Attachment B
Biological Monitoring Methodologies

Monitoring Methodologies for the Burke Ranch Conservation Bank

This plan outlines the general monitoring program for the Burke Ranch Conservation Bank (**Bank**) in Solano County, California. Monitoring is required to verify the long-term integrity of the preserved habitats, and to document changes from the baseline conditions at the time of establishment of the Bank. The goal of this monitoring plan is to identify monitoring methods which accommodate climactic and temporal changes in the landscape and can assist in accurately assessing the overall functionality of the preserved vernal pool ecosystem.

As discussed in the supporting technical documents (CBA Exhibit D.2), rainfall in 2006-2007 was significantly below average recorded rainfall for the local area. Because of the far below average rainfall, coupled with the significant temporal lag between "large" storm events (i.e., events resulting in 1 or more inches of rainfall during a storm event) many vernal pools may not have filled, or the timing and duration of ponding was shorter than normal. Therefore, many common species of vernal pool flora and fauna failed to germinate or hatch, respectively, during the winter inundation and spring dry-down phases. As a result, botanical, invertebrate, and to a lesser extent, wildlife survey results are not characteristic of what would be considered an average season. However, surveys conducted in this initial year are representative of the "dry" end of the spectrum for the vernal pool-annual grassland ecosystem and the results of these surveys can be used as part of the baseline documentation for the site. Supplemental technical studies will be conducted to improve the documentation of baseline conditions documented on site. Upon completion of baseline studies on the Bank, detailed long-term monitoring will be conducted every 5 years thereafter.

To achieve the Plan Goal, annual quantitative monitoring will be utilized to identify dramatic shifts on the landscape while less frequent, but more comprehensive, quantitative surveys will be used to track subtle trends in the habitat. Both annual qualitative monitoring and the ongoing quantitative monitoring will be conducted at the Bank in perpetuity. The annual monitoring effort will review conditions on site including expansion or contraction of weedy areas, introduction of exotic-invasive species, and other broad ecological issues. Detailed monitoring will focus on species composition and cover at a pool and swale level. Survey frequency will be on a five (5) year reoccurrence cycles following completion of the baseline documentation for the Bank. Long-term ecological monitoring of landscape condition, surface hydrology, vegetation, invertebrate use, and wildlife use will be evaluated against the data collected during previous years and the baseline surveys.

MONITORING METHODS

Components of the vernal pool-annual grassland ecosystem to be evaluated during the baseline studies and long-term monitoring of the Bank will include the following parameters:

- Vernal pool and other vernal type wetland (hereafter referred to as "vernal wetland") plant community composition and cover;
- Vernal wetland wildlife assemblages;
- Vernal wetland rare plant species;

- Invasive species; and
- Seasonal avian use of the Bank.

Suitable methods for acquiring the aforementioned baseline data are discussed below. The methods discussed below are general in nature and further refinement of the methods will be required following the supplemental baseline data collection exercise. Nonetheless, the methods presented below are commonly employed practices that are consistent with other ecological data collection and monitoring programs employed elsewhere in the Central Valley.

Vernal Wetland Habitat Monitoring

Monitoring Methods

Vernal Wetlands

Vernal wetland (i.e., vernal pool/vernal swale complex, playa wetlands, and vernal pools) monitoring will consist of conducting vegetation sampling within a subset of each vernal wetland type at the Bank. Vernal wetland sampling locations were permanently established during monitoring in 2008. The plot locations can be found in the 2008 monitoring report (Exhibit 1).

Vegetation sampling methods may follow those of Barbour et.al. 2007 whereby releves (Mueller-Dombois and Ellenberg 1974) are performed within one subjectively placed $10m^2$ plot within each vegetation subtype within a vernal wetland to describe plant species composition and cover. To the extent feasible vegetation subtypes will follow those identified in the Classification, Ecological Characterization, and presence of listed Plant Taxa of Vernal Pool Associations in California (Barbour et. al. 2007). If other sampling methods are utilized they must be able to adequately characterize floristic composition and plant community or association structure and distribution within the sample plots.

