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Groundwater Dependent Ecosystems of the Livermore Valley Groundwater Basin



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Cover photo: Riparian vegetation along Arroyo Las Positas, Livermore, CA.

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1 INTRODUCTION

This technical memorandum is anticipated to be included as an attachment to the 2022 Alternative Groundwater Sustainability Plan (Alt GSP) for the Livermore Valley Groundwater Basin. This memorandum identifies groundwater dependent ecosystems (GDEs) in the Livermore Valley Groundwater Basin. The Livermore Valley Groundwater Basin is managed by the Zone 7 Water Agency, which is the exclusive Groundwater Sustainability Agency (GSA) within its boundaries. Under the California Sustainable Groundwater Management Act (SGMA), GSAs are required to identify GDEs and other beneficial uses and users of groundwater and consider impacts to GDEs and beneficial users when developing their GSPs as codified in the California Code of Regulations (CCR) sections 23 CCR § 354.16(g), Water Code § 10723.2(e), and Water Code § 10727.4 (State of California 2021). SGMA defines GDEs as “ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface” (23 CCR § 351(m)). As described in The Nature Conservancy’s (TNC) guidance for GDE analysis (Rohde et al. 2018), a GDE’s dependence on groundwater refers to reliance of GDE species and/or ecological communities on groundwater for all or a portion of their water needs. Mapping GDEs requires mapping vegetation that can tap groundwater through their root systems, assessing where the depth of groundwater is within the rooting depth of that vegetation, and mapping the extent of surface water that is interconnected with groundwater (Rohde et al. 2018). Once the GDEs are mapped, the occurrence of special-status species can be used to assess the sensitivity of GDEs in the basin.

Based on the 2016 Alternative Groundwater Sustainability Plan (Zone 7 Water Agency 2016), the Livermore Valley Groundwater Basin is divided into three management areas (Figure 1):

- **The Main Basin Management Area** includes the major aquifer in the Livermore Valley Groundwater Basin and is comprised of deep alluvial sediments (Zone 7 Water Agency 2016).
- **The Fringe Management Area** makes up the northern and eastern portions of the Livermore Valley Groundwater Basin and does not provide a large source of groundwater to the basin due to poor water quality and low well yields (Zone 7 Water Agency 2016). The Fringe Management Area contains the Springtown Alkali Sink which supports several special status species and GDEs (Zone 7 Water Agency 2016).
- **The Upland Management Area** primarily makes up the southern portion of the groundwater basin and is underlain by the Livermore Formation, which is not extensively used for groundwater pumping due to poor water yields (Zone 7 Water Agency 2016).

Although groundwater pumping volumes in the Fringe and Upland Management Areas are small, potential GDEs were identified in these areas to provide a baseline inventory of GDEs in the basin and to inform future monitoring efforts rather than to develop sustainable management criteria for the 2022 Alt GSP Update.

This assessment was conducted in coordination with EKI Environment & Water, Inc. (EKI) and the Zone 7 Water Agency, as described below.

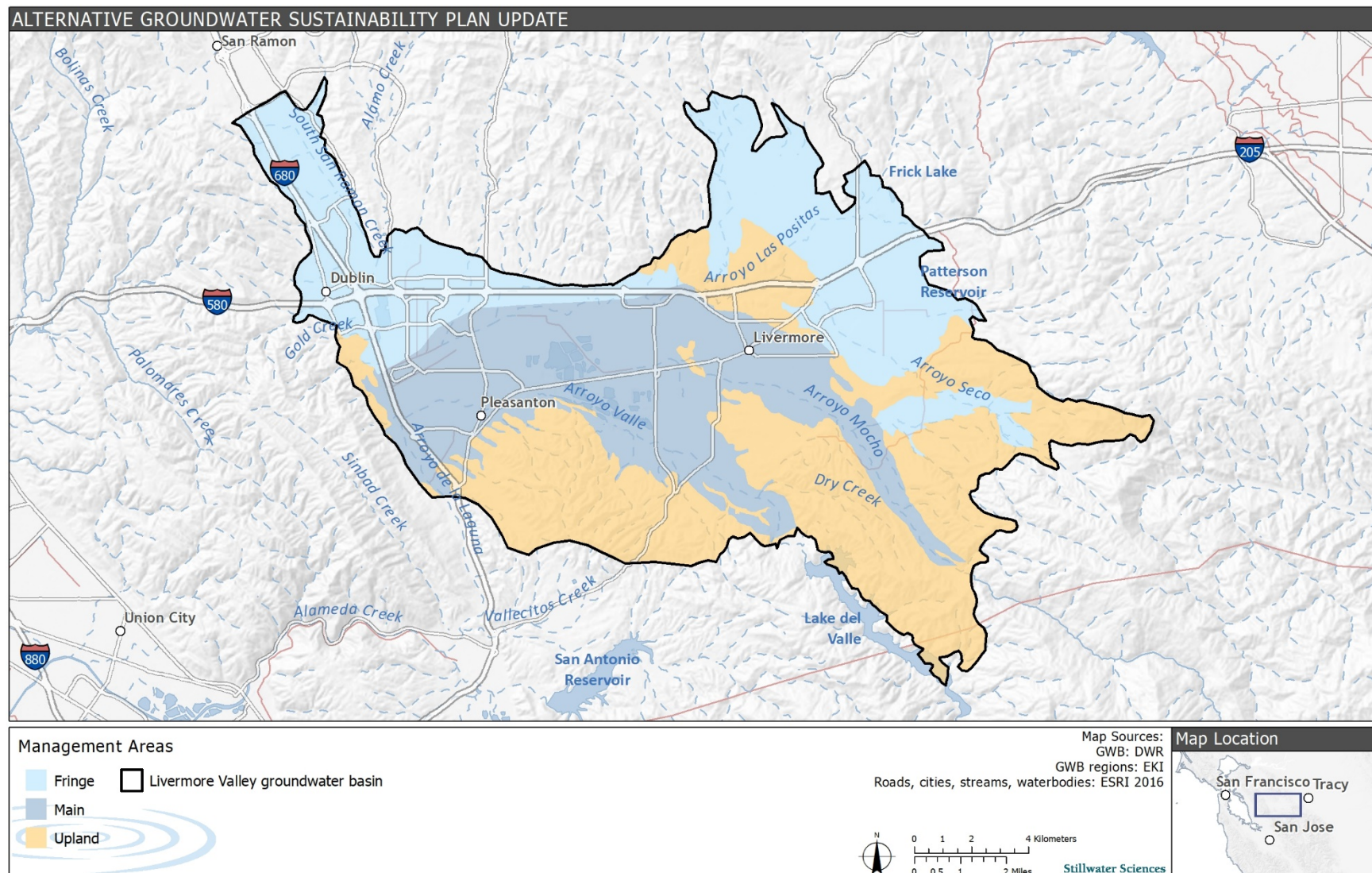


Figure 1. Livermore Valley Groundwater Basin Management Areas.

2 METHODS

2.1 GDE Identification

The procedure used for identifying GDEs is summarized below, and the steps are described in detail in the following sections.

1. **Data sources:** Potential GDEs in the Livermore Valley Groundwater Basin were identified using the California Department of Water Resources' (DWR) indicators of groundwater dependent ecosystems (iGDE) database. The database, which is published online¹ and referred to as the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset (Klausmeyer et al. 2018), includes the location and spatial extent of vegetation and wetland natural communities. This database uses statewide vegetation and wetland mapping coupled with information on the potential groundwater dependence of those communities to identify potential GDEs. This map can be refined by including additional or updated vegetation map sources. The vegetation data sources must then be prioritized (based on data resolution, quality and age) to produce an initial vegetation map of the groundwater basin.
2. **Procedure:** Once the maps are assembled, groundwater dependent vegetation communities are identified through a decision tree based on literature review and wetland status (Lichvar et al. 2016) of dominant species.
3. **Refine potential GDE map:** Potential groundwater dependent vegetation communities were initially identified where depths to groundwater were less than 30 feet (ft) anytime between 2015-2020. Where groundwater depth was unknown (e.g., in portions of the Fringe and Upland Management Areas) the vegetation community was not removed. Where potential GDEs did not reflect current conditions, obvious errors in the vegetation mapping (i.e., polygon boundaries) were corrected using aerial imagery. In addition, the potential GDE map incorporated results of a correlation analysis on depth to groundwater and GDE health-indicating indices provided by EKI. The potential GDE maps were further revised based on input from Zone 7 and EKI.
4. **Field visit:** Where the presence of potential GDE communities was uncertain, Stillwater botanists visited several sites to assess groundwater dependence in the field. Updates based on field observations were incorporated into the final GDE assessment.

2.1.1 Data sources

This section includes brief descriptions of the vegetation community data and other information sources used to identify and aggregate potential GDEs into final GDE units. The Indicators of Groundwater Dependent Ecosystems (iGDE) database (Klausmeyer et al. 2018) was reviewed in a geographic information system (GIS) and used to generate a preliminary map to serve as a guide for initial identification of potential GDEs in the Livermore Valley Groundwater Basin.

