U.S. Department of Energy

Oakland Operations Office, Oakland, California

√T3.2.4

DRAFT FINAL ECOLOGICAL SCOPING ASSESSMENT FOR DOE AREAS

for the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH UNIVERSITY OF CALIFORNIA AT DAVIS, CALIFORNIA

Prepared for:

United States Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, California 95612

Prepared by:

Weiss Associates
5500 Shellmound Street
Emeryville, California 94608
August 4, 1997
Rev. C

DOE Oakland Operations Office, Contract DE-AC03-96SF20686

DRAFT FINAL ECOLOGICAL SCOPING ASSESSMENT FOR DOE AREAS

for the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH UNIVERSITY OF CALIFORNIA AT DAVIS, CALIFORNIA

Prepared for:

United States Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, California 95612

Prepared by:
Weiss Associates
5500 Shellmound Street
Emeryville, California 94608

August 4, 1997
Rev. C

DOE Oakland Operations Office, Contract DE-AC03-965F20686

Issued To: _____ Date: _____

Copy No.: _____ ☐ Controlled ☐ Uncontrolled

Approvals Page

DRAFT FINAL ECOLOGICAL SCOPING ASSESSMENT FOR DOE AREAS

for the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH UNIVERSITY OF CALIFORNIA AT DAVIS, CALIFORNIA

Prepared by:

Weiss Associates
5500 Shellmound Street
Emeryville, California 94608-2411

August 4, 1997
Rev. C

Approved by: _____ Date: _____

Mary Stallard, RG
Project Quality Assurance Manager
Weiss Associates

Approved by: _____ Date: _____

Robert O. Devany, RG, CHG
Project Manager
Weiss Associates

Approved by: _____ Date: _____

Michael D. Dresen, RG, CHG
Program Manager
Weiss Associates

Approved by: _____ Date: _____

Carolyn Atwood
Project Task Leader
Weiss Associates

Approved by: _____ Date: _____

Leslie Reuth
Environmental Scientist
Weiss Associates

CONTENTS

	Page
EXECUTIVE SUMMARY	ES-I
1.INTRODUCTION AND OBJECTIVES	1-1
1.1 Introduction	1-1
1.2 Objectives	1-2
1.3 General Approach	1-2
2.SITE CHARACTERIZATION	2-1
2.1 Data Compilation	2-1
2.2 Media Evaluation	2-2
2.2.1 Surface Soil	2-3
2.2.2 Subsurface Soil	2-3
2.2.3 Ground Water	2-4
2.2.4 Surface Water	2-4
2.2.5 Ponding Storm Water	2-5
2.2.6 Air	2-5
2.2.7 Sediment	2-5
2.3 Identification of Contaminants of Potential Ecological Concern and Radionuclides of Potential Ecological Concern	2-6
2.3.1 Surface Soil and Subsurface Soil	2-6
2.3.2 Surface Water	2-7
2.3.3 Ponded Storm Water	2-7
2.3.4 Air	2-8
2.3.5 Putah Creek Sediment	2-8
2.3.6 Other Media	2-8
2.4 Conclusions	2-9

3.BIOLOGICAL CHARACTERIZATION 3-1

3.1 Introduction 3-1
3.2 Methods 3-2
3.2.1 Database Search 3-2
3.2.2 Field Reconnaissance 3-2
3.3 Physical Setting 3-4
3.3.1 History of Site Use 3-4
3.3.2 Climate 3-5
3.3.3 Meteorology 3-5
3.3.4 Geologic Setting 3-5
3.3.5 Ground Water Hydrology 3-6
3.3.6 Surface Water 3-6
3.3.7 Topography and Drainage: 3-7
3.4 Plant Communities and Habitats 3-7
3.4.1 On-site 3-8
3.4.2 Off-site 3-9
3.4.3 Special-Status Natural Communities 3-11
3.5 Expected/Observed Species 3-12
3.6 Expected/ Observed Special Status Species 3-13
3.6.1 Special Status Plants 3-14
3.6.2 Special Status Animal Species 3-14
3.7 Conclusions 3-15

4.ESPOSURE PATHWAY ASSESSMENT 4-1

4.1 Introduction 4-1
4.2 Exposure Group Selection 4-1
4.3 Food Web Analysis 4-3
4.4 Development of Conceptual Site Models 4-4
4.4.1 Conceptual Models 4-5
4.5 Identification of Potentially Complete Exposure Pathways 4-7
4.5.1 Methodology 4-7
4.5.2 Identification of Complete Exposure Pathways 4-8
4.5.3 Discussion of Relative Potential Significance of Complete Exposure Pathways 4-10
4.6 Conclusions 4-15

5. CONCLUSIONS 5-20

REFERENCES R-20

ACKNOWLEDGMENTS Acknowledgements

LIST OF ACRONYMS Acronyms

TABLES

Table ES-1. Summary of Ecologically Significant Media and Associated Contaminant Classes.