Rare Plants

Rare plant surveys will be conducted during the spring (April-May) and late-season (June-July) flowering periods to maximize detection of rare plant species. Rare plant surveys will be floristic in nature and will follow the protocols identified in "*Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities*" (DFG 2009).

Invasive Plant Species

Invasive plant species have the potential to affect the conservation values of the Bank; therefore a good understanding of the location and extent of invasive, or potentially invasive, plant species is essential to effective long-term management of the site. In particular, invasive plant species that have ecological tolerances that would allow them to be invasive in vernal wetlands need to be identified early so control actions can be implemented.

Invasive plant species will be mapped using GIS and GPS technology in spring and summer to document baseline conditions. Invasive plant species with an overall rating of "High" by the The California Invasive Plant Council (CalIPC) will be mapped during the field survey. However,

given the ubiquitous nature of medusahead grass (*Taeniatherum caput-medusae*) throughout the Bank, this "High" rated invasive plant species will not be mapped as part of this exercise.

Monitoring Timeline

Vernal Wetlands
Qualitative vernal wetland hydrologic and vegetative monitoring will be conducted every winter and spring. Qualitative surveys will include: 1) reviewing overall biological site conditions and grazing effects while traversing the site with meandering transects; and 2) capturing annual variation in floristic character though photo documentation at 20 fixed stations across the Bank.

Vernal pools will be quantitatively sampled for floristic composition once every 5 years following bank establishment. The frequency of these surveys will enhance the baseline understanding of the landscape ecology. The 5 year monitoring period is based on the assumption that no unexpected alterations of the site or adjacent properties would occur to adversely affect the site's hydrology or vegetative composition. If modifications lead to remedial activities, supplemental monitoring may be required.

Every 5 years, an aerial review of vernal pool inundation will be conducted. The Monitoring Biologist will commission an aerial photo during the peak of the wet season. Should the review indicate a measurable reduction in acreage, a field investigation will occur to visually identify if problem areas are present. If variation of acreage is occurring for reasons other than climatological or precipitation variations, the Service will be consulted to determine if adaptive management is required.

Rare Plants
Climatic conditions in the winter and spring of 2006-2007 were not conducive to the germination and growth of many vernal pool associated plant species. In particular, listed vernal pool plant species such as Solano grass (*Tuctoria mucronata*), Colusa grass (*Neostapfia colusana*), and Contra Costa (*Lasthenia conjugens*) may not have germinated on site. Additional follow-up botanical surveys will be conducted in each year of the baseline surveys to augment the baseline data set for rare plant species occurrence at the Bank. Thereafter, the monitoring will occur every 5 years in perpetuity.

Invasive Plant Species
Due to the deleterious nature of natural habitat conversion by invasive plant species, the presence of invasive plant populations will be documented each year during qualitative habitat monitoring as well as general site management or maintenance visits. Expansions of existing populations (in excess of one acre of newly occupied habitat) or newly documented populations will be mapped via GPS during these surveys. The Annual Report will address any documented changes of the invasive plant populations on site.

Aquatic Wildlife Monitoring

Monitoring Methodology

The vernal and playa pools provide an abundant food source for local wildlife including waterfowl and shore birds. Due to the proximity to the drainage spanning the Bank, there is a potential that non-native predatory fish or crayfish may enter the pools. As the pools completely dry down during the summer, these predatory species would not be able to establish a permanent residence. However, even a temporary occupation of the pools could have a deleterious effect on the population of fairy shrimp or CTS larvae in those particular pools. Monitoring for non-native predatory aquatic species will occur as a byproduct of aquatic wildlife monitoring, and any non-native aquatic predators captured will be eradicated.

