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Casmalia Habitat Restoration Plan

for the

California Red-Legged Frog and Western Spadefoot Toad

A Group Project
Submitted in Partial Satisfaction
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for the

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The Casmalia Habitat Restoration Plan (Plan) offers a solution for resolving a potential conflict between the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) mandated closure requirements and federal and state laws for the protection of species at the Casmalia Resources Superfund Site (Site) in Santa Barbara County, California. Currently, the federally protected California red-legged frog (*Rana aurora draytonii*) and the western spadefoot toad (*Scaphiopus hammondii*) are utilizing habitat provided by water storage ponds that may be eliminated due to closure activities at the Site.

In order to meet the closure requirements and concurrently protect the target species, the United States Environmental Protection Agency and CB Consulting, the primary consultant for the Potentially Responsible Parties, requested a plan for the adjacent Casmalia Creek riparian corridor to allow for the establishment of the potentially displaced target species. As such, the Plan includes the following information:

1. The likely interaction between relevant federal and state species-protection laws and CERCLA;
2. The plausibility of the target species functioning within a larger metapopulation context;
3. The availability of water in the Casmalia Creek watershed for restoration activities; and,
4. A habitat creation and restoration plan designed to provide suitable habitat for the target species based on the opportunities and constraints in the Casmalia Creek riparian corridor.

This is a rare instance of CERCLA mandated closure requirements potentially conflicting with federal species-protection laws. The Plan clarifies the likely interaction between applicable laws, while providing a comprehensive habitat creation and restoration plan specific to the Casmalia Creek riparian corridor. The Plan provides transferable design rationale that is equally applicable to other locations within the watershed.

Executive Summary

Currently, the federally protected California red-legged frog (*Rana aurora draytonii*) and the state Species of Special Concern western spadefoot toad (*Scaphiopus hammondii*) use habitat provided by water storage ponds at the Casmalia Resources Superfund Site (Site) in Santa Barbara County, California. As the ponds may be removed to complete Site closure activities, there is a potential conflict between relevant federal and state regulations guiding these closure activities and the protection of the target species. To address this potential conflict, the United States Environmental Protection Agency (EPA) Region IX and CB Consulting (CBC), the primary consultant for the Potentially Responsible Parties, requested a plan for the adjacent Casmalia Creek riparian corridor that would allow for the establishment of the displaced target species (EPA 2001a). To meet this request the Casmalia Habitat Restoration Plan (Plan) provides pertinent and valuable information on: legal context, metapopulation considerations, habitat requirements, availability of water in the riparian corridor, creating and restoring suitable habitat, as well as recommendations.

Legal Context

The apparent conflict between the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) mandated closure requirements and species protection requirements of the Endangered Species Act (ESA) is uncommon but not unique. Federal agencies have a duty to conserve listed species and courts have affirmed this obligation even in instances when doing so may be counter to their primary mission. Remedy selection at other Superfund sites has been modified to minimize affects to listed species. Although CERCLA closure requirements must comply with the ESA, section 7 of the ESA allows a conditional exemption for federal actions that adversely impact listed species provided the actions do not jeopardize their continued existence and are "incidental to, and not the purpose of, otherwise lawful activities" (16 U.S.C. §1536). Due to the Site's Superfund status and the EPA's role, removal of the existing ponds constitutes a federal action, thus subject to section 7.

Assuming the United States Fish and Wildlife Service (USFWS) renders a determination of no jeopardy, an Incidental Take Statement will be granted and will specify the acceptable level of take (*e.g.* mortality, harm, habitat modification). The exemption remains valid only if there is clear compliance with the terms and conditions of binding reasonable and prudent measures identified to minimize the impact of incidental take on the species (USFWS 1998). These measures may involve only minor changes to the project and are restricted to actions that reduce the level of take and are within the action area, which potentially includes a footprint area beyond the boundaries of the action, (USFWS 1998). Although section 7 requires minimizing the impact of incidental take, mitigation cannot be required (USFWS 1998).

Both target species are designated as California Species of Special Concern. This designation does not extend any specific legal protection requirements to the species or

their habitat, rather it is intended to generate special consideration in conducting actions that may negatively affect them.

Metapopulation Considerations

Habitat elimination at the Site may have implications on the target species that extend beyond the Site to include effects upon their metapopulation. The regional persistence of a species relies upon dispersal between local subpopulations within the metapopulation (Hanski 1999). To assess potential subpopulations near the Site, some of their known locations in the surrounding area were cataloged. As there are no data regarding the extent of dispersal occurring between the Site and local subpopulations, a rudimentary notion of the metapopulation structure was obtained by assuming local subpopulations within the target species' 3 kilometer dispersal radius are potentially interacting.

The California red-legged frog has been observed in Casmalia Creek (T. Carson and C. Minton, UCSB, pers. obs. 2001). Due to the proximity of the Site to Casmalia Creek and the absence of dispersal barriers, it is likely the populations of the target species at the Site are connected to Casmalia Creek. Casmalia Creek flows into Shuman Creek, 3 kilometers south of the Site, and movement between California red-legged frogs in Shuman Creek and Casmalia Creek is likely. The San Antonio Terrace, south of the Site, contains western spadefoot toad populations and is among the most productive areas for the California red-legged frog in Santa Barbara County (Christopher 1996). California red-legged frogs from this area are thought to disperse to nearby Shuman Creek (Christopher 1996), and may subsequently disperse to Casmalia Creek. As it is highly probable that California red-legged frogs in Shuman Creek are connected to the population at the Site, it is plausible that the Site population is connected to a highly productive area. Therefore, in evaluating remedy selection alternatives and in creating and restoring habitat, it is important to consider the plausible interaction of the target species at the Site with other subpopulations in the area.

Habitat Creation and Restoration

The habitat requirements of the target species were evaluated extensively. Based on their breeding and larval development requirements and the conditions present in the Casmalia Creek watershed, restoring portions of Casmalia Creek and creating ponded habitat were identified as two potential options to provide suitable habitat. Although "ideal" breeding habitat has not been unequivocally defined for the target species, ponded habitat that contains a suitable hydroperiod and vegetation (a minimum of 20 centimeters of water persisting from January through July) is generally thought to enhance breeding and larval development (USFWS 2000). As the creek experiences high flow velocities and subsequent creek bed scouring, a result of intense rainfall events, (RWQCB 1999), it provides unreliable breeding habitat. However, establishing the appropriate native vegetation and improving the condition of the riparian corridor will provide a variety of additional benefits. As a result, it was determined that creating ponds adjacent to a restored portion of the riparian corridor will provide suitable habitat.

Suggesting the creation of ponded habitat necessitated an analysis to determine if a sufficient volume of water is available to create habitat that will meet the target species' needs. As such, a model was run to simulate a variety of pond scenarios, which could be created to provide suitable habitat. Changing the maximum storage capacity, adding a second pond, or doing both of these allowed for the analysis of a variety of pond scenarios.

The primary input to the model was stormflow from the creek, estimated using the USDA Soil Conservation Service method. As the creek is not gaged, gaged streams in nearby watersheds with similar characteristics allowed for a comparison. Water loss from infiltration and evapotranspiration were outputs. Ten of the 48 scenarios run met the target species' water needs throughout the 45-year period, suggesting that Casmalia Creek is a suitable source of water for creating ponded habitat. From these scenarios, a 3 meter deep, conical shaped pond with a maximum surface area of 2.8 acres at the potential location was deemed most suitable as it met the target species needs while maximizing habitat area. However, in this scenario, annual stormflow in the remainder of the creek was reduced by over 10% in 1 out of 2 years and 100% in 1 out of 11 years. The average reduction in total annual flow to Casmalia Creek's receiving tributary, Shuman Creek, was estimated to be 4%. Reducing annual stormflow and total annual flow volume will alter the flow regime of Casmalia Creek and may affect the structure and function of physical processes potentially adversely affecting biota.

Upon determining the Plan was feasible based on water availability, the analysis focused on four considerations that are critical in assessing the Plan's ability to meet the EPA and CBC's objective. These considerations are:

1. The reduction in the volume of flow downstream of the potential pond location;
2. The plausibility of establishment based on proximity to populations at the Site;
3. The likelihood of the habitat being conducive to the establishment and persistence of individual members of the target species; and,
4. The likelihood of the habitat supporting equivalent sized populations.

Capturing stormflow to create ponded habitat will alter the natural flow regime of Casmalia Creek potentially adversely affect downstream biota. Determining in-stream flow requirements for biota is hindered by both the lack of understanding of potential biological response to a reduction in flow as well as the lack of flow data in Casmalia Creek and Shuman Creek. However, the reduction in flow volumes represents a potentially significant percentage, particularly in low-flow years, and therefore may have an adverse impact on downstream biota, an issue of elevated concern due to the presence of the federally endangered tidewater goby (*Eucyclogobius newberryi*) in Shuman Lagoon.

The potential location for creating and restoring habitat is 1.5 kilometers from the Site and 2.5 kilometers from Shuman Creek, which is within the target species' dispersal distance, and as there are no major barriers to dispersal, it is plausible the target species could become established. As the Plan provides methods, based on extensive research, for creating and restoring habitat suitable to the target species it is likely the habitat will be conducive to the establishment and persistence of individual members of the target species. However, the elimination of ponds at the Site (25 acres of ponded habitat) and the implementation of the Plan (2.8 acres of ponded habitat) will result in a 10-fold loss in habitat area and an increase in the target species' population density.

The effects of increased density on the target species are not thoroughly characterized; therefore, this aspect of the analysis focused on the effects of density on anuran species in general. Studies indicate both positive and negative effects from increased density. However, as potential effects of increased density include a decrease in larval survival rates and increased competition between adults, a prudent approach to providing habitat must be taken. As implementing the Plan will result in a 10-fold reduction in area and increase target species density, it is inadvisable to rely solely on it to provide sufficient habitat for the displaced target species.

As such, the B and C-drainages as well as the Site itself should be considered as possible locations to create and restore suitable habitat. These locations, in conjunction with the Plan or one another, could allow for the creation of equivalent habitat area. Although habitat area at these locations will also be constrained by the availability of water, sources would not be limited to the creek. Potential sources of water from the Site include: storm runoff, treated groundwater, and existing pond water.

Recommendations

As the effects of reducing habitat area and reducing flow are not fully understood it is the recommendation of the Casmalia Team that the EPA and CBC explore opportunities within the watershed that provide habitat area for the target species equivalent to that of the water storage ponds. Further, the Casmalia Team recommends restoring the Casmalia Creek riparian corridor near created habitat to provide additional benefits to the target species. Lastly, as the Plan provides habitat design parameters for creating and restoring habitat conducive to the establishment and persistence of individual members of the target species, these parameters should be incorporated into any habitat creation and restoration plan for the benefit of the target species regardless of location in the watershed.

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The contents of this report reflect the opinions of the Authors of the Casmalia Habitat Restoration Plan. The findings and recommendations are in no way binding on the United States Environmental Protection Agency or the Casmalia Steering Committee.

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List of Acronyms and Abbreviations

AMC – Antecedent Moisture Condition
bgs – Below Ground Surface
BO – Biological Opinion
CBC – CB Consulting
CDFG – California Department of Fish and Game
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
CESA – California Endangered Species Act
CEQA – California Environmental Quality Act
CIMIS – California Irrigation Management Information System
cm – Centimeters
CN – Curve Number
CNDDB – California Natural Diversity Database
CR – Casmalia Resources
CSC – Casmalia Steering Committee
EPA – United States Environmental Protection Agency
ESA – Endangered Species Act
HCP – Habitat Conservation Plan
ITS – Incidental Take Statement
NCDC – National Climatic Data Center
NMFS – National Marine Fisheries Service
NPL – National Priority List
NTU – Nephelometric Turbidity Units
PCB – Polychlorinated Biphenyl
ppm – Parts Per Million
ppt – Parts Per Trillion
PRP – Potentially Responsible Party
RCRA – Resource Conservation and Recovery Act
RI/FS – Remedial Investigation/Feasibility Study
ROD – Record of Decision
RWQCB – California Regional Water Quality Control Board
SCS – United States Department of Agriculture Soil Conservation Service
TDS – Total Dissolved Solids
TSCM – Todos Santos Claystone Member
TSD – Treatment, Storage, and Disposal Facility
UCSB – University of California, Santa Barbara
UHSU – Upper Hydrostratigraphic Unit
USACE – United States Army Corps of Engineers
USDA – Untied States Department of Agriculture
USFWS – United States Fish and Wildlife Service
USGS – United States Geological Survey
VAFB – Vandenberg Air Force Base

1.0 Introduction

1.1 Purpose

The purpose of the Casmalia Habitat Restoration Plan (Plan) is to deliver to the United States Environmental Protection Agency (EPA) Region IX and CB Consulting (CBC) a report, which will assist in completing closure activities at the Casmalia Resources Superfund Site (Site) in Santa Barbara County, California (Figure 1.1). Specifically, this report provides the EPA and CBC with pertinent and valuable information, which will assist in completing Site closure activities despite the presence of the California red-legged frog (*Rana aurora draytonii*) and western spadefoot toad (*Scaphiopus hammondii*).

The federally protected California red-legged frog and the state Species of Special Concern western spadefoot toad, identified as the target species (Figure 1.2), currently inhabit four of the five water storage ponds at the Site. As these ponds may be drained and graded to complete Site closure activities, the EPA and CBC requested the Casmalia Team to deliver a plan for the adjacent Casmalia Creek riparian corridor that would allow for the establishment of the displaced target species (EPA 2001a).

Several constraints and assumptions, developed in conjunction with the EPA and CBC, guided the development of the Plan. The constraints and assumptions were:

1. The ponds currently at the Site will no longer be available for the target species;
2. The current populations of the target species at the Site are not chemically contaminated;
3. The EPA and CBC will ensure the proper long-term management of restored habitat; and,
4. Restoration opportunities are limited to the Casmalia Creek riparian corridor.

Based upon the EPA and CBC's request and given the aforementioned constraints and assumptions, the following project objectives are addressed in this report:

1. The likely interaction between relevant federal and state regulations guiding Site closure activities and the protection of the target species;
2. An analysis of plausible connectivity of the target species at the Site to a larger metapopulation structure;
3. The appropriate habitat to create for the target species;
4. An analysis of the availability of water for habitat creation and restoration activities;
5. A habitat creation and restoration plan designed to provide suitable habitat for the target species based upon the opportunities and constraints of the Casmalia Creek riparian corridor;

6. An evaluation of the plan to determine if it will provide suitable and sufficient habitat area to allow for the establishment of the target species displaced by draining their current habitat; and,
7. Recommendations based upon this evaluation.

The Plan does not address issues related to the possible contamination of the target species that may result from exposure to hazardous waste material present at the Site. The relationship between contamination and biological effects at the Site are unknown at this time. The EPA anticipates beginning ecological risk assessment procedures in the near future; however, timing for this assessment has not been determined.

1.2 Significance

The significance of the information provided in this report cannot be over emphasized. In determining the appropriate actions to complete Site closure activities, the EPA and CBC must comply with federal and state hazardous waste legislation as well as legislation intended to protect natural resources, specifically the target species. This report is significant as it provides the EPA and CBC with preliminary information that will assist in determining the appropriate measures for completing Site closure activities while protecting these resources.

Figure 1.1: Map indicating Casmalia Resources Superfund Site location.

Figure 1.2: Photos of the target species.

California red-legged frog *Rana aurora draytonii*	**Western spadefoot toad** *Spea hammondii* (formerly *Scaphiopus hammondii*)
	
Photo credit: Dr. Mark Jennings from Center for Biological Diversity	Photo credit: Chris Brown from USGS Western Ecological Research Center

2.0 Site History

The Site is located 4 miles from the Pacific Ocean and 10 miles southwest of the City of Santa Maria. The area surrounding the 252-acre Site is sparsely settled and land use consists primarily of agriculture, cattle grazing, and oil field development. Dry land farming and cattle ranching had been the predominant land use since at least the early 1950s. In 1973, Casmalia Resources (CR), as a single owner and operator, opened the Site as a hazardous waste treatment, storage, and disposal (TSD) facility. When the Site closed in 1989, it had accepted more than 5.5 billion pounds of industrial and commercial waste, including but not limited to: polychlorinated biphenyl (PCBs), pesticides, metals, acids, solvents, and cyanide from over 10,000 companies and organizations (EPA 2002).

During its 16 years of operation, the Site treated, disposed of, and stored hazardous wastes in storage/evaporation ponds, landfills, burial trenches, and treatment units, in addition to other management units (EPA 2001b). In 1987, contaminants were detected in groundwater within a few hundred yards of the Site (C. Cooper pers. comm. 2001). Over the next four years, CR ceased accepting waste at the Site and worked to re-open as a Resource Conservation and Recovery Act (RCRA) permitted TSD facility (URS 2001). However, in late 1991, after submitting and resubmitting applications for permits, CR abandoned efforts to obtain the necessary permits (EPA 1993a).

Subsequently, in 1992, the EPA's Emergency Response Team began stabilization and control measures at the Site (EPA 1993b). Later that year, EPA Region IX became the lead agency, taking over for the California Department of Toxic Substances Control (EPA 1996a). By 1996, the EPA had identified many of the largest Potentially Responsible Parties (PRPs). Of the largest PRPs, 51 formed the Casmalia Steering Committee (CSC), for which CBC is the primary consultant. On June 17, 1996, the CSC entered into a Consent Decree to settle a portion of their liability in exchange for their taking over Site closure activities (EPA 2001b). Table 2.1 lists the PRPs that make up the CSC.

In 1998, a species survey conducted for a National Pollution Discharge Elimination System (NPDES) Permit revealed that the target species inhabited four of the five water storage ponds at the Site (Figure 2.1) (Hunt 1999). The ponds were created before and during the Site's closure activities and occupy the southern portion of the Site. Three ponds collect surface runoff (13, A-Series, and Runoff Control Facility [RCF]). The other two ponds collect treated effluent from the liquid treatment activities at the Site (18 and A-5).

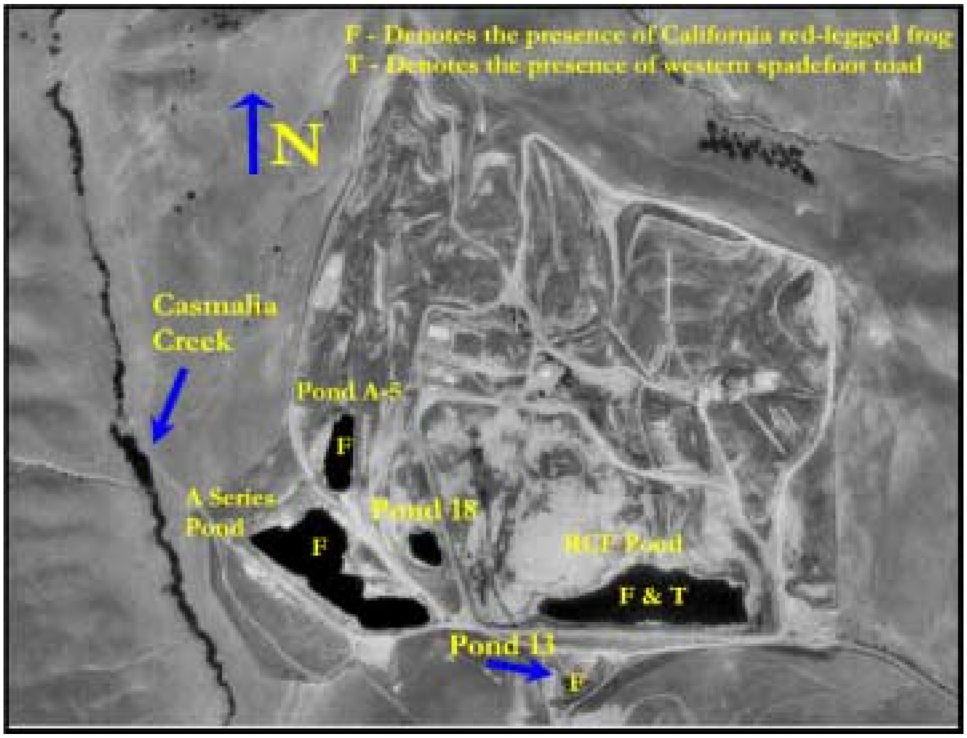
The California red-legged frog, which is a federally protected species under the Endangered Species Act (ESA) and a California Species of Special Concern, is currently making use of the RCF, A-Series, A-5, and 13 ponds (Figure 2.1) (Hunt 1999). The western spadefoot toad, listed as a California Species of Special Concern, is making use of the RCF Pond (Figure 2.1) (Hunt 1999). If during the RI/FS process it is determined that the five ponds pose an ecological threat they may be drained and graded, thereby eliminating the habitat currently utilized by the target species.

Pursuant to the Consent Decree, the EPA and the CSC are working jointly to properly close the Site in accordance with the Comprehensive Environmental Responsibility, Compensation, and Liability Act (CERCLA) and applicable federal and state regulations (*e.g.* the ESA). The Site was officially designated a federal Superfund Site on September 13, 2001. The estimated cost of closure, including costs to date, is $272 million (EPA 2002).

Table 2.1: Casmalia Steering Committee Members.

ABB Vetco Gray Inc.	Mobil Oil Corporation
Aerochem, Inc	New VICI, Inc.
Aerojet General Corporation	Northrop Grumman Corporation
Boeing North America, Inc	Oil & Solvent Process Company, a subsidiary of Chemical Waste Management, Inc.
BP America	Pacific Gas & Electric Company
Caspian/Chemical Energy if California	Pacific Offshore Pipeline Company
Chevron Corporation	The Proctor & Gamble Manufacturing Company
City of Los Angeles	Reynolds Metals Company
City of Oxnard	R.G.G.L. Corporation
Clairol, Inc.	Rhone-Poulenc Inc.
Coastal Oil & Gas Corporation	Rohr, Inc. (formerly Rohr Industries, Inc.)
Conoco Inc.	Romic Environmental Technologies Corporation
County of Los Angeles	Shell Oil Company
Deutsch Company	Shipley Company, Inc.
The Dow Chemical Company	Southern California Gas Company
Everest & Jennings Incorporated	Southern Pacific Lines
Exxon Company, USA	Square D Company
Gemini Industries, Inc.	Teleflex Incorporated
General Dynamics Corporation	Texaco Inc.
General Electric Company	Todd Pacific Shipyards Corp.
General Motors Corporation	Union Pacific Railroad
Hadco Santa Clara, Inc.	Union Pacific Resources
Hughes Aircraft Company	Unocal
Lever Brothers Company	USPCI
Lockheed Martin Corporation	Zeneca, Inc
McDonald Douglas Corporation	

Figure 2.1: Target species locations at the Casmalia Resources Superfund Site.



3.0 Legal Context

3.1 The Endangered Species Act

The Endangered Species Act (ESA) of 1973, as amended, is the federal government's primary statute for the conservation of threatened and endangered plant and animal species. The ESA intends to preserve the nation's natural heritage by conserving species that are endangered with extinction throughout all or a significant portion of their range, as well as to conserve threatened species that are likely to become endangered in the foreseeable future. The United States Department of the Interior's Fish and Wildlife Service (USFWS) and the United States Commerce Department's National Marine Fisheries Service (NMFS) are responsible for administering the ESA. Generally, the USFWS oversees activities affecting listed terrestrial and freshwater species, and the NMFS oversees listed marine and anadromous species.

For a species to become federally listed as threatened or endangered it must undergo an exhaustive review process. The determination to list a species relies upon "the best scientific and commercial data available" and without regard to economic impacts (16 U.S.C. §1533 (b)(1)). Listing protects a species against any action that may negatively affect them or their critical habitat on either federally or privately owned land. Anyone in violation of the ESA is subject to civil and criminal penalties (16 U.S.C. §1540). All federal agencies are obliged to conserve listed species and their critical habitat (16 U.S.C §1536 (a)(1)). Any action permitted, funded, or conducted by a federal agency requires consultation with the appropriate Service (USFWS or NMFS) to ensure that the action will not jeopardize listed species or adversely modify the critical habitat upon which the species depends (16 U.S.C. §1536 (a)(2)).

In certain instances, conditional exemptions are granted for actions that may adversely impact listed species or their habitat provided that the actions are "incidental to, and not the purpose of, otherwise lawful activities" and do not jeopardize the continued existence of the species (16 U.S.C. §1536). The conditional exemption process differs for non-federal and federal actions. Federal agencies are eligible for conditional exemptions per section 7 of the ESA, which involves the action agency undergoing a formal consultation process with the appropriate Service intended to minimize the impacts to protected species and their habitat (16 U.S.C. §1536 (b)).

3.1.1 The ESA's Relevance to the Site

The ESA is relevant to the Site because the potential remediation of the existing water storage ponds may adversely affect the federally threatened California red-legged frog. The potential remedial action has clear federal nexus due to the Site's Superfund status and the EPA's role as the action agency; as such, the potential activities constitute a federal action subject to section 7 of the ESA. The distinction between a federal action and the requisite section 7, and a non-federal action subject to section 10, is an important distinction as the conservation requirements under section 10 are more exhaustive requiring mandatory mitigation and the development of a Habitat Conservation Plan (HCP).

Section 7, Interagency Cooperation, mandates that consultation occur between the action agency and the appropriate Service for federal actions that are likely to affect a listed species or their designated critical habitat. The informal consultation is to notify the USFWS of the presence of a listed species and the potential action. To determine if a listed species is likely affected by the proposed action, the action agency prepares (or has prepared) a "biological assessment" (BA) that it submits to the USFWS (16 U.S.C. §1536 (c)(1)). This has not yet occurred for the Site. Failure to conduct a BA when a listed species is knowingly present is a violation of the ESA (Stanford 2001). The Site is located within a generalized Critical Habitat Unit that covers much of Santa Barbara County, but no assessment of the Site has been conducted to determine if the necessary habitat constituents are present to warrant a Critical Habitat designation.

If the USFWS determines that no adverse effect is likely, section 7 requirements are fulfilled and the proposed action may proceed. If the USFWS determines that an adverse effect is likely, the EPA must initiate formal consultation with the USFWS. If the potential remedial action at the Site includes draining and grading the existing ponds, it is probable the USFWS will determine that such an action is likely to have potentially adverse effects on the California red-legged frog, thus formal consultation will likely be required. In 1998, the EPA initiated informal consultation, notifying the USFWS of its intent to pursue formal consultation (M. Blevins, EPA, pers. comm. 2001).

Formal consultation involves thorough analyses of the proposed action and the effects of the action on the listed species and/or any critical habitat that are likely affected. This formal consultation results in the USFWS rendering a "biological opinion" (BO), which determines if the proposed action is likely to cause "jeopardy" to the continued existence of the species (as a whole) and/or substantially adversely affect critical habitat (16 U.S.C. §1536 (b)(3)). For actions deemed likely to cause "jeopardy" to the species or adverse modification of critical habitat, the USFWS must identify "reasonable and prudent" alternatives that would minimize or avoid jeopardy to the species throughout implementation of the action (16 U.S.C. §1536 (b)(3)).

If the BO results in a "no jeopardy" determination, the action may proceed. The BO contains an Incidental Take Statement (ITS) that may allow for specified levels of "take" of a listed species or a specified level of habitat modification otherwise prohibited by section 9 of the ESA (Stanford 2001). Section 9 of the ESA prohibits acts that might result in the "take" of any listed individuals. The ESA defines "take" to mean "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (16 U.S.C. § 1532(19)). USFWS regulations define harm as "significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering" (50 C.F.R. 17.3 1994). The United States Supreme Court interpreted that indirect harm, such as habitat modifications, that leads in a "proximate and foreseeable" manner to the actual death or injury to an identifiable member of a listed species constitutes a violation of the ESA (Sweet Home Chapter of Communities for a Great Oregon v. Babbitt. 17 F. 3d 1463 (D.C. Cir. 1994)).

In order to be eligible to receive an ITS, the proposed action must: 1) not jeopardize the continued existence of the listed species or adversely modify designated critical habitat, 2) result from an otherwise lawful activity, and 3) be incidental to and not the purpose of the proposed action (USFWS 1998). The ITS exemption remains valid only if the action agency (at the Site this is the EPA) and/or applicant (at the Site this is the CBC) demonstrate clear compliance with the implementation terms and conditions of the binding reasonable and prudent measures identified to minimize the impact of the incidental take on the species (USFWS 1998). The reasonable and prudent alternatives may only include actions within the action area (interpreted to include a footprint area that may extend beyond the boundaries of the actual action area), involve only minor changes to the project, and must reduce the level of take (USFWS 1998). Defining what constitutes a "minor change" is discretionary, and the USFWS is likely to interpret this effect differently depending upon the situation (e.g. a $200,000 alteration to an action may be minor on a multi-million dollar project, but prohibitive to a small-scale farmer) (USFWS 1998).

Section 7 requires minimizing the impact of the incidental take, but it cannot require mitigation (USFWS 1998). The Service should assist in integrating the section 7 consultation processes within the action's overall environmental compliance (USFWS 1998). Additionally, per section 7, the USFWS may make non-binding conservation recommendations apart from the reasonable and prudent alternatives identified in the ITS. The action agency, not the Service, "has the ultimate responsibility for insuring that the agency action does not jeopardize a species or destroy or adversely modify its habitat." (Stanford 2001). Appendix 2 (Endangered Species Act – Section 7) presents a more detailed discussion of section 7.

3.2 California Species Protection Laws

The State of California has a variety of laws and regulations that provide for the conservation of flora and fauna species. The level of protection afforded to a species varies depending upon the status of the species, as designated by the California Department of Fish and Game (CDFG). The California Endangered Species Act (CESA), analogous to the federal ESA, provides for the protection of state-designated threatened and endangered species. Additionally, protective measures may be provided for species that are designated as Fully Protected. The Fully Protected status stems from the state's initial 1960 species conservation law, and many of the species granted Fully Protected Status became subsequently listed as threatened or endangered with the adoption of the CESA.

Vertebrate species not listed under the ESA or CESA that have declining population levels, limited ranges, and/or continuing threats that make them vulnerable to extinction may be designated as Species of Special Concern by the CDFG (CNDB 2001). The Species of Special Concern designation does not entail any specific legal protection requirements. Rather, it is intended to generate special consideration for these species to halt or reverse their decline by calling attention to their plight and addressing the issues of concern early enough to ensure their long term viability and avoid state or federal listing (CNDB 2001).

3.2.1 California Species Protection Laws Relevance to the Site

The target species are designated as Species of Special Concern. There is no legal consequence within the California Code of Regulations or the California Fish and Game Code linked to this designation (S. Adams, CDFG Counsel, pers. comm. 2002) Additionally, the draining of the ponds is a federal action and is unlikely that state permits relating to the target species will need to be obtained. Therefore, at the state level there is no enforceable protection of the target species or their habitat triggered by the Site closure activities. However, any relocation involving the target species is subject to compliance with CDFG regulations.

3.3 The Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) is the federal government's primary program for addressing the cleanup of abandoned and uncontrolled hazardous waste sites, and recovering the response costs. A substantial expansion of CERCLA occurred with the Superfund Amendments and Reauthorization Act (SARA) of 1986; subsequently, the program became referred to as Superfund. The goal of the program is to reduce the release or threat of release of hazardous substances, pollutants, and contaminants that pose a danger to human health or the environment. The National Contingency Plan outlines the cleanup response, designates the roles of federal, state, and local agencies, and establishes cleanup procedures and guidelines.

Under CERCLA, the federal government is entitled to hold the Potentially Responsible Parties (PRPs), including current landowners, certain former landowners, transporters, and generators of the hazardous waste, liable for the response costs of clean up. The PRPs may be liable for the lost economic value of damaged resources. Recovered funds may be utilized by the Natural Resource Trustees to finance mitigation and restoration plans. The EPA evaluates and ranks sites and places those posing the most significant threat on the National Priority List (NPL). Site on the NPL are regulated under Superfund.

Under CERCLA, the EPA has broad discretionary powers in developing a site-specific response strategy. CERCLA is divided into two broad categories of response actions: emergency actions that 1) address immediate, short-term, life-threatening hazardous wastes; and, 2) remedial actions that require long-term cleanup but do not pose an immediate threat to human life. For remedial actions, the EPA conducts a series of steps to evaluate a site in order to determine the appropriate response. An outline of this process is provided in Figure 3.1. CERCLA does not contain specific cleanup standards, but rather defers to all "applicable or relevant and appropriate requirements" from other environmental statutes such as the Clean Air Act and Clean Water Act, among others (40 C.F.R. § 300).

3.3.1 CERCLA's Relevance to the Casmalia Resources Superfund Site

The 1996 Consent Decree between the EPA and the CSC established the long-term cleanup and containment objectives and identified four phases of work to complete over the next 60 years. In 2001, the Site was added to the National Priority List and was designated a Superfund site, thus becoming eligible for additional long-term funding for cleanup activities. The CSC, with the oversight of the EPA, is currently conducting the RI/FS. The RI/FS will aid in the determination of a remedy for site-wide cleanup and containment. One of the potential remedial actions involves draining and grading the existing water storage ponds currently occupied by the target species.

There are nine primary criteria the EPA uses to select the preferred remedy, the foremost of these require that the remedy must be protective of human health and the environment, and must comply with the applicable or relevant and appropriate requirements (ARARs) of federal or state laws, or warrant a waiver recognized by the statute (40 C.F.R. § 300.430). The CERCLA manual clearly indicates that remedy actions must comply with the ESA (EPA 1989).

Additionally, the nine criteria evaluation of the remedy alternatives includes an assessment of the "state acceptance" of the alternative (40 C.F.R. §300.430). The state's concerns are considered, as is the state's official position on the preferred alternative (40 C.F.R. §300.430). Additionally, the public comment period requires a consideration of the state's interests. Thus, the state's interests are a significantly factored into the remedy selection under CERCLA. A remedy that negatively affects a state or federally threatened and/or endangered species and/or Species of Special Concern and does not provide for any species enhancement, such as habitat creation, is more likely to be opposed by the state.

3.4 ESA and CERCLA Interaction

The potential for conflict between the ESA and CERCLA exists because in fulfilling their primary objective the two statutes may otherwise mandate mutually exclusive actions. The potential conflict at the Site would occur if remedial action adversely affects the California red-legged frog. Though unusual, the situation is not unique, as federally listed species inhabit a number of Superfund sites and other sites under EPA jurisdiction. Very little information is available regarding the interaction between CERCLA and the ESA, and no significant case law between the two exists to establish a clear precedence. However, according to former NMFS regional director William Stelle Jr., "it is entirely possible conceptually, legally and scientifically to nest the ESA objectives into the broader environmental objectives of CERCLA" (Steele 2001).

The ESA promotes the conservation of protected species above nearly all other considerations (Turner 1999). Federal agencies have a duty to conserve listed species, and the courts have affirmed this obligation even in instances when doing so may be contrary to the agency's primary mission (*Carson-Truckee Water Conservation District v. Watt* 549 F. Supp. 704 (E.D. Cal 1983), affirmed 741 F 2. *Pyramid Lake v. Navy* d 257 (9th Cir. 1984), 898 F 2d 1410 (9th Cir. 1990)). In comparison, CERCLA grants the EPA relatively broad discretionary power in setting cleanup standards that provides opportunity within the RI/FS process to incorporate the requirements of the ESA, such as the Biological Assessment (Stelle 2001). The impediments to cross-compliance have been characterized as technical, not legal, and the EPA's ability to develop site-specific clean-ups standards present a "powerful opportunity" to blend the objectives of CERCLA and the ESA (Stelle 2001).

CERCLA actions must comply with the ESA and interagency consultation is required when a listed species is present (EPA 1989). As discussed, the ESA allows conditional exemptions for federal agencies per section 7. Previous cases of agency interpretation indicate that there is relatively greater flexibility granted to remedy selection under CERCLA, in comparison to the more rigid species protection requirement of the ESA. This suggests that in a conflict between the two, "protected species should be the odds-on winner" (Turner 1999). This is not likely to be the case in instances when human health is imminently threatened. However, it seems unlikely that the existing storage ponds at the Site constitute an imminent human-health risk.

The presence of a listed species is likely to have a significant affect on selecting and conducting the remedy and "may result in a cleanup that would be considered less than optimal under other conditions" (Turner 1999). Thus, it may be that the typically preferred cleanup method is altered or potentially abandoned to avoid adversely affecting an endangered species or adversely modifying its habitat (Turner 1999). This assertion seems supported by the remedy selection process followed at other Superfund sites in California and Guam, where the presence of listed species has affected the remedy selected (See Andersen Air Force Base, Guam, Concord Naval Weapons Station, Ca., Midway Atoll, Iron Mountain Mine, Ca, Rhone-Poulenc/Zoecon Corp. East Palo Alto, Ca., Whittier Narrows Operational Units, Ca.). Additionally, sites under EPA administration in Hawaii and Midway Atoll have also had their cleanup remedies altered by the presence of listed species (M. Ripperda, EPA, pers. comm. 2001)

Therefore, in conducting the RI/FS and selecting the preferred remedy, the EPA and CBC must recognize the significant protection granted to listed species by the ESA. If formal consultation with the USFWS proceeds as anticipated, the jeopardy/no jeopardy determination in the BO will affect the remedy selection. If a no jeopardy determination is rendered, a section 7 conditional exemption may allow the EPA and CBC to proceed with the elimination of the water storage ponds, but will be required to implement the reasonable and prudent alternatives to minimize take of the California red-legged frog. Early and ongoing consultation with the USFWS to address and incorporate ESA requirements within the RI/FS process will improve the likelihood of allowing Site closure activities to proceed in a manner that achieves the objectives of the ESA and CERCLA as well as the EPA and the CSC.

Figure 3.1: The Superfund process.

Site Discovery	***NPL Ranking /Listing***	***Remedial Investigation (RI)***	***Feasibility Study (FS)***	***Public Comment Period***	***Record of Decision (ROD)***	***Remedial Design***	***Remedial Action***	***5 – Year Review***	***NPL De-listing***
Evidence of potential contamination is reported.	Site Placed on EPA's National Priority List, making it eligible for cleanup action under Superfund.	EPA investigates nature and extent of contamination.	EPA identifies and analyzes alternatives for addressing site contamination.	The public comments on alternatives, during a formal comment period. The EPA considers these.	EPA documents the selected remedy in the ROD.	EPA oversees development of detailed specifications for the selected remedy.	EPA oversees the construction and operation of the remedy.	EPA reviews the effectiveness of the remedy every five years during the cleanup process.	EPA removes the site from the Superfund (NPL) List when cleanup goals are achieved.

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Community Involvement and Enforcement Activities occur throughout the Superfund Process

Modified from EPA 2001 Casmalia Newsletter

4.0 Metapopulation Considerations

It is essential to recognize that the potential elimination of habitat provided by the water storage ponds may have implications on the target species that extend beyond the Site, possibly affecting metapopulation dynamics. The California red-legged frog and the western spadefoot toad typically exist within a metapopulation that consists of various subpopulations distributed across the landscape. These subpopulations differ in their reproductive success as well as their persistence. The interaction between the local subpopulations is essential for the persistence of some species at the regional scale (Hanski 1999). Dispersal ability of the target species and the connectivity of habitat patches are important factors influencing the metapopulation dynamics. In evaluating remedy selection alternatives and in creating and restoring habitat, it is important to consider the potential role of the target species at the Site within a metapopulation and to consider the spatial context of other potential subpopulations that may exist within the surrounding area.

4.1 Metapopulation Theory

The metapopulation paradigm is based upon the concept that within a larger population there may be a distinguishable subset of local populations (or subpopulations) that interact via dispersal of individuals (Hanski 1999). Local subpopulations may experience extinction and subsequent recolonization, a process likened to a “blinking light” (Harrison and Taylor 1997). Though subpopulations are largely reproductively isolated from one another, migration between subpopulations is important for the recolonization of extirpated habitat patches as well as the exchange of genetic material (Hanski 1999). Extinction and colonization rates depend on the number and size of local subpopulations and the degree to which they are isolated from one another. Isolated populations are particularly vulnerable to extinction events due to random environmental events and anthropogenic impacts (Soulé 1987). A subpopulation that exists in a relatively large habitat area, or habitat patch, typically has a lower risk of extinction than smaller patches. The distribution and abundance of subpopulations may expand and contract over time in a very dynamic process due to deterministic processes (*e.g.* predation and competition by exotic predators, habitat degradation, and pond succession) or stochastic processes (*e.g.* drought) (Marsh and Trenham 2001). Through time, individual subpopulations face a high probability of extinction events and therefore, ultimately, the regional persistence of species relies upon dispersal between the local subpopulations within the metapopulation (Hanski 1999). Not all species conform to metapopulation theory, but many pond-breeding amphibians, including the target species, have breeding and dispersal habits that are characteristic of species functioning in a metapopulation (Marsh and Trenham 2001).

Subpopulations will differ in their reproductive success and may be categorized into either source or sink populations. Source subpopulations exist in favorable habitats that produce a greater number of young than that habitat can support, which results in the "excess" young dispersing to habitats that are less populated or unoccupied. Source populations are essential to maintaining the metapopulation. Conversely, sink subpopulations exist in less favorable habitats and are unable to produce sufficient young necessary to sustain populations without immigration from the source population(s). Habitat containing sink populations is capable of supporting individuals (even large numbers of individuals) but is lacking resources, breeding habitat, or some other component necessary for successful breeding that is sufficient to maintain the population through time (Bush 2000). Nevertheless, sink populations are valuable as they increase the total number of individuals within a metapopulation and in doing so maintain individuals that may be critical for recolonizing subpopulations that experience extinction events (Bush 2001). Patch habitats may also provide an important function in dispersal acting as stepping-stone habitats between subpopulations (Smith and Gilpin 1997).

As discussed above, contiguity or connectivity of habitat patches affects the extent of interaction between subpopulations. The colonization and self-sustainability of amphibians in created wetlands depends upon the ability of source populations to disperse into these wetlands (Richter *in litt.* 2001). Colonization rates depend upon a number of factors, including isolation from other habitat, terrain characteristics, site fidelity, size of the source population, and dispersal ability (Pechmann *et al.* 2001). In habitats of equal quality and similar characteristics, dispersal to and colonization of created wetlands decreases as a negative exponential of distance from source populations (Richter *in litt.*. 2001). Large patches or subpopulations connected through dispersal to other subpopulations are more likely to persist. Furthermore, small isolated patches have a higher chance of remaining unoccupied. As a result, subpopulations that are more persistent may serve as sources that help colonize small sink populations that have high rates of extinction.

