4 RESTORATION ELEMENTS COMMON TO ALL STRATEGIES

Certain restoration actions are included in all three restoration strategies. As stated in previous sections, establishing viable anadromous salmonid populations and enhancing the riparian corridor are desired under all restoration strategies. This section describes, by reach, the components that are common to all restoration strategies.

4.1 Reach 1

4.1.1 Reconstruct channel through gravel mining pits in Reach 1

There is a history of large-scale aggregate mining on the San Joaquin River that continues today. Both in-channel and floodplain mining occur along the river. In-channel mining leaves behind large pits within the main river channel, and floodplain mining leaves behind large pits on the floodplain that are separated from the river by narrow, unengineered berms. Many of these berms have failed and resulted in the “capture” of the river channel by the pits. Both in-channel and floodplain pits create deep, slow, and relatively warm pools that may provide habitat for non-native fish species that prey on native fishes. They can also interrupt sediment transport continuity, and create open-water pits on floodplains where fish can become stranded following high flows. In the Tuolumne River, predation by introduced largemouth bass is believed to be a major factor limiting chinook salmon outmigrant survival (EA Engineering 1991), and largemouth bass abundance is greater in in-channel mining pits than in unmined portions of the river (McBain and Trush and Stillwater Sciences 1999, 2000). Based on 1997 aerial photographs, the total surface area of floodplain and in-channel gravel pits in Reach 1 of the San Joaquin River is approximately 1,360 acres. Approximately 190 acres of these pits are in-channel (McBain and Trush 2002).

In order to reduce potential habitat for non-native fish that may prey on outmigrating juvenile salmonids, as well as to re-establish natural floodplain and fluvial geomorphic processes within Reach 1, we propose reconstructing the channel through the in-channel gravel mining pits. The reconstructed channel can be designed to maximize ecological benefits, as well as restore natural function to the river system. The restoration strategies include three different approaches: (1) filling pits that are not hydrologically connected to the river at low flows, but could potentially cause stranding following high-flow events; (2) constructing a three-stage channel through the reach with the in-channel pits; and (3) isolating pits that encroach on the 700-ft-wide floodway. Pits identified for filling, channel reconstruction, and isolation from the main channel are shown in Appendix A and the proposed restoration actions for each identified gravel pit within the floodway are given in Appendix A.

At some of the pits targeted for filling, the area surrounding the pit has been identified for potential riparian vegetation restoration by lowering the surface to serve as a floodplain that would be periodically inundated under the proposed flow regimes. Under this scenario, the pits selected for filling would only be filled to the elevation of the lowered surface. However, for our analysis of the volume of cut and fill material required, we assumed that all selected pits would be filled to the existing surrounding surface elevation. We estimate that 571,000 cubic yards of material is required to fill pits within the 700-ft-wide floodway in Reach 1 (see Appendix A). Potential fill material sites were also identified from the digital aerial photographs and the volume of the fill material was estimated using GIS. A volume of potential fill material was calculated for each site based on the targeted ecological function of each cut site. Ecological function was delineated by the stage above the water surface elevation (WSE) of a 500-cfs base flow. Target ecological function and the average stage above the 500 cfs WSE include the following:

- Riparian forest and scrub—500 cfs base flow WSE plus 4.5 ft
- Valley oak woodland and savanna—500 cfs base flow WSE plus 12 ft
- Elderberry savanna—500 cfs base flow WSE plus 6 ft
- Seasonal wetlands—500 cfs base flow WSE plus 2 ft
- Salmonid rearing habitat—500 cfs base flow WSE plus 0.5 ft

We identified 12,385,000 cubic yards of material within Reach 1 within or adjacent to the 700-ft floodway, based on lowering the cut site to 6 ft above the 500 cfs WSE for each individual cut site (see Appendix A).

Reaches where the channel has captured gravel pits would be filled with local material (whenever possible) and then a three-stage channel would be constructed to restore riverine ecological function and sediment transport through the Reach. The first stage of the engineered channel would have a capacity of 600 cfs and the low bench of the second-stage channel would be inundated at flows over 1,500 cfs. The template channel is designed to have 3.3 ft of freeboard at its design maximum flow of 16,400 cfs (Figure 4-1). Reaches selected for reconstruction of the channel typically included areas where aggregate mining pits have been captured by the river but the pits do not extend outside of the 700 ft floodway. We identified 29,000 linear ft of channel in Reach 1 for channel reconstruction and estimated that 4,109,000 cubic yards of material is required to construct a three-stage channel in Reach 1. We reached this estimate by comparing cross sections of the channel from the DTM with the engineered channel cross-section. The engineered channel was superimposed onto the existing cross section to calculate the material needed for cut and fill. This landscape-scale analysis did not take property ownership into consideration with regard to channel layout, and a more detailed analysis of the materials needed to construct the three stage channel should be completed on a site-by-site basis to refine our broad estimates.

