Appendix 6.B. Terrestrial Effects Analysis Methods

6.B Terrestrial Effects Analysis Methods

6.B.1 Introduction

This appendix describes the methods used to analyze the effects of the proposed action (PA) on federally listed species in the action area. In most cases, effects are evaluated by comparing the value of affected habitat to the value of habitat provided by offsetting measures. As required by the federal Endangered Species Act (ESA), the effects analysis also describes the level of take and the effect of that take on each covered species expected from implementation of the PA.

6.B.2 Spatial Extent of the Terrestrial Effects Analysis

The effects analysis for listed wildlife is primarily confined to the legal Delta (see Chapter 4, *Action Area and Environmental Baseline*, Figure 4-1 for the boundaries of the legal Delta). Nearby areas considered, which fall outside the legal Delta, include an area of transmission line construction that extends east beyond the legal Delta boundary. In addition, vernal pool restoration may occur west and south of Clifton Court Forebay, near but outside the bounds of the legal Delta; and giant garter snake conservation may occur east of the legal Delta or in the Yolo Bypass.

6.B.3 Temporal Extent of the Terrestrial Effects Analysis

Construction of the water conveyance facility will last for 14 years; activities included in the PA also include start-up of the new facilities (assumed to be 1 year) and tracking of operations and maintenance of all covered facilities for another 10 years. Thus, the temporal extent of the analysis is 25 years. Construction of all habitat restoration is expected to have been completed by construction completion. Monitoring and maintenance of restored and protected habitat will continue in perpetuity.

6.B.4 Methods for Assessment of Effects on Terrestrial Species

6.B.4.1 Incidental Take Assessment

The PA is expected to cause incidental take of covered species. To meet regulatory requirements and to ensure adequate mitigation of effects, the amount of take must be discussed and, if possible, quantified. The allowable amount of take is quantified by estimating the loss of habitat for each covered species, using estimation methods described below.

A list of activities entailed in the PA, their effects, and corresponding conservation measures to offset the effects are summarized in Table 6.B-2 and Table 6.B-3 below. Many of the proposed activities will avoid impacts to species habitat. Avoidance commitments are summarized by activity type in Table 6.B-4 and Table 6.B-5; impact assessments were not developed for those activities that will fully avoid affecting covered species.

The effects of construction of the water conveyance facilities can be assessed on the basis of a known disturbance footprint. The disturbance footprint used in the analysis has been determined to be the maximum footprint that will be needed; e.g., it includes all staging, storage and stockpile areas, etc. It is expected that actual impacts will affect a smaller footprint. The project proponent will track actual effects during implementation to demonstrate that effects do not exceed authorize levels, and offsetting measures will be implemented to compensate for actual impacts, as determined during final design and construction.

Restoration will be sited as described in Section 3.4.7, *Terrestrial Species Conservation*, and siting is subject to review and approval by USFWS staff during project implementation. The siting of some of the conservation measures is not precisely known, but the region where restoration is likely to occur is relatively well defined (e.g., vernal pool restoration in the Bryon Hills region). Because restoration has not yet been sited, assumptions were developed to conservatively estimate the maximum loss of species habitat potentially resulting from the conservation measures (Section 3.4.7, *Terrestrial Species Conservation*), as summarized in Table 6.B-3 below.

The estimates of suitable habitat loss presented in Section 5.7, *Effects Analysis for Delta Smelt and Terrestrial Species*, represent the maximum limit on total loss for which the project proponents are seeking incidental take authorization. Once those limits are reached, any request for further take authorization due to habitat loss will first require reinitiation of consultation.

6.B.4.2 Terrestrial Species Habitat Models

Habitat models bring together information about environmental attributes, species life history, and environmental requirements to create a spatially explicit model of suitable habitat at a regional scale. Habitat models collect a variety of information relating to habitat requirements to create hypotheses of species-habitat relationships rather than statements of proven cause and effect relationships (Schamberger et al. 1982). Habitat models for terrestrial species are formulated primarily using vegetation data from existing GIS data sources as described in BDCP Appendix 4.A, *Covered Species Accounts*, Section 4.A.0.1.7, *Species Habitat Suitability Model Methods* (California Department of Water Resources 2013).

The habitat models were created using existing GIS data that in some cases does not provide the necessary information to precisely identify suitable habitat characteristics for a species. For example, the riparian plant alliance data is not a good predictor of the structural characteristics necessary to support nesting least Bell's vireos or western yellow-billed cuckoos. For this reason, *modeled habitat* is differentiated from *suitable habitat*, as defined for each species in Appendix 4.A, *Covered Species Accounts.* Suitable habitat will be identified prior to ground breaking to refine the existing habitat mapping, identify appropriate avoidance and minimization measures, and ensure that effects do not exceed those analyzed in this BA.

6.B.4.3 Analysis of Adverse Effects

Potential adverse effects on each species were assessed in each of four categories:

- Permanent and temporary habitat loss, conversion, and fragmentation;
- construction-related effects; and
- effects of operation and maintenance.

Adverse effects from each of these categories were then assessed collectively in the context of species survival and conservation to determine the net effect on the species. For each effect category, effects were assessed collectively for the PA and for conveyance facility construction. For restoration activities, only those activities with the greatest level of effects in each effect category were assessed in detail. Each of the effects categories applied in the adverse effects analysis is described below along with the methods used to quantify impacts.

6.B.4.3.1 Habitat Loss, Conversion, and Fragmentation

Both permanent and temporary habitat loss and conversion[1] are expected to occur, both as a result of activities with known locations, and from activities with flexible locations. The quality of modeled species habitat was based on the potential for that habitat to support and sustain the species. Factors considered in assessing habitat quality included habitat patch size and isolation from other habitat; adjacent land uses such as roads and other development inferred from aerial imagery; proximity to existing protected lands; and other available information from literature, occurrence databases, and species experts related to species distribution relative to the habitat lost. For most of the covered species, species occurrence data are incomplete and therefore have limited utility for assessing the extent to which modeled habitat is occupied or determining the value of the habitat in terms of supporting populations of a species. However, DWR has conducted extensive field surveys in and around the conveyance facility footprint and alternative alignments for this facility, as detailed in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*. Therefore, occurrence data are used to assess the value of habitat lost from conveyance facility construction more than they are used to assess the value of habitat lost from other activities under the PA.

The analysis of habitat fragmentation effects involved an evaluation of habitat surrounding the habitat to be lost, to determine whether the loss or conversion of habitat would create movement barriers or would isolate patches of remaining habitat in the area.

Activities with known locations include all proposed conveyance construction activities except geotechnical exploration, safe haven work areas, barge landings, and new electrical transmission lines; it also includes operations and maintenance of all existing and proposed CVP/SWP facilities except habitat restoration sites. Habitat loss resulting from activities with known locations was assessed by overlaying GIS data layers representing the geographic footprints of the ground disturbance areas for these activities with GIS data layers showing species habitat models.

Activities with flexible locations include transmission lines, geotechnical activities, safe haven interventions, barge landings, and the establishment and maintenance of habitat restoration sites. The methods applied to assess habitat loss for each of these activity types are described below.

[1] Habitat conversion is changing one habitat type to another, for example, changing or converting cultivated land to grassland through restoration.

6.B.4.3.1.1 Geotechnical Exploration

Geotechnical exploration will result in short-term temporary loss of species habitat; permanent habitat loss will be negligible, resulting solely from the actual bore holes, which will be a series of widely spaced holes, each approximately 8 inches in diameter, which will be grouted. The temporary habitat loss will consist of minor surface disturbances during exploration activities (drilling and exploration trenches) and driving overland, primarily over grasslands and agricultural lands, to access exploration sites. Activities at each site may last up to several weeks depending on location.

A geographic footprint represented in GIS data layers was used to conservatively estimate the area potentially disturbed by geotechnical exploration activities. This footprint consisted of a series of points along the conveyance alignment that were selected based on an assessment of the needs for more detailed geotechnical information. DWR estimates that 1,497 geotechnical exploration sites will be needed to analyze conditions prior to construction. Some of these points fall within areas of proposed conveyance facility construction and others are situated above the proposed tunnels. Based on DWR's experience with these type of activities and some preliminary field estimates, it is expected that the geotechnical exploration sites will result in approximately 0.84 acre of disturbance per site, which includes a 0.23 acre (10,000 square feet) area of temporary disturbance for drilling and staging plus an additional 0.61 acres of temporary disturbance associated with accessing the sites, which will consist of overland travel in agricultural areas and grasslands, which could result in temporary disturbance to vegetation. Figure 6.B-1 shows a typical geotechnical exploration work site. For the analysis, the geotechnical exploration sites, which are represented by points in GIS, were overlain on the conveyance footprint and intersected with the surface footprints and subsurface footprints to establish geotechnical exploration zones (GEZ). Not all surface features were included as part of the surface GEZ because they had not been identified as potential geotechnical exploration sites (i.e., these areas did not have geotechnical exploration site GIS point data within in them). The resulting surface GEZ is 5,980 acres with 913 geotechnical exploration sites and the subsurface GEZ is 1,531 acres with 392 geotechnical exploration sites. This analysis also showed that of the 1,497 geotechnical sites identified only 1,305 represent unique locations (i.e., 192 sites overlapped with at least one other site). The temporary impacts associated with geotechnical explorations within the surface GEZ will be 767 acres (0.84 acre x 913 sites) and within the subsurface GEZ will be 329 acres (0.84 acre x 392 sites). Because the exact locations of these impacts are yet to be determined, estimates were generated by applying the proportion of these impact acreages within the GEZ to the know acreage of modeled habitat within each GEZ. For the surface GEZ, 13% of the area will be temporarily affected (767 acres of impact/ 5,980 acres of surface GEZ) and for the subsurface GEZ 22% of the area will be temporarily affected (329 acres of impact/1,531 acres of subsurface GEZ).