In a metapopulation structure, local or even regional extirpations are common; however, dynamic recolonization events maintain populations over wide areas (Jennings 1996). Anthropogenic habitat destruction and isolation of habitat by roads and urban development has reduced the ability of local source populations to recolonize extirpated sink populations (Jennings and Hayes 1994) and habitat fragmentation and degradation may have transformed former source populations into sink populations. The dynamic nature of metapopulation systems indicates the importance of conserving both aquatic and terrestrial habitat. Amphibian conservation efforts that focus solely on ponds, without adequate consideration of terrestrial habitat are likely to fail to maintain viable populations (Marsh and Trenham 2001).

4.2 Dispersal, Connectivity, and Persistence

Many amphibians disperse to and from habitat patches in response to a variety of factors, including: population pressure, breeding needs, seasonality, and other potential causes. Currently, the movement and dispersal patterns of the target species are not well characterized. Dispersal ability has important implications on the amount of interaction occurring between subpopulations. A number of frog and toad species, including the California red-legged frog, have been observed to disperse between habitat patches in straight-line movement that indicate a clear directional movement toward the target destination (Bulger 1999, USFWS 2000). The extent of dispersal between habitat patches and colonization rates may vary subject to factors such as terrain, presence of barriers, and local climate, specifically temperature and moisture conditions. The rate of dispersal is also a function of many variables including: the degree of site isolation, metapopulation density, and carrying capacity (Bulger 1999). Research also indicates that target species dispersal distance is dependent upon habitat availability and environmental conditions (Scott and Rathbun 1998). The dispersal capability of the target species will depend to varying degrees upon the aforementioned factors, and therefore it is difficult to estimate true migration or dispersal ability.

The movement and dispersal patterns of the California red-legged frog are not thoroughly characterized. However, research by John Bulger in collaboration with Norman Scott and Richard Seymour on adult California red-legged frogs in Santa Cruz County provides some of the most comprehensive information on movement and dispersal patterns (Bulger, Scott, and Seymour 1999). They categorize movement into non-dispersal and dispersal events. Non-dispersal movements are typically short forays into upland habitats, with a return to the initial habitat. These non-dispersal movements typically occur in response to rain events, and may last for days to weeks. They observed 90% of individuals within 40 meters of water during the summer months (with most within 5 meters during dry periods) and within 60 meters of water during the early winter months. Dispersal events were characterized as movements between breeding sites, typically over longer distances and time periods. They found that adults typically dispersed in spurts of 150–500 meters per day, interspersed with several days of idleness. The same study found individuals dispersed during the wet season from 400 – 3200 meters over a time-period ranging from 3 – 60 days, the furthest point-to-point distance between patches was 2.8 kilometers, the furthest movement without aquatic habitat was 1.2 kilometers, and the furthest distance traveled into the uplands was 500 meters. They estimate that less than 25% of adults disperse annually.

Adult California red-legged frogs typically do not move extensive distances from aquatic habitat during dry periods (USFWS 2000). In coastal regions, the California red-legged frog demonstrates active movement throughout the year (Bulger, Scott, and Seymour 1999). Individuals apparently disperse with little regard to topography, vegetation type, and habitat corridors (USFWS 2000). Surveys in San Luis Obispo indicated that individuals dispersed over upland habitat for approximately 1.6 kilometers over the wet season (USFWS 2000). Studies in San Luis Obispo County indicated a dispersal distance of 2.8 kilometers traveled in only 32 days (Rathbun and Schneider 2001). At Vandenberg Air Force Base (VAFB) in Santa Barbara County, restoration project surveys indicate that a California red-legged frog dispersed up to 3 kilometers over dune swale terrain (T. Mullen pers. comm. 2001). In a review of previous research, Bulger indicates that persuasive evidence that suggests dispersal by post-metamorphic anurans contributes more to local population persistence than adult dispersal (Bulger, Scott, and Seymour 1999).

There is little published data on the dispersal and movement patterns of the western spadefoot toad. Researchers believe that little movement occurs during most of the year, and the species typically travels only minimal distances to breeding sites (Morey 2001). However, UCSB Professor Sam Sweet observed the western spadefoot toads up to 1 kilometer from breeding pond locations (S. Sweet, UCSB, pers. comm. 2001) and it has been indicated individuals are known travel up to 3.2 kilometers towards breeding sites (M. Wehtje, CDFG, pers. comm. 2001). Therefore, while the literature indicates movement of the species is typically limited, observations indicate that individuals are capable of dispersing significant distances.

The target species utilize both riparian and upland areas during dispersal. The extent to which the target species rely upon migration corridors is not clear, and there is insufficient evidence to conclude that the target species utilize corridors preferentially to alternative upland habitat. However, researchers indicate that when direct corridors are "obvious", they are likely to be commonly utilized (Bulger, Scott, and Seymour 1999). Though they may not be imperative for dispersal, riparian corridors may facilitate migration between habitat patches in addition to providing important forage and seasonal habitat (USFWS 2000). Researchers observed California red-legged frogs in creeks more than 3 kilometers from breeding sites (USFWS 2000). Although Casmalia Creek is not likely provide suitable breeding habitat for the target species, due to its degraded state, California red-legged frogs have been observed in Casmalia Creek (T. Carson and C. Minton, UCSB, pers. obs. 2001) and the creek may serve as a direct corridor connecting populations at the Site with populations in Shuman Creek (Hunt 2000).

4.3 The Site within the Landscape Context

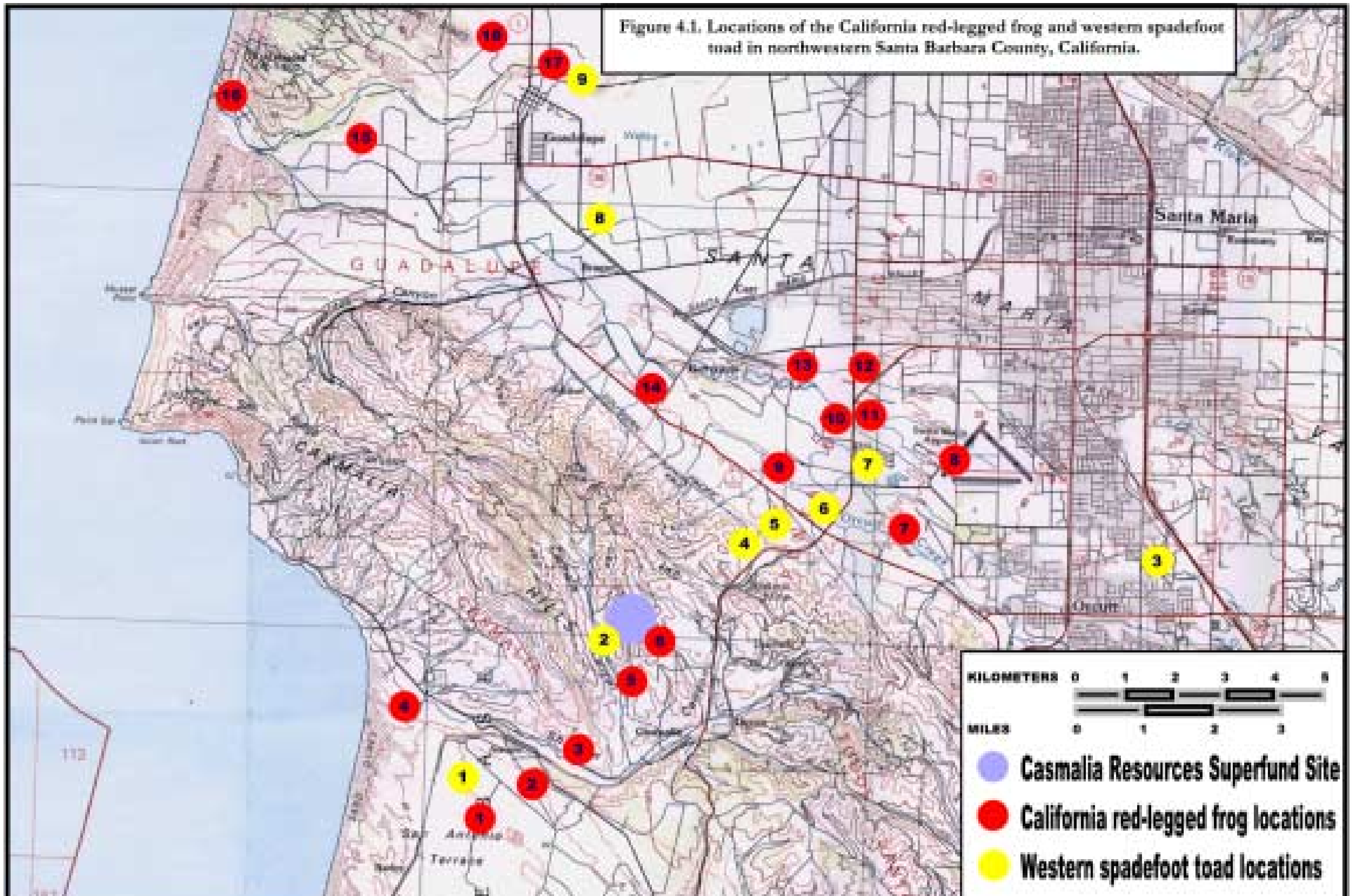
Limited species surveys have been conducted at the Site and in the surrounding region. Observations at the Site indicate that individual California red-legged frogs move between the existing water storage ponds (L. Roberts, USFWS, pers. comm. 2001). There is insufficient data available on the size of the population at the Site no data regarding the extent of dispersal, if any, which occurs between the Site and local subpopulations. However, observations indicate that California red-legged frogs is known to occur in Casmalia Creek and Shuman Creek, with breeding populations observed in Shuman Lagoon (EPA 1996b, Hunt 2000). Research by Sue Christopher of the University of California, Santa Barbara led her to conclude that San Antonio Creek and San Antonio Terrace are likely to be among the most productive areas for the California red-legged frog in Santa Barbara County (Christopher 1996). A substantial number of individuals from San Antonio Terrace are likely to disperse into Shuman Creek (Christopher 1996) and subsequently may disperse into Casmalia Creek. In order to assess potential subpopulations surrounding the Site, the some of the known locations of the target species within the surrounding area were cataloged. The boundaries of the area considered were the Santa Maria River to the north, the San Antonio Creek to the south, California Highway 101 to the east, and the Pacific Ocean to the west. (Figure 4.1, Tables 4.1 and 4.2). The sources of information regarding the locations of the target species include the California Natural Diversity Database (CNDDB), observations by local biologists, and USFWS records.

4.4 Plausibility of Metapopulation Connectivity

It has been observed that the maximum dispersal distance of an individual of both target species is at least 3 kilometers (USFWS 2000, M. Wehtje, CDFG, pers. comm. 2001). The amount of connectivity between potential subpopulations surrounding created and restored habitat is an important consideration in analyzing the metapopulation. Populations or individuals of the target species located in the Santa Maria area are unlikely to be connected to those currently at the Site because of distance and barriers to dispersal. Urban development fragments much of the existing habitat in the Santa Maria area. A crude picture of the metapopulation structure can be obtained by assuming that subpopulations that are within a 3 kilometer radius of other subpopulations are connected.

The California red-legged frog has been observed in Casmalia Creek (T. Carson and C. Minton, UCSB, pers. obs. 2001) and Shuman Creek (EPA 1996) (Figure 4.1, #3, #5). Due to the proximity of the Site to Casmalia Creek and the absence of dispersal barriers, it is highly probable the populations of the target species at the Site are connected to Casmalia Creek. Casmalia Creek flows into Shuman Creek, 3 kilometers south of the Site, and movement between California red-legged frogs in Shuman Creek and Casmalia Creek is likely. The San Antonio Terrace, south of the Site, contains western spadefoot toad populations and is among the most productive areas for the California red-legged frog in Santa Barbara County (Figure 4.1, #1 and #2) (Christopher 1996). California red-legged frogs from this area are thought to disperse to nearby Shuman Creek (Christopher 1996), and may subsequently disperse to Casmalia Creek. As it is highly probable that California red-legged frogs in Shuman Creek are connected to the population at the Site, it is plausible that the Site population is connected to a highly productive area. Western spadefoot toad populations also exist on the San Antonio Terrace on VAFB (Figure 4.1, #1 and #2), and are therefore considered potentially connected to the population currently at the Site as well. Therefore, in evaluating remedy selection alternatives and in creating and restoring habitat, it is important to consider the plausible interaction of the target species at the Site with other subpopulations in the area.

Figure 4.1. Locations of the California red-legged frog and western spadefoot toad in northwestern Santa Barbara County, California.



Note: Numbers correspond to California red-legged frog and western spadefoot toad locations obtained from the California Natural Diversity Database, local biologists, and the United States Fish and Wildlife Service.

Table 4.1: Locations of California red-legged frogs in northwestern Santa Barbara County, CA. (Refer to Figure 4.1)

Site	USGS 7.5-minute Quadrangle	Location	Individuals Observed	Approximate Distance from the Site (km)	Year of Observation	Source
1	Casmalia	VAFB	75+	5.5	Known extant	S. Christopher (UCSB)
2	Casmalia	San Antonio terrace; south of Shuman Creek.	1 juvenile; many tadpoles	4.0	1997	CNDDB
3	Casmalia	Shuman Creek	Undetermined	3.0	1998	M. Blevins (EPA)
4	Casmalia	Shuman Lagoon at the mouth of Shuman Creek	3 adults	6.0	1996	EPA 1996
5	Casmalia	Casmalia Creek	1 juvenile	1.0	2001	Authors (UCSB)
6	Casmalia	Casmalia Resources Superfund Site	Undetermined	0.0	Known Extant	M. Blevins (EPA)
7	Orcutt	Orcutt Creek	Undetermined	6.5	2002 extant	B. Fahey (USFWS)
8	Santa Maria	Santa Maria Airport	Undetermined	8.0	2002 extant	B. Fahey (USFWS)
9	Santa Maria	Laguna County Sanitation District Property East of Hwy 1; South of Betteravia	Undetermined	4.5	2002 extant	B. Fahey (USFWS)
10	Santa Maria	Black Road, SE of the town of Betteravia	Undetermined	6.5	2002 extant	B. Fahey (USFWS)

km – kilometer

Continued on next page

Table 4.1: Continued

Site	USGS 7.5-minute Quadrangle	Location	Individuals Observed	Approximate Distance from the Site (km)	Year of Observation	Source
11	Santa Maria	Just south of Black Road and Mahoney Road intersection.	1 adult 1 juvenile	7.0	1995	CNDDB
12	Santa Maria	Intersection of Green Canyon and Black Road, 0.5 mi. north of Mahoney Rd.	1 adult	8.0	1995	CNDDB
13	Santa Maria	Santa Maria vernal pool complex	Undetermined	7.0	2002 extant	B. Fahey (USFWS)
14	Casmalia	Just east of Hwy 1; due north from Casmalia Resources Site across Hwy 1.	Undetermined	5.5	2002 extant	B. Fahey (USFWS)
15	Guadalupe	Unocal Property	6 adults	12.5	1995	CNDDB
16	Point Sal	Guadalupe Dunes Complex, at the mouth of the Santa Maria River	Undetermined	15.0	1998; Known extant	V. Bloom (USFWS)
17	Santa Maria	Santa Maria River; approx. 3 mi. downstream of Hwy 1 river crossing.	3 adults	13.0	1995	CNDDB
18	Santa Maria	0.5 mi. north of the Santa Maria River channel; 2.7 mi. west of Hwy 1.	1 adult	13.5	1995	CNDDB

km - kilometer

Table 4.2: Locations of the western spadefoot toad in northwestern Santa Barbara County, CA. (Refer to Figure 4.1)

Site	USGS 7.5-minute Quadrangle	Location	Individuals Observed	Approximate Distance from the Site (km)	Year of Observation	Source
1	Casmalia	VAFB	Undetermined	5.0	2002 extant	N. Francine (SAIC).
2	Casmalia	Casmalia Resources Superfund Site	1 adult	0.0	1998	L. Hunt (Hunt & Associates)
3	Santa Maria	2.5 mi. north of intersection of Clark Ave.; north east of city of Orcutt.	7 tadpoles	6.5	1995	CNDDB
4	Guadalupe	0.3 mi. northwest of Lompoc-Casmalia Rd. and Pacific Railroad tracks.	Egg masses reported	9.0	1986	CNDDB
5	Guadalupe	0.5 mi. northwest of intersection of Airox Rd. and Lompoc-Casmalia Rd.; 4 mi. east of Casmalia	1 tadpole	3.0	1995	CNDDB
6	Guadalupe	Hwy 1 & West Black Rd.	2 tadpoles	4.0	1995	T. Mullen (SAIC).
7	Guadalupe	VAFB	Undetermined	5.0	2002 extant	S. Christopher (UCSB)
8	Santa Maria	2.3 mi. southeast of Betteravia Rd. and Hwy 1 intersection.	Undetermined	11.5	1986	CNDDB
9	Santa Maria	0.3 mi. southeast of intersection of Dutard Rd. and Black Rd.; west of Santa Maria Airport.	1 tadpole	13.0	1995	CNDDB

km – kilometer

5.0 Habitat Requirements

This section of the Plan identifies the breeding and non-breeding habitat requirements of the California red-legged frog and the western spadefoot toad. This information provides the rationale for the recommended habitat to create and restore within the Casmalia Creek riparian corridor. Appendix 4 (Western Spadefoot Toad) and Appendix 5 (California Red-legged Frog) provide a detailed description of the biology and ecology of the target species.

5.1 Breeding Habitat

The target species require water for breeding activities and for the complete development and metamorphosis of larvae into juveniles. The depth and duration of water required for breeding and development differ for the target species.

5.1.1 California red-legged frog

Biologists characterize the California red-legged frog as a "pond-dwelling frog", as breeding and development typically occurs in ponds, deep pools and slow backwater regions within creeks and streams (Storer 1925). Breeding and larval development has also been observed in marshes, lagoons, dune ponds, and a variety of other natural and "man-made" aquatic habitats (USFWS 2000). The preferred breeding habitat of the California red-legged frog is often characterized by a mosaic of open water with submerged, emergent, or dense riparian vegetation within freshwater ponds or along slow-moving creeks (USFWS 2000, Jennings 1988). These areas provide habitat for foraging, predator avoidance, breeding, and larval development. Both shallow water and deep-water areas provide necessary habitat. Larvae, juveniles and adults often occupy different regions and depths of aquatic habitats. As such, spatial and vegetative heterogeneity is important for allowing individuals of different life stages to inhabit the most suitable areas.

The California red-legged frog commonly breeds in ponds with a depth of at least 0.7 meters (Jennings and Hayes 1989). Shallow water regions provide habitat important for breeding and larval development (Jennings and Hayes 1994). Egg masses are typically located in shallow water zones and larval and juvenile development generally occurs in water less than 1 meter deep (Jennings and Hayes 1994). The California red-legged frog seems to preferentially select warm-water regions greater than 20 centimeters in depth for breeding (USFWS 2000). Emergent vegetation is required for egg laying and egg attachment (USFWS 2000). Spatial and vegetative heterogeneity also provide a range of microclimates that may be beneficial in providing a temperature regime conducive to the growth and development of larvae. Larvae often reside in shallow unshaded regions, as these typically allow for higher temperatures that enhance their growth and larval development (USFWS 2000).

Aquatic habitat with deep-water regions greater than 1 meter in depth provide the California red-legged frog with an escape refuge that enables them to dive to avoid a variety of common predators, such as bullfrogs and wading birds (USFWS 2000). These deeper portions may also contain significant aquatic vegetation that provides additional protection from predators. In addition, deeper portions of ponds increase the overall storage of water and extend the duration of available water during periods of little or no rainfall.

Researchers at VAFB in northern Santa Barbara County observed California red-legged frog breeding and development typically beginning in late January and February (Christopher 1996). Along the central coast of California, development typically lasts from March through July (USFWS 2000). In order to prevent desiccation of larvae, tadpoles require a minimum water depth of 20 centimeters throughout their development (USFWS 2000).

Though they are often associated with riparian habitats, the USFWS, in the California red-legged frog Draft Recovery Plan, identify streams as risky sites for eggs and tadpoles. This risk to eggs and tadpoles is due to the effects of high velocity flows that can negatively affect reproductive success of the target species by precluding breeding, limiting fertilization success, dislodging or otherwise damaging eggs or vegetation, and displacing larvae (USFWS 2000). High flow events occurring while eggs and larvae are in the creek could result in significant washout and mortality.

5.1.2 Western spadefoot toad

The western spadefoot toad generally breeds in temporary rain pools or shallow portions of ponds, typically only 2.5 – 41 centimeters deep (Childs 1953, Stebbin 1959, S. Sweet and S. Christopher, UCSB, pers. comm. 2001). This species may also utilize pools within ephemeral streams (Storer 1925). The species typically does not breed well in creeks or streams and prefers quieter waters as the males need to remain in one location while vocalizing to attract females and to successfully breed (S. Sweet, UCSB, pers. comm. 2001). The temporary pools utilized may only persist for several weeks. However, pools with longer durations may improve reproductive success and may improve juvenile fitness (Morey 1996). Along the central coast of California, western spadefoot toad breeding and larval development typically occurs from late February through July (Burgess 1950, Feaver 1971). At VAFB, spawning activity was observed in late January through February, and researchers typically found egg masses located in sparsely vegetated, shallow, shelf areas of pools and ponds (Christopher 1996).

5.2 Non-Breeding Habitat

5.2.1 California red-legged frog

Following larval development, the California red-legged frog does not require a permanent water source (USFWS 2000). However, this species may complete its entire lifecycle in aquatic habitat and is rarely found far from water during the dry season (USFWS 2000). Individuals commonly utilize riparian and upland habitat, which may provide important non-breeding benefits for the California red-legged frog (USFWS 2000). These benefits include, but are not limited to, additional foraging and predator avoidance habitat, as well as potentially aiding as dispersal corridors (USFWS 2000). In addition, riparian habitat can be very important during the dry season (Rathbun in USFWS 2000), as ponded habitat may be ephemeral in the more arid regions of its range, such as Santa Barbara County.

Creeks with still or slow moving water, which also provide deep-water regions conducive to predator avoidance, provide habitat commonly utilized by the California red-legged frog. The highest densities of California red-legged frogs are associated with riparian willow communities (Jennings and Hayes 1989). Research indicates this species spends considerable time resting and feeding in riparian vegetation (USFWS 2000). Observations indicate the California red-legged frog may reside in dense riparian vegetation 30 meters from water for up to 77 days (Rathbun in USFWS 2000). Riparian vegetation is likely to provide foraging habitat and increase the number of insect and invertebrate species commonly preyed upon by the California red-legged frog, as well as providing additional resources to support the food web (USFWS 1999).

Previous research on the California red-legged frog in Santa Cruz County indicates the importance of vegetated buffer zones of 50-100 meters around aquatic habitat (Bulger 1999). This research indicated that 90% of non-dispersing adults were within 60 meters of the water source (Bulger 1999). The researchers concluded that providing patches of dense, shrubby and herbaceous vegetation as well as woody debris within this buffer zone is likely to significantly enhance conservation efforts for the California red-legged frog. Observations indicate that dispersing individuals take shelter under upland shrubs (Rathbun and Schneider 2001).

Dense vegetation will provide important protection from terrestrial predators of the target species, including raccoons (*Procyon lotor*), stripped skunks (*mephitis mephitis*), spotted skunks (*spilogale putorius*), opossums (*Didelphis virginiana*) and wading birds such as blue herons (*Ardea herodias*), American bitterns (*Botarus lentiginosus*), and black-crowned night herons (*Nycticorax nycticorax*) (USFWS 2000).

5.2.1 Western spadefoot toad

After breeding, the western spadefoot toad is terrestrial, and retreats to upland burrows for the majority of the year (Jennings and Hayes 1994). The preferred non-breeding habitat of the western spadefoot toad is low-lying grassland, brushland, or deciduous woodland near quiet pools or streams (Stebbins 1959). Upland habitat must be conducive to burrowing, although they may utilize burrows of other animals (Stebbins 1951).

5.3 Vegetation Requirements

The target species utilize a variety of vegetation for both breeding and non-breeding purposes. The western spadefoot toad requires only sparse emergent vegetation for breeding and egg-attachment, whereas the California red-legged frog typically utilizes denser vegetation both for breeding purposes as well as predator avoidance. The breeding pools used by the western spadefoot toad at VAFB are typically vegetated by spike rushes (*Eleocharis sp.)*, sedges (*Carex sp.*), cattails (*Typha sp.*), bulrushes (*Scirpus sp.*) and various grasses (S. Christopher pers. comm. 2001). The California red-legged frog utilizes similar vegetation for breeding, and dense riparian vegetation, such as arroyo willows (*Salix lasiolepis*), cattails (*Typha sp*.), and bulrushes (*Scirpus sp*.) (Jennings and Hayes 1994, USFWS 2000). This vegetation provides refuge from predators and foraging habitat for adult and larval California red-legged frogs (Jennings and Hayes 1994, USFWS 2000).

Three functional groups of vegetation, used by the target species, were identified: egg attachment, cover in water, and canopy cover. Each of these functional groups is comprised of several species of vegetation, some of which may provide multiple functional roles and are included in more than one group. The "egg attachment" functional group includes emergent vegetation and grasses the target species utilize to attach their egg masses to upon the completion of fertilization. The "cover in water" functional group consists primarily of emergent vegetation that provides target species with food for larvae and predator avoidance habitat. Lastly, the "canopy cover" functional group, comprised of a variety of species of trees, may provide additional predator avoidance habitat as well as providing shade that can create various microclimates.

The target species utilize upland vegetation, including herbaceous and woody shrubs, for shelter during dispersal and other non-breeding periods. The extent to which target species utilize upland vegetation is not conclusive, though it may have an important role of providing necessary habitat and shelter.

5.4 Habitat Creation and Restoration within the Casmalia Creek Riparian Corridor

Based upon the breeding and larval development requirements of the target species and the conditions present in the Casmalia Creek watershed, the two options identified for providing suitable habitat include restoring portions of Casmalia Creek and creating ponded habit. The habitat opportunities within the Casmalia Creek watershed were evaluated to determine their suitability for the target species.

5.4.1 Breeding Habitat

Although "ideal" breeding habitat has not been unequivocally defined for either of the target species, ponds that contain the appropriate vegetation and hydroperiod are generally thought to enhance breeding and larval development conditions (USFWS 2000). The Casmalia Creek watershed experiences intense episodic rainfall events that result in a rapid rainfall runoff response (CRWQCB 1999). This results in rapid increases in flow volume and velocity in Casmalia Creek. Due to the "flashy" nature of Casmalia Creek, it provides unreliable breeding habitat. Though breeding may occur in similar coastal tributaries, the breeding environment in Casmalia Creek is not likely to be conducive to the target species' breeding habitat needs. Additionally, the absence of plunge pools and deep water regions, and the currently degraded nature of the Casmalia Creek riparian corridor are likely to contribute to poor breeding conditions.

Ponds may provide a stable environment of still and slow moving water that is identified as conducive to the breeding and larval development needs of the target species. In addition, ponds that provide spatial and vegetative heterogeneity are likely to provide habitat for the target species in different life stages. Further, ponds can support a range of vegetation that provides functional benefits for the target species such as egg attachment, forage, and cover.

Permanent and ephemeral ponds that persist throughout the target species' typical breeding and larval development phase will increase the likelihood of successful larval development. Surface water that persists for durations greater than five weeks is more likely to allow for successful larval development in the western spadefoot toad and reduces the likelihood of mortality due to desiccation (Morey 1996). Furthermore, research on the western spadefoot toad indicates that pools that persisted longer produced larger metamorphosed individuals; increased body size is correlated with increased terrestrial fitness (Morey 1996).

Ponded habitat may present certain risks to the target species. Ponds that fail to persist for an adequate duration may entice the target species to lay eggs in areas that will not support complete larval development and increase the probability of mortality due to desiccation. Further, ponds that experience substantial fluctuations in water levels may strand eggs and result in desiccation and significant mortality. Such ponds will have an adverse affect on reproductive success and may affect the persistence of the population. In addition, perennial ponds also provide suitable habitat for exotic predators, including bullfrogs (*Rana catesbeiana*) and exotic fish species. These predators pose a substantial threat to the target species and continue to contribute to their overall decline (Jennings and Hayes 1989, USFWS 2000). In particular, these predators pose a substantial threat if they become established, making it critical to manage ponds to control this species.

Created ponds must persist at an adequate depth and for an adequate duration (defined as the hydroperiod) and provide suitable vegetation to provide the target species with habitat conducive to successful breeding and larval development. The USFWS recommends ponds managed for the California red-legged frog persist at minimum from March through July (USFWS 2000). However, research indicates that the target species breeding and development in northern Santa Barbara County near Casmalia generally occurs from January through July (Christopher 1996). Therefore, based upon the USFWS recommendations and in accordance with the local timing of breeding and larval development observed for the target species, the recommended hydroperiod is from January through July. The California red-legged frog requires deeper water for breeding and development than the western spadefoot toad. At minimum, the California red-legged frog requires water 20 centimeters deep throughout larval development, however the USFWS recommends ponds managed for this species are 1 meter deep to allow for predator refuge (USFWS 2000). Therefore, for this report the minimum hydroperiod is identified as 20 centimeters of water persisting from January through July, and the ideal hydroperiod is identified as 1 meter water depth maintained January to July. The western spadefoot toad can breed and undergo larval development in shallow temporary rain pools; therefore, ponds that provide the minimum hydroperiod requirements for the California red-legged frog will adequately meet the hydroperiod requirements for the western spadefoot toad.

5.4.2 Non-Breeding Habitat

Researchers indicate that terrestrial habitat protection is an essential component of amphibian conservation efforts due to its fundamental importance in maintaining metapopulation dynamics in both the local and regional context (Marsh and Trenham 2001). Incorporating upland vegetation composed of herbaceous and woody shrubs may provide shelter beneficial to the California red-legged frog, though this may provide the greatest benefit when utilized as a buffer zone of upland vegetation surrounding ponded habitat. The western spadefoot toad requires upland habitat suitable for burrowing. The extent to which the existing habitat is affected by compaction resulting from cattle grazing is unknown at this time. Further, the extent to which loss of grassland cover effects the dispersal or increases the risk of predation for dispersing western spadefoot toads is unknown at this time.

The riparian vegetation and overall condition of the riparian corridor is currently degraded due to cattle grazing (EPA 1996b, CRWQCB 1999). As discussed, the

California red-legged frog routinely utilizes riparian corridors as important non-breeding habitat. Establishing the appropriate native vegetation and improving the condition of the riparian corridor may provide a variety of benefits including providing additional habitat for foraging, dispersal, and predator avoidance.

The upland habitat is degraded due to cattle grazing ((EPA 1996b, CRWQCB 1999). The extent to which this negatively affects the target species use of the upland habitat is unclear. However, research indicates numerous negative effects of poorly managed cattle ranching. These effects may include: reduced vegetative cover due to browsing and trampling, increased upland and bank erosion leading to an increase in sediment load, a reduction in plunge pools, an increase in stream width, an increase in soil compaction, a decrease in forage production, an alteration of plant species composition, an elevation of fecal coliform levels, an alteration of stream water chemistry, and an increase in runoff and higher water temperatures (USFWS 2000). Each of these negative impacts can reduce the suitability of breeding and non-breeding habitat for the target species. Active range management can reduce the adverse impacts resulting from cattle grazing.

5.4.3 Habitat for the Target Species in the Casmalia Creek Riparian Corridor

In comparing the benefits of creating breeding and larval development habitat in Casmalia Creek versus creating ponds adjacent to the riparian corridor, it was determined, for the reasons outlined above, that ponded habitat would provide superior habitat in the Casmalia Creek watershed. Consequently, a habitat creation and restoration plan for the Casmalia Creek riparian corridor should focus on creating ponded habitat. However, riparian habitat can provide important additional non-breeding benefits and therefore restoring portions of the riparian corridor near created ponds is recommended.

Upland habitat, particularly buffer zones extending around aquatic habitat, provides cover important for the target species, chiefly the California red-legged frog. The western spadefoot toad requires upland habitat that is conducive to burrowing, and therefore compaction resulting from concentrated cattle grazing may be problematic. Further, overgrazing results in greater erosion, which may increases sedimentation rates into the created ponds as well as increase turbidity in the creek.

Creating ponded habitat, restoring adjacent portions of the riparian corridor, and improving range management in the terrestrial upland habitat should provide suitable breeding and non-breeding habitat for various life-stages of the target species.

6.0 Water Budget Analysis

As recommended in Habitat Requirements (Section 5.0), a habitat creation and restoration plan for the Casmalia Creek riparian corridor should focus on creating ponded habitat, restoring adjacent portions of the riparian corridor, and improving range management. The Water Budget Analysis focused on determining the feasibility of creating ponded habitat. To determine the feasibility of creating ponded habitat it was of the utmost importance to determine if a sufficient volume of water is available in the Casmalia Creek watershed to create ponds that will meet the minimum hydroperiod (20 centimeters of water persisting from January through July). To determine if sufficient water is available, a Water Budget Model (Section 6.3) was conducted for a variety of hypothetical pond scenarios. In addition, the reduction in the volume of annual stormflow and total annual flow associated with each of the hypothetical pond scenarios were examined.

The Water Budget Analysis conducted for the hypothetical pond scenarios used the following formula:

$$\mathbf{S_1 = S_0 + GWI + SWI + P - SWO - GWO - Et}$$

where

- $\mathbf{S_1}$ = Final storage
- $\mathbf{S_0}$ = Initial storage
- **GWI** = Groundwater inflow (infiltration in)
- **SWI** = Surface water inflow
- **P** = Direct precipitation
- **SWO** = Surface water outflow
- **GWO** = Groundwater outflow (infiltration out)
- **Et** = Evapotranspiration

This formulation is a widely accepted method for determining the water budget of wetlands (Pierce 1993). Precipitation, surface water inflow, and groundwater infiltration represent the inputs of water. Surface water outflow, groundwater outflow, and evapotranspiration represent the outputs of water. Upon estimating the daily volume for each of the inputs and outputs, the information was incorporated into a Water Budget Model discussed below in Section 6.3.

6.1 Inputs

6.1.1 Groundwater (GWI)

As fluctuations in groundwater levels can have a significant impact on the availability of water for ponds, groundwater should be well characterized before it is deemed a viable source. Groundwater level measurements for wells within the Casmalia Creek riparian corridor, suitable for the construction of ponds, are limited to the past few years. As such, the long-term fluctuations in groundwater levels at these locations are not well characterized. Due to the lack of groundwater data in the Casmalia Creek riparian corridor, it is inadvisable to rely on groundwater as an input of water to ponds. As such, groundwater was not calculated as an input in the Water Budget Analysis.

6.1.2 Surface Water (SWI)

The primary source of surface water input to the ponds is Casmalia Creek. However, to minimize the reduction in baseflow in Casmalia Creek, stormflow was the only SWI input considered. Casmalia Creek has never been adequately gaged. Consequently, flow data are extremely limited. Beginning in 1998, the CSC recorded the only known flow data in Casmalia Creek to meet the requirements of their NPDES permit. Data were collected several times a month (7 – 13) following rain events in November through April. These data are not sufficient to estimate the availability of water for hypothetical ponded scenarios. Therefore, an alternative method for estimating the volume of stormflow was required.

6.1.2.1 Estimating Stormflow

The United States Department of Agriculture Soil Conservation Service (SCS) method is widely used for estimating runoff volumes in small watersheds. (USDA 1986). The SCS method, as described by Dunne and Leopold (1978), "is based on a simplified infiltration model of runoff and a good deal of empirical approximation". It provides a technique for estimating the daily output of surface water from a watershed following precipitation events and thereby provides an estimation of daily volumes of stormflow. The SCS method was used to approximate daily and average annual stormflow volumes produced by precipitation events. To use the SCS method, daily precipitation data and a curve number for the Casmalia Creek watershed were required.

Daily Precipitation

The Site's meteorological station collected precipitation data from October 1992 to March 2000. Using these data as the basis for the SCS calculations of estimated stormflow limits the analysis to a nine-year period. Therefore, to extend the analysis, daily precipitation data were required from a nearby weather station. The California Irrigation Management Information System (CIMIS) database provides daily precipitation data from the Santa Maria Airport weather station (NCDC #7946, Santa Maria WSO Airport) run by the National Climatic Data Center. This station served as a suitable surrogate due to the good correlation with precipitation values recorded at the Site (Harding Lawson 2000). Daily precipitation data from the Airport is available from January 1955 to January 1999 (CIMIS 2001), allowing for an estimate of runoff from over 2000 precipitation events over 45 years.

Curve Number

As described by Dunne and Leopold (1978), "the curve number is an empirical rating of the hydrologic performance of a large number of soils and vegetative covers throughout the United States". The curve number (CN) value determines the potential maximum retention of water by the soil during precipitation events. Used to determine storm runoff, the CN value is dependant on the watershed's hydrologic soil group, land use and cover, treatment, and hydraulic condition. These four factors allowed for the determination of the average runoff CN for the Casmalia Creek watershed:

1. **Hydrologic Soil Group –** Santa Barbara County soil surveys indicate that the soils in the Casmalia Creek watershed are predominately clay loams, which corresponds to hydrologic soil group C.
2. **Land Use or Cover –** Cattle grazing is the dominant land use. Therefore, land use was identified as pasture.
3. **Treatment –** The land has not undergone any significant treatment in recent years.
4. **Hydraulic Condition –** Due to the heavily grazed nature of the watershed, the hydraulic condition was deemed poor.

Based upon these factors, an average runoff CN of 86 was selected from SCS CN tables (USDA 1996). The value of the CN estimates the potential maximum retention of water by the soil in equivalent inches depth over the drainage area (**S**). **S** is calculated using the following equation:

$$S = \frac{1000}{CN} - 10$$

Runoff (**Q**) is then calculated, in inches, using S and daily precipitation (**P**), also in inches. **Q** is determined using the following equation:

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

At the onset of a storm, a portion of or all of the precipitation, called the initial abstraction, will not produce runoff. The amount of precipitation that makes up the initial abstraction varies based on the antecedent moisture condition of the soil, which is a function of the previous 5 days of precipitation. The average runoff CN of 86, selected above, represents soil conditions with an antecedent moisture condition (AMC) II. To consider drier and wetter soil conditions, values for AMC conditions I (dry) and III (wet) are selected from SCS tables. Table 6.1 presents the CN values for the three AMCs based on the 5-day Total Antecedent Rainfall.

Table 6.1: Rainfall limits for estimating antecedent moisture conditions.

Antecedent Moisture Condition Class	CN	5-Day Total Antecedent Rainfall (Inches)	
		Dormant Season	Growing Season
I	**70**	Less than 0.5	Less than 1.4
II	**86**	0.5 – 1.1	1.4 – 2.1
III	**94**	Over 1.1	Over 2.1

Modified from U.S. Soil Conservation Service (1972)

Once the CN for the three AMC classes were determined, a Microsoft Excel© spreadsheet was designed to calculate daily runoff values using 45 years of available daily precipitation data. The correct AMC condition class was selected based on the 5-Day Total Antecedent Rainfall. This adjusted the CN to the appropriate AMC class. The volume of stormflow through Casmalia Creek was calculated by multiplying the SCS estimated runoff (Q) by the area of the watershed upstream of the potential pond locations.

Estimated Stormflow

Using the SCS method with an average runoff CN of 86, an average annual stormflow volume of 275,000 cubic meters of water (9,700,000 cubic feet) was calculated in the portion of the watershed directly upstream of the potential pond locations. Annual stormflow varied from zero stormflow to 820,000 cubic meters. An average annual stormflow of 275,000 cubic meters of water suggests that approximately 4.7 centimeters (1.9 inches) of the average annual precipitation of 34.3 centimeters (13.5 inches), or 14%, becomes stormflow. However, several assumptions inherent in the SCS method may affect the accuracy of the calculated volume of stormflow. These assumptions are:

1. The pattern of precipitation extends over a 24-hour period;
2. The major storm runoff process is Horton overland flow; and,
3. The correct CN was used.

The SCS method largely satisfies objections to the assumption of extending the pattern of precipitation over a 24-hour period. (McCuen 1982, Walsh 1989, USDA 1986, Pierce 1993) Assuming that the major storm runoff process is Horton overland flow neglects other runoff processes such as, subsurface stormflow and saturation overland flow. However, as described by Dunne and Leopold (1978), “The techniques [SCS method] still seem to work under other runoff conditions, presumably because the major variables (rainfall, antecedent moisture, soil conditions, and topography) function in the same direction to control the magnitude of stormflow, whatever the runoff process”. To determine whether the correct CN is used for watersheds with ungaged streams, it is prudent to compare calculated stormflow to gaged streams in nearby watersheds identified as reference watersheds.

6.1.2.2 Reference Watersheds

As discussed above, to ascertain whether the correct CN is used for watersheds with ungaged streams, it is prudent to compare calculated stormflow to gaged streams in reference watersheds. This allows for a comparison between the percentages of precipitation that becomes stormflow in each watershed to determine if calculated stormflow has been over or under estimated.

Reference watersheds were selected based on the presence of similar hydrologic soil groups, land uses and vegetation covers, land treatments, and hydraulic conditions. Watersheds with these similar characteristics are likely to have the same CN as the Casmalia Creek watershed. In addition, reference watersheds were chosen relatively close to the Casmalia Creek watershed, as the precipitation patterns are likely to be similar. Similar precipitation patterns are an important consideration as the CN varies based on the 5-day total antecedent precipitation, which in turn affects the percentage of precipitation that becomes stormflow.

The Orcutt Creek and Miguelito Creek watersheds were selected to serve as reference watersheds. The gages measuring flow data at these reference watersheds are within 5 and 27 kilometers of the Casmalia Creek watershed, respectively. Drainage area was the only significant difference between the Casmalia Creek watershed and the reference watersheds. However, as the CN and precipitation patterns are assumed to be similar in the reference watersheds, the percentage of precipitation that becomes stormflow should not be affected by drainage area.