Invertebrates

Monitoring for vernal pool invertebrates will consist of dip-netting known locations of listed crustaceans as well as opportunistic surveys of suitable wetland areas (i.e., vernal type wetland areas with 1 or more inches of ponded water). Primary focus areas for sampling will include the playa pools and drainages on site, where deep, turbid water provides the greatest opportunity for occurrence of vernal pool tadpole shrimp and conservation fairy shrimp. Opportunistic surveys will be conducted by sampling suitable habitat areas along meandering transects throughout each pasture.

Aquatic surveys will consist of three sampling visits timed to coincide with the peak identification period for listed crustaceans. In most years the peak identification period for listed crustaceans is from January to early March. Because of their longer inundation period the playa pools onsite may support identifiable listed crustaceans into April or May. Vernal pools on the study site will be surveyed by dip-netting as well as visual inspection of the water column prior to beginning dip-netting. Dip netting will be conducted using a standard aquarium dip net with a mesh aperture of 1/8 inch or less that is swept through the pool using a up and down / zig-zag motion to sample the entire water column.

California Tiger Salamander

Monitoring for CTS will follow the DFG recommended survey protocol (Attachment A). Typical monitoring will consist of three surveys throughout the breeding season to detect larvae and metamorphosed individuals. Surveys efforts will entail full seining of the entire water volume of each of the three playa pools. Timing will be focused on targeting an early-, mid-, and late-season survey of each pool, and preparation of a brief letter report including results of the surveys. Capture results by pool, and morphometric data on each larval CTS observed, will be documented and provided in the monitoring report.

Monitoring Timeline

Invertebrates

Following the baseline supplemental surveys, aquatic invertebrate monitoring will be conducted the every 5 years following bank establishment. The number and location of pools will be determined during the supplemental baseline surveys in 2008. Pool sampled will be identified by the number recorded in the wetlands delineation (CBA Exhibit D.3) to allow consistent sampling in future years. The presence or absence of vernal pool large branchiopods will be recorded and all species identified will be noted. The sample results will be included in the Annual Report.

California Tiger Salamander

The timing of baseline surveys for CTS are modified from the overall pattern established for the Bank. Initial monitoring (2007/2008) did not document occurrence of this species. Dipnet surveys in 2008/2009 documented one individual larvae. Survey methods were modified to presence/absence seining of the playa pools, and the first two seasons of full seining were completed in 2009/2010 and 2010/2011. Rigorous seining of the entirety of the playa pools on a tri-annual basis will be implemented for three additional consecutive years. The sample results will be included in the Annual Report.

Upon completion of the baseline surveys, full-seine surveys of CTS breeding pools following DFG protocol (attached) will be conducted twice every 10 years in perpetuity, spaced approximately every 5 years but selectively choosing wetter than average years, as part of the long-term monitoring of the Bank. To maximize efficiency of overall sampling efforts, CTS and invertebrate sampling will optimally be performed in the same year(s). Invertebrate surveys occur every 5 years, beginning in Spring 2017. As such, the first of the perpetual CTS surveys will begin in 2016/2017.

Upland Wildlife Monitoring

Monitoring Methodology

Upland species surveys will focus on detecting the presence of delta green ground beetles (DGGB) and avian species. Due to the cryptic nature of DGGB, and the potential for population fluctuation of this species, surveys will focus on the breadth of site use rather than population numbers. Avian surveys are not intended to be an exhaustive survey of the Bank; the surveys efforts are directed towards identifying nesting locations for Swainson's hawk and burrowing owl, and general seasonal avian use patterns at the Bank.

DGGB

DGGB survey(s) will be conducted in mid-spring (late February to early April), on days exhibiting clear, warm weather. Survey will include visually inspecting the margins of the playa pools and other sparsely vegetated areas within 500 feet of the playa pools.

Avian Surveys

Avian surveys will focus on detecting use of the site by nesting and foraging Swainson's hawk and burrowing owl. Surveys for Swainson's hawk will be conducted in late spring, and focus on inspecting the potential nesting trees on site. Visual observations will be made using either binoculars or a spotting scope to determine the number and species of raptors nesting on site. Burrowing owl surveys will focus on fencelines, mounded locations, areas of disturbance (i.e., downed tree limbs), and the Maintenance Facilities Location to detect perched individuals or nest locations. Overall avian use will also be documented through visual observation made while traversing the site using meandering transects. In general, an Area search method (USDA PSW-GTR-144) is appropriate for these avian surveys where a suitable plot size can be in excess of 50 acres given the openness and uniformity of habitats at the Bank.