For more precise identification of potential GDEs, we developed a refined vegetation map by combining the Classification and Assessment with Landsat of Visible Ecology Groupings (CalVeg) dataset with several more recent datasets. Our refined vegetation map incorporates the following datasets:

¹ <https://gis.water.ca.gov/app/NCDatasetViewer/> [Accessed April 28, 2021]

- Classification and Assessment with Landsat of Visible Ecological Groupings (CalVeg) – United States Department of Agriculture - Forest Service (USDA 2014). *Central Coast region: Imagery date: 1997–2013; Minimum mapping unit (MMU): 2.5-acre.*
- Urban Creeks Council 2014 CalVeg update for third-order and higher channels. *Minimum mapping unit (MMU): ~0.5 acre.* Urban Creeks Council (2014).
- Springtown Alkali Sink Preserve Wetlands Mapping Project, Aerial Information Systems, Inc. (AIS 2009). *Minimum mapping unit (MMU): as low as 200 ft sq in wetland areas, 1.2-acre in general study area.*
- Sycamore Alluvial Woodland Tree Survey in Arroyo Mocho and Arroyo Valley, Alameda County, CA, Zone 7 Water Agency, San Francisco Estuary Institute, H.T. Harvey & Associates (SFEI and H.T. Harvey 2017).

AIS (2009) was considered the highest quality vegetation mapping due to its high resolution. The sycamore woodland mapping was also considered high quality but is of limited extent. Because of the recent date, we next used the UCC (2014) along the channels underlain by the original CalVeg mapping (Figure 2).

Table 1 and Figure 2 show, respectively, the acreage and extent of each dataset.

Table 1. Vegetation and wetland data sources for the Livermore Valley Groundwater Basin.

Data source	Mapped area (acres)
CalVeg	36,254
CalVeg – UCC updates	22,906
AIS Springtown Mapping	10,329
Zone 7 Sycamore Survey	40
Total¹	69,531

¹ Totals may not appear to sum exactly due to rounding error.

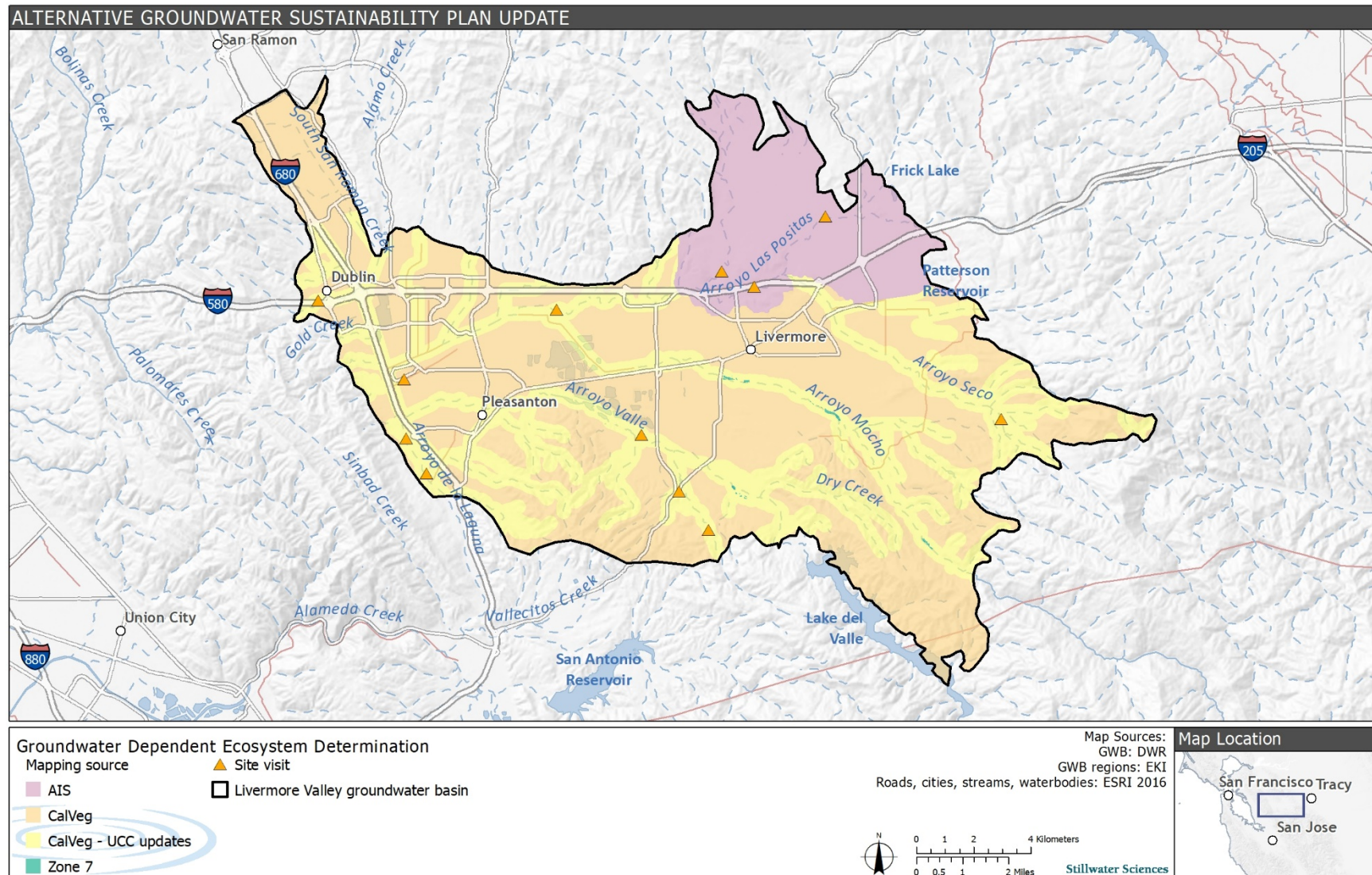


Figure 2. Extent of vegetation mapping data sources.

2.1.2 Procedure

The steps for defining and mapping GDEs outlined in Rohde et al. (2018) were used as a guideline for this process. A decision tree was applied to determine when species or biological communities were considered groundwater dependent based on definitions found in 23 CCR § 351(m) (State of California 2021) and Rohde et al. (2018). This decision tree, created to systematically and consistently address the range of conditions encountered, is summarized below; the term “unit” refers to an area with consistent vegetation and hydrology:

The unit is a GDE if groundwater is likely:

1. An important hydrologic input to the unit during some time of the year, AND
2. Important to survival and/or natural history of inhabiting species, AND
3. Associated with a regional aquifer used as a regionally important source of groundwater.

The unit is not a GDE if its hydrologic regime is primarily controlled by:

1. Surface discharge or drainage from a(n) upslope human-made structure(s), such as a mining pit, irrigation canal, irrigated fields, reservoir, cattle pond, or water treatment pond/facility.
2. Precipitation inputs directly to the unit surface. This excludes vernal pools from being GDEs where units are hydrologically supplied by direct precipitation and very local shallow subsurface flows from the immediately surrounding area.

Rohde et al. (2018) recommend that maps of potential GDEs be compared with local groundwater elevations to determine where groundwater is within the rooting depth of potential GDEs. Given uncertainties in extrapolating well measurements to GDEs and differences in surface elevation of wells and GDEs, Rohde et al. (2018) recommend assigning GDE status to vegetation communities either where groundwater is within 30 ft of the ground surface or where interconnected surface waters are observed.

2.1.3 Refine potential GDE map

The basin-wide vegetation and wetland map was reviewed, and each community was assigned a groundwater dependence category based on rankings for likelihood of connection to groundwater (i.e., unlikely or likely). This determination was based on species composition and the groundwater dependency of dominant species, whether they were considered groundwater dependent by the iGDE database (DWR 2021), and wetland indicator status (Lichvar et al. 2016).

These potential GDEs were then compared with groundwater depth (where known). Depth to groundwater contours for the Main Basin and Fringe Management Areas were provided by Zone 7 and EKI. In the Main Basin and Fringe Management Areas, phreatophytes that occur where groundwater is within 30 ft of the ground surface were identified as likely GDEs. Initial GDE maps used areas with groundwater depth less than 30 ft in a wet period, Spring 2019, using data provided by Zone 7 (Zone 7 2020). The map was revised to include areas where groundwater depths are less than 30 ft anytime between 2015-2020 using raster data of groundwater depth subsequently provided by EKI (EKI 2021).

Groundwater contours or rasters were not available for the Upland Management Area of the Livermore Valley Groundwater Basin due to the general lack of monitoring and production wells in this portion of the Basin. Where well data was available in the Upland Management Area, EKI

evaluated potential groundwater dependence for GDEs that occurred within one kilometer (approximately 0.6 miles) of the well and had minimum depth to water observations less than 30 ft between 2015 and 2020. These potential GDEs were evaluated in the field to assess groundwater dependence.

The southern portion of the Upland Management Area contains extensive valley oak (*Quercus lobata*) and blue oak (*Quercus douglasii*) communities (Figure 3). Valley oaks are included as phreatophytes in California by Klausmeyer et al. (2018) suggesting that they can rely on groundwater for part of their water needs. Klausmeyer et al. (2018) did not include blue oaks in their list of phreatophytes, but focused studies in blue oak woodlands suggest they can depend on groundwater to meet their water needs (e.g., Miller et al. 2010). Though these oaks are deep-rooted (maximum rooting depths range from 30-80 ft, depending on the species) and occur where depth to groundwater is unknown, they are unlikely to be affected by groundwater management because they occur in hillslopes, where hydraulic gradients are steep and groundwater production is de minimis as evidenced by the lack of wells in the area (Zone 7 Water Agency 2016). As such, these communities were not included in the final GDE map presented in Figure 4.