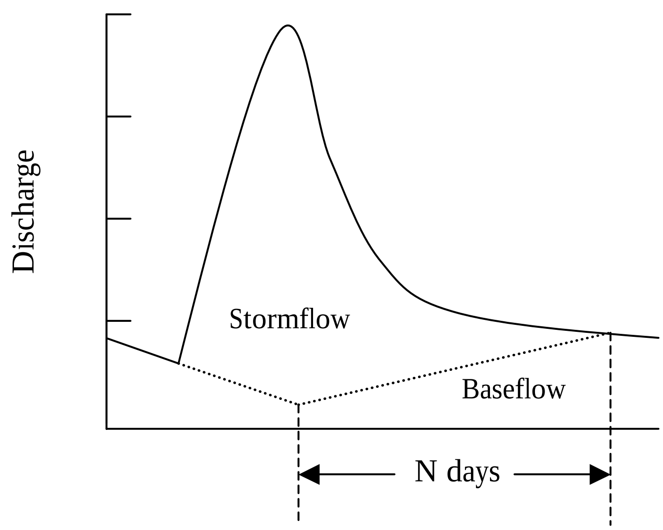
The following steps allowed for a comparison of the calculated average annual percentage of precipitation that runs off as stormflow in the three watersheds:

1. Daily average hydrographs for streamflow at gaging stations within the reference watersheds were created;
2. The daily average hydrographs for the reference watersheds were separated into baseflow and stormflow components;
3. The volume of average annual precipitation within the reference watersheds was calculated; and,
4. The percentage of rainfall that results in stormflow was calculated for the reference watersheds.

The annual average hydrographs were created using the mean of daily mean streamflow values for the entire record of data collected at USGS gaging stations within the reference watersheds.

As stated above, the annual average hydrograph was separated into baseflow and stormflow components. Figure 6.2 presents the technique used to separate the hydrographs. As described by Dunne and Leopold (1978), “techniques of hydrograph separation are all arbitrary and have little to nothing to do with the processes by which stormflow is generated, but if one method is employed consistently, then usable results are obtained”.

Figure 6.1: Method of Hydrograph separation.



To separate the Stormflow from Baseflow, project the pre-storm baseflow under the peak. Draw the separation line rising from beneath the peak to a point on the recession limb that is *N* days after the peak, where *N* (days) = $A^{0.2}$ (square miles). In the case of the proposed pond locations *N* (days) = $2.27^{0.2}$ (square miles) = 1.2 days.
Modified from Dunne and Leopold (1978)

Average annual precipitation was calculated by selecting weather stations within the reference watersheds and averaging annual precipitation for the same period of time as the available stream gage data. The average annual volume of precipitation was then calculated by multiplying the average annual precipitation by the reference watershed’s drainage area. Finally, the percentage of rainfall that results in stormflow was calculated by dividing the average annual stormflow in the reference watersheds by the average annual volume of rainfall in the reference watershed. In addition, as the reference watersheds are representative of the Casmalia Creek watershed, it was assumed that the percentage of average annual stormflow that makes up average annual flow would be similar between the watersheds. Table 6.2 presents the results.

Table 6.2: Comparison of stormflow as a percentage of annual flow and precipitation.

Watershed	Average Annual Flow (m^3)	Average Annual Baseflow (m^3)	Average Annual Stormflow (m^3)	Average Annual Stormflow as a Percentage of Average Annual Flow	Average Annual Volume of Precipitation (m^3)	Average Annual Percentage of Precipitation Resulting in Stormflow
Miguelito Creek	2,080,000	1,080,000	1,000,000	48%	10,900,000	9%
Orcutt Creek	2,250,000	750,000	1,500,000	65%	15,400,000	9%
Casmalia Creek (CN = 86)	430,000 – 580,000	150,000 – 300,000	280,000	48 - 65%	2,000,000	14%

m^3 – cubic meters

As shown in Table 6.2, in the reference watersheds, the average annual percentage of precipitation resulting in stormflow ranges from 9 – 14% of the total precipitation, 4% less than in the portion of the Casmalia Creek watershed immediately upstream of the potential pond location. As the difference in the percentages will mean a significantly smaller volume of water available for ponds, the CN for the Casmalia Creek watershed was adjusted from 86 to 80 to reflect the differences between the watersheds. This allowed for a more conservative estimate of the volume of water available for creating ponds in the Casmalia Creek riparian corridor. Table 6.3 presents the results of the average annual stormflows calculated using both a CN of 86 and 80.

Table 6.3: Comparison of stormflow as a percentage of precipitation with varied CN.

Watershed	Average Annual Flow (m^3)	Average Annual Baseflow (m^3)	Average Annual Stormflow (m^3)	Average Annual Stormflow as a Percentage of Average Annual Flow	Average Annual Volume of Precipitation (m^3)	Average Annual Percentage of Precipitation Resulting in Stormflow
Casmalia Creek (CN = 86)	430,000 – 580,000	150,000 – 300,000	280,000	48 - 65%	2,000,000	14%
Casmalia Creek (CN = 80)	277,000 – 375,000	97,000 – 195,000	180,000	48 - 65%	2,000,000	9%

m^3 – cubic meters

6.1.3 Direct Precipitation (P)

The contribution of direct precipitation was calculated by multiplying the daily precipitation volume by the maximum surface area of the pond. Loss due to interception by wetland vegetation was not calculated, as these losses are not well understood (Pierce 1993). Further, potential loses due to interception is negligible in comparison to losses due to surface water outflow, infiltration, and evapotranspiration.

6.2 Outputs

6.2.1 Surface Water Outflow (SWO)

Output of water in the form of surface water outflow occurred when input, in the form of stormflows, exceeded the maximum storage capacity of hypothetical pond scenario.

6.2.2 Infiltration (GWO)

The Natural Resource Conservation Service Soil Survey maps for the Casmalia Creek watershed classify the majority of the soils within the watershed, including Casmalia Creek riparian corridor, as a clay loam with moderately slow permeability. Moderately slow permeability ranges from 0.51 – 1.52 centimeters/hour. Installing a liner in created ponds or compacting the in-situ soils is necessary if the permeability of soils or subsoils is above 0.0037 – 0.037 centimeters/hour (Pierce 1993). Therefore, for the purposes of conducting the Water Budget Analysis, it was assumed that, at a minimum, soils would be compacted to reduce infiltration rates to 0.0037 centimeters/hour. The total annual loss of water due to infiltration, assuming an infiltration rate of 0.0037 centimeters/hour, is 32.4 centimeters/year.

6.2.3 Evapotranspiration (Et)

Daily Et data, calculated as reference evapotranspiration (ETo) at CIMIS's Santa Maria weather station #38, was used to estimate daily evapotranspiration rates in the hypothetical pond scenarios. This CIMIS weather station is the preferred weather station as it is the closest station to the Site that calculates ETo, which, "is a term used to describe the evapotranspiration rate of a reference crop" (CIMIS 2002).

CIMIS approximates the ETo of a reference crop (grass) using a version of the Modified Penman equation by Pruitt and Doorenbos. CIMIS weather stations record hourly values for a variety of climatic variables but use hourly air temperatures, wind speeds, vapor pressures, and a calculated net radiation to calculate hourly ETo. CIMIS weather station #38 calculated ETo values from May of 1983 and May of 1999. However, to conduct the Water Budget Analysis for the 45 years of available precipitation data, it was necessary to estimate daily ETo values for this period. Dividing the monthly averages, from the 17 years of available ETo data, by the number of days in the month allowed for the calculation of the daily average ETo (Table 6.4).

To evaluate the suitability of using CIMIS #38 to represent average daily ETo values in the Water Budget Model, average annual CIMIS #38 ETo data were compared to average annual Class A pan evaporation data collected at the Site from October 1992 through March 2000 (Table 6.4).

Table 6.4: Comparison of average evapotranspiration and average evaporation.

Month	**Average Evapotranspiration from CIMIS #38 Data[1] (cm/month)**		**Average Evaporation from Site Pan A Data[2] (cm/day)**	
	Monthly (cm/month)	**Daily (cm/day)**	**Monthly (cm/month)**	**Daily (cm/day)**
January	4.76	0.15	6.54	0.21
February	6.00	0.21	9.39	0.34
March	9.55	0.31	11.96	0.39
April	12.90	0.43	13.43	0.45
May	14.51	0.47	15.49	0.50
June	14.50	0.48	16.74	0.56
July	14.63	0.47	18.28	0.59
August	13.55	0.44	18.01	0.58
September	11.05	0.37	15.30	0.51
October	8.93	0.29	12.21	0.39
November	6.18	0.20	8.99	0.30
December	4.81	0.16	8.15	0.26
Total (cm/year)	**121.37**		**154.48**	

cm – centimeters

[1] CIMIS 2002

[2] Harding Lawson Associates 2000

As shown in Table 6.4, the average annual ETo calculated at CIMIS #38 is approximately 21% less than pan evaporation data collected at the Site. This is expected. Wetland studies have indicated that emergent vegetation in a wetland can reduce total evapotranspiration below that of an open water body (Kadlec 1989). In addition, emergent vegetation, in ponds, has been observed to reduce total evapotranspiration to about three quarters of pan evaporation (Pierce 1993). As such, average daily ETo values derived from CIMIS #38 data suitably represent water loss to evapotranspiration. As shown in Table 6.4, the total estimated average annual loss of water due to evapotranspiration is 121.37 centimeters/year.

6.3 Water Budget Model

Upon determining the inputs and outputs for the Water Budget Analysis in the Casmalia Creek riparian corridor, a Water Budget Model was developed in a Microsoft Excel©

spreadsheet. The model was run for the 45 years of available precipitation data to take into account the variability in precipitation patterns resulting in an irregular volume of annual stormflow. Forty-eight hypothetical pond scenarios were set up to simulate one or two various sized conical shaped ponds, which could be excavated in the Casmalia Creek riparian corridor to create habitat. The hypothetical pond scenarios were developed to simulate created ponded habitat to meet conditions presented in Habitat Requirements (Section 5.0). Hypothetical pond scenarios were varied by changing the maximum storage capacity of the ponds, adding a second pond, or both. The maximum storage capacity was varied by altering the pond's depth, and upper and lower radii. Algorithms inserted into the model determined, on a daily basis:

1. The volume of stormflow captured;
2. The volume lost to evapotranspiration;
3. The volume lost to infiltration;
4. The final storage volume; and,
5. The final water depth.

The volume of stormflow captured was based on the available stormflow determined using the SCS method with a CN of 80, the initial volume stored in the pond, and the maximum storage volume of the pond. The water surface area of the pond multiplied by the daily average ETo, as presented in Section 6.2.3, gives the volume lost to evapotranspiration. The daily average infiltration rate multiplied by the wetted area of the pond gives the volume lost to infiltration. The final storage volume was determined by subtracting the daily outputs from the initial storage and daily inputs. Lastly, the final water depth was determined based on the maximum storage capacity of the pond, the pond depth, and the radial circumferences of the pond.

6.4 Results

The Water Budget Analysis was conducted to determine the viability of using natural sources of water, specifically Casmalia Creek, to create ponds within the riparian corridor. The natural sources would be deemed viable if the pond in the hypothetical scenarios met the minimum hydroperiod:

- Minimum Hydroperiod: Minimum of 20 centimeters of water present January through July.

Hypothetical pond scenarios were varied to ensure that the minimum hydroperiod was met in each of the 45 years the model was run while attempting to meet the ideal hydroperiod and maximize the size of the pond.

- Ideal Hydroperiod: Minimum of 1 meter of water present January through July.

Table 6.5 presents the results for 10 of the 48 hypothetical pond scenarios that meet the minimum hydroperiod requirements throughout the 45-year period while also maximizing the number of days that meet the ideal hydroperiod requirements. Each of the hypothetical ponds presented in Table 6.5 was 3 meters deep, with slopes at a ratio of 1:10 (vertical to horizontal), and an infiltration rate of 0.0037 centimeters/hour. Input in the form of stormflow was estimated using a CN of 80 to conservatively estimate the volume of water available to ponds in the scenarios. The only factor that varied between the ponds was the radial circumference of the ponds, which in turn varied the maximum storage volume and surface area.

Table 6.5: Hypothetical pond scenarios and results.

Scenario Number	Pond 1 Lower/ Upper Radius	Pond 2 Lower/ Upper Radius	Maximum Pond Volume	Maximum Pond Surface Area		Number of Days Pond Water Depth < 1 meter	Percentage of Days Water Depth < 1 meter	Number of Years When Ideal Hydroperiod is Not Met
	(m)	(m)	(m^3)	(m^2)	(ac)			(years)
1	5/35	NA	4,500	3,800	0.9	0	0	0
2	10/40	NA	6,600	5,000	1.2	0	0	0
3	15/45	NA	9,200	6,400	1.6	17	0.17%	1
4	20/50	NA	12,200	7,900	1.9	60	0.61%	3
5	25/55	NA	16,000	9,500	2.3	102	1.04%	4
6	30/60	NA	20,000	11,300	2.8	150	1.54%	7
7	10/40	20/50	18,800	12,900	3.2	308	3.15%	9
8	10/40	25/55	22,600	14,500	3.6	323	3.31%	10
9	10/40	30/60	26,600	16,300	4.0	343	3.51%	10
10	5/35	25/55	20,500	15,200	3.8	340	3.48%	9

m – meters m^3 – cubic meters ac – acres
In each of the scenarios, water was below 1 meter in the first three weeks of the first month of the 45-year period.

Scenarios 1 and 2 meet both the minimum and ideal hydroperiods in each of the 45 years of available precipitation data. Scenarios 3 through 10 had similar success, as these ponds met the minimum hydroperiod requirements in each of the 45 years. In addition, the ideal hydroperiod was met in 38 to 44 of the 45 years. In these years, the ideal pond depth was achieved in the either the first 74 – 97% or last 89 – 92% of those days. The depth of water in the days that did not meet the ideal pond depth were no less than 0.42 meters and occurred in January at the expected beginning of the target species' breeding period.

The multiple pond scenarios, 7 through 10, were not as successful. The ideal hydroperiod was met in 35 to 36 of the 45 years. In these years, the ideal pond depth was achieved in 54 – 97% of the days during the hydroperiod. The depth of water in these days was no less than 0.26 to 0.35 meters, depending on the scenario, and occurred at various times throughout the hydroperiod.

6.5 Conclusion

To reduce the effect of assumptions inherent in the methods used to estimate the likelihood that the scenarios will meet the minimum and ideal hydroperiod requirements, inputs to scenarios were conservatively estimated and outputs were liberally estimated. Each of the hypothetical pond scenarios presented in Table 6.5 meet the minimum hydroperiod requirements. In addition, a high percentage of days meet the ideal hydroperiod requirements. As such, it is concluded that Casmalia Creek provides sufficient water to create ponded habitat in the Casmalia Creek riparian corridor and Section 8.0 (Habitat Creation and Restoration Plan) outlines the appropriate pond design. However, capturing stormflow will reduce the volume of flow in the remainder of the creek potentially resulting in adverse effects downstream. The following section discusses the magnitude of potential reductions.

6.6 Effect on Flow

Capturing stormflow for ponded habitat reduces annual stormflow volume and the volume of total annual flow. This reduction will alter the natural flow regime and may adversely affect biota in the remainder of Casmalia Creek and its receiving tributary, Shuman Creek. Therefore, it is important to estimate the potential reduction in stormflow volume and frequency as well as the potential reduction in total annual flow as a result of creating ponded habitat.

6.6.1 Effect on Stormflow

Reducing the volume and frequency of stormflow events may adversely affect biota downstream of the created ponded habitat. Biota in the Casmalia and Shuman Creek riparian corridors may be dependent on stormflow events to carryout their life cycle. In addition, stormflow may reduce exotic vegetation that cannot tolerate stormflow conditions. Therefore, it is important to estimate the potential reduction in stormflow volume and frequency as a result of creating ponded habitat.

To estimate the reduction in stormflow volume and frequency, a simulation was performed on an annual basis over the 45 years of available precipitation data. In the initial year, the pond(s) in each scenario were filled to their maximum storage capacity using stormflow. After the initial year, the only stormflow required to refill the pond(s), will be equal to losses from ETo and infiltration less direct precipitation on the pond. Therefore, the relevant question is whether compensating for these losses by refilling the pond(s) will significantly reduce stormflow volume downstream.

To calculate the stormflow required to refill the pond, direct precipitation was added to the initial pond depth(s) and losses from ETo and infiltration were subtracted, thereby calculating the annual net loss of water. If the stormflow volume in a single year was insufficient to compensate for annual net loss, the deficit was carried into the following year. The annual net loss combined with the previous years' deficit equaled the depth of stormflow required to refill the pond.

As the biological communities in Casmalia and Shuman Creek are not well characterized, the level of reduction in stormflow at which adverse effects occur is unknown. Therefore, four reductions in the contribution of annual stormflow upstream of the created ponded habitat were chosen arbitrarily to represent points at which adverse effects to the biological community downstream would occur: 10%, 25%, 50%, and 100%. Table 6.6 presents the number of years that annual stormflow is affected beyond the arbitrary points over the 45-year period in each of the hypothetical pond scenarios presented above in Table 6.5.

Table 6.6: Number of years annual stormflow is reduced by 10%, 25%, 50%, and 100% in Casmalia Creek for each hypothetical pond scenario.

Scenario Number	Maximum Pond Volume	Maximum Pond Surface Area		Number of Years Stormflow is Reduced by at Least 10%	Number of Years Stormflow is Reduced by at Least 25%	Number of Years Stormflow is Reduced by at Least 50%	Number of Years Stormflow is Reduced by 100%
	(m^3)	(m^2)	(ac)				
1	4,500	3,800	0.9	12	5	3	1
2	6,600	5,000	1.2	16	6	4	1
3	9,200	6,400	1.6	17	9	5	3
4	12,200	7,900	1.9	19	10	5	3
5	16,000	9,500	2.3	22	12	6	4
6	20,000	11,300	2.8	24	15	6	4
7	18,800	12,900	3.2	24	16	9	5
8	22,600	14,500	3.6	27	16	9	5
9	26,600	16,300	4.0	27	18	11	5
10	20,500	15,200	3.8	27	16	10	5

m^3 – cubic meters m^2 – square meters ac – acres
The pond(s) in each scenario were filled in the first year resulting in an 11 - 43% reduction in stormflow in that year.

As presented in Table 6.6, stormflow volume is reduced by at least 10% in 1 out of every 2 to 4 years and stormflow is completely reduced in 1 out every 9 to 15 years. This suggests the potential for adverse effects on downstream biota in Casmalia Creek. However, this only represents a reduction in annual stormflow volume from the portion of the watershed upstream of the created ponded habitat, which is approximately half of the total area of the watershed. In rerunning the simulation to account for a reduction in the total contribution of stormflow to Shuman Creek, stormflow volume is reduced by at least 10% in 1 out of every 2 to 8 years and stormflow is completely reduced in 1 out of 15 – 45 years. Possible effects of reducing annual stormflow volume are discussed in Evaluation (Section 8.7).

6.6.2 Effect on Total Flow

As stated above, capturing stormflow for ponded habitat reduces the volume of water available to biota downstream of created ponded habitat and may cause negative effects if they are dependant on the input of stormflow as a water source. Therefore, it is important to estimate the possible reduction in total annual flow as a result of capturing stormflow to create ponded habitat

As presented in Table 6.2, the average annual stormflow as a percentage of average total annual flow in the reference watersheds ranged between 48% and 65%. Dividing the volume of annual stormflow in Casmalia Creek by 65% allowed for a conservative estimate of the volume of total annual flow. To estimate the percent reduction in total annual flow, the volume of stormflow required to refill the pond(s) in each scenario, estimated in 6.6.1, was divided into the estimated total annual flow. Table 6.7 presents the results, which indicate the average percent reduction over the 45-year period, the maximum reduction in a 1 year period, as well as the number of years the maximum reduction in total annual flow occurred.

Table 6.7: Average percent reduction in annual flow as a result of creating each hypothetical scenario.

Scenario Number	Maximum Pond Volume	Maximum Pond Surface Area		Average Percent Reduction in Annual Flow	Maximum Reduction in Annual Flow in 45-Year Period	Number of Years Maximum Reduction of Annual Flow Occurs
	(m^3)	**(m^2)**	**(ac)**			
1	4,500	3,800	0.9	8%	65%	1
2	6,600	5,000	1.2	10%	65%	1
3	9,200	6,400	1.6	12%	65%	3
4	12,200	7,900	1.9	14%	65%	3
5	16,000	9,500	2.3	15%	65%	4
6	20,000	11,300	2.8	17%	65%	4
7	18,800	12,900	3.2	19%	65%	5
8	22,600	14,500	3.6	20%	65%	5
9	26,600	16,300	4.0	21%	65%	5
10	20,500	15,200	3.8	21%	65%	5

m^3 – cubic meters m^2 – square meters ac – acres

The pond(s) in each scenario were filled in the first year resulting in a 3 – 12% reduction in the annual flow.

As presented in Table 6.7, the reduction in the contribution of total annual flow from the area upstream of the created pond(s) is between 8 and 21% with a maximum reduction in total annual flow of 65% occurring in 1 to 5 years. However, this only represents a reduction in total annual flow volume to Shuman Creek from the portion of the Casmalia Creek watershed upstream of the created ponded habitat. This portion of Casmalia Creek watershed represents approximately one-forth of the entire Shuman

Creek watershed. In rerunning the simulation, the reduction in total annual flow in Shuman Creek is 2 to 5% with a maximum reduction in total annual flow of 16% occurring in 1 to 5 years. This suggests that there is potential for affects on downstream flora and fauna if they are dependant on inputs from Casmalia Creek to maintain water levels in Shuman Creek and Lagoon. Possible effects of reducing total annual flow are discussed in Evaluation (Section 8.7).

7.0 Current Watershed Characteristics

Analyzing the current characteristics of the Casmalia Creek watershed was of fundamental importance in creating a habitat creation and restoration plan that: 1) addresses the factors responsible for the degraded nature of habitat within the watershed; and, 2) identifies feasible restoration opportunities that would work with the natural system to maximize benefits to the target species. The Habitat Creation and Restoration Plan identified the following important characteristics:

1. **Climate**
2. **Geologic Characteristics**
3. **Hydrology and Hydraulic Characteristics**
4. **Chemical Characteristics**
5. **Biological Community Characteristics**

The following sections present a brief description of the current characteristics in the Casmalia Creek watershed. Appendix 6 (Current Watershed Characteristics) presents a more in-depth discussion of watershed characteristics.

7.1 Climate

The climate of the Casmalia Creek watershed is typical of Central California coastal areas. Temperatures are moderate and range from a high monthly average of 23.3^0 C (74^0 F) in October to a low monthly average of 3.9^0 C (39^0 F) in January (CIMIS 2002). The average annual precipitation in the watershed is 34.3 centimeters of which approximately 90% occurs between the months of November and April (CIMIS 2002). In addition, this region typical experiences a high degree of annual variation in the volume of rainfall, with a 45-year low of 8.4 centimeters and a 45-year high of 71.7 centimeters.

7.2 Geologic Characteristics

The Todos Santos Claystone Member (TSCM) of the Sisqouc Formation underlies the watershed. The TSCM, approximately 400 meters deep, is differentiated into weathered claystone, ranging from 3 – 20 meters below ground surface (bgs), and unweathered claystone (URS 2000). The weathered claystone is overlain by clay loam soils, alluvium, and colluvium up to 15 meters bgs (Harding Lawson 2000).

7.3 Hydrology and Hydraulic Characteristics

7.3.1 Groundwater

The Casmalia Creek watershed is located within the San Antonio groundwater basin and is isolated from the adjacent Santa Maria and San Antonio groundwater basins(Harding Lawson 2000). The TSCM is non-water bearing, although minor amounts of water are contained in the Upper Hydrostratigraphic Unit (UHSU) (URS 2000). The depth to groundwater varies within the watershed from 2 meters bgs in some areas within 100 meters of the creek to 9 meters bgs in upland areas in the C-drainage (Figure 7.1) (Harding Lawson 2000). The average hydraulic conductivity for the UHSU and the Lower Hydrostratigraphic Unit are 4.6 x 10^{-5} cm/sec and 1.2 x 10^{-6} cm/sec, respectively (Harding Lawson 2000). The groundwater flow tends to follow topography and trends to the south (URS 2000).

7.3.2.1 Chemical Characteristics

Groundwater samples collected from wells in the B and C-drainages measured chemical constituents at non-detect levels (Harding Lawson 2000). Quarterly groundwater samples at these wells indicate naturally high total dissolved solids (TDS). TDS values range from about 2,000 parts per million (ppm) to 10,000 ppm (CH2M Hill 1999).

7.3.3 Casmalia Creek

Casmalia Creek is a small, second order stream with a single thread channel and low sinuosity. The width of the creek ranges from 0.3 to 1 meter (T. Carson and C. Minton, UCSB, pers. obs. 2001). The creek is typical of a Central California coastal tributary stream that is located in moderately steep, rolling topography (CRWQCB 1999). The creek is approximately 9 kilometers long and drains a watershed of approximately 11 square kilometers. The creek flows southward out of the Casmalia Hills to its confluence with Shuman Creek, which continues another 8 kilometers west to the Pacific Ocean. Anecdotal evidence suggests that the creek is ephemeral during periods of prolonged drought (C. Cooper pers. comm. 2001).

7.3.3.1 Chemical Characteristics

Chemical data for the creek are limited. Creek sediment sampling has not indicated any chemical contamination in Casmalia or Shuman Creeks from Site activities (CRWQCB 1999). Dissolved oxygen, salinity, TDS, and turbidity were found to range from 5.0 – 11.9 ppm, 0.4 –1.1 ppt, 1180 – 1640 ppm, and 13 – 47 NTU, respectively (EPA 1996). Nitrate was found to be at 12.8 ppm (EPA 1996).

7.4 Biological Community Characteristics

7.4.1 Watershed Flora

The Casmalia Creek watershed exhibits a mosaic of vegetation communities that vary with microclimate. Factors such as aspect, slope, elevation, proximity to surface or groundwater, and disturbance influence the range of vegetative communities. The communities present include grassland, southern coastal shrub, chaparral, southern oak woodland, and riparian woodland communities (T. Carson and C. Minton, UCSB, pers. obs. 2001). The upper watershed is comprised of southern oak woodland, chaparral, and coastal sagebrush and is relatively undisturbed by cattle grazing (EPA 1996). The lower watershed is dominated by non-native annual grasses and is highly disturbed by cattle grazing, limiting the composition and extent of vegetation communities (EPA 1996, Hunt 2000).

A 1999 riparian vegetation survey found that only 35% of the plants identified were native species (Hunt 2000). Riparian vegetation is discontinuous and confined to within several meters of Casmalia Creek (T. Carson and C. Minton, UCSB, pers. obs. 2001). Willow is the dominant riparian species and there is little to no understory present. Discontinuous patches of willow are interspersed with sections lacking riparian vegetation.

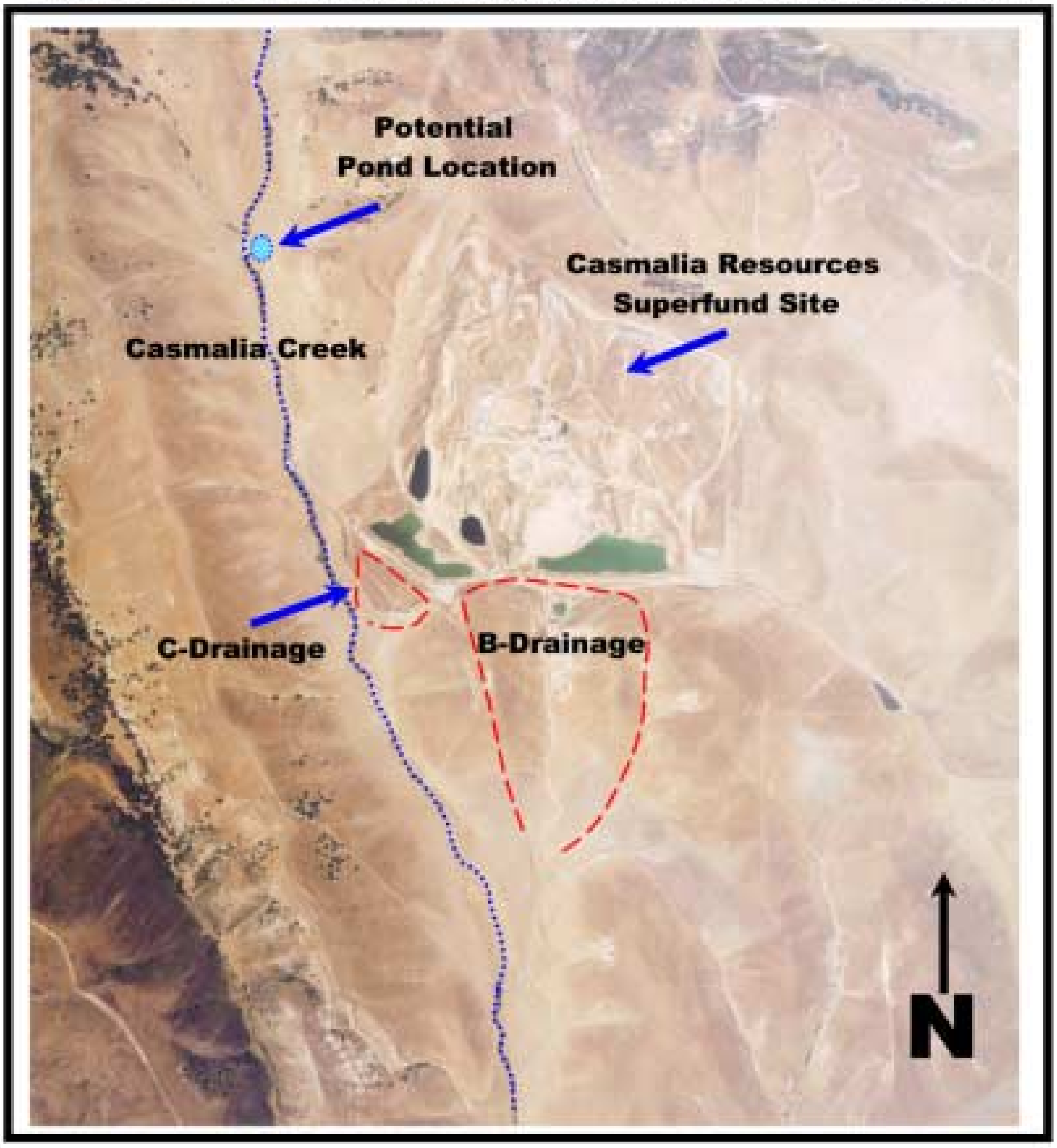
Aerial photos from as early as the 1940s indicate a similar distribution of riparian and upland vegetation over the past 60 years, but do not aid in determining the composition of understory vegetation during this period. Table 7.1 presents a list of vegetation present in the riparian corridor and surrounding area.

7.4.2 Watershed Fauna

Species surveys of the Casmalia Creek riparian corridor conducted from 1998-2000 indicate an array of fauna, as listed in Table 7.2. The current biological community of the creek is impoverished due to the impacts of cattle (EPA 1996, Hunt 2000). In addition to the target species, there are a number of known or potentially occurring federally and state listed, proposed, and candidate species in the vicinity, including, but not limited to: the California tiger salamander (*Ambystoma californiense*), southwestern pond turtle (*Clemmys marmorata pallida)*, least Bell's vireo (*Vireo bellii pusillus)*, and southwestern willow flycatcher (*Empidonax traillii extimus)*.

A 1996 EPA survey of benthic macroinvertebrates in Casmalia Creek indicated a gradient of species diversity and abundance, with declines in both categories in more degraded portions of the watershed impacted by cattle (EPA 1996). The survey found a shift in the composition of benthic invertebrate functional feeding groups in the upper and lower reaches of the creek. In the upper watershed where the cattle density is reduced and the degradation is less apparent, the stream invertebrate community exhibits greater diversity and abundance. The survey indicates a greater proportion of collector-gatherers and collector-filterers in the upper portions of Casmalia Creek and increased filter and deposit feeders in the lower portions of Casmalia Creek. The EPA report indicates this is likely due to the increased nutrient input from cattle excrement in the lower watershed. This elevated nutrient load results in eutrophic conditions and increased bacterial presence that “has had a significant effect on stream benthos” (EPA 1996).

Figure 7.1: Map of B and C-Drainages, and potential pond creation location.



Aerial photo courtesy of Pacific Western Aerial Surveys, Santa Barbara, CA.

Table 7.1: Plant species observed in the Casmalia Creek watershed.

Scientific Name	Common Name	I/N[1]	Habit[2]
Agrostis stolonifera	Creeping bent grass	I	PG
Amsinckia menziesii	Fiddleneck	N	AH
Anagallis arvensis	Pimpernel	I	AH
Anthemis cotula	Mayweed	I	AH
Apium gravolens	Wild celery	I	PH
Artemisia californica	California sagebrush	N	S
Avena barbata	Wild oat	I	AG
Baccharis douglasii	Douglas baccharis	N	PH
Brassica nigra	Black mustard	I	AH
Bromus diandrus	Ripgut grass	I	AG
Bromus hordeaceus	Soft chess	I	AG
Calystegia macrostegia ssp. cyclostegia	Chaparral morning glory	N	V
Capsella bursa-pastoris	Shepherd's purse	I	AH
Carduus pycnocephalus	Italian thistle	I	AH
Cirsium vulgare	Bull thistle	I	AH
Conium maculatum	Hemlock	I	PH
Convolvulus arvensis	Morning-glory	I	V
Distichlis spicata	Saltgrass	N	PG
Erodium botrys	Storksbill	I	AH
Erodium cicutaria	Red-stem filaree	I	AH
Hordeum brachyantherum ssp. californicum	Meadow barley	N	PG
Hordeum leporinum	Foxtail	I	AG
Hordeum marinum	Mediterranean barley	I	AG
Juncus xiphioides	Iris-leaved rush	N	PH
Lepidium niditum	Peppergrass	N	AH
Lolium perenne	Ryegrass	I	PG
Lupinus succulentus	Succulent lupine	N	AH
Malva parviflora	Cheeseweed	I	AH
Medicago polymorpha	Bur clover	I	AH
Mimulus aurantiacus (forma lompocense)	Lompoc monkeyflower	N	S
Nasella pulchra	Purple Needlegrass	N	PG
Pennisetum clandestinum	Kikuyu grass	I	PG
Picris echioides	Prickly ox-tongue	I	AH
Poa annua	Annual bluegrass	I	AG
Polygonum areanastrum	Knotweed	I	AH
Polypogon interruptus	Ditch bread grass	I	AG

Table 7.1: Continued

Scientific Name	Common Name	I/N[1]	Habit[2]
Polypogon monspeliensis	Rabbitsfoot	I	AG
Quercus agrifolia	Coast live oak	N	T
Raphanus sativus	Jointed charlock	I	AH
Rorippa nasturtium-aquaticum	Watercress	I	N
Rumex salicifolius	Willow dock	N	PH
Salix laevigata	Red willow	N	T
Salix lasiolepis	Arroyo willow	N	S
Sanicula arguta	Sanicle	N	PH
Silybum glaucus	Milk thistle	I	AH
Solanum glaucus	Tree tobacco	I	S
Sonchus asper	Prickly sow thistle	I	PH
Sonchus oleraceus	Sow thistle	I	AH
Sorghum bicolor	Sorghum	I	AG
Toxicodendron diversilobum	Poison oak	N	V
Utrica holosericea	Giant creek nettle	N	PH
Vicia sativa	Vetch	I	AH

Adapted from Hunt (2000)

[1] **I/N** **I** Introduced species **N** Native species

[2] **Habit**

AH Annual Herb **PG** Perennial Grass
AG Annual Grass **S** Shrub
PH Perennial Herb **T** Tree
V Vine

Table 7.2: Wildlife species observed in the Casmalia Creek watershed.

The following wildlife species were observed within and adjacent to the Casmalia Creek riparian corridor, along the northern edge of the Shuman Canyon Creek riparian corridor from its confluence with Casmalia Creek downstream for a distance of 1,500 feet, and around the surface runoff storage ponds on the Casmalia Resources Superfund Site.

Pacific treefrog	horned lark (a)
California red-legged frog	common yellowthroat (a)
southwestern pond turtle	Audubon's warbler (b)
western fence lizard	myrtle warbler (b)
southern alligator lizard	common yellowthroat (a)
pied-billed grebe (*,a)	Wilson's warbler (a)
eared grebe (*,b)	western meadowlark (a)
mallard (*)	European starling (a)
gadwall (*)	Song sparrow (a)
greater scaup, female (*,b)	house finch (a)
ruddy duck (*,a)	broad-footed mole
killdeer (*,a)	Botta's pocket gopher
whimbrel (b)	California ground squirrel
long-billed curlew (b)	dusky-footed woodrat
spotted sandpiper (*,a)	raccoon
mourning dove (a)	Viginia opossum
American coot (*,a)	coyote
Red-tailed hawk (a)	bobcat
golden eagle (a)	American badger
American kestrel (a)	blacktailed deer
turkey vulture	
Anna's hummingbird (a)	
Cassin's kingbird (a)	
western kingbird (a)	
black phoebe (a)	
cliff swallow (a)	
violet-green swallow	
bushtit (a)	
oak titmouse (a)	
house wren (a)	
Bewick's wren	
western scrub-jay (a)	
American robin	

(*) observed at the storage ponds at the Site; (a) breeding; (b) wintering or migratory only

Adapted from Hunt (2000)

8.0 Habitat Creation and Restoration Plan

Information discussed in Metapopulation Considerations (Section 4.0), Habitat Requirements (Section 5.0), and Water Budget Analysis (Section 6.0) provided the basis for developing the Habitat Creation and Restoration Plan (Plan). As discussed in Habitat Requirements it was determined that creating ponds and restoring portions of the riparian corridor is the preferred method for providing the target species with suitable breeding and non-breeding habitat. Per the EPA and CBC's request, this Plan focuses on providing the most suitable habitat in the Casmalia Creek riparian corridor. Based upon the opportunities and constraints of the riparian corridor, the following Plan was developed to maximize ponded habitat area while attaining the desired hydroperiod and providing suitable vegetation.

The Plan provides the EPA and CBC with a description of and the rationale for the site selection process as well as methods for creating and restoring habitat in the Casmalia Creek riparian corridor. Although the following Plan was designed to create and restore suitable habitat in the riparian corridor, the majority of the design parameters are applicable to locations throughout the watershed. Appendix 11 (Estimated Plan Costs) presents an estimated cost for the implementation of this Plan based upon the excavation and construction of the pond, the costs of planting vegetation, and the cost of biological monitoring for the created and restored habitat presented in this Plan.

8.1 Pond Site Selection

The following factors, considered when reviewing the Casmalia Creek riparian corridor, allowed for the determination of appropriate pond creation locations:

1. The reliability of sources of water in sufficient volumes to meet the minimum hydroperiod;
2. Topography;
3. Distance between the potential pond location and existing target species locations; and,
4. Distance between the potential pond location and existing exotic predator locations.

It is important to provide a reliable and adequate source of water to the ponds. A reliable and adequate water supply is likely to increase the persistence of vegetation and provide the target species with appropriate habitat.

Locating ponds in topographic low areas, characterized by flat terrain and relatively shallow slopes, will maximize water inputs from natural drainage features (*i.e.* creeks and gullies). In addition, locating ponds in these areas will minimize the amount of excavation required.

Creating ponds within the dispersal range of the target species may facilitate the eventual colonization of the ponds by the target species, if natural migration occurs. In habitats of similar characteristics, dispersal to and colonization of restored wetlands decreases as a negative exponential of distance from source populations (Richter *in litt.* 2001). Therefore, ponds should be located no further than 3 kilometers from existing target species locations, as this is the observed maximum of the their dispersal range (USFWS 2000, M. Wehtje, CDFG, pers. comm. 2001) The colonization and self-sustainability of amphibians in created wetlands depends upon the ability of source populations to disperse into the created ponds (Richter *in litt*. 2001).

The USFWS indicates that exotic predators, particularly bullfrogs have been a significant factor in the decline of the California red-legged frog and pose a threat to western spadefoot toad populations (Jennings and Hayes 1994). In response to this threat, the USFWS recommends that ponds be created at least 1 kilometer from known locations of bullfrogs (USFWS 2000). This distance will discourage the establishment of bullfrogs in the created ponds.

Taking into account the above site selection factors, the location identified in Figure 7.1 is a potential location to create a pond. This location is within the Casmalia Creek riparian corridor where a sufficient and reliable volume of water is present in the form of stormflow, as discussed in Water Budget Analysis (Section 6.0). This location is in a topographic low, characterized by flat terrain and gentle slopes. In addition, the location is approximately 1.5 kilometers from the target species populations in the ponds at the Site and approximately 4 kilometers from Shuman Creek. This location is within the dispersal range of the target species and may allow for the eventual colonization of the pond, if natural migration occurs. Furthermore, this location is a sufficient distance from Shuman Creek to discourage the establishment of exotic predators, which may inhabit this creek.

8.2 Habitat Creation and Restoration Design Parameters

As discussed in Habitat Requirements (Section 5.0), creating ponded habitat, restoring portions of the riparian corridor, and improving range management in the terrestrial upland habitat will likely provide suitable breeding and non-breeding habitat for the various life-stages of the target species. Based on this determination and the site selection process, the following overall goal of the Habitat Creation and Restoration Plan is:

To present a description of and the rationale for possible methods for creating ponded habitat, restoring portions of the riparian corridor, and managing the Casmalia Creek watershed for the benefit of the California red-legged frog & western spadefoot toad.

The following operational goals, based on the overall goal, guided the development of the design parameters presented in Table 8.1:

1. Provide an area of still and/or slow moving water conducive to breeding and larval development, which includes: mating, egg laying, egg development, and larval growth and development by creating a pond which maintains a sufficient depth of water for these activities;
2. Provide a suitable physical habitat structure and vegetation community for breeding and larval development in the pond;
3. Provide additional beneficial non-breeding habitat by restoring the adjacent riparian corridor;
4. Establish the target species within the created and restored habitat; and,
5. Manage the created and restored habitat for the benefit of the target species.

The sections following Table 8.1 detail the rationale for the actions proposed to meet the operational goals.

Table 8.1: Habitat design parameters.

