwv-and-ivt-forecasts/>)
 - Atmospheric River Scale Forecast Products (<https://cw3e.ucsd.edu/arscale/>)
 - Subseasonal to Seasonal (S2S) Experimental Forecasts (https://cw3e.ucsd.edu/s2s_forecasts/)

Planning & Preparedness

- National Drought Mitigation Center Drought Planning (<https://drought.unl.edu/droughtplanning/PlanningHome.aspx>)
- California Drought Planning Resources (<https://drought.unl.edu/droughtplanning/StatePlanning.aspx?st=CA>)
- Nevada Drought Planning Resources (<https://drought.unl.edu/droughtplanning/StatePlanning.aspx?st=NV>)

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Special Thanks

This Drought Status Update is issued in partnership between the National Oceanic and Atmospheric Administration (NOAA) and the California-Nevada Applications Program, a NOAA RISA team, to communicate the current state of drought conditions in California-Nevada based on recent conditions and the upcoming forecast. NIDIS and its partners will issue future Drought Updates as conditions evolve.

The next California-Nevada Drought & Climate Outlook webinar will take place on Monday, January 25 at 11 am PST.



National Oceanic and Atmospheric Administration (NOAA)



**California-Nevada Adaptation Program
(A NOAA CAP/RISA Team)**



New Water Year Begins Amid Preparations for Continued Drought

Published: Oct 03, 2022

SACRAMENTO, Calif. – Conserving water has become a way of life in California, especially as projections forecast warmer, drier conditions. The State’s new water year has begun and with it comes fresh concerns about a fourth year of extreme drought for the state.

California’s water year runs from October 1 to September 30 and is the official 12-month timeframe used by water managers to compile and compare hydrologic records.

Water Year 2022 ended on Friday and featured continued extreme drought with historically dry months and a record-shattering heatwave. Now, the focus shifts to the months ahead with state officials preparing for a fourth dry year.

Over the past 12 months, California saw extreme swings between record-breaking storms and dry conditions driven by our changing climate. In October 2021, parts of Northern California experienced the highest single-day rain totals ever, followed by a dry November and then a record snowfall in parts of the Sierra in December. Conditions took a turn again with the driest January, February, and March in over 100 years.

Despite some rain recorded in parts of California in September, uncertainty remains about what the new water year may bring. Long-range forecasting suggests warmer and drier than average conditions to persist.

“This is our new climate reality, and we must adapt. As California transitions to a hotter, drier future, our extreme swings from wet and dry conditions will continue,” said DWR Director Karla Nemeth. “We are preparing now for continued extreme drought and working with our federal, state, local, and academic partners to plan for a future where we see less overall precipitation and more rain than snow.”

Water Year 2022 ended with statewide precipitation at 76 percent of average. Statewide reservoir storage is 69 percent of average for this time of year. Lake Oroville, the State Water Project’s largest reservoir, sits at 64 percent of average for this time of year.

The current drought from 2020 to 2022 is now the driest three-year period on record, breaking the old record set by the previous drought from 2013 to 2015. This extended, extreme drought is having an impact on all Californians, especially the State’s most vulnerable communities. California is aggressively addressing the urgent need for financial and technical support for water resilience projects across California. To date, DWR has provided over \$480 million in grant funding through its [Small Community](#) and [Urban and Multi-benefit Drought Relief](#) programs. This summer, the Legislature approved hundreds of millions in additional funding and programs to support these communities.

Californians can all do their part to adapt to the hotter, drier future by making water conservation a way of life. Governor Newsom has asked all Californians to reduce water usage at home by 15 percent. Learn more at [saveourwater.com](https://www.saveourwater.com). DWR also recently announced a series of actions to make water conservation more affordable through financial assistance and tax exemptions.

State water officials will provide an update to the media on current dry conditions and the outlook for this winter. DWR will also outline actions being taken now to better prepare for a hotter, drier future. **The media briefing will be held via Zoom at 1 p.m. today.** Credentialed media can register at <https://ca-water-gov.zoom.us/j/8sGNQmPnGyB0S8b9Po0Tduh8Z>.

Californians can access current water conditions in real time at [California Water Watch](https://www.waterwatch.ca.gov), a new website launched by DWR. This website will help Californians see their local hydrological conditions, forecasts, and water conditions down to their address or their local watershed. The site presents data from a variety of sources and allows the public to obtain a quick snapshot of local and statewide water conditions. Complete data for Water Year 2022 is available now.

###

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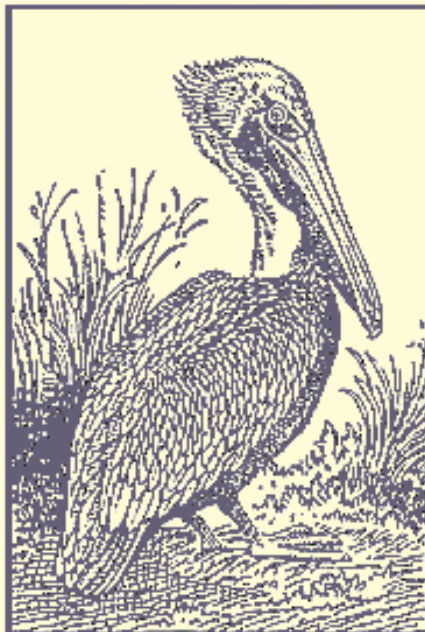
**US Army Corps
of Engineers**

Waterways Experiment
Station

Wetlands Research Program Technical Report Y-87-1 (on-line edition)

Corps of Engineers Wetlands Delineation Manual

by Environmental Laboratory



January 1987 - Final Report

Approved For Public Release; Distribution Is Unlimited



EXH-107

The following two letters used as part of the number designating technical reports of research published under the Wetlands Research Program identify the area under which the report was prepared:

	<u>Task</u>		<u>Task</u>
CP	Critical Processes	RE	Restoration & Establishment
DE	Delineation & Evaluation	SM	Stewardship & Management

The contents of this report are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products.

Corps of Engineers Wetlands Delineation Manual

by Environmental Laboratory

U.S. Army Corps of Engineers
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Final report

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and volcanic activities) may also alter or destroy wetland indicators on a site.

Such atypical situations occur throughout the United States, and all of these cannot be identified in this manual.

13. Certain wetland types, under the extremes of normal circumstances, may not always meet all the wetland criteria defined in the manual. Examples include prairie potholes during drought years and seasonal wetlands that may lack hydrophytic vegetation during the dry season. Such areas are discussed in Part IV, Section G, and guidance is provided for making wetland determinations in these areas. However, such wetland areas may warrant additional research to refine methods for their delineation.

14. Appendix A is a glossary of technical terms used in the manual. Definitions of some terms were taken from other technical sources, but most terms are defined according to the manner in which they are used in the manual.

15. Data forms for methods presented in Part IV are included in Appendix B. Examples of completed data forms are also provided.

16. Supporting information is presented in Appendices C and D. ~~Appendix C contains lists of plant species that occur in wetlands. Section 1 consists of regional lists developed by a Federal interagency panel. Section 2 consists of shorter lists of plant species that commonly occur in wetlands of each region.~~

USER NOTES: CE-supplied plant lists are obsolete and have been superseded by the May 1988 version of the "[National List of Plant Species that Occur in Wetlands](#)" published by the U.S. Fish and Wildlife Service and available on the World Wide Web. (HQUSACE, 27 Aug 91)

Section 3 describes morphological, physiological, and reproductive adaptations associated with hydrophytic species, as well as a list of some species exhibiting such adaptations. Appendix D discusses procedures for examining soils for hydric soil indicators, ~~and also contains a list of hydric soils of the United States.~~

USER NOTES: The hydric soil list published in the 1987 Corps Manual is obsolete. Current [hydric soil definition, criteria, and lists](#) are available over the World Wide Web from the U.S.D.A. Natural Resources Conservation Service (NRCS). (HQUSACE, 27 Aug 91, 6 Mar 92)

Use

17. Although this manual was prepared primarily for use by Corps of Engineers (CE) field inspectors, it should be useful to anyone who makes wetland determinations for purposes of Section 404 of the Clean Water Act. The user is

Section G - Problem Areas

77. There are certain wetland types and/or conditions that may make application of indicators of one or more parameters difficult, at least at certain times of the year. These are not considered to be atypical situations. Instead, they are wetland types in which wetland indicators of one or more parameters may be periodically lacking due to *normal* seasonal or annual variations in environmental conditions that result from causes other than human activities or catastrophic natural events.

Types of problem areas

78. Representative examples of potential problem areas, types of variations that occur, and their effects on wetland indicators are presented in the following subparagraphs. Similar situations may sometimes occur in other wetland types. *NOTE: This section is not intended to bring nonwetland areas having wetland indicators of two, but not all three, parameters into Section 404 jurisdiction.*

- a. *Wetlands on drumlins.* Slope wetlands occur in glaciated areas in which thin soils cover relatively impermeable glacial till or in which layers of glacial till have different hydraulic conditions that produce a broad zone of ground-water seepage. Such areas are seldom, if ever, flooded, but downslope groundwater movement keeps the soils saturated for a sufficient portion of the growing season to produce anaerobic and reducing soil conditions. This fosters development of hydric soil characteristics and selects for hydrophytic vegetation. Indicators of wetland hydrology may be lacking during the drier portion of the growing season.
- b. *Seasonal wetlands.* In many regions (especially in western states), depressional areas occur that have wetland indicators of all three parameters during the wetter portion of the growing season, but normally lack wetland indicators of hydrology and/or vegetation during the drier portion of the growing season. Obligate hydrophytes and facultative wetland plant species (~~Appendix C, Section 1 or 2~~) normally are dominant during the wetter portion of the growing season, while upland species (annuals) may be dominant during the drier portion of the growing season. These areas may be inundated during the wetter portion of the growing season, but wetland hydrology indicators may be totally lacking during the drier portion of the growing season. It is important to establish that an area truly is a water body. Water in a depression normally must be sufficiently persistent to exhibit an ordinary high-water mark or the presence of wetland characteristics before it can be considered as a water body potentially subject to Clean Water Act jurisdiction. The determination that an area exhibits wetland characteristics for a sufficient portion of the growing season to qualify as a wetland under the Clean Water Act must be made on a case-by-case basis. Such determinations should consider the respective length of time that the area exhibits upland and wetland characteristics, and the manner in which the area fits

into the overall ecological system as a wetland. Evidence concerning the persistence of an area's wetness can be obtained from its history, vegetation, soil, drainage characteristics, uses to which it has been subjected, and weather or hydrologic records.

- c. *Prairie potholes.* Prairie potholes normally occur as shallow depressions in glaciated portions of the north-central United States. Many are land-locked, while others have a drainage outlet to streams or other potholes. Most have standing water for much of the growing season in years of normal or above normal precipitation, but are neither inundated nor have saturated soils during most of the growing season in years of below normal precipitation. During dry years, potholes often become incorporated into farming plans, and are either planted to row crops (e.g., soybeans) or are mowed as part of a haying operation. When this occurs, wetland indicators of one or more parameters may be lacking. For example, tillage would eliminate any onsite hydrologic indicator, and would make detection of soil and vegetation indicators much more difficult.
- d. *Vegetated flats.* In both coastal and interior areas throughout the Nation, vegetated flats are often dominated by annual species that are categorized as OBL. Application of procedures described in Sections D and E during the growing season will clearly result in a positive wetland determination. However, these areas will appear to be unvegetated mudflats when examined during the nongrowing season, and the area would not qualify at that time as a wetland due to an apparent lack of vegetation.

Wetland determinations in problem areas

79. Procedures for making wetland determinations in problem areas are presented below. Application of these procedures is appropriate only when a decision has been made in Section D or E that wetland indicators of one or more parameters were lacking, probably due to normal seasonal or annual variations in environmental conditions. Specific procedures to be used will vary according to the nature of the area, site conditions, and parameter(s) affected by the variations in environmental conditions. A determination must be based on the best evidence available to the field inspector, including:

- a. Available information (Section B).
- b. Field data resulting from an onsite inspection.
- c. Basic knowledge of the ecology of the particular community type(s) and environmental conditions associated with the community type.

NOTE: The procedures described below should only be applied to parameters not adequately characterized in Section D or E. Complete the following steps:

- *STEP 1 - Identify the parameter(s) to be considered.* Examine the DATA FORM 1 (Section D or E) and identify the parameter(s) that must be given additional consideration. PROCEED TO STEP 2.
- *STEP 2 - Determine the reason for further consideration.* Determine the reason why the parameter(s) identified in STEP 1 should be given further consideration. This will require a consideration and documentation of:
 - a. Environmental condition(s) that have impacted the parameter(s).
 - b. Impacts of the identified environmental condition(s) on the parameter(s) in question.

Record findings in the comments section of DATA FORM 1. PROCEED TO STEP 3.

- *STEP 3 - Document available information for parameter(s) in question.* Examine the available information and consider personal ecological knowledge of the range of normal environmental conditions of the area. Local experts (e.g., university personnel) may provide additional information. Record information on DATA FORM 1. PROCEED TO STEP 4.
- *STEP 4 - Determine whether wetland indicators are normally present during a portion of the growing season.* Examine the information resulting from STEP 3 and determine whether wetland indicators are *normally* present during part of the growing season. If so, record on DATA FORM 1 the indicators normally present and return to Section D or Section E and make a wetland determination. If no information can be found that wetland indicators of all three parameters are normally present during part of the growing season, the determination must be made using procedures described in Section D or Section E.

California Wetland and Riparian Area Protection Policy

Technical Advisory Team
Josh Collins, Chair

Technical Memorandum No. 4:
Wetland Identification and
Delineation

Version 14.2
March 1, 2011

Version 14.2 corrects several minor typographical errors, updates bibliographic citations, and removes an erroneous citation from section 3.3.2

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are within the range of natural conditions, they should not be regarded as “problem areas” (sensu Environmental Laboratory 1987), but rather as “difficult-to-resolve areas.”

3.3.11 Altered Circumstances

The USACE method of wetland identification and delineation regards conditions of altered wetlands to be “atypical.” The TAT expects that the USACE approach to identifying “atypical” conditions may be adopted with relatively minor (or no) adjustments to determine “altered circumstances” as defined by the TAT (see Glossary):

Altered circumstances exist when one or more of the three wetland parameters (hydrology, substrate, and vegetation) have been sufficiently altered by recent human activities or natural processes to preclude wetland conditions, based on the Water Board methodology for wetland identification and delineation.

However, the TAT suggests that knowing whether circumstances are normal or altered is sufficient to guide delineation, without identifying the altered conditions as “atypical.” Simply stated, “altered circumstances” are the opposite of “normal circumstances” under the methodology recommended by the TAT. An area cannot be “normal” and “altered” at the same time, although in either case the status of the wetland parameters can be “difficult-to-resolve.”

Altered circumstances can result from natural processes or from the actions of people. A variety of natural events can alter wetland parameters, including (but not limited to) landslides that input large amounts of sediment, seismic events that change topography and water sources, the natural breaching of hydrological barriers, major channel avulsions or realignments, and fires that remove surface vegetation and/or organic substrate. People can alter wetland parameters by action including (but not limited to) removing or burying hydrophytes and hydric substrates, grading, increasing drainage, or impounding water that converts wetlands into deepwater areas.

When alterations occur, the USACE methodology requires that practitioners identify the conditions of hydrology, substrate, and/or vegetation that were present prior to the alteration or which would be present absent the alteration, using one or more procedures that are suggested in the USACE guidelines.⁸ Practitioners are then required to approximate the wetland boundaries based on the pre-alteration conditions. The TAT recommends that the Water Board adopt the same approach for areas subject to altered circumstances.

The USACE methodology excludes any judgments about the desirability of altered conditions, and does not consider the likelihood that altered areas will eventually return to pre-altered conditions or change to any other specific conditions. The TAT recommends that the Water Board adopt the same approach to prevent considerations of wetland desirability or speculation about future conditions from influencing wetland identification and delineation.

3.3.12 New Normal Circumstances

⁸ There are other useful procedures not identified in the USACE methodology that can be used to determine the pre-alteration conditions of hydrology, substrate, and vegetation, so long as the procedures are authorized by appropriate regulatory personnel.

New normal circumstances exist when altered circumstances are likely to be permanent. Some of the processes or events that can lead to new normal circumstances include (but are not limited to) landslides and the formation of riverine deltas that cover wetlands or that provide new areas for wetlands to form, the retreat of glaciers that results in new wetlands in outwash areas, the impoundment of rivers and streams that creates wetlands along new shorelines, the breaching of levees that restores floodplain or tidal wetlands, and the permitted destruction or degradation of wetlands. The creation, enhancement, and restoration of wetlands can also cause new normal circumstances. The TAT recommends that the same concept of new normal circumstances should be adopted by the Water Board.

3.3.13 Timing of Field Work

As noted previously, the Water Board should assume that normal circumstances exist unless altered circumstances are clearly evident, based on the USACE approach to assess “atypical” conditions. However, as explained above and in TAT Memorandum No. 3 (TAT 2010b), the determination of the status of the wetland parameters is sometimes complicated by their natural variability, particularly but not exclusively in arid regions of the State. The temporal variability in wetland parameters can reduce the efficacy (but not the validity) of wetland indicators. Practitioners frequently encounter conditions that are more easily and assuredly resolved during the wet season than during the dry season.

The USACE methodology (particularly as amplified in the regional supplements) addresses seasonal effects on wetland delineation by requiring practitioners to infer what the normal conditions would be in 5 of 10 wet seasons, and to base the delineation on the inferred wet season conditions.⁹ The USACE members of the TAT noted that these recommendations presented by the regional supplements are implemented by the USACE whenever possible. In deciding whether or not to seek wet-season data to supplement dry-season delineation, the USACE considers procedural requirements under Section 404 of the Federal Clean Water Act, which allow for extended processing timeframes under some circumstances.

The TAT recommends that the Water Board adopt this same approach. More specifically, the TAT recommends that practitioners should be directed to identify the boundaries of wetlands (and aquatic support areas) as they would exist under wet season conditions, even when the field investigations are conducted during the dry season.

The TAT further recommends that the Water Board presume that all wetlands and aquatic support areas in the State demonstrate seasonal variations in wetland parameters to some degree, and that any given area can present natural conditions leading to difficult-to-resolve indicators, especially during dry seasons. For areas where the indicators are especially difficult to resolve, or where the identification and delineation results are potentially contentious, the TAT recommends that the Water Board consider delineations made during the dry season as provisional or temporary, and that it consider requiring new or continued delineations during the wet season. The primary purposes of these recommendations are to help minimize the uncertainty of wetland identification and delineation, and to help minimize the failure to identify wetland areas. A

⁹ Wetlands result from hydrological, substrate, and biological processes integrated over multi-year periods. An area that is a wetland in the wetter part of a year is still a wetland in the drier part of the year. The USACE methodology recognizes and accounts for this temporal variability in wetland condition.

secondary purpose is to minimize the uncertainty in regional and statewide assessments of net change in wetlands by standardizing the time of year when wetland data are collected.

The TAT also recommends that the Water Board adopt an approach to wetland identification and delineation that minimizes reliance on dry-season data. An approach consistent with this recommendation is presented in both USACE regional supplements. They include specific recommendations to return “if possible” to a delineation site during “the normal wet portion of the growing season” (Arid West Regional Supplement, p 87; Western Mountains, Valleys, and Coast Regional Supplement, p 100) to resolve wetland indicators that were unresolved during dry-season delineation, with no changes in sampling procedures.

USACE members of the TAT expressed concern that unilateral implementation of this recommendation by the State could result in different Federal and State delineations and desynchronized permit processes. The TAT recommends that the Water Board work closely with the USACE to determine the circumstances that warrant supplemental wet season data. Studies are needed to characterize these circumstances. They are likely to differ among regions and types of wetlands. The risk associated with relying on dry-season data is probably less for areas that have less seasonality in precipitation and potential evapotranspiration. There is probably less risk for perennial wetlands (i.e., wetlands that are saturated or inundated year-round) than seasonal wetlands. Risk might also relate to wetland condition, function, or beneficial use. The TAT’s recommendation to delineate aquatic support areas adjoining wetland areas will help in identifying areas that meet the wetland criteria, particularly during the dry season. The TAT emphasizes, however, that any reliance on dry-season data incurs some risk of underestimating wetland extent and distribution, and thus could reduce WRAPP effectiveness.

The TAT suggests that the dry season of California generally extends from about mid-May through November. The wet season therefore extends from about December to mid-May. These definitions are based on the clarity of wetland indicators. For any given area, the timing of the seasons can shift from year to year because of climatic variability. The timing of the seasons also varies with latitude; the wet season is shorter further south. Regional variations in the duration of the wet and dry seasons is a subject for which statewide studies are warranted, and further highlights the potential value of recognizing ecoregions of the State (see section 3.3.7 above).

3.3.14 Validity Periods for Identifications and Delineations

The USACE methodology presumes that the indicators of wetland condition reflect persistent climatic regimes. It presumes, for example, that a wetland area reflects hydrological conditions that are present in at least 5 years out of any 10-year period. In a broader sense, the USACE methodology presumes that the distribution and abundance of aquatic areas reflect hydrological conditions that exist at least half the time over any period longer than ten years.

Climates do change, however. A change in rainfall and runoff patterns lasting for at least a decade would mean that after five years the average hydrological condition would have changed, potentially changing the boundaries of aquatic areas. Such climatic changes are likely to have two direct effects on aquatic area identification and delineation, as discussed immediately below.

First, the distribution and abundance of wetlands and other aquatic areas tend to shift in response to changes in rainfall and runoff. Changes in the hydrological regime of a landscape influence its moisture gradients, and thus can also influence the distribution, abundance, and ecological characteristics of aquatic areas (Naiman et al. 1992, Duever 2005, Stromberg et al. 2009). A landscape could become wetter, for example, with some aquatic support areas naturally developing into wetlands, such that the locations and boundaries of wetlands and other aquatic areas expand geographically, generally laterally and upslope (Mosley and McKerchar 1993). Alternatively, a landscape could become drier over time, with reductions in the distribution and extent of wetlands and other aquatic areas. These interrelationships are discussed in more detail in the TAT's Technical Memorandum No. 3 (TAT 2010b).

Second, delineations cannot be valid indefinitely. According to the USACE methodology, an accepted delineation is deemed "valid" for a period not exceeding 5 years; thereafter the delineation "expires" (the delineation may also be invalidated by significantly altered circumstances prior to its expiration). The TAT recommends that the Water Board recognize that delineations become invalid after a specified period or because of altered circumstances.

3.3.15 Aquatic Support Areas

Technical Memorandum No. 3 (TAT 2010b) describes relationships among wetlands and other aquatic areas in a landscape context. Aquatic support areas exhibit wetland conditions for one or two of the three wetland parameters. Most aquatic support areas adjoin wetland areas or deepwater areas, and are hydrologically and/or ecologically connected to them. The hydrological connections might be due to runoff, interflow, return flow, and/or high groundwater. Aquatic support areas and the other aquatic areas to which they are connected are integral parts of the same landscape moisture gradients.

Some aquatic support areas do not adjoin wetland or deepwater areas. Such aquatic support areas might be hydrologically or geographically isolated (*sensu* Winter and LaBaugh 2003, Comer et al. 2006, Tiner 2003), but they are unlikely to be ecologically isolated.

Aquatic support areas are ecologically significant (TAT 2010b). They are critically important components of California's aquatic environment. They can serve as buffers that protect wetlands from stressors, provide refuge for wetland wildlife, and they can ecologically link wetlands and other aquatic areas. Aquatic support areas can represent the frontline of evolution for local populations of wetland plants and animals that meet the limits of their tolerances to critical environmental factors, including moisture and temperature, in aquatic support areas.

The TAT recommends that the Water Board methodology should require practitioners to identify and delineate aquatic support areas that adjoin wetland areas. In other words, the TAT recommends that, having delineated a wetland area (i.e. the boundary between the wetland area and the adjoining aquatic support area and/or deepwater area), the practitioner should proceed to delineate the boundary between the aquatic support area and its adjoining upland. The intended result in every case is two delineations, one of the wetland area and one of the associated aquatic support area. The same indicators used to identify and delineate wetlands can also be used to identify and delineate aquatic support areas.

Such information is not currently required by the USACE methodology. However, as noted above, the delineation of aquatic support areas can help increase the certainty of dry season wetland delineations by helping to infer the spatial limits of wet season conditions. Furthermore, since aquatic support areas help buffer adjoining wetland areas from external stressors (TAT 2010b), they will be important areas to consider as part of wetland restoration and mitigation planning and design. The delineation of aquatic support areas is one scientific approach to identifying wetland buffers that reflect site-specific conditions.

3.3.16 Landscape Data and Wetland Classification

The TAT is developing a separate memorandum that will recommend a wetland mapping methodology that includes a wetland classification system for California. It is likely that the classification system will include requirements to report the water source(s) and landscape setting(s) of all aquatic areas. This will greatly help the Water Board and other agencies to inventory wetland areas and determine their locally specific stresses and beneficial uses.

The USACE methodology does not require the identification of water sources, but it does require information about landscape context in certain circumstances. That is, if the hydrology and “soil” indicators are to be identified during the dry season, the USACE methodology requires a statement as to which of the follow landscape settings or characteristics apply:

- concave land surface;
- floodplain;
- level or nearly level land surface;
- toe of slope or at base of convergent slope;
- fringe of wetland or other water body;
- restrictive soil layer or aquitard less than 24 inches below the surface;
- groundwater discharge.

The TAT will consider these and other landscape settings in its memorandum on wetland mapping and classification.

4.0 Example Applications

Several California agencies have wetland definitions that differ from each other and from the definition used by the USACE (TAT 2010a). These different wetland definitions lead to different assessments of wetland extent and condition, which can complicate efforts to protect wetlands, to mitigate for their unavoidable losses, and to assess the effectiveness of statewide wetland protection policies and programs. For example, the California Wetlands Conservation Policy calls for no net loss of wetland acreage for the State as a whole. Using different wetland definitions will lead to much uncertainty about the estimates of wetland gains and losses, which can translate into uncertainty about the performance of the policy.

To maximize the comparability among wetland delineations, and to minimize the uncertainty of wetland maps and other inventories of wetland resources, the TAT recommends that all California agencies adopt the same technical definition of wetlands and the same methodology for wetland identification and delineation. This recommendation is based on technical concerns, but the TAT appreciates that it might have significant policy implications for some State



FISH & WILDLIFE GROUNDWATER PLANNING CONSIDERATIONS

Freshwater Wetlands

JUNE | 2019

PREFACE

In 2014, California passed the Sustainable Groundwater Management Act (SGMA) (AB1739, SB 1168, SB 1319), authorizing local groundwater sustainability agencies to develop groundwater sustainability plans for a subset of California's alluvial aquifers. This document provides considerations to assist local groundwater sustainability agencies in avoiding or minimizing adverse impacts to freshwater wetland beneficial uses and users of groundwater in local groundwater management planning and implementation. The information provided is intended to help local groundwater planners, groundwater planning proponents and consultants, and California Department of Fish and Wildlife (CDFW) staff work together to protect wetlands as a public trust resource.

WETLANDS

When acting in an advisory role, CDFW typically considers the U.S. Fish and Wildlife Service's definition of wetlands as "...lands transitional between terrestrial and aquatic systems..." that have one or more of the following attributes:

- (1) at least periodically, the land supports plants that grow wholly or partially in water;
- (2) the substrate is predominantly impermeable or semi-impermeable soil that allows for shallow water retention rather than rapid percolation of surface water to groundwater; and
- (3) the substrate is non-soil and is saturated with water or covered by shallow water at some point during the growing season of each year.

It is estimated that California has lost more than 90% of its historical wetlands.¹



California's managed wetlands support the highest densities of wintering waterfowl found anywhere in the world.

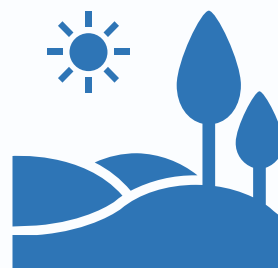
¹ Central Valley Joint Venture Implementation Plan



ECOSYSTEM SERVICES

Wetlands may provide some or all of the following critical ecosystem services:

- purify water by trapping sediments and breaking down pollutants and bacteria;
- recharge groundwater aquifers and contribute to streamflow;
- reduce peak water flows during storm events (flood control);
- store carbon through wetland vegetation and decomposition of organic matter;
- support biodiversity through habitat provision for hundreds of species, including state and federally listed species; and
- buffer climate extremes such as drought and flood.