Monitoring Timeline

DGGB

An adequate baseline of DGGB use of the Bank was compiled though surveys conducted in 1999 and 2007. Due to the extreme rarity of this species, and susceptibility to changes in vegetation cover, surveys for DGGB will be conducted every five years in perpetuity.

Avian Surveys

Baseline avian surveys will be conducted in winter 2007-2008, spring 2008, and summer/fall 2008 to establish a baseline for avian use of the Bank. Long-term monitoring of avian species will be conducted every year in perpetuity, following the survey timelines proscribed for the baseline surveys.

ANNUAL REPORTS

Summary reports of monitoring results will be submitted to the USFWS by December 31st of each monitoring year. The reports will briefly summarize the qualitative and quantitative observations of site conditions, along with photographs documenting site conditions. Any changes in the extent of invasive plant populations will also be mapped and documented. Incidental wildlife observations made during monitoring visits will be summarized in the monitoring reports. The results of the quantitative monitoring will be summarized and included as an appendix to the monitoring report.

Annual reports will confirm maintenance efforts are perpetuating the integrity of the vernal pool ecosystem and will identify any unforeseen problems. Such reported observations could include excessive cattle use or surface damage, erosion, supplemental water inflow from adjacent properties or changes in flows due to surface topographic disturbance or erosion, or acts of vandalism. Any recommendations for remediation will be made in the annual reports.

MONITORING SUMMARY

Table 1. Baseline Monitoring Schedule

Resource Survey	Baseline Survey Years
Vernal Pool Floristics	2007, 2008
Rare Plants	2007, 2008
Invasive Species	2007, 2008

Invertebrates*	Years 1,2,3,5,7,10,15, and 20
California Tiger Salamander	2010,2011,2012, 2013, 2014
Delta Green Ground Beetle	1999, 2007
Swainson's Hawk	2007, 2008, 2011, 2012

*Year 1 is considered 2008

Table 2. Monitoring, Scope, and Frequency for the Burke Ranch Conservation Bank

ACTIVITY	SCOPE	FREQUENCY
HABITAT ASSESSMENT		
Vernal Wetlands	Qualitative Monitoring: One survey each Winter and Spring Quantitative Monitoring: One survey in Spring	Qualitative Monitoring: Annually Quantitative Monitoring: Every 5 years in perpetuity
Rare Plants	Spring (Apr-May) and Summer (Jun-Jul)	Every 5 years in perpetuity
Invasive Plant Species	During qualitative habitat monitoring	Annually
AQUATIC WILDLIFE MONITORING		
Aquatic Sampling	Three samples during peak detection period for VP invertebrates and CTS breeding	Every 5 years in perpetuity
UPLAND WILDLIFE MONITORING		
DGGB	Warm, clear day in mid-Spring (late Feb-early Apr)	Every 5 years in perpetuity
Avian Species	Three samples: Winter, Spring, and Summer/Fall	Annually in perpetuity
REPORTING		
Report Preparation	Summary of qualitative habitat assessment and invasive plants. Detail reporting of comprehensive surveys.	Annually, by December 31st

APPENDIX A. CALIFORNIA TIGER SALAMANDER SURVEY MONITORING

The monitoring methodology is consistent with the California tiger salamander (*Ambystoma californiense*; CTS) larval monitoring protocols contained in the revised draft of the Solano County Habitat Conservation Plan, and are based in part on the joint U.S. Fish and Wildlife Service (USFWS) and California Department of Fish and Game (DFG) (2003) survey guidance.