Design Parameters	Action	Description
Pond		
Create a pond that meets the minimum hydroperiod requirements	Excavate a single conical shaped pond at least 3 meters deep at the potential pond location (Figure 7.1). Grade pond slopes at a 1:10 vertical to horizontal ratio. Create a maximum storage capacity of 20,000 cubic meters. Install a pond liner.	1a
Macro and microtopography	Build gently grading slopes (1:10 vertical horizontal); ridges, terraces, and mounds; and shallow depressions on the slopes, the bottom, and the perimeter of the pond.	1b
Capture and store stormflow	Analyze timing, frequency, and magnitude of stormflow events in Casmalia Creek to determine an appropriate method for capturing and storing stormflow to meet the minimum hydroperiod requirements.	1c
Reduce incoming flow velocity	Install a grassed filter strip or other method for reducing flow velocities into the pond.	1d
Outlet control structure	Install an outlet control structure.	1e
Plant vegetation within and around the pond	Seed the pond and upland areas surrounding the pond, and plant cuttings around pond perimeter with native vegetation.	1f
Casmalia Creek		
Stabilize creek banks	Grade unstable slopes and plant native vegetation.	2a
Plant vegetation within and around the riparian corridor	Seed the riparian corridor and upland areas surrounding the corridor and plant cuttings above the high water mark with native vegetation.	2b
Management		
Manage cattle grazing	Exclude cattle from the riparian corridor, pond, and pond buffer zone by constructing a fence line 7 meters from the edge of the pond buffer zone and the upper most part of the creek bank. Actively manage upland grazing.	3a
Manage created and restored habitat to discourage exotic predators and exotic vegetation	Monitor for exotic predators and vegetation and remove.	3b
Monitor for success of the created and restored habitat	Implement monitoring plan to determine success of created and restored habitat.	3c

Continued on next page

Table 8.1: Continued

Design Parameters	Action	Description
Implementation		
Excavate new pond	Excavate pond at least 1 year prior to draining and grading existing water storage ponds	4a
	Complete excavation of the pond prior to wet season	4b
Evaluate natural colonization	Evaluate the extent of natural colonization and, if necessary, initiate relocation of adults and juveniles prior to eliminating ponds	4c
Drain existing ponds at the Site	Drain existing water storage ponds at the Site in a manner that minimizes the adverse affects to target species	4d
Exclude the target species from former ponds at the Site	Establish a barrier around former ponds at the Site.	4e

8.2.1 Pond Design

1a. Create a pond that meets the minimum hydroperiod requirements

Action:
Excavate a single conical shaped pond at least 3 meters deep at the potential pond location (Figure 7.1), with a maximum storage capacity of 20,000 cubic meters. Grade pond slopes at a 1:10 vertical to horizontal ratio and reduce infiltration rates to or below 0.0037 centimeters/hour.

Rationale:
As presented in Water Budget Analysis (Section 6.0), a pond with the aforementioned design parameters met the minimum hydroperiod requirements, outlined in Habitat Requirements (Section 5.0), in the 45 years analyzed while also maximizing the pond's surface area. In addition, a pond with the aforementioned design parameters met the ideal hydroperiod requirements in 38 of the 45 years analyzed and 98% of the days during the hydroperiod. Although grading at a 1:4 vertical to horizontal is common in wetland construction, grading at a 1:10 ratio will further increase soil stabilization as well as provide gradual transition zones. Gradual transition zones will likely increase the viability of wetland vegetation in response to fluctuating water levels.

Creating only one pond is recommended based solely on the desire to provide water for the target species on an annual basis. Although multiple ponds scenarios had similar success to single pond scenarios, limiting the number of ponds to one increases the likelihood of the pond meeting both the minimum and ideal hydroperiod requirements. However, if in discussions with the appropriate Natural Resources Trustees (USFWS and CDFG), it is determined that the risk of the ponds not meeting the minimum and ideal hydroperiod is justifiable given the benefits of creating multiple ponds, the Plan should incorporate a multiple pond scenario outlined in Water Budget Analysis (Section 6.0). The benefits of multiple ponds include a likely diversity of vegetation, microclimates, and hydroperiods. Macro and microtopography, presented below, discusses these benefits further. An additional consideration that may factor into creating multiple ponds, which dry periodically, is ponds that dry periodically will likely limit the establishment and/or the persistence of bullfrogs or fish, as both bullfrog larvae and fish require year round water. However, the balance between providing water on an annual basis to the target species and reducing the likelihood of the establishment and/or persistence of exotic predators must be determined through discussions with the appropriate Natural Resource Trustees (USFWS and CDFG).

As the infiltration rate of soils at the potential pond location is higher than the recommended minimum of 0.0037 – 0.037 centimeters/hour (Pierce 1993), compaction of the soils or installing a pond liner is imperative to increase the likelihood that the minimum and ideal hydroperiod requirements are met. The soils at the potential pond location are a clay loam and it is possible that compaction of in-situ soils will reduce infiltration rates below 0.0037 centimeters/hour. This is typically the easiest and least expensive method of sealing a pond bottom (USDA 1997). However, further field studies are required to determine if this infiltration rate is achievable through compaction. Clay blankets, waterproof linings, and Geotextiles are alternative methods for lining the pond if compaction will not adequately reduce the infiltration rate. Regardless of the method chosen, place 40 to 60 centimeters of soil cover over the liner to provide a sufficient rooting depth to support pond vegetation (Hammer 1997).

1b. Macro and microtopographic features

Action:
Create macrotopography by building gently grading slopes (1:10 vertical horizontal) and by building ridge and swale complexes within the ponds by incorporating ridges, terraces, and mounds on the slope and bottom of the pond. Create microtopography by excavating shallow depressions on the slopes, bottom, and perimeter of the pond. Create ridge and swale complexes within the ponds by incorporating ridges, terraces, and mounds on the slope and bottom of the pond.

Rationale:
Macro and microtopography add to the complexity of ponded habitat, similar to the benefits of multiple ponds, by creating a diversity of vegetation, microclimates, and hydroperiods (USDA 2000). Creating a variety of habitats will increase the heterogeneity of the pond, which is likely to benefit the target species by allowing individuals in different life stages to inhabit those areas they deem most suitable (Lawler *et al.* 1999). Variations in the timing, depth, and duration of the hydroperiod may also aid in the dispersal, germination, and establishment of a range of vegetation species (USDA 2000).

Gently graded shorelines, identified by the literature as common in wetland design will reduce erosion rates and allow for a gradual shift in vegetation species (USDA 1997, Mitsch and Gosselink 2000). Reduced erosion adds to the stability of ponds and a gradual shift in vegetation will provide a gradient of functional vegetation types, which in turn provides a range of temperature regimes.

Water levels within the pond will vary from year to year during the minimum hydroperiod. Creating macrotopographic features will likely provide the necessary deepwater regions, while also providing the shallower perimeter regions known to be important areas for breeding, foraging, and cover (USFWS 2000). A wetlands ecologist in the State of Washington observed that for the northern red-legged frog (*Rana aurora aurora*), macrotopography, in the form of terraced slopes, created a medium water depth that provided the optimal temperature regime. (Richter *in litt.* 2001). Further, these areas reduced desiccation in this species resulting from water surface fluctuations and declines (Richter *in litt.* 2001).

1c. Capture and store stormflow

Action:
Before initiating habitat creation and restoration activities, analyze the timing, frequency, and magnitude of stormflow events in Casmalia Creek. This will allow for the determination of an appropriate method for capturing and storing stormflow to meet the minimum and ideal hydroperiod requirements outlined in Habitat Requirements (Section 5.0).

Rationale:
A suitable method for capturing and storing stormflow is necessary to meet the minimum and ideal hydroperiod requirements. However, the lack of flow data for Casmalia Creek hindered the analysis necessary to make design decisions regarding methods for capturing and storing stormflow. Although a detailed analysis was not possible, two potential methods for capturing and storing stormflow are:

1. An off-stream pond created by enhancing the creek's floodplain storage capacity; and,
2. An off-stream pond created by diverting stormflow through piping or a channel.

Enhancing the natural floodplain's storage capacity by excavating ponds in the current floodplain of the creek can create an off-stream pond. Using a portion of the excavated material to create a berm between the creek and the pond, and a low dam around the lower end and sides of the pond will increase its storage capacity. The height of the berm between the creek and the pond would be set such that stormflow over a certain flow rate, predetermined to capture a large enough volume of water to persist through at least the minimum hydroperiod, would overtop the berm.

Excavating a pond in close proximity to the creek and diverting stormflow through a channel or pipe can create an off-stream pond. The size of the channel or pipe and height of the inlet would be such that stormflow over a certain flow rate, predetermined to supply the volume necessary to persist through at least the minimum hydroperiod, would flow through the channel or pipe.

Analyzing the timing, frequency, and magnitude of stormflow events in Casmalia Creek will provide the necessary data to make design decisions regarding methods for capturing and storing stormflow. These data will allow for the determination of the height of the berm between the creek and the pond if creating a pond by enhancing the creek's natural floodplain storage capacity. If the pond is created by diverting stormflow, these data will allow for the determination of the size of the channel or pipe as well as the height of the inlet. It is imperative to collect these data to ensure a sufficient amount of water is captured to at least meet the minimum hydroperiod. Both methods are generally accepted by federal and state agencies, which include the United States Army Corps of Engineers (USACE), the USFWS, the CDFG, and the RWQCB. In addition, both methods have been used extensively to create wetlands and detention ponds throughout the United States.

1d. Reduce incoming flow velocity

Action:
Install a grassed filter strip or other method in the inflow channel of the pond to create a high enough roughness coefficient (Manning's n) to significantly reduce incoming flow velocity. The size of the filter strip or other method and required Manning's n value will be determined based on the estimated incoming flow velocity, the size of the pond, the method chosen to capture and store stormflow, as well as the sediment transport capacity of Casmalia Creek.

Rationale:
Regardless of the method chosen to capture and store stormflow, a method to reduce the flow velocity of water entering ponds should be incorporated to minimize potential affects to the target species during breeding and larval development. This method will also serve to reduce erosion and sedimentation rates within the pond. Similar to the effects of high flow velocities in creeks, high flow velocities entering the pond may negatively affect reproductive success of the target species by precluding breeding, limiting fertilization success, dislodging or otherwise damaging eggs, and displacing larvae (USFWS 2000). In addition, high velocity flow may also increase scouring of pond slopes, thereby increasing erosion of the pond slope and negatively affecting vegetation. Negative effects to vegetation include uprooting, removal of seeds, and direct damage to the individual plants.

The sediment carrying capacity of Casmalia Creek is not characterized and the likely rate of sedimentation in the pond is not well understood. However, inclusion of a method for reducing incoming flow velocities will likely reduce the rate of sedimentation by allowing for the settling of a portion of the suspended sediment before it reaches the pond. This will reduce the frequency of excavation to maintain a storage capacity to meet the minimum hydroperiod.

1e. Outlet control structure

Action:
Install an outlet control structure in the pond to pass excess stormflow.

Rationale:
Installing an outlet control structure, such as a spillway, will regulate excess water and control water levels so that they remain below the maximum pond depth. This will reduce the likelihood that vegetation, planted on the perimeter of the pond, is inundated, which would reduce the probability of its successful establishment and persistence. In addition, it will prevent uncontrolled releases from the pond, which may undermine the pond's structural integrity.

1f. Plant vegetation within and around the pond

Action:
Vegetation Recommendations (Section 8.3) presents the appropriate vegetation species as well as planting methods and timing.

Rationale:
As discussed in Habitat Requirements (Section 5.0), the presence of appropriate vegetation within and around ponds will likely provide the target species with habitat conducive to meeting their needs.

8.2.2 Casmalia Creek Design

2a. Stabilize creek banks

Action:
Grade areas of the riparian corridor 1 kilometer up and downstream of the created pond where unstable slopes (slopes greater than 70 degrees), deeply incised channels, and regions of active mass wasting exist to a slope no steeper than 45 degrees to stabilize the creek banks and reduce sediment loads. After completing grading activities, plant native vegetation as outlined in Vegetation Recommendations (Section 8.3).

Rationale:
Stabilizing creek banks will reduce erosion rates, subsequently reducing sedimentation in the pond, and will enhance the establishment of riparian vegetation. Accelerated bank erosion results in increased sediment loading and has a variety of negative effects. These include: a reduction in primary productivity, a reduced dissolved oxygen level, and a

reduction of overall water quality. Accelerated erosion rates will increase the sedimentation of plunge pools and negatively affect potential riparian breeding habitat (USFWS 2000). In addition, stable creek banks, upstream of the created pond, will likely reduce sedimentation of the pond.

Stabilizing the creek banks will also likely increase the ability of planted riparian vegetation to become established. Once established, the riparian vegetation in turn acts to stabilize the banks and reduce erosion.

2b. Plant vegetation within and around the riparian corridor

Action:
Vegetation Recommendations (Section 8.3) presents the appropriate vegetation species as well as planting methods and timing.

Rationale:
As discussed in Habitat Requirements (Section 5.0), the presence of appropriate vegetation within and around the riparian corridor will likely provide additional habitat for foraging and predator avoidance. This may also increase the likelihood of the creek acting as a dispersal corridor for the target species.

8.2.3 Management

3a. Manage cattle grazing

Action:
Exclude cattle from the riparian corridor, the pond, and the pond buffer zone by constructing a fence line 7 meters from the buffer zone and the upper most part of the creek bank. Fencing does not need to encompass the entire pond or riparian corridor if cattle are excluded from these areas by other means, such as sectional fencing.

A comprehensive active management plan for grazing upland areas should be developed and implemented. Several active management techniques include:

- Reducing the number of cattle;
- Increasing upland cattle dispersion by utilizing salt blocks;
- Grazing mobile livestock, such as stockers, resulting in greater cattle distribution; and,
- Incorporating deferred grazing by alternating and excluding pastures with fencing.

Furthermore, the management plan for cattle grazing must evolve as conditions in the watershed can change on a seasonal and annual basis. This will require the active participation of the land manager to monitor the effects of management techniques and to determine appropriate adjustments to the management plan. Appendix 8 (Success and Monitoring Criteria) presents methods for monitoring the effects of cattle management.

Rationale:
Poorly managed rangeland can have negative impacts on wetland and riparian habitat (USFWS 2000). These negative impacts include a reduction or loss of vegetative cover resulting from direct browsing and trampling, increased upland and bank erosion resulting in greater sediment load, reduction in plunge pools, increased stream width, greater soil compaction, decreased forage production, altered species composition, elevated fecal coliform, altered stream water chemistry, and increased runoff and higher water temperatures (USFWS 2000). Each of these negative impacts can reduce the suitability of breeding and non-breeding habitat for the target species.

Conversely, research indicates that properly managed grazing may "enhance riparian vegetation and protect stream banks", suggesting that both grazing and protection of habitat is possible. (Buckhouse, Knight, and Skovlin 1981, Bohn and Buckhouse 1985, Buckhouse and Bunch 1985). However, as noted in Current Watershed Characteristics (Section 7.0), the biological community of the Casmalia Creek watershed is impoverished due to impacts resulting from cattle overgrazing (EPA 1996, Hunt 2000). Currently cattle in the watershed are not managed in a manner conducive to protecting the riparian habitat or minimizing effects of grazing on upland habitat. Therefore, if cattle ranching is to continue in the Casmalia Creek watershed, the aforementioned or similar methods of exclusion or active management strategies should be instituted.

3b. Manage created and restored habitat to discourage exotic predators and exotic vegetation

Action:
Vegetation Recommendations (Section 8.3) presents methods for dealing with exotic vegetation during habitat creation and restoration site preparation. In addition, Appendix 8 (Success and Monitoring Criteria) presents methods for monitoring for and dealing with exotic predators and vegetation upon completion of restoration activities.

Rationale:
As discussed in Habitat Requirements (Section 5.0), exotic predators such as bullfrogs and introduced fish have been a significant factor in the decline of the California red-legged frog (USFWS 2000). In addition, exotic vegetation is problematic as it may out-compete native vegetation, which provides the functional roles required by the target species.

3c. Monitor for success of the created and restored habitat

Action:
Develop and implement success and monitoring criteria based on goals to promote the landscape success and biological, or functional success, of the ecological regime in the created and restored habitat in order to sustain the status of the target species. Select two to five wetland/pond reference sites in watersheds that exhibit similar characteristics and provide a baseline standard for hydrological and biological function. Appendix 8 (Success and Monitoring Criteria) outlines the appropriate success and monitoring criteria.

Rationale:
The identification of appropriate monitoring methods and the quantification of success criteria are essential for determining the success of the Habitat Creation and Restoration Plan and its subsequent implementation. Monitoring and success criteria provide for an assessment of the different components of habitat creation and restoration, and may identify the need for adaptive management to attain the desired conditions. Furthermore, monitoring will provide information that can be used to design adaptive management plans to deal with deficiencies in the habitat creation and restoration plan and/or its implementation, if necessary.

The use of reference sites is widely advocated in wetland creation and restoration. The USACE identify the benefits of reference sites as providing a model for developing restoration actions, providing a target standard for developing performance goals and evaluating performance, and providing a control by which to assess natural fluctuations (*e.g.* drought) at the created and restored habitat relative to the control (Thom and Wellman 1996). Further, concurrent monitoring in reference sites may assist in identifying regional trends that may aid in understanding dynamics at the created and restored site.

8.2.4 Implementation

4a. Excavate new pond

Action:
Excavate the created pond at least 1 year prior to draining and grading the existing water storage ponds.

Rationale:
Creating the pond at least 1 year prior to eliminating the existing water storage ponds will allow vegetation to establish and potentially allow the target species to disperse to the created and restored habitat. Numerous researchers indicate that constructed wetlands that offer the appropriate vegetation and hydrologic regime, and are located in proximity to existing wetlands, will experience natural colonization by fauna (Hammer

1997, Broome 1990, Brooks 1990). Created and restored habitat in the Casmalia Creek riparian corridor should be in place for at least one year prior to the elimination of the existing habitat to allow an opportunity for natural colonization to occur. Natural colonization to the created and restored habitat is possible, as it is located within the dispersal range of the target species. However, there is a lack of similar cases as well as limited colonization data for the target species, thus it is speculative to estimate the extent of colonization that may occur. Previous studies of wetlands created for amphibians indicate that there is no guarantee that species will establish in the new habitat on their own; therefore, it is critical to monitor the extent of natural colonization occurring at the created and restored habitat (Pechmann *et al.* 2001)

4b. Excavate new pond

Action:
Complete the excavation of the pond prior to the onset of the wet season, which typically begins in December.

Rationale:
Excavating before the wet season will allow the target species to utilize the new pond for breeding and development. Further, excavating during the wet season poses a substantial risk of damaging or disrupting breeding activities of the target species as well as making construction more difficult.

4c. Evaluate natural colonization

Action:
Monitor the number of individual members of the target species occurring in the created and restored habitat to determine the extent of natural colonization. Consult with the Natural Resource Trustees (USFWS and CDFG) to determine if an acceptable level of natural colonization is occurring. If an acceptable level of colonization has not occurred, initiate relocation per consultation with the Natural Resource Trustees. If necessary, relocate juveniles and adults in the late summer/early fall once most of the metamorphs have transformed into juveniles. This is the recommended method as relocating tadpoles and egg masses may result in greater mortality and is thought to be less successful than moving adults.(S. Christopher, UCSB, pers. comm. 2001 and T. Hoovey, CDFG, pers. comm. 2001).

For the purpose of this report, the term relocation denotes a manual movement of an individual or population of the target species from one area to another. Relocation of Target Species (Section 8.4) presents several methods for manually relocating these species to the created and restored habitat as well as their corresponding advantages and disadvantages.

Rationale:
Relying upon either natural colonization or relocation poses potential risks to the establishment of the target species in the created and restored habitat. Natural colonization may not occur to the extent desired, or may not occur at all. In discussing the colonization of the created ponds with UCSB Professor Sam Sweet, he indicated that if the target species are left to colonize the new habitat on their own they might disperse in all directions (S. Sweet, UCSB, pers. comm. 2001), likely reducing the number of individuals that reach the created habitat. It is essential to monitor the created and restored habitat to assess the extent of natural colonization and allow for the determination, after consultation with the Natural Resource Trustees (USFWS and CDFG), if manual relocation is appropriate.

Research by Rathbun and Schneider of translocated California red-legged frogs in the Guadalupe Dunes in central coastal California, indicate that there are numerous risks associated with relocating the California red-legged frog. They conclude, as did previous researchers examining other species, that efforts to "save" a species through relocation may be fruitless or even potentially harmful (Rathbun and Schneider *in litt* 2001). The risks of relocation include genetic mixing, disease transmission between populations, and disrupting behavior patterns (Rathbun and Schneider *in litt* 2001). However, if the draining and grading of the existing storage ponds proceeded, it would undoubtedly also pose a significant risk of mortality to the target species. In previous instances of creating wetlands for endangered and threatened species, researchers concluded that the constructed wetlands should be stocked rather than relying solely on natural colonization (Pechmann *et al.* 2001). Similarly, other research indicates the likely need to relocate rare species into created wetlands (Erwin 1990). Therefore, if the created and restored habitat has not been adequately colonized prior to the elimination of the ponds at the Site, then relocation may be necessary. If relocation occurs, relocating tadpoles in springtime is a potential option. If juveniles and adults are relocated, this should occur during the dry late summer/early fall months. Relocating at this time may reduce the California red-legged frog's natural propensity for "homing" back to their initial habitat. Discouraging homing is an important consideration as this behavior may expose individuals to greater risk of predation and desiccation (Rathbun and Schneider *in litt* 2001).

4d. Drain existing ponds at the Site

Action:
Gradually drain existing water storage ponds at the Site beginning in early winter.

Rationale:
Draining the existing ponds gradually over the course of several weeks or months may encourage the target species to relocate to other habitats as the ponds diminish. Typically, the target species' greatest dispersal occurs during the wet season. Encouraging the target species to disperse during the wet season may pose comparatively less threat to juvenile and adults than dispersal during the dry season when the risk of

desiccation is greater (S. Christopher pers. comm. 2001). Draining the ponds during the wet season will pose a threat to larvae, but juveniles and adults of both target species have greater importance in terms of reproduction and the overall persistence of the population. Appendix 7 (Construction Guidelines) presents methods for reducing potential effects during the draining the ponds.

4e. Exclude the target species from former ponds at the Site

Action:
Establish drift fences, or other such barriers, in conjunction with pitfall traps, to encircle the former ponds at the Site to effectively capture the target species and prevent their attempts to recolonize these areas (Sutherland 1996). The use of pitfall traps may result in mortality of individuals due to desiccation, drowning, or predation. Therefore, it is necessary to check traps daily during the breeding season and relocate individual species to the created and restored habitat to reduce the likelihood of mortality.

Rationale:
Many amphibians are philopatric and demonstrate fidelity to their natal ponds (Pechmann *et al.* 2001). Researchers observed frogs and toads returning to former breeding sites even after the ponds had been drained and filled with soil (Pechmann *et al.* 2001). As discussed, the target species express an inclination for "homing" behavior and often return to the same breeding habitat annually (Rathbun and Schneider *in litt* 2001). Due to this tendency, it is necessary to prevent the target species from recolonizing their former habitat at the Site.

8.3 Vegetation Recommendations

As discussed in Habitat Requirements (Section 5.0), appropriate vegetation within and around ponds provides the target species with vegetation conducive to meeting their habitat needs. For this report, the various species of vegetation have been categorized into three functional groups that fulfill the target species' vegetative habitat requirements. The three functional groups are: egg attachment, cover in water, and canopy cover. Each of these functional groups is comprised of several species of vegetation, some of which may provide multiple functional roles and are included in more than one group. Tables 8.2 presents native species appropriate for creating the functional groups within and around the created ponds and restored reaches of the creek. Seeds and cuttings used for planting should be collected locally, preferably within the local watershed, as this will help to preserve the genetic integrity of the populations.

8.3.1 Pond Vegetation

Seed the upper two-thirds of the pond slopes with the native species that make up the egg attachment and cover in water functional groups. Seeding the ponds will allow vegetation to establish a natural vegetation zonation, which reflects the hydrologic and soil conditions (W. Ferren, UCSB, pers. comm. 2001). Transplanting vegetation to the pond would presume an artificial pattern of establishment. Plant the vegetation species that make up the canopy cover functional group as seeds and cuttings around the perimeter of ponds where they are less susceptible to inundation. Dispersing seeds in both the pond and around its perimeter will provide a stock of seeds to establish a seed bank of native species.

Establish a vegetated buffer zone of 75 meters around the pond perimeter with native upland species, such as those outlined in Table 8.3.

8.3.2 Creek Vegetation

After completing non-vegetative bank stabilization activities in the riparian corridor, seed the creek banks in these areas with each of the vegetation species that make up the egg attachment and cover in water functional groups. Immediately following seeding, cover creek banks with natural fiber netting, such as jute or coconut. In addition, in areas where the canopy cover functional group is absent, plant the vegetation species that make up the this functional group as seeds and cuttings above the high water mark in the creek channel where they are less susceptible to inundation.

8.3.3 Exotic Vegetation

Table 7.1 presents a list of observed vegetation in the Casmalia Creek watershed including exotic species. Remove these exotic species, and other problematic exotic vegetation, prior to planting native vegetation. Appendix 7 (Construction Guidelines) presents methods for dealing with exotic vegetation during habitat creation and restoration site preparation. In addition, Appendix 8 (Success and Monitoring Criteria) presents methods for monitoring for and dealing with exotic vegetation upon completion of habitat creation and restoration activities.

Table 8.2: Native species to plant in created and restored habitat.

Species	Functional Group	Timing of Planting	Method of Establishment
Eleocharis sp. (Spikerush)	Egg attachment	Mid-December	broadcast seeding
Juncus sp. (Rush)	Egg attachment	Mid-December to Mid-March	broadcast seeding
Carex sp. (Sedge)	Egg attachment	Mid-December to Mid-March	broadcast seeding
Hydrocotyle verticillata (Marsh pennywort)	Egg attachment	Mid-December to Mid-March	broadcast seeding
Typha sp. (Cattail)	Egg attachment/ Cover in Water	Mid-December	broadcast seeding
Scirpus sp. (Bulrush)	Egg attachment/ Cover in Water	Mid-December	broadcast seeding,
Lemna sp. (Duckweed)	Cover in Water	Mid-December	broadcast seeding
Populus sp. (Cottonwood)	Canopy cover	Mid-December to Mid-March	cuttings, plant same day of cutting
Salix sp., *(Salix lasiolepis)* (Willow)	Canopy cover	Mid-December to Mid-March	cuttings, 2 feet of cutting should be below ground, protect soil surface with mulch[1], plant same day of cutting in areas of moist soil, two to five feet apart[2]

[1] L. Brown SAIC, Inc
[2] Earth Technology Corp. 1990

Table 8.3: Potential vegetation for buffer zone.

Species	Type
Artemisia (California Sagebrush)	Shrubs
Baccaris pilularis (Coyote Brush)	Shrubs
Lupinus arboreus (Bush Lupine)	Shrubs
Grindelia Latifloia	Herb
Hemizonia increscents	Herb
Spergularia macrotheca	Herb
Stipa pulchra (Purple Needlegrass)	Grass
Hordeum californicum (Meadow Barley)	Grass
Distichlis spicata (Saltgrass)	Grass

8.4 Relocation of Target Species

As discussed above in 4c, the target species may need to be relocated from ponds at the Site to the created and restored habitat. If it is determined that relocation is necessary, manually relocate adults and juveniles of both target species to the created and restored habitat. This is the recommended method as relocating tadpoles and egg masses may result in greater mortality and is thought to be less successful than moving adults. (S. Christopher, UCSB, and T. Hoovey, CDFG, pers. comm. 2001). Further, juveniles and adults of both target species are the most important life stage in terms of reproduction and population persistence.

Capture juveniles and adults for relocation using a combination of techniques including dip netting, hand captures, and possibly drift fencing with pitfall traps. If drift fences are used, check often to avoid mortality of the target species. Relocate these life stages during the late summer/early fall once most of the metamorphs have transformed into juveniles. CDFG biologist Tim Hovey recommended moving western spadefoot toads just after metamorphosis, as the toadlets typically complete metamorphosis and emerge from the water over several days, facilitating efforts to capture and translocate these individuals. Adults should be moved to an upland area that has burrowing and foraging habitat. The California red-legged frog is rarely found far from water during the dry season (USFWS 2000) and may be less inclined to return to the Site once it has been relocated. Table 8.4 presents the advantages and disadvantages of the various methods for capturing the target species for relocation.

Manually relocating juvenile and adult individuals of the target species also provides an opportunity for “tagging” individuals. Tagging of individuals will assist in monitoring the target species, determining the success of habitat creation and restoration as well as relocation. Insert PIT tags into every adult as they are relocated to the created and restored habitat. Although some individuals may be too small, tag every individual that is large enough in order to increase the chances of recapturing some in subsequent years. Tagging only a few of the original populations would likely result in the failure to recapture any tagged individuals in subsequent sampling/monitoring periods. Table 8.5 outlines other methods of tagging amphibians and the associated advantages and disadvantages. Monitoring of the target species using tagging and other methods is discussed further in Appendix 8 (Success and Monitoring Criteria).

Table 8.4: Capture methods for amphibians.

Capture Method	Advantages	Disadvantages	Description
Dip nets	Multiple life stages can be sampled	Disturbance to breeding activities	Sweep dip nets through aquatic habitat
Hand capture	Little risk of mortality	Potential to spread disease, difficult to capture adults	Use both hands to carefully capture an individual
Drift fences with pitfall traps	Capture many individuals	Possible mortality due to dehydration or drowning time and labor intensive	A fence encircling a pond with containers in the ground to capture animals

Adapted from Sutherland 1996; Rathbun and Schneider *in litt.* 2001

Table 8.5: Tagging methods for amphibians.

Tagging Methods	Advantages	Disadvantages	Description
Toe-clipping	Inexpensive, simple, quick, long-term monitoring potential (Sutherland 1996)	Pain, proper function often inhibited, infection (S. Christopher, UCSB, pers. comm. 2001)	Clip digits (toes) with nail clippers or scissors in a unique pattern, no more than one toe is clipped per foot (Ministry of Environment 1998) (Sutherland 1996)
PIT Tags	Very small, complications are rare (Phillip 1994, Ministry of Environment 1998)	Expensive reader, some stress and discomfort, smaller individuals cannot be tagged (Ministry of Environment 1998)	A PIT tag is inserted into the skin and the radio signal is read with a hand-held reader (Phillip 1994)
Radio-tags	Track movement, aid in locating individuals, a range of 100 meters on land (Rathbun and Murphy 1996)	Expensive equipment, transmitter failures, possible mortality from drowning, possible skin abrasions, transmitters may be shed (Rathbun and Murphy 1996)	A waist-belt can be slipped onto individuals (Rathbun and Murphy 1996)

Adapted from Sutherland 1996

8.5 Construction Guidelines

As construction activities may adversely affect wildlife in the construction areas, guidelines and minimization measures should be established and followed to reduce possible consequences of these activities. Therefore, follow guidelines presented in Appendix 7 (Construction Guidelines) to ensure the protection of the target species before and during construction activities.

8.6 Success and Monitoring Criteria

The quantification of success criteria and the identification of appropriate monitoring methods are essential for determining the success of the Plan and its subsequent implementation. In addition, information provided by monitoring will serve to build the appropriate knowledge base to develop adaptive management for the created and restored areas. Success and Monitoring Criteria presented in Appendix 8 (Success and Monitoring Criteria) are based on goals to promote the landscape success and biological, or functional success of the ecological regime, in the created and restored habitat in order to sustain or improve the status of the target species. Plant cover, sedimentation, erosion, and water availability are landscape features readily observable. For biological characteristics such as target species population dynamics, dispersal, and predatory potential, the habitat restoration project will be considered successful when the criteria listed in Appendix 8 (Success and Monitoring Criteria) are met.

8.7 Evaluation

The EPA and CBC requested a habitat creation and restoration plan to allow for the establishment of the California red-legged frog and western spadefoot toad in the Casmalia Creek riparian corridor. In order for the target species to successfully establish in the created and restored habitat, the habitat must be both conducive to the needs of the target species as well as accessible to the target species. Therefore, the Habitat Creation and Restoration Plan (Section 8.0) was developed to create habitat suitable to the needs of the target species within the dispersal range of the individuals at the Site while maximizing the habitat area as constrained by the availability of water in the riparian corridor, as discussed in Water Budget Analysis (Section 6.0). The Plan was analyzed to determine the likelihood that it would provide habitat conducive to the successful establishment of the target species in the riparian corridor. The analysis focused on four considerations that are critical in assessing the Plan's ability to meet the EPA and CBC's objective. These considerations are:

1. The reduction in the volume of flow downstream of the potential pond location;
2. The plausibility of the target species establishing in the created and restored habitat based on its proximity to existing populations at the Site;
3. The likelihood of the created and restored habitat to provide suitable habitat conducive to the establishment and persistence of individual members of the target species; and,
4. The likelihood the created and restored habitat is capable of supporting the target species at population sizes equivalent to those currently at the Site.

8.7.1 Reduction in downstream flow

The potential reduction in the volume of total annual flow and annual stormflow were evaluated in Water Budget Analysis (Section 6.0). Altering the natural flow regime by capturing stormflow will reduce the volume of water to downstream biota and may alter in-stream habitat (Allan 1995) in downstream portions of Casmalia Creek and its receiving tributary, Shuman Creek. Changes to physical processes may include an alteration in sediment transport processes and a change in channel structure (Allan 1995). Stormflow events serve an important functional role in channel maintenance, including removing fine materials from the channel bed, scouring encroaching vegetation, and flushing anoxic waters from pools (Gordon, McMahon, Finlayson 1992). However, researchers indicate that determining the biological response to an altered flow regime is imprecise (Gordon, McMahon, Finlayson 1992, Allan 1995).

For the pond outlined in the Plan, the Water Budget Analysis indicates that total annual flow through Shuman Creek was reduced on average by approximately 4%. Further, stormflow through Casmalia Creek was reduced by 10% in 1 out of every 2 years and by 100% in 1 out of every 11 years. Determining in-stream flow requirements for biota is hindered by both the lack of understanding of potential biological response to a reduction in flow as well as the lack of flow data in Casmalia Creek and Shuman Creek. However, the reduction in flow volumes represents a potentially significant percentage, particularly in low-flow years, and therefore may have an adverse impact on downstream biota, an issue of elevated concern due to the presence of the federally endangered tidewater goby (*Eucyclogobius newberryi*) in Shuman Lagoon.

8.7.2 Plausibility of target species establishment

The plausibility of the target species establishing in the created and restored habitat was evaluated based on the proximity to the existing populations at the Site. The distance between the existing habitat at the Site and the potential pond location is 1.5 kilometers, which is within the target species' dispersal distance. As discussed in Metapopulation Considerations (Section 4.0), observations indicate the target species are capable of dispersing up to 3 kilometers over the course of the wet season. No major barriers to dispersal would exist between the target species current habitat and the created habitat or Casmalia Creek. Additionally, the proposed restoration along Casmalia Creek is located within 0.5 kilometer of the existing habitat at the Site and within 2.5 kilometers of Shuman Creek. Surveys indicate the presence of California red-legged frogs in Shuman Creek. Restoring the Casmalia Creek riparian corridor provides habitat benefits to the target species and improves the contiguity with Shuman Creek. Restoring Casmalia Creek may facilitate its potential use as a dispersal corridor for the target species and potentially improve the connectivity to other populations.

8.7.3 Suitable habitat

As discussed in Habitat Requirements (Section 5.0), the target species require ponded or slow moving water for breeding. The Plan provides the methods and rationale for creating ponded habitat suitable to meet these needs. It was determined, in Water Budget Analysis (Section 6.0), the Plan pond design will likely meet the minimum hydroperiod requirements. In addition, because riparian habitat is beneficial to the target species, the Plan identifies methods and rationale for restoring portions of the riparian corridor. Furthermore, upland habitat is necessary for the target species and as such, the Plan provides the methods and rationale for restoring portions of upland habitat. Lastly, due to the negative effects of overgrazing on riparian, upland, and ponded habitat, the Plan suggests methods for actively managed grazing to minimize its effects. As such, the Plan provides the methods and rationale for creating and restoring habitat conducive to the establishment and persistence of the target species in proximity to existing populations at the Site. Therefore, it is plausible that the target species at the Site may disperse to the created and restored habitat and that this habitat will likely be conducive to their establishment and persistence.

8.7.4 Supporting equivalent populations

As it was determined that the Plan will likely provide suitable habitat conducive to the target species' establishment and persistence and it is plausible they will disperse into the habitat, a subsequent analysis of the Plan assessed the likelihood that the created habitat would support the target species at population sizes equivalent to those currently at the Site. The lack information pertaining to the target species hindered this analysis. Specifically, there are no data indicating the population sizes of the target species at the Site, and there is a lack of data regarding their general breeding and non-breeding spatial requirements. Further, although the cumulative area inhabited by the target species at the Site is 25 acres, the water storage ponds are predominated by deep, open water zones, and as such are not likely providing high quality habitat in the majority of the 25 acres. Nevertheless, estimating the percentage of habitat that provides direct and indirect benefits to the target species remains speculative.

The size of the current populations, the general spatial requirements of the target species, and the area of the ponds used by the target species are unknown, considerably hindering an accurate assessment of the Plan's ability to support future populations equivalent to those currently at the Site. Therefore, the evaluation focused on the known information; specifically, that reducing habitat area will increase target species population density. However, density dependence in the target species is not thoroughly characterized, although research examining other amphibian species indicates that density dependent larvae population regulation may be quite extensive (Anholt and Werner 1995), and has important implications on larval development and species mortality. Consequently, the evaluation focused on the effects of density on anurans in general.

Larval anurans may modify their activities in response to a new environment in ways that influence both predation risk and resource acquisition (Anholt and Werner 1995). In reviewing numerous amphibian experiments, University of Virginia Professor H.M. Wilbur concluded that "survival is an exponentially decreasing function of initial density, in part because as density is increased, reduced growth rate leads to a decreasing probability that an individual will obtain the minimum size threshold for metamorphosis before the pond dries or freezes" (Wilbur 1997). Studies of amphibians indicate that density dependence influences the timing of metamorphosis, affecting larval growth rates and larval survival, and body-size at metamorphosis, which have long-term effects on adult survival and fitness (Wilbur 1997).

Further, increasing density is likely to intensify competition for resources, which is a leading cause of larval mortality (Wilbur 1987). Crowding of larvae, particularly due to a reduction of pond area, can lead to growth inhibition and cannibalism. However, in some cases, greater competition, which can be brought on by increased density, may result in improved reproductive success and benefit the population. Specifically, it may allow individuals to grow at the expense of others, *i.e.* large larvae may survive at the expense of small larvae (Griffiths 1997). Additionally, increased density may also affect competition for breeding habitat among adults, as a degree of territoriality and aggressive behavior may be common in anurans (Whitford 1967).

8.7.5 Conclusion

The lack of information regarding the size of the current population, the area of the ponds used by the target species, and the effects of increased density, considerably limited an assessment of the Plan's ability to support populations equivalent to those currently at the Site. Although a reduced area providing higher habitat quality may sustain equivalently sized populations, it is uncertain the degree to which a reduction in habitat area will affect the target species at the Site. Eliminating the existing water storage ponds and implementing the Plan will result in 2.8 acres of ponded habitat, which is approximately a 10-fold reduction in ponded habitat area. As the effects of reducing habitat are not fully understood and the potential effects of increased density include a decrease in larval survival rates and increased competition between adults, a prudent approach to providing habitat must be taken. As such, implementing a plan that will result in a 10-fold reduction in area is inadvisable. Therefore, due to the considerable reduction in habitat area and the possible effects of increased density, it is unlikely the Plan will provide sufficient habitat area to support populations equivalent to those currently at the Site.

Although the Plan is not likely to provide sufficient habitat area to support populations equivalent to those currently at the Site, it does provide the methods and rationale for creating and restoring habitat conducive to the establishment and persistence of the target species within proximity to existing populations. As such, the methods and rationale for creating and restoring habitat are transferable to other areas within the watershed, where habitat area is not limited by water availability in Casmalia Creek. Recommendations (Section 9.0) suggest alternative sites for locating created and restored habitat that could provide suitable habitat of larger area for the target species.

9.0 Recommendation

As discussed in Evaluation (Section 8.7), altering the natural flow regime of Casmalia Creek may affect the structure and function of physical processes downstream and potentially adversely affect biota. In addition, there are a number of uncertainties regarding the target species, including the size of the current populations at the Site, the spatial habitat requirements of the species, and the extent of habitat area within the water storage ponds used by the species. Due to this lack of information, the ability of the Habitat Creation and Restoration Plan to support populations equivalent to those currently at the Site is questionable, particularly given the 10-fold reduction in habitat area and the potential resulting density dependent effects. Therefore, it is inadvisable to implement a plan that substantially reduces habitat area, particularly because planning for the conservation of threatened and sensitive species necessitates a greater degree of prudence. Although it is not recommended to implement the Plan, other potential locations and sources of water exist for the creation and restoration of habitat suitable to the establishment and persistence of the target species within the Casmalia Creek watershed.

The other potential locations for creating habitat of equivalent size include the B-drainage, the C-drainage, and the Site itself (Figure 7.1). These areas, either in conjunction with one another or in conjunction with the Plan, could allow for the creation of habitat area equivalent in size to the existing water storage ponds. Although the size of the habitat at these locations will also be constrained by the availability of water, additional sources of water from the Site may be used to create and restore a larger habitat area then the Plan would allow for on its own. The potential additional sources of water from the Site include: storm runoff, treated groundwater, and existing pond water.

To create habitat equivalent in size to the existing water storage ponds requires a large initial input of water, a portion of which could come from the existing ponds. This is contingent upon the determination that this source would not adversely affect the target species and/or other species. After the initial input of water to the created habitat, the only additional water required to maintain pond size is the volume lost to evapotranspiration, assuming the created habitat is lined to effectively eliminate infiltration. Based upon a pond surface area of 25-acres, the average volume of water lost to evapotranspiration, is approximately 120,000 cubic meters. These losses may be partially replaced from the potential sources, which include: precipitation runoff from the Site, water from Site groundwater treatment operations, and from off-site sources.

As the effects of reducing habitat area and reducing flow are not fully understood it is the recommendation of the Casmalia Team that the EPA and CBC explore opportunities within the watershed that provide habitat area for the target species equivalent to that of the water storage ponds. Further, the Casmalia Team recommends restoring the Casmalia Creek riparian corridor near created habitat to provide additional benefits to the target species. Lastly, as the Plan provides habitat design parameters for creating and restoring habitat conducive to the establishment and persistence of individual members of the target species, these parameters should be incorporated into any habitat creation and restoration plan for the benefit of the target species regardless of location in the watershed.