SOCIO-ECONOMIC VALUE

Wetlands may generate some or all of the following socio-economic values:

- sustain migrating waterfowl and fisheries;
- provide recreation opportunities including waterfowl hunting, bird watching, hiking, and fishing;
- remediate polluted waters by removing excess nitrogen and sediment;
- protect eroding streambanks from high velocity flows;
- support food-supply (e.g. rice fields); and
- maintain cultural and aesthetic values of the landscape, including tribal wetland resources.



WETLAND MANAGEMENT CATEGORIES

Wetlands are often categorized based on the timing of flooded habitat and the species they support. Examples of managed Central Valley freshwater wetland types and their beneficiary species are as follows:

- Seasonal wetlands | Typically flooded for 6 months from October through March | Provide habitat for migratory waterfowl and shorebirds | Most abundant wetland in California;
- Semi-permanent wetlands | Typically flooded for 10 months from October through July | Provide critical habitat for breeding waterfowl and shorebirds, and state and federally listed species (e.g. state-listed Tricolored blackbird); and
- Permanent wetlands | Flooded year-round | Provide critical habitat for molting waterfowl and state- and federally listed-species (e.g., giant garter snake).



WATER RESOURCES

Wetlands – naturally-occurring and managed – receive water from precipitation, surface water, and/or groundwater. Most wetlands have seasonal water needs, meaning they require ‘flooding’ (natural or managed) during specific times of the year. For example, in the Central Valley, many wetlands undergo a fall ‘flood-up’ wherein wetlands are inundated during the fall, ensuring saturated surface conditions for waterfowl migrating south during the winter.

Naturally occurring wetlands rely on precipitation; surface water over-bank flow during floods; and/or high groundwater tables that intersect the ground surface and cause pooling, constituting a groundwater dependent ecosystem. Managed flooding, relying on surface water diversions and groundwater extraction, is used to mimic historic natural flooding or groundwater seepage which has diminished or ceased entirely under contemporary reservoir management regimes and groundwater resource development.



POLICIES & PROTECTIONS

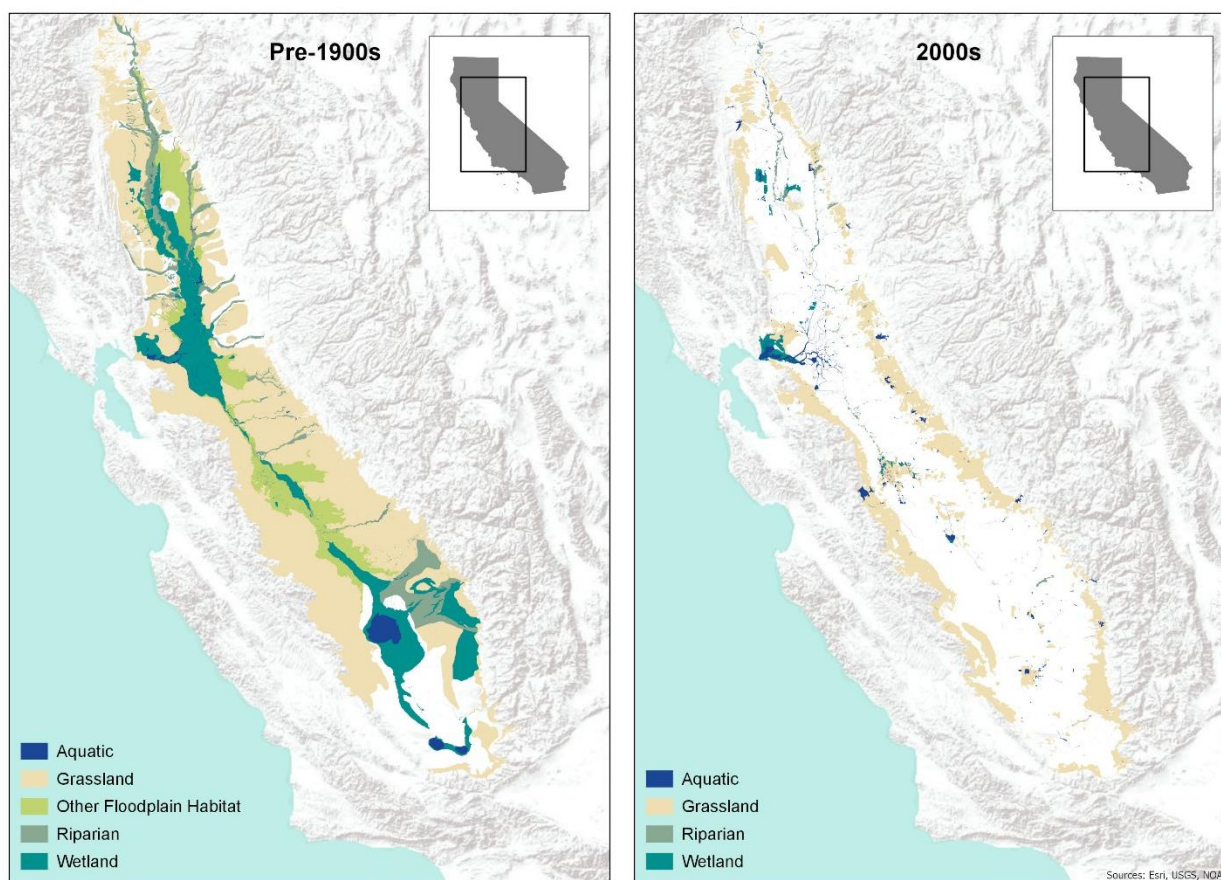
Many policies exist to protect wetlands against further loss and degradation. For example, The Wetlands Conservation Policy (Executive Order W-59-3), also known as the state’s “No Net Loss” policy, was an executive order issued in 1993 providing for the coordination of state-wide activities for the preservation and protection of wetland habitats. The State Water Resources Control Board (SWRCB) also adopted a resolution to ensure that wetlands and riparian areas that historically were protected under the federal Clean Water Act remain protected under the state Porter-Cologne Water Quality Control Act (Resolution No. 2019-0015). Wetlands may also be entitled to protection under the public trust doctrine to the extent that public trust resources, including fish and wildlife, depend on them.

In support of wetland goals and in recognition of their value, various state and federal laws, partnerships, and programs are designed to protect wetlands from further decline. These include but are not limited to: [Clean Water Act](#), [Central Valley Project Improvement Act](#), [Central Valley Joint Venture](#), [Inland Wetland Conservation Program of the Wildlife Conservation Board](#), [National Wildlife Refuge System – Wetlands of International Importance](#), [State Wildlife Areas](#), [Ramsar Convention on Wetlands](#), [Endangered Species Act – Critical Habitat Designations](#), [United States Fish and Wildlife Service \(USFWS\)](#) and [Natural Resources Conservation Service \(NRCS\)](#) federal easement programs, State easement programs (e.g., [Permanent Wetland Easement Program](#)), and State incentive programs (e.g., [California Waterfowl Habitat Program](#)).

CHALLENGES

Despite existing protections, wetland habitats face a range of threats such as development, increasing operations costs, and surface water delivery constraints. A significant number of California wetlands are actively managed, relying upon human intervention to ensure the presence and maintenance of desired wetland habitat conditions. This on-going upkeep requires landowners to have adequate funding for water deliveries and maintenance activities, which can be difficult to secure.

Increased water costs and potential groundwater extraction curtailment, in part resulting from implementation of the Sustainable Groundwater Management Act (SGMA), may pose threats to the continued existence of functional wetlands. Increased costs and decreased water availability may limit landowners' ability to manage wetland habitats to meet necessary ecosystem functions. While lands themselves may be protected from development by fee title purchase or easements, the habitat values on those lands are not necessarily protected from degradation, particularly if they are dependent on managed intervention. An inability to preserve protected lands *and* manage wetlands for habitat outcomes is likely to reduce the abundance and quality of available habitat, leading to species decline.



HABITAT LOSS IN CALIFORNIA'S CENTRAL VALLEY FROM PRE-1900'S TO THE 2000'S. *MAP CREDIT: DUCKS UNLIMITED*

HISTORIC AND CURRENT (CIRCA 1995) AQUATIC/GRASSLAND/RIPARIAN + HISTORIC WETLAND DATA SOURCE: GEOGRAPHIC INFORMATION CENTER. 2003. THE CENTRAL VALLEY HISTORIC MAPPING PROJECT. CHICO (CA): CALIFORNIA STATE UNIVERSITY. AVAILABLE FROM:
[HTTPS://WWW.WATERBOARDS.CA.GOV/WATERRIGHTS/WATER_ISSUES/PROGRAMS/BAY_DELTA/DOCS/CMNT081712/Sldmwa/CSUCHICODPTOFGEOGRAPHYANDPLANNINGCENTRALVALLEY.PDF](https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/docs/cmnt081712/sldmwa/csuchicodptofgeographyandplanningcentralvalley.pdf)

CURRENT (CIRCA 2009) MANAGED WETLAND DATA SOURCE: PETRIK, K., D. FEHRINGER AND A. WEVERKO. 2013. MAPPING SEASONAL MANAGED AND SEMI-PERMANENT WETLANDS IN THE CENTRAL VALLEY OF CALIFORNIA. FINAL REPORT TO THE CENTRAL VALLEY JOINT VENTURE. DUCKS UNLIMITED, INC., RANCHO CORDOVA, CA.

SUGGESTIONS FOR CONSIDERING WETLANDS IN GROUNDWATER PLANNING AND MANAGEMENT

Wetlands are at risk of further decline. Competing water demands are likely to drive up water costs and reduce available water that might otherwise naturally return to a wetland or be applied to a managed wetland. Minimizing the financial and water supply burdens on wetland landowners supports the long-term presence and maintenance of these critical habitats. Groundwater and watershed planning processes should consider the following opportunities to ensure continued ecological and socio-economic benefits generated by wetlands:

- Identify where wetlands are hydraulically connected with the groundwater table to determine the presence of groundwater dependent ecosystems (GDEs); the identification of GDEs is required in SGMA groundwater planning [see, e.g., Water Code § 10727.4(l)].
- Account for natural and managed wetland groundwater use and recharge in water budgets as required by SGMA [Title 23 California Code of Regulations § 351(a), § 356.2(b)(4)]; account for agricultural tailwater inflows to wetlands and wetland outflows to down-stream systems in basin water budgets.
- Monitor wetland coverage over time to track trends and identify relationships to groundwater resources and management practices.
- Credit wetlands for recharge contributions and water quality improvement contributions.
- Consider categorical groundwater pricing or allotments (e.g., reduced groundwater costs for wetlands, or seasonal allotments to meet habitat needs); managed wetlands typically lack the capacity to absorb new costs in the same way as for-profit landowning entities (e.g., some wetlands are enrolled in incentive programs that have contractual obligations such as 'no-profit' clauses).
- Identify opportunities for mutual benefit project and management actions that help recover groundwater levels and that benefit wetland existence (e.g., managed aquifer recharge projects; water supply remediation; addition of semi-permanent wetlands by capturing excess waters from December through April and retaining this water until July or August); targeting multi-benefit actions can assist in identifying funding to implement groundwater management projects.
- Share information about existing wetland incentive programs to private wetlands facing increasing groundwater costs (e.g., [California Waterfowl Habitat Program](#)); note that available incentive program funding will support less than one quarter of Central Valley private wetlands through 2028, leaving 75% vulnerable to significant losses).

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California Department
of Transportation

Highway Design Manual

U.S. Customary Units

Seventh Edition

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CHIEF, DIVISION OF DESIGN
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SACRAMENTO, CALIFORNIA 94274 – 0001**

CHAPTER 300 – GEOMETRIC CROSS SECTION

The selection of a cross section is based upon the joint use of the transportation corridor by vehicles, including trucks, public transit, cyclists and pedestrians. Designers should recognize the implications of this sharing of the transportation corridor and are encouraged to consider not only vehicular movement, but also movement of people, distribution of goods, and provision of essential services. Designers need also to consider the plan for the future of the route, consult Transportation Concept Reports for state routes.

Topic 301 – Traveled Way Standards

The traveled way width is determined by the number of lanes required to accommodate operational needs, terrain, safety and other concerns. The traveled way width includes the width of all lanes, but does not include the width of shoulders, sidewalks, curbs, dikes, gutters, or gutter pans. See Topic 307 for State highway cross sections, and Topic 308 for road cross sections under other jurisdictions.

Index 301.1 – Lane Width

The minimum lane width on two-lane and multilane highways, ramps, collector-distributor roads, and other appurtenant roadways shall be 12 feet, except as follows:

- **For conventional State highways with posted speeds less than or equal to 40 miles per hour and AADTT (truck volume) less than 250 per lane that are in urban, city or town centers (rural main streets), the minimum lane width shall be 11 feet.** The preferred lane width is 12 feet. See Index 81.3 for place type definitions.

Where a 2-lane conventional State highway connects to a freeway within an interchange, the lane width shall be 12 feet.

Where a multilane State highway connects to a freeway within an interchange, the outer most lane of the highway in each direction of travel shall be 12 feet.

- For highways, ramps, and roads with curve radii of 300 feet or less, widening due to offtracking in order to minimize bicycle and vehicle conflicts must be considered. See Index 404.1 and Table 504.3A.
- For lane widths on roads under other jurisdictions, see Topic 308.

301.2 Class II Bikeway (Bike Lane) Lane Width

- (1) **General. Class II bikeways (bike lanes), for the preferential use of bicycles, may be established within the roadbed and shall be located immediately adjacent to a traffic lane as allowed in this manual.** A buffered bike lane may also be established within the roadbed, separated by a marked buffer between the bike lane and the traffic lane or parking lane. See the California MUTCD for further buffered bike lane marking and signing guidance. Contraflow bike lanes are designed for bike travel

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in the opposite direction as adjacent vehicular traffic, and are only allowed on one-way streets. See the California MUTCD for contraflow bike lane marking and signing guidance. Typical Class II bikeway configurations are illustrated in Figure 301.2A. A bikeway located behind on-street parking, physical separation, or barrier within the roadway is a Class IV bikeway (separated bikeway). See DIB 89 for Class IV bikeway (separated bikeway) design guidance. **The minimum Class II bike lane width shall be 4 feet, except where:**

- Adjacent to on-street parking, the minimum bike lane should be 5 feet.
- Posted speeds are greater than 40 miles per hour, the minimum bike lane should be 6 feet, or
- **On highways with concrete curb and gutter, a minimum width of 3 feet measured from the bike lane stripe to the joint between the shoulder pavement and the gutter shall be provided.**

Class II bikeways may be included as part of the shoulder width See Topic 302.

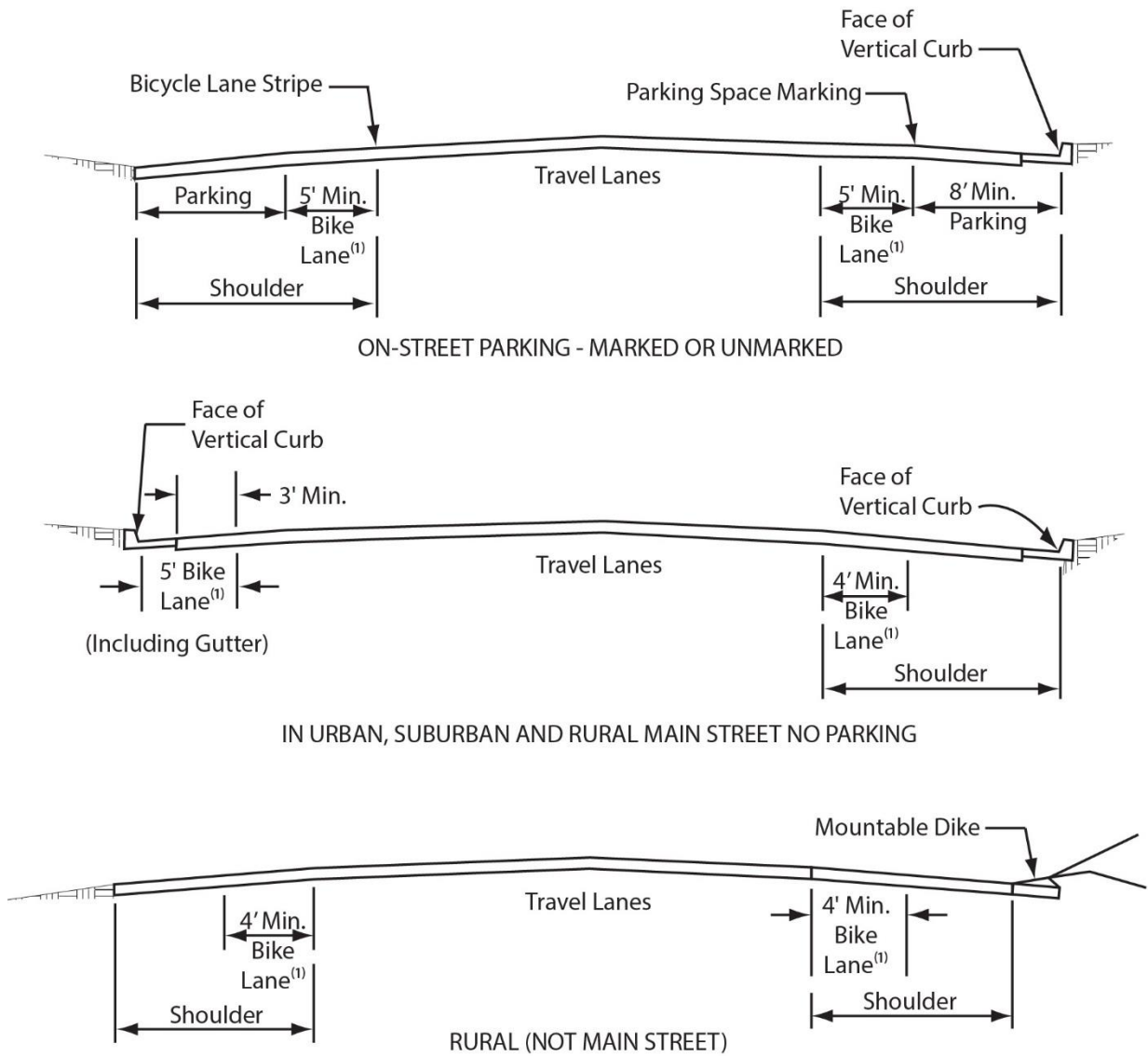
As grades increase, downhill bicycle speeds can increase, which increases the width needed for the comfort of bicycle operation. If bicycle lanes are to be marked, additional bike lane width is recommended to accommodate these higher bicycle speeds. See Index 204.5(4) for guidance on accommodating bicyclists on uphill grades where a Class II bikeway is not included.

If bike lanes are to be located on one-way streets, they may be placed on either or both sides of the street. When only one bicycle lane is provided, it should be located on the side of the street that presents the lowest number of conflicts for bicyclists which facilitates turning movements and access to destinations on the street.

- (2) *On-Street Parking Adjacent to Class II Bikeways.* Parking adjacent to bike lanes is discussed in subsection (1) above and addressed in Table 302.1, Note (7). Part-time bike lanes with part-time on-street parking is discouraged. This type of bike lane may only be considered if the majority of bicycle travel occurs during the hours of parking prohibition. When such an installation is being considered refer to the California MUTCD and traffic operations for direction regarding proper signing and marking.
- (3) *Reduction of Cross Section Elements Adjacent to Class II Bikeways.* There are situations where it may be desirable to reduce the width of the lanes in order to add or widen bike lanes or shoulders. In determining the appropriateness of narrower traffic lanes, consideration should be given to factors such as motor vehicle speeds, truck volumes, alignment, bike lane width, sight distance, and the presence of on-street parking. When on-street parking is permitted adjacent to a bike lane, or on a shoulder where bicycling is not prohibited, reducing the width of the adjacent traffic lane may allow for wider bike lanes or shoulders, to provide greater clearance between bicyclists and driver-side doors when opened.

Figure 301.2A

Typical Class II Bikeway (Bike Lane) Cross Sections



NOTES:

- (1) See Index 301.2 for additional guidance.
- (2) For pavement marking guidance, see the California MUTCD, Section 9C.04.

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301.3 Cross Slopes

(1) *General.* The purpose of sloping on roadway cross sections is to provide a mechanism to direct water (usually from precipitation) off the traveled way. Undesirable accumulations of water can lead to hydroplaning or other problems which can increase accident potential. See Topics 831 and 833 for hydroplaning considerations. For roadways with three (3) lanes or more sloped in the same direction, see topic 833.2.

(2) *Standards.*

- (a) **The standard cross slope to be used for new construction on the traveled way for all types of surfaces shall be 2 percent.**
- (b) **For resurfacing or widening (only when necessary to match existing cross slope), the minimum shall be 1.5 percent and the maximum shall be 3 percent.** However, the cross slope on 2-lane and multilane HMA highways should be increased to 2 percent if the cost is reasonable.
- (c) **On unpaved roadway surfaces, including gravel and penetration treated earth, the cross slope shall be 2.5 percent to 5.0 percent.**

On undivided highways with two or more lanes in a normal tangent section, the high point of the crown should be centered on the pavement and the pavement sloped toward the edges on a uniform grade.

For rehabilitation and widening projects, the maximum algebraic difference in cross slope between adjacent lanes of opposing traffic for either 2-lane or undivided multilane highways should be 6 percent. **For new construction, the maximum shall be 4 percent.**

On divided highway roadbeds, the high point of crown may be centered at, or left of, the center of the traveled way, and preferably over a lane line (tent sections). This strategy may be employed when adding lanes on the inside of divided highways, or when widening an existing "crowned" 2-lane highway to a 4-lane divided highway by utilizing the existing 2-lane pavement as one of the divided highway roadbeds.

The maximum algebraic difference in cross slope between same direction traffic lanes of divided highway roadbeds should be 4 percent.

The maximum difference in cross slope between the traveled way and the shoulder should not exceed 8 percent. This applies to new construction as well as pavement overlay projects.

At freeway entrances and exits, the maximum difference in cross slope between adjacent lanes, or between lanes and gore areas, should not exceed 5 percent.

Topic 302 – Highway Shoulder Standards

302.1 Width

The shoulder widths given in Table 302.1 shall be the minimum continuous usable width of paved shoulder on highways. Typically, on-street parking areas in urbanized areas is included in the shoulder.

When present, Class II bikeways are typically part of the shoulder width, see Index 301.2.

See Rumble Strip Guidelines, Traffic Safety Bulletin 20-07 for placement of rumble strips and rumble stripes in and adjacent to shoulders. Consult the District Traffic Safety Engineer during selection of rumble strip and stripe options and refer to the California MUTCD for markings in combination with rumble strip and stripe. Also see Standard Plans for rumble strip and stripe details.

See DIB 79 for 2R, 3R, certain storm damage, protective betterment, operational, and safety projects on two-lane and three-lane conventional highways.

See Index 308.1 for shoulder width requirements on city streets or county roads. See shoulder definition, Index 62.1(9).

See Index 1102.2 for shoulder width requirements next to noise Barriers.

When shoulders are less than standard width, see Index 204.5(4) for bicycle turnout considerations.

302.2 Cross Slopes

(1) **General - When a roadway crosses a bridge structure, the shoulders shall be in the same plane as the adjacent traveled way.**

(2) **Left Shoulders - In depressed median sections, shoulders to the left of traffic shall be sloped at 2 percent away from the traveled way.**

In paved median sections, shoulders to the left of traffic shall be designed in the plane of the traveled way. Maintenance paving beyond the edge of shoulder should be treated as appropriate for the site, but consideration needs to be given to the added runoff and the increased water depth on the pavement (see discussion in Index 831.4(5) "Hydroplaning").

(3) **Right Shoulders- In normal tangent sections, shoulders to the right of traffic shall be sloped at 2 percent to 5 percent away from the traveled way.**

The above flexibility in the design of the right shoulder allows the designer the ability to conform to regional needs. Designers shall consider the following during shoulder cross slope design:

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Table 302.1

Boldface Standards for Paved Shoulder Widths on Highways

Highway Type	Paved Shoulder Width (ft)	
	Left ⁽⁸⁾	Right ⁽⁸⁾
Freeways & Expressways		
2 lanes ⁽¹⁾	--	8 ⁽⁶⁾
4 lanes ⁽¹⁾	5	10
6 or more lanes ⁽¹⁾	10	10
Auxiliary lanes	--	10
Freeway-to-freeway connections		
Single and two-lane connections	5	10
Three-lane connections	10	10
Single-lane ramps	4 ⁽²⁾	8
Multilane ramps	4 ⁽²⁾	8 ⁽³⁾
Multilane undivided	--	10
Collector-Distributor	5	10
Conventional Highways		
Multilane divided		
4-lanes	5	8 ⁽⁷⁾
6-lanes or more	8	8 ⁽⁷⁾
Urban areas with posted speeds less than or equal to 45 mph and curbed medians	2 ⁽⁴⁾	8 ⁽⁷⁾
Multilane undivided	--	8 ⁽⁷⁾
2-lane		
RRR	See Index 307.3	
New construction	See Table 307.2	
Slow-moving vehicle lane	--	4 ⁽⁵⁾
Local Facilities		
Frontage roads	See Index 310.1	
Local facilities crossing State facilities	See Index 308.1	

NOTES:

- (1) Total number of lanes in both directions including separate roadways (see Index 305.6). If a lane is added to one side of a 4-lane facility (such as a truck climbing lane) then that side shall have 10 feet left and right shoulders. See Index 62.1.
- (2) May be reduced to 2 feet upon concurrence from the Project Delivery Coordinator that a restrictive situation exists. 4 feet preferred in urban areas and/or when ramp is metered. See Index 504.3.
- (3) May be reduced to 2 feet or 4 feet (4 feet preferred in urban areas) in the 2-lane section of a non-metered ramp, which transitions from a single lane upon concurrence from the Project Delivery Coordinator that a restrictive situation exists. May be reduced to 2 feet in ramp sections having 3 or more lanes. See Index 504.3.
- (4) For posted speeds less than or equal to 35 mph, shoulder may be omitted (see Index 303.5(5)) except where drainage flows toward the curbed median.
- (5) On right side of climbing or passing lane section only. See Index 301.2(1) for minimum width if bike lanes are present.
- (6) 10-foot shoulders preferred.
- (7) Where on-street parking is allowed, 10 feet shoulder width is preferred. Where bus stops are present, 10 feet shoulder width is preferred for the length of the bus stop. If a Class II bikeway is present, minimum shoulder width shall be 8 feet where on street parking is provided plus the minimum required width for the bike lane.
- (8) Shoulders adjacent to abutment walls, retaining walls in cut locations, and noise barriers shall be not less than 10 feet wide. See Index 303.4 for minimum shoulder adjacent to bulbouts. See Index 309.1(4) for minimum shoulder width adjacent to high speed rail facilities.

- In most areas a 5 percent right shoulder cross slope is desired to most expeditiously remove water from the pavement and to allow gutters to carry a maximum water volume between drainage inlets. The shoulders must have adequate drainage interception to control the "water spread" as discussed in Table 831.3 and Index 831.4. Conveyance of water from the total area transferring drainage and rainwater across each lane and the quantity of intercepting drainage shall also be a consideration in the selection of shoulder cross slope. Hydroplaning is discussed in Index 831.4 (5).

In locations with snow removal operations it is desirable for right shoulders to slope away from traffic in the same plane as the traveled way. This design permits the snow plowing crew to remove snow from the lanes and the shoulders with the least number of passes.

- For 2-lane roads with 4-foot shoulders, see Index 307.2.
- If shoulders are Portland cement concrete and the District plans to convert shoulders into through lanes within the 20 years following construction, then shoulders are to be built in the plane of the traveled way and to lane standards for width and structural section. (See Index 603.2).
- Deciding to construct pedestrian facilities and elements, where none exist, is an important consideration. Shoulders are not required to be designed as accessible pedestrian routes although it is legal for a pedestrian to traverse along a highway. In urban, rural main street areas, or near schools and bus stops with pedestrians present, pedestrian facilities should be constructed. In rural areas where few or no pedestrians exist, it would not be reasonable or cost effective to construct pedestrian facilities. This determination should involve the local agency and must be consistent with the design guidance provided in Topic 105 and in Design Information Bulletin 82, "Pedestrian Accessibility Guidelines for Highway Projects" for people with disabilities.

