APPENDIX A

Biological Resources Report – Vollmar Natural Lands Consulting

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Analysis of Potential Effects to Surface Biological Resources from Groundwater Pumping

Middle Green Valley Project
Solano County, California

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EXECUTIVE SUMMARY

The purpose of this analysis is to evaluate potential impacts to existing surface biological resources from the additional 186 acre-feet of proposed annual groundwater pumping as proposed in Water Supply Option B (Onsite Groundwater) for the planned 'Middle Green Valley Project.' The analysis focuses on the riparian habitat zones and the species that depend on these habitats (riparian resources) within the topographic valley floor of the 1,905-acre Project Area (Project Area), because these resources are the only surface biological resources present that have critical interactions with groundwater (**Figures 1 and 2**). Information used to prepare this analysis was obtained from review of existing Project and Project Area documents and relevant published literature as cited in the report, a Project Area reconnaissance survey conducted in 2009 and targeted species surveys conducted in 2010 by Vollmar Natural Lands Consulting (VNLC 2009; VNLC 2010), a one-day reconnaissance survey of the riparian habitat zones March 7, 2016 by VNLC Senior Ecologist Derek Hitchcock, and a site visit to the stream gauge downstream of the Project Area on April 14, 2016, in order to verify the field conditions of the stream gauge.

A Water Supply Assessment (WSA) prepared by Solano County in 2013 concluded that groundwater supplies in the Project Area currently have a surplus on an annual and multi-year basis well in excess of the additional pumping proposed (Luhdorff & Scalmanini, Consulting Engineers 2013). Therefore, this analysis focuses on how localized, intra-annual reductions in depth to groundwater due to pumping could impact riparian resources.

The groundwater resources available to the project derive from two water bearing subsurface layers: the Alluvial Deposits (approximately 0-150 feet below the surface), and the Sonoma Volcanics (approximately 150-500+ feet below the surface). There are four riparian 'reaches' within the Project Area: Green Valley Creek, Northwest Tributary to Green Valley Creek, West Tributary to Green Valley Creek, and Hennessey Creek. Of these, Green Valley Creek is perennial while the other three are seasonal. Riparian resources assessed in detail as part of this analysis include riparian-associated trees and shrubs, and the five special-status species known or likely to occur in the riparian habitat zones of the Project Area: Central California coast steelhead, California red-legged frog, western pond turtle, Swainson's hawk, and valley elderberry longhorn beetle. Within the Project Area, Green Valley Creek supports a diverse mix of riparian trees species whose root systems require continuous contact with water at varying maximum depth below the surface (3-25 feet). The other three reaches support minimal water-dependent riparian tree species, indicating the seasonal nature of these creeks. Central California coast steelhead are known to migrate, spawn, and rear in Green Valley Creek, but cannot use the other three reaches for spawning because they are intermittent streams that lack surface flow during the dry season. Central California coast steelhead could use these other three reaches for foraging and movement during the wet season. Suitable foraging and migrating (but not breeding) habitat exists in all four reaches for California red-legged frog and western pond turtle, but these species would not be expected in the three tributary reaches during the dry season. Several species of the tall trees along Green Valley Creek and Hennessey Creek riparian habitat zones provide suitable nesting habitat for Swainson's hawk, and the cropland in the Project Area provides suitable foraging habitat. Blue elderberry shrubs occurring along the Green Valley Creek and Hennessey Creek riparian habitat zones provide suitable habitat for valley elderberry longhorn beetle.

Based on an analysis of the above resource considerations and the hydrogeology data analyzed as part of this study, the key findings of the analysis are as follows:

- The proposed level of groundwater pumping in Option B will not result in Project Area-wide impacts to surface biological resources, but localized drawdown of groundwater in the vicinity of proposed wells (cones of depression) during the dry season could result in impacts to surface biological resources if wells are located in close proximity to riparian resources and are constructed to draw water from the unconfined aquifer.

- Impacts to surface biological resources would be less than significant if proposed wells are constructed to avoid groundwater depletion of the shallow, unconfined part of the aquifer system particularly where there is hydraulic connection in the riparian habitat zones. In addition, criteria should be established to limit localized drawdown in the unconfined aquifer units due to the proposed groundwater pumping to ensure that any cones of depression in that part of the aquifer system do not reach the riparian habitat zones. The depth to respective aquifer units can be characterized with data attained through a site-specific aquifer evaluation, including test well drilling and aquifer testing.

- Impacts to surface biological resources would be less than significant if proposed wells, constructed to draw proportionally from the unconfined aquifer, are located a sufficient distance from riparian habitat zones to ensure the radial extent of any cone of depression within the unconfined aquifer created by the well(s) does not extend to the riparian habitat zones. This distance can be calculated with data attained through a site-specific aquifer evaluation, including test well drilling, aquifer testing, and groundwater level monitoring in the adjacent unconfined aquifer. It is likely that the riparian corridor minimum widths identified in the Middle Green Valley Specific Plan are sufficient to avoid significant impacts to surface biological resources from the proposed groundwater pumping (Green Valley Creek and Lower Hennessey Creek: minimum 200 foot wide corridor; and Unnamed drainage corridors: minimum 100 foot wide corridor). Corridor width is measured from the center line of the creek so that a corridor of 200 feet translates to a 100 foot buffer to each side of the centerline of the creek. Additional hydrogeologic investigations as part of the subsequent well siting and design process will provide data at a level of detail sufficient to calculate the radial extent of any cone of depression within the unconfined aquifer unit resulting from the proposed wells of Option B.

- Central California coast steelhead is the surface biological resource most vulnerable to the potential impacts of groundwater pumping. Any reduction in current Green Valley Creek dry season (May to October) flow that this species uses for juvenile rearing could have potentially significant impacts. The threshold for assessing whether potential impacts to Central California coast steelhead from groundwater pumping would be significant is defined as the point at which induced recharge begins, and Green Valley Creek begins to lose water to the groundwater aquifer. Induced recharge could begin if the radial extent of any cone of depression within the unconfined aquifer resulting from a proposed Option B groundwater pumping well extended to the stream channel.

- Riparian plant species that require continuous root contact with the water table would be impacted if the depth to groundwater fell below the depth that their roots could access (**Table 3)**. If the radial extent of any cone of depression within the unconfined aquifer resulting from a proposed Option B groundwater pumping well extended to the edge of the riparian habitat zones, impacts could result to the more shallow-rooted water dependent riparian species in Green Valley Creek and its tributaries during the dry season: white alder (3 foot maximum depth to water table for survival), narrow-leafed willow (6 foot maximum depth to water table for survival), and arroyo willow and Gooding's black willow (10 foot maximum depth to water table for survival).

- Based on the information and analyses presented in this report, it is concluded that potential impacts to Central California coast steelhead and riparian plant species caused by the proposed level of pumping in Option B would be less than significant if proposed wells are constructed to avoid groundwater depletion of the shallow, unconfined part of the aquifer system, particularly where there is hydraulic connection in the riparian corridor. It is likely that the riparian corridor buffers identified in the Middle Green Valley Specific Plan are sufficient to avoid significant impacts. Additional hydrogeologic investigations as part of the subsequent well siting and design process will provide data at a level of detail sufficient to calculate the radial extent of any cone of depression within the unconfined aquifer unit resulting from the proposed wells of Option B.

- No significant impacts from the proposed groundwater pumping are expected for Swainson's hawk, California red-legged frog, western pond turtle, or valley longhorn elderberry beetle.

- Based on the information presented in this report, it is concluded that no other surface biological resource would be significantly impacted by the proposed level of pumping in Option B with the application of the riparian corridor minimum widths identified in the Middle Green Valley Specific Plan.

1.0 INTRODUCTION

1.1 Proposed Middle Green Valley Development Project

The Middle Green Valley Specific Plan proposes three water supply options: Options A (Municipal Connection), B (Onsite Groundwater), and C (SID Surface Water). In accordance with the Court's denial of the motion for discharge of peremptory writ of mandate in 2015, this analysis is focused on evaluating the potential biological resource impacts of use of onsite groundwater under Option B. This option would utilize local groundwater for domestic supply as the sole source of potable drinking water to the residents and businesses in the Project Area (**Figures 1 and 2**). Groundwater use would be solely for domestic purposes, and SID water would continue to be used for agricultural and domestic irrigation purposes (consistent with existing conditions). The proposed onsite groundwater system would consist of at least three groundwater wells at a sustained flow of potentially 100 gallons per minute (gpm) each, approximately 4.5 miles of pipelines, and 500,000 gallons of storage in two water storage tanks preferably located at elevation. The proposed wells and distribution system would provide the estimated total annual water requirement for the potable domestic supply of 186 acre-feet per year (Luhdorff and Scalmanini 2013).

The Middle Green Valley Specific Plan also proposes buffers around the riparian corridors in the Project Area to support and maintain stormwater management and visual values, while improving downstream water quality, decreasing flood potential, and protecting the functionality of wildlife corridor movement. These buffers are defined by a minimum width of the riparian corridor. The buffer to each side of the creek that extends out of the existing riparian zone is measured from the center line of the creek, and the equivalent of half the distance of the minimum corridor width designated. These distances, would also set minimum distance of groundwater wells from existing riparian habitat, are as follows:

- Green Valley Creek: minimum 200 foot wide corridor (100 foot buffer from creek center line)
- Upper Hennessey Creek: minimum 200 foot wide corridor (100 foot buffer from creek center line)
- Lower Hennessey Creek: minimum 200 foot wide corridor (100 foot buffer from creek center line)
- Unnamed drainages: minimum 100 foot wide corridor (applied to Northwest Tributary and West Tributary to Green Valley Creek) (50 foot buffer from creek center line)

The analysis in this report assumes that groundwater well placement would occur, at a minimum, outside these buffer zones.

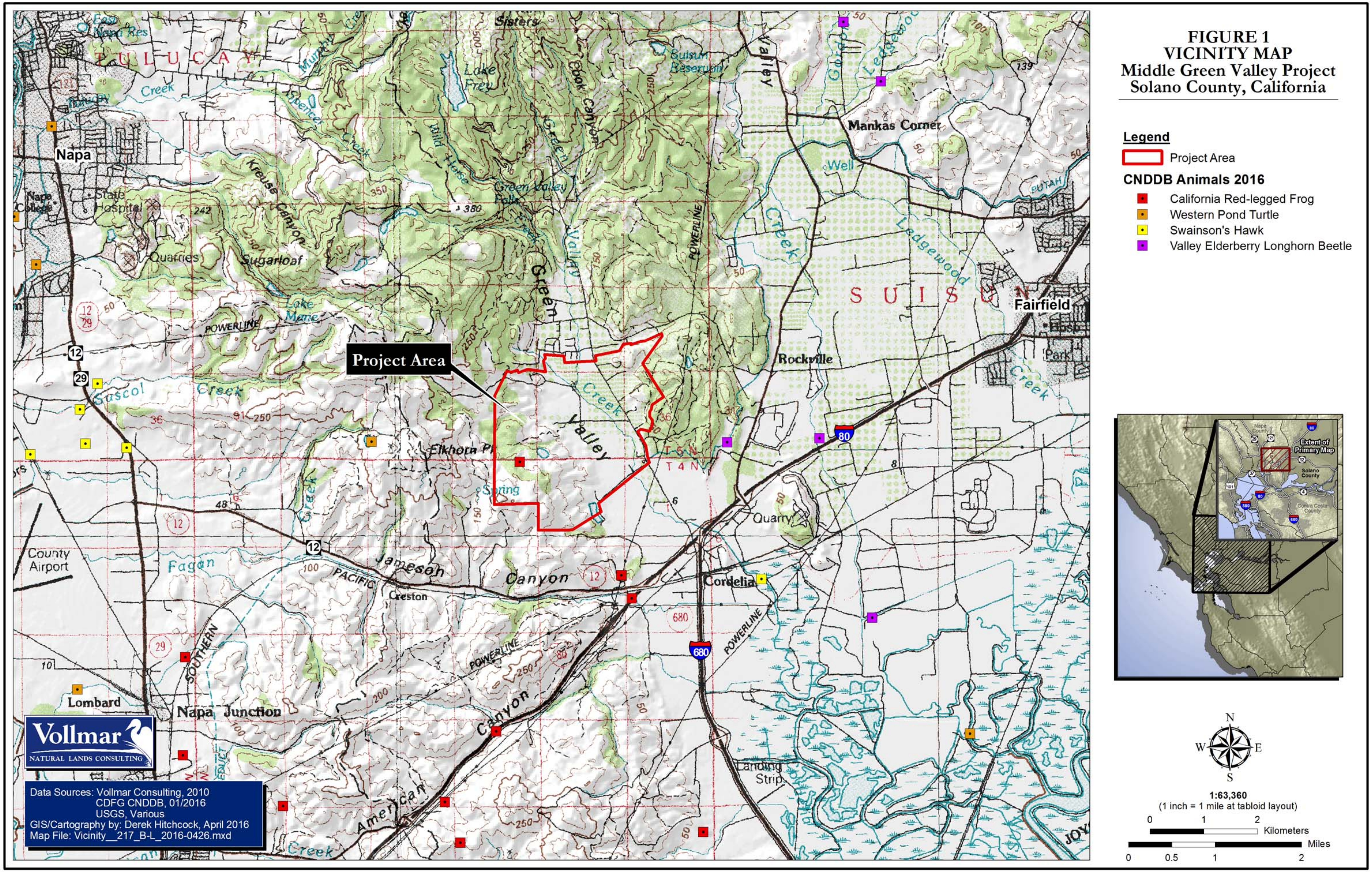
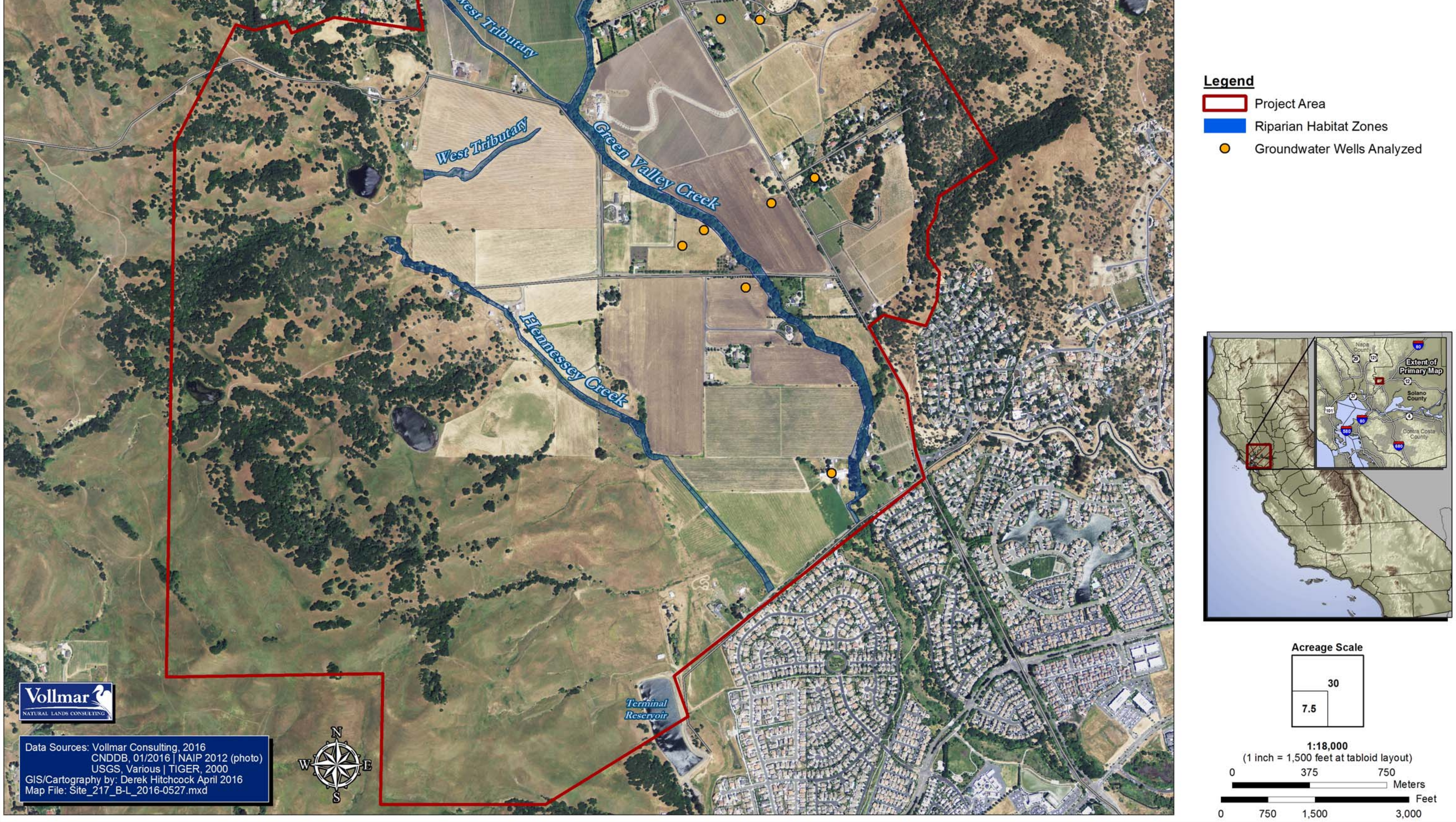