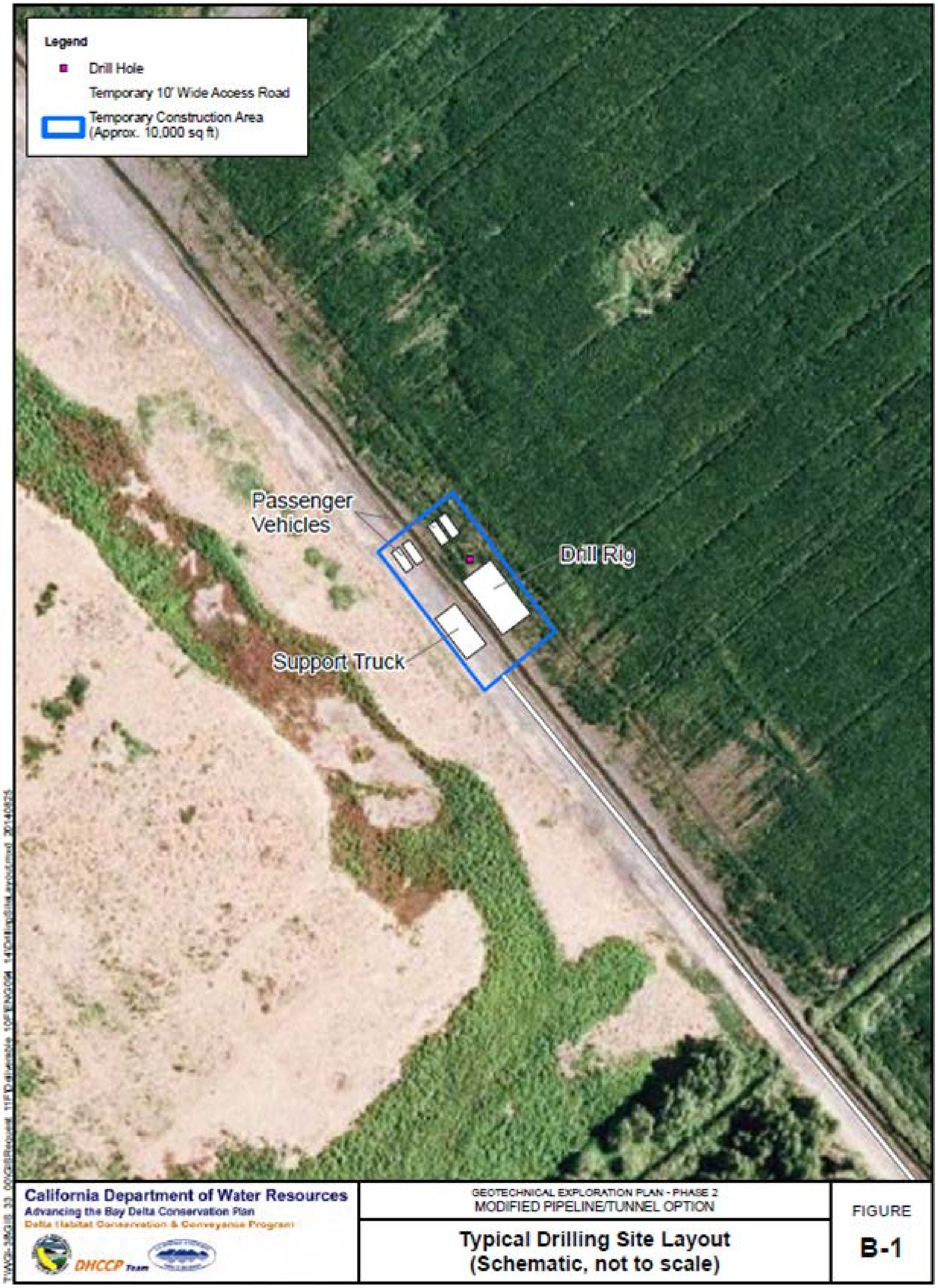

Figure 6.B-1. Example of a Typical Geotechnical Exploration Site

6.B.4.3.1.2 Safe Haven Intervention Work Areas

As described in Section 3.2.3.3.5 *Intermediate Tunnel Access*, safe haven intervention work areas will consist of pressurized safe haven intervention work areas, which will disturb a 0.23-acre area (100 feet by 100 feet), and atmospheric safe haven intervention work areas, each of which will disturb approximately 3 acres. As noted in the PA description, the final determination of both the number and siting of safe haven work areas will depend upon determinations made by the tunnel construction contractors following the completion of geotechnical explorations. The expected number of pressurized safe haven work areas is 31, which will result in approximately 7 acres of disturbance (31 sites multiplied by 0.23 acre). The expected number of atmospheric safe haven work areas will be up to 18, which will result in approximately 54 acres of disturbance (18 sites multiplied by 3 acres) (Chapter 3, *Description of the Proposed Action*, Table 3-8a).

Because the exact location of the safe haven intervention work areas are not known, impacts to species from this activity will need to be approximated. To do this, the subsurface tunnel feature was buffered in GIS; the size of the buffer was based on the size of the safe haven work area. For the pressurized sites, the line was buffered by 50 feet on each side of the alignment to model the width of the 0.23 acre site (approximately 10,000 square feet). This method assumes the 0.23-acre pressurized safe have intervention site will be square, with each side of the square footprint being 100 feet long. The buffering process includes 50 feet from the centerline on both sides of the line, totaling 100 feet. For the atmospheric safe haven work areas, each side of the square site was assumed to be 550 feet and therefore the subsurface tunnel feature was buffered by 275 feet on each side in GIS. The buffered lines were then intersected with the species habitat models to determine the total acres of species habitat that could potentially be affected in each reach. The total acres of the species habitat that overlapped with the tunnel footprint in a given reach were then divided by the total acres of the buffered footprint for that reach. See below for the equation. The proportion of habitat that could potentially be affected by the safe haven intervention work area was then multiplied by the expected acres of impact in that reach to come up with the estimated loss for that reach. This method assumes the highest number of intervention sites in each reach presented in Chapter 3, *Description of the Proposed Action*, Table 3-8a. Although this method may slightly overestimate or underestimate impacts for a specific reach, it is assumed to be conservative because the maximum number of possible intervention sites was assumed.

$$\frac{\text{Total acres of species habitat within the buffered line}}{\text{Total acres in the buffered line}} = \text{The proportion of habitat that has potential to be affected by safe haven intervention sites in that reach.}$$

6.B.4.3.1.3 Barge Landings

As described in the BA Chapter 3, Section 3.2.10.9 *Barge Operations*, the barge unloading facilities will be constructed along waterways adjacent to the conveyance alignment to deliver supplies and materials for construction. The barge landing docks will be approximately 300 feet by 50 feet (approximately 0.34 acre). The exact locations of these facilities will be determined by the construction contractor but generally they will likely fall within the areas identified in Appendix 3.A, *Map Book for the Proposed Action*. Because of the uncertainty of the exact location of these facilities and the amount of space necessary to construct them, the polygons drawn for these areas range between 0.7 acre and 10.7 acres to account for the uncertainty in facility siting within each area. The total temporary impact identified for barge landings in the GIS analysis is approximately 33 acres, which is a conservative estimate based on the anticipated size of the barge unloading facilities (0.34 acre) compared to the sizes of those sites depicted in the mapbooks (0.69 to 10.74 acres).