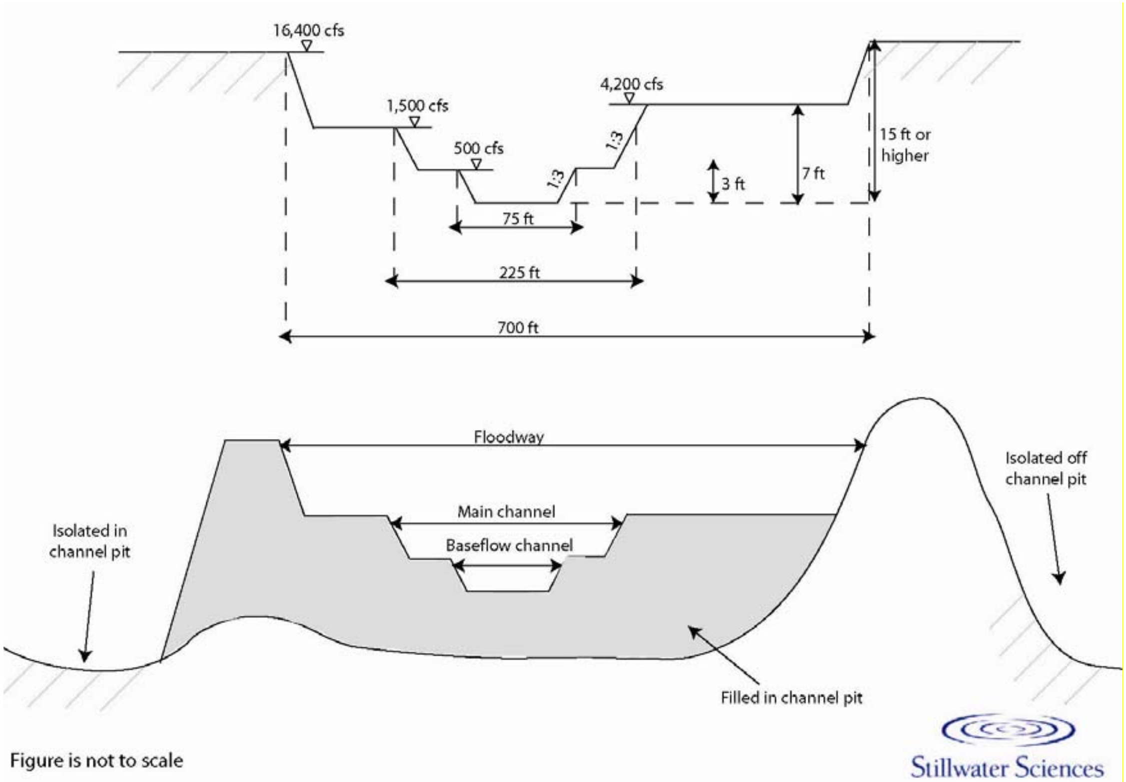

Figure 4-1. Schematic of Reach 1 channel design.

The first bench of the template channel would be expected to support natural recruitment of both herbaceous and woody vegetation under all strategies if left alone after construction. However, encroachment by woody vegetation into these low elevation surfaces within the bankfull channel could lead to reduced habitat complexity (see Section 8.7.6 in the Background Report) and would likely provide less productive juvenile salmonid rearing habitat than similar sites vegetated by herbaceous wetland species. Higher instream primary production and associated secondary production by herbivorous invertebrates would be expected in more open herbaceous wetlands because there would be higher insolation compared to inundated riparian forest and scrub sites. To prevent encroachment by woody riparian tree and shrub species, the first bench of the three-stage channel would be planted with native herbaceous wetland species (e.g., sedges, rushes, native wetland forbs and grasses) (see Section 3.5.2.4). This would create approximately 84 acres of horticulturally restored seasonal wetlands.

In cases where captured aggregate mining pits extend outside of the 700-ft (210-m) floodway, dikes would be constructed at a minimum distance of 700 ft from the opposite bank. Dikes would be constructed with a 25-ft-wide access road on the top and would have a minimum of 3.3 ft (1 m) of freeboard for a 16,400 cfs discharge. The slope used to construct the dike would not exceed 3:1. The top floodplain bench of the three-stage channel would be designed to be inundated at 1,500 cfs. The dikes will be engineered to isolate the main channel from the rest of the aggregate pit and will not be designed to provide flood control. Property ownership was not considered in this landscape-level analysis. We identified nine aggregate pits that encompassed 12,000 linear ft (3,700 m) of channel, which would require 3,099,000 cubic yards of material to construct dikes to isolate the pits from the active channel. The three-stage channel would be reconstructed only on the diked side of the floodway. The opposite bank would be left unchanged. Wetlands would be horticulturally restored on the lower bench of the reconstructed bank to prevent encroachment by woody riparian vegetation. This would create an additional 17 acres of seasonal wetland habitat within the floodway.

In addition, we propose that the portion of the diked mining pits that extend outside of the 700-ft floodway be considered for management as freshwater marsh/wetland habitat. This would involve maintaining at least 350 acres of open water and wetland habitat in Reach 1 as foraging habitat for waterfowl and wading birds (described in Section 3.5.4.3). These habitats could also be seeded with native resident fishes, including Sacramento perch, Sacramento blackfish, hitch, and tule perch.

4.1.2 Augment gravel in Reach 1 at existing riffles to increase chinook salmon spawning habitat

A landscape-scale field reconnaissance conducted in summer and fall 2002 mapped potential chinook salmon spawning habitat in Reach 1A at existing riffles (some existing "riffles" may be better described as "topographic controls," but are referred to herein under the general term "riffle"). Spawning gravel suitability was evaluated based on velocity, surface gravel size distribution, riffle slope, and water depth. The results indicated that although hydraulic and bed texture characteristics suitable for spawning exist in Reach 1A, the gravel lenses within these riffles may not be sufficiently deep for chinook salmon to construct redds in. In general, female chinook salmon dig redds to depths between 0.5 to 2 ft (Burner 1951, Hawke 1978, Groot and Margolis 1991). Egg pockets of the recommended parent stock for the fall-run chinook salmon population from the Tuolumne River are typically found at depths from 0.9 to 1.5 ft (0.3 to 0.46 m) (EA Engineering 1989). Based on these data, we propose adding spawning-size gravels (typically 31–66 mm [1.22–2.60 in] [Kondolf and Wolman 1993]) to achieve a depth of at least 2 ft at potential spawning sites.