FIGURE 1
VICINITY MAP
Middle Green Valley Project
Solano County, California

FIGURE 2
SITE MAP
Middle Green Valley Project
Solano County, California



1.2 Scope of the Analysis

This analysis includes an evaluation of the impacts of pumping an additional 186 acre-feet per year of groundwater on the surface biological resources within the Project Area. Therefore, the scope of the analysis is restricted to only those surface biological resources that have a critical interaction with groundwater. Surface biological resources are only able to substantively interact with groundwater in areas where soils lack a near-surface impervious soil horizon layer (such as duripan) and the depth to groundwater is relatively near the surface. The deepest extent of this interaction for the Project Area is approximately 25 feet, which is the depth that can be reached by the roots of mature red willow (*Salix laevigata*), a species that requires continuous root contact with groundwater (Section 5.1.2, **Table 3**). As a result, surface biological resources outside the topographic floor of Green Valley (such as upland oak woodland and annual grassland habitat) are excluded from this analysis because the depth to groundwater exceeds 25 feet and these resources have no direct interaction with the groundwater, nor do they require year-round root contact with groundwater for survival. Additionally, any ephemeral surface wetland habitat that occurs outside riparian habitat zones would exist only because of the presence of a subsurface hardpan or claypan layer. This soil horizon serves to inhibit infiltration (thus creating the ephemeral wetland) but also restricts root interaction with the groundwater below for the shallow-rooted species that inhabit such habitats. Finally, the majority of the remainder of the topographic valley floor consist of surface vegetation with root depth too shallow to reach groundwater (annual grasslands), or is under agricultural cultivation or the influence of residential irrigation. Therefore, this analysis focuses on the remaining surface biological resources within the topographic valley floor within the Project Area that have a critical interaction with groundwater: the riparian habitat zones along existing creeks and the species that depend on these habitats (riparian resources) (**Figure 2**). There is no existing riparian habitat east of Green Valley Road in the northeast section of the Project Area. All of the historically small drainages have been converted to culverts or ditches and/or have had all riparian habitat removed; therefore, there are no existing surface biological resources in this area that have a critical interaction with groundwater.

2.0 METHODS

The foundation of this analysis is derived from the integration of a detailed review of project documents and existing scientific literature, previous Project Area biological resource surveys and reports, and two visits to the Project Area to review on-the-ground conditions of surface biological resources and stream hydrology.

Key project documents reviewed in detail include: the Middle Green Valley Specific Plan (Solano County 2010), Middle Green Valley Specific Plan Draft Environmental Impact Report (DEIR), Recirculated DEIR, Revised Recirculated DEIR (Solano County 2014), Water Supply Assessment (Luhdorff and Scalmanini 2013), Notice of Determination, requested motion for discharge of the peremptory writ of mandate, and the Superior Court of Solano County order regarding the motion for discharge (Case Number FCS036446) (Solano County 2015).

A comprehensive scientific literature review on the relationships between groundwater sources and surface biological resources, and the potential effects to these resources from groundwater pumping, was conducted as part of the analysis. This review is summarized in detail in Section 5.1.

Vollmar Natural Lands Consulting (VNLC) conducted a reconnaissance-level sensitive biological evaluation of the Project Area (VNLC 2009). The purpose of the evaluation was to assess overall habitat conditions and to determine the potential for occurrence of sensitive biological resources within both proposed development areas and proposed open space lands. The evaluation was conducted through remote assessment of documented special-status species occurrences and aerial photography, review of existing project documents, and a one-day field visit. The evaluation concluded that the key sensitive biological resources that the project will need to address include: Central California coast steelhead, California red-legged frog, western pond turtle, Swainson's hawk, valley elderberry longhorn beetle, and jurisdictional wetlands and other waters and riparian habitats.

VNLC conducted special-status plant, Swainson's hawk nesting, and California red-legged frog surveys throughout the Project Area (VNLC 2010). These surveys were protocol-level, with all but the last round of surveys completed for these resources due to project approval delays. Despite these surveys not being completed to protocol-level or covering all key sensitive biological resources, the information collected was useful in understanding overall site ecological conditions.

A field reconnaissance survey of surface biological resources, riparian vegetation, and wet season hydrology was conducted by VNLC senior ecologist Derek Hitchcock on March 7, 2016. As summarized in Section 4 of this analysis, tree and shrub species were surveyed in order to characterize plant species assemblages and infer underlying physical processes. An additional visit to the Project Area and the stream gauge downstream of the Project Area was conducted on April 14, 2016, in order to verify the field conditions of the stream gauge and re-assess stream hydrology and riparian vegetation and specific locations.

3.0 PHYSICAL PROJECT SETTING

This section provides background information on the Project Area related to watershed setting, climate, geology, and the hydrogeology of the groundwater basin. This information facilitates an understanding of the context of the analysis.

3.1 Project Location

The Project Area is located in western Solano County, north of the intersection of Interstate 80 and Interstate 680, and west of the City of Fairfield (**Figure 1**). Green Valley Road bisects the eastern portion of the Project Area.

3.2 Watershed Setting

The Project Area is located in the central part of the Green Valley Creek Watershed. Green Valley Creek, joined in its headwaters by Cook Canyon Creek and Wild Horse Creek, flows south out of the Vaca Mountains into and through Green Valley, before connecting to the Cordelia Slough and the marshes of Suisun Bay. Green Valley Creek drains a total area of approximately 22 square miles and flows roughly 14 miles from source to slough (**Figure 1**). Two riparian habitat zones, Green Valley Creek and Hennessey Creek, extend and flow southeast through the Project Area. Two tributaries (termed Northwest Tributary and West Tributary for the purposes of this report) enter Green Valley Creek at a single confluence point in the northern section of the Project Area. Hennessey Creek is ultimately also a tributary to Green Valley Creek, but their confluence occurs south of the Project Area boundary (**Figure 2**).

The Project Area encompasses valley floor surrounded by foothills, including moderately steep slopes dominated by native oak woodland and naturalized annual grassland habitat. The Project Area includes grazing lands in the hills, a mixture of cultivated and cultivable agricultural land on the valley floor, including over 200 acres of existing vineyards, and a number of existing building and infrastructure elements, including approximately 55 rural residential units, a 10,000 square foot winery, three livestock feed barns, numerous additional agricultural barns, sheds and other accessory structures, approximately 20 miles of fencing, approximately 6 miles of overhead power and communications lines, three stock ponds, and a Solano County Water Agency operated reservoir. To the north and south of the Project Area, existing suburban residential developments exist in the unincorporated upper Green Valley to the north and incorporated City of Fairfield immediately to the south and southeast.

3.3 Climate

Middle Green Valley is located at the furthest extent of significant maritime influence from the Pacific Ocean to the west in the local region. The extent of low coastal fog often dissipates at or near this location in the summer months. The climate of Middle Green Valley is classified as Mediterranean, characterized by warm summers with occasional morning fog and cool winters in which temperatures seldom drop much below freezing. Most of the rain falls in the winter months and ordinarily little or no rain falls during the summer growing season (Thomasson et al. 1960). Between 1994 and 2010 in nearby Suisun Valley, temperatures ranged from an average low of 38°F and an average high of 57°F in December to an average high 85°F and an average low of 58°F in August. The average annual reference evapotranspiration was approximately 50.5 inches per year with the most reference evapotranspiration occurring in July and the least in January. The annual average precipitation as measured in nearby Fairfield between 1951 and 2011 is approximately 22.7 inches, with most precipitation falling as rain between November and March (Luhdorff and Scalmanini 2013).

3.4 Geology

Geology is particularly important to consider when undertaking an analysis of groundwater and the condition of riparian vegetation. **Figure 3** shows the geologic formations in the vicinity of the Project Area. The WSA provides a detailed account of the geology the Project Area and vicinity (Luhdorff and Scalmanini 2013).