SURVEY TIMING

CTS breeding will be assessed annually for a minimum of five years and then once every five years thereafter. Three of the initial annual surveys should be conducted in years of average or below average rainfall[1]. Surveys conducted during the long-term management period should also be conducted in years of average or below average rainfall. Both interim and long-term surveys should be extended, if needed, depending on rainfall amounts. Surveys will be conducted three times each monitoring year spanning the inundation period of the breeding habitat. Ideally, one survey should be conducted each month in March, April, and May; however, these dates may vary depending on weather patterns and when CTS start breeding. Preliminary site assessments to look for eggs should be conducted to determine the best time to start the surveys for larvae. The final survey shall be timed to detect larvae which are at a stage of development which indicates they will be able to complete metamorphosis (e.g. show remnant gill stubs, have near complete absorption of tail fin, etc.) prior to the pool drying or becoming otherwise unfavorable for larval development. In order to estimate the density of larvae within each pool, sampling will adhere to the methods described below.

SAMPLING METHODOLOGY

All surveys shall be conducted in such a way that the surface area and/or volume of water sampled can be quantified. Minnow seines are the preferred method for surveying for larvae unless vegetation in a pool or other factors prevents adequate sampling. In this case, the revised survey proposal should be submitted to USFWS and DFG in writing. Upon receipt of approval by USFWS and DFG, the pool can be surveyed using dip nets, according to the methods outlined below. Preferably, surveys shall not start if salamander larvae are too small to detect with seines. Seines shall have a mesh size of 3 mm (0.125 inches) or less and have sufficient weights along the bottom and floats along the top. Dip nets shall have a mesh size of 2-mm (0.08 inches) or less.

Dip netting for assessing CTS preference for different depth zones or locations in pool can be carried out in conjunction with seining; however, the dip netting should be carried out in a separate section or in a manner that will not interfere with quantitative sampling of the pool.

[1] Normal rainfall is determined using the range shown in the NRCS National Water and Climate Center tables (http://www.wcc.nrcs.usda.gov/climate/wetlands.html). The lower and upper limits of the normal range are indicated by the columns labeled “30% chance will have less than” and “30% chance will have more than” in the WETS table.

General Habitat Parameters
The attached data sheet shall be used for all CTS surveys and should be filled out as completely as possible or as necessary during each survey. The general information that should be collected includes:

- Date
- Pool ID and Location (Lat/Long)
- Surveyors
- Cloud cover
- Air temperature
- Wind [Beaufort scale or estimated/measured miles per hour (MPH)]

For each pool sampled general habitat parameters will be collected. These parameters include:

- Surface Area: Determine the approximate surface area of the pool using aerials photographs, maps, and a tape measure or by pacing the perimeter. If possible, walk the perimeter of the pool using a GPS unit with submeter technology. For very large pools, measure or pace a section and then estimate.
- Maximum depth
- Turbidity based on visual observations of the following categories:
    a. Clear - bottom is clearly visible.
    b. Tea-colored - water color resembles strong brewed tea, generally clear, but brown in color, bottom is often obscured.
    c. Turbid - water is brown (sometimes gray) in color and visibility in the water column is often limited to only a few inches.
- Hydrological parameters such as connectivity to nearby drainages, water run-off or any other unusual or episodic hydrologic conditions

Seine Netting
Seining shall be done in such a way that the surface area and/or volume of water sampled can be quantified. When it is not feasible to sample the entire pool (e.g. when pools are > 1 acre in size, when pools have deep sections that cannot be seined (deeper than the height of the seine), or when the conditions in the pool prevent the surveyors from effectively pulling the seine across the pool), the surveyors should attempt to sample 30% of the surface area, if possible. In all cases, the survey will include a sufficient number of samples distributed around the pool to be representative of the pool. Surveyors will include a description of any limitations of the sampling in the annual report (e.g., pool too deep to cross, pool bottom too difficult to efficiently pull the seine) and the way in which the limitations were dealt with during the survey. It should also be noted if the limitation are inherent to the pool itself (e.g., deep pool or pool with unconsolidated bottom) or due to a particular practice or temporary condition (e.g., heavy cattle use, high rainfall year).