Table ES-2. Evaluation of Potential Lead and Mercury Contributions from DOE Areas to Putah Creek Ecosystem.

Table ES-3. Numerical Summary of the Biological Characterization and Exposure Pathway Analysis.

Table 1-1. Summary of Investigative Areas at the Site.

Table 2-1. Contaminants of Potential Ecological Concern (COPEC) in Surface Soil (0 to 3 ft bgs).

Table 2-2. Radionuclides of Potential Ecological Concern (ROPEC) in Surface Soil (0 to 3 ft bgs).

Table 2-3. Contaminants of Potential Ecological Concern (COPEC) in Subsurface Soil (> or = 3 ft bgs).

Table 2-4. Radionuclides of Potential Ecological Concern (ROPEC) in Subsurface Soil (> or = 3 ft bgs).

Table 2-5. Identification of Contaminants of Potential Ecological Concern (COPEC) in Surface Water.

Table 2-6. Identification of Radionuclides of Potential Ecological Concern (ROPEC) in Surface Water.

Table 3-1. Special-Status Plant Species Known or Suspected to Occur at the Site and Vicinity.

Table 3-2. Special-Status Animal Species Known or Suspected to Occur at the Site and Vicinity.

Table 4-1. Summary of On-Site Habitats and Potential Ecological Receptors.

Table 4-2. Summary of Off-Site Habitats and Potential Ecological Receptors.

Table 4-3. Relative Significance of Exposure Pathways for Potential Animal Exposure Groups.

Table 4-4. Relative Significance of Exposure Pathways for Potential Plant Exposure Groups.

Table 4-5. Relative Significance of Exposure Pathways for Potential COPECs and ROPECs.

Table 4-6. Potentially Significant Exposure Pathways.

FIGURES

Figure 1-1. LEHR/SCDS Site and UC Davis Location Map.

Figure 1-2. Operable Unit Locations, Storm Water Runoff Monitoring Points and Surface Water Sampling Points.

Figure 1-3. Potential and Known Source Areas.

Figure 1-4. Ecological Scoping Assessment Flowchart.

Figure 2-1. Flowchart for Determining the Soil Concentration Term to be Carried Through the Ecological Scoping Assessment.

Figure 2-2. Identification of COPECs/ROPECs in Ponded Storm Water and Surface Water (Putah Creek).

Figure 3-1. Site Vegetation/Habitat Characterization.

Figure 3-2. Site Vicinity Vegetation/Habitat Characterization.

Figure 3-3. Habitats Occurring Within the Site Boundary: Sparsely covered bare ground, buildings and structures and Ruderal/Landscaped trees in background.

Figure 3-4. Habitats Occurring Within the Site Boundary: Ruderal/Non-native Grassland, Ruderal/Landscaped Trees and Potential Valley Eldeberry Longhorn Beetle Habitat.

Figure 3-5. Evidence of Burrowing Mammals on the Site.

Figure 3-6. Habitats Present Within 1 Mile Radius of Site Boundary: Ruderal/Non-Native Grassland, Great Valley Mixed Riparian Forest, and Putah Creek During High Water.

Figure 3-7. Habitats Occurring Within 1 Mile of the Site Boundary: Cultivated Fields and an Unlined Agricultural drainage Canal.

Figure 3-8. Former Fox or Skunk Burrow on Bank of Unlined Agricultural Drainage Canal, Currently Occupied by Burrowing Owls. Constructed Burrowing Owl Mounds Adjacent to UCD Landfill Unit 3 in Background.

Figure 4-1. Food Web Analysis of Aquatic and Terrestrial Ecosystems.

Figure 4-2. Ecological Exposure Pathways Analysis.

LIST OF ATTACHMENTS

Attachment A Site Drainage Area Map (from Dames & Moore, 1997)

Attachment B Sampling Locations from ATSDR Fish Sampling Report

Attachment C Preliminary List of Plant and Animal Species Detected or Expected to Occur at the Site

Attachment D Preliminary List of Plant and Animal Species Detected, Expected to Occur or Recorded at the Site

Attachment E Fish Species Recorded within the UC Davis Campus Area

Attachment F Explanation of Sensitivity Status Codes

Attachment G Raptors Historically and Currently Housed at UC Davis Raptor Center

Attachment H Botanical Consulting Services - Field Notes

EXECUTIVE SUMMARY

This Ecological Scoping Assessment for the U.S. Department of Energy (DOE) Areas at the former Laboratory for Energy-Related Health Research, at the University of California at Davis (the Site) supports the related *Draft Final Determination of Risk-Based Action Standards for DOE Areas* (DOE, 1997a). The purpose of this Scoping Assessment is to:

- Identify chemical and radionuclide contaminants of potential ecological concern (COPECs and ROPECs, respectively) present in media of potential ecological concern at the Site and vicinity;
- Characterize on-site and near-site ecological communities and habitats;
- Identify complete exposure pathways of potential environmental concern; and
- Provide a preliminary assessment of the relative significance of each potentially complete exposure pathway with respect to receptor and contaminant groups.