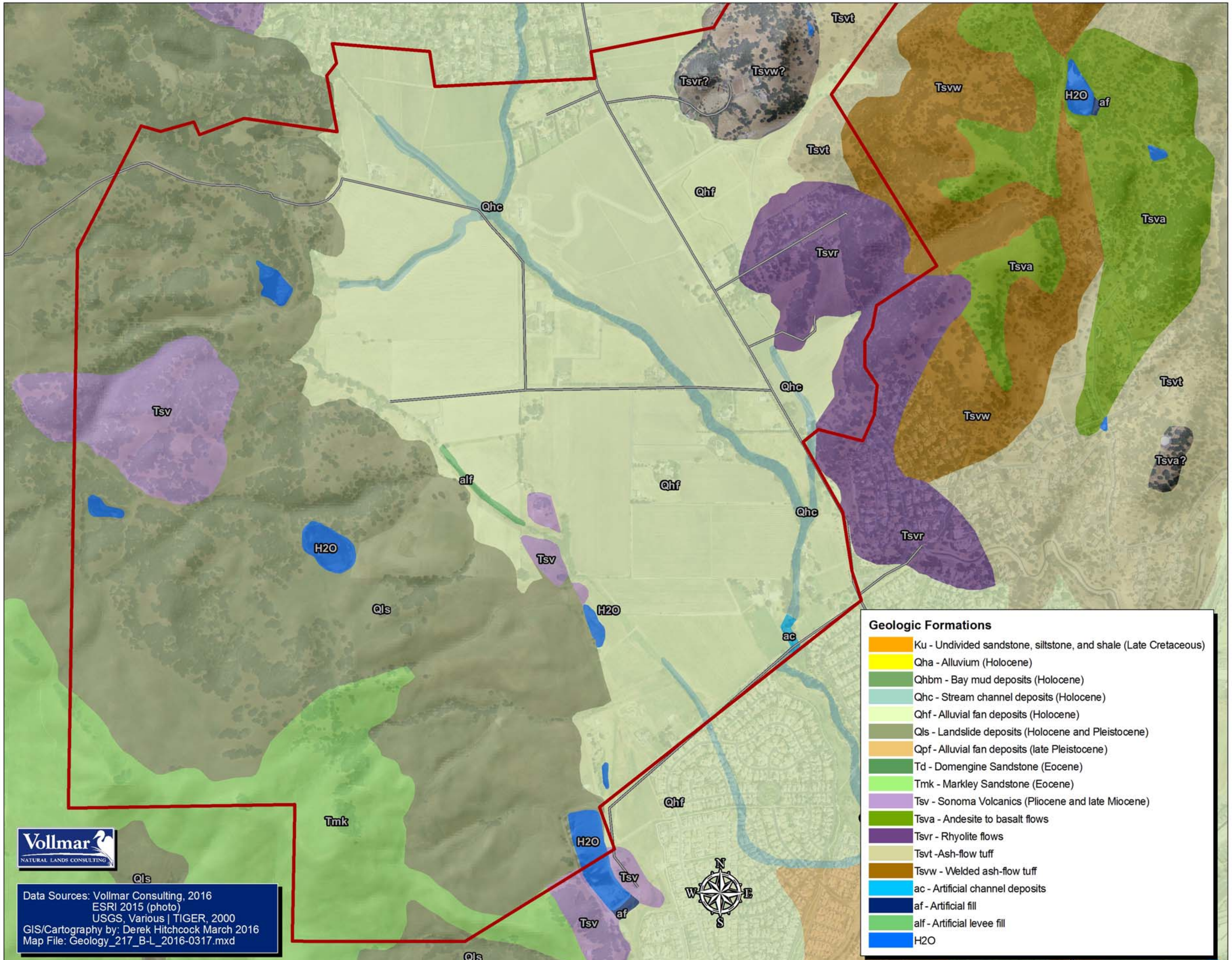
3.5 Hydrogeology of the Groundwater Basin

Green Valley is located on the western edge of the Suisun-Fairfield Valley Groundwater Basin (Basin 2.3) of the San Francisco Bay Hydrologic Region as defined in DWR's Bulletin 118 (CDWR 2003). The elevation of the valley floor ranges from approximately 162 feet above mean sea level (msl) near the intersection of Green Valley Road and Twin Creeks Boulevard to an elevation of 22 feet above msl where Mangels Boulevard crosses Green Valley Creek. Groundwater flows to the south and southeast following the trend of the valley. The valley encompasses roughly 2,400 acres of the 133,600 acres of the Suisun-Fairfield Valley Groundwater Basin.

An understanding of the hydrogeology and description of the subsurface conditions of Green Valley and the Project Area is derived primarily from two studies. First, a U.S. Geological Survey (USGS) study by Thomasson (1960) provides a foundational characterization of the geology and hydrogeology of Green Valley, as confirmed by the Consolidated Final Program Environmental Impact Report for the Central Valley Flood Protection Plan (CDWR 2012). In addition to reviewing previous studies of the Suisun-Fairfield area of Solano County, which includes Green Valley, Thomasson (1960) conducted detailed geologic mapping and groundwater assessments based on data collected through a canvass of well construction, groundwater level, and groundwater quality data from existing wells in Green Valley and throughout Solano and Yolo Counties. Furthermore, Thomasson (1960) described the groundwater resources in Green Valley as distinct from other portions of the Suisun-Fairfield area due to the physical structure of Green Valley, an alluvial valley bounded to the north, east, and west by outcropped bedrock. Second, the Water Supply Assessment (WSA) for the middle Green Valley Project builds on this study to provide information on current, historical, and projected groundwater requirements specific to the Project Area (Luhdorff and Scalmanini 2013). All available well completion records from existing and past wells in Green Valley were analyzed as part of the WSA. Fourteen wells in the Green Valley vicinity with publically-available groundwater level records spanning some period of time between 1918 and 2012 were also compiled. Eight of these wells are within the Project Area, concentrated mainly in the center of the valley (**Figure 2)**.

FIGURE 3
GEOLOGIC FORMATIONS
Middle Green Valley Project
Solano County, California

Legend
- Project Area
- Local Road



Acreage Scale

30

7.5

1:18,000
(1 inch = 1,500 feet at tabloid layout)

0 375 750 Meters

0 750 1,500 3,000 Feet

The major groundwater-producing units in the Project Area are the Sonoma Volcanics and the overlying Alluvial Deposits. The floor of Green Valley is coved by a layer of alluvium composed of clay, silt, sand, and gravel from fans originating in the surrounding hills. Based on drilling logs, the depth of the alluvium is believed to be approximately 150 feet, deepest in the center and decreasing toward the edges of the valley. The water table is typically encountered 1-30 feet below the surface (Luhdorff and Scalmanini 2013). The thickness of the deeper Sonoma Volcanics has not been determined but is known to be quite thick as the deepest wells in the valley extend to 560 feet. The Sonoma Volcanics and the Alluvial Deposits are the principal formations targeted for domestic and agricultural groundwater supply needs in the valley and the surrounding hills. Existing wells on the periphery of the valley and in the surrounding hills target the Sonoma Volcanics almost exclusively, whereas wells constructed in the valley may target the shallow alluvium, the deeper volcanics, or a combination of both. Yields from wells completed exclusively within the Sonoma Volcanics are generally less than those completed only within the alluvium. However, due to the thickness of the Sonoma Volcanics formation, substantial well yields can be realized in deep wells constructed with long intake screens (Luhdorff and Scalmanini 2013).

Unconfined groundwater is "in direct contact vertically with the atmosphere through open spaces in permeable (geologic) material..." (Davis and DeWiest 1966). Unconfined groundwater has an upper surface (often called a water table) that is "the level in the saturated zone at which the hydraulic pressure is equal to atmospheric pressure…" (Heath 1983). Confined groundwater is bounded by very low permeability geologic material such that it "is separated from the atmosphere…" (Davis and DeWiest 1966). Confined groundwater lacks a true water table and is under pressure so that when the aquifer is penetrated by a well, the water will rise above the top of the aquifer.

Unconfined groundwater has the potential for direct, hydraulic connection[1] with surface waters whereby water may flow from groundwater to surface water or vice versa. The magnitude and extent of connections between groundwater and surface water vary by location and over time due to a variety of factors. In the topographic valley floor of the Project Area, it is likely the majority of the unconfined aquifer units occur in Alluvial Deposits and the confined aquifer units are within the Sonoma Volcanics. However, there could be exceptions, including areas where the Sonoma Volcanics are near the surface. The confined versus unconfined nature of the aquifer at the point where groundwater is being extracted is a highly relevant subsurface attribute in relation to surface biological resources. Neither this information nor the well locations themselves is currently known for the Project Area, but it can be determined through site-specific test well drilling and aquifer test data.

An understanding of the Project Area hydrogeology and corresponding analysis of effects of groundwater pumping can be addressed at different temporal scales, including either annual or multi-year effects, versus intra-annual seasonal effects.

[1] In the context of this report, hydraulic connection refers to a condition where the water table, or upper surface, of an unconfined aquifer is in direct contact with a wetted streambed or surface water body. Under this condition exchanges of water between surface water and groundwater occur in part as function of the difference in the elevation of the water table and the elevation of the surface water.

3.5.1 Potential Annual or Multi-year Effects of Groundwater Pumping

Key characteristics of the hydrogeology of the Project Area to understand at an annual or multi-year scale, as well as WSA estimated projected water demands through 2035, include the following (Luhdorff and Scalmanini 2013):

- Groundwater levels consistently exhibit full recovery from dry (drought) periods. Little variation in water source availability is anticipated between normal to dry years. Groundwater levels have remained stable throughout dry periods where records are available, including multiple dry years.

- A supply of **525 acre-feet per year of groundwater would be available** to the Project Area without depleting the groundwater aquifer. An agricultural demand of about 525 acre-feet per year was historically met by groundwater with no annually adverse effects, i.e., groundwater levels remained stable from spring to spring.

- The entire groundwater **demand of 326 to 376 acre-feet per year** in the Project Area (at build out) would include: 90 acre-feet per year currently used for existing private/residential (supplied by private wells), 50 to 100 acre-feet per year currently used for agriculture on lands situated outside SID's service area (supplied by private wells), and 186 acre-feet per year for Project Area potable water domestic use to be supplied by three (or more) new Project wells under Option B.

- Green Valley's groundwater resources have a **surplus of at least 149-199 acre-feet/year** in excess of the proposed addition of 186 acre-feet/year Project Area demand for potable water [525 acre-feet less (326-376 acre-feet) = 149-199 acre-feet per year].

In summary, the groundwater WSA (Luhdorff & Scalmanini 2013) concluded that, at an annual or multi-year scale, overall groundwater supplies in Green Valley and the Project Area currently have a surplus that is well in excess of the additional pumping proposed for the Middle Green Valley Project's Option B, and therefore demonstrates at this temporal scale that the proposed additional groundwater pumping would be sustainable and not result in depletion of the aquifer.

3.5.2 Potential Intra-annual or Seasonal Effects of Groundwater Pumping

To assess the potential impact from groundwater pumping to riparian resources, the temporal scale of the analysis must be reduced considerably, with particular focus on the dry season when these habitats are most stressed and species can be impacted when groundwater levels decline on the scale of weeks (Section 5.1).

Key characteristics of the hydrogeology of the Project Area to understand at an intra-annual or seasonal scale include the following (Luhdorff and Scalmanini 2013):

- Seasonal fluctuations of between 10 and 20 feet between spring and fall measurements are common, due to natural draw down during the dry season and groundwater replenishment during the wet season (**Figure 4)**.

- Both groundwater producing formations in Green Valley have a relatively low specific capacity and correspondingly low transmissivity. (In technical terms, specific capacities in the wells analyzed ranged from 0.08 gpm/foot to 6 gpm/foot, with an average of 0.1 gpm/foot, while average transmissivity was 200 gallons per day/foot). This means that water moves slowly within the aquifer(s) to replenish areas where water has been extracted or lost. This is an important factor related to local effects of groundwater pumping around individual wells.

Commonly accepted knowledge and understanding of groundwater and wells indicates that pumping from a well in a water table (unconfined) aquifer lowers the water table near the well in an area known as a cone of depression[2] (**Figure 5**). The land area above the cone of depression is called the area of influence. Groundwater flows toward the well into the cone of depression which can change the natural direction of groundwater flow within the area of influence around the well. The importance of the cone of depression relative to potential effects to riparian resources occurs if the cone of depression in an unconfined aquifer from a well extends to the riparian habitat zones. As the radial extent of the cone of depression reaches the outer riparian habitat zone the roots of riparian tree species outside the stream channel require a greater distance to make contact with the water table. Impacts to surface waters could be induced when the radial extent of the cone of depression reaches the stream (**Figure 6**). If the stream and the unconfined aquifer are hydraulically connected, the stream may begin to lose water to the groundwater aquifer near the well (known as induced recharge), depending on the elevation of the water table relative to the water level in the stream, and the magnitude of groundwater level reduction by the cone of depression.

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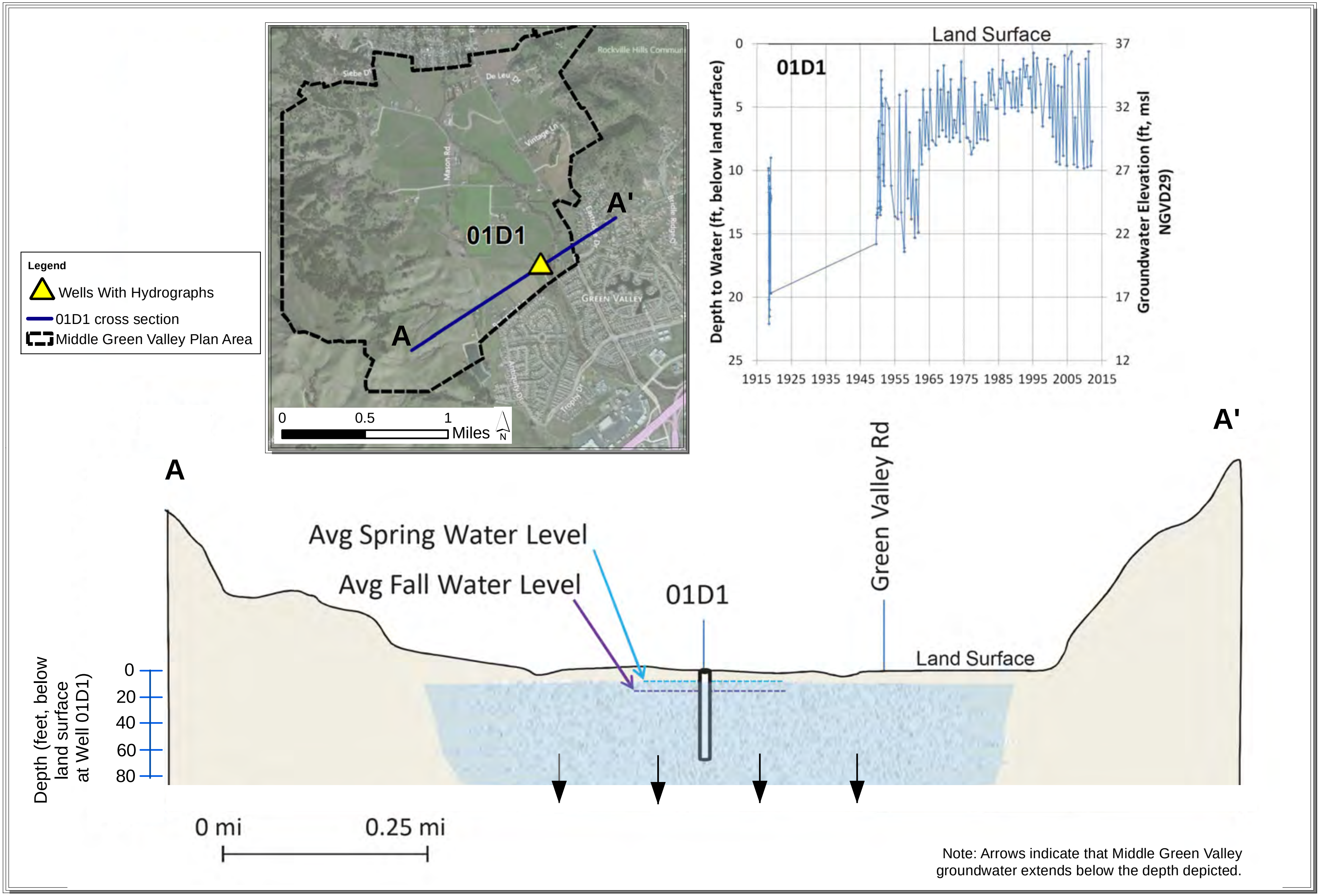
[2] A cone of depression can also be created in a confined aquifer due to groundwater pumping. This condition is not addressed in this report since a confined aquifer is not in direct hydraulic connection with surface waters.