6.B.4.3.1.4 Transmission Lines

The alignments of the permanent and temporary transmission lines will be chosen through the implementation of AMM30, which provides guidance for establishing the alignments such that impacts to terrestrial and aquatic resources are minimized. Construction of transmission lines will result primarily in temporary impacts from overland travel and equipment staging by construction and installation vehicles (Table 6.B-1). The only permanent effect will be from the approximate 1 foot by 1 foot footprint of the poles and will result in a total of 0.1 acres (Table 6.B-1). The temporary effects from overland travel and staging are not expected to result in ground disturbance such that restoration would be needed. In order to provide an estimate of the temporary habitat loss from pole placement, line stringing and equipment and vehicle staging, a 50-foot wide corridors around the preliminary transmission line alignments were established in GIS and used to intersect the modeled habitat for each listed species. This provides a conservative estimate of the temporary species habitat loss, a premise that was validated by comparing the total acreage resulting from this GIS analysis to the construction details presented in the BA, Chapter 3, Section 3.2.7.2 *Construction*. Table 6.B-1 below summarizes this comparison. As seen in this table, the total footprint from the GIS analysis is twice the amount of impact as that described under the preliminary construction details. However, it is unlikely the temporary impacts will double as a result. Therefore, the transmission line temporary impact estimate provided for this analysis more than covers what the actual, temporary habitat loss will likely be.

Table 6.B-1. Assumptions for Transmission Line Effect Analysis

Transmission Line Size	69 kV	230 kV	TOTAL
Preliminary Construction Details			
Permanent Footprint Size for Pole and Tower Construction (Square feet)	6	30	NA
Temporary Footprint Size for Pole and Tower Construction (Square feet)	5,000	5,000	NA
Temporary Access Route Widths (feet)	12	12	NA
Number of Miles of Line (Permanent)[1]	0	17	NA
Number of Miles of Line (Temporary)[1]	6	30	NA
Total Number of Poles (Permanent)[2]	-	121	NA
Total Number of Poles (Temporary)[2]	71	211	NA
Impacts Based On Preliminary Construction Details			
Permanent Impacts for Permanent Pole/Tower Footings (square feet)	-	3,622	3,622
Total Permanent Impacts for Permanent Poles/Towers Footings (acres)	-	*0.08*	*0.1*
Temporary Impact from Access Routes for Permanent Lines (acres)	-	25	25
Temporary Impact from Access Routes for Temporary Lines (acres)	9	44	52
Temporary Impacts from Temporary Pole/Tower Footings (square feet)	428	6,336	6,764
Temporary Impacts for Temporary Poles/Towers Footings (acres)	0.01	0.15	0.2
Number of current turns deviating by more than 15 degrees and/or 2 miles - Permanent Lines[3]	0	11	NA
Number of current turns deviating by more than 15 degrees/and or 2 miles - Temporary Lines[3]	12	23	NA
Each Conductoring Area Size (square feet)	35,000	35,000	NA
Temporary Conductoring Impact for Permanent Lines (acres)	0	9	9
Temporary Conductoring Impact for Temporary Lines (acres)	10	18	28
Temporary Impacts for Permanent Pole/Tower Work Areas (Square Feet)	-	603,680	603,680
Temporary Impacts for Permanent Pole/Tower Work Areas (acres)	-	13.86	14
Temporary Impacts for Temporary Pole/Tower Work Areas (Square Feet)	35,7121	1,062,336	1,419,457
Temporary Impacts for Temporary Pole/Tower Work Areas (acres)	8	24	33
Total Temporary Impacts for Permanent Transmission Lines (acres)	0	48	48
Total Temporary Impacts for Temporary Transmission Lines (acres)	27	87	113
Total Temporary Impacts for Transmission Lines (acres)	*27*	*134*	*161*
Total Impacts for Transmission Lines (temporary) (acres)	*27*	*134*	*161*
Impacts Based on GIS Analysis			
Total Estimated Temporary Impacts from Permanent Lines Assuming a 50-foot Corridor Width (acres)	-	104	104
Total Estimated Temporary Impacts from Temporary Lines Assuming a 50-foot Corridor Width (acres)	37	182	219
Total Estimated Temporary Impacts (acres)	*37*	*286*	*323*

[a] The 230 kV estimate includes some miles of 500 kV and 230/34.5 kV. Effects from the construction of permanent and temporary lines are considered permanent because the effect will persist for more than one year.

[b] Assumes a pole/tower every 450 feet for 69 KV lines, and every 750 feet for 230 kV lines. Effects from the construction of permanent and temporary lines are considered permanent because the effect will persist for more than one year.

[C] The number of conductoring areas was determined by following the transmission alignments on the maps and noting every 2 miles and/or deviations greater than 15 degrees (this was visually estimated and essentially captures all slight and sharp turns in the lines).

6.B.4.3.1.5 Restoration

Implementation of the California WaterFix (CWF) will require, in part, habitat restoration as compensation for effects to listed species and wetlands. Most of this restoration is designed to comply with the state and federal Endangered Species Acts or section 404 of the Clean Water Act. However, in some cases restoration is needed to comply with the California Environmental Quality Act for impacts to non-listed special status species. Restoration will benefit almost all of the listed species described in this biological assessment. However, during the construction of some restoration projects, there is a potential to temporarily or permanently adversely affect listed species, including the species targeted for benefits by the restoration. Because restoration sites have not yet been selected, a method is needed to estimate the potential for and amount of expected adverse effects to state and federal listed species in the absence of proposed restoration sites.

Implementation of CWF restoration will not affect six federally listed terrestrial species (Table 6.B-4). This conclusion is based on two primary factors, the species habitat does not overlap with the restoration area (e.g., grassland restoration will not adversely affect California tiger salamander because grassland restoration will take place in the north and east Delta where there are no known occurrences of California tiger salamander) or species the habitat will be specifically avoided during restoration (e.g., tidal restoration in Cache Slough would be designed to avoid impacts to vernal pools). See Chapter 6, Sections 6.2 through 6.11, for a description of potential adverse effects from restoration (by species) and the avoidance and minimization commitments in place to avoid and minimize effects.

In limited instances, adverse effects may or will occur to some species from restoration implementation (Table 6.B-4). Although the exact location of habitat restoration is unknown, the general region where restoration will occur is known because of species-specific habitat needs (e.g., bathymetry, tidal elevation, connectivity with occupied habitat, etc.) and the commitment to place compensation lands near the location of effect whenever possible. Table 6.B-5 identifies the restoration projects that will be implemented as part of CWF, the species the restoration will benefit, the region where the restoration is assumed to occur, and the terrestrial species likely to be adversely affected by the restoration.

To improve the accuracy of estimated adverse impacts to terrestrial species from restoration projects, *proxy restoration sites* were used when they were available. A proxy restoration site is defined as a restoration project expected to have similar adverse impacts to the listed species as the restoration that will be implemented for the California Water Fix. Using proxy restoration sites allows for a site-specific evaluation of potential adverse effects to listed species. For the purpose of this assessment, a proxy restoration site must meet the following requirements.

- The proxy restoration site must have a drafted biological assessment or approved Habitat Conservation Plan (HCP) associated with it;
- The proxy restoration sites must affect the same terrestrial species affected by habitat restoration implemented under CWF;
- The proxy restoration sites must be within, or near, the legal Delta;

- The proxy restoration site must be designed to benefit the same species the CWF restoration project will benefit.

- It must have designs that meet criteria detailed under CWF for species-specific restoration siting criteria (see Section 3.4, *Conservation Measures*,).

An example of a good proxy restoration site is the Lower Yolo restoration project; this project will serve as a good proxy restoration site to estimate impacts to giant garter snake from tidal restoration because the project is designed to benefit Delta Smelt and salmonids, the same as with CWF tidal restoration. The Lower Yolo restoration project also overlaps with suitable giant garter snake habitat, occurs in the north Delta/Cache Slough region where CWF tidal restoration will occur, and has an available biological assessment with estimates of giant garter snake habitat loss. Table 6.B-8Table 6.B-8 presents the total loss of giant garter snake and valley elderberry longhorn beetle habitat from tidal restoration estimated using this method. Table 6.B-3 lists the main assumptions used to support the analysis.

For each proxy site DWR and Reclamation created a crosswalk between the habitat types on the proxy site and those used in the CWF. Then, the proportion of the project footprint that will affect species habitat was calculated at the proxy site. The proportion of the restoration project that will affect species habitat is calculated by dividing the amount of adversely affected habitat by the size of the restoration project. The proportion of affected habitat at the proxy site will then be multiplied by the total size of the CWF restoration project. For example, if 2% of the Lower Yolo tidal restoration project would affect high quality giant garter snake habitat, and the total tidal restoration commitment for CWF is 305 acres, then the estimated loss of high quality giant garter snake aquatic habitat from tidal restoration performed under the CWF would be 6 acres (2% x 305 acres).

The proxy restoration project is also be used to inform other determinations of indirect effects in the effects analysis such as construction duration and construction-related effects such as noise, light, and dust. The use of proxy sites to estimate impacts from CWF restoration will be conservative because restoration projects implemented under the CWF are likely to be smaller than what is currently estimated in the draft CWF biological assessment. This is because impacts from CWF construction are currently estimated using conservative habitat models which overestimates impacts (this is in contrast to impact estimates from the proxy restoration sites which use ground surveys to determine impacts). When impacts are measured by a qualified biologist during CWF implementation, the effects will likely be found to be less than estimated. As such, CWF restoration commitments may be reduced commensurate with the reduction in impacts through the Section 7 re-initiation process for federally listed species and through a 2081 permit amendment for state listed species (see Section 3.4.9.1, *Compliance Monitoring*, for more details)

6.B.4.3.2 Construction-Related Effects

There is a potential for individual animals to be harassed, injured, or killed as a result of construction activities. The effects analysis includes a description of the potential for effects, examines how those effects will be avoided or minimized, and evaluates any residual, unavoidable effects after minimization measures are applied. There are two basic types of effects from construction: mortality or injury associated with contact with construction equipment and harassment associated with effects that extend out from construction equipment or personnel and include dust, noise, and light.