Shoulder slopes for superelevated curves are discussed in Index 202.2.

See Index 307.2 for shoulder slopes on 2-lane roads with 4-foot shoulders.

302.3 Tapered Edge

The tapered edge is a sloped edge that is placed at the edge of the paved roadbed to provide a smooth reentry for vehicles that leave the roadway. Its design is based on research performed by the FHWA.

The tapered edge should be placed on all pavement edges either during new construction or on overlay projects irrespective of pavement types and is most useful:

- On undivided roadways.
- On roadways with unpaved shoulders.
- On roadways with Class II Bikeways.

The tapered edge is not to be placed on roadways:

- Next to curbs, dikes, guardrails, barriers, walls, and landscape paving.
- Where there is not enough room to place the tapered edge without reducing the existing lane width.

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- Within 3 feet of driveways or intersections.
- Where pavement overlay thickness is less than 0.15 foot.

Tapered edge is optional when the distance between consecutive minor roads or driveways is less than 30 feet. See the Standard Plans for design and construction details regarding tapered edge.

Topic 303 – Curbs, Dikes, and Side Gutters

303.1 General Policy

Curb (including curb with gutter pan), dike, and side gutter all serve specific purposes in the design of the roadway cross section. Curb is primarily used for channelization, access control, separation between pedestrians and vehicles, and to enhance delineation. Dike is specifically intended for drainage and erosion control where stormwater runoff cannot be cost effectively conveyed beyond the pavement by other means. Curb with gutter pan serves the purpose of both curb and dike. Side gutters are intended to prevent runoff from a cut slope on the high side of a superelevated roadway from running across the pavement and is discussed further in Index 834.3.

Aside from their positive aspects in performing certain functions, curbs and dikes can have undesirable effects. In general, curbs and dikes should present the least potential obstruction, yet perform their intended function. As operating speeds increase, lower curb and dike height is desirable. Curbs and dikes are not considered traffic barriers.

On urban conventional highways where right of way is costly and/or difficult to acquire, it is appropriate to consider the use of a “closed” highway cross section with curb, or curb with gutter pan. There are also some situations where curb is appropriate in freeway settings. The following criteria describe typical situations where curb or curb with gutter pan may be appropriate:

- (a) Where needed for channelization, delineation, or other means of improving traffic flow and safety.
- (b) At ramp connections with local streets for the delineation of pedestrian walkways and continuity of construction at a local facility.
- (c) As a replacement of existing curb with gutter pan and sidewalk.
- (d) On frontage roads on the side adjacent to the freeway to deter vehicular damage to the freeway fence.
- (e) When appropriate to conform to local arterial street standards.
- (f) Where it may be necessary to solve or mitigate operational deficiencies through control or restriction of access of traffic movements to abutting properties or traveled ways.
- (g) In freeway entrance ramp gore areas (at the inlet nose) when the gore cross slope exceeds standards.
- (h) At separation islands between a freeway and a collector-distributor to provide a positive separation between mainline traffic and collector-distributor traffic.
- (i) Where sidewalk is appropriate.

- (j) To deter vehicular damage of traffic signal standards.

Dike is appropriate where controlling drainage is not feasible via sheet flow or where it is necessary to contain/direct runoff to interception devices. On cut slopes, dike also protects the toe of slope from erosion. Dike may also be necessary to protect adjacent areas from flooding.

The use of curb should be avoided on facilities with posted speeds greater than or equal to 40 miles per hour, except as noted in Table 303.1. For projects where the use of curb is appropriate, it should be the type shown in Table 303.1.

303.2 Curb Types and Uses

Depending on their intended function, one of two general classifications of curb design is selected as appropriate. The two general classifications are vertical and sloped. Vertical curbs are nearly vertical (approximate batter of 1:4) and vary in height from 4 inches to 8 inches. Sloped curbs (approximate batter of 2:3 or flatter) vary in height from 3 inches to 6 inches.

Sloped curbs are more easily mounted by motor vehicles than vertical curbs. Since curbs are not generally adequate to prevent a vehicle from leaving the roadway, a suitable traffic barrier should be provided where redirection of vehicles is needed. A curb may be placed to discourage vehicles from intentionally entering the area behind the curb (e.g., truck offtracking). In most cases, the curb will not prevent an errant vehicle from mounting the curb.

Curb with gutter pan may be provided to enhance the visibility of the curb and thus improve delineation. This is most effective where the adjacent pavement is a contrasting color or material. B2-4 and B4 curbs are appropriate for enhancing delineation. Where curb with gutter pan is intended as delineation and has no drainage function, the gutter pan should be in the same plane as the adjacent pavement.

The curb sections provided on the Standard Plans are approved types to be used as stated below. The following types are vertical curb, (for information on side gutters, see Index 834.3):

- (1) *Types A1-6, A2-6, and A3-6.* These curbs are 6 inches high. Their main function is to provide a more positive deterrent to vehicles than provided by sloped curbs. Specifically, these curbs are used to separate pedestrians from vehicles, to control parking of vehicles, and to deter vehicular damage of traffic signal standards. They may also be used as raised median islands in low speed environments (posted speed ≤ 35 miles per hour). These curbs do not constitute a barrier as they can be mounted except at low speeds and flat angles of approach.
- (2) *Types A1-8, A2-8, and A3-8.* These 8-inch high curbs may be used in lieu of 6-inch curbs when requested by local authorities, if the curb criteria stated under Index 303.1 are satisfied and posted speeds are 35 miles per hour or less. This type of curb may impede curbside passenger loading and may make it more difficult to comply with curb ramp design (see Design Information Bulletin Number 82, "Pedestrian Accessibility Guidelines for Highway Projects").
- (3) *Type H Curb.* This type may be used on bridges where posted speeds are 40 miles per hour or less and where it is desired to match the approach roadway curb. Type H

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curb is often incorporated into bridge barrier/sidewalk combination railings (See Index 208.10(4)).

Table 303.1**Selection of Curb Type**

Location	Posted Speeds (mph)		
	≤ 35	40	≥ 45
Freeways and Expressways			
Collector-distributor Roads	See Index 504.3(11)		
Ramps			
Conventional Highways			
Frontage Roads (1)	A or B-6	B-6	B-4
Traffic Signals	A or B-6	B-6	B-4
Raised Traffic, Median Islands & Pedestrian Refuge Islands (2)	A or B-6	B-6	B-4 or D
Adjacent to Sidewalks	A (3)	A-6	B-6
Bulbouts/curb extensions	A	NA	NA
Bridges (4)	H, A3, or B3	H or B3	B3

NOTES:

- (1) Based on the posted speed along the frontage road.
- (2) See the National Cooperative Highway Research Program Report 672 entitled "Roundabouts: An Informational Guide, 2nd ed." for information on curbs at roundabouts.
- (3) Type A curb includes Types A1-6, A2-6, A1-8, and A2-8.
- (4) Type H curb typically used in conjunction with Type A curbs next to sidewalks on approach roadway. Type A3 curbs typically used with corresponding Type A curbs on median island of approach roadway. Type B3 curbs typically used with corresponding Type B curbs on approach roadway.

These types are sloped curbs:

- (4) *Types B1, B2, and B3 Curbs* Types B1-6, B2-6, and B3-6 are 6 inches high. Type B1-4, B2-4, and B3-4 are 4 inches high. Since all have a 1:1½ slope or flatter on the face, they are mounted more easily than Type A curbs. Typical uses of these curbs are for channelization including raised median islands. B2 curb with gutter pan also serves as drainage control.
- (5) *Type B4 Curb.* Type B4 curb with gutter pan is 3 inches high and is typically used on ramp gores as described in Index 504.3(11). It may also be appropriate where a lower curb is desirable.
- (6) *Type D Curb.* Type D curb is 4 inches or 6 inches high and is typically used for raised traffic islands, collector-distributor separation islands, or raised medians when posted speeds equal or exceed 45 miles per hour.
- (7) *Type E Curb.* This essentially is a rolled gutter used only in special drainage situations.

Curbs with gutter pans, along with the shoulder, may provide the principal drainage system for the roadway. Inlets are provided in the gutter pan or curb, or both.

Gutter pans are typically 2 feet wide but may be 1 foot to 4 feet in width, with a cross slope of typically 8.33 percent to increase the hydraulic capacity. Gutter pan cross slopes often need to be modified at curb ramps in order to meet accessibility requirements. See Design Information Bulletin Number 82, "Pedestrian Accessibility Guidelines for Highway Projects" and Standard Plan A88A.

Curbs and gutter pans are cross section elements considered entirely outside the traveled way, see Index 301.1.

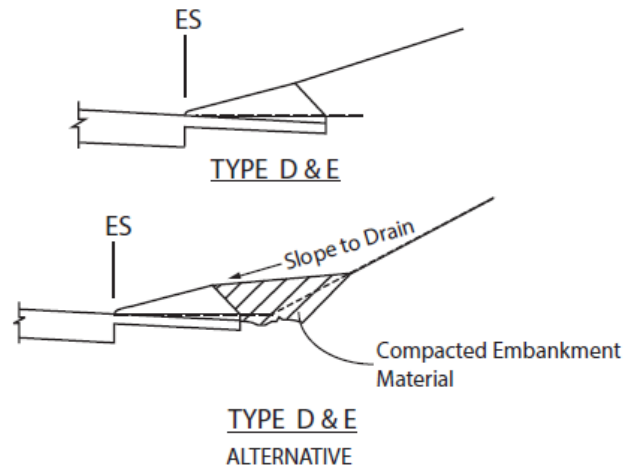
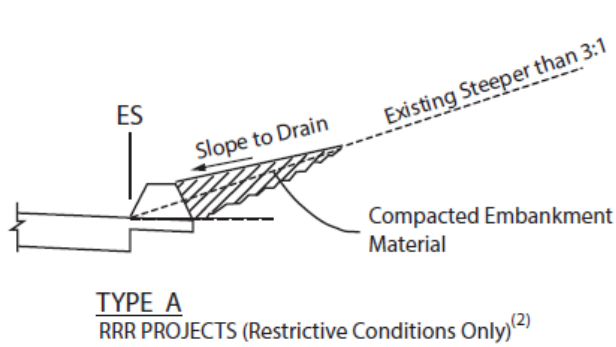
303.3 Dike Types and Uses

Use of dike is intended for drainage control and should not be used in place of curb. Dikes placed adjoining the shoulder, as shown in Figures 307.2, 307.4A, 307.4B, and 307.5, provide a paved triangular gutter within the shoulder area. The dike sections provided on the Standard Plans are approved types to be used as stated below. Dikes should be selected as illustrated in Figure 303.3. Dikes should be designed so that roadway runoff is contained within the limits specified in Index 831.3. For most situations Type E dike is the preferred dike type as discussed below.

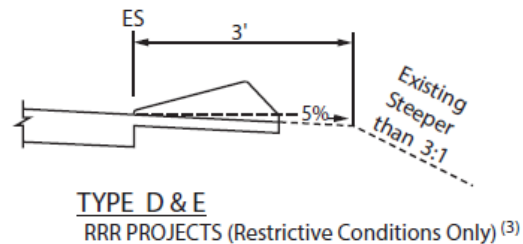
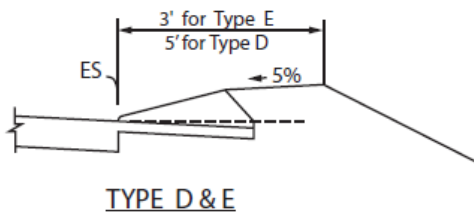
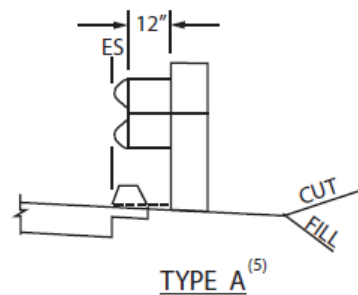
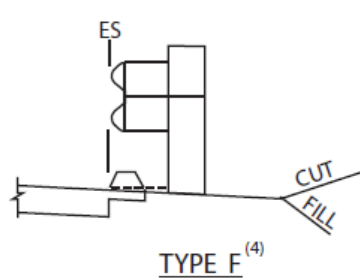
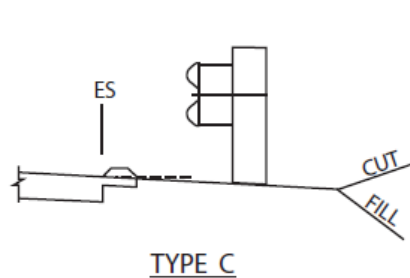
- (1) *Type A Dike.* This 6-inch high dike is to be used where dike is necessary for drainage underneath guardrail with 12-inch blackout installation. This dike is placed directly under the face of guardrail. Otherwise, the use of Type A dike should be avoided. For RRR projects, Type A dike may be used in cut sections with slopes steeper than 3:1 and where existing conditions do not allow for construction of the wider Type D or E dikes. Compacted embankment material should be placed behind the back of dike as shown in Figure 303.3.

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Figure 303.3

Dike Type Selection and Placement⁽¹⁾CUT SECTIONSFILL SECTIONS

5' for Type D

CUT/FILL SECTIONS

Notes:

- (1) See Standard Plans for additional information and details.
- (2) See Index 303.3(1) for restrictive conditions.
- (3) See Index 303.3(3) and Index 303.3(4) for restrictive conditions for Types D and E respectively.
- (4) Use under guardrail when dike is necessary for drainage control.
- (5) Use under guardrail with 12-inch blockouts when dike is necessary for drainage control.

- (2) *Type C Dike.* This low dike, 2 inches in height, may be used to confine small concentrations of runoff. The capacity of the shoulder gutter formed by this dike is small. Due to this limited capacity, the need for installing an inlet immediately upstream of the beginning of this dike type should be evaluated. This low dike can be traversed by a vehicle and allows the area beyond the surfaced shoulder to be used as an emergency recovery and parking area. The Type C dike is the only dike that may be used in front of guardrail. In such cases, it is not necessary to place compacted embankment material behind Type C dike.
- (3) *Type D Dike.* This 6-inch high dike provides about the same capacity as the Type A dike but has the same shape as the Type E dike. The quantity of material in the Type D dike is more than twice that of a Type E dike. It should only be used where there is a need to contain higher volumes of drainage. Compacted embankment material should be placed behind the back of dike as shown in Figure 303.3. For RRR projects that do not widen pavement, compacted embankment material may be omitted on existing fill slopes steeper than 3:1 when there is insufficient room to place the embankment material.
- (4) *Type E Dike.* This 4-inch high dike provides more capacity than the Type C dike. Because Type E dike is easier to construct than Type D dike, and has greater drainage capacity than Type C dike, it is the preferred dike type for most installations. Compacted embankment material should be placed behind the back of dike as shown in Figure 303.3. For RRR projects that do not widen pavement, compacted embankment material may be omitted on existing fill slopes steeper than 3:1 where there is insufficient room to place the embankment material.
- (5) *Type F Dike.* This 4-inch high dike is to be used where dike is necessary for drainage underneath a guardrail installation. This dike is placed directly under the face of guardrail installations.

303.4 Curb Extensions

- (1) *Bulbouts.* A bulbout is an extension of the sidewalk into the roadway when there is marked on-street parking, see Index 402.3. Bulbouts should comply with the guidance provided in Figures 303.4A and B; noting that typical features are shown and that the specific site conditions need to be taken into consideration. Bulbouts provide queuing space and shorten crossing distances, thereby reducing pedestrian conflict time with mainline traffic. By placing the pedestrian entry point closer to traffic, bulbouts improve visibility between motorists, bicyclists, and pedestrians. They are most appropriate for urban conventional highways and Rural Main Streets with posted speeds 35 miles per hour or less. Curb extensions are not to extend into Class II Bikeways (Bike Lanes). The corner curb radii should be the minimum needed to accommodate the design vehicle, see Topic 404.

When used, bulbouts should be placed at all corners of an intersection. When used at mid-block crossing locations, bulbouts should be used on both sides of the street. The curb face of the bulbout should be setback a minimum of 2 feet as shown in Figures 303.4A and B. See the California MUTCD for on-street parking signs and markings. Landscaping and appurtenant facilities located within a bulbout are to comply per Topic 405.

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Figure 303.4A

Typical Bulbout with Class II Bikeway (Bike Lane)

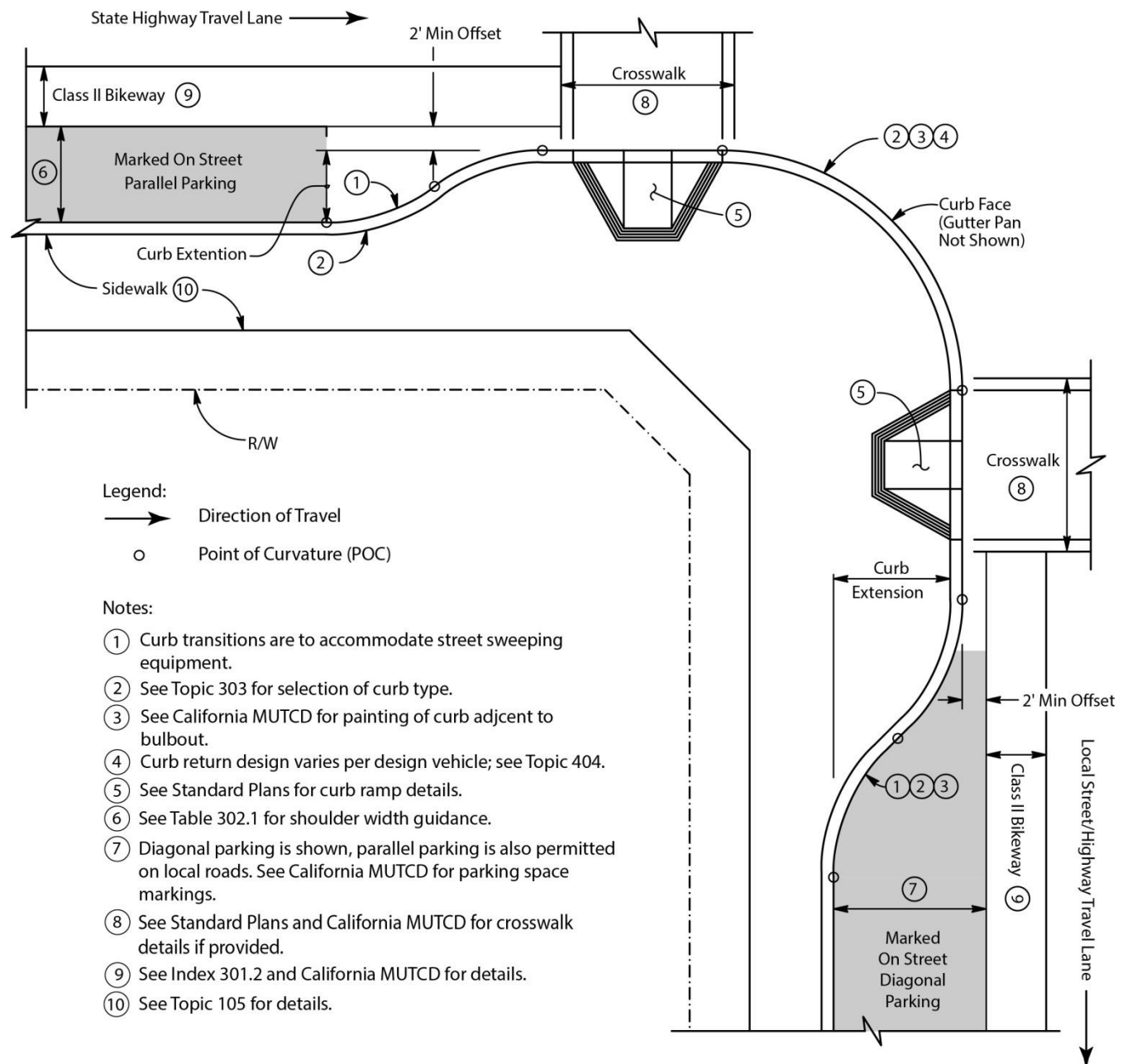
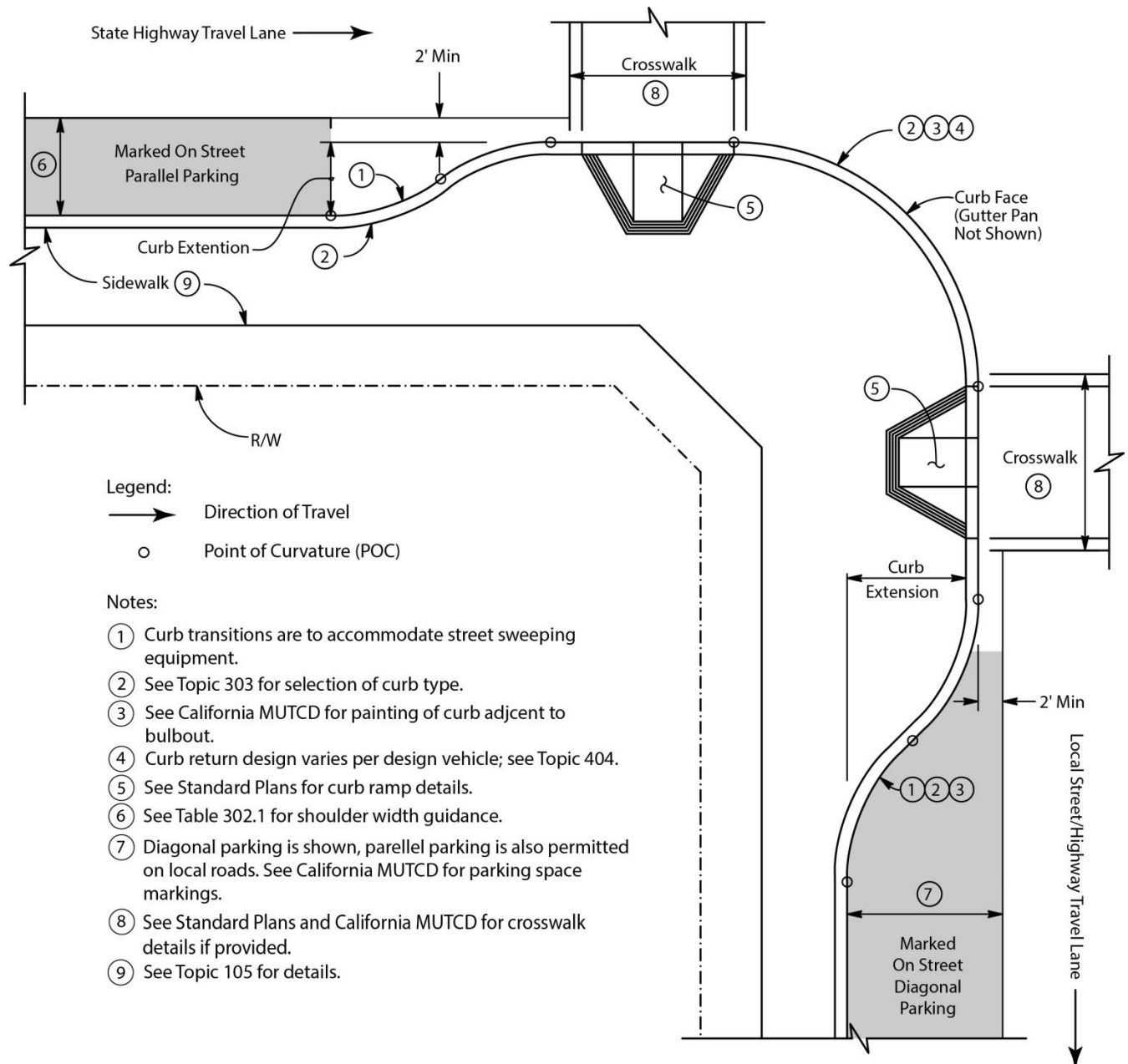


Figure 303.4B

Typical Bulbout without Class II Bikeway (Bike Lane)



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Bulbouts are considered pedestrian facilities and as such, compliance with DIB 82 is required. Avoid bulbouts on facilities where highway grade lines exceed 5 percent.

- (2) *Busbulbs*. A busbulb is a bulbout longer than 25 feet which facilitates bus loading and unloading, and provides for enhanced bus mobility. Busbulbs reduce bus dwell times and provide travel time benefits to transit passengers. However, busbulbs can restrict the mobility of vehicular and bicycle traffic because they allow the bus to stop in their traveled way to load and unload passengers. Therefore, their impact on the mobility of the vehicular and bicycle traffic using the facility must be taken into consideration, and pursuant to the California Vehicle Code, busbulbs or other transit stops which require a transit vehicle to stop in the traveled way require approval from the Department. In lieu of a busbulb, a busbay may be considered which will not impact the mobility of the vehicular and bicycle users of the facility.
- (3) *Busbays*. A busbay is an indentation in the curb which allows a bus to stop completely outside of vehicular and bicycle lanes.

Busbays may be created by restricting on street parking.

303.5 Position of Curbs and Dikes

Curbs located at the edge of the traveled way may have some effect on lateral position and speed of moving vehicles, depending on the curb configuration and appearance. Curbs with low, sloped faces may encourage drivers to operate relatively close to them. Curbs with vertical faces may encourage drivers to slow down and/or shy away from them and, therefore, it may be desirable to incorporate some additional roadway width.

All dimensions to curbs (i.e., offsets) are from the near edge of traveled way to bottom face of curb. All dimensions to dikes are from the near edge of traveled way to flow line. Curb and dike offsets should be in accordance with the following:

- (1) *Through Lanes*. The offset from the edge of traveled way to the face of curb or dike flow line should be no less than the shoulder width, as set forth in Table 302.1.
- (2) *Channelization*. Island curbs used to channelize intersection traffic movements should be positioned as described in Index 405.4.
- (3) *Separate Turning Lanes*. Curb offsets to the right of right-turn lanes in urban areas may be reduced to 2 feet if design exception approval for nonstandard shoulder width has been obtained in accordance with Index 82.2. No curb offset is required to the left of left-turn lanes in urban areas unless there is a gutter pan.
- (4) *Median Openings*. Median openings (Figure 405.5) should not be separated with curb unless necessary to delineate areas occupied by traffic signal standards.
- (5) *Urban Conventional Highways*. When the posted speed is less than or equal to 35 miles per hour, no median curb offset is required if there is no gutter pan.
- (6) *Structure Approach Slabs*. When a dike is required to protect the side slope from erosion, it should be placed on the structure approach and sleeper slabs as well as aligned to tie into the end of the structure railing. The guardrail alignment and edge of shoulder govern the positioning of the dike.

When the Type 14 structure approach slab is used, concrete dikes are preferred. Hot mixed asphalt dike will inevitably crack due to expansion and contraction at the approach/sleeper slab joint. A metal dike insert is used to carry the flow across the sealed joint. The insert acts as a water barrier to minimize erosion of the fill slope. Details of the

metal dike insert are shown in the structure approach plans provided by the Division of Engineering Services, (DES).

- (7) *Bridges and Grade Separation Structures.* When both roadbeds of a curbed divided highway are carried across a single structure, the median curbs on the structure should be in the same location as on adjacent roadways.
- (8) *Approach Nose.* The approach nose of islands should also be designed utilizing a parabolic flare, as discussed in Index 405.4.

303.6 Curbs and Dikes on Frontage Roads and Streets

Continuous curbs or dikes are not necessarily required on all frontage roads. Where curbs or dikes are necessary for drainage control or other reasons, they should be consistent with the guidelines established in this topic and placed as shown on Figure 307.4B. Local curb standards should be used when requested by local authorities for roads and streets that will be relinquished to them.

Topic 304 – Side Slopes

304.1 Side Slope Standards

Slopes should be designed as flat as is reasonable. For new construction, widening, or where slopes are otherwise being modified, embankment (fill) slopes should be 4:1 or flatter. Factors affecting slope design are as follows:

- (a) *Safety.* Flatter slopes provide better recovery for errant vehicles that may run off the road. A cross slope of 6:1 or flatter is suggested for high speed roadways whenever it is achievable. Cross slopes of 10:1 are desirable.