Critical uncertainties that remain regarding chinook salmon spawning include (1) whether spawning habitat availability would be limiting to chinook salmon populations in the San Joaquin River, and (2) where reintroduced salmon may choose to spawn. Therefore, an adaptive management and monitoring approach is proposed to evaluate the potential benefits of increasing spawning habitat through gravel augmentation, enhancing existing spawning habitat, the most appropriate locations for augmentation, and what volumes of gravel might be required. Evidence from predictive modeling suggests that increasing spawning gravels could increase escapement in the San Joaquin River. If spawning habitat in Reach 1A is doubled, the population model predicts that escapements of fall- and spring-run chinook salmon will also essentially double, suggesting that spawning habitat availability could be limiting to the population.

Our reconnaissance efforts and preliminary analysis provides some information on potential gravel enhancement efforts. As part of the reconnaissance effort, riffles were first identified on aerial photographs (1 ft/pixel resolution). Using these photographs as reference, on-the-ground reconnaissance was used to identify four potential locations for gravel augmentation projects. Information on these four sites and the estimated volumes of gravel required to achieve a target depth of 2 ft [0.6 m] (assuming an average existing depth of 0.5 ft [0.15 m], and an added depth of 2 ft (0.6 m) to allow for redistribution of the gravels by flows) is summarized in Table 4-1 below.

Table 4-1. Estimated volume of added gravel for four potential gravel augmentation sites between Friant Bridge and Ledger Island.

Riffle location	River mile	Area (yd^2)	Acres	Volume (yd^3)
Gauge riffle	259.95	900	0.18	65
Lost Lake Park riffle	264.95	5,400	1.12	401
Downstream of boat launch riffle	264.57	3,200	0.66	238
Upper Ledger Island riffle	263.35	4,500	0.93	333
Total		**14,000**	**0.93**	**1,036**

Augmentation sites used in this analysis were selected because they were within five miles of Friant Dam, where water temperature are likely to be cooler and deep pool holding habitat is available for spring-run chinook salmon. Spring-run chinook need cold, deep pools with low water velocities to conserve energy while holding over during the summer months before spawning. Additionally, unlike areas farther downstream, the channel within the first few miles downstream of Friant Dam has not captured in-channel gravel pits that could serve as sediment traps and reduce the effectiveness of gravel augmentation. Additional potential augmentation sites were identified at RM 257.68 and 257.54, but they were excluded from this analysis because they are located between captured gravel pits and are located nine miles downstream of Friant Dam.

Periodic maintenance and additional gravel augmentation would be required after high flows that mobilize the placed gravels and transport them downstream. The steep gradient at these bedrock-controlled riffles will likely result in hydraulic conditions that transport the gravels to downstream pools where they will be deposited. However, sediment transport modeling results suggest that subsequent flows will not be of sufficient magnitude to transport these gravels from these pools to reaches farther downstream (see Section 3.1). Maximum managed flow releases from Friant Dam of 16,400 cfs will be sufficient to mobilize the current bed (D_{50} = 38 mm) in the riffles, but will not be adequate to mobilize gravels out of the pools. Because of this sediment discontinuity, repeated placement of gravel into some riffles would be required, particularly following high-flow events. Monitoring gravels in the augmented sites would provide insight into the appropriate frequency and magnitude of augmentation. When planning an augmentation program, it should be considered that gravel accumulation in pools may reduce habitat quantity and quality for several native resident fish species that prefer deep pool habitats as adults, including Sacramento pikeminnow, hardhead, and Sacramento sucker. These species migrate upstream from these deep pool habitats in the spring to spawn in riffles in upstream reaches and would be expected to spawn in Reach 1 in the spring. Infilling of pools by gravel may also reduce habitat for Pacific lamprey.

Periodic addition of spawning gravels would increase the quality of gravels for chinook salmon spawning (by decreasing the proportion of gravels embedded in fine sediment, resulting in increased permeability), thereby potentially increasing salmonid egg survival within Reach 1. Addition of clean gravels would also provide increased area for aquatic invertebrate production, potentially increasing the prey base for juvenile anadromous salmonids and other native fishes within Reach 1.

Sand and fine sediment deposits in pools and backwaters and along channel margins provide critical habitat for several lamprey species in the San Joaquin River downstream of Friant Dam. The larval life stage that lives burrowed in fine sediment must remain for 4-7 years in these habitats before metamorphosing to the young adult stage. Three species that are found below Friant Dam were just petitioned for listing as threatened under the ESA in January 2003. One of these species—the Kern brook lamprey—appears to exist in the basin *only* as extremely isolated populations, one of which is below Friant Dam. It is important to note that the needs of chinook salmon do not overlap with all native species; i.e., they are not a foolproof "umbrella species." Many other aquatic species may depend on fine sediment deposits, including native bivalves.