The procedures for seine net surveys are as follows:

1) Determine the approximate surface area of the pool using a tape measure or by pacing the perimeter. For very large pools, measure or pace a section and then estimate.

2) Develop a sampling scheme for each pool.[2] If possible, the surveyors should attempt to sample all parts of pools that are 1 acre or less in size. For pools that are > 1 acre, a target of sampling approximately 30% of the surface area should be established, but actual sampling may be less provided that the sampling is representative of the pool. If only a portion of the surface area is being sampled, sampling locations should be from different locations within the pool, ideally a minimum of 10 feet apart and shall include samples from representative sections and depths within the pool. If seining the entire pond, try to minimize the amount of overlap between samples.

3) Drag the bottom of the net across the pond, from shore to shore and check net for captured animals. Drag the net slow enough to keep the bottom down but as fast as possible to prevent escape of larvae. Drag the seine net as many times as it takes to cover the entire pond or to sample the areas that were determined in Step 1. Most pools should be adequately sampled in 3-10 pulls of the seine with the length of the seine pulls varying depending on the dimensions of the pool and conditions of the pool bottom.

4) When seining less than the entire pool, pull the seine through the deepest part of the pool whenever possible.

5) If making parallel pulls, the surveyors should wait several minutes between seine pulls so that larvae settle down before the next pull. The time it takes to count the larvae in the seine pull and record the data is usually a sufficient interval between pulls.

6) Parameters to be recorded for each seine pull include:
   - Distance of seine (i.e. distance walked).
   - Size including length and height of seine.
   - Average depth of water in seine pull.
   - Number of California tiger salamander larvae.
   - Average length of larvae (if multiple size classes are present count sizes classes separately). Record total length (TL) of larvae. Size classes (inch; based on TL) are the following:
     i. Class 1: <0.5
     ii. Class 2: 0.5 to <1
     iii. Class 3: 1 to <2
     iv. Class 4: 2 to <3
     v. Class 5: 3 to <4
     vi. Class 6: 4+
   - During the late season survey, if larvae have developed an adult body shape, measure the snout-vent length (SVL) of a subset of these salamanders as well as the total length.[3]
   - Presence of other amphibian larvae.
   - Presence of other invertebrates.
   - Presence of aquatic predators such as crawfish, minnows and green sunfish. Record location and number by species.

[2] This should be determined in the field by a biologist experienced in sampling California tiger salamander populations and take into consideration depth of pool, condition of pool bottom, prevailing wind direction, etc.
[3] Surveyors should always minimize the amount of time that larvae are out of the water and keep them wet (in the water) when counting more than a dozen or so larvae. Surveyors should measure larvae that are close to metamorphosing last after returning the smaller larvae to the pond.

- General description of the location of the sample (seine pull) in the pool (edge, middle, etc.). A small diagram showing the location of the seine pulls will be included in the annual report.
- Percent cover of submerged or emergent aquatic vegetation or other dominant substrate (e.g. mud).
- Dominant plant species in the pool or pond.

7) Eradicate any aquatic predators found.

8) Each net (as well as other equipment, waders, boots, hands, etc) shall be disinfected according to the procedures outlined below before being used in any other pool that is not hydrologically connected to the one previously sampled.

Dip Netting

Dip netting should be conducted such that the surface area and/or volume of water sampled can be estimated quantitatively. Ideally, the all areas of the pool should be sampled; however, this is generally only accomplished with seining. If this is not possible with dip nets, a target of sampling approximately 30% of the surface area should be established, but actual sampling may be less provided that the sampling is representative of the pool.. The following sampling scheme for dip netting will be used either alone or in combination with seining.

1) Determine the approximate surface area of the pool using a tape measure or by pacing the perimeter. For very large pools, measure or pace a section and then estimate.