Figure 4. Annual Depths to Groundwater and Record for Well 01D1



X:\2011 Job Files\11-112\GIS\MGV Depths to GW Diagram.mxd

LUHDORFF & SCALMANINI CONSULTING ENGINEERS

Figure 4-5
Middle Green Valley
Annual Depths to Groundwater Diagram

Figure 5. Cone of Depression Surrounding Typical Well

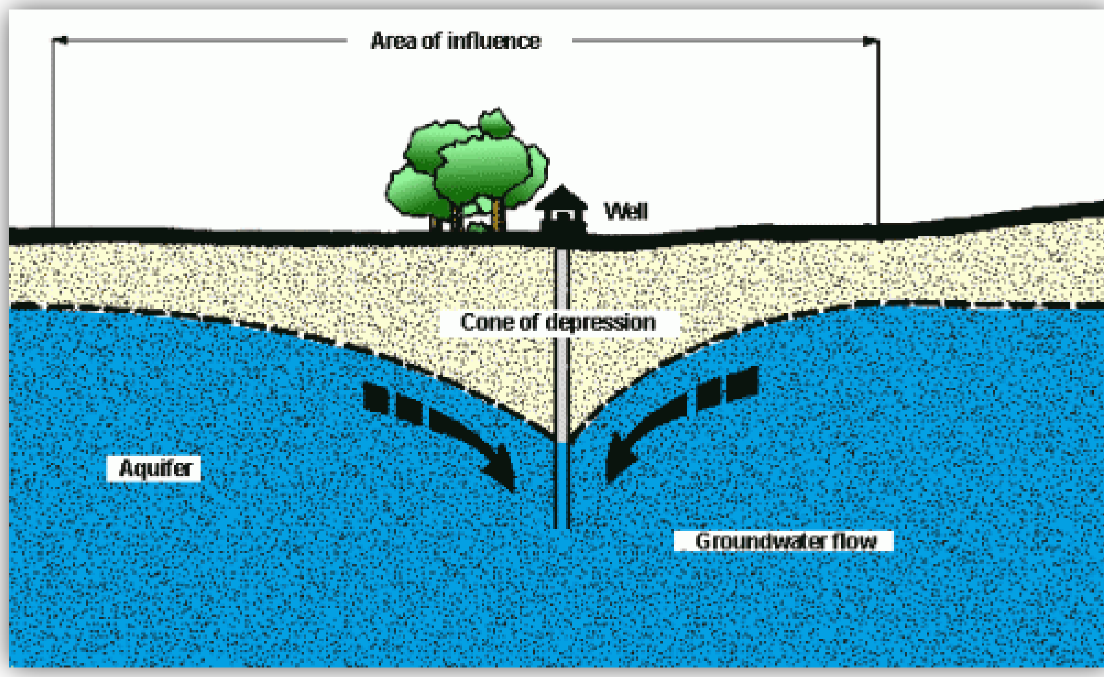
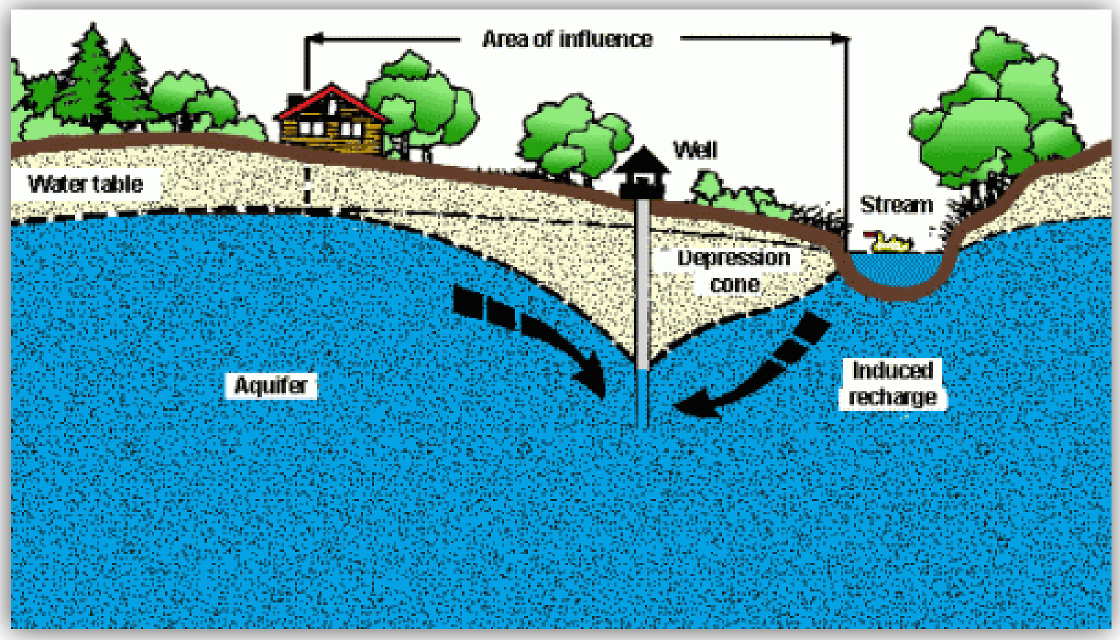


Figure 6. Induced Recharge Occurs when Cone of Depression Extends to Stream



Illustrations for Figures 5 and 6 adapted from "What is Groundwater?" by Lyle Raymond Jr. (Cornell Cooperative Extension, Cornell University, July 1988) by Oregon State University Well Water Program (www.wellwater.oregonstate.edu/groundwater-and-wells)

4.0 CURRENT CONDITIONS OF THE GREEN VALLEY CREEK RIPARIAN ECOSYSTEM

Naiman and Decamps (1997) define the riparian zone as encompassing '… the stream channel between the low and high water marks and that portion of the terrestrial landscape from the high water mark toward the uplands where vegetation may be influenced by elevated water tables or flooding and by the ability of the soils to hold water.' Riparian habitat zones occupy important landscape positions between upland and aquatic ecosystems and are uniquely productive, physically dynamic, and biologically diverse (Gregory et al. 1991; Naiman et al. 1993). Riparian vegetation is a key element of riverine ecosystems, providing many ecological, aesthetic and economic benefits, including terrestrial wildlife habitat structure, food resources, stabilizing geomorphic properties along banks and floodplains, and energy subsidies to aquatic and terrestrial ecosystems (Pusey and Arthington 2003).

Riparian systems typically occur where groundwater is in close proximity to the soil surface or where a direct connection exits between groundwater and surface water. These groundwater–surface water interfaces support greater biomass and often greater species diversity than the surrounding landscape (Baird et al. 2005). Intricately coupled to both groundwater and surface water regimes, riparian ecosystems are sensitive to perturbations in either (Busch et al. 1992; Grimm et al. 1997; Stromberg 1993). The fundamentally defining relationship between surface stream flows and groundwater is the direction of inputs. For a 'gaining' stream, groundwater discharges into the stream and helps maintain base flow in the stream. In a 'losing' stream, surface water recharges groundwater. Streams that have continuous flow in parts of its stream bed year-round during periods of normal rainfall are defined as perennial streams. Streams that normally cease flowing for weeks or months each year are defined as intermittent streams, while channels that flow only for hours or days following rainfall are defined as ephemeral.

A field survey of riparian habitat zones was conducted by VNLC senior ecologist Derek Hitchcock on March 7, 2016. Tree and shrub species were surveyed in order to characterize plant species assemblages and infer underlying physical processes. Shallow-rooted herbaceous and grass species were not considered for the analysis due to their reduced interaction with groundwater. **Table 1** lists the dominant tree and shrub species occurring in the riparian habitat zones of Green Valley Creek and its tributaries within the Project Area, as well as the Army Corps of Engineers (ACOE) wetland indicator status for each species.

This section describes current conditions in the Green Valley Creek riparian habitat zone. Because of their distinct hydrology and riparian plant species assemblages, the riparian habitat zones within the Project Area are divided into four separate reaches for this analysis: Reach 1, the main stem of Green Valley Creek (Green Valley Creek); Reach 2, the tributary to Green Valley Creek entering from the northwest (Northwest Tributary); Reach 3, the tributary to Green Valley Creek entering from the west (West Tributary); and Reach 4, Hennessey Creek (**Figure 2**). Hennessey Creek is also a tributary to Green Valley Creek, but its confluence with Green Valley Creek occurs approximately 0.75 miles south of the Project Area.

Table 1. Dominant Tree and Shrub Species Occurring in the Riparian Habitat Zones of Green Valley Creek and Tributaries, Solano County, CA. (Source Data: VNLC 2016)

FAMILY/Scientific Name	FAMILY/Common Name	Wetland Indicator Status	Life Form
Aoxaceae	**Muskroot Family**		
Sambucus nigra ssp. *caerulea*	blue elderberry	FAC	Shrub/Tree
Anacardiaceae	**Sumac Family**		
Toxidendron diversilobum	poison oak	FACU	Shrub/Vine
Asteraceae	**Sunflower Family**		
Baccharis pilularis	coyote brush	N/A	Shrub
Betulaceae	**Birch Family**		
Alnus rhombifolia	white alder	FACW	Tree
Caprifoliaceae	**Honeysuckle Family**		
Symphoricarpos albus var. *laevigatus*	common snowberry	FACU	Shrub
Fagaceae	**Oak Family**		
Quercus agrifolia	coast live oak	N/A	Tree
Quercus lobata	valley oak	FACU	Tree
Juglandaceae	**Walnut Family**		
Juglans hindsii	Northern California black walnut	FAC	Tree
Lauraceae	**Laurel Family**		
Umbellularia californica	California bay	FAC	Tree
Oleaceae	**Olive Family**		
Fraxinus latifolia	Oregon ash	FACW	Tree
Rosaceae	**Rose Family**		
Heteromeles arbutifolia	toyon	N/A	Shrub
Rosa californica	California rose	FAC	Shrub
Rubus armeniacus	Himalayan blackberry	FACU	Shrub
Salicaceae	**Willow Family**		
Salix exigua	narrow-leafed willow	FACW	Tree/Shrub
Salix gooddingii	Goodding's black willow	FACW	Tree
Salix laevigata	red willow	FACW	Tree
Salix lasiolepis	arroyo willow	FACW	Tree/Shrub
Sapindaceae	**Soapberry Family**		
Aesculus californica	California buckeye	N/A	Tree

Wetland Indicator Status (ACOE):

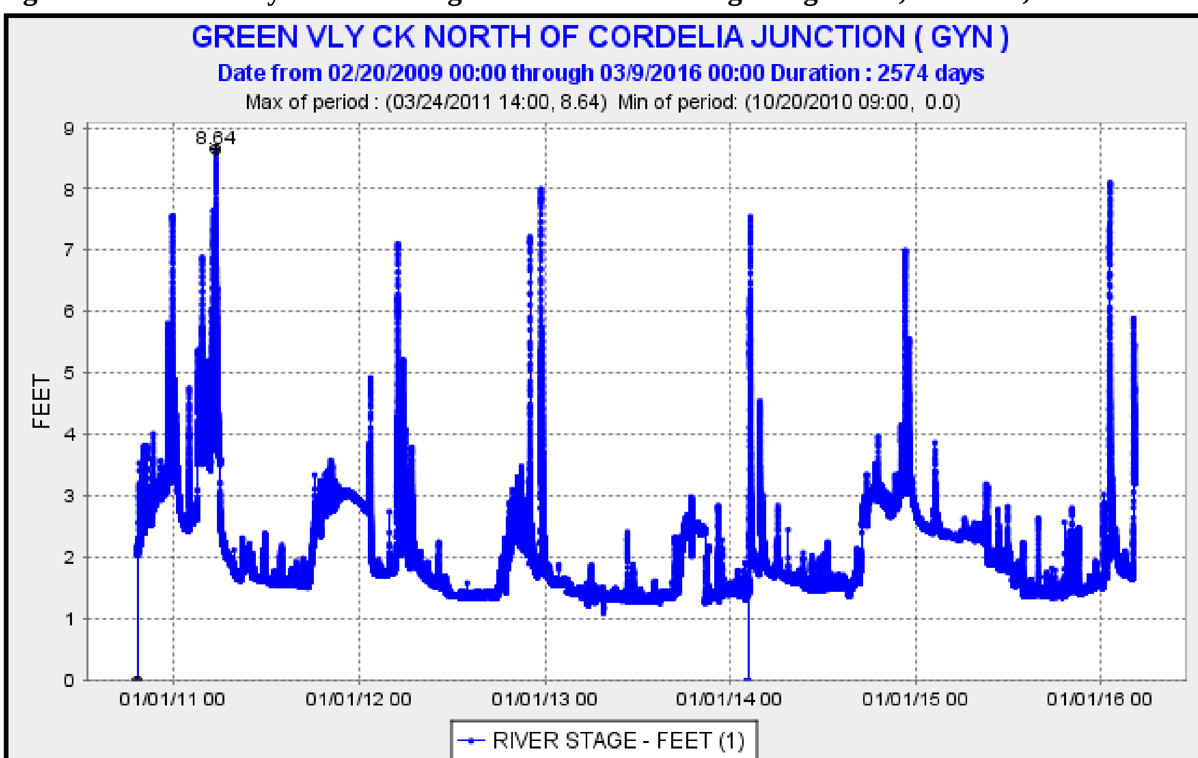
FACW – Facultative Wetland [usually occurs in wetlands (estimated probability 67-99%), occasionally found in non-wetlands]
FAC – Facultative [equally likely to occur in wetlands (estimated probability 34-66%), or non-wetlands]
FACU – Facultative Upland [usually occurs in non-wetlands (estimated probability 67-99%), occasionally found in non-wetlands]