4.1.3 Increase chinook salmon spawning habitat in Reach 1A

In addition to gravel augmentation at existing riffles, there are additional opportunities for increasing chinook salmon spawning habitat within Reach 1A. Creating additional spawning habitat for chinook salmon may be necessary to support viable populations because reduced flows and in-channel aggregate mining have greatly reduced available spawning habitat from historical conditions. In addition, the low channel gradient in Reach 1 (reach average of 0.00056 for Reach 1 and 0.0007 for Reach 1A) creates conditions of low bedload transport capacity that, in combination with a restricted upstream supply of sediment due to Friant Dam, act to make the prospect of significant natural gravel replenishment very unlikely. The extremely low bedload transport capacity will reduce the likelihood that newly created spawning habitat will be mobilized and transported downstream by high-flow events.

In general, and assuming that suitably sized gravel is available, chinook salmon prefer to spawn in depths from 1 to 3 ft, where water velocities range from 1 to 3 ft/s. Observations of heavily used spawning riffles on the Tuolumne River show that channel widths of 75−100 ft and riffle slopes of 0.0010 to 0.0015 provide these preferred conditions of velocity and depth at spawning flows ranging from 100 to 500 cfs (McBain and Trush 1998). Most of Reach 1A is composed of long reaches of very low gradient punctuated by discrete slope breaks that create depth and velocity conditions unsuitable for spawning by chinook salmon. The steep drops at the slope breaks provide an opportunity to create chinook spawning habitat in this otherwise low-gradient reach, by adding gravel in a way that reduces the local slope to a range that can support salmon spawning. The slope breaks occur at natural riffles, at cobble weirs at the heads of riffles that maintain the head of water for off-take channels, at natural bedrock outcrops, at remnant bed features resulting from gravel mining activity, and downstream of channel constrictions such as the Leger Island Haul Road bridge. The long, low-gradient reaches are often backwaters from the various natural and non-natural slope breaks, or are long pool habitats resulting from in-channel gravel extraction.

We propose to augment gravel primarily below selected slope breaks to create slopes of 0.0010–0.0015 to provide suitable depths and velocities for chinook salmon spawning at specific flows at channel widths of 75–100 ft. The gravel augmentation would essentially redistribute channel gradient to reduce the steep slope breaks and would greatly increase potential chinook salmon spawning habitat and create additional sites for spawning to occur. The most suitable locations for augmentation occur where a natural grade-control structure (such as a bedrock outcrop or other topographic high point on the bed) can provide a stable desired bed slope that should act to reduce sediment loss through downstream transport. Taking advantage of both upstream and downstream controls has the potential to create relatively stable spawning habitat conditions. Figure 4-2 schematically illustrates the intended augmentation strategy.

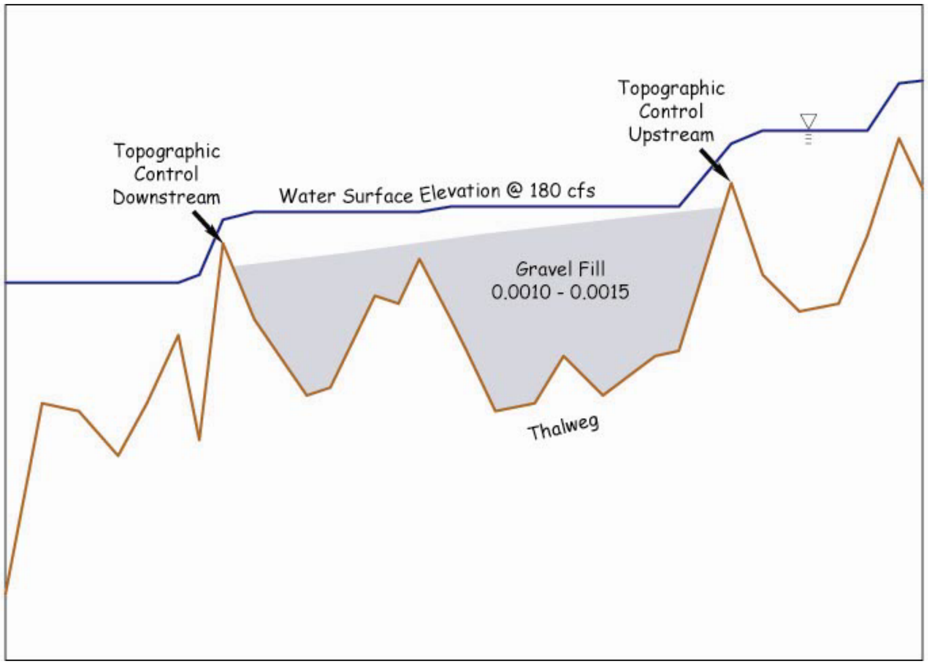

Figure 4-2. Schematic diagram showing conceptual design of creating potential spawning habitat between existing topographic control streams.

In this strategy, gravel is added primarily for increasing chinook salmon spawning habitat rather than for restoring natural geomorphic processes; however, gravel introduction would likely restore some geomorphic functions at certain locations during high flows (e.g., bar and riffle creation/maintenance in downstream reaches). This measure is, therefore, not a process-based restoration strategy based on emulating the natural system, but is instead the creation of artificial chinook salmon spawning habitat in areas where gravels are not currently stored due to habitat degradation. Some redistribution of the introduced gravel will likely occur during high flow events, which will result over time in only a portion of the introduced gravel retaining preferred depth and velocity conditions for chinook salmon spawning. Overall, gravel introduction should nonetheless result in significant increases in chinook salmon spawning habitat. A simple computation shows that each foot of elevation drop that can be redistributed at a slope of 0.0010 over 1,000 ft with a channel width of 75 ft could create an additional 75,000 ft^2 of potential spawning habitat.