6.B.4.3.2.1 Mortality and Injury

Potential construction-related mortality and injury are assessed for each species qualitatively, taking into account the duration that such effects are anticipated to occur, and (when the information is available) the intensity of effect. The analysis then evaluates measures that will be implemented to avoid and minimize these effects, and assesses any residual effects that cannot be avoided.

6.B.4.3.2.2 Harassment, Dust and Light

The effects of dust and light are described qualitatively in each species section. These effects have a limited spatial extent beyond the edge of the construction footprint and are addressed with avoidance and minimization measures. The analysis evaluates the measures that will be implemented to avoid and minimize these effects, and assesses any residual effects that cannot be avoided.

6.B.4.3.2.3 Harassment, Noise

The effects of noise have potential to reach beyond the areas immediately adjacent to the construction footprint. For this reason, a method was developed to characterize noise levels beyond the footprint. For the species with potential to be sensitive to noise—riparian brush rabbit, San Joaquin kit fox, and western yellow-billed cuckoo—the noise levels and potential for effects are described in the effects analysis.

The assessment of potential construction noise levels is based on methodology developed by the Federal Transit Administration (FTA) (2006). Effects associated with construction activities will be temporary, which, for the purposes of this chapter, is defined as occurring during construction, which at most sites is an activity lasting several years (as shown in Appendix 3.D Assumed Construction Schedule for the Proposed Action). Noise levels produced by commonly used construction equipment are summarized in Table 6.B.4.3.2.1-1. Individual types of construction equipment are expected to generate maximum noise levels ranging from 76 to 101 dBA at a distance of 50 feet. The construction noise level at a given receiver depends on the type of construction equipment used and the distance and shielding between the activity and the receiver, which is an individual of a covered species.

An inventory of equipment expected to be in service by project activity type is included in Table 6.B.4.3.2.1-1. The source level is based on the maximum sound pressure level over a defined period (Lmax) of equipment emission levels developed by FTA. Utilization factors for construction noise are used in the analysis to develop 24-hour sound level (Leq) noise exposure values. The Leq value accounts for the energy-average of noise over a specified interval (usually 1 hour), so a utilization factor represents the amount of time a type of equipment is used during the interval. In practice over a multi-year construction schedule, equipment utilization factors for a given hour of a workday will vary from zero to 100%.

To characterize the source level of the worst-case noise condition during a given phase of construction, the six loudest pieces of equipment are assumed to operate simultaneously at a perimeter location, at a receiver distance of 50 feet. Pile drivers are assumed to operate up to 100% of a given hour, assuming multiple drivers are used at a site. Heavy trucks are also assumed to operate up to 100% of a given hour. With the exception of impact pile driving, trucks are assumed to be the dominant source of noise. Source emission levels for trucks are up to 88 dBA at 50 feet, as shown in Table 6.B.4.3.2.1-1.

Other sources of construction noise include machinery noise during installation of power transmission lines, use of helicopters for installing conductor line, use of earth-moving equipment at offsite areas, use of machinery at staging areas, operation of concrete plants, and machinery noise associated with the use of barges for in-water pile driving. Work at excavation sites will involve the use of rock drills, crushers, and screens.

Sheet piles and tubular steel piles will be driven at many project sites. These will be placed using vibratory hammers where feasible but in many cases would also require impact pile driving; since the frequency of use for vibratory hammers is unknown, the pile driving noise analysis assumes that all driving will be performed using impact drivers, which generate louder noise for comparable durations. Some piles will be placed using cast-in-drilled-hole technique; here again the number and location of such piling placements is unknown and the analysis assumes that these would be placed using the louder impact pile driving technique. As shown in Table 6.B.4.3.2.1-1, the source noise level for an impact pile driver is 101 dBA at 50 feet. Construction assumptions for pile driving, including numbers of pile installations per day are included in Appendix 3.E, Pile Driving Assumptions for the Proposed Project. The estimated sound levels from the various construction activities evaluated are a function of distance based on calculated point-source attenuation over “soft” (i.e., acoustically absorptive) ground, such as that found in the action area (hard ground would be bedrock and pavement).

6.B.4.3.2.3.1 Sensitivity to Noise and Thresholds for Mitigation

A 60 dBA is used here as a threshold for effects on covered wildlife species; this threshold is also supported by the California Department of Water Resources (DWR) Section 01570, Specification 05-16 that suggests the following guidelines for DWR construction projects:

Where ambient noise levels are less than 60 dBA and it is determined that construction related noise will cause noise levels to exceed 60 dBA, or where the ambient noise levels are greater than 60 dBA and it is determined that construction related noise will cause noise levels to exceed the ambient level by 5 dBA, a temporary sound wall shall be constructed between the sensitive area and the construction related noise source. The 60 dBA limit is not a regulatory requirement. Although the 60 dBA limit is not a regulatory requirement, it has been established as a threshold for establishing noise impacts by consensus of experts, local and resource agencies, including the U.S. Fish and Wildlife Service (USFWS). It is estimated that among other things, noise levels above 60 dBA may interfere with communication among birds and other wildlife.

Table 6.B.4.3.2.1-1. Commonly Used Construction Equipment and Noise Emission Levels for Each Construction Activity

Equipment	Typical Noise Level (dBA) 50 Feet from Source	Equipment Used for Construction Activities								
		Geotechnical Exploration	Safe Haven Work Areas	North Delta Intakes	Tunneled Conveyance Facilities	Clifton Court Forebay	Power Supply and Grid Connections	HOR Gate	Reusable Tunnel Material Areas	Restoration
Pile-driver (Impact)	101			X	X	X		X		
Pile-driver (Vibratory)	96			X	X	X		X		
Grader	85	X	X	X	X	X		X	X	X
Bulldozers	85	X	X	X	X	X	X		X	X
Truck	88	X	X	X	X	X	X	X	X	X
Loader	85	X	X	X	X	X	X	X		
Air Compressor	81			X	X	X				
Backhoe	80	X	X	X	X	X	X	X		X
Pneumatic Tool	85									
Excavator	85	X	X	X	X	X		X	X	X
Auger Drill Rig	85	X	X	X	X	X				
Crane, Derrick	88			X	X	X	X	X		
Compactor (Ground)	82			X	X	X				
Concrete mixer	85			X	X					
Generator	81	X	X	X	X	X				
Pump	76		X	X	X	X				
Roller	74	X		X	X	X		X		

Source: Federal Highway Administration 2006.
dBA = A-weighted decibel.

6.B.4.3.2.3.2 Existing Baseline Conditions in the Study Area

The baseline is the existing ambient noise level in a given location. Baseline noise levels vary greatly depending on the extent of urban development and proximity to transportation corridors. Ambient rural noise levels are typically in the range of 40–50 dB (Table 6.B.4.3.2.1-2). Ambient noise levels near major highways can be as high as 75 dB. Existing traffic noise levels along highways and other major roadways were calculated using peak-hour traffic volume data provided by the project traffic consultant (Fehr & Peers 2015).

Table 6.B.4.3.2.1-2. Typical Ambient Sound Levels as a Function of Population Density

Location	L_{dn} (A-Weighted Decibel)
Rural: Undeveloped	35
Rural: Partially Developed	40
Suburban: Quiet	45
Suburban: Normal	50
Urban: Normal	55
Urban: Noisy	60
Urban: Very Noisy	65

Sources: Cowan 1994; Hoover and Keith 2000.
L_{dn} = day-night sound level.

To assess increases in noise levels due to construction of the project, a baseline of 40 dBA is used to describe the existing ambient noise level in the study area. Because many of the facilities that will be constructed under the PA are located primarily in rural areas, a baseline level of 40 dBA is characteristic of the project's mostly rural setting, and is therefore assumed to apply to the entire action area. The ambient baseline level of 40 dBA is used in this analysis to conservatively account for increases in noise levels. Noise monitoring at specific locations has not been conducted for this project.

6.B.4.3.2.3.3 Construction Noise Effects

The predicted noise levels from construction activities are summarized below in Table 6.B.4.3.2.1-3. Table 6.B.4.3.2.1-4 summarizes the predicted noise levels of construction activities that involve impact pile driving. Discussions of these activities are also provided below.

6.B.4.3.2.3.3.1 Geotechnical Exploration Noise Effects

Potential equipment noise levels from geotechnical explorations are derived by combining the noise levels of the six loudest pieces of equipment that would likely operate at the same time. Assuming 100% utilization within a given hour of day, the combined noise level is 89 dBA Leq (1hr) at 50 feet (Table 6.B.4.3.2.1-3).