4.1 Reach 1: Green Valley Creek

4.1.1 Hydrologic and Geomorphic Conditions

California Department of Water Resources stream gauge data has been recorded from a station located on Green Valley Creek at Mangels Blvd. (0.6 miles south and downstream of the Project Area) since 2001 (Station ID: GYN; 38.2206, -122.148; data available at http://cdec.water.ca.gov/; station description in **Appendix A**). This station records stage data, which is the water level above an arbitrary point or the location of an installed pressure transducer. At this station the pressure transducer is located in the middle of the stream, at stream bottom (George Benny, DWR Water Resources Tech II, pers. comm. 2016). In this way the data can be interpreted as a reasonable approximation of stream depth at this location. **Figure 7** displays the stage data from this station from 2011 to early 2016. Despite this date range covering one of the driest periods on record in California, the water level never dips below 1 foot depth. These data demonstrate that Green Valley Creek currently is a perennial stream, confirmed verbally by the staff assigned to visit the station regularly (George Benny, DWR Water Resources Tech II, pers. comm. 2016). The perennial nature of the stream is also corroborated by landowners along Green Valley Creek in the Project Area (Jerry LeMasters, pers. comm. 2016). Landowners in the valley also refer to abundant year-round producing springs in the hills north of the valley that augment the hydrology of the stream (Frank Lindemann, pers. comm. 2016). In this way, the stage data displayed in **Figure 7** reflects both rainfall (with peak flows occurring at stream stages of approximately 7 – 9 feet depth each winter) and a consistent base stage (> 1 foot) during the dry season.

Figure 7. Green Valley Creek at Magels Blvd. Stream Gauge Stage Data, Fairfield, CA.



The geomorphic setting of Green Valley Creek appears moderately intact, with some signs of incision, most likely due to the riparian habitat zone being spatially constrained by agricultural practices. Historically, the highly variable annual flow patterns would have resulted in periodic channel migration during extremely high flows and frequent floodplain inundation.

4.1.2 Riparian Vegetation

The riparian habitat zone along the main stem of Green Valley Creek currently supports a thin band of mature riparian forest. Historically, the outer riparian habitat zone would have been considerably wider, but land use practices over the past 160 years have narrowed the riparian habitat zone to just a few feet wider than the stream channel. However, what remains is in good condition. Mature trees are relatively evenly spaced, and represent a diverse species assemblage likely similar to historical condition (**report cover photo)**. Dominant large trees in the interior riparian habitat zone include white alder (*Alnus rhombifolia*), Goodding's black willow (*Salix gooddingii*), red willow (*S. laevigata*), and narrow-leafed willow (*S. exigua*). Valley oak (*Quercus lobata*) and arroyo willow (*Salix lasiolepis*) are the dominant trees in the outer riparian habitat zone, with less common occurrences of Oregon ash (*Fraxinus latifolia*), California bay (*Umbellularia californica*), blue elderberry (*Sambucus nigra ssp. caerulea)*, and naturalized cultivars of Northern California black walnut (*Juglans hindsii*). Dominant shrub species, primarily in the outer riparian habitat zone, include poison oak (*Toxidendron diversilobum*), coyote brush (*Baccharis pilularis*), common snowberry (*Symphoricarpos albus* var. *laevigatus*), and California rose (*Rosa californica*). The west side of the lower portion of Green Valley Creek within the Project Area is lined with large, mature, eucalyptus (*Eucalyptus globulus*), a non-native non-riparian species presumably planted as a windbreak (**Photo 1**).

Photo 1: Green Valley Creek near southern boundary of Project Area (3/7/2016)

4.2 Reach 2: Northwest Tributary to Green Valley Creek

4.2.1 Hydrologic and Geomorphic Conditions

There is no hydrologic data available specific to the Northwest Tributary. However, very few riparian tree species are present, and most of these are small (< 10 feet) arroyo willow growing in the middle of the small channel near the confluence with the main stem of Green Valley Creek. This vegetative signature is indicative of a hydrologic regime based on small natural winter flows, and as it approaches its downstream confluence with Green Valley Creek during the dry season, the possible hydrologic influence of the main stem of Green Valley Creek and gradually accumulating agricultural runoff. Perennial flow would result in a mature assemblage of riparian tree species whereas larger, scouring winter flows would eliminate small trees in the middle of the channel. It is possible the small arroyo willow near the confluence access groundwater seasonally, but it is unlikely they would be able to establish and develop roots that could reach the groundwater in the absence of agricultural runoff or the hydrologic influence of the confluence (based on personal experience of the author in the nearby Napa Valley).

The geomorphic setting of the Northwest Tributary appears moderately intact, with some signs of incision.

4.2.2 Riparian Vegetation

The condition of the riparian habitat zone along the Northwest Tributary varies considerably and does not appear to represent historical conditions. This is likely due to land use practices aimed at complete clearing of the vegetation at different times and with different intensities over the past 160 years. The upper section is dominated by the non-riparian tree coast live oak (*Quercus agrifolia*), as well as the rare occurrence of red willow and coyote brush. The understory is dominated by poison oak and non-native Himalayan blackberry (*Rubus armeniacus*). The middle section of the Northwest Tributary is exclusively Himalayan blackberry (**Photo 2)**. The lower section of the Northwest Tributary, as it approaches the confluence with the main stem of Green Valley Creek, includes young to medium aged valley oak on the upper edges of channel and arroyo willow within the channel (**Photo 3**).

Photo 2: Northwest Tributary to Green Valley Creek facing southwest (3/7/2016)

Photo 3: Northwest Tributary to Green Valley Creek near confluence with main stem (3/7/2016)

4.3 Reach 3: West Tributary to Green Valley Creek

4.3.1 Hydrologic and Geomorphic Conditions

There is no hydrologic data available specific to the West Tributary, but the vegetative signature is indicative of a hydrologic regime based on small pulses of intermittent surface flow in the winter, and possible connection of vegetation to groundwater sources.

The geomorphic setting of the upper portion of the West Tributary appears moderately intact, with some signs of incision. As it approaches its confluence with the main stem of Green Valley Creek, the West Tributary is diverted into a 3-foot diameter underground pipe for approximately 375 feet, completely altering the geomorphology of the creek.

4.3.2 Riparian Vegetation

The condition of the riparian habitat zone along the West Tributary varies considerably and has been altered significantly by human agricultural practices. The upper portion of the West Tributary supports an assemblage of small-statured tree and shrub species that were only viewed from a distance during the field survey due to landowner access limitations. It was not possible to discern tree species but there were willows (*Salix* sp.) present. Although more specific survey was not possible in 2016, the special-status plant species survey for the Specific Plan area conducted by VNLC in 2010 covered riparian species occurring along this West Tributary. As it approaches its confluence with the main stem of Green Valley Creek, riparian habitat is eliminated for approximately 375 feet by the diversion of the creek into a 3-foot diameter underground pipe. The creek flow is released from the pipe approximately 75 feet from Mason Road and in this section, two medium-aged valley oak provide a small amount of riparian habitat around the returned surface flow (**Photo 4**). The creek then passes through a culvert under Mason Road to connect to the main stem of Green Valley Creek.

Photo 4: West Tributary to Green Valley Creek near confluence with main stem (3/7/2016)

4.4 Reach 4: Hennessey Creek

4.4.1 Hydrologic and Geomorphic Conditions

There is no hydrologic data available specific to Hennessey Creek. The riparian vegetative signature is indicative of a hydrologic regime based on steady and occasionally significant surface flow in the winter, and no flow during the dry season. In fact, severe sedimentation along Hennessey Creek, a tributary to Green Valley Creek, has caused damage to private property within the project reach during flood events (Martin and Fortin 2003). In addition, a landowner who has lived along Hennessey Creek for decades maintains that the creek is always dry during the dry season (Frank Lindemann, pers. comm. 2016).

The geomorphic setting of Hennessey Creek shows signs of moderate to severe incision, likely a result of land use practices in the upland portion of its watershed that have resulted in high velocity flows during large rain events. Historically, it is likely the upland watershed area would have had greater landscape-wide infiltration rates due to a larger overall canopy of mature tree species and deep-rooted perennial grasses that respectively slowed, and then allowed rainfall to sink more deeply into the soil, resulting in reduced discharge to the stream.

4.4.2 Riparian Vegetation

Hennessey Creek, the largest tributary to Green Valley Creek in the Project Area, lacks water-dependent riparian tree species associated with perennial surface flows or consistent connection of roots to the groundwater table (**Table 3**). The riparian habitat zone is dominated by valley oak, with less common occurrences of California buckeye (*Aesculus californica*), California bay, coast live oak, blue elderberry, and toyon (*Heteromeles arbutifolia*) (**Photo 5**). The understory is dominated by poison oak and large stands of non-native Himalayan blackberry and periwinkle (*Vinca major*).

Photo 5: Hennessey Creek near Mason Road (3/7/2016)

4.5 Special-Status Species Occurrence and Habitat Requirements

A key beneficiary of healthy riparian habitat in the Project Area are wildlife species whose life history traits require intact, mature riparian habitat and/or consistent instream flows. In addition to freshwater habitats from instream flows, specific benefits of this habitat for wildlife include tall structure for avian nesting sites, temporally variable leaf and bark insects, nectar and pollen, acorns and other seeds and fruits, and cover from predators. **Table 2** lists the special-status species with a ranking that could influence environmental permitting processes and are known to occur or have the potential to occur in the Project Area, along with their preferred habitat. This is followed by a more detailed summary of the life history traits and associated quality and timing of habitats required by each species, documented occurrences on or adjacent to the Project Area, and likelihood of occurrence within the riparian habitat zones of the topographic valley floor.

Table 2. Special-status Wildlife Species Associated with Riparian Habitats that are known or have Potential to Occur in the Project Area.

Common Name, Scientific Name[1]	Status[2]	Preferred Habitat
Central California Coast steelhead *Oncorhynchus mykiss irideus*	FT	Gravel-bottomed, fast-flowing, well-oxygenated freshwater streams with perennial flow for spawning and rearing; pool habitats with ample overstory riparian cover; habitat with large structures such as boulders, undercut banks, and large woody debris that provide feeding opportunities, segregation of territories, refuge from high water velocities, and cover from fish and bird predators.
California red-legged frog *Rana draytonii*	FT SSSC	Still or slow-moving water sources such as ponds, lakes, reservoirs and backwater stream areas with emergent vegetation and adjacent riparian woodlands.
western pond turtle *Emys marmorata*	SSSC	Slack or slow-moving water (ponds, streams, ditches) with basking sites and nesting areas of open unshaded slopes in the vicinity.
Swainson's Hawk *Buteo swainsoni*	ST	Tall trees for nesting, often in riparian corridors; annual grasslands and croplands for foraging.
valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	FT	Mature blue elderberry shrubs (*Sambucus nigra ssp. caerulea*)

1. Scientific and common names from California Natural Diversity Database (2016)
2. FT = Federally Threatened; ST = California State Threatened; SSSC = California Department of Fish and Wildlife Species of Special Concern

The special-status plant survey conducted throughout the Project Area by VNLC (VNLC 2010) identified only one special-status plant species (*Balsamorhiza macrolepis* var. *macrolepis*). However, this species does not occur in riparian habitats. In addition, California black walnut (*Juglans hindsii*) was not included in this analysis because there is a history of grafting non-native walnut species on to existing northern California black walnut, as well as hybridization with southern California black walnut (*Juglans californica*). There is mounting evidence in the botanical community that there are very few northern California black walnut remaining in naturally occurring populations. The nearest stands substantiated by genetic testing occur in the Sacramento-San Joaquin Delta (H. Bartosh, pers. comm. 2015). Because expensive genetic testing is outside the scope of this analysis and existing verified seeds sources are far from the Specific Plan area (and therefore less likely to be adapted to local conditions), it was determined California black walnut are unlikely to occur in the Plan Area.