To summarize, the procedure for gravel augmentation depends on identifying locations with suitable opportunities for creating appropriate gradients, and augmenting gravels where appropriate grade control features upstream and downstream would increase storage of the material. Grade control features provided by bedrock outcrops may be the most suitable control features for this purpose, but geomorphic controls provided by riffle crests could also be used, along with the artificial drops provided by cobble weirs, although they would not be as stable as bedrock control features. Downstream channel constrictions such as bridges may also provide suitable controls. We recommend maintaining an active channel width of 75-100 ft through placing gravel at channel margins where necessary. This action is intended to provide appropriate depths and velocities during chinook salmon spawning flows and, to some degree, to mimic low-flow channel widths found in locations where the channel has already adjusted to a new, lower flow regime (e.g., at Ball Ranch and near Lanes Bridge).

Determining the precise location and feasibility of these additional spawning habitats will require additional analyses centered on the collection of detailed ground-surveyed longitudinal profiles. Provisional analysis using the longitudinal profiles and bathymetric data from the 1998 Ayers and Associates topography identified 18 potential candidate sites in Reach 1A (the last being a short distance below Lanes Bridge and into Reach 1B). These locations probably represent the maximum possible extent of supplemental gravel sites and it is likely that fewer sites would be chosen when higher-resolution topography and additional factors are considered. One example location occurs downstream of North Fork Friant Bridge and is projected to extend from a location below the current riffle crest (cross-section 580), caused in part by the scour-induced erosion under the bridge and subsequent expansion deposition, approximately 1,750 ft downstream to the topographic control at cross-section 575 (Figure 4-3). The introduction of seven thousand cubic yards of gravel is estimated to result in a total of 131,000 ft^2 of spawning habitat upon introduction (assuming the channel width is narrowed to 75 ft). Expanding the width of the channel to 100 ft would require less fill material along the floodplain than a narrower channel. Introducing gravel at several of the sites would likely result in a substantial increase in spawning habitat for chinook salmon in the San Joaquin River.

We propose that site-specific feasibility of gravel introduction be explored in the future by:

- collecting additional ground-surveyed topographic data as the basis for slope calculations and identifying longitudinally precise beginning and end points for introduction;
- analyzing the hydraulic design to create suitable conditions of flow velocity and depth at spawning flow discharges;
- conducting engineering feasibility studies to examine the suitability of creating 75-100-ft-wide channel cross-sections; and
- analyzing sediment transport potential in regraded and re-sectioned channels to estimate the potential for sediment loss.

4.1.4 Reduce fine sediment input to the mainstem channel of Reach 1A

Gravel quality is a key factor influencing the success of incubation and emergence of salmonid eggs and alevins. Accumulation of fine sediment in gravels can affect salmonid survival-to-emergence by reducing intragravel flow of oxygen to the developing eggs and flow of metabolic wastes from the eggs and alevins (Coble 1961, Cooper 1965, Lotspeich and Everest 1981, McNeil 1964, Platts et al. 1979). Fine sediment in gravel interstices can also physically impair the ability of alevins to swim up through the gravel layer, and entomb them (Philips et al. 1975, Hausle and Coble 1976).

Although no quantitative sediment source analysis was conducted, reconnaissance-level field observations suggest that there is considerable fine sediment deposition in Reach 1A. The fine sediment typically occurs in pools, but some fines also occur in riffles. The source of this sand is unknown, but potential sources include Cottonwood Creek, Little Dry Creek, and erosion from bluffs. Overall input from Little Dry Creek is probably not significant, as large, abandoned gravel pits exist at the mouth of the creek that are likely to trap sediment (both gravel and sand). Gullies entering the mainstem from north bank bluffs near orchards may also be contributing fine sediment into the mainstem channel.

Once a watershed-scale assessment of fine sediment sources has identified problematic sources of fine sediment, there are many ways to control and reduce the amount of fine sediment entering the channel. Riparian buffer zones can filter out upslope fine sediment from surface erosion