Embankment slopes 4:1 or flatter are recoverable for vehicles. Drivers who encroach on recoverable slopes can generally stop or slow down enough to return to the traveled way safely. See Index 309.1(2) for information on clear recovery zones.

A slope which is between 3:1 and 4:1 is considered traversable, but not recoverable. Since a high percentage of vehicles will reach the toe of these slopes, the recovery area should be extended beyond the toe of slope. The AASHTO Roadside Design Guide should be consulted for methods of determining the preferred extent of the runout area.

Embankment slopes steeper than 3:1 should be avoided when accessible by traffic. District Traffic, and the AASHTO Roadside Design Guide should be consulted for methods of determining the preferred treatment.

Regardless of slope steepness, it is desirable to round the top of slopes so an encroaching user remains in contact with the ground. Likewise, the toe of slopes should be rounded to prevent users from nosing into the ground.

- (b) *Erosion Control.* Slope designs steeper than 4:1 must be approved by the District Landscape Architect in order to assure compliance with the regulations affecting Stormwater Pollution contained in the Federal Clean Water Act (see Index 82.4). Slope steepness and length are two of the most important factors affecting the erodibility of a slope. Slopes should be designed as flat as possible to prevent erosion. However, since there are other factors such as soil type, climate, and exposure to the sun, District Landscape Architecture and the District Stormwater Coordinator must be contacted for erosion control requirements. See Topic 906.

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A Storm Water Data Report (SWDR) documents project information and considerations pertaining to Storm Water Best Management Practices (BMPs) and Erosion Control methods. The SWDR is prepared and signed by key personnel (including the District Landscape Architect) at the completion of each phase of a project. By signing the SWDR, the District Landscape Architect approves compliance with the proposed slope designs.

- (c) *Structural Integrity.* Slopes steeper than 2:1 require approval of District Maintenance. The Geotechnical Design Report (See Topic 113) will recommend a minimum slope required to prevent slope failure due to soil cohesiveness, loading, slip planes and other global stability type failures. There are other important issues found in the Geotechnical Design Report affecting slope design such as the consistency of the soil likely to be exposed in cuts, identification of the presence of ground water, and recommendations for rock fall.
- (d) *Economics.* Economic factors such as purchasing right of way, imported borrow, and environmental impacts frequently play a role in the decision of slope length and steepness. In some cases, the cost of stabilizing, planting, and maintaining steep slopes may exceed the cost of additional grading and right of way to provide a flatter slope.
- (e) *Aesthetics.* Flat, gentle, and smooth, well transitioned slopes are visually more satisfying than steep, obvious cuts and fills. In addition, flatter slopes are more easily revegetated, which helps visually integrate the transportation improvement within its surrounding environment. Contact the District Landscape Architect when preparing a contour grading plan.

Where normal slopes catch in a distance less than 18 feet from the edge of the shoulder, a uniform catch point, at least 18 feet from the edge of the shoulder, should be used. This is done not only to improve errant vehicle recovery and aesthetics, but also to reduce grading costs. Uniform slopes wider than 18 feet can be constructed with large production equipment thereby reducing earthwork costs.

Transition slopes should be provided between adjoining cuts and fills. Such slopes should intersect the ground at the uniform catch point line.

In areas where heavy snowfall can be expected, consideration should be given to snow removal problems and snow storage in slope design. It is considered advisable to use flatter slopes in cuts on the southerly side of the roadway where this will provide additional exposure of the pavement to the sun.

304.2 Clearance From Slope to Right of Way Line

The minimum clearance from the right of way line to catch point of a cut or fill slope should be 10 feet for all types of cross sections. When feasible, at least 15 feet should be provided.

Following are minimum clearances recommended for cuts higher than 30 feet:

- a. Twenty feet for cuts from 30 feet to 50 feet high.
- b. Twenty-five feet for cuts from 50 feet to 75 feet high.
- c. One-third the cut height for cuts above 75 feet, but not to exceed a width of 50 feet.

The foregoing clearance standards should apply to all types of cross sections.

304.3 Slope Benches and Cut Widening

The necessity for benches, their width, and vertical spacing should be finalized only after an adequate materials investigation. Since greater user benefits are realized from widening a cut than from benching the slope, benches above grade should be used only where necessary. Benches above grade should be used for such purposes as installation of horizontal drains, control of surface erosion, or intercepting falling rocks. Design of the bench should be compatible with the geotechnical features of the site.

Benches should be at least 20 feet wide and sloped to form a valley at least 1 foot deep with the low point a minimum of 5 feet from the toe of the upper slope. Access for maintenance equipment should be provided to the lowest bench, and if feasible to all higher benches.

In cuts over 150 feet in height, with slopes steeper than 1½:1, a bench above grade may be desirable to intercept rolling rocks. The Division of Engineering Services – Geotechnical Services (DES-GS) should be consulted for assistance in recommending special designs to contain falling and/or rolling rocks.

Cut widening may be necessary:

- (a) To provide for drainage along the toe of the slope.
- (b) To intercept and store loose material resulting from slides, rock fall, and erosion.
- (c) For snow storage in special cases.
- (d) To allow for planting.

Where the widened area is greater than that required for the normal gutter or ditch, it should be flush with the edge of the shoulder and sloped upward or downward on a gentle slope, preferably 20:1 in areas of no snow; and downward on a 10:1 slope in snow areas.

304.4 Contour Grading and Slope Rounding

Contour grading, slope rounding and topsoil replacement are important factors in roadside design to help make highway improvements compatible with the surrounding environment while comply with National Pollutant Discharge Elimination System permits (NPDES). Smooth, flowing contours that tie gracefully into the existing adjacent roadside and landforms are visually appealing and conducive to safe vehicle recovery (see Index 304.1), reduce the

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potential for erosion and stormwater runoff, and reduce roadside maintenance activities while contributing to the long term success of revegetation planting.

Contour grading plans are to be prepared to facilitate anticipated roadside treatments and future maintenance activities. These plans should show flattened slopes where right of way permits. The tops and ends of all cut slopes should be rounded. Rock cut slopes should be irregular where possible to provide a natural appearance and the tops and ends should also be rounded. All slope designs should include consideration of an application of local or imported topsoil and duff to promote the growth of vegetation, improve stormwater pollutant filtration and control erosion. The calculation of the final grade for a project needs to take into account the reapplication of topsoil and duff.

Local topsoil and duff material within the grading limits should be identified on the plans, removed or excavated, stockpiled, and reapplied. This is to be performed on all projects that include grading or earthwork unless the materials are determined to be unsuitable. Refer to Index 904.2(2).

Coordinate the development of contour grading plans including, removal, stockpiling, suitability of material and application of topsoil and duff with the District Landscape Architect. See Index 904.2.

304.5 Stepped Slopes

Stepped cut slopes should be used to encourage material revegetation from the adjacent plants. Stepped slopes are a series of small benches 1 foot to 2 feet wide. Generally, stepped slopes can be used in rippable material on slopes 2:1 or steeper. Steps may be specified for slopes as flat as 3:1. Steps are provided to capture loose material, seed, and moisture. Topsoil should be reapplied to stepped slopes to encourage revegetation.

For appearance, steps on small cuts viewed from the roadway should be cut parallel to the road grade. Runoff is minimized on steps cut parallel to roads with grades up to 10 percent, as long as the natural ravel from construction is left on the steps. Steps less than one-half full should not be cleaned.

High cuts viewed from surrounding areas should be analyzed before a decision is made to form steps parallel to the roadway or horizontal. In some cases, horizontal steps may be more desirable. Special study is also necessary when a sag occurs in the vertical alignment within the cut. In all cases at the ends of cuts, the steps should wrap around the rounded transition.

The detail or contract special provisions should allow about a 20 percent variation, expressed in terms of tenths of a foot. Some irregularity will improve the appearance of the slope by making it appear more natural.

In designing step width, the material's weathering characteristics should generally be considered. Widths over approximately 2 feet should be avoided because of prominence and excessive time to achieve a weathered and natural appearance. Contact the DES-GS and the District Landscape Architect for more information about the width of steps.

Topic 305 – Median Standards

305.1 Width

Median width is expressed as the dimension between inside edges of traveled way, including the inside shoulder. This width is dependent upon the type of facility, costs, topography, and right of way. Consideration may be given to the possible need to construct a wider median than prescribed in Cases (1), (2), and (3), below, in order to provide for future expansion to accommodate:

- a. Public Transit (rail and bus).
- b. Traffic needs more than 20 years after completion of construction.

Median width as presented in Case (1) below applies to new construction, projects to increase mainline capacity and to reconstruction projects. Any recommendation to provide additional median width should be identified and documented as early as possible and must be justified in a project initiation document and/or project report. Attention should be given to such items as initial costs, future costs for outside widening, the likelihood of future needs for added mixed flow or High-Occupancy Vehicle (HOV) lanes, traffic interruption, future mass transit needs and right of way considerations. (For instance, increasing median width may add little to the cost of a project where an entire city block must be acquired in any event.)

Median pedestrian refuge areas at intersections lessen the risk of pedestrian exposure to traffic. See Index 405.4(3) and DIB 82 for pedestrian refuge guidance.

If additional width is justified, the minimum median widths provided below should be increased accordingly.

Minimum median widths for the design year (as described below) should be used in order to accommodate the ultimate highway facility (type and number of lanes):

(1) Freeways and Expressways.

- (a) Urban Areas. Where managed lanes (HOV, Express, etc) or transit facilities are planned, the minimum median width should be 62 feet. Where there is little or no likelihood of managed lanes or transit facilities planned for the future, the minimum median width should be 46 feet. However, where physical and economic limitations are such that a 46-foot median cannot be provided at reasonable cost, the

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minimum median width for multilane freeways and expressways in urban areas should be 36 feet.

- (b) Rural Areas. The minimum median width for multilane freeways and expressways in rural areas should be 62 feet.

- (2) *Conventional Highways.* Appropriate median widths for non-controlled access highways vary widely with the type of facility being designed. In Urban and Rural Main Street areas, the minimum median width for multilane conventional highways should be 12 feet. However, this width would not provide room for left-turn lanes at intersections with raised curb medians, nor left-turn lanes in striped medians with room for pedestrian refuge areas. Posted speed and left shoulder width can also affect median width. See Table 302.1.

Medians refuge areas at pedestrian crosswalks and bicycle path crossings provide a space for pedestrians and bicyclists. They allow these users to cross one direction of traffic at a time. Where medians are provided, they should allow access through them for pedestrians and bicyclists as necessary. Bicycle crossings through paved medians should line up with the bicycle path of travel and not require bicyclists to utilize the pedestrian crosswalk. See Index 405.4 for additional requirements.

Where medians are provided for proposed future two-way left-turn lanes, median widths up to 14 feet may be provided to conform to local agency standards (see Index 405.2). **In rural areas the minimum median width for multilane conventional highways shall be 12 feet.** This provides the minimum space necessary to accommodate a median barrier and 5-foot shoulders. Whenever possible, and where it is appropriate, this minimum width should be increased to 30 feet or greater.

At locations where a climbing or passing lane is added to a 2-lane conventional highway, a 4-foot median (or "soft barrier") between opposing traffic lanes should be used.

- (3) *Facilities under Restrictive Conditions.* Where certain restrictive conditions, including steep mountainous terrain, extreme right of way costs, and/or significant environmental factors are encountered, the basic median widths above may not be attainable. Where such conditions exist, a narrower median, down to the limits given below, may be allowed with adequate justification. (See Index 307.5.)

- (a) Freeways and Expressways. **In areas where restrictive conditions prevail the minimum median width shall be 22 feet.**

- (b) Conventional Highways. Median widths should be consistent with requirements for two-way left-turn lanes or the need to construct median barriers (as discussed in Index 305.1(2)), but may be reduced or eliminated entirely in extreme situations.

The above stated minimum median widths should be increased at spot locations to accommodate the construction of bridge piers or other planned highway features while maintaining standard cross section elements such as inside shoulder width and horizontal clearance. If a bridge pier is to be located in a tangent section, the additional width should be developed between adjacent horizontal curves; if it is to be located in a curve, then the additional width should be developed within the limits of the curve. Provisions should be made for piers 6 feet wide or wider. Median widths in areas of multilevel interchanges or other major structures should be coordinated with the Division of Engineering Services, Structures Design (DES-SD).

Consideration should also be given to increasing the median width at unsignalized intersections on expressways and divided highways in order to provide a refuge area for large trucks attempting to cross the State route.

In any case, the median width should be the maximum attainable at reasonable cost based on site specific considerations of each project.

See Index 613.4(2)(b) for paved median pavement structure requirements.

305.2 Median Cross Slopes

Unsurfaced medians up to 65 feet wide should be sloped downward from the adjoining shoulders to form a shallow valley in the center. Cross slopes should be 10:1 or flatter; 20:1 being preferred. Slopes as steep as 6:1 are acceptable in exceptional cases when necessary for drainage, stage construction, etc. Cross slopes in medians greater than 65 feet should be treated as separate roadways (see Index 305.6).

Paved medians, including those bordered by curbs, should be crowned at the center, sloping towards the sides at the slope of the adjacent pavement.

305.3 Median Barriers

See Traffic Safety Systems Guidance.

305.4 Median Curbs

See Topic 303 for curb types and usage in medians and Index 405.5(1) for curbs in median openings.

305.5 Paved Medians

(1) *Freeways.*

(a) 6 or More Lanes--Medians 30 feet wide or less should be paved.

(b) 4 Lanes--Medians 22 feet or less in width should be paved. Medians between 22 feet and 30 feet wide should be paved only if a barrier is installed. With a barrier, medians wider than 30 feet should not normally be paved.

Where medians are paved, each half generally should be paved in the same plane as the adjacent traveled way.

(2) *Nonfreeways.* Unplanted curbed medians generally are to be surfaced with minimum 0.15 foot of Portland cement concrete.

For additional information on median cross slopes see Index 305.2.

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305.6 Separate Roadways

- (1) *General Policy.* Separate grade lines are not considered appropriate for medians less than 65 feet wide (see Index 204.7).
- (2) *Median Design.* The cross sections shown in Figure 305.6 include a clear recovery zone that provides maneuvering room for out-of-control users. See Index 309.1(2).

See Index 302.1 for shoulder widths and Index 302.2 for shoulder cross slopes.

Topic 306 – Right of Way

306.1 General Standards

The right of way widths for State highways, including frontage roads to be relinquished, should provide for installation, operation and maintenance of all cross section elements needed depending upon the type of facility, including median, traffic lanes, bicycle lanes, outside shoulders, sidewalks, recovery areas, slopes, sight lines, outer separations, ramps, walls, transit facilities and other essential highway appurtenances. For minimum clearance from the right of way line to the catch point of a cut or fill slope, see Index 304.2. Fixed minimum widths of right of way, except for 2-lane highways, are not specified because dimensions of cross-sectional elements may require narrow widths, and right of way need not be of constant width. The minimum right of way width on new construction for 2-lane highways should be 150 feet.

306.2 Right of Way Through the Public Domain

Right of way widths to be obtained or reserved for highway purposes through lands of the United States Government or the State of California are determined by laws and regulations of the agencies concerned.

Topic 307 – Cross Sections for State Highways

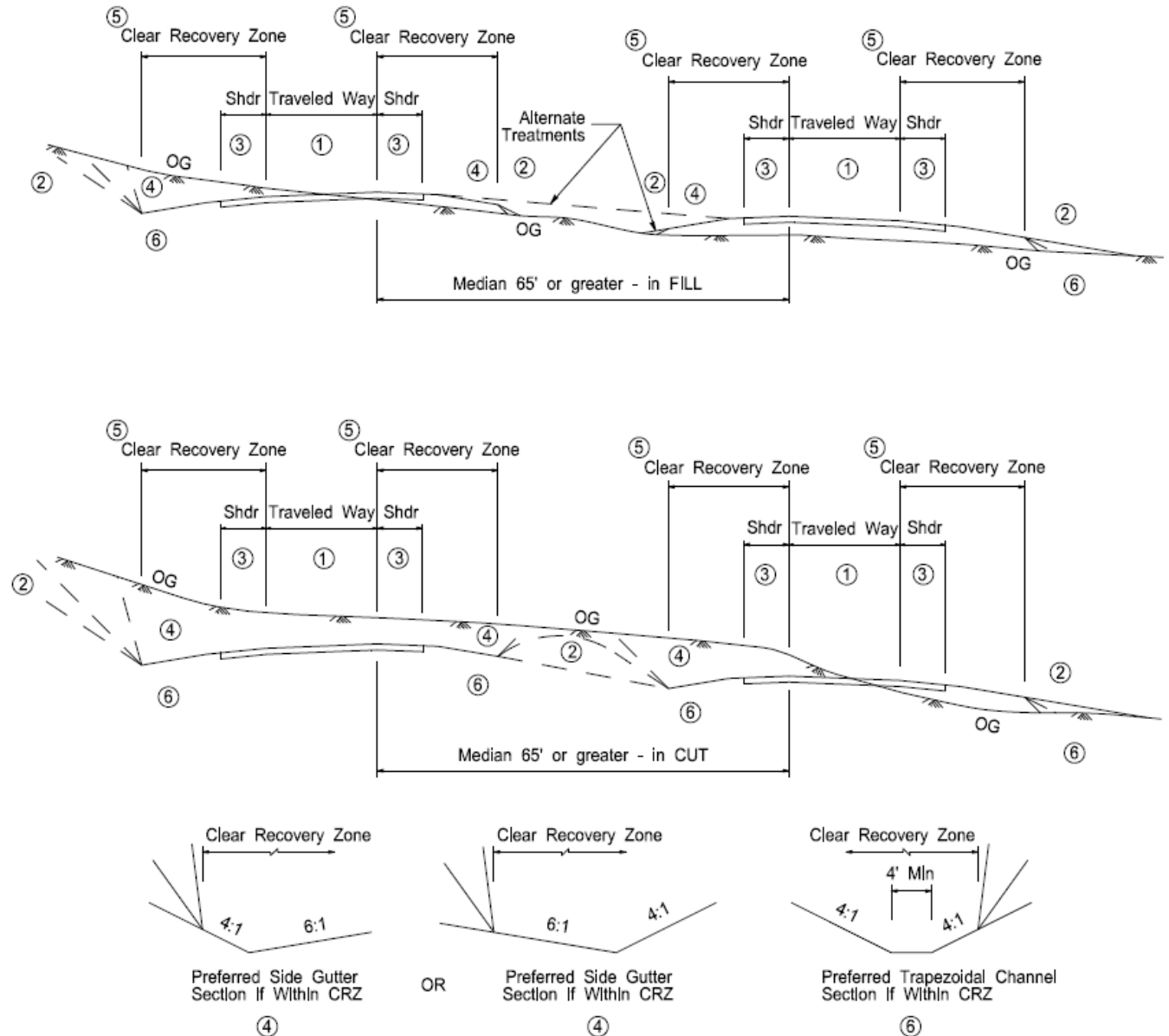
307.1 Cross Section Selection

The cross section of a State highway is based upon the number of vehicles, including trucks, buses, bicycles, and safety, terrain, transit needs and pedestrians. Other factors such as sidewalks, bike paths and transit facilities, both existing and future should be considered. For 2-lane roads the roadbed width is influenced by the factors discussed under Index 307.2. The roadbed width for multilane facilities should be adequate to provide capacity for the design hourly volume based upon capacity considerations discussed under Index 102.1.

When it becomes necessary to widen an existing cross section, e.g., add or widen the paved shoulder or lane, refer to Index 653.2 and Index 662.3 to ensure proper drainage of both the existing and widening structural sections. See also Chapter 680, Pavement Design for Widening Projects.

Figure 305.6

Optional Median Designs for Freeways with Separate Roadways



NOTES:

- | | | | |
|------------------|-----------------|-----------------------|--------------------|
| ① CROSS SLOPES | See Index 302.2 | ④ SIDE GUTTERS | See Index 834.3(3) |
| ② SIDE SLOPES | See Index 304.1 | ⑤ CLEAR RECOVERY ZONE | See Index 309.1(2) |
| ③ SHOULDER WIDTH | See Index 302.1 | ⑥ ROADSIDE CHANNELS | See Topic 860 |

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307.2 Two-lane Cross Sections for New Construction

These standards are to be used for highways on new alignment as well as on existing highways where the width, alignment, grade, or other geometric features are being upgraded.

A 2-lane, 2-way roadbed consists of a 24-foot wide traveled way plus paved shoulders. In order to provide structural support, the minimum paved width of each shoulder should be 2 feet. Shoulders less than 4 feet are not adequate for bicycles. Where 4-foot shoulders are not possible, consideration should be given to providing turnouts for bicycles. See Index 204.5(4) for turnout information. See Topic 1003 and Index 301.2 for information on bicycle design criteria and Figure 307.2 for typical 2-lane cross sections.

Shoulder widths based on design year traffic volumes shall conform to the standards given in Table 307.2.

Table 307.2

Shoulder Widths for Two-lane Roadbed New Construction Projects

Two-way ADT (Design Year)	Shoulder Width ⁽¹⁾ (ft)
Less than 400	4 ⁽²⁾
Over 400	8 ⁽³⁾

NOTES:

(1) See Index 302.1 for shoulder requirements when bike lanes are present.

(2) Minimum bridge width is 32 feet (see Index 208.1).

(3) See Index 405.3(2)(a) for shoulder requirements adjacent to right-turn only lanes.

On 2-lane roads with 4-foot shoulders, the shoulder slope may be increased to 7 percent for additional drainage capacity where a dike is used. A design exception to Index 302.2 will be required to document the decision to increase the slope.

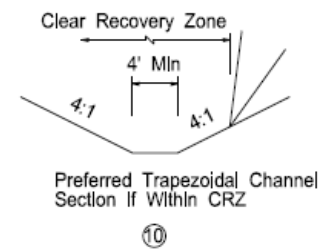
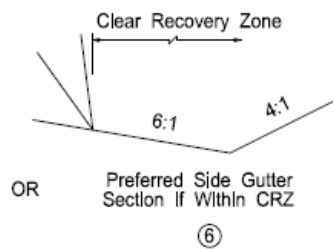
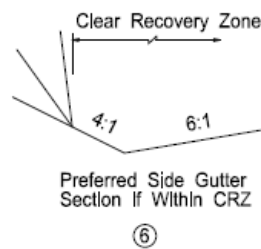
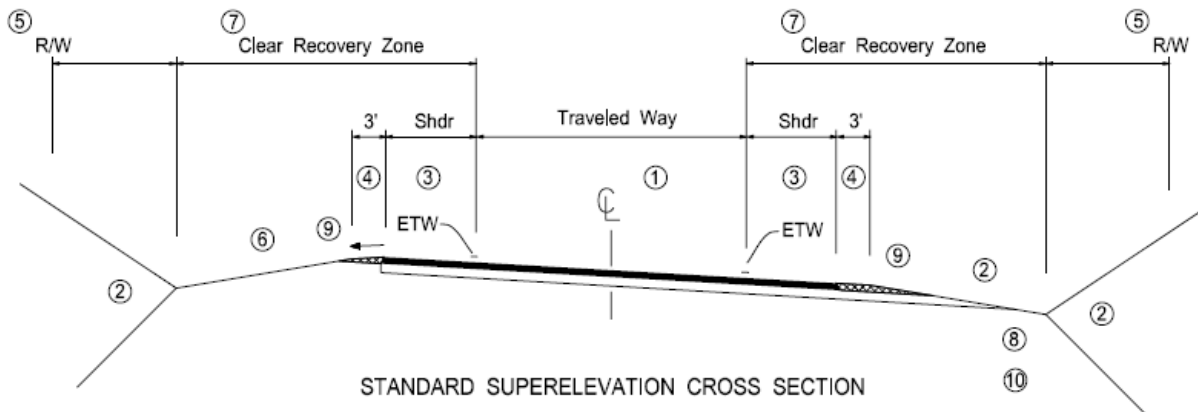
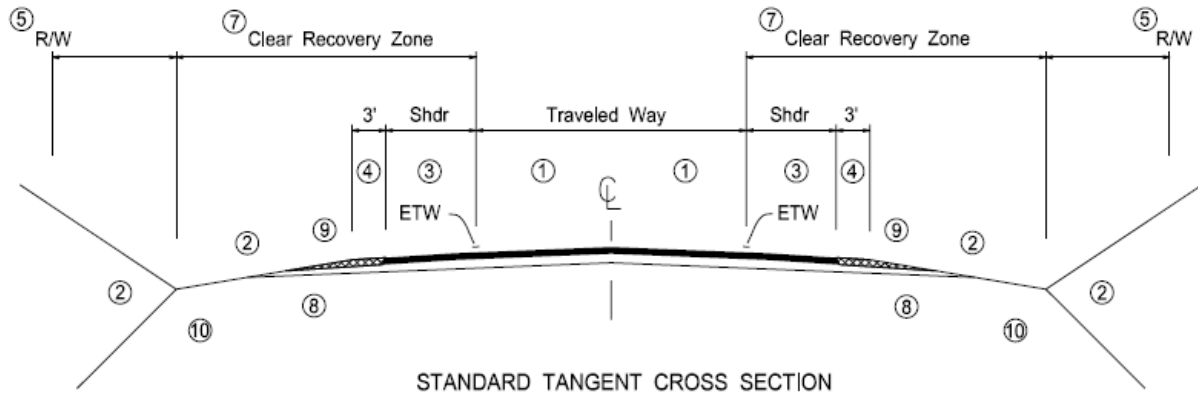
Bicycles are not prohibited on conventional highways: therefore, where the shoulder width is 4 feet, the gutter pan width should be reduced to 1 foot, so 3 feet is provided between the traffic lane and the longitudinal joint at the gutter pan. Whenever possible, grate type inlets should not be located in bicycle paths of travel. See Index 837.2(2) for further grate guidance.

307.3 Two-lane Cross Sections for 2R, 3R, and other Projects

Standards and guidelines for two-lane cross sections on resurfacing and restoration (2R) projects and resurfacing, restoration, and rehabilitation (3R) projects are found in DIB 79 and Index 603.4. DIB 79 also includes screening criteria to determining whether the project fits 2R or 3R.

Figure 307.2

Geometric Cross Sections for Two-lane Highways (New Construction)



NOTES:

- ① CROSS SLOPES See Index 302.2
- ② SIDE SLOPES See Index 304.1
- ③ SHOULDER WIDTH See Index 302.1
- ④ DIKE PLACEMENT See Index 303.3
- ⑤ RIGHT OF WAY See Index 306.1 and Index 304.2

- ⑥ SIDE GUTTERS See Index 834.3(3)
- ⑦ CLEAR RECOVERY ZONE See Index 309.1(2)
- ⑧ PAVEMENT DRAINAGE See Indexes 653.1, 653.2, 662.3
- ⑨ SHOULDER BACKING See Index 672
- ⑩ ROADSIDE CHANNELS See Topic 860

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3R design criteria apply to all structure and roadway 3R projects on two-lane conventional highways and three-lane conventional highways not classified as multilane conventional highways.

3R design criteria also apply to certain storm damage, protective betterment, operational, and safety nonfreeway improvement projects that are considered spot locations as described in detail in DIB 79.

3R criteria apply to geometric design features such as lane and shoulder widths, horizontal and vertical alignment, stopping sight distance, structure width, cross slope, superelevation, side slope, clear recovery zone, curb ramps, pavement edge drop, dike, curb and gutter, and intersections. They may also apply to such features as bike lanes, sidewalk, and drainage.

307.4 Multilane Divided Cross Sections

The general geometric features of multilane divided cross sections are shown in Figures 307.4A and B.

Divided highways may be designed as two separate one-way roads where appropriate to fit the terrain. Economy, pleasing appearance, and safety are factors to be considered in this determination. The alignment of each roadway may be independent of the other (see Indexes 204.8 and 305.6). Optional median designs may be as shown on Figure 305.6. See Index 309.1 (2) for Clear Recovery Zone.