6.B.4.3.2.3.3.2 Safe Haven Noise Effects

Potential noise levels at safe have work areas will be comparable to those listed for geotechnical exploration sites in Table 6.B.4.3.2.1-3.

Table 6.B.4.3.2.1-3. Predicted Noise Levels from Construction Activities

Distance Between Source and Receiver (feet)	Calculated Leq (1hr)(dBA)								
	Geotechnical Exploration	Safe Haven Work Areas	North Delta Intakes	Tunneled Conveyance Facilities	Clifton Court Forebay	Power Supply and Grid Connections	HOR Gate	Reusable Tunnel Material Areas	Restoration
50	89	89	96	96	96	91	96	91	91
100	81	81	88	88	88	83	88	83	83
200	73	73	80	80	80	75	80	75	75
400	65	65	72	72	72	67	72	67	67
600	64	64	68	68	68	63	68	63	63
800	**60**	**60**	64	64	64	**60**	64	**60**	**60**
1,000	58	58	62	62	62	57	62	57	57
1,200	56	56	**60**	**60**	**60**	55	**60**	55	55
1,400	53	53	57	57	57	53	57	53	53
1,800	50	50	54	54	54	50	54	50	50
2,000	47	47	51	51	51	49	51	49	49
3,000	46	46	50	50	50	44	50	44	44
4,000	45	45	49	49	49	40	49	40	40
5,280	40	40	43	43	43	40	43	40	40

The 60 dBA thresholds are shown in bold for each activity.

6.B.4.3.2.3.3.3 North Delta Intake Construction Noise Effects

Potential reasonable worst-case equipment noise levels from construction of the intakes are derived by combining the noise levels of the six loudest pieces of equipment that would likely operate at the same time (heavy trucks). Assuming 100% utilization within a given hour of day, the combined noise level is 96 dBA Leq (1hr) at 50 feet (Table 6.B.4.3.2.1-3).

Estimated sound levels from impact pile driving conducted during periods of construction described above are shown in Table 6.B.4.3.2.1-4.

Typically noise from pile driving is not constant; however, because multiple pile drivers would be used, a utilization factor of 100% has been applied. Use of the pile driver simultaneously with noise from other equipment in Table 6.B.4.3.2.1-3 would produce a combined level of 102 dBA Leq (1hr) at 50 feet, as shown in Table 6.B.4.3.2.1-4.

The results shown in Table 6.B.4.3.2.1-4 indicate that during periods of pile driving, wildlife within 2,000 feet of an active intake construction site could be exposed to construction noise in excess of 60 dBA Leq (1hr).

Table 6.B.4.3.2.1-4. Predicted Noise Levels from Construction—Pile Driving and Construction Equipment

Distance Between Source and Receiver (feet)	Calculated Daytime Leq (1hr) Sound Level (dBA)
50	102
100	94
200	86
400	79
600	74
800	71
1,000	68
1,200	66
1,500	63
2,000	**60**
2,500	58
2,800	56
3,000	56
4,000	52
4,500	51
5,000	50
5,280	49

6.B.4.3.2.3.3.4 Tunneled Conveyance Facilities, Clifton Court Forebay, and HOR Gate Noise Effects

Potential reasonable worst-case equipment noise levels from construction work areas adjacent to tunnel conveyance facilities, Clifton Court Forebay, barge landings, and the HOR gate would be comparable to those listed for the North Delta intake sites in Table 6.B.4.3.2.1-3 and Table 6.B.4.3.2.1-4 when pile driving is occurring.

6.B.4.3.2.3.3.5 Power Supply and Grid Connections Noise Effects

Potential reasonable worst-case equipment noise levels from construction of the power transmission lines are derived by combining the noise levels of the three loudest pieces of equipment that would likely operate at the same time (an excavator, a truck and a drill rig for driving micropiles for construction of towers). Assuming 100% utilization within a given hour of day, the combined noise level is 91 dBA Leq (1hr) at 50 feet (Table 6.B.4.3.2.1-3).

The results shown in Table 6.B.4.3.2.1-3 indicates that wildlife within 800 feet of an active power supply and grid connection construction area could be exposed to construction noise in excess of 60 dBA Leq (1hr).

Construction of transmission lines will also include helicopter use for installing conductor line. Use of helicopters will be temporary and intermittent. Two light-duty helicopters are assumed to operate four hours a day to install new poles and lines. Light- to medium-duty helicopters have a source level of up to 84 Lmax at a reference distance of 500 feet (Nelson 1987). It would generally take less than 10 minutes to string the line between each structure. It is estimated that helicopters would not be in any given line mile for more than 3 hours. Given that noise exposure to helicopters would be isolated to line-stringing events, it is not considered to contribute significantly to ambient noise during periods of construction.

6.B.4.3.2.3.3.6 RTM Storage Sites Noise Effects

Potential equipment noise levels from earth-moving activities at RTM storage sites are derived by combining the noise levels of the three loudest pieces of equipment that would likely operate at the same time (an excavator, a truck and a bulldozer). Assuming 100% utilization within a given hour of day, the combined noise level would be 91 dBA Leq (1hr) at 50 feet (Table 6.B.4.3.2.1-3).

The results shown in Table 6.B.4.3.2.1-3indicate that wildlife within 800 feet of equipment operating in the RTM storage areas could be exposed to construction noise in excess of 60 dBA Leq (1hr).

6.B.4.3.2.3.3.7 Restoration Noise Effects

The most noise-producting activities associated with restoration site development are those that entail grading, i.e. the use of earth-moving equipment. Therefore potential equipment noise levels from restoration activities would be comparable to those listed for the RTM storage sites (see Table 6.B.4.3.2.1-3), but would be of much shorter duration (months compared to years at RTM storage sites).

6.B.4.3.2.3.4 Operations and Maintenance Noise Effects

6.B.4.3.2.3.4.1 Operations of Water Conveyance Facilities

Potential pump noise levels during operation of the Combined Pumping Plant was evaluated by calculating sound power levels of the pump based on horsepower (Hoover and Keith 2000). The analysis assumes that air handling units, compressors and emergency generators are integrated into the building structure. Faceplate horsepower for pumps is specified in the Conceptual Engineering Report (see Appendix 3.B). The results shown assume maximum horsepower and flow capacity of the plant. Pump specifications are shown in Table 6.B.4.3.2.1-5. Combined source noise levels assume that pump enclosures (including buildings) provide a nominal 15 dB of noise attenuation. This is a conservative estimate based on masonry construction with openings in the structure for ventilation (Federal Highway Administration 2011). This analysis assumes that pumps are operating 24 hours a day. The estimated sound levels from pump operation are shown in Table 6.B.4.3.2.1-5 below.

Table 6.B.4.3.2.1-5. Pump Specifications

Pump Location	Quantity	Pumping Plant Capacity (cfs)	Pump Horsepower	Individual Pump Source Level (dBA)	Combined Equipment Source Level (dBA)	Assumed Attenuation (dB)	Combined Source Level with Attenuation (dBA)
Clifton Court Forebay Pumping Plant	7	9,000	6,000	98	106	15	91
	2		3,000	95	98		

cfs = cubic feet per second.
dB = decibels.
dBA = A-weighted sound level in decibels.

Table 6.B.4.3.2.1-6. Predicted Noise Levels from Pumping Plant Operation

Distance Between Source and Receiver (Feet)	Intake 2Combined Pumping Plant Calculated L_{eq} Sound Level (dBA)
50	91
100	83
200	75
300	71
400	67
600	63
800	59
1,000	57
1,200	55
1,400	53
1,600	52
1,800	50
2,000	49
2,500	47
2,800	45
3,500	43
4,500	40
5,280	38

Notes: Calculations are based on Federal Transit Administration 2006. Calculation do not include the effects, if any, of local shielding from walls, topography, or other barriers that may reduce sound levels further.

Noise levels assume a nominal pump enclosure attenuation of 15 dB.

dBA = A-weighted sound level in decibels.

The results shown in Table 6.B.4.3.2.1-6 indicate that pump operations would exceed 60 dBA up to approximately 800 feet from the pumps.

6.B.4.3.2.3.4.2 Maintenance Activities

Maintenance activities will be intermittent and generally are not anticipated to result in noise levels substantially above ambient levels in the action area.

6.B.4.3.3 Effects from Operations and Maintenance

There is a potential for individual animals to be harassed, injured, or killed as a result of operation and maintenance activities, including enhancement and management activities on protected lands such as native species plantings and nonnative species control. The analysis of the effects of operations and maintenance includes an assessment of potential effects, an evaluation of measures that will be applied to avoid or minimize effects, and an assessment of any residual, unavoidable effects after the minimization measures have been applied.