4.5.1 Steelhead – Central California Coast DPS (Oncorhynchus mykiss irideus)

Status: Federally Threatened

The central California Coast steelhead Distinct Population Segment (DPS) includes "all naturally spawned anadromous *O. mykiss* (steelhead) below natural and manmade impassable barriers in California streams from the Russian River (inclusive) to Aptos Creek (inclusive), and all drainages of San Francisco, San Pablo, and Suisun Bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin Rivers. Tributary streams to Suisun Marsh including Suisun Creek, Green Valley Creek, and an unnamed tributary to Cordelia Slough (commonly referred to as Red Top Creek), excluding the Sacramento-San Joaquin River Basin, as well as two artificial propagation programs: the Don Clausen Fish Hatchery, and Kingfisher Flat Hatchery/ Scott Creek (Monterey Bay Salmon and Trout Project) steelhead hatchery programs" (NOAA 2006). Steelhead trout can reach up to 55 pounds in weight and 45 inches in length, though average size is much smaller. They are usually dark-olive in color, shading to silvery-white on the underside with a heavily speckled body and a pink to red stripe running along their sides. Maximum age is about 11 years.

In the San Francisco Bay region (both Interior SF Bay and Coastal SF Bay strata) data for steelhead remain limited (NMFS 2011). There are no time series of population abundance data for the naturally spawning component of the Central California Coast steelhead DPS. The naturally spawning population in the largest river system in the DPS, the Russian River, is believed to have declined seven-fold since the mid- 1960s (NOAA 2006). Direct and indirect effects caused by modification of natural flow regimes have had significant negative impacts on steelhead in this DPS (e.g., mortality of adults/juveniles, alterations of fish communities and impacts to migration, spawning, rearing and refugia) (NMFS 2011).

The general habitat requirements of central California coast steelhead are similar to other anadromous organisms. They are born and develop through the life stages of fry to juvenile fish in freshwater streams before migrating to the ocean to feed as adults. They return to freshwater streams, often the same stream in which they were born, to spawn in suitable habitat. Unlike other Pacific salmonids, they can spawn more than one time (called iteroparity). Migrations can be hundreds of miles. All steelhead hatch in gravel-bottomed, fast-flowing, well-oxygenated rivers and streams. Water quality is a critical factor during the freshwater residence time with cool, clear, and well-oxygenated water needed for maximum survival (Moyle 2002). Optimal spawning temperatures are 4˚C to 11˚C (McEwan and Jackson 1996). Juvenile steelhead (ages 1+ and 2+) occupy deeper water than fry and show a stronger preference for pool habitats with ample cover, as well as for rapids and cascade habitats (Dambacher 1991). Juveniles generally occupy habitat with large structures such as boulders, undercut banks, and large woody debris that provide feeding opportunities, segregation of territories, refuge from high water velocities, and cover from fish and bird predators. Juvenile steelhead require at least intermittently fairly fast-moving water to maintain the food supplies necessary for growth (Moyle et al. 2008).

Outside of these general habitat requirements, steelhead display a “dizzying array of life history variation” (Satterthwaite et al. 2009), and 32 possible life history trajectories have been identified for steelhead (Thorpe 2007). Central California coast steelhead show a tremendous amount of juvenile and adult life history variation, though all adult runs occur during the winter (Moyle et al. 2008). This large diversity of life history, in particular in regard to flexible reproductive strategies, presents a great challenge in managing for the habitat of the species. Bjorkstedt et al. (2005) concluded that the central California coast steelhead DPS historically was comprised of 37 independent populations (i.e., 11 functionally independent and 26 potentially independent) and possibility 30 or more dependent populations of winter-run steelhead. Winter-run steelhead in the Pacific Northwest and northern California are the ocean-maturing type, entering freshwater between November and April, with well-developed gonads, and spawning shortly thereafter. Adult female steelhead will prepare a redd (or nest) in a stream area with suitable gravel type composition, water depth, and velocity. The adult female may deposit eggs in 4 to 5 "nesting pockets" within a single redd. The eggs hatch in 3 to 4 weeks. Emergent fry migrate into shallow water (<15 inches) areas such as the stream edge or low gradient riffles, often in open areas with coarse substrates.

(Hayes et al. 2008) described three life history pathways prior to ocean entry. Some juvenile central California coast steelhead emigrated to the estuary after spending only a few months in the upper watershed, while a second group spent one to two years rearing in the upper watershed. Both of these types of fish typically spent one to ten months rearing in the estuary prior to ocean entry. The third pathway observed by Hayes et al. (2008) was for juveniles to rear for at least a year in the upper watershed, followed by downstream migration and immediate ocean entry without estuarine occupancy. These life history pathways are not discrete, however (Moyle et al. 2008).

Central California Coast steelhead are opportunistic predators of aquatic and terrestrial insects, small fish, frogs, and mice, but their primary diet consists of benthic aquatic insect larvae, particularly caddisflies (*Trichoptera*), midges (*Chironomidae*), and mayflies (*Ephemeroptera*). Depending on season and steelhead size, they also may eat salmon eggs, juvenile salmon, sculpins, and suckers (Merz 2002). Young animals feed primarily on zooplankton.

<u>Occurrence on and adjacent to the Project Area</u>

Steelhead have been documented in Green Valley Creek and its tributaries and suitable habitat for migration and possible spawning and/or rearing is present within the Project Area (Solano County 2014). In a report on the historical distribution and current status of steelhead (*O. mykiss*) in the streams of the San Francisco Estuary, Leidy et al. (2005) conclude that steelhead have been collected in the Green Valley Creek drainage from the 1950s to the present, and that while the watershed is relatively small, its position adjacent to the Suisun Creek drainage provides habitat opportunities to salmonids migrating upstream from the Suisun and Cordelia Slough area. However, over this time period populations have varied considerably. In the 1970s through the mid-1980s significant steelhead numbers were documented in the Creek. Based on the results of an electrofishing survey of Green Valley Creek in January 1975, the California Department of Fish and Wildlife calculated the average steelhead density for undisturbed sections of the creek to be about 68 fish per 100 feet (Week 1975). According to residents living upstream of the Via Palo Alto Bridge, a steelhead run persisted in Green Valley Creek until approximately 1986 (Gray 1990). Since that time surveys conducted in 1994, 1996, and 1997 caught no more than 1 individual (Leidy 2002). This general pattern of decline in the second half of the 20th century is similar to all Central California Coast salmonids. However, there is recent indication that steelhead may be attempting to reestablish viable populations in Green Valley Creek, with the most recent sighting occurring on 01/25/2016 at the Via Palo Linda Bridge just north of the Project Area where seven adult steelhead were observed (Tonia Freeman, pers. comm. 2016). The California Natural Diversity Database (CNDDB) contains no records for steelhead in the vicinity of the project, but this is an artifact resulting from sightings not being registered in the database.

Likelihood of Occurrence within the Riparian Habitat Zones of Topographic Valley Floor
Based on a documented history of occurrence in Green Valley Creek (Leidy et al. 2005), combined with the recent 1/25/2016 sighting, it is likely that in any given year steelhead will occupy the main stem of Green Valley Creek. During periods of sufficient winter flows, it is possible juvenile steelhead would use the Northwest Tributary, the 75 feet of West Tributary nearest its confluence with Green Valley Creek, or Hennessey Creek for foraging habitat, although these tributaries to Green Valley Creek provide low quality habitat. Due to lack of perennial surface flow and minimal suitable spawning gravels, it is unlikely that steelhead would use these tributary streams as spawning habitat.

4.5.2 California Red-Legged Frog (Rana draytonii)

Status: Federally Threatened, California Species of Special Concern

The California red-legged frog (CRLF) is a medium-sized native frog, typically 4-5 inches in length when mature. As indicated by its name, the hind legs as well as the abdomen of adults are reddish in color. CRLF is federally-listed as threatened and is a state species of special concern, due to its ongoing extirpation throughout most of its historic range. Green Valley is 5.5 miles north of U.S. Fish and Wildlife Service (USFWS) designated critical habitat (Solano unit SOL-1) (USFWS 2010). USFWS has completed a recovery plan for the species (USFWS 2002).

CRLF historically ranged from Marin County along the coast and from Shasta County inland south to Baja California, Mexico (Jennings and Hayes 1994). Within this region, it occurred throughout the Coast Ranges, Central Valley, and western Sierra Nevada foothills up to about 1,500 meters (5,200 feet) in elevation. Over the past 200 years, CRLF's range has been greatly reduced (and continues to be reduced), with most remaining populations occurring in the Coast Ranges from Marin to Ventura County. The loss of range is due to a combination of initial harvesting of the species for food, loss and degradation of breeding habitat, and competition/predation by introduced predatory species such as the bullfrog (Hayes and Jennings 1986).

CRLF breed in streams, deep pools, backwaters within streams and creeks, ponds, marshes, sag ponds, dune ponds, lagoons, and stock ponds. Breeding adults are often associated with deep (greater than 2 feet), stagnant or slow moving water, as well as with dense, shrubby riparian or emergent vegetation (Hayes and Jennings 1988). CRLF utilize non-aquatic habitats for refuge, dispersal and foraging. The species is known to rest and feed in riparian vegetation, and it is believed that the moisture and cover of the riparian zone provides foraging habitat and facilitates dispersal. Accessibility to sheltering habitat is essential for CRLF survival within a watershed, and can be a factor limiting frog population numbers. Sheltering habitat includes mammal burrows, damp leaf litter, downed wood, riparian vegetation, and dense shrubbery within several hundred meters of aquatic sites. CRLF may shelter further than 350 feet from water for weeks at a time in any season (USFWS 2002).

Occurrence on and adjacent to the Project Area

In the spring of 2010, VNLC biologists completed a survey for CRLF in the Project Area. One adult CRLF was observed in an upland pond approximately 0.3 miles from the Hennessey Creek riparian habitat zone. Inclusive of this 2009 record, the California Natural Diversity Database (CNDDB) contains records of CRLF in the vicinity of the project site. **Figure 1** displays these records. The nearest occurrences are 0.75 and 1 mile south of the Project Area, respectively.

Likelihood of Occurrence within the Riparian Habitat Zones of Topographic Valley Floor

The survey by VNLC biologists in the spring of 2009 did not detect any CRLF in the riparian habitat zones of the Project Area. No breeding habitat was observed, but quality habitat for refuge, dispersal, and foraging was observed. Due to these survey results and the presence of adequate breeding habitat within migration distance, it is likely that CRLF occurs (but does not breed) in the main stem of Green Valley Creek. The species may also occur along the riparian habitat zones of Northwest Tributary, West Tributary, and Hennessey Creek as migrating or sheltering individuals.

4.5.3 Western Pond Turtle (Emys marmorata)

Status: California Species of Special Concern

Western pond turtle is a small to medium sized drab brown to tan turtle. It is the only turtle native to California. Current taxonomy recognizes two subspecies, the northwestern pond turtle (*Emys marmorata marmorata*) and the southwestern pond turtle (*Emys marmorata pallida*), and these hybridize through a broad portion of the species' range. Western pond turtle is considered a state species of special concern due to the historic and continuing loss of habitat (CDFW 2016).

Western pond turtle primarily inhabits perennial aquatic habitats, including ponds, slow moving streams, lakes, marshes and canals. The species frequently basks on logs or other objects out of the water. Turtles use upland habitats, usually grasslands, in the vicinity of aquatic habitats for egg-laying, hibernation, and aestivation. Egg-laying sites are typically within 650 feet, but as far as 1300 feet from their primary habitat. Grassy, south-facing slopes are preferred for egg-laying. Mating typically occurs in late April or early May and most egg-laying occurs during May and June, although sometimes as late as early August. Hatchlings emerge after approximately three months and require shallow water habitat with relatively dense submergent or short emergent vegetation in which to forage (CDFG 2000).

Occurrence on and adjacent to the Project Area

The CNDDB contains a record for the western pond turtle 1.5 miles west of the Project Area (**Figure 1**). There are no documented occurrences within the Project Area.

Likelihood of Occurrence within the Riparian Habitat Zones of Topographic Valley Floor

The survey by VNLC biologists in the spring of 2009 did not detect any western pond turtle but the survey did record quality habitat for western pond turtle in the riparian habitat zone along Green Valley Creek in the Project Area. As a result, it is likely that western pond turtle occurs in the main stem of Green Valley Creek. Due to reduced habitat quality, it is unlikely that western pond turtle uses the riparian habitat zones of Northwest Tributary, West Tributary, and Hennessey Creek other than, perhaps, as migration corridors during the wet season.

4.5.4 Swainson's Hawk (Buteo swainsoni)

Status: State Threatened

The Swainson's hawk is a summer nesting migrant (late February to September) to California's Central Valley (CPF 1993). It concentrates in areas around the valley basin but also occurs on low terrace areas to the east and west. More than 85% of the known nests in the Central Valley are within riparian systems in Sacramento, Sutter, Yolo, and San Joaquin counties (CDFG 1994). It typically nests in tall trees, often along riparian corridors, and research has shown that preferred nest trees are valley oak, Fremont's cottonwood (*Populous fremontii*), willows (*Salix spp.*), sycamores (*Platanus spp.*) and walnuts (*Juglans spp.*) (Bloom 1980, Schlorff and Bloom 1983, Estep 1989). Swainson's hawk forages in annual grasslands and croplands. Its prey includes large insects and small mammals, including ground squirrels, especially when nesting. Ironically, it often prefers annual croplands and irrigated pastures over natural annual grasslands due to the greater abundance of prey in these agricultural landscapes.

Occurrence on and adjacent to the Project Area

The CNDDB contains a record for Swainson's hawk 1.9 miles southeast of the Project Area (**Figure 1**). This nest was observed in May 2004 within the riparian corridor along Cordelia Slough, surrounded by annual grassland. There are no documented occurrences within the Project Area. Protocol-level nesting surveys initiated but not completed (due to project approval delays) by VNLC in 2010 did not find any Swainson's hawks or their nest in or adjacent to the Project Area.