307.5 Multilane All Paved Cross Sections with Special Median Widths

A multilane cross section with a narrow median is illustrated in Figure 307.5. This section is appropriate in special circumstances where a wider median would not be justified. It should not be considered as an alternative to sections with the median widths set forth under Index 305.1. It may be used under the following conditions:

- (a) Widening of existing facilities.
- (b) Locations where large excavation quantities would result if a multilane roadway cross section with a basic median width were used. Examples are steep mountainous terrain and unstable mountainous areas.
- (c) As an alternate cross section on 2-lane roads having frequent sight distance restrictions.

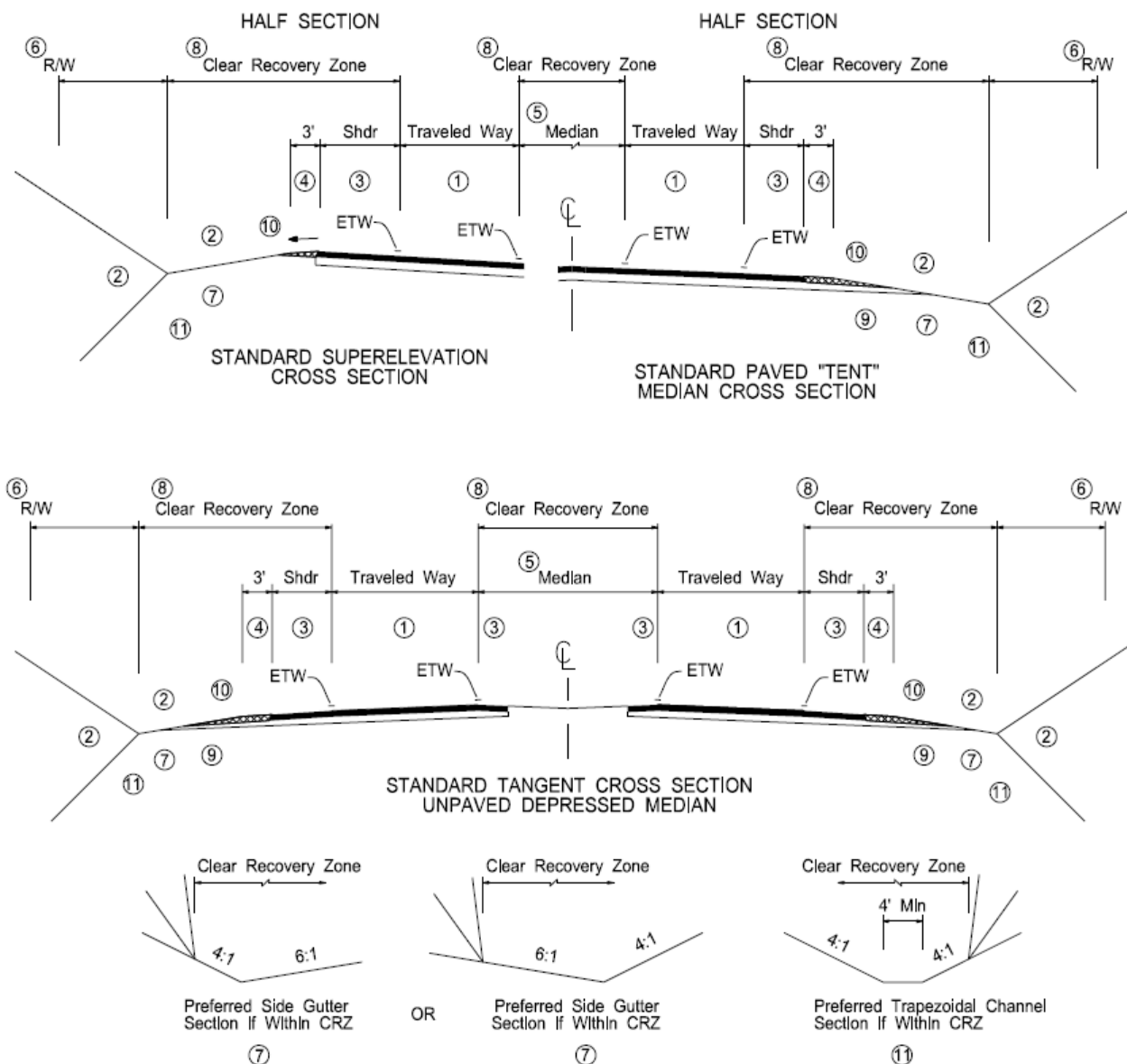
The median width should be selected in accordance with the criteria set forth in Index 305.1(3).

In general, the outside shoulder should be 8 feet wide (10 feet on freeways and expressways) as mandated in Table 302.1. Where large excavation quantities or other factors generate unreasonable costs, 4-foot shoulders may be considered.

However, a design exception is required except where 4-lane passing sections are constructed on 2-lane highways. Where the roadbed width does not contain 8-foot shoulders, emergency parking areas clear of the traveled way should be provided by using daylighted cuts and other widened areas which develop during construction.

Figure 307.4A

Geometric Cross Sections for Freeways and Expressways



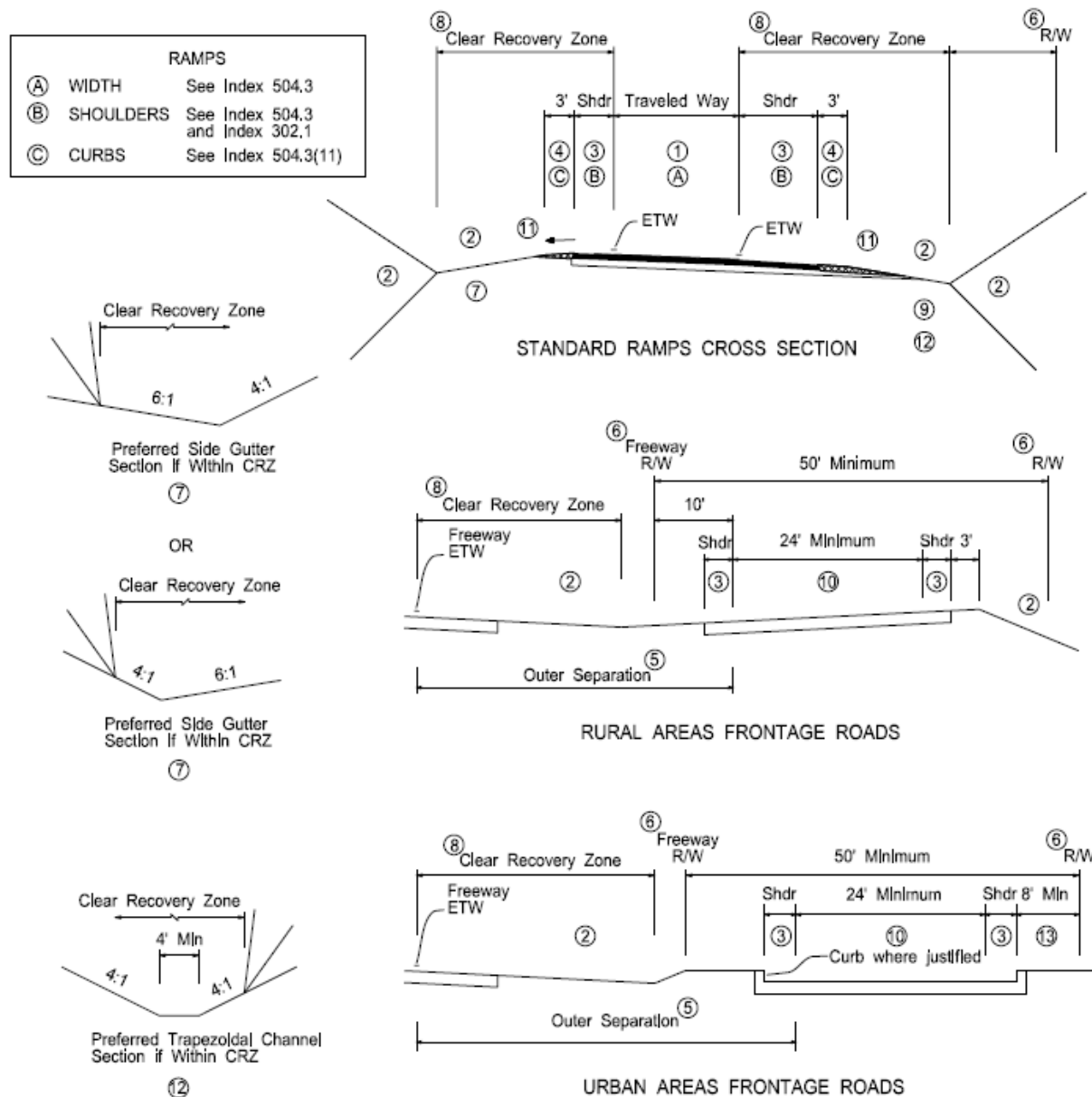
NOTES:

① CROSS SLOPES	See Index 302.2	⑥ RIGHT OF WAY	See Indexes 306.1, 304.2
② SIDE SLOPES	See Index 304.1 and Index 304.2	⑦ SIDE GUTTERS	See Index 834.3(3)
③ SHOULDERS WIDTH PAVING	See Index 302.1 and Index 613.5(2)	⑧ CLEAR RECOVERY ZONE	See Index 309.1(2)
④ DIKES	See Index 303.3	⑨ PAVEMENT DRAINAGE	See Indexes 653.1, 653.2, 662.3
⑤ MEDIANS WIDTH SLOPES PAVING SEPARATE ROADWAYS	See Index 305.1 See Index 305.2 See Index 305.5 See Index 305.6	⑩ SHOULDER BACKING	See Index 672
		⑪ ROADSIDE CHANNELS	See Topic 860

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Figure 307.4B

Geometric Cross Sections for Freeways and Expressways



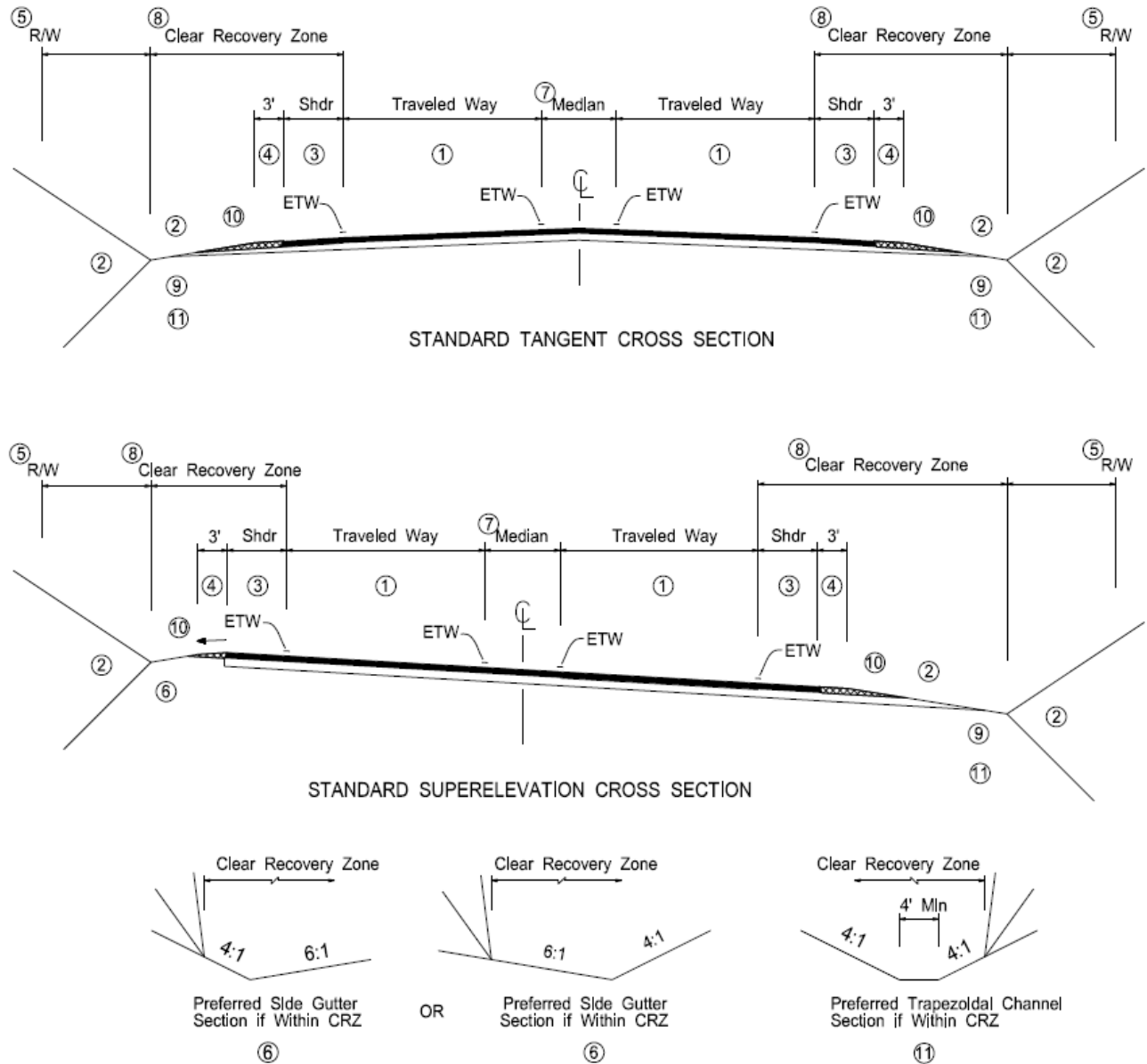
NOTES:

- (1) CROSS SLOPES See Index 302.2
(2) SIDE SLOPES See Index 304.1 and Index 304.2
(3) SHOULDERS WIDTH See Index 302.1
PAVING See Index 613.5(2)
(4) DIKES See Index 302.2
(5) OUTER SEPARATION See Index 310.2

- (6) RIGHT OF WAY See Indexes 306.1, 304.2
(7) SIDE GUTTERS See Index 834.3(3)
(8) CLEAR RECOVERY ZONE See Index 309.1(2)
(9) PAVEMENT DRAINAGE See Indexes 653.1, 653.2, 662.3
(10) CROSS SECTION See Index 310.1
(11) SHOULDER BACKING See Index 672
(12) ROADSIDE CHANNELS See Topic 860
(13) SIDEWALKS See Index 105.2

Figure 307.5

Geometric Cross Sections for All Paved Multilane Highways



NOTES:

- | | | |
|---|----------------|---------------------------------|
| ① | CROSS SLOPES | See Index 302.2 |
| ② | SIDE SLOPES | See Index 304.1 |
| ③ | SHOULDER WIDTH | See Index 302.1 |
| ④ | DIKES | See Index 303.3 |
| ⑤ | RIGHT OF WAY | See Index 306.1 and Index 304.2 |

- | | | |
|---|---------------------|---------------------------------|
| ⑥ | SIDE GUTTERS | See Index 834.3(3) |
| ⑦ | MEDIANS | See Index 305.1(3) |
| ⑧ | CLEAR RECOVERY ZONE | See Index 309.1(2) |
| ⑨ | PAVEMENT DRAINAGE | See Indexes 653.1, 653.2, 662.3 |
| ⑩ | SHOULDER BACKING | See Index 672 |
| ⑪ | ROADSIDE CHANNELS | See Topic 860 |

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307.6 Multilane Cross Sections for 2R and 3R Projects

3R projects on freeways, expressways, and multilane conventional highways are required to meet new construction standards. See Index 309.1 (2) for Clear Recovery Zone.

For additional information on 2R and 3R projects, see DIB 79.

307.7 Reconstruction Projects

Reconstruction projects on freeways, expressways, and conventional highways are required to meet new construction standards.

Topic 308 – Cross Sections for Roads Under Other Jurisdictions

308.1 City Streets and County Roads

The minimum width of local roads and streets that are to be reconstructed as part of a freeway or expressway project should conform to locally adopted standards except as described below.

Where a local facility, not on the NHS, within the State right of way crosses over or under a freeway or expressway but has no connection to the State facility, the minimum design standards for the cross section of the local facility within the State's right of way shall be the local agency adopted standards. If the local facility is on the NHS, AASHTO standards will apply. If the local agency has standards that exceed AASHTO standards, then the local agency standards can apply. See the Local Assistance Procedures Manual Chapter 11 for information on design guidance and documentation of design decisions for local assistance projects.

AASHTO standards for local roads and streets are given in AASHTO, A Policy on Geometric Design of Highways and Streets. These standards relate to the functional classification and system characteristics of the local roadway system. See Chapter 1 of these standards for information on the functional classification and system characteristics of roadways.

AASHTO, A Policy on Geometric Design of Highways and Streets, gives minimum lane and shoulder widths. When selecting a cross section, the effects on capacity of commercial vehicles and grades should be considered as discussed under Topic 102 and in the Transportation Research Board, Highway Capacity Manual.

The minimum width of 2-lane overcrossing structures shall not be less than 32 feet face of curb to face of curb.

If the local agency has definite plans to widen the local street either concurrently or within 5 years following freeway construction, the reconstruction to be accomplished by the State should generally conform to the widening planned by the local agency. Stage construction should be considered where the planned widening will occur beyond the 5-year period following freeway construction or where the local agency has a master plan indicating an

ultimate width greater than the existing facility. Where an undercrossing is involved, the initial structure construction should provide for ultimate requirements.

Where a local facility crosses over or under a freeway or expressway and connects to the State facility (such as ramp terminal intersections), the minimum design standards for the cross section of the local facility shall be at least equal to those for a conventional highway with the exception that the outside shoulder width shall match the approach roadway, but not less than 4 feet, and as shown below.

Where the 2-lane local facility connects to a freeway within an interchange, the lane width of the local facility shall be 12 feet.

Where a multilane local facility connects to a freeway within an interchange, the outer most lane in each direction of the local facility shall be 12 feet.

Shoulder width shall not be less than 5 feet when railings or other lateral obstructions are adjacent to the right edge of shoulder.

If gutter pans are used, then the minimum shoulder width shall be 3 feet wider than the width of the gutter pan being used.

The minimum width for two-lane overcrossing structures at interchanges shall be 40 feet curb-to-curb.

Topic 309 – Clearances

309.1 Horizontal Clearances for Highways

- (1) *General.* The horizontal clearance to all roadside objects should be based on engineering judgment with the objective of maximizing the distance between roadside objects and the edge of traveled way. Engineering judgment should be exercised in order to balance the achievement of horizontal clearance objectives and reduction of maintenance cost and exposure to workers, with the prudent expenditure of available funds.

Certain yielding types of fixed objects, such as sand filled barrels, guardrail, breakaway wood posts, etc. may encroach within the clear recovery zone (see Index 309.1(2)). While these objects are designed to reduce the severity of accidents, efforts should be made to maximize the distance between any object and the edge of traveled way.

Horizontal clearances are measured from the edge of the traveled way to the nearest point on the obstruction (usually the bottom). Consideration should be given to the planned ultimate traveled way width of the highway facility. **Horizontal clearances greater than those cited below under Subsection (3) - "Minimum Clearances" shall be provided where necessary to meet horizontal stopping sight distance requirements.** See subsection (4) for high speed rail clearance guidance. See discussion on "... technical reductions in design speed..." under Topic 101.

- (2) *Clear Recovery Zone (CRZ).* The roadside environment can and should be made as safe as practical. A clear recovery zone is an unobstructed, relatively flat (4:1 or flatter) or gently sloping area beyond the edge of the traveled way which affords the drivers of errant vehicles the opportunity to regain control. For embankment slopes, a clear recovery zone of 4:1 or flatter should apply on all highways with distances referenced in Subsection (2)(a), except if guardrail or barrier is provided. Dike, curb and gutter are acceptable within the clear recovery zone, but there are limitations if used with guardrail. See the

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Traffic Safety Systems Guidance for information on guardrail and barrier placement. The AASHTO Roadside Design Guide provides detailed design guidance for creating a forgiving roadside environment. See also Index 304.1 regarding side slopes.

See DIB 79 for 2R, 3R, certain storm damage, protective betterment, operational, and safety projects on two-lane and three-lane conventional highways.

The following clear recovery zone widths are the minimum desirable for the type of facility indicated. Consideration should be given to increasing these widths based on traffic volumes, operating speeds, terrain (e.g., steeper than 4:1), horizontal curvature, and costs associated with a particular highway facility:

- Freeways and Expressways – 30 feet
- Conventional Highways – 20 feet*

*On conventional highways with posted speeds less than or equal to 35 miles per hour and curbs, clear recovery zone widths do not apply. See minimum horizontal clearance, Index 309.1(3)(c).

(a) Necessary Highway Features.

Fixed objects, when they are necessary highway features, including, but not limited to, bridge piers, abutments, retaining walls, and noise barriers closer to the edge of traveled way than the distances listed above should be eliminated, moved, redesigned to be made yielding, or shielded in accordance with the following guidelines:

- Fixed objects, when they are necessary highway features, should be eliminated or moved outside the clear recovery zone to a location where they are unlikely to be hit.
- If necessary highway features such as sign posts or light standards cannot be eliminated or moved outside the clear recovery zone, they should be made yielding with a breakaway feature.
- If a fixed object, when they are necessary highway features, cannot be eliminated, moved outside the clear recovery zone, or modified to be made yielding, it should be shielded by guardrail, barrier or a crash cushion.

Shielding and breakaway features must be in conformance with the guidance found in Traffic Safety Systems Guidance. For input on the need for shielding at a specific location, consult District Traffic Operations.

Existing above-ground utilities and existing large trees as defined in Index 904.5(1) should conform to the guidance associated with necessary highway features stated above. When the planting of trees is being considered, see the additional discussion and standards in Chapter 900.

(b) Discretionary Fixed Objects.

Discretionary fixed objects are features or facilities that are not necessary for the safety, maintenance or operation of the highway, but may enhance livability and sustainability. These may include, but are not limited to, transportation art, gateway monuments, solar panels, and memorial/historical plaques or markers. See Subsection (4) for high speed rail clearance guidance. When discretionary fixed objects are constructed on freeways, expressways or conventional highways, they should be located beyond the clear recovery zone at a minimum of 52 feet horizontally or 8 feet vertically up-slope from the planned ultimate edge of traveled way. However, if discretionary fixed objects are to be placed less than the 52 feet horizontally or less than the 8 feet vertically up-slope, they should be made breakaway or shielded behind existing guardrail, barrier or other safety device.

Shielding and breakaway features must be in conformance with the guidance found in Traffic Safety Systems Guidance. For input on the need for shielding at a specific location, consult District Traffic Operations.

Where compliance with the guidelines stated in Subsections (2)(a) and (b) are impractical, the minimum horizontal clearance cited in Subsection (3) Minimum Clearances shall apply to the unshielded fixed object. These minimum horizontal clearances apply to yielding objects as well.

(3) *Minimum Clearances.* **The following minimum horizontal clearances shall apply to all objects that are closer to the edge of traveled way than the clear recovery zone distances listed above:**

- (a) **The minimum horizontal clearance to all objects, such as bridge rails and safety-shaped concrete barriers, as well as sand-filled barrels, guardrail, etc., on all freeway and expressway facilities, including auxiliary lanes, ramps, and collector-distributor roads, shall be equal to the standard shoulder width of the highway facility as stated in Table 302.1. A minimum clearance of 4 feet shall be provided where the standard shoulder width is less than 4 feet. Approach rail connections to bridge rail may require special treatment to maintain the standard shoulder width.**
- (b) **The minimum horizontal clearance to walls, such as abutment walls, retaining walls in cut locations, and noise barriers on all facilities, including auxiliary lanes, ramps and collector-distributor roads, shall not be less than 10 feet per Table 302.1.**
- (c) **On conventional highways, frontage roads, city streets and county roads within the State right of way (all without curbs), the minimum horizontal clearance shall be the standard shoulder width as listed in Tables 302.1 and 307.2, except that a minimum clearance of 4 feet shall be provided where the standard shoulder width is less than 4 feet. For RRR projects, widths are provided in DIB 79.**

On conventional highways with curbs, typically in urban conditions, a minimum horizontal clearance of 1 foot 6 inches should be provided beyond the face of curbs to any obstruction. On curbed highway sections, a minimum clearance of 3 feet should be provided along the curb returns of intersections and near the edges of driveways to allow for design vehicle offtracking (see Topic 404). Where sidewalks are located immediately adjacent to curbs, fixed objects should be located beyond the back of sidewalk to provide an unobstructed area for pedestrians.

In areas without curbs, the face of Type 60 concrete barrier should be constructed integrally at the base of any retaining, pier, or abutment wall which faces traffic and is

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15 feet or less from the edge of traveled way (right or left of traffic and measured from the face of wall). See Index 1102.2 for the treatment of noise barriers.

The minimum width of roadway openings between Temporary Barrier System on bridge deck widening projects should be obtained from the HQ Transportation Permit Program.

The HQ Transportation Permit Program must be consulted on the use of the route by overwidth loads.

See Traffic Safety Systems Guidance for other requirements pertaining to clear recovery zone, guardrail at fixed objects and embankments, and crash cushions.

- (4) *High Speed Rail Clearances.* When a high speed rail corridor is to be constructed longitudinally to a freeway, expressway or a conventional highway with posted speeds over 40 miles per hour, the nearest fixed object or feature associated with the operation of the rail facility should be located a minimum of 52 feet horizontally from the planned ultimate edge of the traveled way. **The minimum shoulder width adjacent to barrier (longitudinal to the high speed rail) shall be 10 feet, in addition to the fixed objects in Table 302.1 Note (8).** See Index 62.10 for the definition of high speed rail. The terrain and the required highway features between the edge of traveled way and the rail facility to be constructed must be evaluated to determine on a case-by-case basis whether or not shielding behind guardrail, barrier or other safety device in conformance with the guidance found in Traffic Safety Systems Guidance is needed. For input on the need for shielding at a specific location, consult District Traffic Operations.

- (5) *Other Transportation Facilities.* Contraflow BRT, light rail facilities, and heavy rail facilities are considered fixed objects and the clearances noted in Index 309.1 apply.

Parallel BRT facilities are preferred to have the following minimum separation between lanes:

- Freeways and Expressways** – 4 feet
- Conventional Highways (see also Index 108.5)
 - Posted Speeds over 40 miles per hour – 4 feet
 - Posted Speeds equal or greater than 25 miles per hour and up to 45 miles per hour in an urban environment –2 feet, with curbed separation, 4 feet with 2-foot curbed separation recommended.

**See “A Guide for HOT Lane Development”, FHWA, and Caltrans High Occupancy Vehicle Guidelines for additional information.

309.2 Vertical Clearances

(1) Major Structures.

- (a) Freeways and Expressways, All construction except overlay projects – **16 feet 6 inches shall be the minimum vertical clearance over the roadbed of the State facility (e.g., main lanes, shoulders, ramps, collector-distributor roads, speed change lanes, etc.).**
- (b) Freeways and Expressways, Overlay Projects – **16 feet shall be the minimum vertical clearance over the roadbed of the State facility.**
- (c) Conventional Highways, Parkways, and Local Facilities, All Projects – **15 feet shall be the minimum vertical clearance over the traveled way and 14 feet 6 inches**

shall be the minimum vertical clearance over the shoulders of all portions of the roadbed.

- (2) *Minor Structures.* Pedestrian over-crossings shall have a minimum vertical clearance 2 feet greater than the standard for major structures for the State facility in question. Sign structures shall have a vertical clearance of 18 feet over the roadbed of the State facility.
- (3) *Rural Interstates and Single Routing in Urban Areas:* This subset of the Interstate System is composed of all rural Interstates and a single routing in urban areas. Those routes described in Table 309.2B and Figure 309.2 are given special attention in regards to minimum vertical clearance as a result of agreements between the FHWA and the Department of Defense. **Vertical clearance for structures on this system shall meet the standards listed above for freeways and expressways.** In addition to the standards listed above, vertical clearances of less than 16 feet over any portion of this system must be approved by FHWA in coordination with Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA). Documentation in the form of a Design Standard Decision Document must be submitted to FHWA to obtain approval for less than 16 feet of vertical clearance. Vertical clearances of less than 16 feet over any Interstate will require FHWA/SDDCTEA notification. See <http://www.fhwa.dot.gov/design/090415.cfm>
- (4) *General Information.* The standards listed above and summarized in Table 309.2A are the minimum allowable on the State highway system for the facility and project type listed. For the purposes of these vertical clearance standards, all projects on the freeway and expressway system other than overlay projects shall be considered to be covered by the "new construction" standard.