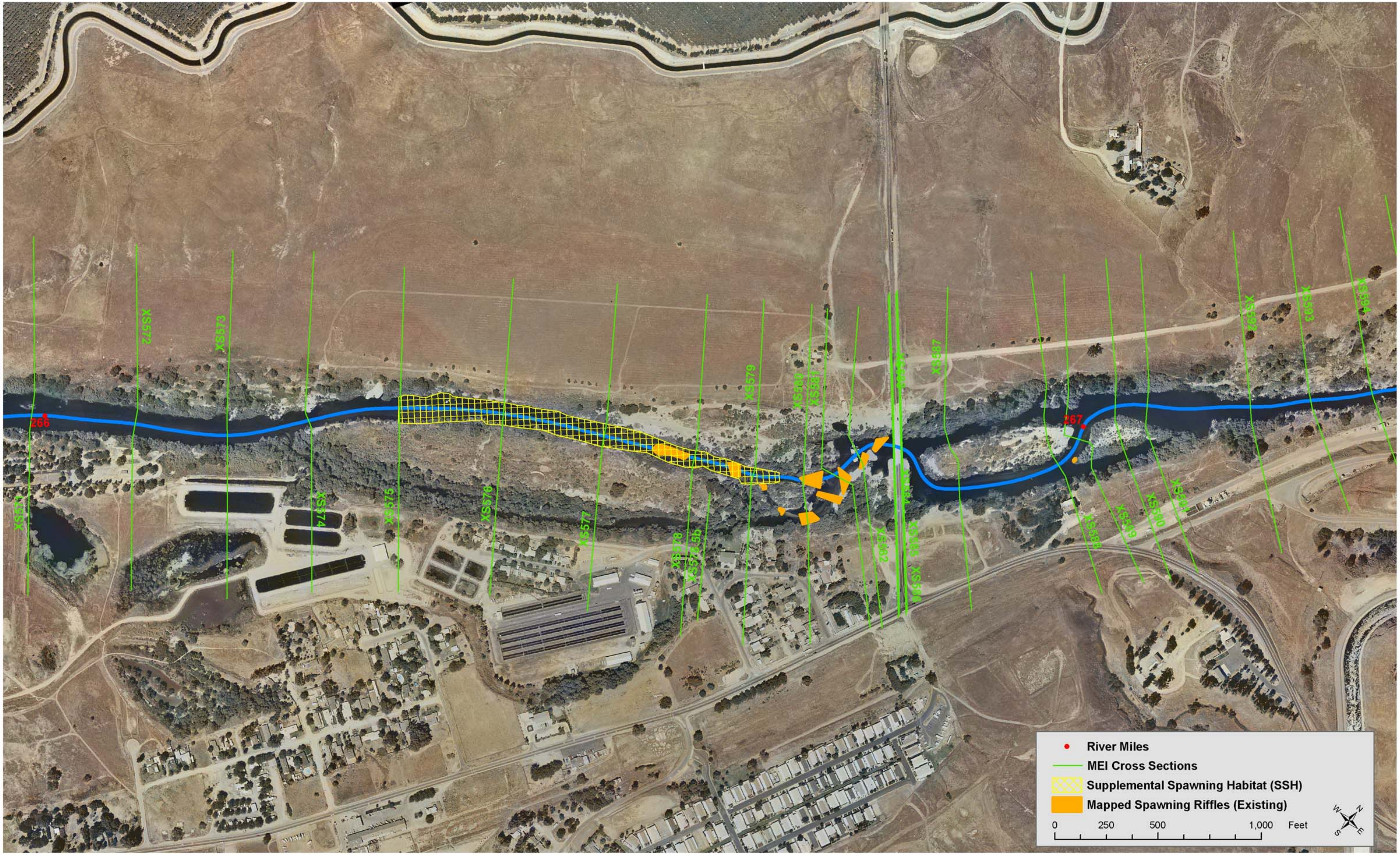

Figure 4-3. Sample location of gravel introduction to increase potential salmon spawning habitat.

before it becomes channelized. Providing sedimentation basins at the mouth of tributary streams and gullies may trap fine sediment before it enters the channel. Sediment basins can also be used to capture fine sediment from gravel mining operations adjacent to the San Joaquin River. The use of sediment traps must consider the volume of sediment and its source. For example, if very large volumes of sand are being transported downstream through a tributary, then sedimentation basins may not be effective in reducing the volume of sand actually entering the main channel. Additionally, sediment basins can trap coarse sediment moving into the main channel that could be suitable for spawning gravel. A feasibility assessment and refinement of approaches will be required once sources of fine sediment are identified.

4.1.5 Reduce the volume of fine sediment stored in the channel

As described in above, fine sediment infiltration is a key factor influencing the success of salmonid survival-to-emergence, and reconnaissance-level field observations indicate that there is considerable fine sediment in Reach 1A. Efforts to reduce the volume of fine sediment stored within the channel would also greatly improve habitat quality and suitability for salmonid egg incubation and emergence.

Sediment transport modeling suggests that even moderate flows of 500 cfs will be sufficient to mobilize sand on the surface of riffles. These modeling results also suggest that larger flows (greater than 1,000 cfs) will be sufficient to move sand out of pools, although at an extremely low transport rate. Thus, if sources of fine sediment are identified and controlled, discharges released from Friant Dam during ecologically significant time periods may provide incidental geomorphic benefits of moving fine sediment downstream and reducing the overall volume of fine sediment stored in the channel. The benefits will be most obvious in the first few miles downstream of Friant Dam, since there are relatively few sources of sand within this part of the Reach. The benefits will likely decrease downstream.

These strategies for reducing the volume of fine sediment in the channel only apply to surface fines, since only the highest magnitude flows, according the sediment transport model, will result in coarse sediment transport. As a result, subsurface fine sediment will remain in the bed, even at the flows described above. More invasive and active approaches, such as suction-dredging or ripping of riffles may be required to reduce the volume of subsurface fine sediment. Reducing subsurface fines is important to (1) limit the immobilization of fine sediment when female salmon dig their redds, so that fines are displaced downstream of the redds; and (2) provide interstitial spaces available for macroinvertebrates that are prey for juvenile salmonids.

4.1.6 Restrict ramping rates following high flows to reduce fine sediment infiltration of gravels in spawning riffles

As described above, fine sediment infiltration is a key factor influencing the survival of salmonid eggs to fry emergence. Efforts to reduce the volume of fine sediment stored within spawning riffles would also greatly improve habitat quality and suitability for salmonid egg incubation and fry emergence.

Discharges from Friant Dam should be kept reasonably high to encourage fine sediment transport as suspended load. Because sheer stresses in riffles are greater than in pools, it is expected fine sediment riffles would be more easily suspended and transported downstream. A gradual ramp down would encourage fine sediment to drop out in pools instead of riffles, as the sheer stresses are greater at riffles during low flow than in pools.