This analysis addresses contaminants and potential exposure pathways specific to the areas for which the Department of Energy (DOE) is taking responsibility as specified in the Memorandum of Agreement (MOA) between DOE and the University of California Davis (DOE/UC Davis, 1997b), but is site-wide with respect to biological characterization.

This evaluation has been completed following California Department of Toxic Substances Control (DTSC) Guidance for Ecological Scoping Assessments (CAL-EPA 1996a and 1996b) and as such does not quantitatively assess potential ecological risk at the Site and Site vicinity. Quantitative evaluation of the actual risk or hazard associated with complete exposure pathways, if any, is typically evaluated during a Phase I Predictive Ecological Risk Assessment. However, a semi-quantitative analysis of surface water-related exposure pathways was initiated in response to the recent attention given to surface water-related exposure pathways by the Agency for Toxic Substances and Disease Registry (ATSDR, 1997a and 1997b).

Six environmental media groups have been identified as being of potential ecological concern when contaminants are present. Chemicals in five contaminant classes are present in DOE Area soil at levels above background concentrations. Contaminants present above background levels in DOE Areas in surface and subsurface soil are the source for all complete ecological exposure pathways. A summary of ecologically significant media and associated contaminant classes at the Site is shown in Table ES-1.

Table ES-1. Summary of Ecologically Significant Media and Associated Contaminant Classes.

Environmental Media	COPEC/ROPEC				
	Volatile Organic Compounds	Semi-volatile Organic Compounds	Radionuclides	Pesticides	Metals
Surface Soil	✓	✓	✓	✓	✓
Subsurface Soil	✓	✓	✓	✓	✓
Ambient Air	✓		✓	✓	✓
Subsurface Air	✓		✓	✓	✓
Storm Water	✓	✓	✓	✓	✓
Surface Water	✓	✓	✓	✓	✓
Sediment			✓	✓	✓

Storm water run-off was identified as the only possibly significant source of contaminants into the Putah Creek ecosystem. However, ATSDR (ATSDR, 1997) concluded that, with the exception of lead and mercury, chemical and radionuclide contaminant levels in Putah Creek surface water, sediments, and fish do not pose a significant risk from the perspective of human exposure or ingestion. Because contaminants present in DOE Area surface soil have the potential to migrate to Putah Creek via erosion and runoff during storm events the storm water to surface water exposure pathways were evaluated using semi-quantitative methods. Results are shown below in Table ES-2 and indicate that DOE Areas are not a source of mercury to Putah Creek and that the DOE contribution of lead to Putah Creek is not significant.

Table ES-2. Evaluation of Potential Lead and Mercury Contributions from DOE Areas to Putah Creek Ecosystem.

Analyte	Maximum Concentration in DOE OU Surface Soil (ppm)	Background Concentration in DOE OU Surface Soil (ppm)	Maximum Concentration in DOE Storm Water (mg/L)	Maximum Concentration in Putah Creek downstream (mg/L)	COPEC in Surface Water?	DOE Mass Contribution
Lead	21	10.1	0.0384	0.01	Yes	0.07-0.09 %
Mercury	1	0.49	ND <0.0002	0.00027	No	Not Calculated

A biological field survey was conducted to compile an inventory of on-site and off-site plant and animal species (receptors) and to characterize on-site and off-site aquatic and terrestrial ecological habitats and communities. Data from other recent studies was also incorporated into this characterization, as was data from the California Natural Diversity Database. On-site and off-site biota were segregated into exposure groups and a generalized food web was constructed. From the

food web analysis an exposure pathway assessment was conducted to identify potentially complete ecological exposure pathways including the bioaccumulation pathway. A complete pathway is defined as consisting of a source, a transport mechanism, a receptor, and an uptake route. Preliminary evaluation of the biological characterization and exposure pathway analysis are summarized below in Table ES-3 and indicates that biological receptors are present or have the potential to occur both on and off-site, at least one complete exposure pathway exists for each exposure group, and not all complete exposure pathways are likely to be significant. Based on the nature of this Scoping Assessment, significance is defined on a qualitative basis.

Table ES-3. Numerical Summary of the Biological Characterization and Exposure Pathway Analysis.

Location	Habitat Types	Special Status Plant Species	Special Status Plant Communities	Special Status Wildlife Species	Exposure Groups	Significant, Complete Exposure Pathways
On-site	3	0	0	14	11	6
Off-site	8	2	3	31	20	7

Results of this Scoping Assessment indicate that a Phase I Predictive Ecological Assessment may be warranted in the future to evaluate and quantify potential adverse risks for identified exposure scenarios, following remedial action at the site. This Scoping Assessment provides preliminary information regarding the potential significance of ecological exposures, and may be carried forward as the basic data set for any subsequent ecological studies.