This effect category also includes effects of operation and maintenance-related factors such as dust, noise, vehicle traffic, human disturbance, and night lighting, on habitat and individuals potentially present in the vicinity of operations and maintenance activities. Potential operation and maintenance-related effects are assessed for each species, measures that will be implemented to avoid and minimize these effects are evaluated, and any residual effects that cannot be avoided are then assessed.

6.B.4.4 Summarizing Effects on Wildlife and Plants

The effects analysis includes a summary, for each species, of the combined effects of all aspects of the PA. Table 6.B-2 below summarizes suitable habitat loss and proposed compensation as a result of the PA; see Section 3.4.7, *Terrestrial Species Conservation*, for description of all conservation measures and Section 5.7, *Effects Analysis for Delta Smelt and Terrestrial Species*, for description of all adverse effects.

Table 6.B-2. Effects Analysis Methods and Assumptions for Water Conveyance Facility Construction.

Activity/Impact Mechanism	Method of Impact Estimation	Key Assumptions for Purposes of Analysis
Water Conveyance Facility Construction		
Conveyance facilities construction/ permanent removal of habitat	• GIS layer for construction footprint was overlain on modeled habitat and critical habitat GIS layers.	• Construction of the forebay, intakes, permanent access roads, shafts, Clifton Court expansion area result in permanent removal of habitat within construction footprint.
Reusable tunnel material/ permanent removal of habitat	• GIS layer for footprint of reusable tunnel material areas was overlain on modeled habitat and critical habitat GIS layers. • Where AMMs require avoidance of species habitat, this requirement was factored into the impact estimation for species.	• For the purposes of impact analysis, it is assumed reusable tunnel material areas will not be returned to pre-project conditions. • The final footprint for the reusable tunnel material will meet avoidance and minimization requirements in the AMMs.
Conveyance facilities/ Potential Temporary Activities	• GIS layer for footprint of staging areas, intake pipelines, and barge unloading facilities was overlain on modeled habitat and critical habitat GIS layers.	• Staging areas, intake pipelines, and barge unloading facilities are unlikely to be used after construction is complete; however, for the purposes of this analysis, the effects to species are considered permanent. • Subsurface segments of the tunnel/pipeline have no effects on biological resources.
Transmission line construction/ permanent removal of habitat	• GIS layer representing a conservative estimate of the total distance of the transmission line alignment was overlain on modeled habitat and critical habitat GIS layers. • The transmission line footprint assumes a 50-foot corridor to conservatively estimate a maximum take limit.	• Transmission line direct effect will not exceed the maximum take limit which is based on a footprint that extends outside the action area. • Although a significant portion of the transmission lines will be removed upon project completion, due to the 14-year duration of the project, the impact to species habitat will be considered permanent. • Permanent effects to suitable habitat will be primarily from pole placement; tower placement; vegetation clearing around poles, towers, and under lines. • Vegetation clearing is expected to be needed in riparian areas. Grassland and cultivated lands are not expected to require vegetation clearing under transmission lines.

		• Existing roads will be used for access and maintenance whenever possible. • The effects of overland travel in agricultural areas and grasslands to access pole/tower construction sites and provide maintenance for these facilities will result in minimal temporary disturbance to vegetation (mostly vegetation trampling and minor soil disturbance). No permanent access roads will be necessary, as it is the practice of utilities to only construct permanent access roads in areas of steep terrain and/or areas of dense trees and shrubs.
Geotechnical Exploration Activities/temporary removal of habitat	• Geotechnical exploration sites are assumed to result in 0.61 acre of temporary disturbance along access routes (overland travel) and 0.23 acre of disturbance at each exploration site. Total disturbance per site is assumed to be 0.84 acre. • Up to 1,550 terrestrial sites will be selected for a total geotechnical footprint of 1,302 acres (1,550 sites x 0.84 acre) • Estimated impact determined by the % of the conveyance alignment footprint, for both surface and subsurface footprints, that constitutes geotechnical exploration sites (1,302 acres/conveyance alignment footprint acres).	• Although a small, permanent effect will occur in the form of a cement-filled, drilling hole, all other effects are temporary. • Small, widely scattered, permanent effects from drilling in mostly disturbed locations are expected to be so small as to be insignificant. • Temporary impacts will be primarily from vehicles traveling off road, over land; equipment staging areas; and drilling or shallow-pit excavations. • Shallow pits will be returned to pre-project condition. • Activities are not expected to last more than 21 days at one site.
Safe Haven Work Areas	• GIS layer represents a conservative estimate of the footprints of safe haven work areas. Sizes range from 10.4 to 13.5 acres.	• Some of these areas may fall with in access shaft and tunnel work areas and thus not result in additional impacts • Safe haven work areas will be utilized between 9 to 12 months, and may occasionally exceed one year. • Safe haven work areas will avoid listed species habitat.
Barge Unloading Facilities	• GIS layer represents a conservative estimate of the footprints of barge unloading facilities Sizes range from 0.7 to 10.7 acres.	• Each barge unloading facility will be utilized for 5 to 6 years, and will be removed at the end of construction. • Actual locations will be decided by the contractor but likely will fall within the areas identified in the mapbooks in Appendix 3.A, *Map Book for the Proposed Action*.

Table 6.B-3. Effects Analysis Assumptions for Habitat Restoration.

Activity/Impact Mechanism	Impact Analysis Assumptions	Restoration Assumptions: Location and Spatial Extent
Tidal Wetland Restoration—Compensation for Effects on Wetlands (Section 404)		
Inundation/ Permanent loss of habitat	• Unless otherwise stated below, species impacts were estimated by applying the proportion of impacts from a proxy restoration site as described in Section 6.B.4.3.1.5, *Restoration*. Total CWF	Tidal wetland restoration is assumed to be accomplished through the conversion of cultivated lands. • A conservative assumption of the 404 wetland mitigation requirement is 1,200 acres (Mike

Activity/Impact Mechanism	Impact Analysis Assumptions	Restoration Assumptions: Location and Spatial Extent
	restoration is estimated to be 1,495 acres, also as described in Section 6.B.4.3.1.5, *Restoration*. • Additional methods below. • Giant garter snake: The giant garter snake habitat in the Lower Yolo Restoration Project Biological Assessment was described as suitable, moderate, and marginal; these habitat types were crosswalked to the high, medium, and low aquatic habitat values in this analysis. Ephemeral aquatic habitat described in the Lower Yolo BA are assumed to be of the same value of all aquatic habitat in this analysis. • Valley elderberry longhorn beetle: acres of estimated impact from tidal restoration were converted to a "number of shrubs and stems" impacted using the method outlined in Table 6.B-10 below. The stem count data (collected during surveys by qualified biologists) is from the McCormack Williamson restoration project where the interior (land side) portion of the levee slopes will be modified. The stem count data is from 3.38 miles of surveyed levee; this is not the entirety of the site but is a large site with a high density of elderberry bushes and for the purposes of this analysis considered adequate. This project requires disturbance to the levee where elderberry bushes are most dense; therefore the proportions developed from these surveys were high. These proportions were then normalized by including the acres of the entire site to be flooded in the proportion equation. See Table 6.B-9 below for the details.	Bradbury pers. comm.). • Restoration for 404 and Section 7 compensation will occur in the north or east Delta or in the Cache Slough region; restoration in the west and central Delta is also possible.

1 This table of impact analysis methods and key assumptions is not intended to be all inclusive of all activities under the PA. Rather, this table shows how effects were calculated for activities that have effects significant enough to be estimated. Minor activities are described in Chapter 6, *Effects Analysis for Delta Smelt and Terrestrial Species*. Also, the assumptions made are for the purposes of analysis only and reflect reasonable, worst-case assumptions for the PA. Actual footprints of activities may be less than or greater than that assumed and will still fall within the limits of the permits because impacts are within the total range evaluated.

2 Compensation for vernal pool effects may be achieved through a mitigation bank.

Table 6.B-4. Species Habitat that will be Avoided by Restoration Activities.

Species and Habitat	Tidal Restoration	Grassland Restoration for Giant Garter Snake	Nontidal Restoration for Giant Garter Snake	Riparian Restoration for Valley Elderberry Longhorn Beetle	Channel Margin Enhancement
Riparian brush rabbit	X	X	X	X	X
San Joaquin kit fox	X	X	X	X	X
California least tern	X	X	X	X	X
Least Bell's vireo	X	X	X	X	X
Western yellow-billed cuckoo	X	X	X	X	X
Giant garter snake		X			
California red-legged frog	X	X	X	X	X
California tiger salamander	X	X	X	X	X
Valley Elderberry Longhorn Beetle		X		X	
Vernal pool fairy shrimp	X	X	X	X	X
Vernal pool tadpole shrimp	X	X	X	X	X

Table 6.B-5. Species Habitat that will be Avoided by Transmission Line Construction, Geotechnical Exploration Activities, Safe Haven Work Areas, and Barge Unloading Sites.