Zone 7 made additional comments on the preliminary GDE map, noting discrepancies between mapped GDEs and current vegetation as well as recent stream restoration projects which may be connected to groundwater. The vegetation map was subsequently adjusted to ensure that mapped polygons aligned with the current extent of vegetation, with a focus on the restoration project areas identified in comments provided by Zone 7.

EKI performed a correlation analysis between depth to groundwater and two remote sensing indices that indicate GDE's health by GDE unit, the Normalized Derived Moisture Index (NDMI) and the Normalized Derived Vegetation Index (NDVI), which indicate the vegetation moisture and vegetation greenness, respectively. The premise of the analysis is that, since the NDMI and NDVI indices can quantify changes in the rates and patterns of vegetation growth and moisture levels in plants over time, the relationship between these two indices and the depth to groundwater can be evaluated to examine whether these measures of GDE "health" have a relationship to shallow groundwater conditions. The preliminary GDE map was subsequently revised based on the results of the correlation analysis provided by EKI.

The occurrence and extent of interconnected surface water is uncertain in the Livermore Valley Groundwater Basin. Potential reaches of interconnected surface water were identified by EKI based on analysis of streambed elevations relative to recent depth to groundwater observations. These reaches generally overlapped with mapped GDEs and were not evaluated separately. Man-made open water areas (e.g., Chain of Lakes and golf course ponds) were removed from the final GDE map.

2.1.4 Field visit

Stillwater Sciences and EKI identified 12 sites to examine in the field based on uncertainties in the preliminary GDE maps, as shown on Figure 2. These sites included gaps in the GDE map where vegetation appeared similar to GDEs that occurred immediately upstream and downstream of the site, riparian vegetation along channels, and mapped GDEs underlain by thick clay layers. Additionally, Stillwater scientists assessed potential GDEs where groundwater data was sparse (near Sycamore Park) and near Springtown. Groundwater dependence of these sites was determined by assessing various local water sources and the width of the riparian zone. Where riparian zones were narrow and relatively sparse, other water sources likely support the vegetation. Where existing vegetation and wetland areas extend beyond a narrow strip along the

channel, groundwater dependence was considered likely. The results of the field investigation are shown in Table 2 and Figure 3, and the Final likely GDE map is presented in Figure 4.

2.2 Special-status Species

As part of the ecological inventory, special-status species and sensitive natural communities that are potentially associated with GDEs in the Livermore Valley Groundwater Basin were identified. For the purposes of this document, special-status species are defined as those:

- Listed, proposed, or under review as endangered or threatened under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA);
- Designated by California Department of Fish and Wildlife (CDFW) as a Species of Special Concern;
- Designated by CDFW as Fully Protected under the California Fish and Game Code (Sections 3511, 4700, 5050, and 5515);
- Designated as Bureau of Land Management (BLM) sensitive;
- Designated as rare under the California Native Plant Protection Act (CNPPA); and/or
- Included on CDFW's most recent Special Vascular Plants, Bryophytes, and Lichens List (CDFW 2020b) with a California Rare Plant Rank (CRPR) of 1, 2, 3, or 4.

2.2.1 Data sources

Stillwater ecologists queried databases on regional and local occurrences and spatial distributions of special-status species within the Livermore Valley Groundwater Basin. Spatial database queries included potential GDEs plus a 1-mile buffer. Databases queried include:

- California Natural Diversity Database (CNDDDB) (CDFW 2020);
- California Native Plant Society (CNPS) Manual of California Vegetation (2020);
- eBird (2021); and
- TNC freshwater species lists generated from the California Freshwater Species Database (CAFSD) (TNC 2020).

2.2.2 Procedure

Stillwater reviewed the database query results and identified special-status species and vegetation communities that may occur within or be associated with the vegetation and aquatic communities in or immediately adjacent to potential GDEs. Stillwater ecologists then consolidated these special-status species and sensitive community types into a list, along with summaries of habitat preferences, potential groundwater dependence, and reports of any known occurrences.

Wildlife species were evaluated for potential groundwater dependence using determinations from the Critical Species Lookbook (Rohde et al. 2019) or by evaluating known habitat preferences, life histories, and diets. Species GDE associations were assigned one of three categories:

- Direct—species directly dependent on groundwater for some or all water needs (e.g., cottonwood with roots in groundwater, juvenile steelhead in dry season)
- Indirect—species dependent upon other species that rely on groundwater for some or all water needs (e.g., riparian birds)

- No known reliance on groundwater

Sensitive natural communities were classified as either likely or unlikely to depend on groundwater based on species composition using the same methodology as vegetation communities (Section 2.1.3). Plant species were evaluated for potential groundwater dependence based on their habitat (Jepson Flora Project 2020) and association with vegetation communities classified as GDEs. Special-status plant GDE associations were assigned one of three categories: likely, possible, or unlikely. The “possible” category was included to classify plant species with limited habitat data or where a species may have an association with a vegetation community identified as a GDE (e.g., Coast live oak, California sagebrush).

Database query results for local and regional special-status species occurrences were combined with their known habitat requirements to develop a list of groundwater dependent special-status species (Section 3.2) that satisfy the following criteria: (1) documented to occur within the GDE unit, or (2) known to occur in the region and suitable habitat present in the GDE unit.

3 RESULTS

3.1 Comparison with iGDE Database

The differences between the iGDE map (DWR 2021) and the final GDE map are shown in Figure 3. The primary differences are the addition of GDEs in the northeast portion of the basin where the AIS mapping occurred and removal of man-made open water polygons along Chain of Lakes (along Arroyo Valle) and near Dublin. Some changes reflect differences between the UCC update to the CalVeg map and Stillwater's edits to the map along Arroyo Mocho and Arroyo Valle. In particular, the width of the riparian vegetation along both rivers increased in places. The reclassification near Lake Boris on Arroyo Valle (downstream of Site I) reduced the extent of GDEs downstream of the lake. In addition, several changes were made based on the site visit (Figure 3, Table 2). The vegetation was removed along Arroyo Del Laguna and west of Pleasanton (Sites B, C, and D). These sites occur above a thick clay layer (known colloquially as the Overburden layer) that precludes connection to the aquifer. Observations during the field visit suggested that the riparian vegetation at Sites B–D was likely dependent on surface water rather than groundwater due to the relatively narrow riparian zone. Site L (Figure 3) was also removed since the very sparse riparian vegetation suggested the area was not connected to groundwater. Wetlands mapped within man-made lakes and ponds (e.g., Frick Lake in the eastern part of the basin) were also removed. The final GDE map is presented in Figure 4.

Table 2. Likely groundwater dependence of field sites.

Site	Site description	Groundwater dependence
A	Mature trees including oaks (<i>Quercus</i> spp.), redwood (<i>Sequoia sempervirens</i>), tree of heaven (<i>Ailanthus altissima</i>), eucalyptus (<i>Eucalyptus</i> spp.)	Likely, kept
B	Flood control channel with planted willows (<i>Salix</i> spp.)	Unlikely, removed
C	Narrow band of willows, cottonwoods (<i>Populus</i> spp.), and oaks; channel incised up to 30 ft	Unlikely, removed
D	Narrow band of willows, cottonwoods, and valley oaks (<i>Quercus lobata</i>)	Unlikely, removed
E	Narrow band of sparse riparian vegetation	Unlikely, removed
F	Valley oak, live oak (<i>Quercus agrifolia</i>) and willow	Likely, kept
G	Willows, live oak, eucalyptus; may have perennial flow	Likely, kept
H	Near Springtown; likely groundwater dependent	Likely, added
I	Similar to upstream and downstream GDEs	Likely, added
J	Mature riparian trees, little surface water	Likely, added
K	Sycamore Park; closed canopy, mature riparian trees	Likely, added
L	Sparse valley oaks along incised, intermittent channel	Unlikely, removed