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Appendices

Appendix 1: Original EPA Project Proposal

Proposed Project for UCSB's Bren School
Project #1: Management Plan for Casmalia Creek

Objective: Develop and deliver to EPA a management plan for Casmalia Creek riparian habitat to receive endangered species displaced by draining of waste storage ponds at Casmalia. Plan must be appropriate for use in obtaining permission to eliminate current drainage pond habitat.

Project Significance: The completion of this project will allow EPA to expeditiously and efficiently begin work on the riparian zone. Establishment of and maintenance of this zone will allow us to complete necessary closure work, such as draining ponds. Without the requested analysis, our closure activities will be delayed significantly and possibly halted because of failure to comply with endangered species laws and codes.

Background: The Casmalia Resources Disposal Site is a former hazardous waste facility located 4 miles from the Pacific Ocean, 10 miles southwest of Santa Maria, 1.5 miles southwest of Vandenberg Airforce Base, and 1.2 miles south/southeast from the unincorporated town of Casmalia. The Site vicinity is sparsely settled, and land use consists primarily of agriculture, cattle grazing, and oil field development.

During 16 years of operation between 1973 and 1989, the facility accepted more than 4.5 billion pounds of industrial and commercial waste from over 10,000 companies and organizations. The facility owner/operator treated, disposed, and stored this waste in 43 storage /evaporation ponds, 6 landfills, 7 burial trenches, and 3 treatment units, among other management units. The U.S. Environmental Protection Agency (EPA) is now working with companies that sent waste to the Site to properly close this facility which is likely to involve capping landfills and other areas of the Site and draining, grading, and closing current Site ponds.

Problem Statement: The California Red-Legged Frog, a federal threatened species and a fully protected species under CA Department of Fish and Game (F&G) and the Western Spade Foot Toad, a fully protected species under F&G have migrated to on-site storage ponds. They may have moved because their former habitat, the Casmalia Creek, has been significantly disturbed by cattle. The on-site ponds offer the requisite environmental factors for reproduction for these species (e.g., emergent and overhanging vegetation). The California Tiger Salamander, fully protected under F&G and emergency listed under the Federal Endangered Species Act, may also inhabit the Site. Its habitat, the riparian corridor, has been overgrazed by cattle. In addition, there are protected bird species, like the Golden Eagle and migratory birds, on Site.

EPA believes that it will drain the Site storage ponds as part of the final remedy for the Site. In order to drain these ponds, we must create an alternate and appropriate habitat for the above mentioned species and must ensure that this habitat is maintained in perpetuity. This habitat is likely to be the riparian corridor around the Casmalia Creek. We need a management plan for the riparian corridor around Casmalia Creek, including a plan for restoring the area.

Client: USEPA, San Francisco Office
(contact: Katherine Kaplan, Kaplan.Katharine@epamail.epa.gov)

Stakeholders: U.S. EPA, County of Santa Barbara, California Department of Toxic Substances, Regional Water Quality Control Board Central Coast, possibly private companies responsible for the cleanup at the Site

Available Data and Information: EPA has extensive current and historic groundwater data as well as historic soil data for this Site. We have also begun our remedial investigation/feasibility study and anticipate sampling areas relevant to his project this summer. All data will be made available to the Bren graduate students. We can also make available federal, state, and county guidance that may be useful for the completion of this project. In addition, EPA staff will be available to support the students and identify additional resources as well.

Deliverables: Draft management plan for the riparian corridor around Casmalia Creek. The plan would include an analysis supporting the recommendations made. This plan should:

- Identify the needs (i.e., regarding habitat) of the three species identified above primarily. Other important species, including birds, should be identified.
- Identify the management techniques for similar riparian corridors that have been found elsewhere to be protective of the above named species (including restoration techniques for riparian zone, restoration/mitigation for current uses (agriculture/grazing), as well as alternative uses for the area bordering the riparian corridor)
- Prioritize portions of the corridor that could provide the highest quality habitat– what should be restored first because its restoration will be more meaningful or can be completed more easily and/or affordably
- Recommend management techniques for the corridor in perpetuity
- Support these recommendations

Support: ???
Ideally:

1. Commit to two paid summer internships (3 months) plus any expenses.
2. Commit to interact with group and provide information and feedback.

Appendix 2: The Endangered Species Act – Section 7

Section 7: Interagency Cooperation
The Endangered Species Act (ESA) of 1973, as amended, is the Federal government's primary statute for the conservation of threatened and endangered plant and animal species. The ESA is intended to preserve the Nation's natural heritage by conserving species that are endangered of extinction throughout all or a significant portion of their range, as well as to conserve threatened species that are likely to become endangered in the foreseeable future (16 U.S.C. §1532). Section 7 of the Act establishes the substantive and procedural requirements for Federal agencies and outlines the Interagency Consultation protocol. Any action permitted, funded, or conducted by a federal agency requires consultation occur between the lead "action agency" and either the Secretary of the Interior or the Secretary of Commerce. The Department of the Interior's Fish and Wildlife Service (USFWS) and the Commerce Department's National Marine Fisheries Service (NMFS) are responsible for administering the Act. Generally, the USFWS oversees activities affecting listed terrestrial and freshwater species, and the NMFS oversees listed marine and anadromous species.

The section 7 requirements may be generalized into two broad themes; the first theme is the proactive conservation of listed species, and the second theme is avoiding future adverse effects to listed species (USFWS 1998). The central theme of Section 7(a)(1) is the recovery of listed species. This section sets forth a broad mandate for the proactive conservation of listed species and declares that federal agencies have a duty to further endangered species conservation (16 U.S.C. §1536 (a)(1)). As such, all federal agencies are obliged to conserve listed species and the designated critical habitat upon which they depend (16 U.S.C. §1536 (a)(1)).

Section 7(a)(2) is concerned with avoiding future adverse effects to listed species a result of federal actions. This section mandates that any action permitted, funded, or conducted by a federal agency require consultation between the action agency and the appropriate Service (USFWS or NMFS) (16 U.S.C. §1536 (a)(2)). The consultation is to determine if the action will affect listed species or their designated critical habitat to ensure that the action will not jeopardize listed species or adversely modify the critical habitat upon which the species depends (16 U.S.C. §1536 (a)(2)).

The following information is intended to provide an overview of section 7 and the consultation process, outlining the procedural and substantive requirements of the Act, in order to aid the EPA and CBC in their understanding of the section 7 requirements as they relate to potential actions related to the Site closure activities at the Casmalia Resources Superfund Site. This section addresses the broader substantive goals of the Act's objective of species protection and enhancement, as well as specifying the procedural requirements for federal interagency consultation and cooperation.

The following information is based upon the procedures outlined in the U.S. Fish and Wildlife Service Endangered Species Act Section 7 Consultation Handbook of 1998.

Informal Consultation

Informal consultations are not mandated, but often precede formal consultations and allow the applying federal agency and the Service (USFWS or NMFS) to determine if a formal consultation is necessary. Most consultations only require informal consultation. (USFWS 1998). Informal consultation is intended to (USFWS 1998):

- clarify if listed, proposed, and candidate species or designated or proposed critical habitat may be present in the action area;
- identify the effects the action may have on these species or critical habitat;
- explore potential ways to modify the action to minimize or avoid adverse effects to the species or critical habitat;
- identify ways to modify the action for the benefit of the species and identify conservation opportunities on and around the action area.

The informal consultation is also intended to allow for the resolution of conflicts and/or differences in opinion between the Service and action agency regarding the extent of adverse affects of the proposed action. Informal consultation between the action agency (at Casmalia this is EPA Region IX) or the designated non-federal representative (CB Consulting) and the Service include phone calls, emails, letters, meetings, and similar correspondence prior to initiating formal consultation or prior to the Service determining that formal consultation is not necessary (USFWS 1998).

If it determined that a designated species or critical habitat is present in the action area a biological assessment (BA) must be prepared and submitted to the Service. Biological Assessments are required of any federal action that modifies the physical environment to the extent that it constitutes a "major construction activity" under the National Environmental Policy Act of 1969 (NEPA) (USFWS 1998). The purpose of the BA is to determine if the listed and proposed species are likely to "adversely affected" by the action. The action agency (EPA) may prepare the BA, or may designate the non-federal representative (CB Consulting) to prepare (or in-turn have prepared) the BA. The contents of the BA are discretionary, however, they typically include site surveys to determine the presence of the species, an analysis of the likely affects of the action upon the species and the opinions experts on the species (USFWS 1998). Further, the BA should describe the potential affects to all the listed species present, not solely those likely to affected, and should consider the cumulative effects of other foreseeable actions (USFWS 1998). Information gathered for the preparation of and Environmental Impact Statement other environmental documents (such as the RI/FS) may be utilized or modified for use as or in the BA (USFWS 1998):

Once initiated the BA must be completed by the action agency and submitted to the Service within 180 days. Upon submittal of a complete adequate BA, the Service has 30 days to review the it and render a determination of what effect the action is likely to have on the species and/or critical habitat. The Service may make one of the following determinations for listed species and designated critical habitat (USFWS 1998):

- **No effect**: the proposed action has will have no affects on species or critical habitat;
- **Is not likely to adversely affect**: the species may be affected, but the effects are determined to be discountable, or insignificant, or completely beneficial;
- **Nonconcurrence**: there is insufficient information presented or the action agency has not adequately completed the BA;
- **Is likely to adversely affect**: the action will have adverse direct of indirect effects for the species that are not discountable, or insignificant, or completely beneficial. If the action will have beneficial affects as well as adverse affects for the species a formal Section 7 consultation is required.

If the effects of the action are not completely determinable, "the benefit of the doubt is given to the species." (USFWS 1998). If a "no-effect" or a "not likely to adversely affect" determination is made by the Service, no formal consultation is required. (USFWS 1998). Nonconcurrence requires the completion or modification of the BA in order for it to become satisfactory to the Service. If the action is determined to be likely to have adverse affects, formal consultation between the action and the Service is required. Formal consultation may not be initiated until the BA is completed. A diagram of the informal consultation process is shown in Figure 2.

Formal Consultation

Formal consultations are required for proposed federal actions that are likely to adversely affect listed species or their designated critical habitat. The purpose of formal consultation is to determine if the adverse affects of the proposed action are likely to jeopardize the continued existence of a listed species (as a whole) or adversely modify of destroy critical habitat (USFWS 1998). A diagram of the formal consultation process is shown in Figure 1. The formal consultation process is intended to generate information regarding the following (USFWS 1998):

- identify the nature and extent of the action's possible effects on the listed species and its critical habitat;
- identify reasonable and prudent alternatives if an action is likely to result in jeopardy or the adverse modification of habitat;
- provide identified levels of incidental take otherwise prohibited by section 9;
- provide mandatory reasonable and prudent measures to minimize the impacts of incidental take;
- identify potential conservation opportunities to benefit listed species and critical habitat; and
- provide information on the listed species to establish a future baseline.

The formal consultation will result in a final ruling by the Service. This ruling, called the Biological Opinion (BO), is the determination as to whether the proposed action will result in “jeopardy or no jeopardy” to a listed species or an “adverse or no adverse modification” of critical habitat. The formal consultation process is intended to be flexible and allow for modifications to the proposed action. Successive biological opinions may be rendered as a project is modified.

Initiating Formal Consultation
After a biological assessment has determined an action is likely to adversely affect a listed species, formal consultation is initiated in writing with a formal request to the Service from the action agency. The agency must provide the Service with the following information: a description of the proposed action, a description of the area to be affected, the listed species and critical habitat that may be affected, a description of how the action will affect the listed species and critical habitat and an analysis of cumulative effects, all relevant reports such as environmental impact statements or biological assessments, and any other relevant information pertaining to the action, listed species, or critical habitat(USFWS 1998, Stanford 2001). The information on the potential effects to listed species and critical habitat provided must be based upon the best available scientific and commercial data. The costs of finding data or funding studies are borne by the action agency or designated non-federal representative (USFWS 1998).

Unlike informal consultation, the formal consultation has a statutory timeline. Formal consultation should be completed within 90 days. As recommended by the Consultation Handbook, the agency, the applicant (this may be a non-federal entity conducting a Section 7 consultation in conjunction with federal agency) and the Service should work cooperatively during this period to ensure the following information has been adequately determined (USFWS 1998):

- assess the status of the pertinent species and critical habitat;
- verify the scope of the proposed action and identify the area directly and indirectly affected, and cumulative effects;
- identify the adverse effects likely to result in jeopardy to the species or adverse modification of critical habitat;
- develop reasonable and prudent alternatives to the action;
- identify the adverse effects not likely to jeopardize listed species, but that constitute “take” as defined in section 9;
- develop reasonable and prudent measures, and terms and conditions for the incidental take statement as necessary; and
- identify conservation recommendations.

Other relevant and interested parties, including state and regional agencies should be included during the process outlined immediately above. Following this period, the Service has an additional 45 days to render the final biological opinion. Therefore, unless an extension is granted or mutually agreed upon, once all the necessary information has been submitted to the Service a biological opinion is rendered within 135 days. (USFWS 1998).

Biological Opinion

The biological opinion is the Services final determination as to the effects the proposed action and whether the action is likely to adversely affect the listed species or adversely modify critical habitat, and identify the reasonable and prudent alternatives as appropriate (16 U.S.C. §1536 (b)(3)(A)). The Consultation Handbook outlines the formal consultation for the biological opinion as requiring the following (USFWS 1998, Stanford 2001):

- Address, salutation, introductory paragraph, and consultation history;
- Description of the proposed action;
- Status of the species/critical habitat;
- Species/critical habitat description
- Life History
- Population Dynamics
- Status and distribution
- Analysis of the species/critical habitat likely to be affected
- Environmental Baseline;
- Status of the species in the action area
- Factors affecting the species environment within the area
- Effects of the action;
- Factors to consider;
- Analyses of the effects of the action
- Species' response to the proposed action
- Cumulative effects (including the cumulative effects of reasonably foreseeable actions);
- Conclusion (Jeopardy/No jeopardy determination);
- Reasonable and prudent alternatives;
- Incidental Take Statement;
- Extent of take anticipated
- Effect of take
- Reasonable and prudent alternatives
- Terms and conditions
- Coordination of incidental take statements with other laws, regulations, and policies
- Conference report/conference notice (as appropriate);
- Conservation recommendations (as appropriate);
- Reinitiation notice or closing statement; and
- Literature cited.

Consultation history
This includes any correspondence prior to formal consultation, including documentation of the initial date of consultation, a chronology of subsequent information requests, extension requests, or other applicable past and current actions (USFWS 1998).

Description of the proposed action
This includes a description of the proposed action, the direct and indirect action area, and the conservation measures that may be included in the action. (USFWS 1998).

Status of the Species
This section presents the biological and ecological species profile, including the species/critical habitat description, life history, population dynamics, status and distribution of the species, and an analysis of the species/critical habitat likely to be affected. (USFWS 1998).

Environmental baseline
This includes any prior and ongoing human and natural factors and events that resulted in species current status. It includes the status of the species in the action area and the factors affecting the species in the action area. The current baseline is to allow for a "snapshot" by which future analysis made be made to monitor a species health. (USFWS 1998).

Effects of the action
The effects of the action are identified and analyzed in the following three broad categories: factors to be considered, analyses of the effects of the action, and the species response to the proposed action. The factors to consider in determining the effects of the project include: proximity to action, geographic distribution of affected area(s), timing of action in relation to species' lifecycle, nature of the effects of the action on species' lifecycle, population dynamics, distribution, and direct and indirect effects on the primary constituent elements of critical habitat constituents, duration of the action, disturbance frequency, disturbance intensity, and disturbance severity (USFWS 1998). Disturbance intensity typically examines pre-action and post-action population size and/or critical habitat extent. Disturbance severity is measured based upon the likely recovery time.

This section should include the analyses of the effects of the actions. This includes the beneficial effects (as appropriate) and the direct and indirect effects of the proposed action, and the interrelated and interdependent activities (USFWS 1998). Interrelated activities are those that are part of the proposed action and depend upon the action for their justification. Interdependent activities are those that have no independent utility apart from the project (USFWS 1998). Indirect effects include those effects that are likely to reasonably likely to occur as a result of the project, or foreseeable future federal and non-federal projects.

The species response to the proposed action includes examining the number of individuals/populations in the affected area, their sensitivity to change, their resilience, and the likely recovery rate (USFWS 1998).

Cumulative effects

The 1998 Consultation Handbook defines this section in the following manner: (USFWS 1998).

> The cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

This definition is currently under review and new guidance may be issued regarding cumulative effects in the future.

Conclusion

The information outlined above should provide adequate information for the Service to determine the status of species, the environmental baseline, all the effects of the proposed action, and the cumulative effects of all other reasonably foreseeable future non-federal actions. Based upon all of the information outlined above, the Service will render its opinion as whether the proposed action is likely to jeopardize the continued existence of the species or result in destruction or adverse modification of critical habitat. The jeopardy determination is typically based upon the aggregate effects of the action to the species as a whole, as opposed to jeopardy to individual members of the species.

Reasonable and prudent alternatives

If the Service determines that there are reasonable and prudent alternatives that the action agency may undertake to avoid jeopardy to the species or adverse modification of critical habitat, these must be identified. Reasonable and prudent alternatives are identified as those that are (USFWS 1998):

- thought to avoid the likelihood of jeopardy to the species or adverse modification of critical habitat;
- implementable in a manner consistent with the intended purposes of the action;
- consistent with the scope of the action agency's legal authority and jurisdiction, and
- economically and technologically feasible.

The Service is strongly encouraged to work with the action agency and any non-federal representative to develop the reasonable and prudent alternatives as they often have a better understanding of the feasibility of alternatives. The Service will typically defer to the action agency's expertise in determine the feasibility of alternatives, however the

Service has the final determination of which alternatives are included in the Biological Opinion (USFWS 1998). If it is determined that no reasonable and prudent alternatives exist there must be a written justification for the determination.

Incidental Take Statement (ITS)

The ITS allows for a specified level of "take" of listed species (excluding plants) otherwise prohibited by Section 9, provided that the "take" does not jeopardize the entire species (Stanford 2001). Section 9 of the Act provides for the protection of listed species and prohibits acts that might result in the "take" of any listed individuals. Section 9 defines "take" to mean "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (16 U.S.C. § 1532(19)). The Fish and Wildlife Service regulations define harm as "significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering" (50 C.F.R 17.3 (1994)). The Supreme Court interpreted that indirect harm, such as habitat modifications, that leads in a "proximate and foreseeable" manner to the actual death or injury to an identifiable member of a listed species constitutes a violation of the Act (See Sweet Home Chapter of Communities for a Great Oregon v. Babbitt. 17 F. 3d 1463 (D.C. Cir. 1994)).

Every biological statement must contain an ITS even if there is presumed to be no actual take. In order eligible to receive an ITS, the proposed action must 1) not jeopardize the continued existence of the listed species or adversely modify designated critical habitat, 2) result from an otherwise lawful activity, and 3) be incidental to and not the purpose of the proposed action (USFWS 1998).

If incidental take considered likely to occur, a description of the take, its amount (likely number of individuals) and extent (nature of habitat modification), and the reasonable and prudent measures taken minimize the take must be identified. This includes the terms and conditions of monitoring, reporting take, and any special considerations involving dead, injured, and sick listed species.

The ITS exemption is valid only if the action agency and/or applicant demonstrate clear compliance with the implementing terms and conditions of the *binding* reasonable and prudent measures identified to minimize the impact of the incidental take on the species (USFWS 1998). The reasonable and prudent alternatives may only include actions within the action area (interpreted to include a footprint area that may extend beyond the boundaries of the actual action area), involve only minor changes to the project, and reduce the level of take (USFWS 1998). Defining what constitutes a "minor change" is discretionary, and the Service is likely to interpret this effect differently depending upon the situation/applicant (e.g. a $100,000 change to an action may be minor on a multi-million dollar project, but prohibitive to small-scale farmer) (USFWS 1998).

Section 7 requires that the impact of the incidental take is minimized, but it cannot require mitigation (USFWS 1998). The Service should assist in the integration of the section 7 consultation process within the action's overall environmental compliance (USFWS 1998).

Conference Report/Conference Notice (as applicable)
If necessary, a conference report should be included in the Biological Opinion notifying the action agency that proposed species or proposed critical habitat is likely to be jeopardized or adversely modified by the potential action (USFWS 1998).

Conservation Recommendations
The Service may also include non-binding conservation recommendations identifying opportunities that the action agency may, at its discretion, pursue to the furtherance of listed species. This may include conservation recommendation that identify ways to minimize jeopardy to proposed or candidate species and avoid or minimize adverse modification of their habitat.

Reinitiation Notice
Reinitiation of the Section 7 formal consultation may be required for the following reasons (USFWS 1998):

- the amount or extent of incidental take is exceeded;
- new information is revealed regarding the effects of the action on listed species/critical habitat;
- the action is modified to the extent that it will result in effects on listed species/critical not previously considered; and
- a new species is listed in the action area.

Literature Cited:
The Biological Opinion is to be based upon "the best scientific and commercial data available", as such all literature used in forming the Biological Opinion must be identified (USFWS 1998).

Other Section 7 Considerations
Commitment of resources
The action agency should not make "irreversible or irretrievable commitments of resources" on the proposed action prior to the Service issuing its Biological Opinion containing the final determination of no jeopardy/adverse modification (16 U.S.C. §1536 (d)). This includes initiating the work, and in any other manner obligating itself to performing work on or as a result of the action (Stanford 2001). The "irreversible or irretrievable" commitment of resources have been interpreted to mean those expenditures spent on a project that will at any time violate Section 7 of the Act, or cannot be utilized in modifying to the project or in another project entirely (Stanford 2001).

Section 7 Exemptions: Endangered Species Committee
It is possible that actions for which there are no reasonable and prudent alternatives may seek an exemption by special committee. The exemption permits acts otherwise

prohibited by Section 9. There have been very few exemptions granted by the Endangered Species Committee in the past thirty years and the process of obtaining a Section 7 exemption is both cumbersome and complex (Stanford 2001). The Endangered Species Committee is a seven member cabinet-level committee includes the heads of various agencies, departments, and special presidential nominees. Barring national security reasons or natural disaster, obtaining an exemption under Section 7 is an unlikely prospect. Of the few exemptions the Committee has granted, several were only to be later reversed by the courts (See Tennessee Valley Auth. v. Hill, 437 U.S. 153, 172-73 (1978) (Tellico Dam). See also Spotted Owl cases.)

REFERENCES: Appendix 2

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Figure 1: Section 7 Formal Consultation Process (USFWS 1998).

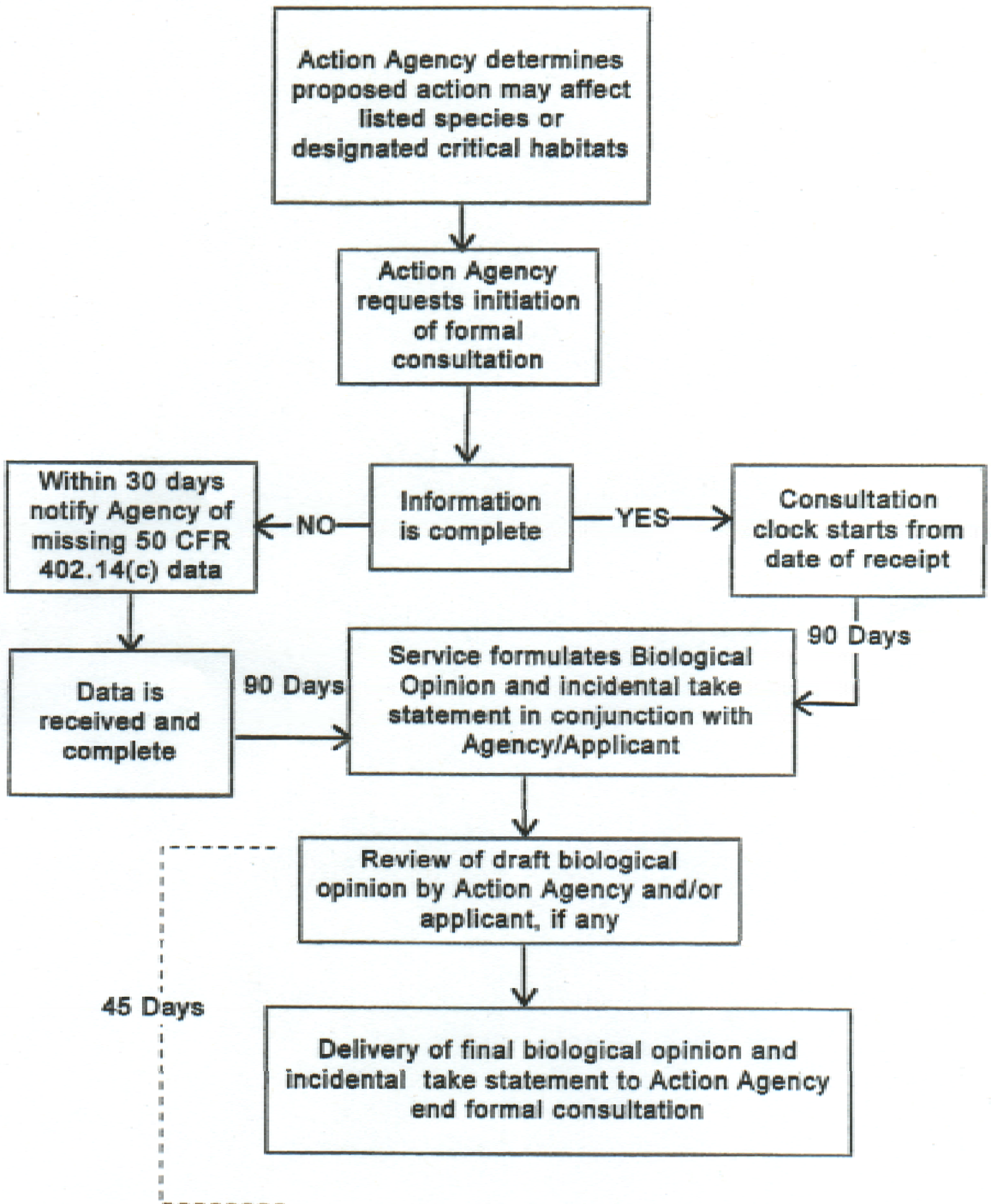
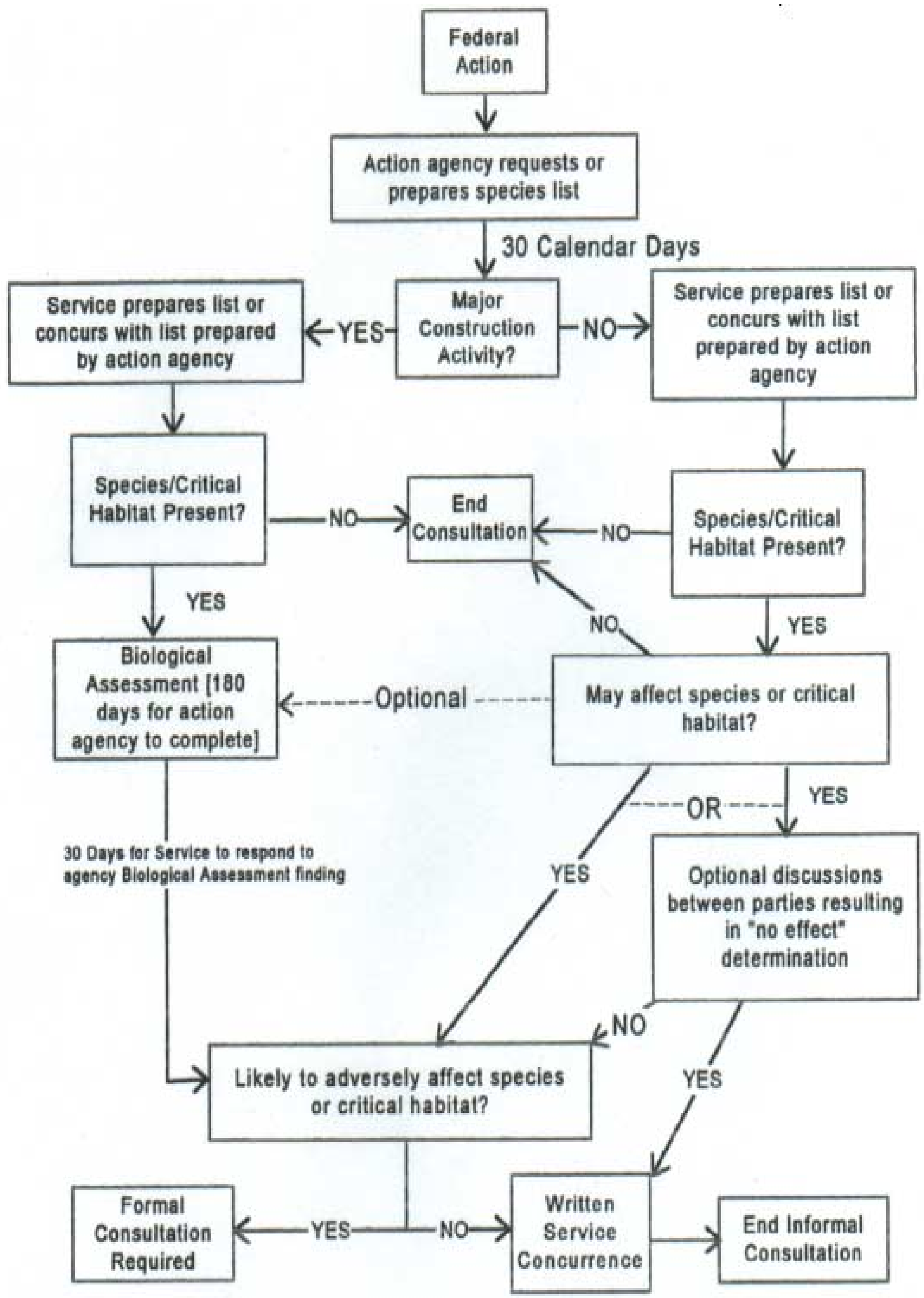


Figure 2: Section 7 Informal Consultation Process (USFWS 1998)



Appendix 3: Potentially Applicable Regulations

The following is a brief discussion on State of California and Santa Barbara County legislation and regulations that are potentially applicable if the CBC were to undertake habitat creation and restoration activities outlined in Habitat Creation and Restoration Plan, Section 8.0 of this report. This appendix was not created with the intent of covering all of the potentially applicable state and local regulations. Rather, it is a compilation of information gathered in the process of writing this report. The appendix is divided by the state and county agencies responsible for carrying out the regulations.

California Coastal Commission

Due to the Site's close proximity to the Pacific Ocean, alterations to Casmalia Creek could potentially impact coastal zone resources. Therefore, it is relevant to determine if Casmalia Creek lies within the coastal zone and whether a restoration project altering this resource falls under the jurisdiction of the California Coastal Commission (Commission). Additionally, the creation of ponded habitat adjacent to the creek has the potential to impact coastal zone resources.

The Commission regulates land and water uses within the coastal zone consistent with the policies of the California Coastal Act, i.e. Division 20 of the California Public Resources Code. With only a few noted exceptions, a coastal development permit is required to develop within the coastal zone. The permit is obtained from the Commission itself unless a Local Coastal Program (LCP) has been developed and approved by the Commission. If an approved LCP exists, the authority to issue a permit is transferred to the appropriate county. Santa Barbara County (the location of the Site) has an approved LCP and thus coastal zone projects in this area fall under the jurisdiction of Santa Barbara County. However, an LCP only applies to areas *within* the coastal zone and the county has no jurisdiction *outside* the coastal zone. (M. De La Plaine, California Coastal Commission Federal Consistency Review Supervisor, pers. comm. M. Hood, August 31, 2001).

Under certain circumstances, the Commission's jurisdiction extends outside the coastal zone. Specifically, the Commission has regulatory authority over all federally permitted or funded projects, including those undertaken by federal agencies, which affect California's coastal zone resources. This is termed *federal consistency review* and applies to all projects which may impact coastal resources regardless of the location of the property with respect to the coastal zone boundary (Coastal Zone Management Act of 1972 as amended through P.L. 104-150, The Coastal Zone Protection Act of 1996, §307;p M. De La Plaine, California Coastal Commission Federal Consistency Review Supervisor, pers. comm. M. Hood, August 31, 2001).

Maps provided by the Commission delineate the coastal zone boundaries in the referenced area and reflect that, while Shuman Creek and its watershed cross into the Coastal Zone, Casmalia Canyon and its watershed lie outside the zone. Although a permit would not, in most cases, be required for projects or activities outside the coastal zone, restoration of Casmalia Creek or the creation of ponded habitat near the Site would either be directly undertaken by the EPA and/or federally permitted by, for example, the Army Corps of Engineers. The Commission has regulatory authority over all federally permitted or funded projects, including those undertaken by federal agencies, which affect California's coastal zone resources. Therefore, federal consistency review would apply regardless of whether the project lies inside or outside the coastal zone (M. De La Plaine, California Coastal Commission Federal Consistency Review Supervisor, pers. comm. M. Hood, August 31, 2001). However, the Commission only has jurisdiction if an adverse affect on the coastal zone is identified and this determination is the responsibility of the Commission (M. De La Plaine, California Coastal Commission Federal Consistency Review Supervisor, pers. comm. M. Hood, August 31, 2001).

A federal agency planning to undertake an activity that is likely to affect coastal zone resources must notify the Commission of the project with a "consistency determination."(15 C.F.R. §930.34). The "consistency determination" must indicate whether the proposed project is consistent to the maximum extent possible with the goals of the California Coastal Act (15 C.F.R. §930.39). The determination must be based upon an evaluation of the relevant provisions of the California Coastal Act and provide a detailed description of the proposed activity, the coastal effects and comprehensive data and information sufficient to support the federal agency's conclusion (15 C.F.R. §930.39). If the federal agency believes there will not be an effect on the coastal zone, it may submit a "negative determination" with supporting documentation to the Commission (15 C.F.R. §930.35). If the Commission agrees, a permit waiver may be granted (M. De La Plaine, California Coastal Commission Federal Consistency Review Supervisor, pers. comm. M. Hood, August 31, 2001).

The process is similar for projects that are permitted by a federal agency. The permitting agency typically is the entity that advises the Commission of the project and requests review (M. De La Plaine, California Coastal Commission Federal Consistency Review Supervisor, pers. comm. M. Hood, August 31, 2001). The applicant must provide a "consistency certification" to the federal agency which certifies that the proposed activity complies with the California Coastal Act and will be conducted in such a way as to be consistent with it (5 C.F.R. §930.57). At the same time, the applicant shall furnish to the Commission a copy of the certification, with all necessary information and data (Coastal Zone Management Act of 1972 as amended through P.L. 104-150, The Coastal Zone Protection Act of 1996, §307). This includes a detailed description of the proposal, a brief assessment of the probable effects on the coastal zone and a brief set of findings indicating that the activity is consistent with the California Coastal Act (15 C.F.R. §930.57, §930.58). The Commission will then review the proposed action and render a decision.

The policies within the California Coastal Act which are relevant to this project include protecting the biological productivity and quality of coastal streams and wetlands, maintaining natural buffer areas that protect riparian habitats, limiting erosion control methods which may impede the movement of sediments and nutrients normally carried into coastal waters, planning dredging and spoils disposal to avoid significant disruption to wildlife habitats and water circulation, minimizing interference with waterflow, minimizing alteration of natural streams, minimizing depletion of ground water, and ensuring channelizations or alterations to streams incorporate the best mitigation measures (California Public Resources Code §30210-§30265.5). The proposed project will be reviewed by the Commission for consistency with these and other goals. Thus, an effort should be made to include mitigation measures in these areas if Casmalia Creek is restored and/or ponded habitat is created.

The California Coastal Act also requires that public agencies pursuing or supporting activities outside of the coastal zone, that have the potential to impact coastal resources lying in the coastal zone, consider the effect of the actions and help to ensure that certain policies found within the California Coastal Act, specifically in §30210-§30265.5 of the California Public Resources Code, are achieved (California Public Resources Code §30200). Therefore, other permitting agencies involved in a project, which includes the restoration of Casmalia Creek or the creation of ponded habitat, may review the plan for adherence to the aforementioned policies as well.

Although the Commission has legal jurisdiction over all direct federal activities and federally permitted projects, it is reluctant to become involved in projects unless they are partially within the coastal zone or lie just outside the zone (M. De La Plaine, California Coastal Commission Federal Consistency Review Supervisor, pers. comm. M. Hood, August 31, 2001). Casmalia Creek and the Site are close to the coastal zone boundary, however, the Commission often limits its involvement in projects outside the coastal zone to large-scale projects with significant impacts on the coastal zone (M. De La Plaine, California Coastal Commission Federal Consistency Review Supervisor, pers. comm. M. Hood, August 31, 2001). For example, a project involving sand mining approximately 500,000 cubic yards of sand per year for 10 years in the Santa Maria River threatened serious erosion of coastal zone resources and, thus, the Commission chose to review this project (M. De La Plaine, California Coastal Commission Federal Consistency Review Supervisor, pers. comm. M. Hood, August 31, 2001). The Commission also rarely becomes involved in CERCLA projects (M. De La Plaine, California Coastal Commission Federal Consistency Review Supervisor, pers. comm. M. Hood, August 31, 2001). This is primarily due to the complexity of these projects and the lack of expertise in this area on the part of the Commission (M. De La Plaine, California Coastal Commission Federal Consistency Review Supervisor, pers. comm. M. Hood, August 31, 2001).

In addition to the aforementioned circumstances that may lead to non-involvement on the part of the Commission, a third case exists which may allow a project to proceed without the need to obtain a permit from the Commission. Federal consistency review contains a category for "environmentally beneficial" projects, which are defined as projects that protect, preserve or restore the natural resources of the coastal zone (15 C.F.R. §930.33) The State and Federal agencies may agree to exclude projects of this nature from further federal consistency review but must allow for public participation in this process (15 C.F.R. §930.33). Although this is a viable and applicable option if Casmalia Creek is restored and/or ponded habitat is created, no project has invoked this provision and, thus, there is no precedent to follow and this may lead to delays in processing (M. De La Plaine, California Coastal Commission Federal Consistency Review Supervisor, pers. comm. M. Hood, August 31, 2001.) As a result, it has been suggested that the most expeditious manner to notify the Commission of the project would be with a negative determination M. De La Plaine, California Coastal Commission Federal Consistency Review Supervisor, pers. comm. M. Hood, August 31, 2001).

It should be noted that although CERCLA contains a provision which exempts the EPA from obtaining local, state or federal permits on-site, the Commission has indicated that it is their position that the federal consistency review process is not a permitting process but rather a consultation/coordination of efforts between the agencies and thus the Commission must be involved when required (M. De La Plaine, California Coastal Commission Federal Consistency Review Supervisor, pers. comm. M. Hood, August 31, 2001).

The California Department of Fish and Game

Streambed Alteration Agreement

Section 1603(a) of the California Fish and Game Code states that "It is unlawful for any person to substantially divert or obstruct the natural flow or substantially change the bed, channel, or bank of any river, stream, or lake designated by the department, or use any material from the streambeds, without first notifying the department of that activity." (California Fish and Game Code §1603 (a)). According to the California Department of Fish and Game (CDFG), notification is generally required for any project that will take place in or in the vicinity of a river, stream, lake, or their tributaries (N. Lomus, CDFG Environmental Specialist, pers. comm. M. Hood, September 3, 2001). This includes rivers or streams that flow at least periodically or permanently through a bed or channel, with banks that support fish or other aquatic life, and watercourses having a surface or subsurface flow that support or have supported riparian vegetation (N. Lomus, CDFG Environmental Specialist, pers. comm. M. Hood, September 3, 2001). Thus, a habitat restoration project involving the Casmalia Creek or areas "in the vicinity" would require notifying the CDFG in order to determine if a Streambed Alteration Agreement is needed (N. Lomus, CDFG Environmental Specialist, pers. comm. M. Hood, August 31, 2001).

The notification process includes providing the CDFG with a biological assessment in order to determine if listed species may be affected (N. Lomus, CDFG Environmental Specialist, pers. comm. M. Hood, August 31, 2001). If the CDFG determines that a proposed project may substantially adversely affect existing fish or wildlife resources, a Lake or Streambed Alteration Agreement must be obtained from the CDFG. The project specifics which will need to be provided to the CDFG include the estimated project cost, for that part of the project that will impact the creek, and a description of the project. The description must include a description of any stabilization structures or materials, excavation activities, the type of equipment to be used, whether the project will use material from the streambed, if materials will be disposed of or deposited in the streambed, if water will be diverted from the stream, if water quality will be affected, if the project will affect fish, amphibians or other aquatic life or terrestrial life, whether any endangered or threatened species are thought or known to occur in the area, the anticipated impacts on wetland and/or riparian vegetation and wildlife resources, and the site conditions before and after the project (N. Lomus, CDFG Environmental Specialist, pers. comm. M. Hood, September 3, 2001).

In addition to its determination pertaining to potential permanent impacts to fish or wildlife in the stream or creek in which the project will take place, the CDFG also reviews potential impacts to downstream species (N. Lomus, CDFG Environmental Specialist, pers. comm. M. Hood, August 31, 2001). Thus, impacts to species would be reviewed in the Casmalia Creek as well as downstream impacts to species in Shuman Creek. If it is determined that there will be permanent impacts, mitigation measures are required utilizing a 5 to 1 acreage ratio (N. Lomus, CDFG Environmental Specialist, pers. comm. M. Hood, August 31, 2001). This ratio could decrease depending upon the quality of the alternative habitat that is provided (N. Lomus, CDFG Environmental Specialist, pers. comm. M. Hood, August 31, 2001). The CDFG will assist in developing plans to minimize impacts (N. Lomus, CDFG Environmental Specialist, pers. comm. M. Hood, August 31, 2001).

It is the position of the CDFG that the CERCLA provision exempting the EPA from obtaining permits on-site would not apply in this case due to the fact that it involves a federal action on private property whereas a federal action on federal land would not require a Streambed Alteration Agreement (N. Lomus, CDFG Environmental Specialist, pers. comm. M. Hood, August 31, 2001).

Santa Barbara County Code, Grading Chapter 14

Creek Restoration

Proposed excavation and grading in the riparian corridor would require obtaining a grading permit from the County of Santa Barbara. A grading permit is necessary under Sec. 14.8 (6) for “grading within fifty feet of the top of the bank of any stream, creek or natural watercourse”. Furthermore, the County Planning Department should be consulted to determine if there is potential for significant environmental damage. Environmental thresholds, set by the County, will guide the determination of the potential for significant environmental damage (A. Leider, Santa Barbara County, pers. comm. T. Carson and C. Minton, November 13, 2001).