Species and Habitat	Transmission Line Construction	Geotechnical Exploration Activities	Safe Haven Work Areas	Barge Unloading Sites	Notes
San Joaquin kit fox			X		
Least Bell's vireo	X	X	X		Suitable habitat for least Bell's vireo will be avoided during transmission line construction, safe havens, and geotechnical exploration.
Western yellow-billed cuckoo	X	X	X		Assume geotechnical, safe havens, and transmission line activities will avoid permanent effects to western yellow-billed cuckoo habitat.
Giant garter snake upland			X		Safe havens will avoid impacts on giant garter snake upland habitat.
GGS aquatic	X	X	X		Geotechnical, safe havens and transmission line activities will avoid permanent effects to aquatic habitat.
California red-legged frog			X		Safe havens will avoid impacts on California red-legged frog habitat.
California tiger salamander			X		Safe havens will avoid impacts on California tiger salamander habitat.
Valley Elderberry Longhorn Beetle		X	X		Geotechnical activities and safe havens have enough flexibility in implementation to avoid elderberry bushes.
Vernal pool shrimp	X	X	X		Geotechnical exploration, safe havens, and transmission line construction will avoid impacts to vernal pool crustaceans and their habitat.

X demarcates species/habitat impacts for activities that could be avoided and that will not require take authorization.
Blank cells indicate that impacts will not be avoided.

Table 6.B-6. Restoration proposed for California Water Fix, Target Species, and Species Adversely Affected.

Restoration Type	Species Benefitting from Restoration	Total Restoration	Location of Proposed Restoration	Terrestrial Species Adversely Affected by Restoration	Mechanism for Adverse Effect to Terrestrial Species
Tidal habitat	Chinook salmon, Central Valley steelhead, green sturgeon, Delta Smelt, Mason's lilaeopsis	305 acres	Cache Slough, North Delta, West Delta	Giant garter snake, valley elderberry longhorn beetle, Swainson's hawk, and Mason's lilaeopsis	Permanent removal of levee that could include aquatic tidal edge and upland cover for the snake and elderberry bushes for the beetle; Permanent flooding of cultivated foraging habitat for the hawk.
Grassland habitat	Giant garter snake	1,044 acres[1]	North and East Delta; in Stoke Lakes, Caldoni Marsh, or in between.	Swainson's hawk	Conversion of high-quality foraging habitat (cultivated land) to moderate quality foraging habitat (grassland)
Nontidal marsh habitat	Giant garter snake and greater and lesser sandhill cranes	625 acres[2]	North and East Delta; in Stoke Lakes, Caldoni Marsh, or in between.	Swainson's hawk	Permanent removal of foraging habitat.
Riparian habitat	Valley elderberry longhorn beetle, valley elderberry longhorn beetle, least Bell's vireo, western yellow-billed cuckoo, and Swainson's hawk	100 acres[3]	North Delta, Cache Slough, Along the Sacramento River	Giant garter snake and Swainson's hawk	Conversion of cover/basking habitat (grassland) to non-habitat (riparian)
Vernal pool habitat	Vernal pool fairy shrimp and vernal pool tadpole shrimp	0.90 acres	Byron Hills Region or Conservation Bank	San Joaquin kit fox, California tiger salamander, California red-legged frog, and Swainson's hawk	Conversion of grassland habitat to wetted habitat
Channel Margin habitat	Chinook salmon, Central Valley steelhead, Mason's lilaeopsis	52,164 linear feet (~5 miles on both sides of the river, 10 miles total)	Sacramento River, Steamboat and Sutter Sloughs, or other locations agreed upon by NMFS and DFW	Giant garter snake, valley elderberry longhorn beetle, Swainson's hawk, and Mason's lilaeopsis	Permanent removal of levee that could include aquatic tidal edge and upland cover for the snake, elderberry bushes for the beetle, and nesting trees for the hawk

1. = 2/3 of giant garter snake upland compensation commitment.
2. = 521 acres of nontidal wetland restoration to compensate for effects to giant garter snake aquatic habitat (783 acres of compensation, 2/3 of which is assumed to be achieved through restoration) + 104 acres of nontidal wetlands to compensate for effects to greater and lesser sandhill crane roosting habitat.
3. = 79 acres of riparian restoration for valley elderberry longhorn beetle and 21 acres for Swainson's hawk nesting habitat; Swainson's hawk compensation assumes that nesting tree replacement will occur within the 21 acres of nesting riparian habitat compensation.

Table 6.B-7. Maximum Habitat Loss and Total, Potential Compensation from Water Conveyance Facility Construction and Protection Habitat Restoration.

Resource	Total Modeled Habitat in the Action Area	Permanent Habitat Loss from Proposed Actions							Temporary Effects		Maximum Effects		Mitigation Ratios		Total Proposed Compensation if All Impacts Occur	
		North Delta Intakes	Reusable Tunnel Material	Head of Old River Barrier	Water Conveyance Facilities	Clifton Court Forebay	Safe Havens	Restoration	Transmission Lines	Geotech Activities	Total Impacts	Total Impacts	Protection	Restoration	Total Compensation, Protection	Total Compensation, Restoration
	Acres	Permanent (Acres)	Permanent (Acres)	Permanent (Acres)	Permanent (Acres)	Permanent (Acres)[b]	Permanent (Acres)	Permanent (Acres)	Temporary (Acres)	Temporary (Acres)	Permanent (Acres)	Temporary (Acres)				
Mammals																
Riparian brush rabbit	n/a[a]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
San Joaquin kit fox	5,192	0	62	0	4	216	0	11	46	225	293	76	2:1	0:1	586	0
California Least Tern[c]	61,751	37	1	3	34	2,191[b,c]	2	0	9	170	2,268[c]	179[c]	0[c]	0[c]	0[c]	0[c]
Least Bell's vireo[d]	13,062	6	14	0	16	1	0	0	7	10	37[d]	17[d]	0[d]	0[d]	0[d]	0[d]
Western yellow-billed cuckoo																
Breeding habitat[e]	1,616	0	6	0	0	0	0	0	1	1	6[e]	2[e]	0:1[e]	0:1[e]	0[e]	0[e]
Migratory habitat[e]	9,608	5	6	0	11	0	1	0	3	7	23[e]	10[e]	0:1[e]	0:1[e]	0[e]	0[e]
Total	**11,224**	**5**	**12**	**0**	**11**	**0**	**1**	**0**	**4**	**8**	**29**	**12**	**0:1[e]**	**0:1[e]**	**0[e]**	**0[e]**
Giant garter snake																
Aquatic - High	13,598	0	27	0	29	4	2	0	11	18	61	29	-[f]	3:1[g]	-[f]	183
Aquatic - moderate	12,095	0	3	0	45	11	0	34	1	6	94	7	-[f]	3:1[g]	-[f]	282
Aquatic - low	635	12	53	1	18	2	1	2	6	13	88	19	-[f]	3:1[g]	-[f]	264
Upland-high	32,216	37	81	0	34	0	1	0	18	28	154	46	-[f]	3:1[g]	-[f]	462
Upland-moderate	8,357	17	75	2	75	217	0	44	44	63	430	108	-[f]	3:1[g]	-[f]	1,290
Upland-low	22,046	9	3	0	18	2	1	74	6	6	107	12	-[f]	3:1[g]	-[f]	321
Aquatic Total	**26,328**	**12**	**83**	**1**	**93**	**16**	**3**	36	**18**	**37**	243	**55**	-	3:1[g]	-	**729**
Upland Total	**62,619**	**62**	**159**	**2**	**127**	**219**	**2**	118	**68**	**98**	690	**166**	-	3:1[g]	-	**2,073**
Total	**88,947**	**74**	**242**	**3**	**220**	**235**	**5**	154	**85**	**135**	933	**221**	-	3:1[g]	-	**2,802**
California red-legged frog																
Aquatic habitat	118	0	0	0	0	1[h]	0	0	0[h]	0	1[h]	1	3:1[h]	0:1[h]	3[h]	0[h]
Upland cover and dispersal habitat	3,498	0	0.1	0	0	46	0	11	12	6	57	18	3:1	0:1	171	0
Total	**3,616**	**0**	**0.1**	**0**	**0**	**47**	**0**	**11**	**24**	**6**	**58**	**19**	**-**	**-**	**174**	**0**
Aquatic habitat (miles)	26	0	0	0	0	0	0	0	0	0	0	0	-	-	0	0
California tiger salamander																
Terrestrial cover and aestivation	12,724	0	0	0	0	46	0	11	7	2	57	11	3:1	0:1	171	0
Valley elderberry longhorn beetle																
Nonriparian channels and grasslands	16,300	31	65	1	57	72	1	0	35	52	227	87[i]	-[i]	-[i]	0[i]	0[i]
Riparian vegetation	15,195	14	14	0	19	1	1	0	8	11	49	19[i]	-[i]	-[i]	0[i]	79[i]
Total	**31,495**	**45**	**79**	**1**	**76**	**73**	**2**	**0**	**43**	**63**	**276**	**106**				**79[i]**
Vernal Pool Crustaceans	89	0	0.2	0	0	6	0	0	0	0	6	0	2:1	2:1/3:1[j]	12	12/18[j]

[a] There is no modeled riparian brush rabbit habitat in the action area. Please see Appendix 4A Species Accounts for detailed information on habitat for riparian brush rabbit.