Likelihood of Occurrence in Within the Riparian Habitat Zones of Topographic Valley Floor

Although there are no documented occurrences of Swainson's hawk in Green Valley or the Project Area, several species of the tall trees along the Green Valley Creek riparian habitat zone provide suitable nesting habitat, and the cropland in the Project Area provide suitable foraging habitat. Therefore it is possible that Swainson's hawk could occur in the Project Area.

4.5.5 Valley Elderberry Longhorn Beetle (Desmocerus californicus dimorphus)

Status: Federally Threatened

The valley elderberry longhorn beetle (beetle) occurs only in the Central Valley of California in association with blue elderberry shrubs (*Sambucus nigra ssp. caerulea*). The beetle is completely dependent on its host plant, which is a common component of the remaining riparian forests and adjacent upland habitats of California's Central Valley (USFWS 1999). Use of the elderberry by the beetle, a wood borer, is rarely apparent. Frequently, the only exterior evidence of the elderberry's use by the beetle is an exit hole created by the larva just prior to the pupal stage. The life cycle takes one or two years to complete. The species prefers to lay eggs in elderberry shrubs 2-8 inches in diameter, with some preference shown for "stressed elderberries" (CNDBB 2016). The animal spends most of its life in the larval stage, living within the stems of an elderberry plant. Adult emergence is from late March through June, about the same time the elderberry produces flowers. The adult stage is short-lived. Further information on the life history, ecology, behavior, and distribution of the beetle can be found in a report by Barr (1991) and the recovery plan for the beetle (USFWS 1984).

Occurrence on and adjacent to the Project Area

In 2014, USFWS withdrew a petition to delist the species and published a revised historical distribution of the species (USFWS 2014b). Based on the revised distribution of the species, VELB are not expected to occur in western Solano County and is not expected in the Project Area. Historically, the CNDDB contains a record for two occurrences of valley elderberry longhorn beetle in the vicinity of the Project Area (**Figure 1**). In 2004, one elderberry with five exit holes was observed 1.0 mile east of the Project Area. This shrub and one additional shrub were transplanted due to construction activities (mapped according to original location) approximately 1.0 miles southwest to the Green Valley Creek Restoration Site, just north of the intersection of Green Valley Creek and Mangels Blvd. No valley elderberry longhorn beetle was observed at the new location in 2005-2006. Also in 2004, the presence of bore holes were found in a number of dead branches and trunks of elderberry 2.0 miles east of the Project Area in the riparian corridor of Suisun Creek. There are no documented occurrences within the Project Area.

Likelihood of Occurrence within the Riparian Habitat Zone of Topographic Valley Floor

Although there are no documented occurrences of valley elderberry longhorn beetle in Green Valley or the Project Area, blue elderberry shrubs occurring along the Green Valley Creek and Hennessey Creek riparian habitat zones provide suitable habitat. Therefore it is possible that valley elderberry longhorn beetle could occur in the Project Area.

5.0 POTENTIAL IMPACTS TO RIPARIAN RESOURCES FROM GROUNDWATER PUMPING

To fulfill its purpose as an informational document, the following analysis of potential impacts to riparian resources from groundwater decline due to additional pumping explores how seasonal, localized reductions in depth to groundwater within the cone of depression surrounding wells could impact riparian resources. This section reviews documented cases from available literature of impacts to riparian resources from groundwater pumping, summarizes thresholds at which impacts begin to occur, and then incorporates site-specific knowledge to assess the potential impacts to riparian resources of Green Valley Creek and its tributaries from the groundwater pumping proposed in water supply Option B for the Middle Green Valley Development Project.

5.1 Summary of Documented Effects of Groundwater Decline on Riparian Resources

There are numerous documented cases where depletions of surface and shallow alluvial groundwater have contributed to the loss, fragmentation, or severe ecological impairment of riparian systems (Dynesius and Nilsson 1994, Stromberg et al. 1996). Identifying the vulnerability of riparian and wetland ecosystems to anthropogenic activities and climatic variation necessitates a thorough understanding of the groundwater to surface water interactions that maintain them (Winter et al. 1998; Wurster et al. 2003).

5.1.1 Effects of Groundwater Decline on Wildlife

The most straightforward impact of groundwater decline occurs in stream systems where surface flows dependent upon or supported by groundwater are diminished or eliminated once the groundwater declines to a level where it is disconnected from surface water. This potentially dramatic effect is exemplified in a study by Smith (1994) on Redwood Creek in Sonoma County, California. Intermittent spells of dry climate and groundwater extraction in the creek's tributary region have, at times, all but dried up the stream channel. The most significant impact of streamflow reduction has been on fish (salmonoid) populations (Zektser et al. 2004). Groundwater pumping is apparently sufficient to eliminate most steelhead and salmon from the lower 1 mile of Redwood Creek in severe drought years (Smith 1994). In addition, the interception of terrestrial sediments and nutrients by the riparian zone has important consequences for stream fish, maintaining habitat structure, water clarity and food-web structure (Pusey and Arthington 2003).

Increased rates of transfer of thermal energy between the atmosphere and the aquatic environment in the absence of an intact riparian zone may potentially disrupt reproduction by desynchronizing the thermal regimen from regional factors, such as the flow regimen, as well as having direct effects on mortality rates, body morphology, disease resistance and metabolic rates (Pusey and Arthington 2003). In the absence of adequate shade from riparian tree and shrub species, cold water temperatures required by salmonids (Section 4.5.1) can be elevated to lethal levels. Flow reductions can serve to elevate water temperatures as well. If a body of water is deep enough to stratify, sunlight will only transfer heat through the photic zone (light-reaching), thus shallower bodies of water tend to warm more quickly and reach higher temperatures than deeper water bodies.

A study by Lovich and Meyer (2006) documented how western pond turtle populations are threatened as groundwater pumping continues to deplete aquatic habitat along the Mojave River, reducing or minimizing perennial aquatic habitat. There are no peer-reviewed journal studies documenting potential impacts of groundwater pumping on red-legged frog, Swainson's hawk, or valley elderberry longhorn beetle.

5.1.2 Effects of Groundwater Decline on Riparian Vegetation

Glennon and Maddock (1994) provide a history of riparian decline as a result of anthropogenic hydrologic disruptions in Arizona. In these cases, the trees and associated shrubs and herbaceous vegetation gradually desiccated as groundwater pumping and surface water diversions for domestic and irrigation purposes disrupted surface flows and lowered the groundwater table below the root zone of these plants. Surface water diversions and groundwater pumping have contributed to the degradation of 90% of Arizona's once perennial low desert streams and rivers and an equal amount of its riparian habitat. A study on the San Pedro River in Arizona demonstrated that regional ground-water depletions or localized (near stream) drawdowns in the floodplain aquifer can decrease instream flows and concurrently lower the water table beneath the riparian zone (McGlothlin et al. 1988). Ground water pumping lowered the water table in many areas of the Mojave River causing increased mortality of native riparian vegetation (Lines & Bilhorn 1996; Lines 1999).

A case study of the interdependence of groundwater, riparian vegetation, and streambank stability was conducted on the Carmel River in Carmel Valley, California (Groeneveld and Griepentrog 1985). The study links a Mediterranean climate and groundwater extraction with the decline of riparian vegetation and subsequent severe bank erosion. The study demonstrates that groundwater is closely coupled with streamflow to maintain water supply to riparian vegetation, particularly where precipitation is seasonal. It is important to note that in this case, multiple high yield groundwater extraction wells were placed directly inside the Carmel River corridor.

Certain studies have honed in on the specific thresholds of depth and rate of groundwater decline where mortality or dieback occurs. Seasonal declines of 3 feet have caused mortality of saplings of cottonwood and willow (Shafroth et al. 2000). Mature cottonwood trees have been killed by abrupt, permanent drops in the water table of 10 feet, with lesser declines (5 feet) reducing stem growth. Abrupt declines in the water table greater than 3 feet produced leaf desiccation and branch dieback within three weeks and significant reductions in live crown volume (Scott et al. 1999, 2000).

In general, even short-term declines in alluvial groundwater tables can change the distribution and abundance of riparian plant associations (Cooper et al. 2003; Shafroth et al. 2000). Trees growing in association with a formerly stable water table may be more sensitive to declines than trees formerly associated with a more variable water table environment (Scott et al. 1999). Excavations of sapling roots suggest that root distribution is related to groundwater history. Therefore, a decline in water table relative to the condition under which roots developed may strand plant roots where they cannot obtain sufficient moisture (Shafroth et al. 2000). This is because root systems appear to be tailored to site-specific groundwater environments and the historical stability of the water table would influence root distribution, which may in turn condition the response of trees to subsequent water table changes (Yeager 1935). Riparian vegetation occurs predominantly on soils derived from stream channel deposits; therefore the presence of groundwater is more of a driving factor for root distribution than soil layer types (i.e. clay).

In the absence of perennial flows and associated aquatic species, target riparian habitat is often defined by intact riparian vegetation beneficial to a wide range of non-aquatic wildlife. There is no potential for significant impacts to riparian vegetation unless groundwater levels decline below the lowest root depth of riparian species. There is an extinction depth elevation (i.e., water table elevation below which the roots are unable to obtain water) at which transpiration is zero. Values of the extinction depth can be approximated by the maximum rooting depth of the species as determined through field studies or literature research (Baird et al. 2005). **Table 3** presents Facultative Wetland and Facultative species (see footnote to **Table 3** for definitions) occurring in the riparian habitat zones of Project Area, and lists the maximum depth to water table of the species that require root contact with the water table.

Table 3. Water Table Requirements of Facultative Wetland[1] and Facultative Species[2] Occurring in the Riparian Habitat Zones of Green Valley Creek and Tributaries, Solano County, CA.

Common Name	Scientific Name	Water Table Required	Maximum Depth to Water Table (feet)[3]
white alder	*Alnus rhombifolia*	Yes	3
narrow-leafed willow	*Salix exigua*	Yes	6
Goodding's black willow	*Salix gooddingii*	Yes	10
arroyo willow	*Salix lasiolepis*	Yes	10
red willow	*Salix laevigata*	Yes	25
blue elderberry	*Sambucus nigra ssp. caerulea*	No	N/A
Northern California black walnut	*Juglans hindsii*	No	N/A
California bay	*Umbellularia californica*	No	N/A
Oregon ash	*Fraxinus latifolia*	No	N/A
California Rose	*Rosa californica*	No	N/A

[1] FACW – Facultative Wetland [usually occurs in wetlands (estimated probability 67-99%), occasionally found in non-wetlands]
[2] FAC – Facultative [equally likely to occur in wetlands (estimated probability 34-66%), or non-wetlands]
[3] California Riparian Restoration Handbook (Griggs 2009)

5.1.3 Indicators of Water Stress in Riparian Vegetation

Although cottonwoods do not occur in the Project Area, they have similar plant physiological characteristics to the willow species that do occur, and therefore studies on cottonwoods provide some indication of the type of response willows would have to groundwater decline. A study by Cooper et al. (2003) examined the physiological and morphological response patterns of riparian cottonwoods to acute water stress imposed by groundwater pumping. *Populus deltoides* responded to rapid alluvial water table decline with decreased shoot water potential followed by leaf mortality and branch die-back (sacrifice). The parameters predawn water potential (for defining plant water status and soil water availability) and percent leaf loss were significantly related to the depth of water table declines. The results suggest that

Populus deltoides is extremely sensitive to even short term (1–3 weeks) groundwater pumping that lowers the water table below the deepest annual water table depth. This experiment indicates that once the hydrologic connection between tree roots and the water table or capillary fringe is broken during the growing season, uncontrolled cavitation can occur within 2–3 weeks leading to a partial canopy die-back.

When alluvial groundwater is depleted as a result of river dewatering or groundwater pumping, riparian cottonwoods exhibit drought-stress responses including stomatal closure and reduced transpiration and photosynthesis, altered 13C composition, reduced predawn and midday water potentials, and xylem cavitation (Rood et al. 2003). At the Hassayampa River, *Salix gooddingii* and *Populus fremontii* trees underwent physiological stress, observed as canopy dieback and reduced photosynthetic rates, as depth to ground water exceeded 10 feet, with *S. gooddingii* undergoing the greatest ground-water related mortality (Horton et al. 2001). Evidence of considerable water stress included low shoot water potentials, low leaf gas exchange rates and large amounts of canopy dieback. These parameters were significantly related to depth of ground water.

5.2 Analysis of Potential Effects to Project Area Stream Reaches from Option B

The following analysis assumes that groundwater well placement would occur, at minimum, outside the buffer zones proposed in the Middle Green Valley Specific Plan [Green Valley Creek and Lower Hennessey Creek: minimum 200 foot wide corridor (100 foot buffer from creek center line); Northwest Tributary and West Tributary corridors: minimum 100 foot wide corridor (50 foot buffer from creek center line).

5.2.1 Reach 1: Green Valley Creek

The main stem of Green Valley Creek has perennial flow, several riparian tree species that require root contact with water at varying maximum depths (3-25 feet), and contains habitat that supports or has the potential to support the five special-status species found in the Project Area (central California coast steelhead, red-legged frog, western pond turtle, Swainson's hawk, and valley elderberry longhorn beetle).