4.1.7 Conserve and enhance the stand of sycamore alluvial woodland on Little Dry Creek

The only known sycamore alluvial woodland habitat within the study area is located along Little Dry Creek (the confluence with the San Joaquin River occurs near RM 260.5 in Reach 1A), and it is distributed in a 29-acre narrow 1-mi long band along the creek (CDFG 1997). Because Little Dry Creek retains moisture year-round, wetland plants such as cattail and tule are established within the stand (CDFG 1997). This location is one of only 17 known stands greater than 10 acres of Central California sycamore alluvial woodland in California (CDFG 1997). Because of the unique characteristics of this vegetation type and its rarity throughout the state, we recommend preserving this existing stand when considering any restoration actions at the mouth or along Little Dry Creek. In addition, enhancing habitats in the vicinity of the existing stand may allow for more individual trees to grow in the area, thereby providing additional benefits to wildlife species known to inhabit sycamore alluvial woodlands, including Swainson's hawk and several species of bats, as well as providing shade, overhanging cover, bank stability, and large woody debris for potential steelhead habitat.

4.1.8 Conserve and expand existing valley oak woodland in Reach 1A

Valley oak woodland historically occurred over large areas on the uplands adjacent to Reach 1 (Background Report Section 8.6.3.1). This habitat type currently covers only approximately 265 acres in Reach 1A (Table 3-2 in Restoration Objectives Report). The topography of Reach 1A is particularly suitable for re-establishing oak woodland habitat (Restoration Objectives Report Section 3.3.4), by providing enhanced conditions suitable for valley oak and associated plant species, such as California black walnut, box elder, and Oregon ash, as well as enhancing existing patches of habitat for wildlife species that forage and nest within these areas, such as Swainson's hawk, acorn woodpecker, and lark sparrow. Expanding this community type would help restore natural ecosystem functions to upper floodplains and terraces along the river corridor. Enhancing and expanding the size of existing patches would also increase connectivity between existing patches of valley oak woodland within this reach (benefits of habitat connectivity are described in Section 3.5.3.5).

The restoration of valley oak woodland along the San Joaquin River will likely require a combination of preserving existing patches as a source of acorn dispersal for natural regeneration and recolonization, and horticultural restoration to expedite recolonization of oaks, as natural recruitment of oaks, especially in savannas, is low or nonexistent (Pavlick et al. 1991). Horticultural restoration would build off of areas with existing stands of oak woodland where soil and topographic conditions are already suitable for this vegetation type. Horticultural restoration would be done with local seed and seedlings to preserve the genetic integrity of the local oak population (CNPS 1989, as cited in CALPIF 2002). Active restoration of oak woodlands would be conducted in stages to promote a mix of oaks and associated plant species and age classes so that some acorn production would occur each year. In addition, eliminating grazing from conserved or horticulturally restored oak woodland areas would help promote natural regeneration (livestock eat acorns and oak saplings and grazing can lead to soil compaction and changes in soil chemistry [McCreary 1990]).

California's Oak Woodland Conservation Act provides funding opportunities for the protection and conservation of oak woodlands (AB 242, passed 2001). The program is administered by the Wildlife Conservation Board and offers financial incentives to private landowners (such as easements and land improvement grants), as well as public education and outreach, to protect and promote oak woodland habitats. Because over 85% of oak woodland habitat in California occurs on private land (CalPIF 2002), these opportunities may be important for implementing restoration or enhancement measures in Reach 1A.

4.2 Reach 2

4.2.1 Conserve existing elderberry patches at Chowchilla Bypass

Elderberry savanna is a rare native vegetation type that occurs on well-drained floodplains and terraces throughout the state. Although we know little about its historical distribution and abundance in the project area, this community currently has very restricted distribution in the San Joaquin River corridor (McBain and Trush 2002). The largest known patch of elderberry savanna (~63 acres) was mapped by CDWR in the vicinity of the Chowchilla Bifurcation Structure at RM 215–216. As described in Section 3.5.4.5, elderberry is the host-plant for the federally threatened valley elderberry longhorn beetle. Kucera et al. (2001) report holes in the trunks of elderberry plants in this area, which may have been made by exiting beetles. Because the host species of elderberry is widely distributed throughout the San Joaquin Valley, the beetle could occur in other locations of the study area that support suitable habitat (Kellner 1992). Protecting and conserving existing elderberry savanna patches would benefit the elderberry beetle and other associated wildlife (see Section 3.5.3.5), as well as promote a diversity of plant species and habitat types along the river corridor.

Because valley elderberry longhorn beetle is a listed species, floodplain construction projects may require mitigation and potentially formal consultation under the ESA, California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). Should mitigation be required, efforts to enhance existing elderberry patches within this reach could be conducted to increase the amount of contiguous habitat available.

4.3 Reach 3

4.3.1 Management of Mendota Pool

Mendota Pool is currently fed by the San Joaquin River, the Delta-Mendota Canal (which brings water from the Delta to Mendota Pool), and by Fresno Slough in high flow years. The reservoir is believed to currently support a fish community composed primarily of trout and non-native fishes, including catfish spp., striped bass, largemouth bass, rainbow trout, and carp. Under current conditions, the gates of Mendota Pool are periodically removed to allow sediment trapped behind Mendota Dam to be transported downstream to restore water storage capacity of the reservoir. The resulting large sediment pulses may affect chinook salmon, lamprey species, resident native fishes, and other aquatic organisms in downstream reaches. Mendota Pool is drained periodically for routine maintenance and inspection. When year-round instream flows are restored in the San Joaquin River downstream of Friant Dam, the timing or methods used for draining Mendota Pool may need to be modified to reduce potential impacts on chinook salmon and other species. In addition, Mendota Pool provides a potential opportunity for establishing a native resident fish community. This measure would be explored under all three strategies in terms of its potential feasibility, benefits, and drawbacks, but may be more likely to succeed under Strategies 2 or 3, in which the San Joaquin River and anadromous fish are routed around Mendota Pool instead of through it (see Section 6.1.3).