Creating Ponded Habitat

A grading permit would need to be obtained from the County of Santa Barbara. A grading permit is necessary under Sec. 14-8 (6) for “grading within fifty feet of the top of the bank of any stream, creek or natural watercourse” and under Sec. 14-8 (7) for “the construction of water impounding structures of earth (which are not under the direct control of the State of California or the federal government) where the maximum depth to which water may be impounded is five feet or more where one acre-foot or more of water will be impounded, …”. In addition, the creation of dams and reservoirs is regulated under Sec. 14-30 (a) and (b). Furthermore, a minor conditional use permit, pursuant to Zoning Ordinance Article III Section 35-315.4: Minor Conditional Use Permits, would need to be obtained. Finally, the County Planning Department should be consulted to determine if there is potential for significant environmental damage. Environmental thresholds, set by the County, will guide the determination of potential for significant environmental damage (A. Leider, Santa Barbara County, pers. comm. T. Carson and C. Minton, November 13, 2001).

As the project is being undertaken for restoration purposes and could be considered a beneficial project. For this reason, it is likely that the permit process and environmental review would be fairly smooth and expedited (A. Leider, Santa Barbara County, pers. comm. C. Minton, January 13, 2002).

Appendix 4: Western Spadefoot Toad

Background

The western spadefoot toad (*Scaphiopus hammondii*) ranges from Shasta County, California in the north and extends into the northwestern portion of Baja California (Figure 1) (Stebbins, R. C. 1985). By 1994, more than 80% of western spadefoot toad habitat in southern California had been lost to development or other uses and, at least 30% had been lost in northern and central California (Jennings and Hayes 1994). Of additional concern, only a small number of small preserves protect habitat for the western spadefoot toad (e.g. Santa Rosa Plateau in Riverside County, California and Pixley Vernal Pools Preserve in Tulare County, California) (Jennings and Hayes 1994). Western spadefoot toad densities have recently declined rapidly in the Sacramento Valley (with near extirpation) and the eastern San Joaquin Valley (Fisher and Shaffer 1996).

The species is currently listed as a California Species of Special Concern by the California Department of Fish and Game (CDFG). It has been reported that one to five western spadefoot toads have been sighted in the RCF Pond on the Site (M. Blevins, EPA Environmental Scientist, pers. comm. M. Hood, April 4, 2001, L. Hunt, Hunt and Associates, pers. comm. M. Hood, December 20, 2001) which encourages the development of a plan which provides suitable alternative habitat prior to the drainage of the pond. It has been suggested that the observance of just one western spadefoot toad near water during the breeding season is sufficient to conclude that a breeding population exists in the area. (T. Mullen, SAIC Biologist, pers. comm. M. Hood and S. Erickson, November 1, 2001.)

Habitat

Breeding Habitat

The preferred habitat for the western spadefoot toad is low-lying grassland, brushland, or deciduous woodland near quiet pools or streams (Stebbins 1959). The CDFG also states that grasslands with shallow, temporary pools are suitable habitat for the western spadefoot toad (Morey 2001). The western spadefoot toad only requires water for breeding purposes (S. Sweet, UCSB Associate Professor of Ecology, Evolution and Marine Biology, pers. comm. M. Hood, June 27, 2001) and is otherwise terrestrial with the ability to absorb water effectively from the soil (Ruibal *et al.* 1969)

Unfortunately, there is little documentation on the optimal density levels within a specific habitat area for the western spadefoot toad (T. Hovey, CDFG Marine/Fisheries Biologist, pers. comm. S. Erickson, November 19, 2001). However, with some amphibians, the amount of habitat needed has been determined by ascertaining the amount of acres required to sustain the food source. For example, a horned lizard population requires 200-250 acres as this is the required acreage to sustain the ant that it feeds on (M. Wehtje, CDFG Environmental Specialist 4, pers. comm. M. Hood, November 8, 2001). However, there is no indication that this method or an alternative method is utilized in determining the required habitat acreage for the western spadefoot toad (M. Wehtje, CDFG Environmental Specialist 4, pers. comm. M. Hood, November 8, 2001).

Characteristics of the breeding habitat that need to be considered include vegetation, water depth, duration of water in a pool or stream, water flow, and water quality. Typically, the western spadefoot toad resides in areas with minimal vegetation (S. Sweet, UCSB Associate Professor of Ecology, Evolution and Marine Biology, pers. comm. M. Hood, June 27, 2001). UCSB researcher Sue Christopher conducted surveys of Vandenberg Air Force Base (VAFB) observed western spadefoot toads in cattle ponds, or other agricultural ponds, as well as in disturbed vernal ponds. However, she found a shallow water shelf with sparse vegetation appears to be important for breeding as this is where the egg masses are normally found. She also found that dense vegetation is not associated with the western spadefoot toad in the Vandenberg area as compared to the areas that harbor the California red-legged frog in this location. In general, the western spadefoot toad will most likely be found in ponds with opposite characteristics than those that harbor the California red-legged frog, with the California red-legged frog preferring deeper water with denser vegetation. In some locations, however, she found the species to co-exist. Sue found the breeding pools used by the western spadefoot toad on the VAFB are typically vegetated by spikerushes (*Eleocharis sp.)*, sedges (*Carex sp.*), cattails (*Typha sp.*), bulrushes (*Scirpus sp.*) and various grasses.

The depth of the breeding pools can be very shallow. Studies of the western spadefoot toad in Utah, Arizona and Nevada, documented sightings in water as shallow as one inch and as deep as sixteen inches (Stebbins 1951). Although these studies did not involve California western spadefoot toads, the findings are consistent with the behavior of California western spadefoot toad populations. One study in Madera County, California noted a population located in a pool measuring six feet by eleven feet and was approximately one foot at its greatest depth (Childs 1953). At the Santa Rosa Plateau preserve in California, the pools, which have been known to harbor the western spadefoot toad, were quite large and resembled shallow lakes (S. Christopher, UCSB Ph.D. Candidate Ecology, Evolution and Marine Biology, pers. comm. M. Hood, August 5, 2001). However, the breeding ponds are typically formed and maintained by rainfall (Morey 2001) and breeding often occurs in rain pools that disappear relatively quickly (Stebbins 1951). In Sink Valley near Alton, Kane County, Utah, tadpoles were found in muddy water in cattle hoof-marks in a short-grass pasture located in a shallow basin formed by slumping of soil in the wetter part of the meadow (Stebbins 1951). Toads have been observed breeding in ponds as deep as ten feet (S. Sweet, UCSB Associate Professor of Ecology, Evolution and Marine Biology, pers. comm. M. Hood, June 27, 2001). However, ponds that are too deep may result in the presence of bullfrogs, a known predator of the western spadefoot toad (M. Wehtje, CDFG Environmental Specialist 4, pers. comm. M. Hood, September 12, 2001).

Although the western spadefoot toad has adapted to breeding in shallow temporary pools by increasing its developmental rate (Brown 1967a) this could be detrimental to recently metamorphosed individuals (Morey 1996). Larval period and body size of a recently metamorphosed toad are both positively correlated with pool duration: pools that remained filled longer produced larger metamorphosed individuals (Morey 1996). Further, increased body size may be positively correlated with terrestrial fitness (Morey 1996). Thus, it has been suggested that pool duration should be considered when planning vernal pool preserves and wetland restoration projects with the goal being to increase pool duration (Morey 1996). Additionally, while it has been suggested that the pools must last at least 3 weeks for reproduction to be successful (Feaver 1971) other researchers have indicated that the western spadefoot toad in the wild rarely completes larval development in pools drying in less than 30 days after the embryos hatch (Morey 1996). Thus, as it may take up to 6 days for embryos to hatch, pools should hold water for a minimum of 5 weeks after breeding in order to allow for successful metamorphosis and avoid mortality due to desiccation (Morey 1996) with longer lasting pools being even more advantageous to the species.

According to some researchers, the western spadefoot toad does not typically breed well in creeks or streams and prefers quieter waters (S. Sweet, UCSB Associate Professor of Ecology, Evolution and Marine Biology, pers. comm. M. Hood, June 27, 2001). Although the species will not necessarily avoid creeks, a creek may not provide good breeding habitat (S. Sweet, UCSB Associate Professor of Ecology, Evolution and Marine Biology, pers. comm. M. Hood, June 27, 2001). Standing water is preferred for breeding as the males float while vocalizing to attract females and need to remain in one location, versus rafting downstream, to successfully breed (S. Sweet, UCSB Associate Professor of Ecology, Evolution and Marine Biology, pers. comm. M. Hood, June 27, 2001). Observations of the western spadefoot toad in Inyo County, California, noted they were found in canals with slowly flowing water and standing water in short-grass meadows with scrubby vegetation (Stebbins 1951). Both larvae and adults were found in the quieter waters of the canals of permanent water (Stebbins 1951).

With regard to the substrate of the aquatic environment for the western spadefoot toad, it has been observed at VAFB in cattle ponds or other agricultural ponds, as well as disturbed vernal ponds, all of which had a sandy substrate (S. Christopher, UCSB Ph.D. Candidate Ecology, Evolution and Marine Biology, pers. comm. M. Hood, July 17, 2001). The water quality was poor (i.e. cloudy and muddy) which was most likely due to the type of substrate and lack of dense vegetation, rather than a preference for muddy water (S. Christopher, UCSB Ph.D. Candidate Ecology, Evolution and Marine Biology, pers. comm. M. Hood, July 17, 2001). However, in Inyo County, California, observations of the western spadefoot toad also revealed a large concentration of both larvae and adults in turbid water. Elsewhere the water was clear, and it is possible that the turbidity may have helped to protect them (Stebbins 1951). In this regard, poor water quality does not appear to have a negative impact on the western spadefoot toad (S. Sweet, UCSB Associate Professor of Ecology, Evolution and Marine Biology, pers. comm. M. Hood, June 27, 2001) and the species may, in fact, benefit from turbid water created by a sandy substrate. However, it is not a requirement that the substrate be sand

(S. Sweet, UCSB Associate Professor of Ecology, Evolution and Marine Biology, pers. comm. M. Hood, June 27, 2001).

Other important characteristics of the rain pools include temperature, chemistry and absence of predators. Temporary rainpools need to have temperatures greater than 9º Celsius and less than 30º Celsius (Brown 1967a) for normal development to occur. Breeding pools must be free of predators, such as fishes, crayfishes and bullfrogs (*Rana catesbeiana*), for successful recruitment to take place (Jennings and Hayes 1994) Additionally, a study completed by Burgess (1950) concluded that the development of western spadefoot toad larvae was more rapid in field water taken from temporary rain pools in which the species normally breeds, than in tap water (Burgess 1950). The field water was a highly colloidal solution taken from a pool formed on a fine clay soil and was much more alkaline than tap water. The water quality characteristics are shown in Table 1 below:

Table 1 - Water Quality Characteristics of Tap Water and "Field Water" (Temporary Rain Pools: from Burgess 1950)

Quality	Tap Water	Field Water
PH	7.95	8.97
Phosphate	3.6 ppm	10.25 ppm
Calcium	68.0 ppm	85.00 ppm
Carbonates	0.0 ppm	89.0 ppm
Bicarbonates	246.0 ppm	1350.0 ppm
Chlorides	26.79 ppm	970.1 ppm
Total Solids	357.3 ppm	5501.33 ppm
Dissolved Solids	357.3 ppm	3590.33 ppm
Suspended Solids	0.0 ppm	1910.0 ppm

In the lab, western spadefoot toad larvae developed faster in the field water. Thus, it would appear that the above field water qualities constitute beneficial water quality parameters for the species.

Upland / Non-breeding Habitat

The western spadefoot toad requires a habitat that allows for burrowing as the species is chiefly terrestrial and spends the majority of the year in underground burrows. It is an excellent burrower and digs backwards into the soil (Stebbins 1959). The toad is then concealed from view and typically no open burrow can be seen (Stebbins 1951). They may utilize the burrows of other animals as well (Stebbins 1951). The burrows are at least one meter in depth.

The specific characteristics of the soil used by the western spadefoot toad for burrowing are not well known but it has been noted that the toads typically choose areas with friable or sandy soils. (Ruibal et. al 1969, T. Mullen, SAIC Biologist, pers. comm. M.

Hood and S. Erickson, November 1, 2001). Burrowing into compacting soil could leave the toad imprisoned until sufficient moisture loosens the soil (Ruibal 1969). Also, compacting soils, which may become hard during the dry season, may be problematic for newly metamorphosed juveniles due to the difficulty of burrowing in hard, dry soil. This inability to burrow could result in mortality (S. Sweet, UCSB Associate Professor of Ecology, Evolution and Marine Biology, pers. comm. M. Hood, June 27, 2001). It has been determined that toads, in general, do not burrow in the pools where egg laying occurred which suggests that they do not burrow in clay (Ruibal 1969). It has been suggested by some biologists that certain land uses such as cattle grazing may be detrimental to the ability of the western spadefoot toad to burrow. Specifically, cattle could potentially compact the soil due to the continual pressure from their weight (K. Frye, Rincon Consultants, Inc. Biologist, pers. comm. M. Hood, October 15, 2001.). However, other experts do not believe this is a concern (M. Wehtje, CDFG Environmental Specialist 4, pers. comm. M. Hood, November 8, 2001). Thus, the potential impacts of cattle on the toad's ability to dig into soil as well as emerge from a burrow are inconclusive. Other land uses that may require the use of equipment (such as cultivation) also have the potential to impact the toad. The weight of the equipment may compact the soil and digging and/or turning over soil may disturb a toad in a burrow.

Life Cycle and Reproduction

Unfortunately, very little data has been collected on the population structure of this species. It is known that the western spadefoot toad exhibits demographic variability as year-to-year variability in rainfall results in fluctuations in recruitment (Fisher and Schaffer 1996). This dependence upon sufficient rainfall points to the demographic instability of this species and the likely vulnerability to habitat destruction and other anthropogenic threats (Fisher and Schaffer 1996).

It is not known how many years the western spadefoot toad will breed during its lifetime. However, it is believed that the species has the ability to stay underground for two to three years if there is insufficient rainfall during which time no breeding would occur (M. Wehtje, CDFG Environmental Specialist 4, pers. comm. M. Hood, November 8, 2001). Although more research is needed, it is believed that the western spadefoot toad reaches sexual maturity at about two years of age and can live to be five to seven years of age. (M. Wehtje, CDFG Environmental Specialist 4, and T. Hovey, CDFG Marine/Fisheries Biologist, pers. comm. S. Erickson, November 8 and 9, 2001.) Thus, it appears that the average western spadefoot toad has approximately three to five years during which to breed but may or may not emerge during each of those years depending upon rainfall.

Unfortunately, there is little documentation on the exact population size below which a western spadefoot toad population will go extinct. (T. Hovey, CDFG Marine/Fisheries Biologist, pers. comm. S. Erickson, November 9, 2001). However, it has been suggested that four to five pairs of toads may constitute a viable breeding population (M. Wehtje, CDFG Environmental Specialist 4, pers. comm. M. Hood, November 8, 2001).

Although there is no specific breeding season (Stebbins 1951), the western spadefoot toad emerges from its burrow after a sufficient amount of rainfall has fallen to ensure the breeding ponds have an adequate volume of water (Stebbins 1959). This typically occurs between January and April in California populations and breeding normally occurs during this time period (Brown 1967a). They may then form large, vocal breeding groups (Jennings and Hayes 1994). The males may also float on the surface of the water while vocalizing to attract the females (S. Sweet, UCSB Associate Professor of Ecology, Evolution and Marine Biology, pers. comm. M. Hood, June 27, 2001).

After breeding, egg clusters (ranging from 10-42 eggs) are attached to plant stems or pieces of detritus in temporary rain pools or pools in ephemeral streamcourses. (Storer 1925). Oviposition may occur between late February and late May (Storer 1925, Burgess 1950, Stebbins 1985, Feaver 1971) but will not occur until temperatures in breeding pools have reached at least 9º Celsius (Brown 1967a). The eggs hatch in approximately .6 – 6 days,(Brown 1967a) and larval development is completed between 3 and 11 weeks later (Feaver 1971). The larval development period is often determined by the amount of time the pool remains filled (Morey 1996). Tadpoles typically will remain in the shallow, covered portions of the pools in order to be protected from predators (M. Wehtje, CDFG Environmental Specialist 4, pers. comm. M. Hood, November 8, 2001).

The digging reflex for burrowing is immediate after transformation (Stebbins 1951) and newly metamorphosed tadpoles often hide in mud cracks, decomposing cow dung or other debris near the breeding ponds for several days prior to dispersing (Morey 2001). Thus, assuming late oviposition (end of May) and a development time of 11 weeks, a water body would not be expected to harbor the western spadefoot toad after the month of August in California populations.

Prey and Feeding Behavior

Prey items for the western spadefoot toad may include crickets, butterflies, beetles, flies, ants, and earthworms (Morrey 1991). A variety of insects, worms and other invertebrates are also consumed as prey (Stebbins 1972) as adults are strictly carnivorous (Denver 1997). The larvae of all spadefoot toads are carnivorous and many will eat dead tadpoles of almost any species (Bragg 1964). In an experiment performed on western spadefoot toads, individual toads only ate mealworms that were active. This evidence may indicate that only live prey is consumed in a natural setting (Dimmit and Ruibal 1980b).

The foraging activities of the western spadefoot toad are limited to a few months out of the year during the rainy season (Dimmit 1980b). In addition, toads are typically nocturnal foragers, which further restricts their feeding activities. Adult western spadefoot toads can eat, on average, 11 percent of their body weight at one time (Dimmit, 1980b). By metabolizing the lipid content in its prey, this species is able to obtain enough energy to survive its long dormancy period (Dimmit, 1980b).

For western spadefoot toad larvae, studies showed that the drying up of water was an environmental stress that resulted in the cessation of feeding (Denver 1997, Denver, Mirhadi and Phillips 1998). Te stress of habitat desiccation causes hormones to suppress foraging activities and appetite, allowing larvae to accelerate metamorphosis (Denver 1997). A study by Morey and Reznick (2000) showed that food is a limiting factor for growth of western spadefoot toad larvae. The study further showed that when food was eliminated prior to a critical stage in development, no larvae successfully completed metamorphosis (Morey and Reznick 2000). At Gosner stages 36-39 (Gosner stages are a standard way of staging embryo and larval development in amphibians) larvae have fully developed toes on their limbs, but still retain their tail (Gosner 1960). During this period of development, larvae with larger body sizes were better able to complete metamorphosis with a reduction in food availability (Morey and Reznick 2000).

Predation and Introduced Species

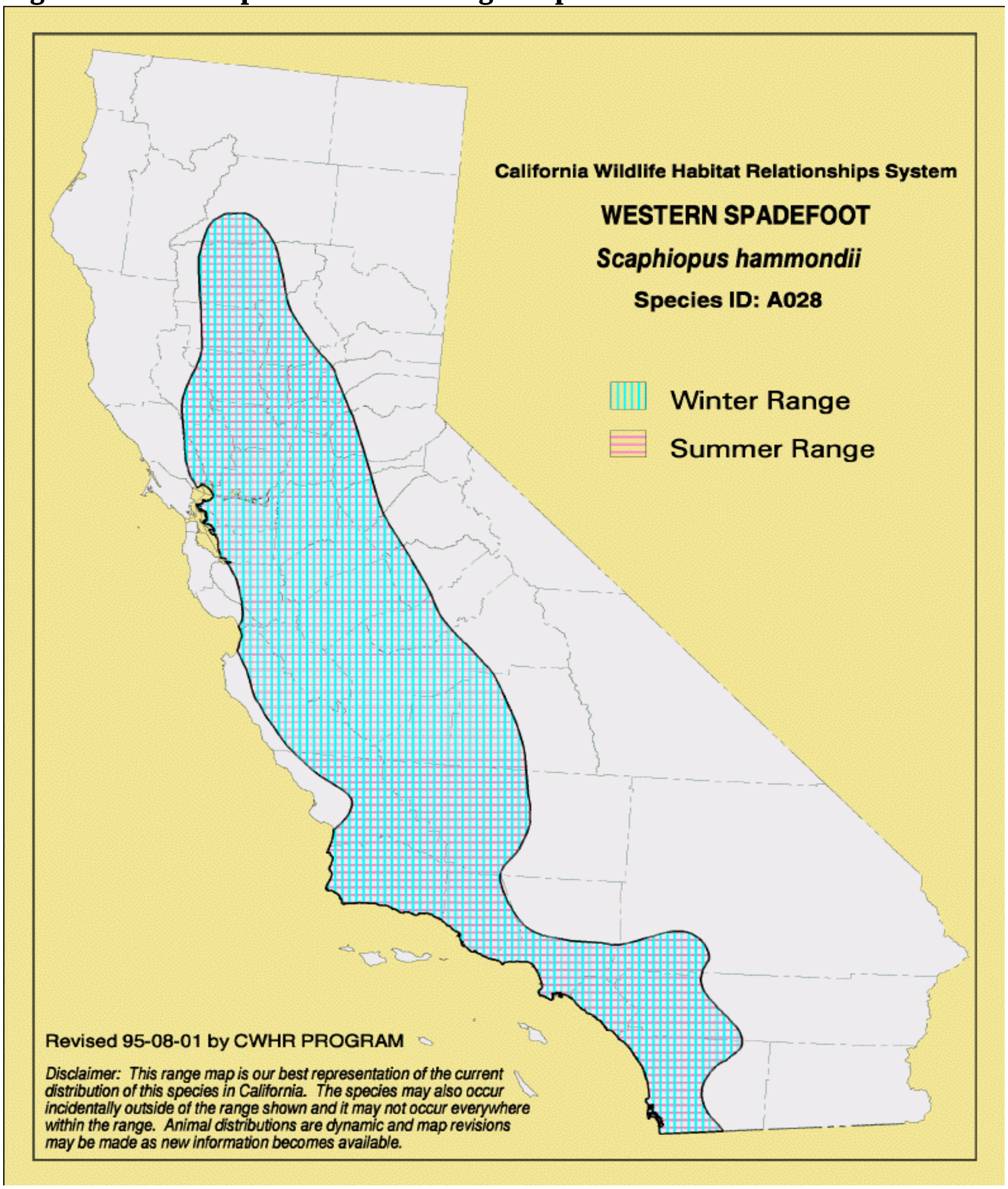
The western spadefoot toad has a variety of native predators during its larval and post-metamorphic stages including California tiger salamanders (*Ambystoma californiense*), garter snakes (*Thamnophis spp.*), great blue herons (*Ardea herodias*), and raccoons (*Procyon lotor*) (Childs 1953). Exotic predators such as introduced fish, bullfrogs, and crayfish are known to have a negative affect on breeding (Jennings and Hayes 1994).

Movement Patterns

The western spadefoot toad becomes active nocturnally above the ground surface after an adequate amount of rainfall has fallen to ensure the breeding ponds have a sufficient volume of water (Stebbins 1959). Initially, they emerge from their burrows to a depth of about one meter prior to fully emerging from the burrow (Jennings and Hayes 1994). The western spadefoot toad is otherwise minimally active during most of the year, but may travel up to several meters during rainy nights (Morey 2001). Surface activity could occur at any time between October and April if a sufficient amount of rain has fallen (Jennings and Hayes 1994). Although movements to and from breeding ponds are often minimal as well (Morey 2001), Sam Sweet indicated that the western spadefoot toad may be found as far as 0.5 mile from the breeding pond location (S. Sweet, UCSB Associate Professor of Ecology, Evolution and Marine Biology, pers. comm. M. Hood, June 27, 2001.) Additionally, according to some biologists, the toad may travel up to 2 miles when moving towards a water source to breed using other calling males to guide it (M. Wehtje, CDFG Environmental Specialist 4, pers. comm. M. Hood, November 8, 2001).

A study involving the couch spadefoot toad (*Scaphiopus couchii*) and the southern spadefoot toad (*Scaphiopus multiplicatus*) revealed that there may be additional environmental correlates of emergence including low frequency sound (below 100 Hz) and vibration, regardless of other environmental conditions, i.e. adequate rainfall or temperature (Dimmit and Ruibal 1980a). In addition, soil temperature below 20ºC inhibited response to sound. Finally, the study discovered that increasing the soil temperature and wetting the soil (not saturated) without the sound stimulus did not result in emergence. Although this study did not involve the western spadefoot toad, it is an indication, among other findings, that sound of a specific frequency may result in emergence from burrows in this species as well (Dimmit and Ruibal 1980a).

Figure 1: Western Spadefoot Toad Range Map



(Map courtesy of California Wildlife Habitat Relationship System)

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Appendix 5: California Red-legged Frog

Background
The California red-legged frog has been described as being in the final stages of decline in California's Great Central Valley relative to its historical distribution (Fisher and Shaffer 1996). In addition to the Great Central Valley, populations of California red-legged frogs in the foothills of the Sierra Nevada and in southern California have declined dramatically in distribution and abundance (Davidson, Schaffer and Jennings 2001). This species has disappeared from about 75% of its former range, and half of this loss has taken place over the past 25 years (Phillips 1994). Although the species has not declined along much of the central coast area of California relative to other regions of its range, the rapidly expanding vineyards in Santa Barbara and San Luis Obispo Counties pose a threat to California red-legged frogs in the future 15 C.F.R. §930.33. The continued urban encroachment threatens the aquatic habitats on which this species depends for survival and reproduction.

Historically, the California red-legged frog was found in 46 counties in California ranging from Mendocino and Shasta Counties, California south to Baja California, Mexico (Jennings and Hayes 1985). At present, the range of the California red-legged frog extends from Marin County, California to Baja California, Mexico, with only isolated populations present in the foothills of the Sierra Nevada, along the northern Coast, and in the northern Transverse Ranges (Figure 1) (USFWS 2001). Throughout these areas, populations of California red-legged frogs have been found in 248 drainages or streams in a total of 26 counties (USFWS 2001). The California red-legged frog has been found up to approximately 1.7 km above sea level (Davidson, Schaffer and Jennings 2001). However, the majority of historic sites were less than 1 km in elevation (Davidson, Schaffer and Jennings 2001).

The taxon is allopatric with the northern red-legged frog (*Rana aurora aurora*) near Point Reyes National Seashore in Marin County and in parts of Sonoma County, California (USFWS 2000). This zone of overlap may also include Humboldt and Mendocino Counties where red-legged frogs exhibit characteristics of both subspecies (USFWS 2000). The range of the northern red-legged frog extends north from the contact zone in Mendocino County, California to British Columbia, Canada.

The California red-legged frog was listed as threatened on May 23, 1996 by the U.S. Fish and Wildlife Service (USFWS) (61 FR 25813) pursuant to the Federal Endangered Species Act of 1973, as amended (USFWS 2001). A total of 1,674,582 hectares, in 28 California counties, have been designated as habitat critical for the recovery of this species (USFWS 2001). The most significant threats to California red-legged frogs are associated with human interference. The loss and fragmentation of habitat including urbanization, reservoir construction, livestock grazing, and the introduction and spread of non-native species are the primary human impacts affecting this species(USFWS 1996). Pollution and anthropogenic climate change may become increasing threats to the species in the future. Statewide, wind-borne agrochemicals from agricultural land use may be negatively affecting California red-legged frog populations that are upwind (Davidson, Schaffer and Jennings 2001).

California red-legged frogs were first observed at the Site during the spring of 1998 (M. Blevins, EPA. Environmental Scientist, personal communication S. Erickson, August 27, 2001). Since then, they have been found in the RCF Pond, Pond 13, Pond A-5, and the A-series Pond (Figure 2) (Hunt 1999). California red-legged frogs have not been found in Pond 18, the smallest of the five Site ponds. In surveys conducted in November of 1999, the following numbers of California red-legged frogs were observed in each pond: 3 adults and 2 subadults in pond A-5, the A-series pond, and the RCF pond, and 2 adults and 6 subadults in pond 13 (Hunt 1999).

Habitat

Breeding Habitat

Considered by early biologists to be a "pond-dwelling frog" (Storer 1925, Stebbins 1966) the California red-legged frog usually breeds in ponds with spatial heterogeneity (Lawler *et al.* 1999) and often with a depth of at least 0.7 meters (Jennings and Hayes 1989). The preferred breeding habitat of this species is often characterized by a mosaic of open water with submerged, emergent, or dense riparian vegetation within freshwater ponds or along slow-moving creeks (Jennings 1988, USFWS 2000). Riparian vegetation, such as arroyo willow (*Salix lasiolepis*), cattails (*Typha sp*.), and bulrushes (*Scirpus sp*.) provide refuge from predators and foraging habitat for adult and larval frogs (Jennings and Hayes 1994, USFWS 2000).

As a result of egg-laying near the surface and at the edges of ponds (Storer 1925) tadpoles and recently metamorphosed juveniles can often be found at high densities in the shallower areas of ponds. The vegetation in shallow waters provides shelter for tadpoles and the warming of shallow areas by the sun encourages the growth of algae and diatoms which provide food for larvae (Storer 1925). However, tadpoles are able to take refuge in pools with dense submergent vegetation and deep areas (Lawler *et al.* 1999). In order to prevent desiccation of larvae, tadpoles require a minimum water depth of 20 cm throughout their development, which typically lasts from March through July along the central coast of California (USFWS 2000).

According to Jennings and Hayes (1994) juveniles seem to prefer open, shallow water-bodies, but observations by Fellers *et al.* (2001) suggest that juvenile California red-legged frogs inhabit a wide range of habitats including pools, creeks surrounded by grazed woodlands, and artificial stock ponds. Adults, on the other hand, are often observed in deeper pools (Fellers *et al.* 2001, S. Christopher, pers. comm. S. Erickson, August 17, 2002). This separation in habitat use among different life stages may be a mechanism for juveniles to avoid predation by, and competition with, adults (USFWS 2001, S. Christopher, pers. comm. S. Erickson, August 17, 2002). Although adults have been known to consume larvae of their own kind, it may be that any such separation of habitats has more to do with other factors, such as physiological requirements for the different life stages, rather than avoidance of predation or competition.

California red-legged frogs are sensitive to salinity levels and water temperature. Eggs and embryos have the lowest salinity tolerance of all life stages, with abnormalities occurring in greater than 40 percent of embryos when salinity levels are between 5 and 6.5 parts per thousand (Jennings and Hayes 1989). Eggs that were exposed to salinities greater than 6 parts per thousand experienced 100 percent mortality. Data collected from field studies at Pescadero Marsh revealed dead egg masses in salinities between 4.2 and 5.2 parts per thousand (Jennings and Hayes 1989). Furthermore, adult California red-legged frogs were observed leaving areas with salinities above 6.5 parts per thousand as water levels diminished.

Temperature tolerances of the California red-legged frog are not known. At water temperatures near or above 29º Celsius, adult California red-legged frogs may become stressed and may die if exposed for an extended period of time (Jennings and Hayes 1989). Furthermore, adult California red-legged frogs may require water temperatures less than 15.6º Celsius for egg laying (Storer 1925). Northern red-legged frog embryos can only survive in water that is between 4º Celsius and 21º Celsius, making this the lowest lethal temperature limits of any North American ranid frog (Licht 1971, Nussbaum 1983).

Upland / Non-breeding Habitat

While moving through coastal dune scrub upland habitat following a relocation effort, California red-legged frogs have been observed taking shelter in stands of mock heather (*Ericameria ericoides*), bush lupine (*Lupinus arboreus*), and coyote bush (*Baccharus pilularis*) that were a meter high (Rathbun and Schneider *in litt* 2001). In the Scott Creek study, frogs appeared to opportunistically use different plant species for cover during terrestrial dispersal spurts of several days. Commonly used species included California blackberry (*Rubus ursinus*), poison oak (*Toxicodendron diversilobum*), and coyote brush (*Baccharis pilularis*), however, cover preferences were not specifically examined in this study (Bulger, Scott, and Seymour 1999). Non-breeding habitat of the California red-legged frog may include spaces under large rocks, trees and logs (USFWS 2000). In addition, adults have been found in drains and watering troughs. Mammal burrows and moist leaf litter may provide temporary habitat if a permanent water source is not available (Jennings and Hayes 1994).

Life Cycle and Reproduction

The rangewide breeding season of the California red-legged frog takes place from November to April (Jennings and Hayes 1985) however, the onset of breeding and the peak breeding time are dependent on local weather patterns. At the Site, the peak of breeding occurs in February when the highest percent of annual rainfall is expected (S. Christopher, pers. comm. S. Erickson, August 17, 2002). The low thermal maximum for embryos, and the necessity of larvae reaching metamorphosis before breeding waters disappear, necessitates breeding early following sufficient rainfall. (Hayes and Jennings 1986). Males arrive at breeding locations before females, and initiate breeding behavior with mating vocalizations. Calling males may occur individually or in groups of several individuals (USFWS 2000).

Female frogs can arrive at breeding sites up to four weeks after the arrival of males(USFWS 2000). Females are attracted to specific locations at breeding sites by the calling of males in combination with other factors. After breeding, the female releases her eggs while the male fertilizes them. This process typically occurs at night. (USFWS 2000).

Individual eggs are approximately 2.0 to 2.8 millimeters in diameter and are reddish brown in color (Storer 1925). The female deposits from 2,000 to 6,000 such eggs in a single mass that she attaches typically to emergent vegetation, such as bulrushes (*Scirpus* sp.) and cattails (*Typha* sp.), during fertilization (USFWS 2001). These initially compact and cohesive jelly-coated egg masses can also be attached to roots, twigs, and rocks, but they are usually deposited near the surface of the water (Lawler *et al.* 1999, USFWS 2001, Phillips 1994).

Embryos of California red-legged frogs typically hatch to larvae in six to fourteen days following fertilization (Storer 1925). The rate at which embryos develop and emerge from the eggs is largely a function of water temperature. Newly emerged larvae will rest on the surface of the jelly from the eggs until the jelly softens and eventually disappears (Storer 1925).

Metamorphosis may occur when tadpoles are ¾ to 1 $^{1}/_{5}$ inches (18-30 millimeters) in length (Wright and Wright 1949). This transformation into terrestrial juvenile frogs requires four to five months unless overwintering occurs (Storer 1925, Feller *et al.* 2001). Overwintering has been defined as the period in which tadpoles remain in the larval stage throughout the winter season (Gosner 1960). Although overwintering of California red-legged frog tadpoles is not a common behavior, it has been observed at a limited number of breeding sites throughout their range (Feller *et al.* 2001). As a result of this behavior, the period of time spent in the larval stage can last from 4 - 13 months Feller *et al.* 2001).

Of the many embryos produced by a pair of frogs, few are likely to live to adulthood. For example, Lawler *et al*. (1999) found that only about 30 to 40 percent of larvae reached metamorphosis in the absence of bullfrogs (*Rana catesbeiana*). When bullfrogs were present however, they found that tadpole survival was reduced to five percent (Lawler *et al.* 1999).

Although the minimum age at sexual maturity for California red-legged frogs is two years for males and three years for females (Jennings and Hayes 1985) they may not reproduce for another year following sexual maturity (Jennings and Hayes 1994). Adult females generally reproduce once a year, with a minimum reproductive size of about 85 millimeters snout-vent length (SVL) (Jennings and Hayes 1985). California red-legged frogs may live as long as eight to ten years (USFWS 1999), but the average lifespan is considered to be closer to five or six years.

Prey and Feeding Behavior

California red-legged frogs feed on a variety of organisms throughout their life cycle (Hayes and Tennant 1985). Feeding behavior and prey selection are specific to the age and size of the individual. Substrate, time of day, and climatic conditions also contribute to feeding behavior and food availability.

Larval California red-legged frogs feed on periphyton, including various species of algae, and almost any kind of decomposing organic detrital material present at the breeding site (Licht 1974). Starvation tests conducted on *Rana aurora aurora* tadpoles show that new larvae were able to survive for many days at a time without external food. Licht (1974) found that most *Rana aurora aurora* tadpoles survived for approximately 24 days after hatching, and many survived for more than 30 days, without food. As a result of these experiments, Licht (1974) concluded that food shortage was not a significant cause of mortality, nor was it an important factor in controlling populations of red-legged frogs. Results of studies such as this one may correlate to the California red-legged frog as well, however, the feeding ecology of *Rana aurora draytonii* has not been studied in detail (USFWS 2000).

Newly metamorphosed California red-legged frogs exhibit both terrestrial and semi-aquatic feeding behavior. During dry periods from July through September, young juvenile frogs remain close to water margins. At the onset of rainy conditions, frogs can venture away from pond or river margins to search for food in nearby upland habitat (Licht 1974). This type of foraging may occur diurnally and nocturnally, and is associated with a broader range of activity in juvenile frogs (Hayes and Tennant 1985). Newly metamorphosed California red-legged frogs have been observed catching small macroinvertebrates along the banks of rivers in the vegetation, while occasionally entering the open water to consume insects on the surface of aquatic plants (Licht 1986). Data collected from the gut contents of California red-legged frogs suggests that newly metamorphosed individuals consume mainly insects of the families *Hemiptera* and *Diptera*, and arachnids. Juvenile frogs also consumed mollusks, specifically slugs (Licht 1974).

The feeding behavior of adult frogs occurs largely on land and nocturnally (Hayes and Tennant 1985). Observations of feeding behavior and preferences of adult California red-legged frogs in San Luis Obispo County, California, revealed that over half the prey mass consisted of vertebrate species. Larger frogs were occasionally observed feeding on California mice (*Peromyscus californicus*) and Pacific tree frogs (*Hyla regilla*) (Hayes and Tennant 1985, USFWS 2000). Invertebrates were consumed much more frequently, however, and prey items consisted of Carabid beetles, water striders (*Gerris* sp.), lycosid spiders, and larval neuropterans.

Predation and Introduced Species

Metamorphosis is a time of enhanced vulnerability to predation (Wilbur 1980) and thus is another stage where significant mortality can occur. Herpetologists recognize that the extent and timing of predation on amphibians is strongly influenced by body sizes of the predators and the prey (Wilbur 1980). Given the complex life cycle of California red-legged frogs, this species faces a diverse array of predators. The diversity of native and non-native predators is accountable for a significant portion of the mortality experienced by the California red-legged frog.

Embryos of California red-legged frogs are vulnerable to any predators that can penetrate the jelly embryonic membranes of eggs. Thus, both native and non-native predators can determine the presence or absence of tadpoles in a given pond. Predation of eggs and tadpoles by introduced aquatic species such as the bullfrog, African clawed frog (*Xenopus laevis*), red swamp crayfish (*Procambarus clarkii*), signal crayfish (*Pacifastacus leniusculus*), and species of fish such as catfish (*Ictalurus spp*.), bass (*Micropterus spp*.), sunfish (*Lepomis spp*.), and mosquitofish (*Gamgusia affinis*) is an important factor in the persistence of the California red-legged frog (Rathbun 1998, USFWS 2000).

Rathbun documented egg predation by native newts at Scott Creek drainage in Santa Cruz County, California, and suggested that this predation by *Taricha* sp. might be a significant factor in the population dynamics of the California red-legged frog (Rathbun 1998). Licht, however, has documented that *Rana aurora aurora* egg predation is uncommon and mortality occurring during larval tadpole stages is the strongest factor limiting frog numbers (Licht 1974). The time shortly after tadpoles emerge from eggs may in fact be the heaviest period of predation in this species. This time of increased vulnerability may be due in part to highly visible aggregations of individuals around spawning sites, or the lack of developed defense mechanisms. According to Licht (1974) active swimming does not begin for days after larvae have emerged from eggs, and this inability to escape predators may contribute to increased predation.

Juvenile frogs are more active during the day, and are preyed upon by garter snakes (*Thamnophis* sp.), among other predators (Davidson 1996). Licht (1974) has recognized red-legged frog (*Rana aurora aurora)* predation by garter snakes, and the occurrence of snakes along the pond and river where tadpoles and frogs live. Gregory (1979) studied the predator avoidance behavior of the red-legged frog and found that no more than twenty-five percent of adult frogs were in the water on any given day during field studies, and snakes tended to be found most frequently in areas where frogs were most abundant. Frogs would jump into the water to flee a snake at very close range, otherwise remain motionless in attempt to avoid detection altogether. Licht (1974) found a contrary response to the presence of predators, which was described as an action to seek cover in vegetation on the bank of a pond or creek. This discrepancy in predator response observations by Licht and Gregory is attributed to differences in the density of vegetation along the shoreline and in the amount of protective cover, the presence of predatory fish in the water, or the different habitat preferences of the red-legged frog at various life stages (Gregory 1979).

Although the predator avoidance behavior of the California red-legged frog has not been studied in detail, it may be useful in predator management planning to recognize the documented predator avoidance behavior of related taxa. Determining the activity response to the threat of predators may also provide information on the important habitat features for the California red-legged frog. In reference to the Site, information on related taxa (*i.e.*, *Rana aurora aurora*) has facilitated the development of important habitat features associated with restoration activities for the California red-legged frog.

Adult California red-legged frogs are preyed upon by several native species of mammals, birds, and reptiles. Great blue herons (*Ardea herodias*), black-crowned night herons (*Nycticorax nycticorax*), American bitterns (*Botaurs lentiginosus*), and red-shouldered hawks (*Buteo lineatus*) are known to feed on adult frogs while wading in shallow water at the edges of ponds or in upland habitat (USFWS 2000). Possible mammalian predators include raccoons (*Procyon lotor*), opposums (*Didelphis virginiana*), and skunks (*Mephitis mephitis, Spilogale putorius*).

It has been suggested that bullfrogs introduced into California have contributed to population declines of other ranid frogs via both increased predation and competition (Moyle 1973, Hayes and Jennings 1986). Historically, bullfrogs became established in areas of southern and central California during a time when populations of the California red-legged frog were deteriorating due to intense commercial exploitation and harvest for food (Jennings and Hayes 1985). Since then, bullfrogs have adapted to a wide variety of environmental conditions in California. Bullfrogs have adopted similar ecological niches as the California red-legged frog, but grow larger and can eat a larger range of prey. Unlike the California red-legged frog, however, bullfrogs are restricted to areas with a permanent water source (Storer 1925).