When approved by a design exception (see HDM Index 82.2) clearances less than the values given above may be allowed on a case by case basis given adequate justification based upon engineering judgment, economic, environmental or right of way considerations. Typical instances where lesser values may be approved are where the structure is protected by existing lower structures on either side or where a project includes an existing structure that would not be feasible to modify to the current standard. In no case should vertical clearance be reduced below 15 feet over the traveled way or 14 feet 6 inches over the shoulders over any portion of a State highway facility.

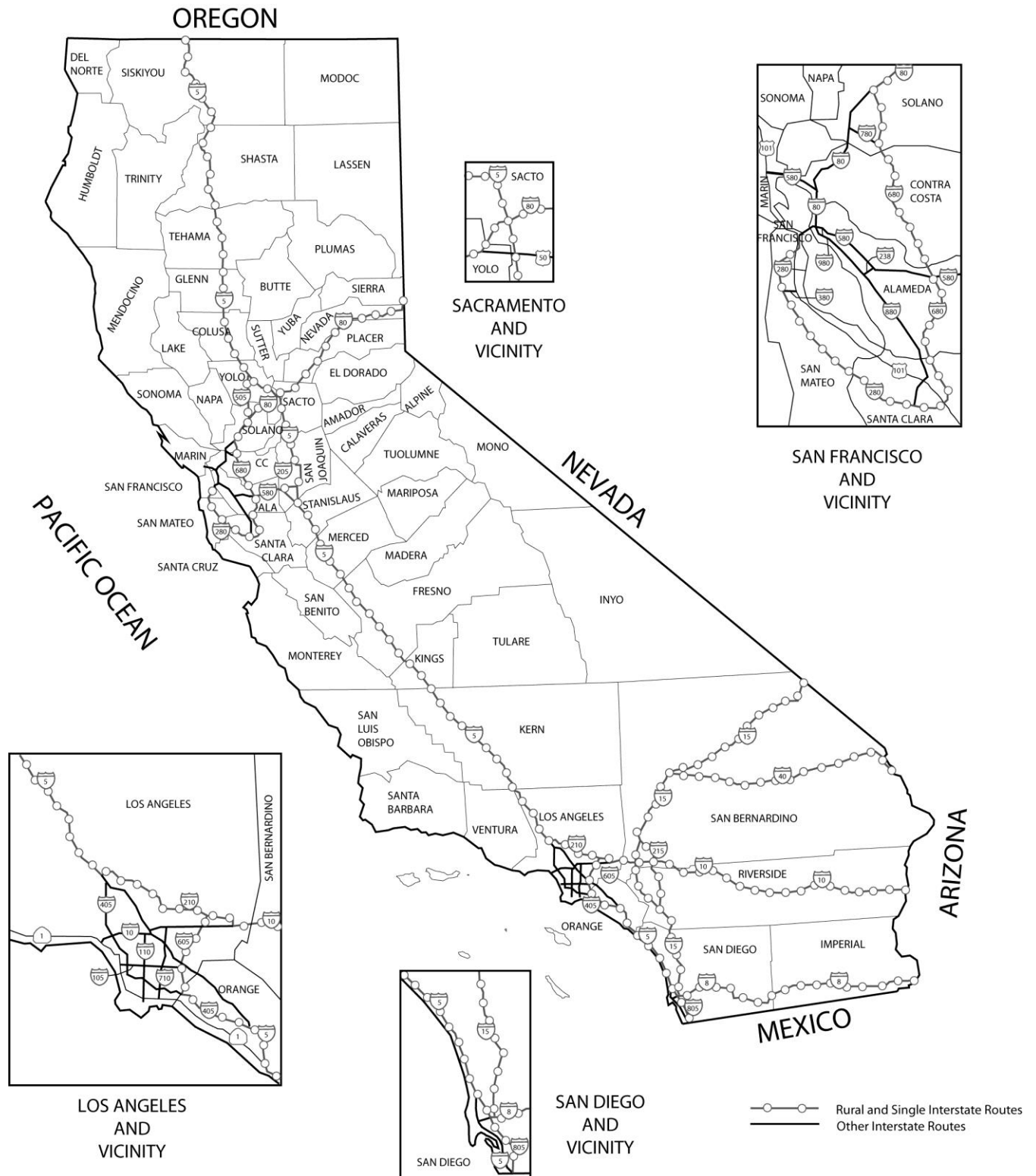
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Table 309.2A**Minimum Vertical Clearances**

	Traveled Way	Shoulder
Freeways and Expressways, New Construction, Lane Additions, Reconstruction and Modification	16½ ft	16½ ft
Freeways and Expressways, Overlay Projects	16 ft	16 ft
All Projects on Conventional Highways and Local Facilities	15 ft	14½ ft
Sign Structures	18 ft	18 ft
Pedestrian, Bicycle Overcrossings, and Minor Structures	Standard + 2 ft See 309.2(2)	
Structures on the Rural and Single Interstate Routing System	See 309.2(3)	

Figure 309.2

Department of Defense Rural and Single Interstate Routes



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Table 309.2B

California Routes on the Rural and Single Interstate Routing System

ROUTE	FROM	TO
I-5	U. S. Border	I-805 just N. of U. S. Border
I-5	I-805 N. of San Diego	I-405 near El Toro
I-5	I-210 N. of Los Angeles	Oregon State Line
I-8	I-805 near San Diego	Arizona State Line
I-10	I-210 near Pomona	Arizona State Line
I-15	I-8 near San Diego	Nevada State Line
I-40	Junction at I-15 near Barstow	Arizona State Line
I-80	I-680 near Cordelia	Nevada State Line
I-205	Junction at I-580	Junction at I-5
I-210	I-5 N. of Los Angeles	I-10 near Pomona
I-215	I-15 near Temecula	I-15 near Devore
I-280	Junction at I-680 in San Jose	At or near south city limits of San Francisco to provide access to Hunter's Point
I-405	I-5 near El Toro	Palo Verde Avenue just N. of I-605
I-505	Junction at I-80	Junction at I-5
I-580	I-680 near Dublin	Junction at I-5
I-605	I-405 near Seal Beach	I-210
I-680	Junction at I-280 in San Jose	I-80 near Cordelia
I-805	I-5 just N. of U. S. Border	I-5 N. of San Diego

Efforts should be made to avoid decreasing the existing vertical clearance whenever possible and consideration should be given to the feasibility of increasing vertical clearance on projects involving structural section removal and replacement. Any project that would reduce vertical clearances below 16 feet 6 inches or lead to an increase in the vertical clearance should be brought to the attention of the Project Delivery Coordinator or District approval authority, depending upon the current District Design Delegation Agreement, the District Permit Engineer and the Regional Permit Manager at the earliest possible date.

The Regional Permit Manager should be informed of any changes (temporary or permanent) in vertical clearance.

(5) *Federal Aid Participation.* Federal-aid participation is normally limited to the following maximum vertical clearances unless there are external controls such as the need to provide for falsework clearance or the vertical clearance is controlled by an adjacent structure in a multi-structure interchange:

(a) Highway Facilities.

- 17 feet over freeways and expressways.
- 15 feet 6 inches over other highways (15 feet over shoulders).
- For pedestrian structures, 2 feet greater than the above values.

(b) Railroad Facilities.

- 23 feet 4 inches over the top of rails for non-electrified rail systems.
- 24 feet 3 inches over the top of rails for existing or proposed 25 kv electrification.
- 26 feet over the top of rails for existing or proposed 50 kv electrification.

These clearances include an allowance for future ballasting of the rail facility. The cost of reconstructing or modifying any existing railroad-highway grade separation structure solely to accommodate electrification will not be eligible for Federal-aid highway fund participation. Where a rail system is not currently electrified, the railroad must have a plan adopted which specifies the intent to electrify the subject rail segment within a reasonable time frame in order to provide clearances in excess of 23 feet 4 inches.

Any exceptions to the clearances listed above should be reviewed with the FHWA early in the design phase to ensure that they will participate in the structure costs. All excessive clearances should be documented in the project files. Documentation must include reasons for exception including the railroad's justification for increased vertical clearance based on an analysis of engineering, operational and/or economic conditions at a specific structure location with appropriate approval by the HQ Right of Way, Railroad Agreement Coordinator and concurrence by the FHWA.

See Index 1003.1(3) for guidance on Class I bikeway vertical clearance.

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309.3 Tunnel Clearances

Cross sections for tunnels should match the full paved width of the approach roadways, including shoulders. See Topics 301 and 302.

- (1) *Horizontal Clearances.* Tunnel construction is so infrequent and costly that the width should be considered on an individual basis. For the minimum horizontal clearance standards for freeway and expressway tunnels see Index 309.1.

A minimum emergency egress walkway width of 4 feet shall be provided on one side. The emergency egress walkway should be elevated a minimum of 6 inches or separated from the roadway with barrier.

In one-way tunnels on conventional highways the minimum side clearance from the edge of the traveled way shall be 4 feet on the left and 6 feet on the right. For two-way tunnels, this clearance shall be 6 feet on each side. This clearance provides space for bicycle lanes or for bicyclists who want to use the shoulder.

- (2) *Vertical Clearances.* **For conventional highways the minimum vertical clearance listed in Index 309.2(1)(c) shall be used. On freeways and expressways, the vertical clearance listed in Index 309.2(1)(a) and (b) shall be used.** Cost weighed against the probability of over-height vehicles will be the determining factors.

309.4 Lateral Clearance for Elevated Structures

Adequate clearance must be provided for maintenance, repair, construction, or reconstruction of adjacent buildings and of the structure; to avoid damage to the structure from a building fire or to buildings from a vehicle fire; to permit operation of equipment for fire fighting and other emergency teams. **The minimum horizontal clearance between elevated highway structures, such as freeway viaducts and ramps, and adjoining buildings or other structures shall be 15 feet for single-deck structures and 20 feet for double-deck structures. Spot encroachments on this clearance shall be approved in accordance with Index 82.2.**

309.5 Structures Across or Adjacent to Railroads

Regulations governing clearances on railroads and street railroads with reference to side and overhead structures, parallel tracks, crossings of public roads, highways, and streets are established by the PUC. The PUC requirements are minimums for all grade separated structures. The railroad clearances are much greater due to operational requirements.

- (1) *Normal Horizontal and Vertical Clearances.* Although General Order No. 26-D specifies a minimum vertical clearance of 22 feet 6 inches above tracks on which freight cars not exceeding a height of 15 feet 6 inches are transported, a minimum of 23 feet 4 inches should be used in design to allow for reballasting and normal maintenance of track. Railroads on which freight cars are not operated, should have a minimum vertical clearance of 19 feet. See Index 309.2(5)(b) for FHWA maximums. In establishing the grade line, the District should consult the DES to obtain the depth of structures and false work requirements, if any (see Index 204.8(4)).

Horizontal clearance from piers, abutments, and barriers shall be 25 feet minimum to centerline of track. For clearances less than 25 feet, the piers supporting bridges over the railroads are to be heavy construction or are to be protected by a reinforced concrete crash wall. Piers are to be considered heavy construction if they have a cross-sectional

area equal to or greater than that required for the crash wall where the larger of its dimension is parallel to the track.

Crash walls for piers from 12 to 25 feet clearance from the centerline of track are to have a minimum height of 6 feet above the top of rail. Piers less than 12 feet clearance from the centerline of track are to have a minimum crash wall height of 12 feet above the top of rail. Horizontal clearances other than those stated above must be approved by the PUC and concurred by the affected railroad entity. Coordinate early in the design phase of the project with the District Railroad Coordinator when railroad agreements are required.

For future planned track expansion, a minimum horizontal clearance distance of 20 feet between existing and future track centerlines shall be provided for freight tracks and 25 feet for commuter tracks. See Figure 309.5A for typical horizontal railroad clearances and Figure 309.5B for limits of permanent vertical clearance envelope for grade separated structures.

Code of Federal Regulations 646.212(a)(2) provides that if the railroad establishes to the satisfaction of the Department and FHWA that it has definite demand and plans for installation of additional tracks within a reasonable time, for grade separation structures, Federal funds may be used to provide space for more tracks than are in place.

Vertical clearance greater than 23 feet 4 inches may be approved on a site by site basis where justified by the railroad to the satisfaction of the Department and the FHWA. A railroad's justification for increased vertical clearance should be based on an analysis of engineering, operational and/or economic conditions and the need for future tracks at a specific location. Contact the District Railroad Coordinator for further information.

Table 309.5A

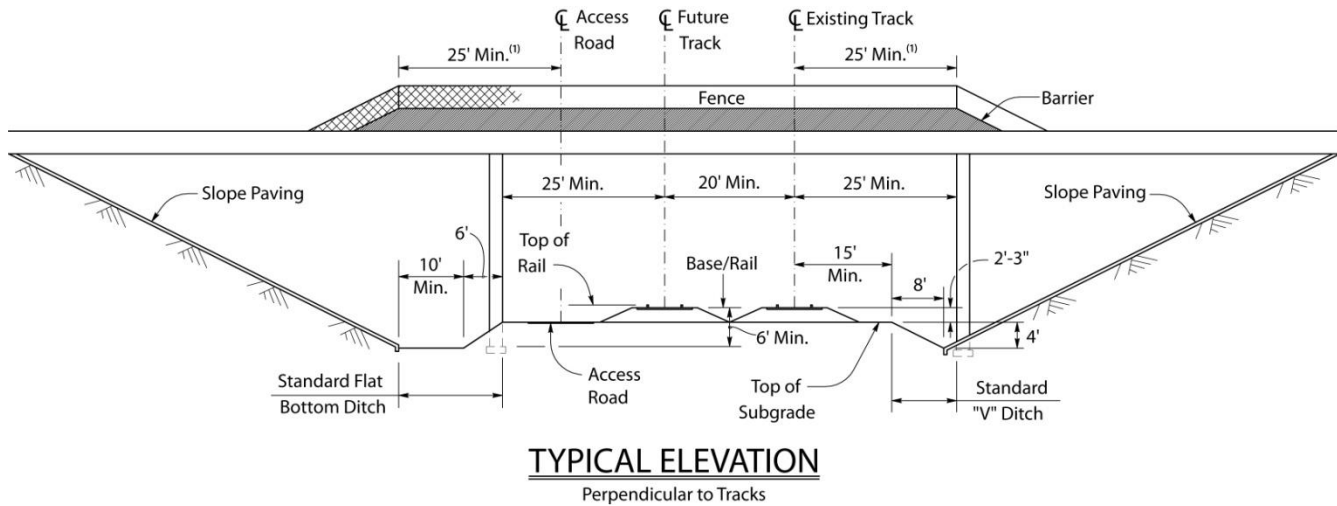
Minimum Vertical Clearances Above Highest Rail

Type of Structure	Type of Operation	
	Normal Freight	No Freight Cars Operated
Highway overhead and other structures including through railroad bridges.	23' – 4"	19' – 0"

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Figure 309.5A

Typical Horizontal Railroad Clearance from Grade Separated Structures

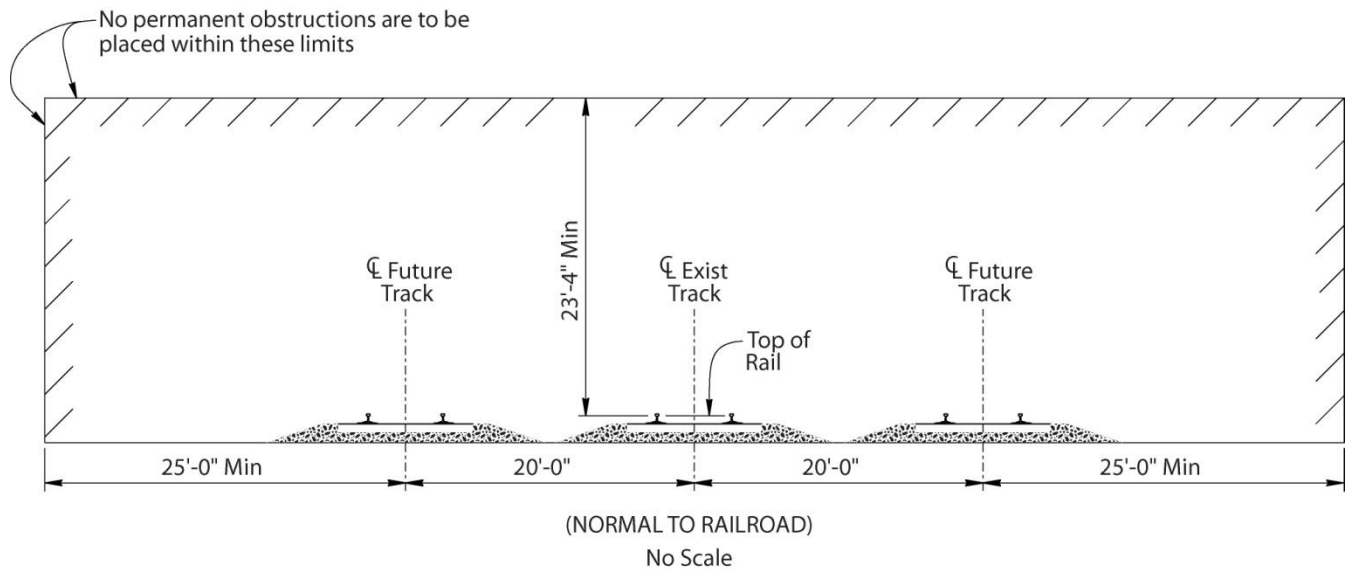


NOTE:

The limits of the fence with barrier rail should extend to the limits of railroad right-of-way or a minimum of 25 feet beyond the centerline of the outermost existing track, future track or access roadway, whichever is greater.

Figure 309.5B

Permanent Railroad Clearance Envelope



[Safety](#)

Lane Width

The adopted criteria describe design values for through travel lanes, auxiliary lanes, ramps, and turning roadways. There are also recommended widths for special-purpose lanes such as continuous two-way left-turn lanes. AASHTO also provides guidance for widening lanes through horizontal curves to provide for the off-tracking requirements of large trucks. Lane width does not include shoulders, curbs, and on-street parking areas. Table 3 summarizes the range of lane widths for travel lanes and ramps.

TABLE 3
Ranges for Lane Width

Type of Roadway	Rural		Urban	
	US (feet)	Metric (meters)	US (feet)	Metric (meters)
Freeway	12	3.6	12	3.6
Ramps (1-lane)	12-30	3.6-9.2	12-30	3.6-9.2
Arterial	11-12	3.3-3.6	10-12	3.0-3.6
Collector	10-12	3.0-3.6	10-12	3.0-3.6
Local	9-12	2.7-3.6	9-12	2.7-3.6

(Source: A Policy on Geometric Design of Highways and Streets, AASHTO)

It is FHWA policy that the requirement of a formal design exception for lane width is applicable for all travel lanes, including auxiliary lanes and ramps. With respect to the practice of widening lanes through horizontal curves, a formal design exception is not necessary for cases not providing additional lane width, but the decision should be documented in project records. Exhibit 7-3 in the *Green Book* describes minimum lane widths for two-lane rural highways for a range of design speeds and design-year traffic. The table entries show a 24-foot traveled way (12-foot lanes) for most conditions. Careful inspection of this table (see subnote [a]) shows that 11-foot lanes are acceptable and within policy for reconstruction

projects in which an existing 22-foot dimension is operating in a satisfactory manner. For such cases the designer should document this is the case, but retention of the 11-foot width would not require a design exception.

Safety

Speed is a primary consideration when evaluating potential adverse impacts of lane width on safety. On high-speed, rural two-lane highways, an increased risk of cross-centerline head-on or cross-centerline sideswipe crashes is a concern because drivers may have more difficulty staying within the travel lane. On any high-speed roadway, the primary safety concerns with reductions in lane width are crash types related to lane departure, including run-off-road crashes. The mitigation strategies for lane width presented in Chapter 4 focus on reducing the probability of these crashes.

In a reduced-speed urban environment, the effects of reduced lane width are different. On such facilities, the risk of lane-departure crashes is less. The design objective is often how to best distribute limited cross-sectional width to maximize safety for a wide variety of roadway users. Narrower lane widths may be chosen to manage or reduce speed and shorten crossing distances for pedestrians. Lane widths may be adjusted to incorporate other cross-sectional elements, such as medians for access control, bike lanes, on-street parking, transit stops, and landscaping. The adopted ranges for lane width in the urban, low-speed environment normally provide adequate flexibility to achieve a desirable urban cross section without a design exception.

Designers should understand the interrelationships among lane width and other design elements. On high-speed roadways with narrow lanes that also have narrow shoulders, the risk of severe lane-departure crashes increases. Drivers on rural two-lane highways may shift even closer to the centerline as they become less comfortable next to a narrow shoulder. At other times, they may shift closer to the shoulder edge and are at greater risk of driving off the paved portion of the roadway (and over potential edge drop-offs) as they meet oncoming traffic.

Horizontal alignment is another factor that can influence the safety of lane width reductions. Curvilinear horizontal alignments increase the risk of lane departure crashes in general, and when combined with narrow lane widths, the risk will further increase for most high-speed roadways. In addition, trucks and other large vehicles can affect safety and operations by off-tracking into adjacent lanes or the shoulder. This affects the safety of other drivers, as well as non-motorized users such as bicyclists who may be using the adjacent lane or shoulder. It is important to understand this interaction of design elements when a design exception for lane width is being evaluated.

Substantive Safety

Figure 6 shows accident modification factors for variations in lane width on rural two-lane highways. Note that there is little difference between 11- and 12-foot lanes.

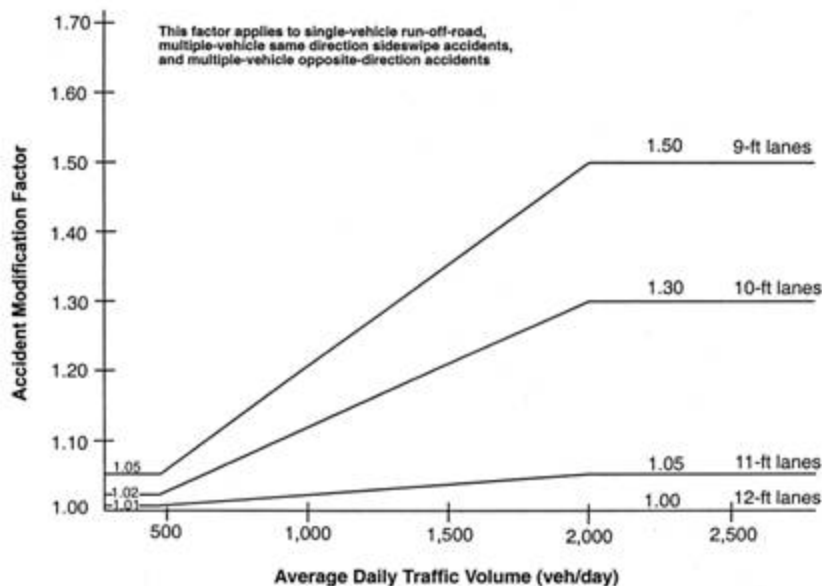


FIGURE 6
 Accident Modification Factors for Lane Width on Rural Two-Lane Highways.

(Source: Prediction of the Expected Safety Performance of Rural Two-Lane Highways, FHWA)

Figure 6 is a graph. The "x" axis is labeled "Average Daily Traffic Volume (veh/day)," and is marked in increments of 500; 1,000; 1,500; 2,000; and 2,500. The "y" axis is "labeled Accident Modification Factor," and is marked in decimal increments of 1.00, 1.10, etc., through 1.70. A note at the top of the "x" axis states, "This factor applies to single-vehicle run-off-road, multiple-vehicle same direction sideswipe accidents, and multiple-vehicle opposite-direction accidents." The accident modification factors for the various lane widths begin as horizontal lines showing a very minor difference in crash risk. As traffic exceeds 500 vpd, the AMFs increase linearly and at 2000 vpd, the AMFs return to horizontal lines. At this point the AMF for 12-foot lanes is 1.00, for 11-foot lanes is 1.05, for 10-foot lanes is 1.30, and for 9-foot lanes is 1.50, illustrating that the expected crash risk is significantly higher for 9- and 10-foot lanes on rural two-lane highways.

For multilane urban arterials and multilane rural arterials, the expected difference in substantive safety for variations in lane width is much less than the order of a few percentage points when comparing lane widths of 10 to 12 feet.

Traffic Operations

Lane width has an effect on traffic operations and highway capacity, particularly for high-speed roadways. The interaction of lane width with other geometric elements, primarily shoulder width, also affects operations.

When determining highway capacity, adjustments are made to reflect the effect of lane width on free-flow speeds. Lane widths of less than 12 feet (3.6 meters) reduce travel speeds on high-speed roadways, as summarized in Tables 4 and 5.

TABLE 4
 Operational Effects of Freeway Lane Widths

Lane width (ft)	Reduction in Free-Flow Speed (mi/h)
-----------------	-------------------------------------

12	0.0
11	1.9
10	6.6
Lane width (m)	Reduction in Free-Flow Speed (km/h)
3.6	0.0
3.5	1.0
3.4	2.1
3.3	3.1
3.2	5.6
3.1	8.1
3.0	10.6

Source: Highway Capacity Manual

TABLE 5
Operational Effects of Lane and Shoulder Width on Two-Lane Highways

Lane width (ft)	Reduction in Free-Flow Speed (mi/h)			
	Shoulder Width (ft)			
	≥0<2	≥2<4	≥4<6	≥6
9<10	6.4	4.8	3.5	2.2
≥10<11	5.3	3.7	2.4	1.1
≥11<12	4.7	3.0	1.7	0.4

≥3.6	4.2	2.6	1.3	0.0
Lane width (m)	Reduction in Free-Flow Speed (km/h)			
	Shoulder Width (m)			
	≥0.0<0.6	≥0.6<1.2	≥1.2<8	≥1.8
2.7<3.0	10.3	7.7	5.6	3.5
≥3.0<3.3	8.5	5.9	3.8	1.7
≥3.3<3.6	7.5	4.9	2.8	0.7
≥3.6	6.8	4.2	2.1	0.0

Source: Highway Capacity Manual

Summary

Table 6 summarizes the potential adverse impacts to safety and operations for a design exception for lane width.

TABLE 6
Lane Width: Potential Adverse Impacts to Safety and Operations

Safety & Operational Issues	Freeway	Expressway	Rural Two-Lane	Urban Arterial
Run-off-road crashes	X	X	X	
Cross-median crashes	X	X		
Cross-centerline crashes			X	
Sideswipe (same direction) crashes	X	X		X
Rear-end crashes if operations deteriorate (abrupt speed reduction)	X	X	X	

Reduced free-flow speeds	X	X	X	X
Large vehicles off-tracking into adjacent lane or shoulder	X	X	X	X

Freeway: high-speed, multi-lane divided highway with interchange access only (rural or urban).
Expressway: high-speed, multi-lane divided arterial with interchange and at-grade access (rural or urban).
Rural 2-Lane: high-speed, undivided rural highway (arterial, collector, or local).
Urban Arterial: urban arterials with speeds 45 mi/h (70 km/h) or less.

Lane Width Resources

- *A Policy on Design Standards Interstate System*, AASHTO, 2005.
- *A Policy on Geometric Design of Highways and Streets*, AASHTO, 2004.
- *Guide for the Planning, Design, and Operation of Pedestrian Facilities*, AASHTO, 2004.
- *A Guide for Reducing Collisions on Horizontal Curves*, NCHRP Report 500, Volume 7, Transportation Research Board, 2004.
- *A Guide for Reducing Collisions Involving Pedestrians*, NCHRP Report 500, Volume 10, Transportation Research Board, 2004.
- *A Guide for Reducing Collisions Involving Heavy Trucks*, NCHRP Report 500, Volume 13, Transportation Research Board, 2004.
- *A Guide for Addressing Head-On Collisions*, NCHRP Report 500, Volume 4, Transportation Research Board, 2003.
- *A Guide for Addressing Run-Off-Road Collisions*, NCHRP Report 500, Volume 6, Transportation Research Board, 2003.
- *Roadside Design Guide*, AASHTO, 2002.
- *Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400)*, AASHTO, 2001.
- *Highway Capacity Manual*, Transportation Research Board, 2000.
- *Guide for the Development of Bicycle Facilities*, AASHTO, 1999.
- *Highway Safety Design and Operations Guide*, AASHTO, 1997.
- *Use of Shoulders and Narrow Lanes to Increase Freeway Capacity*, NCHRP Report 369, Transportation Research Board, 1995.
- *Roadway Widths for Low-Traffic Volume Roads*, NCHRP Report 362, Transportation Research Board, 1994.
- *Effective Utilization of Street Width on Urban Arterials*, NCHRP Report 330, Transportation Research Board, 1990.
- FHWA Roadside Hardware Web site http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/

Cannabis is here to stay, its unpleasant odors are not

By using plant-based odor removers, cannabis processors are safely and effectively neutralizing foul smells, instead of just masking them.