2) Based on the surface area of the pool, use the following table to determine the number of samples to be taken:

Pool Area	Approx. diameter	Approx. Max. Dimensions	Shallow Samples	Medium Samples	Deep Samples	Total Samples
< 100 ft^2	12 ft	10 x 10 ft	2	0	2	**4**
100 - 500 ft^2	12 to 24 ft	20 x 25 ft	4	0	4	**8**
500 - 1000 ft^2	24 to 36 ft	20 x 50 or 30 x 30 ft	4	4	4	**12**
1000 – 1500 ft^2	36 - 44 ft	37 x 40 or 25 x 60 ft	6	6	6	**18**
1500 – 2000 ft^2	44 to 50 ft	45 x 45 or 20 x 100 ft	8	8	8	**24**
> 2000 ft^2	> 50 ft	BIGGER	10	10	10	**30**

3) Each sample location should ideally be a minimum of three (3) feet from any other sample point. This will help ensure that the samples are independent of each other. If possible, locate the general position of each sample on a map of the pool, either by printing an aerial photograph of the pool or by drawing a sketch of the pool on the data sheet. A separate data sheet should be prepared for each pool sampled.

4) Also select sample locations in order to best sample the various microhabitats within the pool (e.g. vegetated vs. unvegetated sections).

5) Include representative sample locations from different depth zones in pools when the entire pool or waterbody is not sampled. Depth zones can be determined by dividing the pool into concentric bands (assuming it gets deeper towards the center). Before or during sampling, at least one depth

transect of the pond from center to shore should be taken. For larger pools, it may be possible to take depth samples in the different zones in part of the pool before beginning sampling in other parts of the pond.

6) Sampling shall be conducted in a manner that provides a measurable area and volume water sampled. Make sure that the dip net mostly follows the contour of the bottom for the entire time before bringing net up. Be aware of moving swiftly enough to capture larvae swimming away, but not so quickly that they are disturbed and escape before net reaches them.

7) Parameters to be recorded for each sample include:
   - Size of net, length of net sweeps, and depth of water.
   - Number of California tiger salamander larvae.
   - Average length of larvae (if multiple size classes are present count sizes classes separately). Record total length (TL) of larvae. Size classes (inch; based on TL) are the following:
     i. Class 1: <0.5
     ii. Class 2: 0.5 to <1
     iii. Class 3: 1 to <2
     iv. Class 4: 2 to <3
     v. Class 5: 3 to <4
     vi. Class 6: 4+
   - During the late season survey, if larvae have developed an adult body shape, measure the snout-vent length (SVL) of a subset of these salamanders as well as the total length.[4]
   - Presence of other amphibian larvae.
   - Presence of other invertebrates.
   - Presence of aquatic predators such as crawfish, minnows and green sunfish. Record location and number by species.
   - General description of the location of the sample in the pool (edge, middle, etc.).
   - Percent cover of submerged or emergent aquatic vegetation or other dominant substrate type (e.g. mud).
   - Dominant plant species.
   - Depth of water at the sample location.
   - Turbidity based on visual observations of the following categories:
     i. Clear - bottom is clearly visible.
     ii. Tea-colored - water color resembles strong brewed tea, generally clear, but brown in color, bottom is often obscured.
     iii. Turbid - water is brown in color and visibility in the water column is often limited to only a few inches.

8) Carefully remove all larvae and other animals and debris from net before proceeding to next sample point.

9) Eradicate any aquatic predators found.

10) Disinfect all boots, waders, nets, and other equipment that will come into contact with water when moving on to sample a new pool, unless it is hydrologically connected to the previously sampled pool. For disinfection, follow the guidelines below.

[4] See previous footnote.