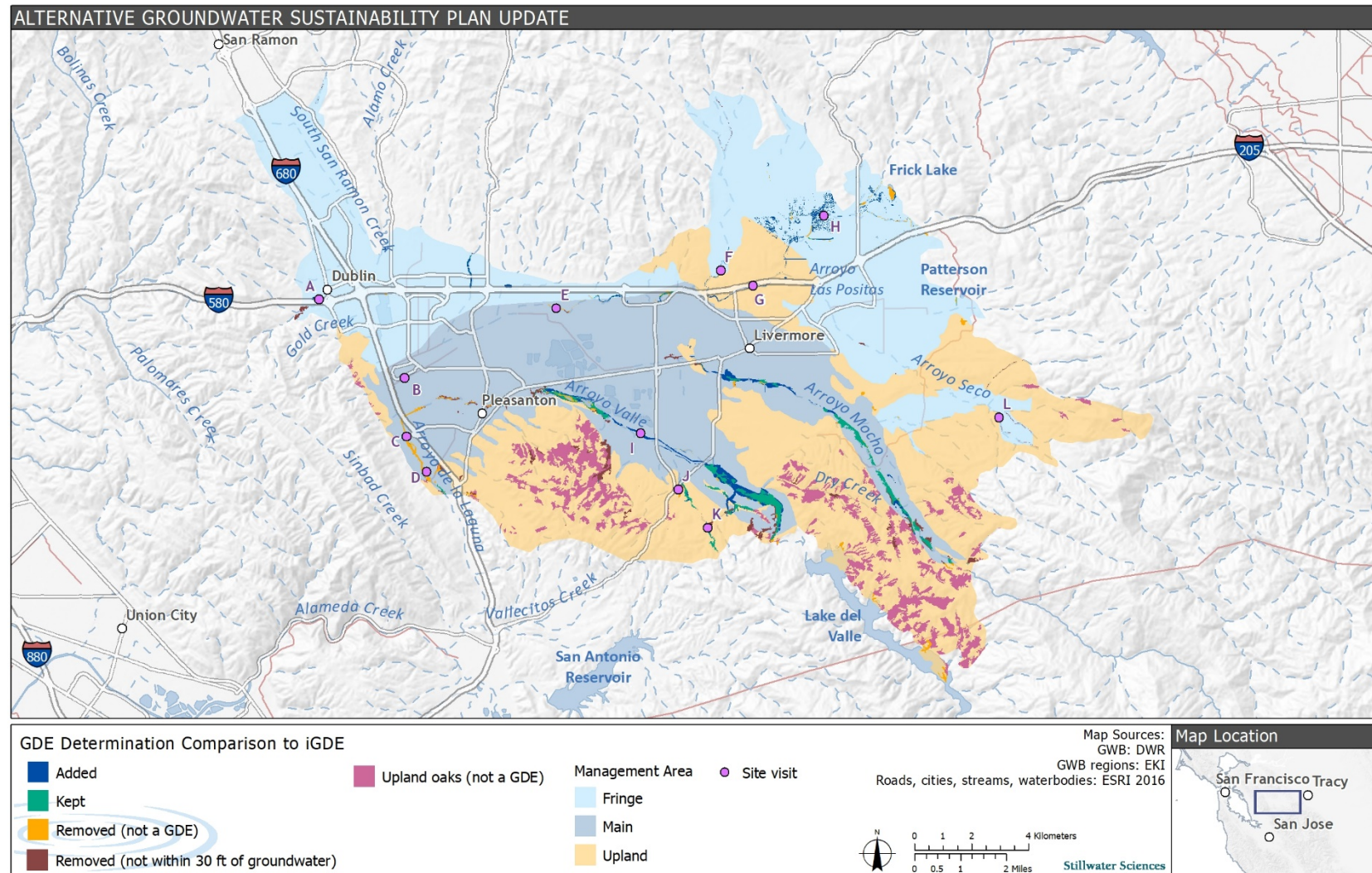


Figure 3. Comparison of the GDE map with the iGDE database (DWR 2021).

Note: The reasons for GDE removal are discussed in Section 3.1 and Table 2.

3.2 GDEs in the Livermore Valley Groundwater Basin

The Livermore Valley Groundwater Basin contains 1062 acres of likely GDEs, approximately 2% of the total basin area (Figure 4). The Main Basin Management Area contains approximately 69% of the total likely GDE area, the Fringe Management Area approximately 20%, and the Upland Management Area contains the remaining 11% of the GDEs. The most prevalent vegetation communities across all likely GDE units are the riparian mixed hardwood alliance and California sycamore alliance, which respectively comprise 40% and 30% of likely GDE area in the basin and are located almost entirely in the Main Basin Management Area. The Alkaline mixed grasses and forbs alliance comprises 10% of total likely GDE area and is located almost entirely in the Fringe Management Area.

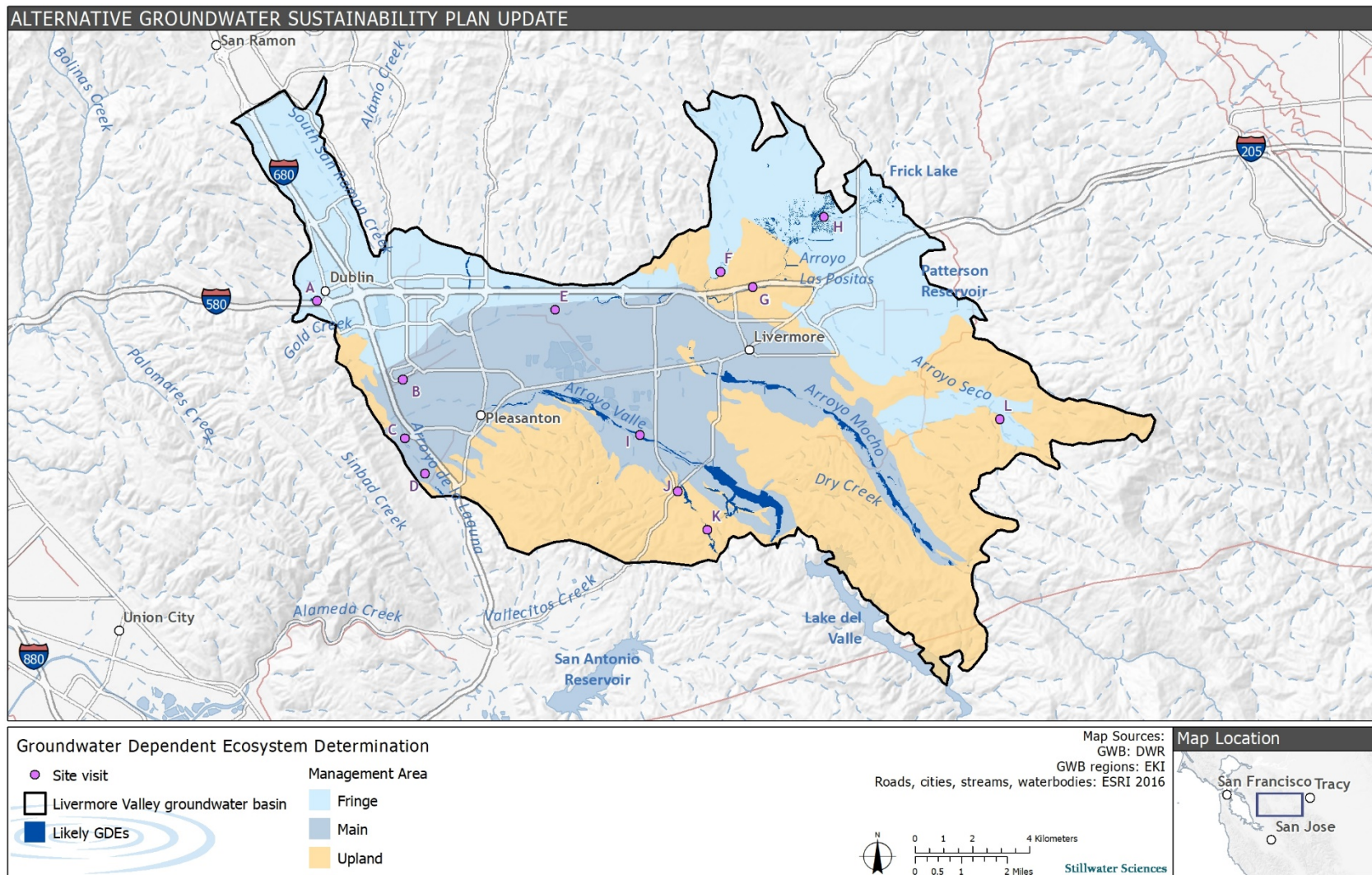


Figure 4. Groundwater dependent ecosystems in the Livermore Basin.

The Main Basin Management Area contains 737 acres of likely GDEs. The most prevalent vegetation communities are the California sycamore alliance (250 acres), riparian mixed hardwood alliance (239 acres), and valley oak alliance (212 acres) (Figure 5). GDEs typically occur along riparian zones, particularly Arroyo Mocho, Arroyo Valle, and Arroyo Las Positas. Additional GDEs occur in Sycamore Park in the upper extent of Arroyo Valle. The valley oak alliance is mostly found in the upstream portions of Arroyo Mocho within the main basin.

The riparian mixed hardwood alliance is comprised of willows (*Salix* spp.) and Fremont cottonwoods (*Populus fremontii*), which have maximum reported rooting depths in the literature of about 7 ft (The Nature Conservancy 2018) but can occur at relative elevations of 10–15 ft in some cases (Stillwater Sciences 2007). Maximum rooting depths for California sycamore (*Platanus racemosa*) are not reported in the literature, but American sycamore (*Platanus occidentalis*) has a maximum reported rooting depth of about 9 ft (The Nature Conservancy 2018). The valley oaks (*Quercus lobata*) that make up the valley oak alliance have the deepest rooting depth of the riparian vegetation found in the main basin measured maximum rooting depths up to 24 ft (The Nature Conservancy 2018).