[b] California least tern habitat loss from Clifton Court Forebay dredging is considered a temporary effect, see Section 6.4, *Effects on California Least Tern*, for more details.

[c] Permanent and temporary loss of California least tern foraging habitat is considered a discountable effect and therefore no compensation is proposed, see Section 6.4, *Effects on California Least Tern*, for more details.

[d] Least Bell's vireo suitable habitat loss will be avoided through design modifications, see Section 6.5, *Effects to Least Bell's Vireo*, for more details.

[e] Western yellow billed cuckoo suitable habitat loss will be avoided through design modifications, see Section 6.5, *California Least Tern*, for more details.

[f] Compensation can be achieved through restoration or protection. The protection component of habitat compensation will be limited to up to 1/3 of the total compensation.

[g] 3:1 mitigation ratio for in-kind mitigation with no limitation as to where it occurs in the Delta. DWR will mitigate at a rate of 2:1 for each, aquatic and upland habitat, if the mitigation is created/protected in a USFWS agreed-to high-priority conservation location for GGS, such as the eastern protection are between Caldoni Marsh and Stone Lakes.

[h] California red-legged frog aquatic habitat loss will be avoided through design, no effects are expected and therefore no compensation is proposed.

[i] The removal of elderberry bushes will be avoided to the maximum extent practicable, however, elderberry bushes may need to be trimmed in the placement of, and also maintenance of, transmission lines. Compensation for these effects are expected to be covered by excess mitigation for the water conveyance facility construction (given the conservative nature of the impact analysis). Geotechnical activities will avoid elderberry bushes. See Section 3.4.7.9.1, *Avoidance and Minimization Measures*, for more details. The impact assessment is based on the loss of elderberry bush stems (and not modeled habitat) and the compensation is based on the required number of transplants, elderberry seedlings, and native plant plantings. See Table 6.10-2 for a complete description of how compensation was determined.

[j] Compensation varies for vernal pool crustaceans, depending on whether the compensation is achieved with by conservation bank/or non-bank means. See Table 6.11-1 for more details.

Table 6.B-8. Total, Estimated Habitat Loss from Tidal Restoration to Giant Garter Snake Habitat using Lower Yolo Restoration Project as a Proxy.

Species/Habitat	Total Impact from Tidal Restoration	Total Acres of Tidal Wetland	Proportion of the Species Modeled Habitat that Overlapped with the Footprint	Acres of Impact by Tidal Wetland Restoration	Acres of Habitat Estimated to be Impacted by Tidal Restoration	Totals to Carry Forward to Impact Table (Rounded Up)
Giant Garter Snake						
Aquatic-High	0	1,643	0.00	305	0.00	0
Aquatic-moderate	183	1,643	0.11	305	33.97	34
Aquatic-Low	11	1,643	0.01	305	2.04	2
Upland-High	0	1,643	0.00	305	0.00	0
Upland-Moderate	236	1,643	0.14	305	43.81	44
Upland-Low	401	1,643	0.24	305	74.44	74

Table 6.B-9. Total, Estimated Habitat Loss from Tidal Restoration to Valley Elderberry Longhorn Beetle Habitat (Elderberry Bushes) using the McCormack-Williamson Project as a Proxy.

Stem diameter (in) at ground level	Exit holes present?	No. of stems in action area[a]	Acres of Habitat Loss	Proportion of Stem Lose at McCormack-Williamson Restoration Site	Acres of Tidal Restoration Estimated for CWF	No. of stems Estimated to be Affected by Tidal Restoration[a]
≥1 to ≤3	No	294	1,364	0.215	305	66
>3 to <5	No	68	1,364	0.050	305	15
≥5	No	11	1,364	0.008	305	2
≥1 to ≤3	yes	111	1,364	0.081	305	25
>3 to <5	yes	41	1,364	0.030	305	9
≥5	yes	4	1,364	0.003	305	1

1. Project disturbance is 18,000 linear feet (3.38 miles) long, assumed the project disturbance width is 50 feet to get an area of total disturbance.

Table 6.B-10. Method for Estimating Effects on Valley Elderberry Longhorn Beetle Habitat.

Step 1. Develop a Shrub/Acre Assumption for Riparian and Nonriparian Habitats from DHCCP Survey Data. 1) 5,304 acres of VELB modeled habitat on DHCCP botanical survey parcels and within boat survey areas (see Assumptions below) 2) Total of 2,638 shrubs estimated from DHCCP survey data (see Assumptions below) 3) Of the 5,304 acres of VELB modeled habitat surveyed, 2,691 acres were riparian and 2,612 acres were non-riparian; 4) 92% of shrubs in DHCCP surveys were classified in Habitat field in data as being in riparian, 4) 2,426 shrubs identified by DHCCP as being in riparian/2,691 acres of modeled riparian habitat = 0.90 shrubs/acre of modeled riparian habitat in survey area 5) 212 shrubs identified by DHCCP as being in "non-riparian" habitat/2,612 acres of modeled non-riparian habitat in survey area = 0.08 shrubs/acre of modeled non-riparian habitat 6) Multiply the number of acres riparian and nonriparian habitat estimated to be lost from the impact analysis by the “shrubs/acre” estimates described under steps 4 and 5. ***Assumptions #1***: areas identified by DHCCP staff as riparian are equivalent to the riparian habitat used in the model. ***Assumption #2***: in data from DHCCP, points with no notes in size classes 1-3 assumed to be one shrub; size class 4 or notes identify a clump assumed to be 3 shrubs; note of several shrubs assumed to be 4 shrubs. Small clumps assumed to be 2 shrubs ***Assumption #3***: all areas of modeled habitat in boat survey areas and botanical survey parcels were surveyed for shrubs ***Assumption #4***: all shrubs mapped fall within modeled habitat for VELB. A cursory review of modeled habitat overlain with DHCCP data reveals that only a small fraction of points fall outside of modeled habitat. ***Assumption #5***: that ditch, riprap, ruderal correspond to modeled non-riparian habitat, possible some of the mapped shrubs are outside of modeled habitat **Note**: DHCCP GIS staff generated survey area for boat by buffering landward by 40 feet, average distance to levee roads approximately 45 feet, shortened area due to limitations in visibility from boat (i.e., vegetation toward top of levee may be obscured, which was mentioned at times in notes)
Step 2. Develop a “Number of Stems With and Without Exit Holes” per Shrub Assumption, for Riparian and Nonriparian Habitats, Using Existing Data from One Project: Southport Sacramento River Early Implementation Project (Southport)[2] Gather VELB data from Southport data collected along the Sacramento River along River Road in West Sacramento (56 shrubs). 1) Calculate the average number of stems per shrub. 2) Calculate average proportion of stems of three diameters (1-3 inches, 3-5 inches, >5 inches) for riparian and nonriparian areas. 3) Calculate the proportion of occupied (presence of exit holes) shrubs for riparian and nonriparian areas. 4) Results

[2] Initially, two projects were used to calculate the stems per shrub and exist holes per stem assumptions, Southport and the State Plan of Flood Control (SPFC) project. However, after reviewing the data, the stems per shrub numbers were far less on the SPFC site than on Southport (4 stems per shrub versus 20 stems per shrub, respectively). This disparity between the two estimates greatly affected the average stems per shrub estimate. It was decided to simply use the Southport data for stems per shrub estimate (20 stems per shrub). This is consistent with the method to create conservative methodologies and impact estimates.

Average Number of stems per shrub		**Average Proportion of Stems by Diameter from Southport**					
Southport	**20**	**Nonriparian**			**Riparian**		
		1-3 inches	1-3 inches	3-5 inches	1-3 inches	3-5 inches	> 5 inches
		56%	23%	21%	67%	17%	16%
Proportion of occupied stems (presence of exit holes)							
Nonriparian				**Riparian**			
unoccupied	7	54%		unoccupied	21	49%	
occupied	6	46%		occupied	22	51%	
total	13			total	43		
Step 3. Apply impacted shrubs estimate from Step 1 to the "combined stems per shrub" assumption (10) in Step 2 to get the number of impacted stems. Then apply the proportional assumptions for "stems by diameter" and "occupied stems" from Step 2 to the number of impacted stems to estimate the number of impacted stems by diameter and by presence of exit holes. See Chapter 6, *Effects Analysis for Delta Smelt and Terrestrial Species*, to see the impact results.							

6.B.5 References

6.B.5.1 Written References

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6.B.5.1.1 Personal Communications

Bradbury, Mike. DWR California WaterFix Permitting Lead, Program Manager II. July 3—Email regarding a "planning tool for mitigation development" for 404 wetland permit requirements.