The presence of introduced predatory fish species is also attributed to the decline of the California red-legged frog. Before bullfrog introduction, thirty-five species of exotic fish species were released in California, and at least six were well established in areas of historic California red-legged frog extirpation (Hayes and Jennings 1986). Although bullfrogs are generally known to prey on post-metamorphs, the majority of California red-legged frog predation by non-native aquatic predators has been found to occur in the premetamorphic stages of life. It has also been found that the predatory potential of fish may intensify in pools in which area is small and relatively homogeneous (USFWS 2000). Without sufficient vegetative cover and shallow water margins, tadpoles are not able to utilize antipredator avoidance behavior characteristic of decreased movement and increased shelter use. This behavior may be very effective against predators, such as fish, that locate prey by detecting movement (Kiesecker *et al.* 1999). The distribution of mosquitofish in California is widespread, and their occurrence has been documented in areas where the red-legged frog has persisted and where populations have declined (Davidson, Shaffer and Jennings 2001). Ecologically, mosquitofish are more efficiently adapted for aquatic life and are able to prey on larval amphibians more easily than bullfrogs (Hayes and Jennings 1986). Lawler *et al.* (1999) have found that mosquitofish reduce the mass of new metamorphs which may lead to decreased fitness as an adult.

Introduced predators do not always contribute to red-legged frog extirpation from a particular site. Studies have suggested that both California red-legged frogs and bullfrogs can coexist at specific sites; however, the prevalence of non-native predation may become much more destructive in combination with habitat modification associated with intensive human activities, livestock grazing, and climate change (Davidson, Shaffer and Jennings 2001). Although predation by non-native species likely plays a role in the decline of the California red-legged frog, other factors should be equally considered and evaluated.

Movement Patterns

California red-legged frogs are active year-round in coastal areas (Bulger, Scott, and Seymour 1999). The activity patterns of the California red-legged frog vary depending on life stages. Juveniles are active both during the day and at night, while adults are primarily nocturnal (Hayes and Tennant 1985). As a result, juveniles tend to have longer periods of activity than adults and subadults. This difference may be due to the energy budget of individuals during different stages of their growth. As adults, frogs may use less energy dispersing and foraging and allocate more energy to courtship behavior and mating.

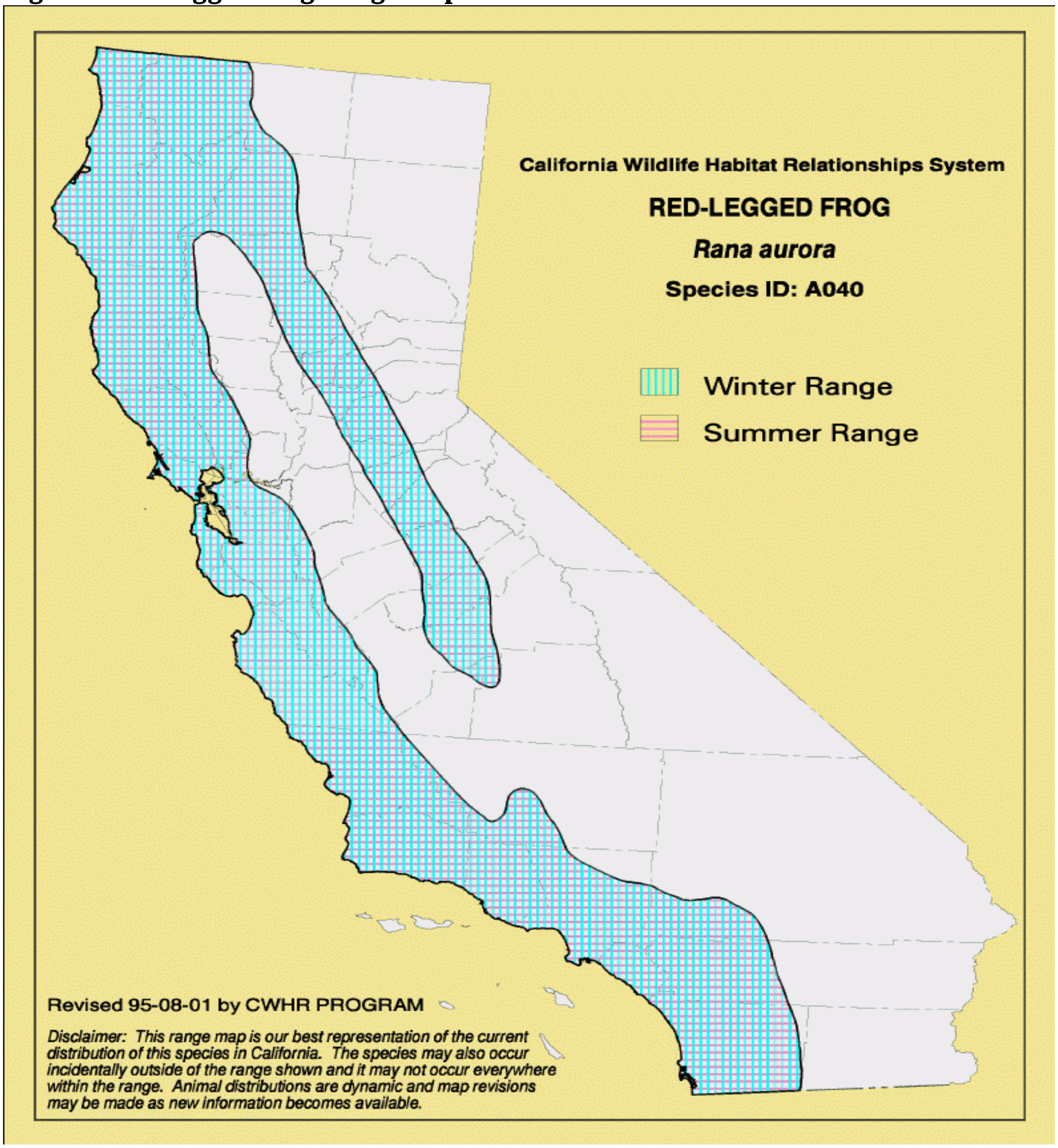
Individuals often disperse short distances into upland habitat for periods of days to weeks in response to precipitation events, returning to aquatic sites after each upland interval (Bulger, Scott, and Seymour 1999). California red-legged frogs traveling overland have been observed dispersing 1200 meters without contacting a pond or a stream, although, most dispersing individuals move to the nearest pond to breed, and to the nearest pond or stream after breeding (Bulger, Scott, and Seymour 1999). Some individuals may disperse across landscapes to other aquatic sites. California red-legged frogs have been documented traveling over 2 miles during winter migration events, which usually take place during the night (USFWS 2000). Long excursions into upland habitat during the winter months can be a normal part of the life cycle of this species (Rathbun and Schneider *in litt.* 2001).

During the dispersal from one occupied aquatic habitat to the next, red-legged frogs will utilize direct corridors or upland habitat (Bulger, Scott, and Seymour 1999). Direct corridors often facilitate the movement or dispersal of organisms that use them. The presence of ravines and small watercourses as frog habitat constitutes critical landscape features for California red-legged frogs, although they may not always provide directional dispersal facilitation. In addition, juveniles have been observed using swales (low areas with damp soil and grasses) rather than tracking directly over sand dunes (S. Christopher, pers. comm. S. Erickson, January 24, 2002). When dispersing over land, California red-legged frogs have been tracked scaling canyon side-slopes with slopes greater than 50% and over more than 100 meters, and vertical rock faces appear to be the only topographic constraints to red-legged frog dispersal (Bulger, Scott, and Seymour 1999).

During the dry season, this species is seldom found far from a source of water. The lack of water during the dry season may induce some frogs to disperse from their breeding habitat in search of forage and cover (USFWS 2000). The use of terrestrial habitat by California red-legged frogs at Scott Creek watershed in Santa Cruz County, California, was directly related to soil moisture, which was the strongest predictor of frog distance from water in the summer and early winter (Bulger, Scott, and Seymour 1999). In the winter, however, frogs were observed less frequently in upland habitat despite regular rains. Bulger (1999) asserts that the observed reduction in terrestrial habitat use may be attributed to hormonal timing of breeding and the homing of males and females to breeding sites.

At the Site, the movement of the California red-legged frog may need to be restricted to prevent individuals from re-entering the existing on-site ponds once relocation or pond drainage has begun. The California red-legged frog has been documented to pass over frog barriers as high as 1.8 meters, but can also be excluded by barriers of the same height depending on the type of material used (Rathbun, Scott, and Murphey 1997). The effectiveness of a frog barrier depends, at least in part, on the type of material used to construct the barrier. Rathbun *et al*. (1997) documented the ability of the California red-legged frog to pass over a barrier one way, but not back the other way. In that study, the frogs were able to get over the barrier with the plastic surface facing the frog, while the chain-link fence side of the barrier proved impossible to cross.

Figure 1: Red-legged Frog Range Map



(Map courtesy of California Wildlife Habitat Relationship System)

REFERENCES: Appendix 5

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Appendix 6: Current Watershed Characteristics

This appendix presents additional information on following characteristics as they pertain to both Casmalia Creek and the watershed:

1. Casmalia Creek
2. Geologic Characteristics
3. Hydrology and Hydraulic Characteristics
4. Chemical Characteristics
5. Biological Community Characteristics

Casmalia Creek

Casmalia Creek is characterized as a typical coastal tributary stream that is located in moderately steep, rolling topography (CRWQCB 1999). The creek is approximately 9 kilometers (5.6 miles) long and drains a watershed of approximately 10.7 square kilometers (4.1 square miles). The creek flows southward out of the Casmalia Hills to its confluence with Shuman Creek.

The upper 4 kilometers of the creek drains an area of approximately 5.8 square kilometers (2.3 square miles) and has an approximate slope of 4%. The lower 5 kilometers of the creek drains an area of approximately 4.8 square kilometers (1.8 square miles) and has an approximate slope of 2%. The potential locations for the created ponds discussed in this report are located in the lower 5 kilometers of Casmalia Creek.

Based on Rosgen's (1996) geomorphic characterization and morphological classification system the creek can be classified as a "G6" stream type. The channel is for the most part, narrow and deep with a low sinuosity. Furthermore, the creek can be generally described as having a single-thread channel, entrenched (Ratio: <1.4), with a low width to depth ratio (< 12), and slopes ranging between (2 – 4%), with a channel made up primarily of silts and clays.

Seven of ten additional parameters presented by Rosgen (1996), which influence current and potential geomorphic processes, were adapted and used to examine Casmalia Creek. The adapted parameters are: 1) streamflow regime, 2) stream size and stream order, 3) organic debris and/or channel blockage, 4) depositional patterns, 5) meander patterns, 6) channel stability and streambank erosion potential, and 7) altered channel materials and dimensions. Table 1 presents the seven parameters as they apply to Casmalia Creek.

Table 1: Casmalia Creek parameters that influence geomorphic processes

Parameter	Description
Streamflow Regime	E & P 3. Streamflow varies from perennial to ephemeral based on the volume and timing of rainfall. Variation in streamflow is dominated primarily by stormflow runoff.
Stream Size and Stream Order	S-3 – S-6(2). Bankfull widths range from 2 – 15 meters and Casmalia Creek is a second order stream.
Organic Debris and / or Channel Blockage	D3-Infrequent. Debris within the bankfull area is infrequent and is made up primarily of small to medium sized material, easily moved, and floatable material. The material ranges from small twigs to small and medium sized logs.
Depositional Patterns	There are few identifiable depositional features.
Meander Patterns	Distinct meanders do not exist along the creek corridor.
Channel Stability and Streambank Erosion Potential	Channel stability ranges from good to poor. Streambank erosion potential ranges from very low to extreme and is closely tied to channel stability and vegetation. Extensive erosion is evident along the creek. Furthermore, the creek channel is being actively incised in reaches throughout the creek. Large portions of the creek can be characterized as being unstable (slopes greater than 70 degrees), having deeply incised channels, and regions of active mass wasting (CRWQCB 1999, pers. obs. 2001). Cattle graze within the creek channel and along the riparian corridor resulting in direct stream bank erosion and a reduction in the density of riparian vegetation, which adds to the instability of the channel banks.
Altered Channel Materials and Dimensions	The stream channel has been altered by the introduction of culverts and debris placed in channel to increase deposition. Furthermore, agricultural activities have altered the vegetation in the watershed and affected channel materials.

Adapted from Rosgen (1996)
Data from T. Carson and C. Minton

Geologic Characteristics

The Todos Santos Claystone Member (TSCM) of the Sisqouc Formation underlies the watershed. The TSCM is approximately 1,300 feet deep and has been differentiated into weathered claystone, ranging from 10 – 65 feet below ground surface (bgs), and unweathered claystone (URS 2000). The weathered claystone is distinguishable by color, the prevalence of fractures and joints, and the presence of secondary mineralization (URS 2000). The weathered claystone is overlain by clay loam soils, alluvium, and colluvium up to 50 feet below ground surface (Harding Lawson 2000).

Hydrology and Hydraulic Processes

The following information is a summation of the hydrology and the hydraulic processes in the Casmalia Creek watershed.

Groundwater

Casmalia Creek is located within the San Antonio groundwater basin and is isolated from the adjacent Santa Maria and San Antonio groundwater basins (Harding Lawson 2000). The TSCM, in the Casmalia Creek watershed, has been divided into three Hydrostratigraphic Units (HSUs). These three HSUs are the surficial material (characterized by sandy clay soils, alluvium, and colluvium), the Upper Hydrostratigraphic Unit (characterized by weathered claystone), and the Lower Hydrostratigraphic Unit (characterized by unweathered claystone). The TSCM is considered to be non-water bearing, although minor amounts of water are contained in the Upper Hydrostratigraphic Unit (UHSU) (URS 2000). The depth to groundwater varies within the watershed from 2 meters bgs in some areas within 100 meters of the creek to 3 meters bgs in the B-drainage to 9 meters bgs in upland areas in the C-drainage (Harding Lawson 2000). The average hydraulic conductivity for the UHSU and the Lower Hydrostratigraphic Unit are 4.6 x 10^{-5} cm/sec and 1.2 x 10^{-6} cm/sec, respectively (Harding Lawson 2000). The groundwater flow tends to follow topography and trends to the south (URS 2000).

Upon reviewing current data and previous investigations (URS 2000), reported that vertical hydraulic gradients exist between the three HSUs and zones of perched water exist in the vadose zone. These zones of perched water are laterally and horizontally discontinuous over distances of inches to several tens of feet (URS 2000). The Average Hydraulic Conductivity for the UHSU and the LHSU are 4.6 x 10^{-5} cm/sec and 1.2 x 10^{-6} cm/sec, respectively (Harding Lawson 2000). The groundwater flow tends to follow topography and trends to the south (URS 2000).

Surface Water

Water reaches Casmalia Creek from dry-weather flow through groundwater sources and storm flow primarily in the form of Horton overland flow. Typical of small, coastal California watersheds, the Casmalia Creek watershed is characterized as extremely flashy. Consequently, due to the relatively small size of the watershed, there is a rapid response to storm events and the flow in the creek channel rises and falls quite rapidly, on the order of hours. Also typical of the region, there is a high degree of annual variation in the volume of rainfall. Anecdotal evidence has suggested that the creek will remain dry throughout the entire year during periods of prolonged drought (C. Cooper, EPA, pers. comm. C. Minton 2001). Gaining an understanding of the volume and timing of flow within Casmalia Creek was of fundamental importance to better determine the water available for restoration activities proposed in the Habitat Creation and Restoration Plan (Section 8.0).

However, flow data for Casmalia Creek is extremely limited. The creek has never been adequately gaged. The only known flow data collected on the creek were recorded by the CSC at a location close to the Site, beginning in 2000, to meet requirements dictated in their NPDES permit. This data was collected several times a month (7 – 13 sampling dates per month) during the rainy season (November through April) following rain events in 2000 and 2001. This data, on its own, is insufficient to draw any conclusions about the magnitude and timing of flow in the creek. Therefore, to determine the water available for restoration activities proposed in the Habitat Creation and Restoration Plan (Section 8.0) an analysis was conducted to determine if storm flow through Casmalia Creek is sufficient to provide an adequate amount of water for restoration activities to meet the needs of the vegetation and the target species. Storm flows were the only water source considered for ponds so that diversions from Casmalia Creek would not affect base flow. It is undesirable to reduce base flow as it could significantly affect downstream flora and fauna.

To estimate the volume of storm flow derived from rainfall events, the U.S. Department of Agriculture Soil Conservation Service (SCS) method (USDA 1986) was used to estimate overland flow from each of the over 2000 rainfall events that occurred over the past 46-years. Over the 46-year record of available rainfall data the average yearly storm flow volume derived from the portion of the watershed directly upstream of potential pond locations was approximately 14,000,000 cubic feet of water (390,000 cubic meters). Due to the relatively large amount of average yearly storm runoff through the creek, it was predicted that the average yearly storm flow volume through Casmalia Creek is likely sufficient to fill ponds and meet the needs of the target species.

Physical and Chemical Characteristics

The following information is a summation of the Physical and Chemical Characteristics of groundwater and surface water in the Casmalia Creek watershed.

Creek sediment sampling, conducted in 1999, did not indicate any chemical contamination in Casmalia or Shuman Creek from Site activities (CRWQCB 1999). Furthermore, groundwater samples at wells in the both the B-drainage and the C-drainage are considered to be at non-detect levels (Harding Lawson 2000). However, the Casmalia Creek watershed is naturally high in total dissolved solids (TDS) as evidenced by creek samples collected in 1995 and 1996 (EPA 1996c) as well as quarterly groundwater samples taken at monitoring wells in the B and C-drainages. TDS ranges from about 2,000 parts per million (ppm) to 10,000 ppm in groundwater and from slightly below to slightly greater than 1,000 ppm in Casmalia Creek (CH2M Hill 1999). EPA water quality measurements collected in 1996 at four points along Casmalia Creek indicate a pH range of 8.1 - 8.4. (EPA 1996b) The creek sampling results are summarized in Table 2.

Table 2: Creek Sampling Results

	Pre-release October 10, 1996 Location				Post-release February 1996 Location			
Parameters	**1**	**2**	**3**	**4**	**1***	**2****	**3****	**4***
Time	0825	1220	1145	1105	1458	1003	1124	1656
Temp (C°)	14.9	20.9	23.5	16.6	19.5	13.0	17 .2	18.2
pH	8.2	8.1	8.3	8.4	8.1	8.3	8.8	8.9
Dissolved Oxygen (mg/L)	7.3	8.5	8.2	5.0	8.5	9.5	11.9	8.5
Conductivity (mmhos/cm)	1.81	2.06	2.23	2.29	1.51	1.75	1.87	2.11
Oxidation Reduction Potential (V)	+0.04 5	+0.03 5	+0.04 1	+0.08 9	+0.40 9	+0.40 3	+0.39 7	+0.39 9
Salinity (ppt)	0.4	0.6	0.7	0.7	0.8	0.9	1.0	1.1
Total Suspended Solids (mg/L)	-	-	-	-	30	22	2	24
Total Dissolved Solids (mg/L)	-	-	-	-	1310	1180	1460	1640
Turbidity (NTU)	-	-	-	-	47	40	16	13

Source: EPA Emergency Response Team 1996
*Sampled on February 13, 1996.
**Sampled on February 14, 1996.

In addition, a 1996 analysis of surface water chemistry in Casmalia Creek indicated that nitrate levels, found at 12.8 mg/L, exceeded the drinking water standard of 10 mg/L (EPA 1996c). This is thought to be a result of cattle excrement being discharged into the creek. Portions of the creek have been observed to be eutrophic. The same 1996 sampling event found nickel in concentrations of 164 ug/L, which exceeds the EPA's Maximum Contaminant Level (MCL) standard of 100 ug/L for drinking water. However, the aquatic life protection standard is higher than 164 ug/l due to the high hardness naturally present in Casmalia Creek (D. Niles, RWQCB, pers. comm. to T. Carson 2001). Nickel toxicity to aquatic life is hardness dependent with increasing hardness corresponding to higher concentrations being less toxic.

Lastly, a California Regional Water Quality Control Board staff report indicates high turbidity in Casmalia Creek both in winter and in summer months. Rain events in the winter and intense grazing in the summer are believed to be the cause of the high turbidity.

Biological Community Characteristics

The current flora and fauna in the watershed are discussed directly below.

Watershed Flora

The Casmalia Creek watershed exhibits a mosaic of vegetation communities that vary with microclimate and are influenced by aspect, slope, elevation, proximity to surface or groundwater, and disturbance. The communities present include grassland, southern coastal shrub, chaparral, southern oak woodland, and riparian woodland communities (EPA 1996b). The upper watershed is comprised of southern oak woodland, chaparral, and coastal sagebrush and is relatively undisturbed by cattle grazing (EPA 1996b). The lower watershed is dominated by non-native annual grasses and is highly disturbed by cattle overgrazing, limiting the composition and extent of vegetation communities (EPA 1996b, CRWQCB 1999, Hunt 2000). The most comprehensive list of vegetation in the watershed was compiled by Hunt and Associates (2000) and is presented in Table 3.

The riparian vegetation overstory is comprised almost entirely of willow. Distinct patches of dense willow overstory extend in reaches of the creek ranging from 50-150 meters. There is little to no understory in these reaches. Interdispersed between the sections of willows are reaches of the creek, ranging from 25 – 50 meters in length, that are largely absent of riparian vegetation. However, in the last 1.5 kilometers of the Casmalia Creek corridor, as it nears the confluence with Shuman Creek, the willow overstory is almost continuous.

Aerial photos from the early 1940s, mid-1950s, and late 1990s indicate a similar distribution of riparian and upland vegetation throughout the past 60 years. However, the earliest photographs were taken after dryland farming and cattle grazing began and as such they do not aid in determining possible changes in the composition of overstory. Furthermore, the photos do not aid in determining the historical extent and composition of understory vegetation.

Previous reports, including independent assessments by the EPA in 1996, RWQCB in 1999, and Hunt and Associates characterized the Casmalia Creek riparian habitat as degraded as a result of cattle grazing (EPA 1996b, CRWQCB 1999, Hunt 2000). In areas where riparian vegetation is present, it is confined to areas directly adjacent to Casmalia Creek and is not observed to extend more than a few meters beyond the banks (pers. obs. 2001). The willows display grazing impacts with a browse line at 5 feet (Hunt 2000). In addition to the impacts of cattle trampling and grazing of low-lying vegetation, the land lessee bulldozed sections of riparian vegetation to clear portions of the creek corridor for access roads to the surrounding land (CRWQCB 1999). A previous riparian corridor vegetation survey performed for the CSC in 1999, found that due to “the chronic disturbance of cattle grazing, only 35% of the plants identified were native species” (Hunt 2000).

Watershed Fauna

Species surveys of the Casmalia Creek riparian corridor conducted from 1998-2000 indicate an array of fauna, as listed in Table 4. The current biological community of the Creek is impoverished due to the impacts of cattle (EPA 1996b, CRWQCB 1999, Hunt 2000). These impacts include increased bank erosion, which reduces bank vegetation, which in turn reduces the amount of allocthonous material input (primarily leaf litter). Increased sedimentation increases turbidity thereby reducing light input and limiting primary productivity and thus reducing dissolved oxygen. Increased sedimentation may also negatively impact immobile benthic macroinvertibrates through smothering.

A 1996 survey of benthic macroinvertibrates indicated a gradient of species diversity and abundance, with declines in both categories in more degraded portions of the watershed. In the upper watershed where cattle density is reduced and the degradation is less apparent, the stream invertebrate community exhibits greater diversity and abundance. The upper watershed has increased riparian vegetation and allocthonous input dominates the energy input into the stream. There is a shift in the composition of benthic invertebrate functional feeding groups in the upper and lower reaches of the Creek. The survey indicates a greater proportion of collector-gatherers and collector-filterers in the upper portions of Casmalia Creek and increased filter and deposit feeders in the lower portions. This is likely due to the increased nutrient input from cattle excrement in the lower watershed. This increased nutrient load results in eutrophic conditions and increased bacterial presence that “has had a significant effect on stream benthos.” (EPA 1996b).

Table 3: Plant species observed in the Casmalia Creek watershed.

Scientific Name	Common Name	I/N[1]	Habit[2]
Agrostis stolonifera	Creeping bent grass	I	PG
Amsinckia menziesii	Fiddleneck	N	AH
Anagallis arvensis	Pimpernel	I	AH
Anthemis cotula	Mayweed	I	AH
Apium gravolens	Wild celery	I	PH
Artemisia californica	California sagebrush	N	S
Avena barbata	Wild oat	I	AG
Baccharis douglasii	Douglas baccharis	N	PH
Brassica nigra	Black mustard	I	AH
Bromus diandrus	Ripgut grass	I	AG
Bromus hordeaceus	Soft chess	I	AG
Calystegia macrostegia ssp. cyclostegia	Chaparral morning glory	N	V
Capsella bursa-pastoris	Shepherd's purse	I	AH
Carduus pycnocephalus	Italian thistle	I	AH
Cirsium vulgare	Bull thistle	I	AH
Conium maculatum	Hemlock	I	PH
Convolvulus arvensis	Morning-glory	I	V
Distichlis spicata	Saltgrass	N	PG
Erodium botrys	Storksbill	I	AH
Erodium cicutaria	Red-stem filaree	I	AH
Hordeum brachyantherum ssp. californicum	Meadow barley	N	PG
Hordeum leporinum	Foxtail	I	AG
Hordeum marinum	Mediterranean barley	I	AG
Juncus xiphioides	Iris-leaved rush	N	PH
Lepidium niditum	Peppergrass	N	AH
Lolium perenne	Ryegrass	I	PG
Lupinus succulentus	Succulent lupine	N	AH
Malva parviflora	Cheeseweed	I	AH
Medicago polymorpha	Bur clover	I	AH
Mimulus aurantiacus (forma lompocense)	Lompoc monkeyflower	N	S
Nasella pulchra	Purple Needlegrass	N	PG
Pennisetum clandestinum	Kikuyu grass	I	PG
Picris echioides	Prickly ox-tongue	I	AH
Poa annua	Annual bluegrass	I	AG
Polygonum areanastrum	Knotweed	I	AH
Polypogon interruptus	Ditch bread grass	I	AG

Table 3: Continued

Scientific Name	Common Name	I/N[1]	Habit[2]
Polypogon monspeliensis	Rabbitsfoot	I	AG
Quercus agrifolia	Coast live oak	N	T
Raphanus sativus	Jointed charlock	I	AH
Rorippa nasturtium-aquaticum	Watercress	I	N
Rumex salicifolius	Willow dock	N	PH
Salix laevigata	Red willow	N	T
Salix lasiolepis	Arroyo willow	N	S
Sanicula arguta	Sanicle	N	PH
Silybum glaucus	Milk thistle	I	AH
Solanum glaucus	Tree tobacco	I	S
Sonchus asper	Prickly sow thistle	I	PH
Sonchus oleraceus	Sow thistle	I	AH
Sorghum bicolor	Sorghum	I	AG
Toxicodendron diversilobum	Poison oak	N	V
Utrica holosericea	Giant creek nettle	N	PH
Vicia sativa	Vetch	I	AH

Adapted from Hunt (2000)

[1] **I/N** **I** Introduced species **N** Native species

[2] **Habit**

AH Annual Herb **PG** Perennial Grass
AG Annual Grass **S** Shrub
PH Perennial Herb **T** Tree
V Vine

Table 4: Wildlife species observed in the Casmalia Creek watershed.

The following wildlife species were observed within and adjacent to the Casmalia Creek riparian corridor, along the northern edge of the Shuman Canyon Creek riparian corridor from its confluence with Casmalia Creek downstream for a distance of 1,500 feet, and around the surface runoff storage ponds on the Casmalia Resources Superfund Site.

Pacific treefrog	horned lark (a)
California red-legged frog	common yellowthroat (a)
southwestern pond turtle	Audubon's warbler (b)
western fence lizard	myrtle warbler (b)
southern alligator lizard	common yellowthroat (a)
pied-billed grebe (*,a)	Wilson's warbler (a)
eared grebe (*,b)	western meadowlark (a)
mallard (*)	European starling (a)
gadwall (*)	Song sparrow (a)
greater scaup, female (*,b)	house finch (a)
ruddy duck (*,a)	broad-footed mole
killdeer (*,a)	Botta's pocket gopher
whimbrel (b)	California ground squirrel
long-billed curlew (b)	dusky-footed woodrat
spotted sandpiper (*,a)	raccoon
mourning dove (a)	Viginia opossum
American coot (*,a)	coyote
Red-tailed hawk (a)	bobcat
golden eagle (a)	American badger
American kestrel (a)	blacktailed deer
turkey vulture	
Anna's hummingbird (a)	
Cassin's kingbird (a)	
western kingbird (a)	
black phoebe (a)	
cliff swallow (a)	
violet-green swallow	
bushtit (a)	
oak titmouse (a)	
house wren (a)	
Bewick's wren	
western scrub-jay (a)	
American robin	

(*) observed at the storage ponds at the Site; (a) breeding; (b) wintering or migratory only

Adapted from Hunt (2000)

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Appendix 7: Construction Guidelines

Construction activities may adversely impact wildlife in the construction areas. These activities may result in the displacement or disturbance of the target species (the California red-legged frog and the western spadefoot toad). The following guidelines (adapted from the official guidelines put forth by the USFWS) shall be followed to ensure the protection of the target species prior to and during construction activities (USFWS 1999).

A USFWS and CDFG approved biologist(s) shall survey the work site two weeks before the onset of activities. If the target species in any life stage are found, the approved biologist(s) shall contact the USFWS and the CDFG to determine if moving any of these life stages is appropriate. In making this determination the USFWS and the CDFG shall consider if an appropriate relocation site exists. If the USFWS and the CDFG approve moving the animals, the approved biologist(s) shall be allowed sufficient time to move the target species from the work site before work activities begin. Only USFWS and CDFG approved biologist(s) shall participate in activities associated with the capture, handling and monitoring of target species.

At least 15 days prior to the onset of pre-construction surveys, the applicant or project proponent shall submit the name(s) and credentials of biologists who would conduct activities specified in the following measures. No project activities shall begin until proponents have received written approval from the U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (CDFG) that the biologist(s) is qualified to conduct the work.

Before any construction activities begin on the project, a USFWS and CDFG approved biologist(s) shall conduct a training session for all construction personnel. At a minimum, the training shall include a description of the target species, the habitat, the importance of the target species and their habitats, the general measures that are being implemented to conserve the species as they relate to the project and the boundaries within which the project may be accomplished.

A USFWS and CDFG approved biologist(s) shall be present at the work site until such time as all relocation (if needed) of the target species, instruction of workers, and habitat disturbance have been completed. After this time, the contractor or permittee shall designate a qualified person to monitor on-site compliance with all minimization measures. The approved biologist(s) shall ensure that this individual receives training.

During project activities, all trash that may attract predators shall be properly contained, removed from the work area and disposed of daily. Following construction, all trash and construction debris shall be removed from work areas.

All fueling and maintenance of vehicles and other equipment and staging areas shall occur at least 20 meters from any riparian habitat or water body in areas sloped away from the watershed. Contamination of habitat shall not occur during such operations. Prior to the onset of work, the permittee shall prepare a contingency plan to respond to accidental spills. All workers shall be informed of the importance of preventing spills and the appropriate measures to take if a spill occurs.

An approved biologist(s) shall ensure that the spread or introduction of invasive, exotic plant species shall be avoided to the maximum extent possible. When practicable, invasive exotic plants shall be removed from the project area.

The number of access routes, size of staging areas and the total area of the activity shall be limited to the minimum necessary to achieve the project goal. Routes and boundaries shall be clearly demarcated to minimize the extent of habitat disturbance to the immediate project area.

To control erosion during and after project implementation, the applicant shall implement best management practices as identified by the Central Coast Regional Water Quality Control Board.

If a work site is to be temporarily dewatered by pumping, intakes shall be completely screened with wire mesh not larger than five millimeters to prevent the target species from entering the pump system. Water shall be released or pumped downstream at an appropriate rate to maintain downstream flowing during construction. Upon completion of construction activities, any barriers to flow shall be removed in a manner that would allow flow to resume with the least disturbance to the substrate.

A USFWS and CDFG approved biologist(s) shall permanently remove, from within the project area any exotic vertebrate species such as bullfrogs, to the maximum extent possible. The permittee shall have the responsibility to ensure that their activities are in compliance with the California Fish and Game Code.

In addition, to the above guidelines and minimization measures, mesh fences surrounding all construction activities in the area should be provided which will help to prevent the possible migration of the target species into work areas. Also, construction personnel shall be prohibited from entry into the designated constructions areas, except for necessary construction for mitigation-related activities. Finally, the timeframe noted in #12 above limiting the activities near breeding habitat should be modified for the protection of the western spadefoot toad with work activities being limited to the months of September through December. However, heavy rainfall even during these months could result in the toads abandoning their burrows, emerging and possibly beginning to breed. If this occurs, an approved CDFG biologist should be consulted as to the appropriate plan of action.

Appendix 8: Success and Monitoring Criteria

The quantification of success criteria and the identification of appropriate monitoring methods are essential for determining the success of the Plan and its subsequent implementation. In addition, information provided by monitoring will serve to build the appropriate knowledge base to develop adaptive management for the created and restored areas. The success and monitoring criteria presented in this section are based on goals to promote the landscape success and biological, or functional success of the ecological regime, in the created and restored habitat in order to sustain or improve the status of the target species. Plant cover, sedimentation, erosion, and water availability are landscape features readily observable. For biological characteristics such as target species population dynamics, dispersal, and predatory potential, the habitat restoration project will be considered successful when the criteria listed in Tables 1 and 2 in this appendix are discussed.

A fundamental aspect of monitoring and success criteria is selecting reference sites. Reference sites provide a similar baseline standard that may provide basis for determining the relative success of the created and restored habitat and to examine the variability of response to natural environmental fluctuations, such as drought. There are a number of benefits of utilizing reference sites. The USACE identify the benefits to include providing a model for developing restoration actions, providing a target standard for developing performance goals and evaluating performance, and providing a control by which to assess natural fluctuations (e.g. drought) at the created and restored habitat relative to the control (Thom and Wellman 1996). Further, they state that while pre- and post-construction comparisons provide useful information, a meaningful evaluation of performance requires reference site comparisons (Thom and Wellman 1996). Horner and Raedeke (1989) identified the following criteria as features that are commonly assessed in evaluating reference sites to created and restored wetland sites:

- function
- climate and hydrology
- influences by human activities, habitation, and economic activities
- runoff water quality
- history of and potential for such activities as grazing, mowing, and burning
- size, morphology, water depth, proportions of wetland zone
- vegetation types
- soils substrates
- use by fauna.

Furthermore, monitoring will provide information, which can be used to design adaptive management plans to deal with deficiencies in the habitat creation and restoration plan and/or its implementation, if necessary.

Table 1: Success Criteria

	Rationale	Feature	Success Criteria	Action if Not Met
Target Species	1a	Population size	Same as ponds at Site prior to relocation	Continue monitoring, consult with Natural Resource Trustees
	1b	Reproduction (evidence of breeding and survival of reproducing adults)	Evidence of reproducing adults and presence of other life stages	Continue monitoring and determine reasons for lack of reproduction
	1c	Exotic predators	None established	Eliminate when found, continue monitoring
Vegetation	2a	**Erosion**		
		Functional Groups		
		Egg attachment	Soil stabilized; no washouts or gullying	Stabilize
		Cover in water	Soil stabilized; no washouts or gullying	Stabilize
		Canopy	Soil stabilized; no washouts or gullying	Stabilize
	2b	**Establishment and Growth**		
		Functional Groups		
		Egg attachment	Percent cover - - year 1 - 20%, Year 2 - 40%, year 3 - 60%, year 4 - 80%, year 5 – 75 - 80%	Replant/Reseed

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Table 1: Continued

	Rationale	Feature	Success Criteria	Action if Not Met
Vegetation - Continued		Cover in water	Percent cover - - year 1 - 20%, year 2 - 40%, year 3 - 60%, year 4 - 80%, year 5 – 75 - 80%	Replant/Reseed
		Canopy	Willows and Cottonwoods - years 1-5 - Continued growth with height reaching 5-6 feet in 3 years Sycamores - years 1-5 - Continued growth with height reaching 5 feet in 5 years	Replant/Reseed
	2c	**Exotic Species** ***Functional Groups***		
		Egg attachment	First 4 years - no interference; year 5 – 5% tolerance	Remove
		Cover in water	First 4 years - no interference; year 5 – 5% tolerance	Remove
		Canopy	First 4 years - No interference; year 5 – 5% tolerance	Remove

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Table 1: Continued

	Rationale	Feature	Success Criteria	Action if Not Met
Created Pond	3a	Hydroperiod	Greater than 1 meter January through August	Compare hydrologic conditions to reference sites
	3b	Water release	Only through structure	Develop adaptive management
	3c	Pond form	Maintenance of form	Reshape to meet design criteria
	3d	Incoming flow velocities	No adverse affects to target species, vegetation, and pond slopes. Decreased sedimentation rate.	Develop adaptive management
	3e	Structures	Meet design parameter and maintain stability	Develop adaptive management
Casmalia Creek	4a	Physical Integrity	Physical habitat structurally sound. No active mass wasting and <70 degree slopes	Re-stabilize, vegetative control, and possible grading
	4b	Biological integrity	Robust Macroinvertebrate community	Develop adaptive management
	4c	Water quality	Chemical characteristics indicative of healthy aquatic system.	Develop adaptive management

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Table 1: Continued

	Rationale	Feature	Success Criteria	Action if Not Met
Management	5a	Fencing	Functional and no evidence of cattle within fence line	Restore fence
	5b	Grazing management alternatives	No adverse impacts to target species attributed to grazing in the upland portion of the watershed	Revise management alternatives

Table 2: Monitoring

	Rationale	Feature	Time Frame	Method
Target Species	1d	Population size	Annually for minimum of 10 years, timing/season varies for species monitored	Field surveys, mark-recapture
	1e	Evidence of breeding	Annually during the breeding season for minimum of 10 years	Aquatic surveys
	1f	Survival of reproducing adults	Annually during the breeding season for minimum of 10 years	Field surveys, mark-recapture
	1g	Presence of exotic predators	Bi-annually for minimum of 10 years	Field surveys
Vegetation	2d	**Erosion**		
		Functional Groups		
		Egg attachment	After all major storm events until vegetation is established	Visual surveys
		Cover in water	After all major storm events until vegetation is established	Visual surveys
		Canopy	After all major storm events until vegetation is established	Visual surveys

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Table 2: Continued

	Rationale	Feature	Time Frame	Method
Vegetation Continued	2e	**Establishment and Growth**		
		Functional Groups		
		Egg attachment	4 times/year for 5 years	Field surveys, transects
		Cover in water	4 times/year for 5 years	Field surveys, transects
		Canopy	4 times/year for 5 years	Field surveys, transects
	2f	**Exotic Species**		
		Functional Groups		
		Egg attachment	4 times/year for 5 years	Field surveys, transects
		Cover in water	4 times/year for 5 years	Field surveys, transects
		Canopy	4 times/year for 5 years	Field surveys, transects
Created Pond	3f	Hydroperiod	Weekly sampling December through August or until ponds are dry, the latter of the two. 5 years.	Visual monitoring of staff gauges
	3f	Water release	Weekly sampling December through August or until ponds are dry, the latter of the two. 5 years.	Visual inspection
	3g	Pond form	Annually (September or October)	Visual inspection

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Table 2: Continued

	Rationale	Feature	Time Frame	Method
Created Pond - Continued	3g	Incoming flow velocities	Annually (September or October) See vegetation and species monitoring for frequency with regards to these parameters	Visual inspection
	3h	Structures	1st Year – After storm events that produce high flows and once during the dry season when the pond is dry or at its lowest point After 1st Year – biannually: once in February or March and once in September or October.	Visual inspection
Casmalia Creek	4d	Physical Integrity	First wet season and then concurrently with vegetation monitoring 5 – 10 years	EPA/CDFG Rapid Bioassessment Protocol
	4e	Biological integrity	Biennially for 5 – 10 years	EPA/CDFG Rapid Bioassessment Protocol
	4f	Water quality	Seasonal monitoring 5 – 10 years	EPA/CDFG Rapid Bioassessment Protocol

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Table 2: Continued

	Rationale	Feature	Time Frame	Method
Land Management	5d	Fencing	Monthly inspections and following storm events	Inspect condition
	5e	Grazing management alternatives	Seasonal monitoring	Inspect condition of slopes and upland habitat
Site Development	6a	Site condition and development	Annually	Photographic record
	6b	Site condition and development	Annually	Descriptive narrative

Target Species

Success Criteria

Measure the success criteria for the target species both annually and at the end of the 10-year monitoring period following natural colonization or relocation. Measure success in terms of the overall success of the populations after the 10-year monitoring period, but also assess the success of various features on a year-to-year basis. Neither of the target species achieve sexual maturity until at least two years of age, and the California red-legged frog can live up to 8 or 10 years. Both target species are relatively long-lived and may exhibit great year-to-year variation in breeding activities. For these reasons, measuring the success of the populations annually and after 10 years will allow for a better understanding of the population dynamics in the created and restored habitat. It will also allow for an evaluation of whether year-to-year variations are result in stable or unstable populations in the long term.

1a. One of the goals of the target species success criteria is the presence of populations of the target species similar in size to what exists at the Site prior to draining within five to ten years following colonization or relocation. This would indicate that the populations are not decreasing in size and may be self-sustaining (T. Mullen pers. comm. with M. Hood, December 17, 2001). Prior to translocation, monitoring will take place in the ponds at the Site as part of the RI/FS to measure population sizes of the target species that will then be used in evaluating the success of this feature. In the event that the populations are not comparable in size to those at the Site, continue annual monitoring so determine whether the populations seem to be self-sustaining and stable regardless of the size of the populations.

1b. It will be important to observe relatively stable numbers of breeding adults and sufficiently regular and successful reproduction and recruitment over an extended number of years to ensure that the subpopulation at the created and restored habitats will successfully establish and persist over time (W. Sadinski, TNC, pers. comm. with S. Erickson September 17, 2001). Measure the success of reproduction each year as well as after the 10-year monitoring period is complete. A further recommendation includes the continuation of monitoring if reproduction has not taken place and the implementation of adaptive management that will determine the reasons for a lack of reproduction.

1c. The absence of exotic vertebrate species, particularly bullfrogs, will be an extremely important criterion for the created and restored habitats. Bullfrogs compete with the target species for resources, and may prey on the target species during larval life stages.

Actively remove bullfrogs or other exotic species found in the created and restored areas where target species have established. Removing individual bullfrogs and relocating them to different areas or exterminating individuals may prevent establishment. Since few attempts have been successful in permanently removing bullfrogs from many areas implement a monitoring protocol that checks for bullfrogs at regular intervals to ensure the absence of these exotic species from the created and restored habitats (see 1g.) (S. Christopher pers. comm. with S. Erickson, January 24, 2002).