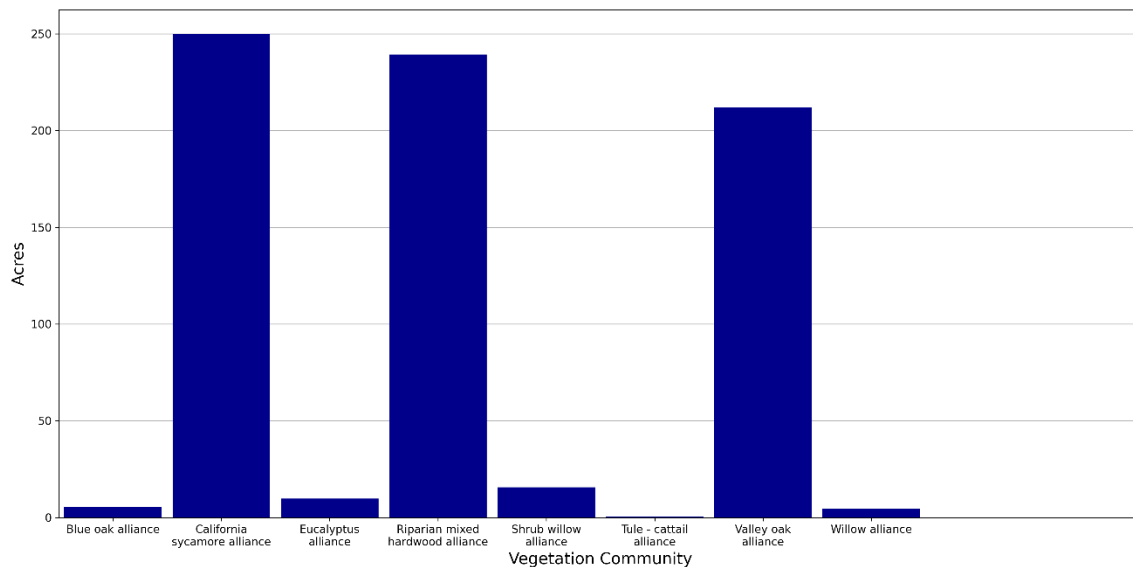


Figure 5. Likely GDE vegetation communities in the Main Basin Management Area, by acreage. Only eight likely GDE vegetation communities occur in the management area.

The Fringe Management Area contains 210 acres of likely GDEs. The most prevalent vegetation community is the alkaline mixed grasses and forbs alliance (100 acres). Other alkaline communities are also prevalent: alkaline mixed scrub alliance (29 acres) and alkaline flats (15 acres) (Figure 6). The GDEs in the Fringe Management Area occur along Arroyo Las Positas and the smaller spring-fed channels and wetlands in the northeast portion of the Fringe Management Area near Springtown (the northeasternmost site visit marker in Figure 4). Of the 144 acres of alkaline likely GDE vegetation communities, 54 acres occur in the Springtown Alkali Sink, as defined in the Zone 7 Alternative GSP (2016). The rooting depth of species in the alkaline mixed grasses and forbs alliance is unknown but is likely shallow (< 2 ft). The dominant species of the alkaline mixed scrub alliance is iodine bush (*Allenrolfea occidentalis*), which has reported maximum rooting depths of 2 ft. The dominant species of the tule-cattail alliance include sedges (*Carex* spp.), tules (*Scirpus* spp.), cattails (*Typha* spp.), and spikerushes (*Eleocharis* spp.). The

rooting depth of these genera is typically less than 1 ft. The riparian mixed hardwood alliance has maximum rooting depths of about 7 ft (see above).

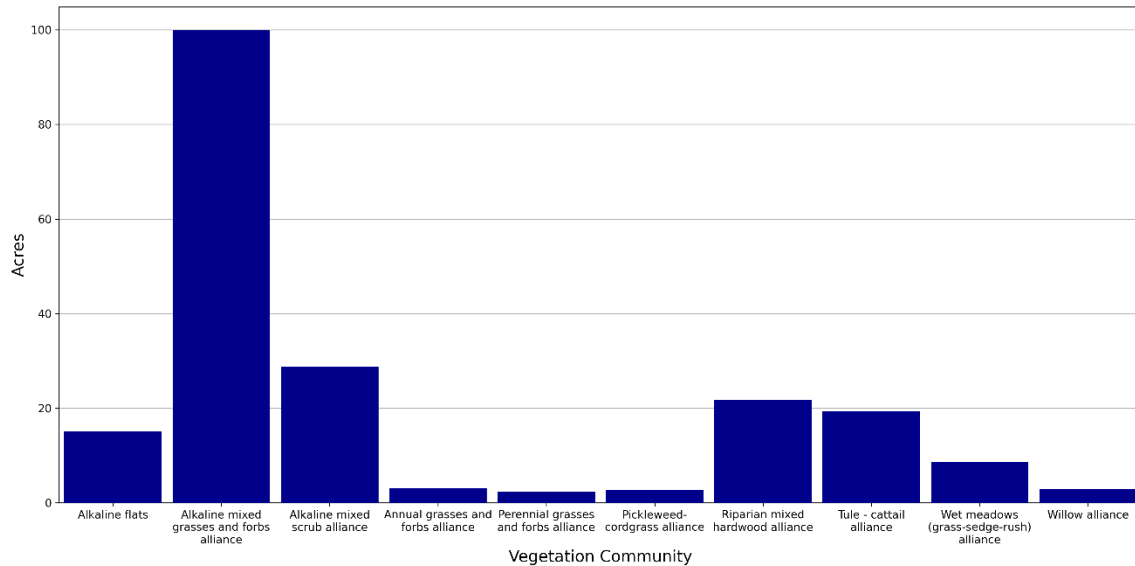


Figure 6. Ten most common likely GDE vegetation communities in the Fringe Management Area, by acreage.

The Upland Management Area contains 101 acres of likely GDEs. The most prevalent vegetation community is the riparian mixed hardwood alliance (74 acres) (Figure 7). GDEs in this unit occur in the riparian zones of smaller tributaries. The riparian mixed hardwood alliance is comprised of willows (*Salix* spp.) and Fremont cottonwoods (*Populus fremontii*), which have maximum reported rooting depths in the literature of about 7 ft (The Nature Conservancy 2018) but can occur at relative elevations of 10–15 ft in some cases (Stillwater Sciences 2007).

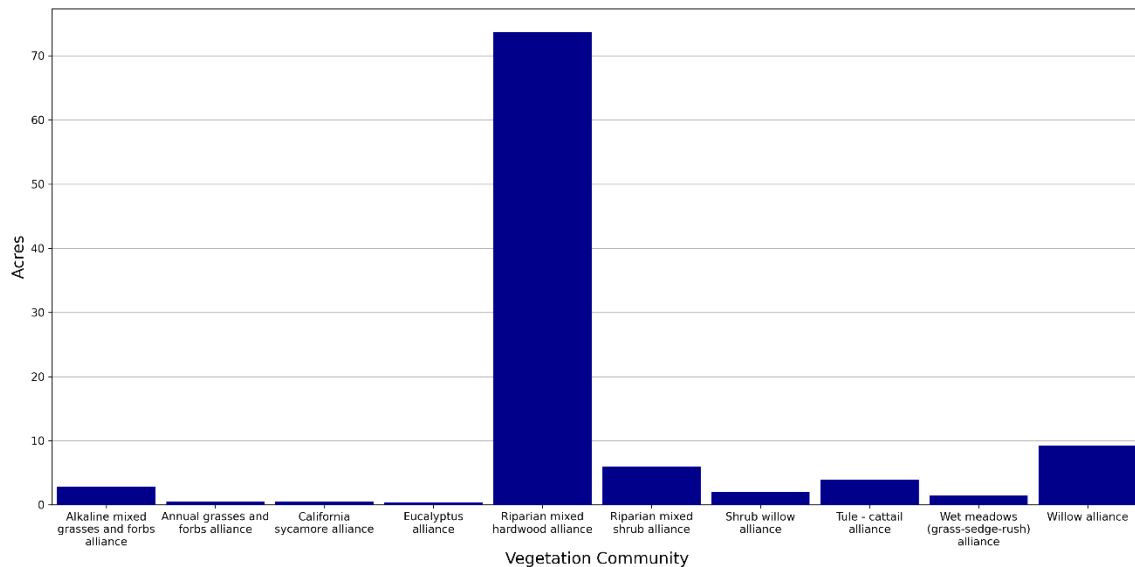


Figure 7. Ten most common likely GDE vegetation communities in the Upland Management Area, by acreage.

3.3 Special-status Species

3.3.1 Critical habitat

The Livermore Valley Groundwater Basin includes United States Fish and Wildlife Service (USFWS) designated critical habitat for four federally listed species: Alameda whipsnake (*Masticophis lateralis euryxanthus*) (936 acres), California red-legged frog (*Rana draytonii*) (7,273 acres), California tiger salamander (*Ambystoma californiense*) (0.5 acres), and vernal pool fairy shrimp (*Branchinecta lynchi*) (1,337 acres) (USFWS 2006a, USFWS 2010, USFWS 2005, USFWS 2006b). The locations of critical habitat for each species within the Livermore Valley Groundwater Basin are shown in Figure 8. Of the designated critical habitat, most of the habitat for the vernal pool fairy shrimp is co-located with mapped GDEs, but this species relies on vernal pools, which are dependent on rainfall, rather than groundwater and is therefore unlikely to be groundwater dependent. Most of the critical habitat for California red-legged frogs and Alameda whipsnake occurs outside of the defined GDEs, with approximately 2 acres of their critical habitat overlapping with a riparian GDE at the upstream end of Arroyo Mocho.