[Laura Hauptert](#)

In the worlds of manufacturing and processing, odor control is an often-overlooked topic, only considered after bringing a facility online as complaints from neighbors roll in. This subject deserves more attention during facility design in many industries, given how frequently odors are problematic, but it is especially worthy of consideration in the cannabis growing and processing business.

When in the flowering phase, marijuana plants (Figure 1) produce a scent referred to as pungent, skunky, floral, fruity or even “sewer-like,” and this smell is amplified in greenhouses and cultivation areas when handling large crops. A terpene called myrcene, which some strains of marijuana contain in very high concentrations, is a contributor to the odor, and sulfur-containing compounds within and outside of grow facilities are the primary source.

This smell can be far-reaching, often detected more than a mile from a cultivation area or greenhouse, and local governments are increasing efforts to reduce or eliminate it. For these reasons, companies must often create an odor mitigation plan before opening, and they are subject to hefty fines in many locales if odors are noticeable, especially if neighboring residents complain.

To combat offensive odors and corresponding fines, many companies attempt to cover up the smells, but this is not an effective practice because simply masking odors is a temporary solution. Proper odor management requires neutralizing unpleasant smells by altering their molecular makeup. This can be accomplished using custom formulations of modern plant-based odor removers, effective in greenhouses, processing facilities and other cannabis-related applications.

Odor mitigation challenges

Cannabis odor is a complex mixture of chemicals, and the scent typically comes from the terpenoids and terpenes it contains. Terpenoids can be further classified into monoterpenoids, sesquiterpenoids, diterpenoids and triterpenoids — each of which are acyclic, monocyclic or polycyclic hydrocarbons — with all contributing to odors.

Additionally, recent studies have determined the presence of sulfur-containing compounds in the air around cannabis facilities. These compounds, even at low concentrations measured in the parts per billion, can contribute heavily to strong and offensive odors.

Complicating mitigation matters, the concentrations and combinations of odorous chemicals vary from one facility to the next. Because these smells and their chemistry vary, there is no single odor solution that works for every application.

As the cannabis industry expands, many municipalities are imposing restrictions on the methods employed by commercial growers to handle odors. Particularly in urban areas, large-scale ventilation systems that pump untreated air outdoors are widely prohibited, so some facilities turn to industrial filtration systems — but these are costly to install, operate and maintain. Sealing a greenhouse is an alternative option, but this can cause overheating and harmful humidity increases.

There are several odor control methodologies used across multiple industries, but traditional solutions each have shortcomings in various forms. These methods include masking agents, chemical scrubbers, adsorption and carbon filters, ozone, biological filters and others (Figure 2).

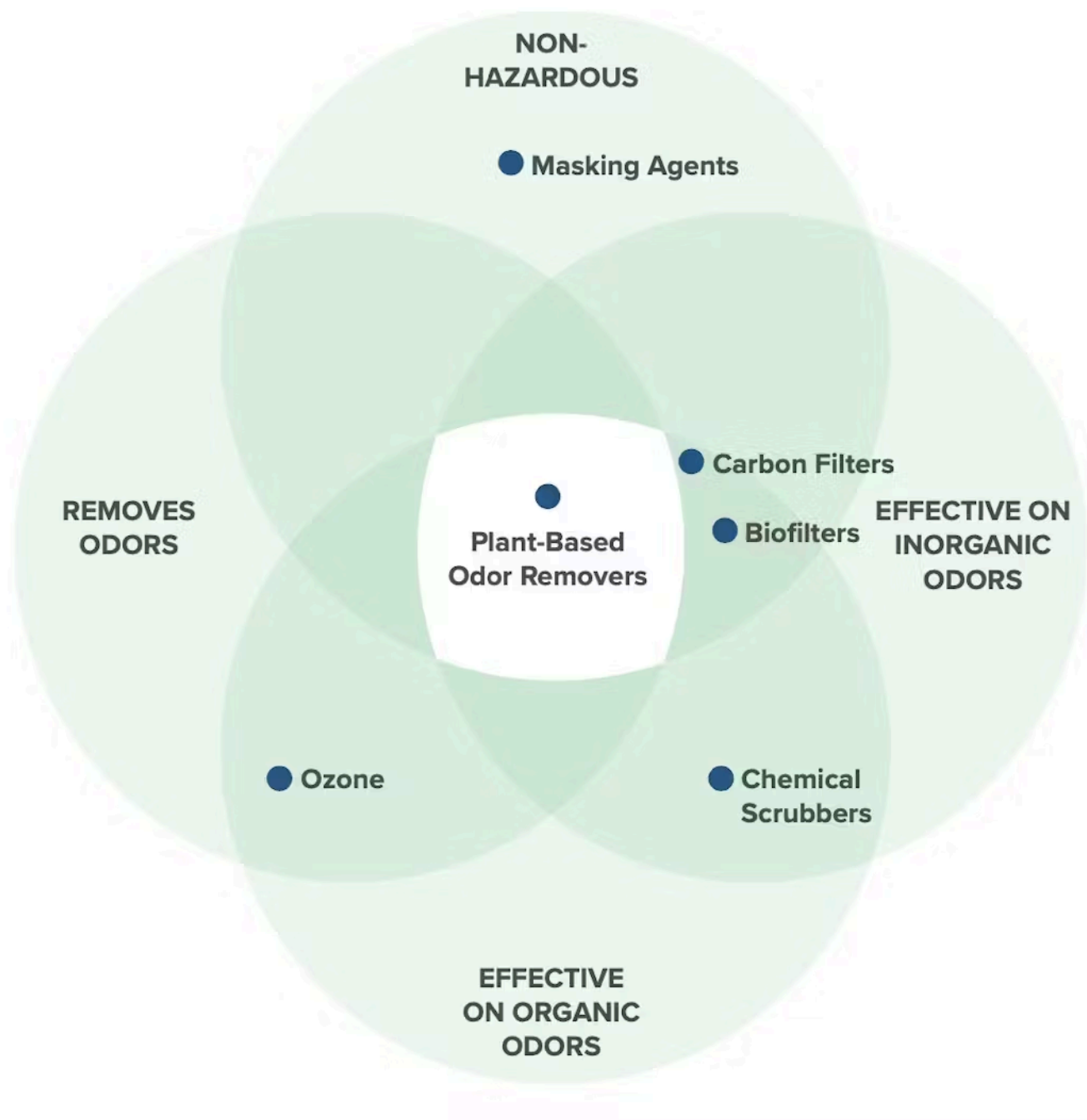


Figure 2: While traditional odor control methodologies perform well in certain applications, all have shortcomings. Modern plant-based odor removers occupy the sweet spot of safe and effective odor neutralization.

While ozone — a powerful oxidant and anti-microbial — can be used to effectively remove odors from greenhouses, it causes side effects when used around humans, requiring facility evacuation during and after use. This is disruptive to operations and requires an excessive level of scheduling and planning. Additionally, ozone is highly caustic, and it can cause damage in the accidental presence of other chemicals.

Most cannabis greenhouses use carbon filters to remove odors emitted from the facility. These filters work by pushing a contaminated air stream through activated carbon. Carbon is porous,

providing it with a large surface area, enabling absorption of the odorous chemicals.

Activated carbon filters work well on sulfur-rich compounds, but they are not as effective at treating nitrogen-based compounds. They also require annual or more frequent replacement, resulting in high ongoing maintenance costs. Carbon filters also restrict airflow through greenhouse fans, and because airflow is vital to growing, additional fans are often required.

Other traditional odor control methodologies require equipment, materials, setup and maintenance from multiple partners, and these complexities can render systems unwieldy and costly to operate.

Plant-based solutions

To address these and other issues, many growers and processors are turning to modern plant-based odor removers for safe and effective odor neutralization. These formulations are research-based, optimized to chemically react with and neutralize odor-causing components at the molecular level. For example, OMI Industries supplies its environmentally friendly Ecosorb CNB 204 product, which is specially formulated to substantially reduce the odor-causing chemicals in cannabis facilities. It is vaporized and distributed at growing and processing facilities through various delivery systems, and it can be combined with existing carbon and other filtration systems.

To develop effective neutralization products, scientists begin by collecting and studying gaseous samples from facilities using gas chromatography mass spectrometry (GC-MS) to determine the precise molecular makeup of odors, even those present in minute amounts (Figure 3).





Figure 3: OMI Industries uses GC-MS instrumentation to identify the odor-causing substances in the air or near a facility, then develops custom plant-based formulas to neutralize odors.

A GC chromatogram (Figure 4) is a visual output of the data recorded by the detector, and it is presented as a plot of detector response (y-axis) versus retention time (x-axis).

Each compound detected appears as a single peak on the graph, with the corresponding retention time value used for identification. Once the odor-causing compounds are identified, OMI scientists concoct a formulation using plant oils to molecularly neutralize the odors when the compound is combined with odors in the atmosphere.

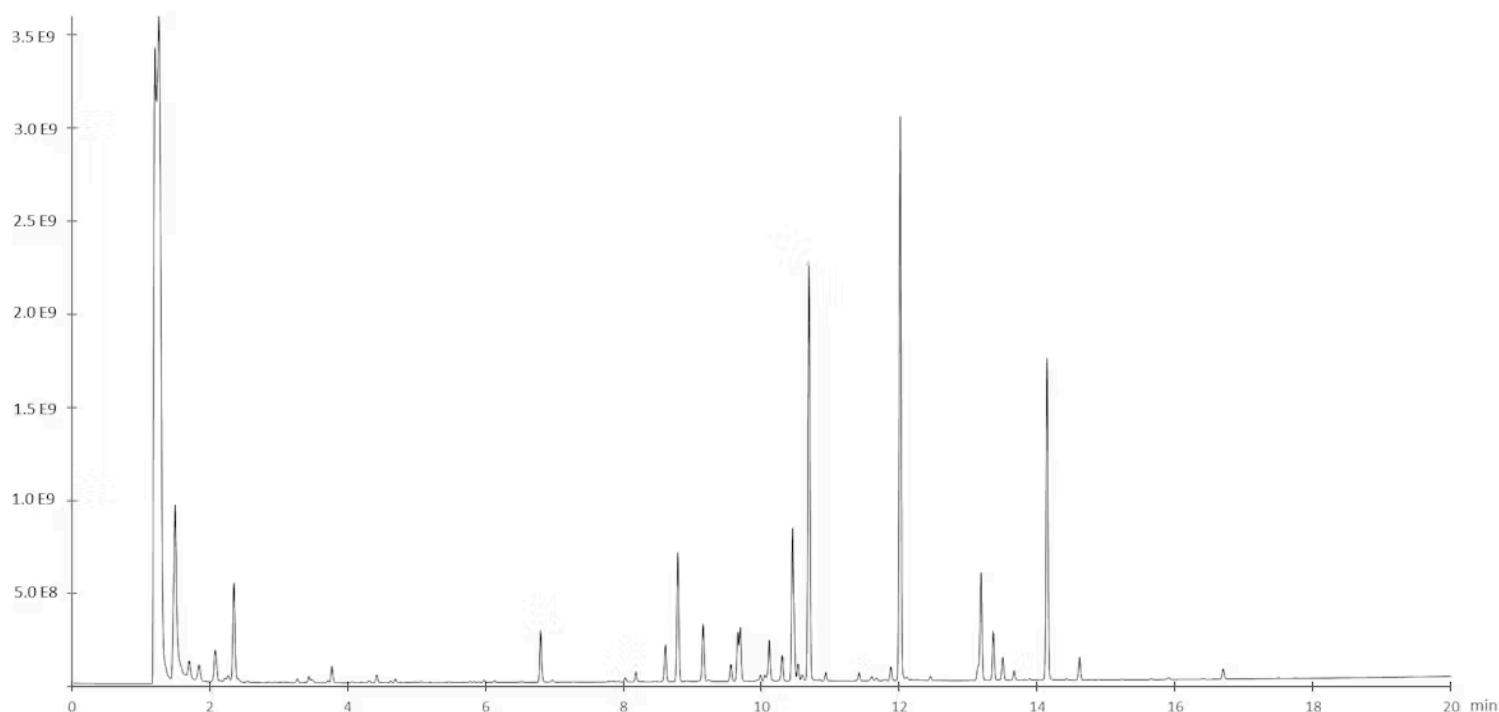


Figure 4: Each peak in a GC chromatogram represents the presence of a compound, identified and quantified by the x- and y-axes, respectively.

This results in versatile and cost-efficient solutions — specially crafted for maximum effectiveness in each application — with each leveraging customized concentrations of plant oils, biobased surfactants and water to eliminate odors. This includes those caused by cannabis, cannabinoids, terpenes, sesquiterpenes and sulfur-containing compounds.

Delivery via vaporization

Distributed during growth and processing, these plant-based odor removers absorb cannabis odors at the source, rather than masking the odors with synthetic fragrances or harsh chemicals. Additionally, these natural formulations are safe for use around people and animals, eliminating downtime when used periodically, and allowing for continuous use when required.

Vapor phase systems pump undiluted odor eliminators through perforated pipe distribution systems, creating a dry vapor to eliminate airborne odors on contact at their point of exhaust from a facility (Figure 5).



These systems deliver dry odor eliminator at rates as low as 130 cubic feet per minute (CFM) to as high as 2,400 CFM, making them adaptable to many locations and applications. These flexible and efficient delivery systems:

- Produce small droplets and high absorption for stable odor control.
- Require no mixing or water dilution onsite to operate.
- Can be provided with service contracts to relieve the facility of most maintenance tasks.

Odor control at a cultivation facility

When a cannabis enterprise planned a state-of-the-art 4,000-square-foot marijuana cultivation facility for growing, processing and producing edible products, they knew there was a need for odor control. Located in a busy commercial area — within a mile of residential neighborhoods, apartment complexes, restaurants, retail stores, schools and golf courses — the enterprise needed a solution to eliminate all traces of odor.

Despite the legality of cannabis in the facility's state, the owners did not wish to draw negative attention, such as complaints from neighboring businesses or residents. And in compliance with city zoning bylaws for permitting, the owners were required to guarantee they would not emit “noxious, harmful or hazardous” odors into the surrounding neighborhood.

To mitigate escaping odors, the company invested in an internal charcoal filtration system to remove odors, while recirculating air inside the facility. It also installed UV technology in the exhaust pipes to kill organic odor-causing bacteria, and it fitted the roof with a complete perimeter vaporization system delivering Ecosorb CNB 100 to absorb remaining traces of escaping odors.

The perimeter system continuously mists dry odor removal vapor to scrub remaining smells from the air before they leave the facility's vicinity. The CNB 100 blend of plant oils is chemically crafted to neutralize the complex odor molecules produced by cannabis plants. With its natural ingredient composition and ability for delivery without water dilution, OMI Industries' Ecosorb CNB 100 provides a safe, effective and environmentally friendly means of odor control — with minimal required maintenance.

As demonstrated by minimal complaints from neighbors, the odor control system is performing its job successfully.

Odor mitigation for a CBD manufacturer

Another cannabis processor — a cannabidiol (CBD) manufacturing company that produces 1,000 Kg/month of CBD oil and a growing number of CBD products — did not anticipate such malodorous exhaust at the outset of its operations. In a short span after opening, the manufacturer received an alarming number of odor complaints from nearby residents and businesses, and local authorities threatened to shut its doors.

The manufacturer experimented with multiple products to cut down the distinct and potent smells, but after six months of unsuccessful trial and error, the processor turned to OMI Industries for its odor mitigation expertise. By pulling air samples from the facility and analyzing them using GC-MS, OMI's Ecosorb team identified their CNB 204 solution as the best product for odor removal.

Two 75 CFM vaporization units were installed at the facility exhaust areas, pumping the proven blend of plant-based odor eliminators into the air to neutralize smells long before reaching the surrounding residents and businesses.

The manufacturer quickly learned to vary the volume of Ecosorb used based on odor control needs — greatest when marijuana is in its flowering phase and during intense intervals of processing, and less during other times.

When polled five months after adopting Ecosorb vapor phase CNB 204, the manufacturer and surrounding community reported a substantial improvement. Notably, the community no longer notices the manufacturer's presence, empowering it to operate without the threat of being forced out of business.

Eco-products empower business continuity

By applying plant-based odor removers to facility exhaust or around the perimeter, processors can

effectively mitigate foul odors in a variety of industries — including cannabis — using safe, **Source URL:** <https://www.processingmagazine.com/material-handling-dry-wet-filtration-separation/article/21282544/cannabis-is-here-to-stay-its-unpleasant-odors-are-not>

environmentally friendly and cost-efficient methods. These custom formulations do not mask smells, but instead eliminate them by breaking down and neutralizing odor-causing molecules.

These odor management systems are simpler to operate and maintain than traditional odor control methodologies, and their use of renewable and biobased ingredients enables clean and environmentally conscious operation. By adopting these systems, cannabis growers and processors can significantly improve community relationships, and redirect focus from fielding complaints to growing their business.

Laura Haupert, Ph.D., is the chief scientific officer for OMI Industries, where she leads research and development, regulatory, safety and quality control.

OMI Industries

www.omi-industries.com

State Water Resources Control Board

Cannabis Cultivation Policy

ATTACHMENT A

Definitions and Requirements for Cannabis Cultivation

**As Adopted by the State Water Board on
February 5, 2019**

**As Approved by Office of Administrative Law on
April 16, 2019**

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No.	TERM
32.	Tier 1 or 2 cannabis cultivators with any portion of the disturbed areas existing within the setbacks shall submit a Disturbed Area Stabilization Plan to the Regional Water Board Executive Officer. The Disturbed Area Stabilization Plan shall be approved by the applicable Regional Water Board Executive Officer prior to the cannabis cultivator initiating any land stabilization activities. This requirement does not apply to disturbed areas resulting from activities authorized under 404/401 CWA permits, a CDFW LSA Agreement, coverage under the Cannabis Cultivation General Order water quality certification, or site-specific WDRs issued by the Regional Water Board.
33.	Cannabis cultivators under any Cannabis Cultivation General Order or individual WDRs implementing this Policy shall self-certify that they have complied with or will comply with all applicable Requirements in this Policy no later than the onset of the winter period of the same year as the application date and each year thereafter. If application occurs after the onset of the winter period, cannabis cultivators shall self-certify that all applicable Requirements in this Policy will be implemented by the onset of the winter period of the next calendar year, and each year thereafter. Those cannabis cultivators that cannot implement all applicable Requirements by the onset of the winter period shall, within 90 days of application submittal, submit to the Executive Officer of the applicable Regional Water Board a time schedule and scope of work for use by the Regional Water Board in developing a compliance schedule.
34.	Cannabis cultivators shall implement interim Requirements immediately following land disturbance, to minimize discharges of waste constituents. Interim Requirements are those that are implemented immediately upon site development. Cannabis cultivators shall complete all winterization Requirements prior to the onset of the winter period to prevent waste discharges that may result in water quality degradation.
35.	Cannabis cultivators shall not cause downstream exceedance of applicable water quality objectives identified in the applicable water quality control plan(s).
36.	The landowner is ultimately responsible for any water quality degradation that occurs on or emanates from its property and for water diversions that are not in compliance with this Policy. Landowners will be named as responsible parties and will be notified if a Cannabis Cultivation General Order Notice of Applicability or conditional exemption has been issued for cannabis activities on their property. The cannabis cultivator and the landowner will be held responsible for correcting non-compliance.
37.	Cannabis cultivators shall comply with the minimum riparian setbacks described below for all land disturbance, cannabis cultivation activities, and facilities (e.g., material or vehicle storage, petroleum powered pump locations, off-stream water storage areas, and chemical toilet placement). The riparian setbacks shall be measured from the waterbody's bankfull stage (high flow water levels that occur every 1.5 to 2 years) or from the top edge of the waterbody bank in incised

No.	TERM																		
	channels, whichever is more conservative. Riparian setbacks for springheads shall be measured from the springhead in all directions (circular buffer). Riparian setbacks for wetlands shall be measured from the edge of wetland as delineated by a Qualified Professional with experience implementing the Corps of Engineers Wetlands Delineation Manual (with regional supplements). The Regional Water Board Executive Officer may require additional riparian setbacks or additional requirements, as needed, to meet the performance requirement of protecting surface water from discharges that threaten water quality. If the cannabis cultivation site cannot be managed to protect water quality, the Executive Officer of the applicable Regional Water Board may revoke authorization for cannabis cultivation activities at the cannabis cultivation site. Minimum Riparian Setbacks^{1,2} <table><tr><th>Common Name</th><th>Watercourse Class³</th><th>Distance</th></tr><tr><td>Perennial watercourses, waterbodies (e.g. lakes, ponds), or springs⁴</td><td>I</td><td>150 ft.</td></tr><tr><td>Intermittent watercourses or wetlands</td><td>II</td><td>100 ft.</td></tr><tr><td>Ephemeral watercourses</td><td>III</td><td>50 ft.</td></tr><tr><td>Man-made irrigation canals, water supply reservoirs, or hydroelectric canals that support native aquatic species</td><td>IV</td><td>Established Riparian Vegetation Zone</td></tr><tr><td>All other man-made irrigation canals, water supply reservoirs, or hydroelectric canals</td><td>IV</td><td>N/A</td></tr></table> ¹ A Regional Water Board may adopt site-specific WDRs or an enforcement order for a cannabis cultivator with requirements that are inconsistent with the setbacks in this table if the Executive Officer determines that the site-specific WDRs or enforcement order contains sufficient requirements to be protective of water quality. ² Cannabis cultivators enrolled in a Regional Water Board order adopting WDRs or a waiver of WDRs for cannabis cultivation activities prior to October 17, 2017, may retain reduced setbacks applicable under that Regional Water Board order unless the Regional Water Board's Executive Officer determines that the reduced setbacks applicable under that order are not protective of water quality. ³ Except where more restrictive, the stream class designations are equivalent to the Forest Practice Rules Water Course and Lake Protection Zone definitions (California Code of Regulations, title 14, Chapter 4. Forest Practice Rules, Subchapters 4, 5, and 6 Forest District Rules, Article 6 Water Course and Lake Protection). ⁴ Spring riparian setbacks default to the applicable watercourse riparian setback 150 feet downstream and/or upstream of the spring's confluence with the watercourse or 150 feet downstream of the point where the spring forms a watercourse with defined bed and banks.	Common Name	Watercourse Class ³	Distance	Perennial watercourses, waterbodies (e.g. lakes, ponds), or springs ⁴	I	150 ft.	Intermittent watercourses or wetlands	II	100 ft.	Ephemeral watercourses	III	50 ft.	Man-made irrigation canals, water supply reservoirs, or hydroelectric canals that support native aquatic species	IV	Established Riparian Vegetation Zone	All other man-made irrigation canals, water supply reservoirs, or hydroelectric canals	IV	N/A
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All other man-made irrigation canals, water supply reservoirs, or hydroelectric canals	IV	N/A																	



CALIFORNIA

The dirty secret of California’s legal weed

An L.A. Times/WeedWeek investigation finds alarming levels of pesticides in cannabis products at dispensaries across the state



(Photo illustration by Jim Cooke / Photos via Getty Images)

By Paige St. John and Alex Halperin

June 14, 2024 3 AM PT

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ging yuppies in neon beachwear stand before a green wall with the catchphrase “You have changed ... so has cannabis.”

The social media post is part of “Real CA Cannabis,” a \$5-million taxpayer-funded campaign to promote California cannabis as safe, tested and “regulated by the state to protect consumers.”

In reality, that safety is far from certain.

An investigation by The Times, in conjunction with cannabis industry newsletter [WeedWeek](#), found alarming levels of pesticides in cannabis products available on dispensary shelves across the state, including some of the most popular brands of vapes and pre-rolled weed.

Twenty-five of 42 legal cannabis products that The Times and WeedWeek purchased from retail stores and had tested at private labs showed concentrations of pesticides either above levels the state allows or at levels that exceed federal standards for tobacco. The contaminants include chemicals tied to cancer, liver failure, thyroid disease and genetic and neurologic harm to users and unborn children.

Most of the pesticides found were in low concentrations that risk long-term harm by repeated use, though the extent of the health threat may not be known for years.

Vapes tested from five well-known brands had pesticide loads that exceeded federal Environmental Protection Agency risk thresholds for harm from a single exposure, The Times and WeedWeek found. Users might experience irritation to the lungs, eyes and throat as well as rash, headache, diarrhea and abdominal pain.

Some individual products contained as many as two dozen pesticides.

The findings dovetail with scores of complaints that two private cannabis testing labs have filed over the last eight months, reporting pesticides in products certified by other labs as safe. The results, the labs said, suggest some level of contamination in more than 250,000 vapes and pre-rolled joints on store shelves, about the number sold legally in California in a two-day period.

Toxic chemicals in legal weed

See our chart of 36 toxic chemicals appearing at the highest levels in legal cannabis products.



How dirty is your weed?

Check to see if the cannabis product you use is on our list.



There are strong profit incentives driving contamination. Expanding legal markets encourage intensive growing practices to increase yield, inviting the use of pesticides to protect those high-value crops from insect infestations common in greenhouse environments.

At the same time, the soaring popularity of vapes has created heavy demand for bulk oils, which are made from lower-quality cannabis, often grown illegally.

Reviews of confidential lab reports, public records and interviews show California regulators have largely failed to address evidence of widespread contamination in the state's weed crop.

The state's requirements for weed testing also have not been updated to include dangerous chemicals currently used in cultivation, including illegal, smuggled pesticides so toxic that law enforcement officers who encounter them are advised to don respirators and take blood poisoning tests.

The health stakes from contaminated weed are high.

An estimated 5 million Californians consume cannabis products in any given month, according to the most recent federal health surveys. The presence of pesticides is particularly fraught for those who turn to weed for relief from medical conditions — conditions that put them at increased risk of harm.

Long-term public health concerns are exacerbated by the growing use of vapes, which contain the greatest contamination levels and are marketed to young adults who are

more apt to consider vaping a healthful alternative to tobacco or alcohol.

California Department of Cannabis Control officials declined to make anyone available for an interview. The agency also would not release either external or internal discussions of pesticide contamination, and refused to release information on its ability to test cannabis products, saying such knowledge would encourage bad actors.

It would not furnish the results of pesticide tests it had received from other state agencies and would not provide the safety certificates for cannabis products on the market. It also declined to say what action it has taken on at least 85 contamination complaints it has received since last fall from private labs, or disclose what tainted products it pulled from sale.

“When we receive complaints, we swiftly assess them, conduct appropriate investigations, and take appropriate action,” the agency’s press office said by email.

The agency is now scrambling to initiate California’s first market tests for pesticides, sending a recent [email warning](#) license holders of coming “product embargos, voluntary and mandatory recalls, and disciplinary actions.” The private labs that raised alarms for many months questioned why authorities did not act sooner.

California cannabis regulators initially responded to those complaints with a single product recall, and in orders that remain confidential, required three other products be removed from store shelves.

Frustrated that more was not done, Josh Swider, the chief executive of Infinite Chemical Analysis Labs and author of most of the complaints, in December sent his summary of contaminated products directly to Gov. Gavin Newsom and cannabis regulators in an email. “Those failing products alone represented 150,000 packages of flower, vapes or pre-rolls for sale to unsuspecting consumers,” he wrote.

“The government’s responsibility does not end after writing regulation.”

After Swider sent his letter, an additional product was recalled for pesticide contamination. The remaining tainted batches were left to sell out.



Insecticide foggers are affixed to posts in a Siskiyou County cannabis greenhouse raided by law enforcement in July 2023. (California Regional Water Boards)



California's legalization of recreational cannabis in 2016 ushered in a multibillion-dollar industry estimated to be the largest legal weed market in the world. But many of the promises of legalization have proved elusive. In a series of occasional stories, we'll explore the fallout of legal weed in California.