Warm temperatures during summer and fall months may provide suitable conditions for establishing a native resident community in Mendota Pool, particularly in strategies where Mendota Pool is isolated from the mainstem San Joaquin River. Because it is possible to drain Mendota Pool, and fewer fish could enter Mendota Pool from upstream, it may be feasible to physically remove many non-native fish and restock the reservoir with native fish. If a community could be successfully established, it could be used as a source of native fish for seeding perennial wetlands and other newly restored habitats. Depending on temperatures, water quality, and other habitat characteristics that would be provided at Mendota Pool, native resident fish that could be introduced include Sacramento perch, hitch, Sacramento blackfish, prickly sculpin, and tule perch. Restoring wetland and riparian habitats at Mendota Pool could increase its habitat value for native fish. Larvae of non-native fish species would continue to be recruited into Mendota Pool from the Delta-Mendota Canal and Fresno Slough, but predation by established populations of native fishes might prevent successful establishment of non-native populations (P. B. Moyle, pers. comm., 2002). However, periodic draining of the reservoir may be necessary to ensure that non-native fish do not become established. Mendota Pool could also provide an opportunity to educate the public about native fishes and their ecology. Such efforts would be expected to increase public support for further restoration efforts in the San Joaquin basin and elsewhere.

In strategies where San Joaquin River flows would be routed through Mendota Pool (Strategy 1; see Chapter 5), the presence of piscivorous, non-native fishes may reduce survival of downstream-migrating salmon and lamprey. The need to periodically release sediment from behind Mendota Dam may also reduce habitat quality for chinook salmon and other native aquatic species downstream. It may be possible to screen inflow into Mendota Pool to prevent adult non-native fish from entering the reservoir. Even with screens, however, larvae of non-native fish species would still be recruited into the reservoir and it is uncertain whether non-native fish would be able to move upstream into the reservoir from downstream reaches.

4.4 Reach 4B2 and 5

4.4.1 Conserve and enhance existing mixed riparian habitat

Conservation of sycamore alluvial woodland, valley oak woodland/savanna, and elderberry savanna vegetation types in Reaches 1 and 2 are proposed as common elements to all strategies and are discussed in detail by reach above. In addition to these areas, Reaches 4B2 and 5 offer opportunities for conservation of existing high-quality riparian forest and scrub habitat between the existing project levees due to their relatively wide floodways and lack of encroaching adjacent land uses. Much of the river corridor and adjacent lands in Reaches 4B2 and 5 is already under public ownership (Figure 2-1) or conservation easement (Stevinson Corporation easements are discussed in Sections 3.5.3.1 and 3.5.3.5). Efforts should be made to coordinate with current easement holders and federal and state agencies to identify additional key parcels for conservation. Potential easement areas should be prioritized by the amount of intact riparian and floodplain habitats, connectivity with other preserved or restored areas, and potential to increase riparian habitat extent along the river corridor (see Sections 3.5.3.1 and 3.5.3.7 for further discussion).

In addition to bringing new areas under protection, restoration efforts should take advantage of opportunities to develop coordinated projects with managers of existing conservation easements and public lands. Joint restoration efforts (e.g., horticultural restoration or regrading) could maximize efficiency of implementation, while enhancing the habitat value and ecosystem function of riparian areas that are already protected in Reaches 4B2 and 5. As described below for the pilot-level project for alkali scrub restoration on federal lands in Reach 5, this type of action should begin on a pilot scale and then, through monitoring and adaptive management, be expanded, as appropriate.

4.4.2 Conduct 10-acre pilot alkali scrub habitat restoration project

Historical accounts (as summarized in Chapter 8 of McBain and Trush 2002) indicate that alkali sink, saltbush scrub, and other alkali vegetation types were once common along the outer margins of the flood basins on either side of the San Joaquin River from Reach 3 through Reach 5. Remnants of this vegetation type currently occur in the project area in the San Luis National Wildlife Refuge Complex (approximately 5 acres was mapped by CDWR as occurring south of the San Joaquin River from RM 125–129, near the confluence of Salt Slough in Reach 5) and in the Alkali Sink Ecological Reserve a few miles south of Reach 2B. Alkali scrub habitat supports a variety of specially adapted plant and wildlife species (discussed in Section 3.5.4.4), as well as contributing to the overall diversity of vegetation types within the planning area. Suitable salinity and soil conditions for the development of alkali scrub habitat exist in Reach 5 (i.e., clays or clay loams with moderate or higher soil salinity levels). Implementation of a pilot 10-acre project to restore alkali sink habitat in the vicinity of existing patches of this habitat type within Reach 5 should be included under all strategies. This pilot effort might include regrading to provide topographic complexity that would benefit a mosaic of alkali scrub vegetation (e.g., alkali sink, alkali marsh, and alkali meadow), and horticultural restoration depending on site conditions (e.g., to provide immediate habitat benefits and an initial seed source for natural regeneration). The pilot effort would be monitored and managed adaptively to improve the success of the initial pilot effort and provide input into future restoration efforts.