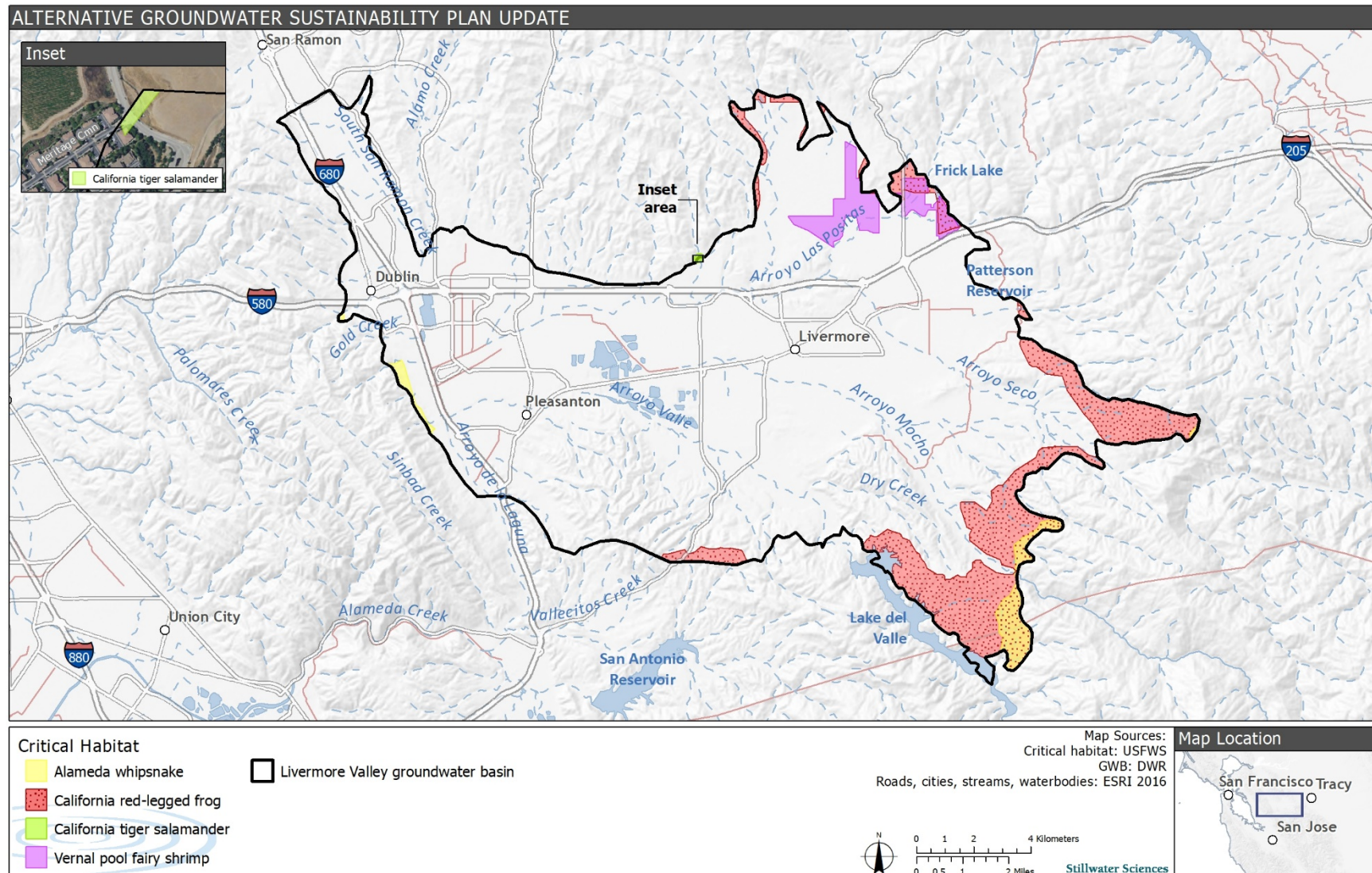


Figure 8. Designated critical habitat within the Livermore Valley Groundwater Basin.

3.3.2 Plants

Twenty-two special-status plants occur within the basin (Table 3). Of these, 12 were likely dependent upon groundwater, four were possibly dependent on groundwater, one was unlikely to be groundwater dependent, and five were not groundwater dependent (Table 3). All 12 special-status plants likely dependent on groundwater occurred in the Fringe Management Area, and three of the 12 also occurred in the Upland Management Area. The likely groundwater dependent special-status plants in the Fringe Area mostly were observed in or around the Springtown Alkali Sink.

Table 3. Groundwater dependance of special-status plant species in the Livermore Valley Groundwater Basin.

Common name <i>Scientific name</i>	Status ¹	Association with GDE	Documented occurrence location	Query source ²
Alkali milk-vetch <i>Astragalus tener</i> var. <i>tener</i>	G2T1, S1, 1B.2	Likely	Fringe	CNDDB
Heartscale <i>Atriplex cordulata</i> var. <i>cordulata</i>	G3T2, S2, 1B.2	Likely	Fringe	CNDDB
Brittlescale <i>Atriplex depressa</i>	G2, S2, 1B.2	Likely	Fringe	CNDDB
Lesser saltscale <i>Atriplex minuscula</i>	G2, S2, 1B.1	Possible	Fringe	CNDDB
Big-scale balsamroot <i>Balsamorhiza macrolepis</i>	G2, S2, 1B.2	Not a GDE	Uplands	CNDDB
Big tarplant <i>Blepharizonia plumosa</i>	G1G2, S1S2, 1B.1	Not a GDE	Outside of basin	CNDDB
Congdon's tarplant <i>Centromadia parryi</i> subsp. <i>congdonii</i>	G3T1T2, S1S2, 1B.1	Possible	Fringe, Uplands	CNDDB
Hispid salty bird's-beak <i>Chloropyron molle</i> subsp. <i>hispidum</i>	G2T1, S1, 1B.1	Likely	Fringe	CNDDB
Palmate-bracted bird's-beak <i>Chloropyron palmatum</i>	G1, S1, 1B.1	Likely	Fringe, Uplands	CNDDB
Livermore tarplant <i>Deinandra bacigalupii</i>	G1, S1, 1B.1	Likely	Fringe	CNDDB
Hospital Canyon larkspur <i>Delphinium californicum</i> subsp. <i>interius</i>	G3T3, S3, 1B.2	Not a GDE	Main, Uplands	CNDDB

Common name <i>Scientific name</i>	Status ¹	Association with GDE	Documented occurrence location	Query source ²
Jepson's coyote-thistle <i>Eryngium jepsonii</i>	G2, S2, 1B.2	Likely	Fringe	CNDDB
San Joaquin spearscale <i>Extriplex joaquinana</i>	G2, S2, 1B.2	Possible	Fringe	CNDDB
Stinkbells <i>Fritillaria agrestis</i>	G3, S3, 4.2	Unlikely	Fringe	CNDDB
Diablo helianthella <i>Helianthella castanea</i>	G2, S2, 1B.2	Possible	Fringe, on the edge of basin	CNDDB
Prostrate vernal pool navarretia <i>Navarretia prostrata</i>	G2, S2, 1B.2	Likely	Fringe	CNDDB
Hairless popcornflower <i>Plagiobothrys glaber</i>	GX, SX, 1A	Likely	Fringe, Uplands	CNDDB
California alkali grass <i>Puccinellia simplex</i>	G3, S2, 1B.2	Likely	Fringe, Uplands	CNDDB
Chaparral ragwort <i>Senecio aphanactis</i>	G3, S2, 2B.2	Not a GDE	Outside of Basin	CNDDB
Long-styled sand-spurrey <i>Spergularia macrotheca</i> var. <i>longistyla</i>	G5T2, S2, 1B.2	Likely	Fringe	CNDDB
Saline clover <i>Trifolium hydrophilum</i>	G2, S2, 1B.2	Likely	Fringe	CNDDB

Common name <i>Scientific name</i>	Status ¹	Association with GDE	Documented occurrence location	Query source ²
Caper-fruited tropidocarpum <i>Tropidocarpum capparideum</i>	G1, S1, 1B.1	Not a GDE	Outside of Basin	CNDDDB

¹ Status codes:

G = Global

T = Subspecies or variety

Federal

FT = Listed as threatened under the federal Endangered Species Act

FPT = Proposed as threatened under the federal Endangered Species Act

FD = Federally delisted

State

S = Sensitive

SE = Listed as Endangered under the California Endangered Species Act

ST = Listed as Threatened under the California Endangered Species Act

SSC = CDFW species of special concern

SFP = CDFW fully protected species

Rank

1 Critically Imperiled—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.

2 Imperiled—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.

3 Vulnerable—At moderate risk of extinction or elimination due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.

4 Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.