Central California coast steelhead is the most water-dependent riparian resource. Green Valley Creek stream gauge data 0.6 miles downstream of the Project Area demonstrates that flow depth annually drops to approximately 1 foot depth during the dry season from May – October (**Figure 7**). This time period overlaps with the freshwater rearing period for juvenile steelhead of various potential age classes that require at least intermittently fairly fast-moving water to maintain the food supplies necessary for growth (Section 4.5.1). Because small changes in stream depth could impact this critical aquatic habitat, the threshold for assessing potential impacts to central California coast steelhead from groundwater pumping will be defined as the point at which induced recharge begins, and Green Valley Creek begins to lose water to the groundwater aquifer. No significant impacts to central California coast steelhead would occur if there were no induced recharge. Induced recharge would begin if the radial extent of the cone of depression in the unconfined aquifer adjacent to a proposed Option B groundwater pumping well extended to the stream channel of Green Valley Creek, where a hydraulic connection was already present between the creek and the unconfined aquifer (as in **Figure 6**). Any reduction in current Green Valley

Creek dry season flow would represent a potential impact to central California coast steelhead because juvenile steelhead that may be present require at least intermittently fairly fast-moving water to maintain the food supplies necessary for growth.

Riparian plant species that require root contact with the water table would be impacted if the depth to groundwater fell below the depth that their roots could access (**Table 3)**. If the radial extent of the cone of depression in the unconfined aquifer adjacent to a proposed Option B groundwater pumping well extended to the edge of the riparian habitat zone, the quantity of additional groundwater pumping could result in impacts to the more shallow-rooted water dependent riparian species in Green Valley Creek: white alder (3 foot maximum depth to water table for survival), narrow-leafed willow (6 foot maximum depth to water table for survival), and arroyo willow and Gooding's black willow (10 foot maximum depth to water table for survival). The analysis of all available well completion records from existing and past wells in Green Valley conducted as part of the WSA demonstrates a surplus of groundwater in the Project Area (Luhdorff and Scalmanini 2013; Section 3.5) that limits the depth that groundwater could decline based the scale of the proposed pumping in Option B. Less than significant impact would occur to red willow (25 foot maximum depth to water table for survival) because the scale of the proposed pumping in Option B (3-4 times less than historical peaks) would not result in groundwater to decline to this depth. There would be less than significant impact to the other riparian plant species that do not require root contact with the water table in Green Valley Creek (**Table 3**) by the groundwater pumping proposed in Option B.

California red-legged frog and western pond turtle would be impacted once ponded riparian refugia dried up. If the radial extent of the cone of depression in the unconfined aquifer adjacent to a proposed Option B groundwater pumping well extended to the edge of the stream channel, where a hydraulic connection was present between the stream and the unconfined aquifer, causing induced recharge, this could result in a small reduction in surface flow. However, due to the documented surplus of groundwater in the Project Area (Luhdorff and Scalmanini 2013; Section 3.5) ponded riparian refugia would not dry up entirely due to the scale of pumping proposed in Option B. Therefore, the impacts to California red-legged frog and western pond turtle in Green Valley Creek due to the groundwater pumping proposed in Option B would be less than significant.

Swainson's hawk is known to nest in tall riparian trees of the Central Valley. Of the more shallow-rooted, water dependent riparian species in Green Valley Creek (white alder, narrow-leafed willow, arroyo willow, and Gooding's black willow), Gooding's black willow is the only species that grows tall enough and is of the appropriate species for potential Swainson's hawk nesting (Section 4.5.4). However, any potential effects of groundwater pumping proposed by Option B to nesting habitat in Gooding's black willow would occur slowly over multiple breeding seasons and as a result would not negate the ability of Swainson's hawk to successfully nest. Therefore, impacts to Swainson's hawk in Green Valley Creek by the groundwater pumping proposed in Option B would be less than significant.

Valley elderberry longhorn beetle require the habitat of the blue elderberry shrub. Although occurring in the outer riparian habitat zone of Green Valley Creek, blue elderberry are not a species that requires root contact with the water table. Therefore, impacts to valley elderberry longhorn beetle in Green Valley Creek due to the groundwater pumping proposed in Option B would be less than significant.

5.2.2 Reaches 2-4: Northwest Tributary, West Tributary, and Hennessey Creek

The Northwest Tributary, West Tributary, and Hennessey Creek differ from the main stem of Green Valley Creek in that they lack perennial flows, contain habitat for the three water-dependent special-status species that is only appropriate for wet season (November – April) foraging and/or migration, and overall have little high quality or intact riparian tree and shrub habitat.

Central California coast steelhead would only access the Northwest Tributary, West Tributary, and Hennessey Creek for foraging during the winter months when surface flows are present. Groundwater levels and surface flows are naturally high during the wet season and would not be impacted by the additional proposed pumping of Option B. Therefore, impacts to central California coast steelhead in the Northwest Tributary, West Tributary, and Hennessey Creek due to the groundwater pumping proposed in Option B would be less than significant.

Riparian plant species that require root contact with the water table would be impacted if the depth to groundwater fell below the depth that their roots could access (**Table 3)**. If the radial extent of the cone of depression in the unconfined aquifer adjacent to a proposed Option B groundwater pumping well extended to the edge of the riparian habitat zone, the quantity of additional groundwater pumping could result in impacts to the more shallow-rooted water dependent riparian species in in the Northwest Tributary, West Tributary, or Hennessey Creek: arroyo willow and Gooding's black willow (10 foot maximum depth to water table for survival). Impacts to red willow would be less than significant due to the 25-foot maximum rooting depth to the water table for this species and the documented surplus of groundwater in the Project Area (Luhdorff and Scalmanini 2013; Section 3.5). The impact to the other riparian plant species that do not require root contact with the water table in Green Valley Creek (**Table 3**) due the groundwater pumping proposed in Option B would be less than significant.

California red-legged frog and western pond turtle would only use the Northwest Tributary, West Tributary, and Hennessey Creek for foraging and migration when moisture levels are adequate. During the wet season (November – April), groundwater levels are naturally high and would not be impacted by the additional proposed pumping of Option B. If the radial extent of the cone of depression in the unconfined aquifer adjacent to a proposed Option B groundwater pumping well extended to the stream channel of the Northwest Tributary, West Tributary, or Hennessey Creek in the dry season, impacts would be less than significant for these species because there is no surface flow in these creeks. Therefore, impacts to California red-legged frog and western pond turtle in the Northwest Tributary, West Tributary, and Hennessey Creek due to the groundwater pumping proposed in Option B would be less than significant.

Swainson's hawk is known to nest in tall riparian trees of the Central Valley. As described in Section 4.2.2 and 4.3.2 the Northwest Tributary and the West Tributary do not have any tall trees of the appropriate species for Swainson's hawk nesting sites (Section 4.5.4). Hennessey Creek does have tall valley oak that could provide potential nesting habitat for Swainson’s hawk. However, valley oak does not require root contact with the water table and the additional groundwater pumping proposed would not impact the survival of this tree species. Therefore, impacts to Swainson’s hawk in the Northwest Tributary, West Tributary, and Hennessey Creek due to the groundwater pumping proposed in Option B would be less than significant.

Valley elderberry longhorn beetle require the habitat of the blue elderberry shrub. Although occurring in the outer riparian habitat zone of Hennessey Creek, blue elderberry are not a species that requires root contact with the water table. Therefore, impacts to valley elderberry longhorn beetle in the Northwest Tributary, West Tributary, and Hennessey Creek due to the groundwater pumping proposed in Option B would be less than significant.

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6.0 CONCLUSIONS

The current demonstrated surplus of groundwater in Green Valley (Luhdorff and Scalmanini 2013; Section 3.5), as well as historical groundwater conditions during periods of significantly higher pumping than proposed by Option B, indicate that the proposed level of groundwater pumping in Option B will not result in Project Area-wide impacts to surface biological resources. Despite the overall groundwater abundance, localized drawdown of groundwater in the vicinity of proposed wells (cones of depression) during the dry season (May – October) could result in impacts to the most water-dependent surface biological resources if the radial extent of such cones of depression in the unconfined portion of the aquifer system extended to the riparian habitat zones in the Project Area.

Impacts to surface biological resources would be less than significant if proposed wells are constructed to avoid groundwater depletion of the shallow part of the aquifer system, particularly where there is hydraulic connection in the riparian habitat zone. In addition, criteria should be established to limit localized drawdown in the unconfined aquifer units due to the proposed groundwater pumping to ensure that any cones of depression in that part of the aquifer system do not reach the riparian habitat zones. The depth to respective aquifer units as well as the radial extent of the cones of depression within the unconfined aquifer can be characterized with data attained through a site-specific aquifer evaluation, including test well drilling, aquifer testing, and groundwater level monitoring in the adjacent unconfined aquifer. In fact, Mitigation Measures 16-1a (well locations and depths), 16-2a (well design to avoid any potential interference with surface streams), and 16-2b (actions related to adaptive management driven by ongoing monitoring) from the June 26, 2014, Revised Recirculated DEIR released by the Solano County for the Middle Green Valley Specific Plan are written in a way that would ensure mitigation for any potential impacts to surface waters.

Regardless of subsurface aquifer layers, the proposed level of pumping in Option B will have no impacts to surface biological resources if proposed wells are located a sufficient distance from riparian habitat zones to ensure the radial extent of the cone of depression within the unconfined aquifer does not extend to the riparian habitat zone. It is likely that the riparian corridor buffers identified in the Middle Green Valley Specific Plan are sufficient to avoid significant impacts to surface biological resources from the proposed groundwater pumping [Green Valley Creek and Upper/Lower Hennessey Creek: minimum 200 foot wide corridor (100 foot buffer from creek center line); and Unnamed drainage corridors: minimum 100 foot wide corridor (50 foot buffer from creek center line)]. Additional hydrogeologic investigations as part of the subsequent well siting and design process will provide data at a level of detail sufficient to calculate the radial extent of the cone of depression in the unconfined portion of the aquifer system resulting from the proposed wells of Option B.

Central California coast steelhead is the surface biological resource most vulnerable to the potential impacts of groundwater pumping. The dry season (May - October) is the time of the year in which groundwater pumping could impact surface flows, and Green Valley Creek is the only stream in the Project Area that provides dry season habitat for this species. Small changes in dry season stream depth could impact critical juvenile rearing aquatic habitat, when juvenile steelhead of various potential age classes require at least intermittently fairly fast-moving water to maintain the food supplies necessary for growth. Any reduction in current Green Valley Creek dry season flow that this species requires for juvenile rearing could potentially have impacts.

Shallow-rooted water-dependent riparian species in Green Valley Creek and its tributaries during the dry season would be the next most vulnerable: white alder (3 foot maximum depth to water table for survival) and narrow-leafed willow (6 foot maximum depth to water table for survival) on Green Valley Creek, and arroyo willow and Gooding's black willow (10 foot maximum depth to water table for survival) on Green Valley Creek and sparsely on the other creeks. No significant impacts from the proposed groundwater pumping are expected for Swainson's hawk, California red-legged frog, western pond turtle, or valley longhorn elderberry beetle. The proposed level of pumping in Option B will have no impacts on any other riparian biological resources if proposed wells are located a sufficient distance from riparian corridors to ensure the radial extent of the cone of depression within the unconfined aquifer does not extend to the riparian corridor. The riparian corridor widths identified in the Middle Green Valley Specific Plan are likely sufficient to ensure that the radial extent of the cone of depression within the unconfined aquifer does not extend to the riparian corridor, and to thereby avoid any impacts to surface biological resources as a result of the proposed level of pumping in Option B.

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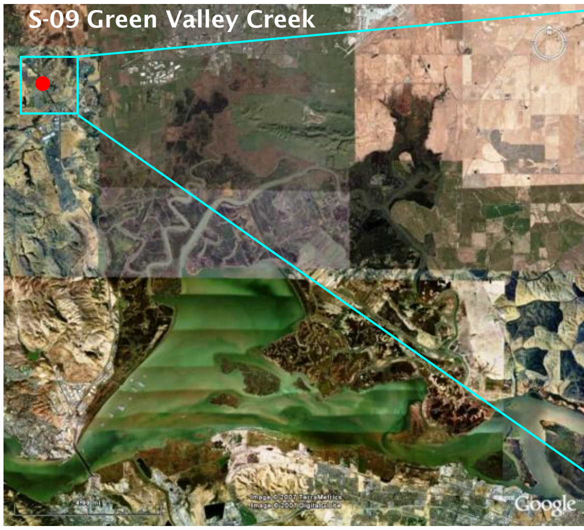
APPENDIX A

STREAM GAUGE S-09 GREEN VALLEY CREEK SITE, EQUIPMENT, AND OPERATIONS DESCRIPTION

S-09 Green Valley Creek



LOCATION DESCRIPTION

Site location: At the Mangels Boulevard over-crossing of Green Valley Creek
Waterbody: Green Valley Creek
Coordinates: Latitude 38° 13’ 15” Longitude 122° 08’ 47”

Driving directions: From I-80 W, in Fairfield, take the Green Valley Road exit. As you enter the exit, turn right getting into the left lane to the stop sign. Turn right onto Suisun Valley Rd and take another immediate left onto Mangels Blvd. Take Mangels Blvd through three stoplights to Vintage Valley Drive. Stay in the left turn lane, make a u-turn at the stop light and head back 200 yards and park next to the station along the west side of Green Valley Creek.

EQUIPMENT AND OPERATIONS

Established: 3/30/2001
Description of Site: Consists of a control box located adjacent to the Creek, a pressure transducer and cabling attached to the Mangels Blvd. over-crossing.
Monitoring equipment: DL800 with pressure transducer-stage only
Parameters collected: Stage
CDEC Code: N/A
Notes:

- To collect staff reading, lower tape reel from bridge where marked to very top of water surface. 16’=0 15’=1.0 ft, 14’=2.0 ft. etc.

Mangels Rd over-crossing and monitoring equipment box


Green Valley Creek and Mangels Rd over-crossing view from monitoring equipment box