[Read the stories](#)

Meanwhile, licensing files show the state's seed-to-sale inventory system contains faulty data, including missing crops, misidentified products and safety tests that don't match the goods sold. Testing is done by state-approved independent labs, but no state-run lab is accredited to test for pesticides. There is no routine testing for the chemicals in products on store shelves, putting California out of sync with "best practices" adopted by the Cannabis Regulators Assn.

Those gaps leave policing of the industry largely in the hands of labs financially beholden to the companies whose products they test. Legislation to require independent fraud and accuracy checks has remained stalled in Sacramento for two years amid backroom negotiations between industry players and regulators.

"California is dropping the ball on enforcement where public health is concerned," said cannabis researcher Cindy Orser, a former director of a private California cannabis testing lab.

Testing for harmful chemicals

California requires cannabis products to be tested for 66 pesticides. That list, unchanged since 2018, has not kept pace with current cultivation practices.

Tests conducted for The Times and WeedWeek identified seven off-list pesticides in legal products on store shelves. One brand of vape contained fenvalerate, a fungicide proven to lower sperm counts and prohibited in the United States since 2008. Sixteen products contained pymetrozine, an insecticide known to cause liver cancer and to mimic human hormones, part of a chemical class known as endocrine disruptors, which over time cause reproductive disorders. Pymetrozine is approved for only limited use by the federal EPA, and is banned in the U.K., Canada and Norway.

A pink acai vape from Stiiizy, the state's top-selling cannabis brand, carried more than 60 times the maximum amount of pymetrozine allowed by federal regulators in

cigarettes. But because California does not require testing for pymetrozine, the company that makes Stiiizy products said it is not in violation of state regulation.

“We adhere to all standards and limits set by the State of California, which has some of the strictest testing requirements and pesticide limits in the country,” Stiiizy President Tak Sato said in an email.



Vapes by West Coast Cure, Flavorade, Phat Panda, Phire and Dime were among those found with pesticides, including chemicals not monitored by regulators. (Jason Armond / Los Angeles Times)

The Times and WeedWeek testing also found another off-list chemical, propargite, a carcinogenic insecticide that UCLA researchers have linked to brain-cell death and increased incidence of Parkinson's disease in Central Valley residents. It showed up in some vapes at nearly three times what is permitted in cigarettes.

Slipping into the legal supply

The state's unlicensed cannabis operations remain a primary source of concern. Deadly carbofuran and methamidophos, banned insecticides usually smuggled from Mexico, continue to appear across California, according to state Department of Fish and Wildlife, regional water board and county investigative records. On a Trinity County farm in 2023, an environmental health report shows, officers found a 3-pound tin of Fumitoxin, a poison that emits phosgene gas, along with evidence workers there were suffering severe diarrhea from exposure.

The chemicals occasionally turn up in the legal market. One, methamidophos, was detected in January in dried cannabis at a Van Nuys manufacturer, along with evidence the company was shipping the product across the country. Its license was revoked.





2

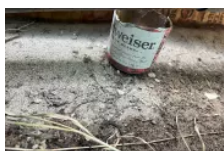


3

EXH-210

1. Opened mylar bags of illegal Chinese-label fumigants scatter the floor of a cannabis greenhouse in Siskiyou County. Lab tests identified 10 pesticides in the unbranded product, two potentially fatal if inhaled. (California Water Boards) 2. A Chinese fumigant containing isoprocarb, not approved for use in the United States, recovered from the Siskiyou County cannabis farm. (Integral Ecology Research Center) 3. Blue- and green-labeled unbranded pesticides sit on the top shelf, among other chemicals, at the farm. The Chinese-language products have prompted health warnings for law enforcement, but not cannabis consumers. (California Water Boards)

Interviews, confidential lab reports and public agency records also show a surge in pesticides smuggled from China that contain chemicals not permitted in the United States nor screened for in legal weed.



CALIFORNIA

A new threat to cannabis users: Smuggled Chinese pesticides

June 14, 2024

These unmonitored chemicals are so toxic California advised cannabis enforcement agents to wear hazmat suits and respirators during field inspections, and to undergo annual blood poisoning tests.



“Repeated inhalation of pesticide residues through regular smoking or vaping is quite concerning as this is a relatively direct route of exposure into the bloodstream,” said Kimberly Paul, an epidemiologist and assistant professor in neurology at UCLA who was lead researcher on the Central Valley study. “Low-level pesticide residues are something to be concerned about.”

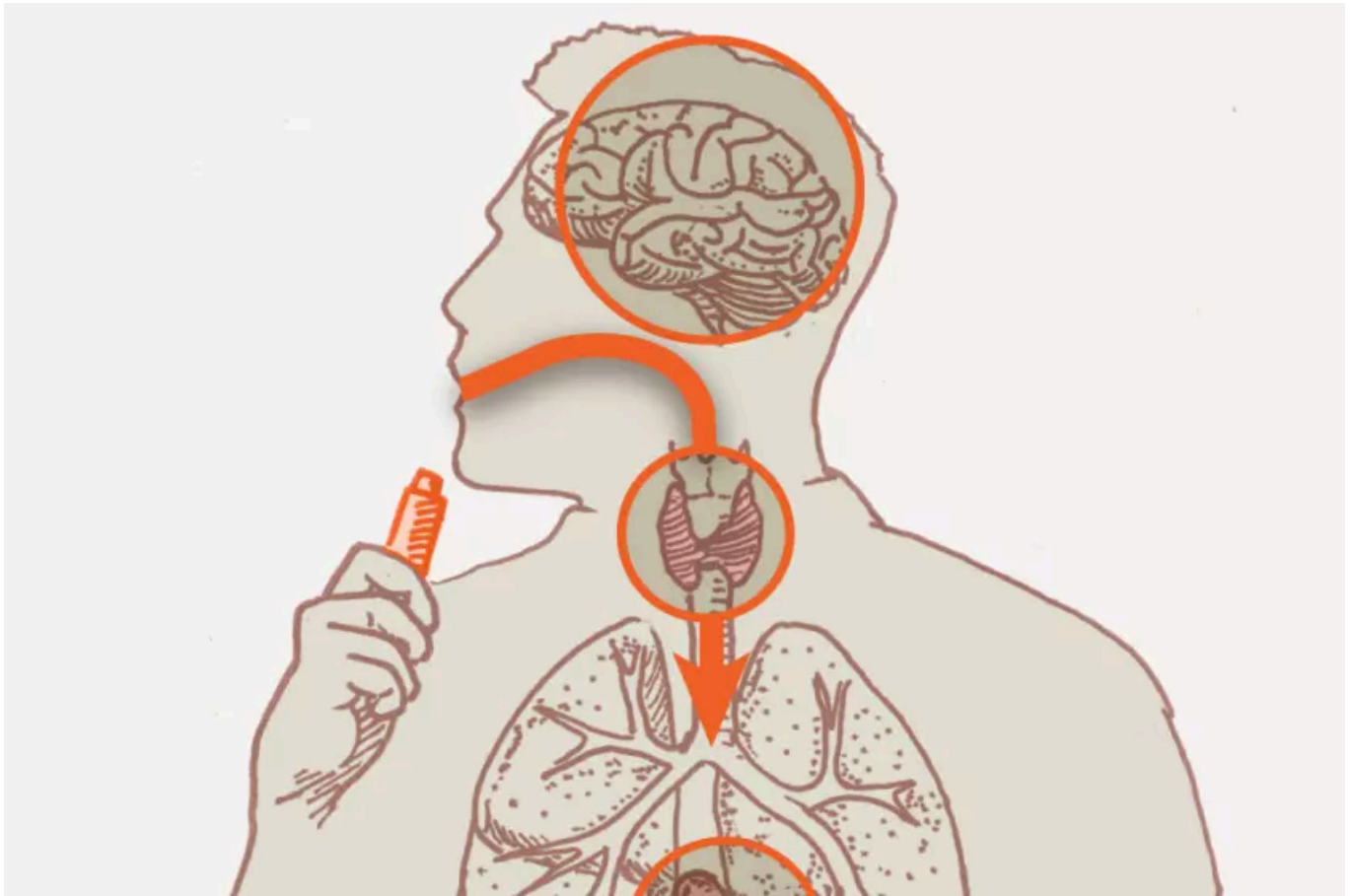
National health surveys by the U.S. Substance Abuse and Mental Health Services Administration show those between ages 18 and 25 make up the largest part of the market: More than 40% of young adults used cannabis within the last year. Separate studies by the University of Michigan Institute for Social Research show 1 in 3 high school seniors last year used cannabis, two-thirds of them by vaping. Despite state laws against marketing to children, many brands reflect this youth appeal, from weed

bags modeled after McDonald's Happy Meals to vape flavorings that mimic bubblegum.

The risk for medical users

Pesticides, which are designed to kill living organisms, have their place in agriculture. Regulation is focused on limiting contact exposure to agriculture workers and residues lingering on fruits and vegetables at the market. Tolerances take into account the body's ability to filter toxins through the liver.

Smoking and vaping, however, deliver chemicals directly to the lungs, into the blood and to the brain. The only other consumer product intended for smoking in this country is tobacco. Rather than demand pesticide inhalation studies for tobacco, the EPA decades ago decided smoking itself is so carcinogenic as to eclipse other health threats. The agency thus set a universal cap for tobacco contaminants at 0.01 part per million before requiring determination of health impacts, a standard California used to set limits for many chemicals in cannabis.



Contaminated weed in you

An illustrated explainer of how consuming weed that is contaminated with dangerous chemicals can have severe impacts on health including neurological damage, endocrine disruption, reproductive harm, loss of appetite, weakness and heart failure.

Arizona State University toxicologist Max Leung, who was part of the state team that in 2017 advised California cannabis regulators on pesticide risks, said the threats are greater for medical marijuana users who have epilepsy, Parkinson's or other neurological disorders.

But Leung said the lack of federal recognition of cannabis' widespread use, whether state-sanctioned or not, has left consumers vulnerable. There is a lack of data on health impacts experienced by cannabis users, though some states do solicit health complaints from the public, and in a few cases, those have led to product recalls for pesticides. California does not collect such information.

Rather than uniform national health standards, Leung and his team found a patchwork of disparate state regulations, different pesticides capped at different levels or not capped at all.

“You’ve got all of this contamination, but what do they do?” Leung said. “There’s just no research.”

After passage of Proposition 64 created a legal recreational market in California, toxicologists with the Department of Pesticide Regulation proposed to ban from inhaled weed products 42 chemicals the agency said are harmful to people, the environment or water, according to a copy of the March 2017 proposal.

The limits were rejected amid industry concerns about testing costs and lab capacity.

Six months later, the pesticide agency returned with more relaxed rules. It cut the zero-tolerance list by half, to 21 chemicals, and set limits for 45 other pesticides on a par with tobacco standards. Manufacturers of products that failed screening can attempt to lower the pesticide levels — such as by dilution — or incorporate the weed into edibles, where higher levels are tolerated. If they fail again, according to state regulation, the batches must be destroyed.

Pesticide agency records, including interagency memos and emails, show that since 2018, despite repeated requests, cannabis regulators have not updated the list of chemicals that weed is tested for — even after pesticide regulators made a direct appeal to the governor’s cannabis advisor, Nicole Elliott. In January, the Department of Cannabis Control, which Elliot now heads, said it was working to update those regulations, but as of June no changes had been proposed.

State toxicologists have also been stymied from taking a more active role in protecting the public from cannabis pesticides.

California’s Department of Pesticide Regulation conducts some of the nation’s most sophisticated evaluation of pesticide exposure to the public. It even has an employee whose job title is “cannabis and hemp program manager.”

But when it comes to cannabis, a spokesperson for the pesticide agency said, responsibility for protecting consumers rests solely with the Department of Cannabis Control.

The pesticide regulators did try, early on, to draft their own public health advisories for cannabis, but those were never issued. The agency released copies of six under a public records request, and would not say how many more existed.

One of those advisories was for piperonyl butoxide contamination in cannabis. It was among the chemicals The Times and WeedWeek found in testing.

“Acute toxicity symptoms may include tearing, drooling, runny nose, congestion, and difficulty breathing,” the unreleased advisory read. It added that laboratory animals exposed to the pesticide had more miscarriages and produced offspring with fingers and toes that were sometimes fused.

In 2019, toxicologists in the Department of Pesticide Regulation tried but did not succeed in launching a program to monitor chemicals being used in the illicit market. Internal memos from 2021 show that those same toxicologists were barred from seeing data collected from product safety tests, making it impossible for them to monitor what was circulating in the legal market.



The highest pesticide concentrations were found in Backpack Boyz vapes. (Jason Armond / Los Angeles Times)

There is no easy way in California to trace contamination. The state does not investigate the sources of pesticides in cannabis goods, but instead relies on a system of paper trails — seed-to-sale inventories and lab testing certificates — to protect the public.

Tests for The Times and WeedWeek showed repeated contamination in small batches of vapes stamped with the unique tracking number of a Van Nuys manufacturer, David Shin.

Among them were Backpack Boyz carts with as many as two dozen pesticides, half of those above state safety limits and including chlorfenapyr, prohibited at any amount, at 2,000 times above the minimum detection level.

The bulk oil for these vapes originated from cannabis grown on a single Central Valley farm. Shin said he bought the oil through a broker and did no independent testing of his own.

He flavored and packaged the vapes and a state-certified lab declared the products pesticide-free. They were then distributed by a wholesaler to Backpack Boyz dispensaries across the state.

Alerted to the pesticides found by The Times and WeedWeek, Shin said he could not unravel the source of contamination. A manager for the wholesaler said the company was launching its own investigation. The owners of Backpack Boyz LLC, which holds no cannabis license, did not respond for comment.



Andy Garcia, a sales rep for Backpack Boyz, talks to a possible client at the Hall of Flowers trade show in Ventura County. (Genaro Molina / Los Angeles Times)

The problem with cannabis trim

The THC oil that fills vape pens is extracted from biomass, plant material made up of lower potency leaves and stalks left after harvest, moldy flower and even high-quality buds that sit too long. Harsh chemicals and extreme temperatures in the extraction process can destroy a few pesticides, but most pesticides become more concentrated. That makes vapes more likely than select flowers to exceed safe limits.

The rise of intense cultivation practices — densely planted greenhouses and industrial warehouses with “sea of green” crops supported by netting — invites infestations of whiteflies, spider mites and mold. Clean cannabis can be commercially grown, but it requires time and care, said Sam Feliciano, a former pest control manager for a high-

end Los Angeles brand, Maven Industries. It is cheaper and faster to douse high-value crops with chemicals, as Feliciano and other workers were ordered to do at Maven, they allege in a civil lawsuit.



When good weed goes bad

An illustrated explainer of how chemicals used to control weed-killing pests make their way into cannabis products, and what producers can do when their products fail a lab test.

“I didn’t want to upset them and tell them, ‘No, it’s not OK to do that stuff,’” Feliciano said. “They simply would’ve just got rid of me.” Feliciano alleged in the civil suit that he suffered bouts of nausea, disorientation and confusion brought on by cannabis pesticide treatments. He told The Times that because of the impact to his health, he decided to quit. The workers in November were ordered to have their complaints heard by a private arbitrator.

By email, Maven Industries Chief Executive David Bosworth declined to comment on the lawsuit but asserted the company's products "are certified as safe and are, in fact, safe for consumer use."

Legalization has also brought large-scale cultivation out of the mountains and into agricultural areas, including Central Valley farmlands, where airborne pesticides drift from almond groves and grape vineyards.

At the same time, the explosion in vape sales has created heavy demand for distillate. California vape sales tripled from 2020 to 2023 to become a \$1.4-billion market, and now only slightly trail those of packaged flower.

To feed this demand, bulk oil manufacturers seek out lower-quality weed, much of it contaminated, to buy at discounted rates.

To meet state screening limits, the extracted oils, or distillates, are blended to dilute pesticides.

One manufacturer who solicits farmers for "dirty" weed defended the practice, saying he provided struggling growers an income source while keeping otherwise unusable cannabis out of the landfill.

The amber-colored bulk oil moves on an opaque market, traded by brokers who operate without license or regulation. It is bought by manufacturers who sometimes will use oil from the same batches to fill thousands of vape cartridges for competing brands.

This cheap commodity oil now dominates the market, selling for a fraction of the cost to produce a clean product.

The cannabis industry's reliance on low-quality weed enrages old-style farmers such as Mary Gaterud, who nurtures her sun-grown plants on a Humboldt County farmstead that has been her principal means of support for decades.

She is offended by the pleas she regularly receives from those seeking “old, moldy or even dirty trim,” as a San Luis Obispo distributor put it in a text to her in February.

A Humboldt buyer, with “Turn That Trash into Cash” in the subject line, asked for “trim with all levels of pesticides and heavy metals.”

“The people who are doing it right get crushed,” she said. “The bad actors are encouraged and rewarded. And the consumers are poisoned while being told they are safe.”



The Weed Whistleblowers

In February 2022 a group of California cannabis testing labs, upset about what they believed was widespread fraud in weed potency claims, decided to force regulators into action.

They formed a blind round robin, each lab testing retail flower samples without knowing whose work they were checking. In the course of testing for potency, one batch of flower was found to contain three times the allowed level of pyrethrins.

Cannabis regulators were alerted but issued no recall. In fact, it wasn't until the end of 2023, six years after recreational sales became legal, that California sought to remove a product for pesticide contamination, according to the agency's published recalls.

When cannabis was first legalized, labs rushed to be licensed to capitalize on the expanding market. But labs with stringent testing methods and expensive equipment complained to the state of losing customers to operators that promised high potency results or had track records for approving most products.



Determined to spur regulators into action, Infinite Chemical Analysis Labs co-founder Josh Swider launched his own product testing campaign. (Genaro Molina / Los Angeles Times)

“There’s no checks and balances ... to make sure no one’s doing something wrong when they’re not being watched,” said Swider, of Infinite Chemical Analysis Labs. “That’s all we’ve ever asked for.

“I don’t want to be the judge, jury and executioner. I just wanna let everyone be treated fairly.”

Swider embarked on doing what regulators were not — testing weed specifically for pesticides.

He ultimately sent cannabis regulators 77 complaints about pesticide contamination he found in tests conducted from last October to May.

The complaints included Zoap flower sold by Grizzly Peak Farms and Cru Mai Tai vape carts, both with chlorfenapyr, prohibited at any detectable level; Fog City Farms Shark Bites with too much piperonyl butoxide and spiromesifen; West Coast Cure Biscotti vapes with myclobutanil, and Jack Herer-flavored ones with chlorfenapyr, paclobutrazol, bifenazate and trifloxystrobin. Backpack Boyz vapes contained chlorfenapyr, bifenazate, bifenthrin, etoxazole, malathion, myclobutanil, piperonyl butoxide, pyrethrins and spiromesifen. Most of the manufactures told reporters they were unaware of contamination because their product had been certified as safe by private labs.

It took 41 days from receiving Swider's complaint for regulators to announce California's [first-ever pesticide recall](#) of a cannabis product, the Zoap flower sold by Grizzly Peak Farms. The lab that had cleared the product for market, ProForma Labs, also lost its license. But regulators took no action against [those who grew the weed](#), a cultivation arm of the Kolas brand. Tests for The Times and WeedWeek showed Zoap sold under a Kolas label also contained chlorfenapyr.

Kevin McCarty, an owner of Sacramento-based Kings Holdings, which grew the Zoap strain, said no zero-tolerance pesticides were used in its cultivation and the cannabis had been certified by state-licensed labs. The Department of Cannabis Control "has not initiated any additional recalls involving us, and we have no additional comment," McCarty wrote by email.

The Department of Cannabis Control's second pesticide recall came in January, eight weeks after Swider's tipoff. The affected Fog City pre-rolls were nearly sold out by the

time the public was alerted in January.

Four flavors of Phat Panda vapes also were voluntarily removed from sale, for what regulators told consumers was a labeling mistake — despite outside tests that showed dangerous levels of malathion. California has issued no pesticide warnings since.

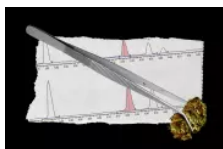
Swider's tests found that 19 varieties of vapes by California's fourth-largest brand, West Coast Cure, carried a large assortment of illegal pesticide loads. After learning of those results, operators of a San Francisco-based lab, Anresco, undertook their own tests and also notified California regulators of pesticides in eight West Coast Cure products.

Sarah Otis, Anresco's director of quality assurance, said regulators asked for reams of supporting data, then refused to say whether they would act on the information. "Now that we know there's contaminated product on the market, like what, what do we do with that?" she said.



Some batches of West Coast Cure vape pens exceeded safety limits for multiple pesticides. (Jason Armond / Los Angeles Times)

Anresco also agreed to test products for The Times and WeedWeek, as did a Santa Cruz-based cannabis testing company, SC Labs. Reporters bought products from dispensaries across the state, choosing some that were the subject of complaints and others at random. The results confirmed Swider's findings and identified additional contaminated products. Some goods violated state limits for a single chemical. Others, such as vapes by West Coast Cure and Backpack Boyz, contained dozens of undisclosed pesticides.



CALIFORNIA

How we tested for pesticides

June 14, 2024

Manufacturers universally defended their products and cast doubt on the lab testing industry.

Manufacturers Respond

June 14, 2024

“We’ve invested millions of dollars to build our business in compliance with California’s laws and regulations. We firmly advocate for the stringent testing mandated by the state to guarantee the safety and excellence of our products,” said Logan Wasserman, the CEO of West Coast Cure’s parent company, Shield Management Group. He contended that responsibility for ensuring product safety was on the labs that declared his vapes pesticide-free.

The Department of Cannabis Control issued no public recalls of West Coast Cure products, but did conduct a surprise inspection at its Long Beach facility. In early May, the agency levied a \$3.2-million fine against Wasserman’s company, saying it failed to guard against product tampering, including storing goods in the parking lot in shipping containers that had no security cameras. It was also cited for failing to provide legally required video proving the selection of product samples for lab testing was not rigged.

Wasserman did not respond to questions about the citations.

Directors of labs that had certified products cited as contaminated in Swider’s crusade accused him of seeking a competitive edge, even spiking pesticides into clean samples. They accused clients of having clean material tested and sending contaminated goods to market. None made these statements on the record. They cited fear of lost business, litigation and personal harm.

They also said pesticide testing is inexact, and easily manipulated.

“You could give it to 10 different labs and get 10 different results,” said Paul Hamrah, owner of Verity Analytics, the San Diego lab that approved vapes by West Coast Cure, Phat Panda and Maven that subsequently showed pesticides. Hamrah asserted that those testing products for The Times and WeedWeek tampered with the results as part of “an elaborate smear campaign.”

The labs denied the allegation.

State inspectors visited Hamrah’s lab in January, “trying to shut us down because of cases made against us by Infinite,” Hamrah said. In late April the state suspended Verity Analytics’ license, saying the lab “has engaged in activity that poses harm to public health, safety or welfare.”

The suspension — reviewed by The Times and WeedWeek — said Verity inflated potency of four cannabis products, failed to show accreditation, could not provide the chemical standards it used to check calibration and told regulators it had “unacceptable” accuracy ratings for testing pesticides, molds and solvents. Inspectors also said Verity labeled a pesticide as “non detect” when equipment showed contamination, without offering “any scientific criteria.”

Hamrah said what inspectors took to be a pesticide hit was instead “instrument noise.”

“I am determined to prove my lab is a victim of a grand and elaborate frame job by several labs because they couldn’t compete with us,” he said. “We were expanding and they got scared.”

Meanwhile, Swider became a target. He said he lost clients as word of his activism spread. Then while traveling in March, Swider received a cellphone call from a blocked number.

“I’m going to come and get you and your ... whole family,” the caller said. “You’re gonna pay for this.”

“It makes me want him to get out” of the cannabis industry, said his wife, Kaylena Swider. “He’s like, ‘What would I do?’”

In late May, Swider filed one more round of complaints with the Department of Cannabis Control, alerting the agency to excessive pesticides in 16 products, some of them subject of prior complaints but still for sale.

Days later, he received an email from the agency.

It was sending inspectors to audit his lab.



Cannabis regulators

California’s Business and Professions Code 26011.5 is explicit about the mission of the state cannabis regulatory agency: “The protection of the public shall be the highest priority. ... Whenever the protection of the public is inconsistent with other interests sought to be promoted, the protection of the public shall be paramount.”

In industry presentations, Elliot, the Department of Cannabis Control director, often identifies the challenges facing California cannabis as economic.

Chief among her concerns, she told the National Cannabis Industry Assn. in February, is the large swath of California that prohibits dispensaries. These “cannabis deserts,” as Elliott calls them, are the greatest constraint to “scalability,” or expansion, of California’s legal market.

To drive business to licensed dispensaries, Elliott's agency conceived the [Real CA Cannabis](#) campaign.

"We know we have a good amount of consumption from the illegal market. We know there's an opportunity through education to shift some behavior to the legal market," Elliott told the trade group.

The social media campaign, launched in February, included ads targeted at seniors, among others, because polling showed they were most swayed by safety messages.

The catchphrases promoting legal weed include "the good stuff" and "quality you can trust."

The belief that any cannabis product carrying a certificate of analysis, or COA, is safe is foundational for dispensary owners.

"We will not accept it [for sale] if it doesn't have a COA," said Dave Sisson, a board member of Foothills Health and Wellness, a legacy dispensary that over two decades has earned the trust of medical providers who send cancer patients to the store in Shingle Springs, east of Sacramento.

To learn some of these certified products carry pesticides, Sisson said, "is absolutely terrible."

"These are medically compromised people. They have to be very, very careful of what they put into their body."

"As a retailer, I'm sitting in this really strange position where everything comes to me 'safe and tested,'" said the owner of a multicounty dispensary chain, speaking anonymously because of concern of being tied to bad publicity for the struggling legal

industry. “But it’s so crazy that we’re operating in a system where” many are “gaming it.”

Elliott declined to be interviewed on the extent of the pesticide threat. Her agency selectively responded to requests for public records, and refused to release records regarding policies on pesticide contamination. It contended that it conducts random testing of products for sale to consumers.

Behind the scenes, internal records showed, the cannabis agency as early as late February sent buyers into the field to obtain products on Swider’s lists. They remained stockpiled for months while the department worked to get its Richmond lab — able only to test potency and check for mold — accredited to run pesticide screens. As of early June, accreditation records showed the lab was still not ready, and most of the products flagged for contamination had sold out. On Monday, a spokesperson said the regulatory agency would be able to begin tests on consumer products collected from store shelves by the following week.

Other agencies in the Newsom administration also refused to release cannabis-related records. The Department of Fish and Wildlife provided partial summaries but no records of pesticides encountered by its agents on raids. The Department of Toxic Substances Control said its reports on pesticides encountered on cannabis sites were confidential. The Department of Pesticide Regulation over eight months released only partial records that hinted at the extensive work its staff had undertaken to address pesticide-tainted weed.

Department of Cannabis Control employees, who spoke on condition of anonymity, complained of a lack of willingness within the agency to take a hard line on pesticide contamination. One said she was schooled on the importance of “not disrupting the market.”

In January, as The Times and WeedWeek began asking questions regarding its handling of licensed cannabis products, the agency launched a series of product recalls — not for pesticides, but for mold and misleading potency claims.

The department also asked the Legislature for an \$8.2-million budget increase, seeking to hire more enforcement lawyers and laboratory staff to develop testing protocols.

Within 48 hours of being provided the findings of this story for response, the deputy director of lab services left. No public reason for the departure was given.

A day later, speaking to the National Cannabis Industry Assn., Elliott emphasized her concern for public health.

“My road map isn’t about preserving what is. It’s about creating what is best for consumers, for the general public,” she said. “That’s sort of my North Star.”

How dirty is your weed

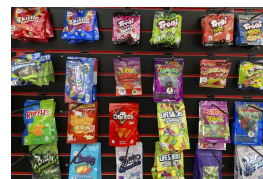
Alex Halperin is editor of the industry newsletter WeedWeek.

Times staff writer Adam Elmahrek contributed to this report.

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Paige St. John covers criminal justice, disasters and investigative stories for the Los Angeles Times from Northern California.