5 Demonstrably Secure—Common; widespread and abundant.

Q Taxonomic questions associated with this name

Ranks such as S2S3 indicate a ranking between S2 and S3

California Rare Plant Rank (CRPR)

1B Plants rare, threatened, or endangered in California and elsewhere

2B Plants rare, threatened, or endangered in California, but more common elsewhere

4 More information needed about this plant, a review list

4 Plants of limited distribution, a watch list

CRPR Threat Ranks:

0.1 Seriously threatened in California (high degree/immediacy of threat)

0.2 Fairly threatened in California (moderate degree/immediacy of threat)

0.3 Not very threatened in California (low degree/immediacy of threats or no current threats known)

GDE Likelihood**Likely** Species habitat includes multiple GDE habitats and the species has a wetland plant rating in the USACE Arid West Regional Supplement (FAC, FACW, or OBL)**Possible** Species habitat range includes at least some GDE habitats (per CNPS and/or Jepson), however the species has an upland plant rating in the USACE Arid West Regional Supplement (FACU, UPL, or NL/UPL [i.e., not listed therefore considered upland])**Unlikely** Species habitat associations do not include a potential GDE and it is associated with upland habitats. However, it has a plant rating in the USACE Arid West Regional Supplement of sometimes occurring in wetlands (e.g., FAC).**Not a GDE** Species habitat associations do not include a potential GDE and it is associated with upland habitats. Also, it has an upland plant rating in the USACE Arid West Regional Supplement.²Query source: CNDDDB: California Natural Diversity Database (CDFW 2020a)

3.3.3 Terrestrial and aquatic wildlife

Thirty-one special-status terrestrial and aquatic wildlife species were identified as having the potential to occur within the Livermore Valley Groundwater Basin. Of these, 14 were potentially groundwater dependent species: two amphibian species, two reptile species, seven bird species, and three mammal species. Additional information on these groundwater dependent species, including regulatory status and habitat associations, is provided in Table 4. Ten of the groundwater dependent special status species are likely to occur in the Main Basin, eight of the groundwater-dependent special status species are likely to occur in the Fringe Management Area, and 13 of the groundwater-dependent special status species are likely to occur in the Upland Management Area.

Table 4. Groundwater-dependence of special-status terrestrial and aquatic wildlife species with potential to occur or suitable habit in the Livermore Valley Groundwater Basin.

Common name <i>Scientific name</i>	Status ¹ Federal/State	Potential to occur in the Livermore Valley Groundwater Basin ²	Documented occurrence location	Query source ³	GDE . association ⁴	Habitat and documented occurrences in Livermore Valley Groundwater Basin Groundwater Basin
Invertebrates						
Longhorn fairy shrimp <i>Branchinecta longiantenna</i>	FE/–	Likely	Main, Fringe, Uplands	CNDDDB, CAFSD	No known reliance on groundwater	Vernal pools; also found in sandstone rock outcrop pools, grass-bottomed pools, and claypan pools.
Vernal pool fairy shrimp <i>Branchinecta lynchi</i>	FT/–	Likely (critical habitat)	Fringe	CNDDDB, CAFSD	No known reliance on groundwater	Vernal pools; also found in sandstone rock outcrop pools. The Livermore Valley Groundwater Basin includes 1,337 acres of USFWS designated critical habitat.
Crotch bumble bee <i>Bombus crotchii</i>	–/SCE	Likely	Fringe, Uplands	CNDDDB	No known reliance on groundwater	Inhabits open grassland and scrub habitats in Coastal California east towards the Sierra-Cascade Crest. Nests are often located underground in abandoned rodent burrows, or above ground in tufts of grass, rock piles, or tree cavities.
Western bumble bee <i>Bombus occidentalis</i>	–/SCE	Likely	Fringe, Uplands	CNDDDB	No known reliance on groundwater	Uses flowering plants in meadows and forested openings; abandoned rodent burrows are used for nest and hibernation sites for queens.

Common name <i>Scientific name</i>	Status ¹ Federal/State	Potential to occur in the Livermore Valley Groundwater Basin ²	Documented occurrence location	Query source ³	GDE . association ⁴	Habitat and documented occurrences in Livermore Valley Groundwater Basin Groundwater Basin
Amphibian						
California red-legged frog <i>Rana draytonii</i>	FT/SSC	Likely (Critical Habitat)	Main, Fringe, Uplands	CNDDDB, CAFSD	Direct	Breeds in still or slow-moving water with emergent and overhanging vegetation, including wetlands, wet meadows, ponds, lakes, and low-gradient, slow moving stream reaches with permanent pools; uses adjacent uplands for dispersal and summer retreat. Relies on surface water that may be supported by groundwater (Rohde et al. 2019). The Livermore Valley Groundwater Basin includes 7,273 acres of USFWS designated critical habitat.
California tiger salamander <i>Ambystoma californiense</i>	FT/ST	Likely (Critical Habitat)	Fringe, Uplands	CNDDDB, CAFSD	No known reliance on groundwater	Grassland, oak savannah, or edges of woodland that provide subterranean refuge (typically mammal burrows); breeds in nearby temporary ponds, vernal pools, or slow-moving parts of streams. The Livermore Valley Groundwater Basin includes 0.5 acres of USFWS designated critical habitat.
Foothill yellow- legged frog <i>Rana boylei</i>	BLMS/SE	Likely	Main, Uplands	CNDDDB	Direct	Shallow tributaries and mainstems of perennial streams and rivers, typically associated with cobble or boulder substrate; occasionally found in isolated pools, vegetated backwaters, and deep, shaded, spring-fed pools. The frog is reliant on surface water that may be fed by groundwater.
Western spadefoot <i>Spea hammondi</i>	BLMS/SSC	Likely	Fringe, Uplands	CNDDDB, CAFSD	No known reliance on groundwater	Areas with sparse vegetation and/or short grasses in sandy or gravelly soils; primarily in washes, river floodplains, alluvial fans, playas, alkali flats, among grasslands, chaparral, or pine-oak woodlands; breeds in ephemeral rain pools with no predators.

Common name <i>Scientific name</i>	Status ¹ Federal/State	Potential to occur in the Livermore Valley Groundwater Basin ²	Documented occurrence location	Query source ³	GDE . association ⁴	Habitat and documented occurrences in Livermore Valley Groundwater Basin Groundwater Basin
Reptile						
Alameda whipsnake <i>Masticophis lateralis euryxanthus</i>	FT/ST	Likely (Critical Habitat)	Uplands	CNDDDB	Indirect	Chaparral (northern coastal sage scrub and coastal sage) and rocky outcrops; may venture into adjacent habitats, including grassland, oak savanna, and woodlands. Relies on native vegetation that may be groundwater dependent vegetation (e.g., <i>Quercus</i> spp.) (Rohde et al. 2019). The Livermore Valley Groundwater Basin includes 936 acres of USFWS designated critical habitat.
Coast horned lizard <i>Phrynosoma blainvillii</i>	BLMS/SSC	Likely	Main, Fringe	CNDDDB	No known reliance on groundwater	Open areas with sandy soil and/or patches of loose soil and low/scattered vegetation in scrublands, grasslands, conifer forests, and woodlands; frequently found near ant hills. Feeds on ants and other small invertebrates (e.g., spiders, beetles, and grasshoppers).
Northern California legless lizard <i>Anniella pulchra</i>	–/SSC	Possible	Outside of basin	CNDDDB	No known reliance on groundwater	Occurs in moist, warm, loose soil with plant cover and in sparsely vegetated areas of chaparral, pine-oak woodlands, desert scrub, and stream terraces with sycamores, cottonwoods, or oaks. Forages in loose soil, sand, and leaf litter for larval insects, beetles, termites, and spiders.
San Joaquin coachwhip <i>Masticophis flagellum ruddocki</i>	–/SSC	Likely	Uplands	CNDDDB	No known reliance on groundwater	Open, dry, treeless areas, including grassland and saltbush scrub; uses rodent burrows, shaded vegetation, and surface objects as refuge.
Southwestern pond turtle <i>Actinemys pallida</i>	BLMS/SSC	Likely	Main, Fringe, Uplands	CNDDDB, CAFSD	Direct	Ponds, lakes, rivers, streams, creeks, marshes, and irrigation ditches with basking sites. Feeds on aquatic plants, invertebrates, worms, frog and salamander eggs and larvae, crayfish, and occasionally frogs and fish. Relies on surface water that may be supported by groundwater (Rhode et al. 2019).