Monitoring

In order to determine whether colonization or relocation, establishment, and reproduction of the target species have been successful, conduct monitoring annually for a minimum of 10 years following draining of the ponds at the Site (Dodd and Siegel 1991). A monitoring period of 10 to 15 years is advised for the relocation of amphibians in order to determine if reproduction is successful (Dodd and Seigel 1991). The USFWS also recommends a monitoring period for the California red-legged frog of at least 10 ten years. Begin additional monitoring at the created and restored areas before draining the ponds at the Site in the event that the target species migration to the created and restored habitat on their own.

Monitor for the western spadefoot toad only during the rainy season during breeding periods, as it spends most of the year in burrows. Monitor for the California red-legged frog both during the breeding season and near the end of the dry season depending on the feature to be monitored. During the monitoring period, locate and record individuals with PIT tags, or other markings. Regularly examine PIT tags to determine whether they are still functioning properly.

1d. Monitor the size of the populations of the target species using a combination of techniques. In order to estimate population size for the western spadefoot toad, conduct egg mass counts in the shallow water areas of the restored and created habitat during the breeding season. This involves visual searches along the edges of breeding habitats, and supplement this with counts of calling males as well as counts of recently metamorphosed individuals (Impact Sciences 2001). For the California red-legged frog, conduct visual surveys annually at the end of the dry season according to the USFWS Protocol, while utilizing pitfall traps and dip nets to facilitate estimation of population size.

1e. Field surveys during the breeding season will determine the presence or absence of breeding adults as well as the presence or absence of other life stages. Identify the various life stages using visual surveys, pitfall traps, and dip nets.

Employ dip netting, hand captures, and drift fencing to capture juvenile and adult California red-legged frogs and western spadefoot toads during the late summer. Mortality of tadpoles and egg masses is likely avoided at this time of the year, and California red-legged frogs are relatively easy to locate at this time. During the dry season, California red-legged frogs rarely migrate far from their water source.

1f. Monitor adult survival from one year to the next for at least 10 years by employing mark-recapture methods with the use of PIT tags. A monitoring plan with this temporal requirement will appropriately capture the life history and ecology of the target species.

Read PIT tags during annual recapture events conducted in accordance with monitoring for evidence of breeding (see 1e.), during the breeding season field surveys. Monitor at this time so that new adults can be marked as needed, and surviving adults can be located and recorded. Use PIT tags in order to provide a safe and effective method of gathering population information for the target species.

1g. Since monitoring is recommended to take place twice each year during both the breeding season and late summer, monitoring specifically for exotic vertebrate species should also occur during these times. Biannual field surveys should take place for a minimum of 10 years to determine the presence of exotic predators in the created and restored habitats. Give special attention to the presence of bullfrogs, as there is significant evidence relating the extirpation of California red-legged frogs to the colonization of bullfrogs in areas of southern and central California.

Bullfrogs have adopted similar ecological niches as those utilized by the California red-legged frog and may out compete this species for resources. Bullfrogs can be distinguished from California red-legged frogs by yellow coloration of the throat, a solid green snout, a body length of six inches or more, a large tympanum (or ear disk), and a "squawk" sound made when jumping into the water (USFWS 1997). In cases where bullfrogs are not seen, a "squawk" is considered adequate in identifying the presence of this species.

Vegetation

Success Criteria

Erosion

2a. The inspector will evaluate the stability of the soil and ensure no washouts or gullying have occurred. If erosion is evident, stabilize the soil.

Establishment and Growth

2b. While the planted vegetation may establish more quickly, the monitoring plan will cover a five-year period in order to ensure the stability and persistence of the canopy species. For example, if the planted cottonwoods have continued to grow and establish meeting the five-year success criteria, it is much more likely they will persist than if they are not closely monitored for the full five years and given the opportunity to reach this point of stability. With the five-year plan in mind, the success criteria for each year has been set at a level of 20% for year one, 40% for year two and so on as this is a reasonable expectation for establishment and growth. Utilize the final five-year value of 75%-80%, as this is a commonly used value that is viewed as a sufficient percent cover for the system to be functional and sustainable. Additionally, if the percent cover has increased consistently each year and met the success criteria, it is highly likely that a stable environment exists and will persist.

If it is determined during monitoring that a functional group does not meet the performance criteria but is just below the criteria value, wait before deciding to replant; however, if the functional group is substantially below the criteria, replant the necessary species. If, for example, after the first year, 50% or more of the vegetation does not survive, locate large patches of bare areas and replant in these areas. If, however, the vegetation is well distributed, continue monitoring without replanting.

Based on standard practice, base all of the percent cover values on a percentage of the baseline value from a chosen reference site and the percent cover in the restored and created habitat area shall be no less than the minimum recorded in the reference site. The reference site should have similar hydrologic features to the created and restored habitat areas.

Invasion by Exotic Species

2c. For the first four years, no tolerance is the success criteria for this feature, i.e. no interference, by exotic species. This will allow the planted native species to establish and grow free from competition with exotic species for resources.

After the first four years, assess the sustainability of the system for one additional year (year five) with no maintenance with the success criteria raised to a 5% level of tolerance. Eliminating the maintenance during this time will determine if the exotics will remain at a level that is low enough not to interfere with the natives without assistance. In addition, if no problems are noted in the planted vegetation during the four years with maintenance but begin to deteriorate without maintenance, determine and address the reason for the decline in an effort to avoid decline in the future. Begin long-term monitoring and maintenance of weeding once each season once the 5% goal with no maintenance is reached. This may require weeding after the first trial year and beginning the process again.

Monitoring

Erosion

2d. Complete visual inspections after significant rain events. A suggested standard is a rain event that results in greater than 1 inch of rain within a 24-hour period.

Establishment and Growth

2e. Complete field surveys for the establishment and growth of the planted vegetation a minimum of once per season for five years. As noted previously, it may take less than five years for the majority of planted species to establish. However, the full five years may be needed to ensure the canopy species will persist. Willows are a rapidly growing species and cottonwoods grow relatively quickly as well. However, since the establishment and growth will be dependant on site conditions, monitor for the five-year period. A five-year monitoring plan will also help ensure the system as a whole will be sustainable. The monitoring frequency of once each season is recommended due the fact that changes in the vegetation will be particularly evident during different seasons and the monitor will have the opportunity to detect these changes. In addition, by viewing the system once per season rather than less frequently, negative changes or trends can be detected in time to correct them before the system is significantly affected. Similarly, each plant species has a specific growing season, possibly more than one, which may vary from other species. Viewing the vegetation each season will allow the monitor to evaluate each plant species during its specific growing season.

The monitoring will include an evaluation of the percent cover of the species within a given functional group. For example, upon assessing the percent cover for the “egg attachment” functional group, sum up all of the plant species that comprise that group to determine the percent cover. Standard practice dictates the use of cross transects with point intercept to assess percent cover. Perform these transects along the created and restored areas. Sound methodology will include an assurance of randomness in the choice of cross transect points.

Begin long-term monitoring/maintenance that consists of weeding once per year only after the goal of 75%-80% is reached and the system has proven to be sustainable. The long term monitoring phase should last a minimum of 10 years. Ten years will allow ample time for the canopy species to fully develop. The regulatory agency overseeing the project will determine the required long-term monitoring period.

Exotic Species

2f. Assess the extent of invasion by exotic species within the system once each season in order to ensure any interference is detected in time to remove the exotics before they begin to substantially compete with the native species for resources. Additionally, early removal will help ensure the invasive species do not have the opportunity to seed. Evaluating the system for a full five-year period will help make certain that the native species have an ideal environment to successfully establish and grow. See Tables 10 and 15 for a list of common exotic species and those at the Site.

Pond

Success Criteria

Hydroperiod

3a. As presented in Habitat Requirements (Section 5.0) it is imperative to provide at least 1 meter of water between January and July to provide a sufficient depth of water to meet the breeding and larval development needs of the target species. Therefore, if water is present at 1 meter for this period the minimum hydroperiod has been achieved and this design parameter will be deemed successful.

If it is determined that the minimum hydroperiod is not met due to the structures installed to control water input and output, an adaptive management plan should be developed and implemented. The adaptive management strategy should focus on determining if the type of structure, the installation of the structure, or a combination of both has led to the failure to either meet or continue to meet its design criteria. If the type of structure is responsible for the failure observed, put into place an alternative structure. If the installation of the structure is the cause of the failure, refit or reinstall the structure in order to comply with the design parameters. If both the structure and the installation are the determined to be defective, employ an alternative method or technique of diverting flow into the created ponds.

If the pond does not meet the hydroperiod due to weather conditions, compare the hydrologic conditions of the reference sites to those of the created pond. If the hydrologic conditions of a reference site are similar to the created pond, then the failure to achieve the desired hydroperiod may be attributed to weather conditions. In which case, consult the Natural Resource Trustees (which may include USFWS and CDFG) to determine if adaptive management strategies should be developed and implemented.

3b. As presented in the Plan, variances in the pond's form, expressed in macro and microtopographic features, increases the complexity of the ponds and will provide a variety of habitat. Therefore, if the macro and microtopographic features maintain their form this design parameter will be deemed successful.

If the pond does not maintain its form as defined in the design criteria, reshape it to meet the design parameters. These steps may include reshaping the banks to the desired slope and contour if they have substantially altered due to erosion or sediment deposition. Additionally, remove sediment if the pond is accumulating a substantial amount of deposition that significantly reduces (>33%) the pond's storage capacity. An approved USFWS biologist must approve and monitor any grading or dredging that is deemed necessary to ensure that impacts to the target species and other species as well as vegetation are minimized.

3c. As presented in the Plan, it is important to reduce the flow velocity of water entering the pond to minimize potential affects to the target species as well as to reduce erosion and sedimentation rates within the pond. Therefore, if impacts to vegetation and the target species meet the success criteria for vegetation and target species as outlined above in 1b and 2a and sedimentation rates to the pond have been reduced, this design parameter will be deemed successful.

If it is determined that the flow velocity has not be reduced sufficiently to minimize the affects presented above an adaptive management plan should be developed and implemented. The adaptive management strategy should focus on determining if the type of structure, the installation of the structure, or a combination of both has led to the failure to either meet or continue to meet its design criteria. If the type of structure has led to the failure, put into place an alternative structure. If the installation of the structure is the cause of the failure, refit or reinstall the structure in order to comply with the design parameters. If both the structure and the installation are the determined to be defective, employ an alternative method or technique of reducing flow velocities into the created pond.

3d. As presented in the Plan, it is important to incorporate a spillway to reduce the likelihood that vegetation, planted on the perimeter of the pond, will become inundated and prevent uncontrolled releases from the pond, which may undermine the pond's integrity. Therefore, if it is observed during the monitoring for pond water levels that there is no evidence of inundation and/or no evidence of water released away from the outlet control structure, this design parameter will be deemed successful.

If it is determined that the outlet control structure is not functioning properly an adaptive management plan should be developed and implemented. The adaptive management strategy should focus on determining if the type of structure, the installation of the structure, or a combination of both has led to the failure to either meet or continue to meet its design criteria. If the type of structure has led to the failure, put into place an alternative structure. If the installation of the structure is the cause of the failure, refit or reinstall the structure in order to comply with the design parameters. If both the structure and the installation are the determined to be defective, employ an alternative method or technique of controlling water levels in the pond.

3e. As presented in the Plan, structures will be incorporated into the pond design to perform a variety of functions. These structures might include: berms, overflow berms, dams, channels, piping, outlet control structures, and a method for reducing incoming flow velocity. If these structures function properly so that the minimum hydroperiod is met, vegetation and the target species are not adversely affected by incoming flow velocities, erosion and sedimentation within the pond is reduced, water is only released from the outlet control structure, perimeter vegetation is not inundated, and the structures are deemed stable the individual structures will have met their design parameters successfully.

If it is determined that the structures are not functioning properly or have become unstable an adaptive management plan should be developed and implemented. The adaptive management strategy should focus on determining if the type of structure, the installation of the structure, or a combination of both has led to the failure to either meet or continue to meet their design criteria. If the type of structure has led to the failure, put into place an alternative structure. If the installation of the structure is the cause of the failure, refit or reinstall the structure in order to comply with the design parameters. If both the structure and the installation are the determined to be defective, employ an alternative method or technique of meeting the structure's design parameters.

Monitoring Criteria

3f. To determine if a sufficient amount of water is being captured to maintain water levels above the 1 meter minimum during the desired hydroperiod and to assure that the outlet control structure is controlling releases as intended; conduct bi-weekly sampling of water levels beginning in December (Gibson and Skordal 2000). Continue sampling through August or until the ponds are completely dry, whichever is later. Compare the observed water levels to the predicted water levels used to select the method for capturing water to determine if adjustments to the structure are necessary. Continue the sampling cycle on a yearly basis until the hydraulic conditions of the created ponds have been adequately characterized.

3g. During the dry season, examine the stability of the slopes as well as the continued existence of the micro and macrotopography within the ponds. Based on these results, determine whether or not the pond is maintaining its form sufficiently to meet the design criteria outlined in Pond Design (Section 8.2.1). This includes inspecting the pond as well as the method for reducing flow velocity to determine if sedimentation has significantly reduced either's ability to meet their design criteria.

3h. During the first year of implementation, inspect the stability of the structure after storm events that produce high flows, as determined through an investigation of creek flow conditions, or after rain events that have been predicted to generate flow into the pond. In addition, inspect this area to determine if flow velocities are reduced sufficiently such that they have not affected the vegetation planted in or near the outlet of the structure. Inspections in the first year are critical to determine if the structure has been properly selected and/or installed. Conduct a similar inspection when the pond is either dry or at its estimated lowest point. After the first year, conduct inspections biannually, once in the wettest months (February or March) and once in the driest months (September or October) to ensure that the structure is stable.

During inspections, examine the stability of the structure by focusing on whether the structure is in its original location, whether erosion has occurred anywhere along the structure and whether there has been an accumulation of debris near or behind the structure, both of which may undermine its integrity. Furthermore, examine the creek bed to determine if it has shifted (risen, lowered, or moved horizontally) such that the structure is no longer functioning properly.

Casmalia Creek

Success Criteria

4a. Physical Habitat Integrity
The success of the physical habitat integrity of Casmalia Creek will be determined by utilizing the EPA's guidelines for the "Rapid Bioassessment Protocols for use in Streams and Rivers" or the CDFG's "California Stream Bioassessment Procedure". The CDFG procedure is a regionally adapted version of the EPA guidelines. Both of these provide acceptable methodologies assessing the physical habitat integrity of creeks and provide a framework for assessing changes over time.

A survey of the physical integrity includes visually examining the stability of creek banks. It will be successful if the creek bank slopes, within the restored reaches, remain stable (i.e. creek bank slopes are less than 70 degrees and there is no evidence of active mass wasting).

If it is determined that the channel banks have not been stabilized and erosion is actively occurring, re-stabilize the bank through the use of jute netting or a similar geotextile cover/blanketing techniques. Further, apply additional erosion control vegetative methods in the appropriate planting season. If substantial regions of active mass wasting are observed, reduce the slope of the banks by grading to a slope of less than 45 degrees.

4b. Biological Integrity
The success criteria for the biological integrity of Casmalia Creek is met when the benthic macroinvertebrate community is robust and diverse, as assessed by a qualified individual per EPA or CDFG protocol. The assessment is based upon the EPA's guidelines for the "Rapid Bioassessment Protocols for use in Streams and Rivers" or the CDFG's "California Stream Bioassessment Procedure". Both of these provide acceptable methodologies for conducting surveys and assessing the biological integrity of the creeks.

In 1996, the EPA conducted benthic macroinvertebrate surveys in accordance with the Rapid Bioassessment Protocols. The results of these surveys may aid in the development of baseline conditions for Casmalia Creek. Monitoring should occur seasonally per the protocol recommendations.

4c. Water quality
The EPA's "Rapid Bioassessment Protocols for use in Streams and Rivers" and the CDFG's "California Stream Bioassessment Procedure", both include measurements parameters including temperature, specific conductance, dissolved oxygen, pH, turbidity, that act as basic indicators of water quality. The success criteria will be met when these indicators are within ranges characteristic of creeks that are conducive to supporting a robust community of aquatic organisms. Per EPA and CDFG protocol, a qualified individual may make an evaluation of water quality.

Monitoring Criteria

4d. Physical Habitat Integrity
The EPA's "Rapid Bioassessment Protocols for use in Streams and Rivers" and the CDFG into the "California Stream Bioassessment Procedure" provide protocol for assessing the physical/habitat integrity.

During the first year of implementation, inspect the stability of the banks after storm events that produce high flows, as determined through an investigation of creek flow conditions. Examine the banks to determine if slopes have become unstable (> 70 degrees) and/or if active mass wasting is occurring.

4e. Biological Integrity
Surveys assessing the diversity and abundance of the benthic macroinvertebrate community provide an effective assessment tool for evaluating the overall ecological health and the biological integrity of stream ecosystems. The EPA's "Rapid Bioassessment Protocols for use in Streams and Rivers" and the CDFG into the "California Stream Bioassessment Procedure" provide protocol for surveying benthic macroinvertebrates and assessing Biological Integrity.

4f. Water quality
The EPA's "Rapid Bioassessment Protocols for use in Streams and Rivers" and the CDFG's "California Stream Bioassessment Procedure", both include measurements parameters including temperature, specific conductance, dissolved oxygen, pH, turbidity, that act as basic indicators of water quality.

Management

Success

5a. Fencing will be considered successful if fences are in functional condition and there is no evidence of cattle grazing within the fence line.

Restore to functional condition damaged fences and/or those that are no longer performing the intended role of excluding cattle. If evidence suggests that cattle grazing is occurring within the fence line, reassess the condition of the fence.

5b. The grazing management alternatives will be considered successful if there are no adverse impacts to the target species that can be attributed to grazing in the upland portions of the watershed.

If the grazing management alternatives are not successful, revise the alternatives to address its inadequacies.

Monitoring

5d. Conduct monthly inspections to determine the presence and condition of fences. If fencing crosses Casmalia Creek, conduct additional inspections after high flow events to determine if these events have compromised the integrity of the fencing. Carry out seasonal monitoring to determine the extent to which the additional recommended grazing management practices have been adopted and whether this has had a positive effect on the upland vegetation.

5e. Conduct seasonal monitoring of the grazing management alternatives to determine the adequacy of the alternative in relation to the varying conditions between seasons.

Site Development

Monitoring

6a. Photograph the pond, riparian corridor, and surrounding landscape using 35mm film from a variety of directions at fixed point benchmark locations. This provides a permanent record of the initial conditions and facilitates a comparison of the site conditions through time. Photographs should be taken seasonally during the first 5 years and then seasonally during year 10.

6b. A descriptive narrative of the site conditions, including notable features and changes in the habitat characteristic should be written at the time the photographs are taken. The descriptive narrative also provides a record of the site conditions and development through time.

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Appendix 9: Site Runoff Calculation

The United States Department of Agriculture Soil Conservation Service (SCS) method is widely used for estimating runoff volumes in small watersheds (USDA 1986). The SCS method, as described by Dunne and Leopold, "is based on a simplified infiltration model of runoff and a good deal of empirical approximation" (Dunne and Leopold 1978). It provides a technique for estimating the daily output of surface water from a watershed following precipitation events. The SCS method was used to approximate daily and average annual runoff volumes produced by precipitation events. To use the SCS method, daily precipitation data and a curve number for the Site were required.

Daily Precipitation

The Site's meteorological station collected precipitation data from October 1992 to March 2000. Using these data as the basis for the SCS calculations of estimated stormflow limits the analysis to a nine-year period. Therefore, to extend the analysis, daily precipitation data were required from a nearby weather station. The California Irrigation Management Information System (CIMIS) database provides daily precipitation data from the Santa Maria Airport weather station (NCDC #7946, Santa Maria WSO Airport) run by the National Climatic Data Center. This station served as a suitable surrogate due to the good correlation with precipitation values recorded at the Site (Harding and Lawson 2000). Daily precipitation data from the Airport is available from January 1955 to January 1999 (CIMIS 2001). Allowing for the estimation of runoff from over 2000 precipitation events over 45-years.

Curve Number

As described by Dunne and Leopold, "the curve number is an empirical rating of the hydrologic performance of a large number of soils and vegetative covers throughout the United States." The curve number (CN) value determines the potential maximum retention of water by the soil during precipitation events. Used to determine storm runoff the CN value is dependant on the watershed's hydrologic soil group, land use and cover, treatment, and hydraulic condition. However, the CN over the 252-acre Site varies, as these factors are not homogenous. Harding Lawson Associates estimated an average CN for the entirety of the Site of 86 (Harding Lawson 2000). The value of the CN estimates the potential maximum retention of water by the soil in equivalent inches depth over the drainage area (**S**). **S** is calculated using the following equation:

$$S = \frac{1000}{CN} - 10$$

Runoff (**Q**) is then calculated, in inches, using S and daily precipitation (**P**), also in inches. **Q** is determined using the following equation:

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

At the onset of a storm, a portion of or all of the precipitation, called the initial abstraction, will not produce runoff. The amount of precipitation that makes up the initial abstraction varies based on the antecedent moisture condition of the soil, which is a function of the previous 5-days of precipitation. The average runoff CN of 86, used to calculate stormflow, represents soil conditions with an antecedent moisture condition (AMC) II. To consider drier and wetter soil conditions, values for AMC conditions I (dry) and III (wet) are selected from SCS tables. Table 1 presents the CN values for the three AMCs based on the 5-day Total Antecedent Rainfall.

Table 1. Rainfall limits for estimating antecedent moisture conditions

Antecedent Moisture Condition Class	**CN**	**5-Day Total Antecedent Rainfall (Inches)**	
		Dormant Season	**Growing Season**
I	**70**	Less than 0.5	Less than 1.4
II	**86**	0.5 – 1.1	1.4 – 2.1
III	**94**	Over 1.1	Over 2.1

Modified from U.S. Soil Conservation Service (1972)

Once the CN for the three AMC classes were determined a Microsoft Excel© spreadsheet was designed to calculate daily runoff values using the 45-years of available daily precipitation data. The correct AMC condition class was selected based on the 5-Day Total Antecedent Rainfall. This adjusted the CN to the appropriate AMC class. The volume of stormflow through Casmalia Creek was calculated by multiplying the SCS estimated runoff (Q) by the area of the watershed upstream of the potential pond locations.

Estimated Runoff

Using the SCS method with an average runoff CN of 86, an average annual runoff volume of 49,000 cubic meters of water (1,700,000 cubic feet) was calculated for the Site. This suggests that approximately 4.7 centimeters (1.85 inches) of the average annual precipitation of 34.3 centimeters (13.5 inches), or 14%, becomes runoff. However, several assumptions inherent in the SCS method may affect the accuracy of the calculated volume of stormflow. These assumptions are:

4. The pattern of precipitation extends over a 24-hour period; and,
5. The major storm runoff process is Horton overland flow.

The SCS method largely satisfies objections to the assumption of extending the pattern of precipitation over a 24-hour period (McCuen 1982, Walsh 1989, USDA 1986, Pierce

1993). Assuming that the major storm runoff process is Horton overland flow neglects other runoff processes such as, subsurface stormflow and saturation overland flow. However, as described by Dunne and Leopold, "The techniques [SCS method] still seem to work under other runoff conditions, presumably because the major variables (rainfall, antecedent moisture, soil conditions, and topography) function in the same direction to control the magnitude of stormflow, whatever the runoff process" (Dunne and Leopold 1978).

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Appendix 10: Additional Research

Source / Sink Issue
Although it is unlikely that the populations at the Site in Casmalia are isolated, there is currently a lack of data regarding the number of individuals of both target species utilizing the ponds at the Site. Further limitations include the lack of data on the size and extent of subpopulations that may be a part of a larger metapopulation. A determination as to whether the subpopulations at the Site are source populations (those that have a net "export" of individuals) or sink populations (those that are net "importers" of individuals and depend on external immigration for their persistence) will need to be assessed as well. In addition, it remains unknown whether observations of individual life stages of either target species constitute actual populations or isolated individuals.

Few surveys have been carried out for the target species, in part because much of the land surrounding the Site is privately owned and is therefore difficult for biologists to monitor. By obtaining adequate survey information, discussed further in Appendix 8 (Success and Monitoring Criteria), the appropriate analysis may be completed. Furthermore, the movement patterns and dispersal ability of the species are variable and highly dependent on local site conditions and topography. For these reasons, the Team was unable perform a Population Viability Analysis (PVA) and to assess whether the subpopulations of the target species at the Site are sources or sinks. It is also not known to what extent the target species prefer dispersal corridors, such as waterways, to upland or other habitat for migration.

Species-Specific Data
The minimum viable population size is unknown for both the California red-legged frog and the western spadefoot toad. In addition, the optimal density levels within a specific habitat area for the target species are unknown so recommendations cannot be made regarding habitat acreage needed to support the numbers at the Site.

Other sensitive species in or around the ponds at the Site
Although this project focuses on the California red-legged frog and the western spadefoot toad as requested by the EPA and CBC, there are other species occurring on the Site. The following provides a sample of some additional species that may by present on the Site, but were not addressed in the Plan. Pacific treefrogs (*Pseudacris regilla*) and western toads (*Bufo bufo*) have been observed in and around the ponds at the Site, although these species are not federally or state listed (Hunt 1999). Surveys conducted on the Site report the potential presences of sensitive species including the Southwest pond turtle (*Clemmys marmorata pallida*), least Bell's vireo (*Vireo belli pusillus*) and Southwestern willow flycatcher (*Empidonax traillii extimus*) (Hunt 2000). In addition, two-striped garter snakes (*Thamnophis hammondii)*, and several birds protected under the Migratory Bird Treaty Act occur on the Site. California tiger salamander (*Ambystoma californiense*) surveys are expected to be conducted by CSC in 2002 (M. Blevins, EPA Environmental Scientist, pers. comm. with S. Erickson, February 11, 2002).

Toxicity (Species)
It is currently unknown if populations of the target species at the Site are directly exposed to toxins, and the sensitivity of the target species to pesticides, herbicides, heavy metals, air pollutants, and other contaminants is also largely unknown (USFWS 2000). No testing has been completed regarding the possible effects of contaminants on the target species so the impacts this may have on these or surrounding populations is unknown. The uncertainty about movement patterns complicates this because even if the populations are contaminated, the potential for individuals to reach and subsequently impact other populations is unknown. There is a lack of data regarding contaminants in the sediments of the ponds at the Site. Tests have been performed on the surface water in the ponds at the Site but it is unknown what the effects may be on the target species. In 1999, all five storage ponds were sampled according to the Routine Groundwater Monitoring Element of Work (RGMEW), but no conclusions have been made regarding potential exposure and intake of chemicals or other contaminants by either of the target species (Harding Lawson 2000).

The early stages of many amphibians are restricted to aquatic environments, and are more susceptible to dermal absorption of toxic compounds and to ingestion of contaminated materials in the water. The presence of toxicants in frog wetland habitat may threaten the survival of larval individuals, and in turn may affect the reproductive effort of some amphibian populations. There have been no observations reported in the scientific literature of malformations or mortality in California red-legged frogs associated with exposure to contaminants; however, ecotoxicology often involves the use of surrogate species to measure potential threats from toxic substances. Although the populations of the target species at the Site have not yet been studied with respect to potential contamination, it is relevant to assess the potential vulnerability of the populations as it relates to similar species.

Sensitivity to nitrogen compounds has been measured in red-legged frogs (*Rana aurora aurora*), and is fairly low when compared to other ranid species. Median lethal concentrations of exposure to ammonium nitrate and sodium nitrate have been observed at levels of approximately 72 mg/L and 630 mg/L, respectively (Schuytema and Nebeker 1999). Marco *et al.* (1999) observed median lethal concentrations to nitrite treatments at levels of 5.59 mg/L over 4 days of exposure (Marco, Quilchano, and Blaustein 1999). Levels of nitrite in natural aquatic habitats are usually low; however, in specific areas of shore sites with high contents of organic matter or in agricultural landscapes with fertilizer runoff, nitrogen contaminants may cause acute effects on frogs (Marco, Quilchano, and Blaustein 1999).

Levels of nitrogen compounds in the Casmalia Creek corridor and surrounding upland habitat are an important consideration for the restoration project. Access by cattle to the riparian corridor may contribute significantly to nitrogen composition of the soil and water via waste products. An assessment of the effects of waste pilings and organic waste matter would be necessary to determine the potential threat to habitat of the target species at the Site.

Chlorine-containing compounds (i.e. pesticides and polychlorinated biphenyls (PCBs)) have demonstrated a tendency to accumulate in aquatic organisms, and have been observed to adversely affect ranid growth and development. A decline of hatching success, significant decrease in body length, and lowered activity and swimming speeds have all been observed for both the green frog (*Rana clamitans*) and the leopard frog (*Rana pipiens*) when exposed to PCBs (Rosenshield, Jofre, and Karasov 1999). PCBs persist in the environment for long periods of time and may pose a chronic threat to California red-legged frogs at the Site by impairing reproductive capability of adults, or contaminating the food supply.

Pesticides, insecticides, and herbicides used in agricultural practices may also be detrimental to California red-legged frogs. According to the USFWS (2000) and the California Department of Pesticide Regulation, there are nearly 150 pesticides or herbicides used within one square mile of known California red-legged frog locations or their habitat. However, studies have not been conducted to assess the effects on California red-legged frog populations in these areas. Potential pesticides listed by the USFWS as possible contaminants in California red-legged frog habitat include: Acephate, Chlorpyrifos, Diazinon, Malathion, and others (Hunt 2000). Diazinon has been found to be extremely toxic to amphibians, and studies on green frogs showed a lethal concentration to 50 percent of test frogs (LC50) equivalent to only .005 mg/L over a 16-day test period. Chlorine-containing compounds such as these could affect recruitment and survival directly, or could expose the prey base to toxic chemical concentrations (Hunt 2000).

Contaminant fate and effects are very important to the nature of the Site and future restoration objectives; however, until more quantitative exposure data is gathered for the target species, studies relating contaminant effects to other ranid or spadefoot toad species serve as useful tools to minimize uncertainty in the risk assessment process. Important constituents for a detailed toxicological study can only be identified through appropriate data collection (i.e., water quality testing, sediment sampling, specimen sampling, etc.) and monitoring.

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Appendix 11: Estimated Plan Costs

The following cost estimates are based on the recommendations presented in Habitat Creation and Restoration Plan.(Section 8.0) and Success and Monitoring Criteria (Appendix 8). The estimates are intended to provide the EPA and CBC with a general idea of the cost of implementing habitat creation and restoration activities. The cost of land is not included in the estimate. Costs are presented in 2002 dollars.

Figure 1: Total Estimated Costs

Item	Description		Estimated Cost
	Total Estimated Construction Costs		
1	Construction and Vegetation Costs	$	210,000.00
	Total Estimated Monitoring Costs		
2	Fauna and Vegetation Monitoring Costs	$	130,000.00
	Total Estimated Costs	**$**	**340,000.00**

Notes on Items:

1	Construction and Vegetation Costs are outlined in Tables 2 & 3
2	Fauna and Vegetation Monitoring Costs are outlined in Table 4 & 5

Figure 2: Estimated Construction Costs

Item	Description	Quantity	Unit	Unit Price		Amount
	Grading					
1	Mobilization	1.0	LS	$ 10,000.00	$	10,000
2	Clear the land before grading. (organics etc.)	6.6	AC	$ 1,000.00	$	6,600
3	Excavation Above Water Table	13,900	CM	$ 2.50	$	34,750
4	Excavation Below Water Table	6,100	CM	$ 5.00	$	30,500
5	Contour Grading	17,000	SM	$ 2.25	$	38,250
6	Erosion Control	5.0	AC	$ 1,000.00	$	5,000
7	Grade/Construct Keyway Adjacent to Creek	NIC	CM	$ 2.50		
8	Geotextile Reinforcement Fabric	NIC	SM	$ 20.00		
				Subtotal	$	125,100
	Drainage Infrastructure					
9	12" PVC Low Flow Inlet to Basin	15	M	$ 72.00	$	1,080
10	Headwall Structure at Basin	1	LS	$ 10,000.00	$	10,000
11	Headwall Structure at Creek	1	LS	$ 10,000.00	$	10,000
12	Energy Dissipater at Basin	1	LS	$ 2,500.00	$	2,500
13	Rock Rip Rap at Creek	50	SM	$ 100.00	$	5,000
				Subtotal	$	28,580
	Miscellaneous					
14	Access Ramp	28	SM	$ 22.50	$	630
				Subtotal	$	630
	SUBTOTAL CONSTRUCTION COSTS				$	154,310
	10% CONTINGENCY				$	15,431
	TOTAL ESTIMATED CONSTRUCTION COSTS				**$**	**169,741**

LS - Lump Sum AC - Acre CM - Cubic Meter SM - Square Meter

Estimates based upon similar detention ponds construction costs obtained from Carlson, Barbee & Gibson, Inc.

Notes on Items:

1 A one time lump sum cost for mobilizing equipment

2 The land surrounding the created pond was the only area considered for clearing. 6.6 acres represents the total area of a buffer zone 50 meters beyond the created pond. However, the actual acreage will be smaller as the riparian corridor is within the buffer zone and will not be cleared.

3 It was assumed that the entire pond would need to be excavated to make a conservative estimate.

4 The water level was assumed to be 1.5 meters below ground surface. Water levels in the area have been as high as 1 meter.

5 It was assumed that the entire surface area of the pond would undergo contour grading to create micro and microtopography

6 Unused excavated soil and portions of the pond and buffer zone will require erosion control measures

7 Because the pond slope is 1:10 keyway is not included

8 Because the pond slope is 1:10 geotextile is not included

9 A 12" Inlet Pipe is large enough to capture sufficient volumes of stormflow to fill the pond

Figure 3: Estimated Vegetation Costs

Item	Description	Quantity	Unit	Unit Price	Amount
	Pond and Riparian Corridor				
1	Seed				
	Scirpus sp. (Bulrush)	9	LB	$ 75.00	$ 675.00
	Typha sp. (Cattails)	9	LB	$ 70.00	$ 630.00
	Carex sp. (Sedge)	9	LB	$ 200.00	$ 1,800.00
	Juncus sp. (Rush)	9	LB	$ 275.00	$ 2,475.00
	Eleocharis sp. (Spikerush)	9	LB	$ 300.00	$ 2,700.00
2	Application	3	AC	$ 2,000.00	$ 6,000.00
3	Plantings				
	Salix sp., (Salix lasiolepis) (Willow)	180	PP	$ 5.00	$ 900.00
				Subtotal	$ 15,180.00
	Buffer				
4	Seed				
	Lupinus arboreus (Bush Lupin)	20	LB	$ 30.00	$ 600.00
	Grindelia Latifloia	20	LB	$ 100.00	$ 2,000.00
	Hordeum californicum	20	LB	$ 14.50	$ 290.00
	Distichlis spicata	20	LB	$ 200.00	$ 4,000.00
	Stipa pulchra (Purple Needlegrass)	20	LB	$ 25.00	$ 500.00
	Artemisia (California Sagebrush)	20	LB	$ 17.50	$ 350.00
	Baccaris pilularis (Coyote Brush)	20	LB	$ 15.00	$ 300.00
5	Application	6.6	AC	$ 2,000.00	$ 13,200.00
				Subtotal	$ 21,240.00
	SUBTOTAL VEGETATION COSTS				$ 36,420.00
	10% CONTINGENCY				$ 3,642.00
	TOTAL ESTIMATED VEGETATION COSTS				**$ 40,062.00**

LB - Pound AC - Acres PP - Planting

Estimated Seed Costs were obtained Steve Canepa of Rana Creek Habitat Restoration, Carmel Valley, CA

Estimated Application Costs were obtained S&S Seeds, Carpenteria, CA and Acacia Landscape, Santa Barbara, CA

Notes on Items:

1 Assumed 3 pounds of seeds per acre and the upper 2/3 of the pond (3 acres) would be seeded.

3 Assumed that willow species would be collected in the watershed and planted around 50% of the pond perimeter and 50% of the riparian corridor at 2 meter intervals

4 Assumed 3 pounds of seeds per acre and the buffer zone around the pond (6.6 acres) would be seeded.

Figure 4: Estimated Fauna Monitoring Costs

Item	Description	Quantity	Unit	Unit Price	Amount
	Prior to and During Construction				
1	Pre-Construction Survey for Target and Exotic Species	1	LS	$ 960.00	$ 960.00
2	Species Survey During Construction	60	HR	$ 85.00	$ 5,100.00
				Subtotal	$ 6,060.00
	Post Construction Monitoring for 10 years				
	Bi-annual monitoring for target and exotic species for 10 years				
3	Biologist Cost	640	HR	$ 110.00	$ 70,400.00
4	Annual Report	80	HR	$ 60.00	$ 4,800.00
5	Project Manager Cost	80	HR	$ 120.00	$ 9,600.00
				Subtotal	$ 84,800.00
	SUBTOTAL SPECIES MONITORING COSTS				$ 90,860.00
	10% CONTINGENCY				$ 9,086.00
	TOTAL ESTIMATED FAUNA MONITORING COSTS				**$ 99,946.00**

LS - Lump Sum HR - Hour

Estimated Species Monitoring Costs were obtained from SAIC Inc. and Larry Hunt.

Notes on Items:

1 1 day for pre-construction for two biologists at $85 + $35/hour for 8 hours (Larry Hunt)
2 Daily inspection of site during construction. Estimated 30 days to complete construction and 2 billable hours for survey. (SAIC)
3 32 hours per monitoring event for two biologists (SAIC and Larry Hunt)
4 8 hours per annual report (SAIC)
5 8 hours per year for project manager services (SAIC)

Figure 5: Estimated Vegetation Monitoring Costs

Item	Description	Quantity	Unit	Unit Price	Amount
	Post Construction Monitoring for 10 years				
	Quarterly monitoring of vegetation for 10 years				
1	Biologist Cost	80	HR	$ 120.00	$ 9,600.00
2	Annual Report	120	HR	$ 60.00	$ 7,200.00
3	Project Manager Cost	80	HR	$ 120.00	$ 9,600.00
				Subtotal	$ 26,400.00
	SUBTOTAL VEGETATION MONITORING COSTS				$ 26,400.00
	10% CONTINGENCY				$ 2,640.00
	TOTAL ESTIMATED VEGETATION MONITORING COSTS				**$ 29,040.00**

HR - Hour

Estimated Vegetation Monitoring Costs were obtained from SAIC, Inc.

Notes on Items:

1	8 hours per monitoring event for two biologists
2	12 hours per annual report
3	8 hours per year for project manager services

Appendix 12: Casmalia Photographs and Images

Figure 1: Aerial Photograph of Casmalia Resources Superfund Site and Vicinity, October 2001.

Figure 2: Aerial Photograph of Casmalia Resources Superfund Site and Vicinity, 1985.

Figure 3: EPA Casmalia Resources Superfund Site Schematic.

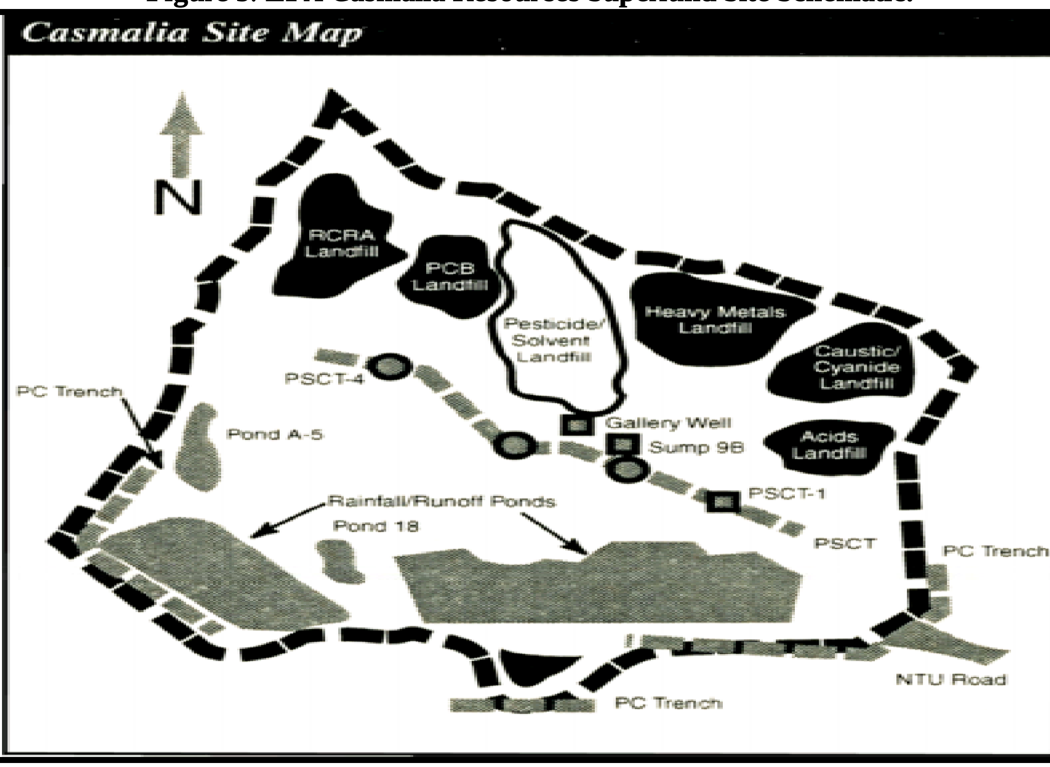

Figure 4: Casmalia Creek south of the Site facing southward, April 2001.

Figure 5: Casmalia Creek north of the Site facing southward, September 2001.

Figure 6: California red-legged frog facing upstream in Casmalia Creek, September 2001.

Figure 7: Cattle in Casmalia Creek north of the Site, September 2001.

Figure 8: Casmalia Creek south of the Site, April 2001.

Figure 1: Courtesy of Arturo Keller, Ph.D., UCSB.
Figure 2: Courtesy of California Department of Toxic Substances.
Figure 3: Courtesy of the United States Environmental Protection Agency.
Figure 4: Courtesy of Monica Hood, UCSB.
Figure 5: Courtesy of Tim Carson, UCSB.
Figure 6: Courtesy of Tim Carson, UCSB.
Figure 7: Courtesy of Tim Carson, UCSB.
Figure 8: Courtesy of Monica Hood, UCSB.