Disinfection Procedure
Consult USFWS and DFG for most current disinfection procedures. If none are available use the following:

1) All organic matter shall be removed from nets, traps, boots, vehicle tires, and other surfaces that have come into contact with water or potentially contaminated sediments
2) Boots, nets, traps, etc., shall be scrubbed, sprayed, or dipped in a bleach solution (0.5 to 1.0 cup per gallon of water) and rinsed with clean water between study sites. Do not clean equipment in the immediate vicinity of a pond or wetland. Take care to remove all traces of the bleach solution (or other approved disinfectant) before entering the next aquatic habitat.
3) When working at sites with known or suspected disease problems, disposable gloves shall be worn and changed between handling each animal. Gloves shall be wetted down with water from the site or distilled water prior to handling amphibians. Remove the gloves by turning them inside out to avoid cross-contamination.
4) Used cleaning materials shall be disposed of safely, off site.

Data Analysis
The area sampled will be estimated per sample location. For seine samples, the area covered by each seine pull will be estimated by multiplying the width of the net (measure net width in feet before going out into the field) by the distance walked (in feet as calculated on data sheets). For dip-net samples, the area covered will be estimated by multiplying the width of the dip-net (in inches) by the length of the pull [approximately three (3) feet]. The density of larvae captured (larvae/ square foot) per sample will be averaged for each pool and the average density (larvae/ square foot) will be multiplied by the total area of the pool to estimate the total number of larvae per pool during each survey.

REFERENCE SITES
CTS survey results should be compared with those from nearby offsite locations that support functioning ecosystems with similar species and habitat characteristics. Use of one or several reference sites allows for comparisons in CTS breeding population numbers and productivity which may fluctuate from year to year depending on environmental conditions such as rainfall patterns and temperature. Small differences in CTS survey results may be attributable to geographical distance between a project site and reference site as well as differences in microclimate, topography and other environmental conditions (for example, valley floor versus Potrero Hills area). However, comparison of CTS data between different sites with similar vegetation and wildlife communities may provide important early signs of a significant decrease in a local CTS breeding population which may require remedial actions.

Data from other CTS survey efforts in the region should be included in the analysis of CTS sampling data presented in the annual and final reports submitted to USFWS and DFG. Only reference site data available at the time of report preparation will be required to be included in the report.

REPORTING
Annual reports detailing the results of the baseline surveys (Survey years 1 – 5) will be submitted to USFWS and DFG. The final report will include a summary of the previous 5 years of monitoring.

Summary reports for the long-term monitoring will be submitted to USFWS and DFG every five years Raw survey data will be included as an appendix to each monitoring report.

Preliminary CTS survey results should be provided electronically to USFWS and DFG within fourteen (14) days of the last CTS survey of the season. This information will then be made available upon written request to other CTS surveyors in the region.

CALIFORNIA TIGER SALAMANDER (CTS) LARVAE FIELD DATA SHEET

Property/Project Name: _____ **County:** _____

Pool/Pond ID: _____ **Coordinates**[1]: _____ **Survey Number**: _____

Date: _____**Start Time**[2]: _____**End Time**: _____

Surveyor(s): _____

Cloud Cover (%): _____ **Air Temperature (F/C):** _____**Wind (mph or Beaufort scale):**_____**Wind Direction**: ____

Maximum Water Depth (in/cm):_____**Water Turbidity (clear, tea colored, milky, etc)** _____

Survey Type: Seine / Dip Net **Net Length:** _____ **Dip Net Size:** _____

Sample #	1	2	3	4	5
Pull Length (feet or meters)					
Depth (maximum depth of pull)					
CTS Size Class 1[3]**: <0.5**					
CTS Size Class 2: 0.5 to <1					
CTS Size Class 3: 1 to <2					
CTS Size Class 4: 2 to <3					
CTS Size Class 5: 3 to <4					
CTS Size Class 6: 4+					
Other Amphibian Larvae[4]					
Invertebrates[5]					
Dominant Plant Species and % Cover[6]**:**					

Notes:

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[1] UTM or Lat/Long
[2] Use twenty-four hour clock (e.g., 1300 not 1:00 pm)
[3] Record length of size class in left-hand column and the number captured in the sample columns
[4] Record species in left-hand column and number captured in sample column
[5] Record invertebrate taxa captured in the sample columns
[6] Record submerged and emergent plant taxa and percent cover