Common name <i>Scientific name</i>	Status ¹ Federal/State	Potential to occur in the Livermore Valley Groundwater Basin ²	Documented occurrence location	Query source ³	GDE . association ⁴	Habitat and documented occurrences in Livermore Valley Groundwater Basin Groundwater Basin
Bird						
American peregrine falcon <i>Falco peregrinus anatum</i>	–/SFP	Likely	Main, Fringe, Uplands	CNDDDB, eBird	No known reliance on groundwater	Wetlands, woodlands, cities, agricultural lands, and coastal area with cliffs (and rarely broken-top, predominant trees) for nesting; often forages near water. Prey includes birds (e.g., shorebirds, ducks, grebes, gulls, pigeons, and songbird) and bats.
American White Pelican <i>Pelecanus erythrorhynchos</i>	–/SSC	Likely	Main, Fringe, Uplands	CAFSD, eBird	Indirect	Salt ponds, large lakes, and estuaries; loafs on open water during the day; roosts along water's edge at night. Forages for small fish in shallow water on inland marshes.
Bald eagle <i>Haliaeetus leucocephalus</i>	BGEPA, BLMS/SE, SFP	Likely	Main, Fringe, Uplands	CNDDDB, CAFSD, eBird	Indirect	Large bodies of water or rivers with abundant fish, uses snags or other perches; nests in advanced-successional conifer forest near open water (e.g., lakes, reservoirs, rivers). Bald eagles are reliant on surface water that may be supported by groundwater and/or groundwater-dependent vegetation (Rhode et al. 2019).
Burrowing owl <i>Athene cunicularia</i>	BLMS/SSC	Likely	Main, Fringe, Uplands	CNDDDB	No known reliance on groundwater	Level, open, dry, heavily grazed or low-stature grassland or desert vegetation with available burrows. Preys on invertebrates and vertebrates.
Golden eagle <i>Aquila chrysaetos</i>	BGEPA, BLMS/SFP	Likely	Main, Fringe, Uplands	CNDDDB, eBird	No known reliance on groundwater	Open woodlands and oak savannahs, grasslands, chaparral, sagebrush flats; nests on steep cliffs or medium to tall trees. Primary prey are small to medium mammals and birds; also scavenges and catches fish.
Grasshopper sparrow <i>Ammodramus savannarum</i>	–/SSC	Likely	Main, Uplands	CNDDDB	No known reliance on groundwater	Grasslands. Ground forager that feeds on insects, including grasshoppers.

Common name <i>Scientific name</i>	Status ¹ Federal/State	Potential to occur in the Livermore Valley Groundwater Basin ²	Documented occurrence location	Query source ³	GDE . association ⁴	Habitat and documented occurrences in Livermore Valley Groundwater Basin Groundwater Basin
Loggerhead shrike <i>Lanius ludovicianus</i>	–/SSC	Likely	Main, Fringe, Uplands	CNDDDB, eBird	No known reliance on groundwater	Open shrubland or woodlands with short vegetation and and/or bare ground for hunting; some tall shrubs, trees, fences, or power lines for perching; typically nests in isolated trees or large shrubs. Feeds on insects, amphibians, reptiles, small mammals, and birds.
Redhead <i>Aythya americana</i>	–/SSC	Likely	Main, Fringe, Uplands	CAFSD, eBird	Indirect	Freshwater emergent wetlands with dense stands of cattails (<i>Typha</i> spp.) and bulrush (<i>Schoenoplectus</i> spp.) interspersed with areas of deep, open water; forages and rests on large, deep bodies of water. Summer resident in southern California.
Swainson's hawk <i>Buteo swainsoni</i>	–/ST	Likely	Main, Fringe, Uplands	CNDDDB, eBird	Indirect	Nests in oaks or cottonwoods in or near riparian habitats; forages in grasslands, irrigated pastures, and grain fields. Swainson's hawks rely on groundwater-dependent vegetation in riparian woodland areas for nesting (Rohde et al 2019). Preys on mammals and insects.
Tricolored blackbird <i>Agelaius tricolor</i>	–/ST	Likely	Main, Fringe, Uplands	CNDDDB, CAFSD, eBird	Indirect	Feeds in grasslands and agriculture fields; nesting habitat components include open accessible water with dense, tall emergent vegetation, a protected nesting substrate (including flooded or thorny vegetation), and a suitable nearby foraging space with adequate insect prey.
White-tailed kite <i>Elanus leucurus</i>	BLMS/SFP	Likely	Main, Fringe, Uplands	CNDDDB, eBird	Indirect	Lowland grasslands and wetlands with open areas; nests in trees near open foraging area. Predominately preys on small mammals, but its diet also includes birds and lizards.

Common name <i>Scientific name</i>	Status ¹ Federal/State	Potential to occur in the Livermore Valley Groundwater Basin ²	Documented occurrence location	Query source ³	GDE . association ⁴	Habitat and documented occurrences in Livermore Valley Groundwater Basin Groundwater Basin
Willow Flycatcher <i>Empidonax traillii</i>	–/SE	Likely	Main, Uplands	CAFSD, eBird	Indirect	Dense brushy thickets within riparian woodland often dominated by willows and/or alder, near permanent standing water. Reliant on groundwater-dependent riparian vegetation, including for nest sites that are typically located near slow-moving streams, or side channels and marshes with standing water and/or wet soils (Rohde et al 2019). Feeds on insects, fruits, and berries.
Mammals						
American badger <i>Taxidea taxus</i>	–/SSC	Likely	Fringe, Uplands	CNDDB	No known reliance on groundwater	Shrubland, open grasslands, fields, and alpine meadows with friable soils.
Pallid bat <i>Antrozous pallidus</i>	BLMS/SSC	Likely	Fringe, Main, Uplands	CNDDB	No known reliance on groundwater	Roosts in rock crevices, tree hollows, mines, caves, and a variety of vacant and occupied buildings; feeds in a variety of open woodland habitats. Habitat and prey (e.g., insects and arachnids) not associated with aquatic ecosystems.
San Joaquin kit fox <i>Vulpes macrotis mutica</i>	FE, BLMS/ST	Likely	Outside of Basin	CNDDB	No known reliance on groundwater	Annual grasslands or open areas dominated by scattered brush, shrubs, and scrub.
San Joaquin pocket mouse <i>Perognathus inornatus</i>	BLMS/–	Possible	Outside of Basin	CNDDB	Indirect	Open grasslands, savanna, and desert shrub communities; often in areas with sandy washes and finely textured soils. Birthing dens are in burrows near the base of shrubs. Predominantly granivorous, eating seeds of annual and perennial grasses, shrubs, and forbs. Also feeds on soft-bodied insects, cutworms, earthworms, and even grasshoppers.

Common name <i>Scientific name</i>	Status ¹ Federal/State	Potential to occur in the Livermore Valley Groundwater Basin ²	Documented occurrence location	Query source ³	GDE . association ⁴	Habitat and documented occurrences in Livermore Valley Groundwater Basin Groundwater Basin
Townsend's big-eared bat <i>Corynorhinus townsendii</i>	BLMS/SSC	Likely	Main, Uplands	CNDDDB	Indirect	Most abundant in mesic habitats, also found in oak woodlands, desert, vegetated drainages, caves or cave-like structures (including basal hollows in large trees, mines, tunnels, and buildings) and riparian communities. Feeds on moths, beetles, and soft-bodied insects and drinks water.
Yuma myotis <i>Myotis yumanensis</i>	BLMS/–	Likely	Main, Uplands	CNDDDB	Indirect	Uses a variety of habitats, including riparian, agriculture, shrub, urban, desert, open forests, and woodlands. Distribution is strongly associated with water; drinks water and forages near or over waterbodies.

¹ Status codes:

Federal

FE = Listed as endangered under the federal Endangered Species Act
 FT = Listed as threatened under the federal Endangered Species Act
 FPE = Federally proposed as endangered
 BGEPA = Federally protected under the Bald and Golden Eagle Protection Act
 BLMS = Bureau of Land Management Sensitive Species

State

SE = Listed as Endangered under the California Endangered Species Act
 ST = Listed as Threatened under the California Endangered Species Act
 SCE = State Candidate Endangered
 SSC = CDFW Species of Special Concern
 SFP = CDFW Fully Protected species

² Potential to Occur:

Likely: the species *has* documented occurrences and the habitat is high quality or quantity

Possible: no documented occurrences and the species' required habitat is moderate to high quality or quantity

Unlikely: no documented occurrences and the species' required habitat is of low to moderate quality or quantity

³ Query source:

CAFSD: California Freshwater Species Database (TNC 2021)
 CNDDDB: California Natural Diversity Database (CDFW 2020a)
 eBird: (eBird 2021)

⁴ Groundwater Dependent Ecosystem (GDE) association:

Direct: Species directly dependent on groundwater for some or all water needs

Indirect: species dependent upon other species that rely on groundwater for some or all water needs (e.g., riparian birds).

No known reliance on groundwater: Species is not known to rely on groundwater. For species associated with vernal pools, it is assumed that the seasonal water in the vernal pools originates from rainfall rather than groundwater.

4 SUMMARY

In the Livermore Valley Groundwater Basin, likely GDEs occur in all three management areas. Likely GDEs in the Main Basin Management Area typically occur along riparian zones along major channels (e.g., Arroyo Valle, Arroyo Mocho, and Arroyo Las Positas). Likely GDEs in the Fringe Management Area include riparian vegetation (willows and cottonwoods) and alkaline-tolerant plants that occur along spring-fed channels and wetlands in Springtown Alkali Sink in the northeast corner of the basin. Likely GDEs in the Upland Management Area occur in riparian zones along smaller tributaries.

Twelve special status plants identified in the basin are likely dependent on groundwater. Groundwater dependent special-status plant species occur primarily in the Fringe and Upland Management Areas. There are 14 groundwater dependent special-status wildlife species likely to occur in the basin. Groundwater dependent special-status wildlife are likely to occur in all three management areas.

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