1. INTRODUCTION AND OBJECTIVES

1.1 Introduction

This Ecological Scoping Assessment has been prepared on behalf of the U.S. Department of Energy (DOE) for DOE Areas at the Laboratory for Energy-Related Health Research Site (Site), by Weiss Associates (WA), Emeryville, California. This document has been prepared following *Guidance for Ecological Risk Assessments at Hazardous Waste Sites and Permitted Facilities* issued by the California Environmental Protection Agency (CalEPA), Department of Toxic Substances Control (CalEPA, 1996a and 1996b).

The Ecological Scoping Assessment conducted for the Site and vicinity addresses those areas for which DOE has taken responsibility, based on the Memorandum of Agreement (MOA) between the DOE and the University of California, Davis (UC Davis) (DOE/UC Davis, 1997a). Investigative areas are summarized in Table 1-1. For consistency with previous documents and reports, this report uses the Operable Unit (OU) designations previously adopted as shown in Table 1-1 below. However, the reader should be aware that these are not formal CERCLA OU designations, and that the OU designations are likely to change in the future when the Federal Facilities Agreement is signed for this Site.

Table 1-1. Summary of Investigative Areas at the Site.

Party Taking Responsibility	Operable Unit	Investigative Area	Description
DOE	OU-1	Southwest Trenches	Disposal trenches and chemical dispensing area in the southwest corner of the Site.
	OU-1	DOE Disposal Box	Subsurface disposal area defined by metal matting located between the two sets of dog pens.
	OU-2	Radium Treatment System	Radium-226 treatment tank and the associated leach field and dry wells.
	OU-2	Strontium Treatment System	Strontium-90 treatment tanks and associated leach system.
	OU-3	Dog Pens Area	Western set of dog pens, including the southern portion of the area currently occupied by the Cellular Biology Lab. The Eastern Dog Pens and North Chemical Dispensing Area are also included.
	OU-4	Domestic Septic Systems	Seven domestic septic tanks at the Site.
UC Davis	OU-1	Southern Solid Waste Trenches	Trenches located along the south side of the Western Dog Pens.

Party Taking Responsibility	Operable Unit	Investigative Area	Description
	OU-1	Eastern Solid Waste Trenches	Trenches located between Landfills Nos. 1 and 2.
	OU-1	49 Waste Holes	Pits located along the south side of the Eastern Dog Pens.
	OU-5	Landfill Disposal Units	Three UC Davis landfill units.
	OU-6	Ground Water	Ground water beneath the Site.
	OU-6	Surface Water	Surface water (includes Putah Creek and storm water runoff).

In addition to the DOE investigative areas defined above, the surface water and storm water runoff portion of OU-6 could result in potentially complete exposure pathways with respect to DOE OUs and therefore, have been included in the Scoping Assessment to the extent necessary to conduct a complete evaluation.

Figure 1-1 shows the Site and vicinity. Figure 1-2 shows the general Site configuration including identified DOE Areas, storm water sampling locations and surface water sampling locations. Figure 1-3 shows the Site and identifies those areas for which DOE and UC Davis are taking responsibility.

1.2 Objectives

This Ecological Scoping Assessment supports the *Draft Final Determination of Risk-Based Action Standards for DOE Areas* (DOE, 1997b), and serves as the Ecological Scoping Assessment step in the Comprehensive Environmental Response, Compensation and Liabilities Act (CERCLA) process. The goal of this Scoping Assessment is to identify potential ecological issues at the Site. The information in this document is intended to assist the Remedial Program Managers in determining whether additional quantitative evaluations may be warranted in the future. Neither this document nor the associated action-standard determination is intended to constitute a CERCLA Baseline Human Health or Ecological Risk Assessment.

1.3 General Approach

In general, environmental data from the Site and vicinity are evaluated in this document to identify contaminants of potential ecological concern (COPECs) and radionuclides of potential ecological concern (ROPECs) in ecologically significant media. Also, biological resources are surveyed and potential exposure pathways are evaluated. This technical approach follows guidelines established in *Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities* (CalEPA, 1996b), and is outlined in Figure 1-4. Components of this assessment include:

- Identification of COPECs and ROPECs;
- Characterization of plant communities and habitats;

- Characterization of invertebrate and vertebrate animal populations and communities;
- Documentation of special status species;
- Establishing spatial distribution of ecological components;
- Sorting species into exposure groups based on dietary habits and niche space;
- Construction of a generalized food web;
- Evaluation of potential exposure pathways; and
- Establishment of decision criteria for evaluating the need to initiate a future Phase I Predictive Assessment.

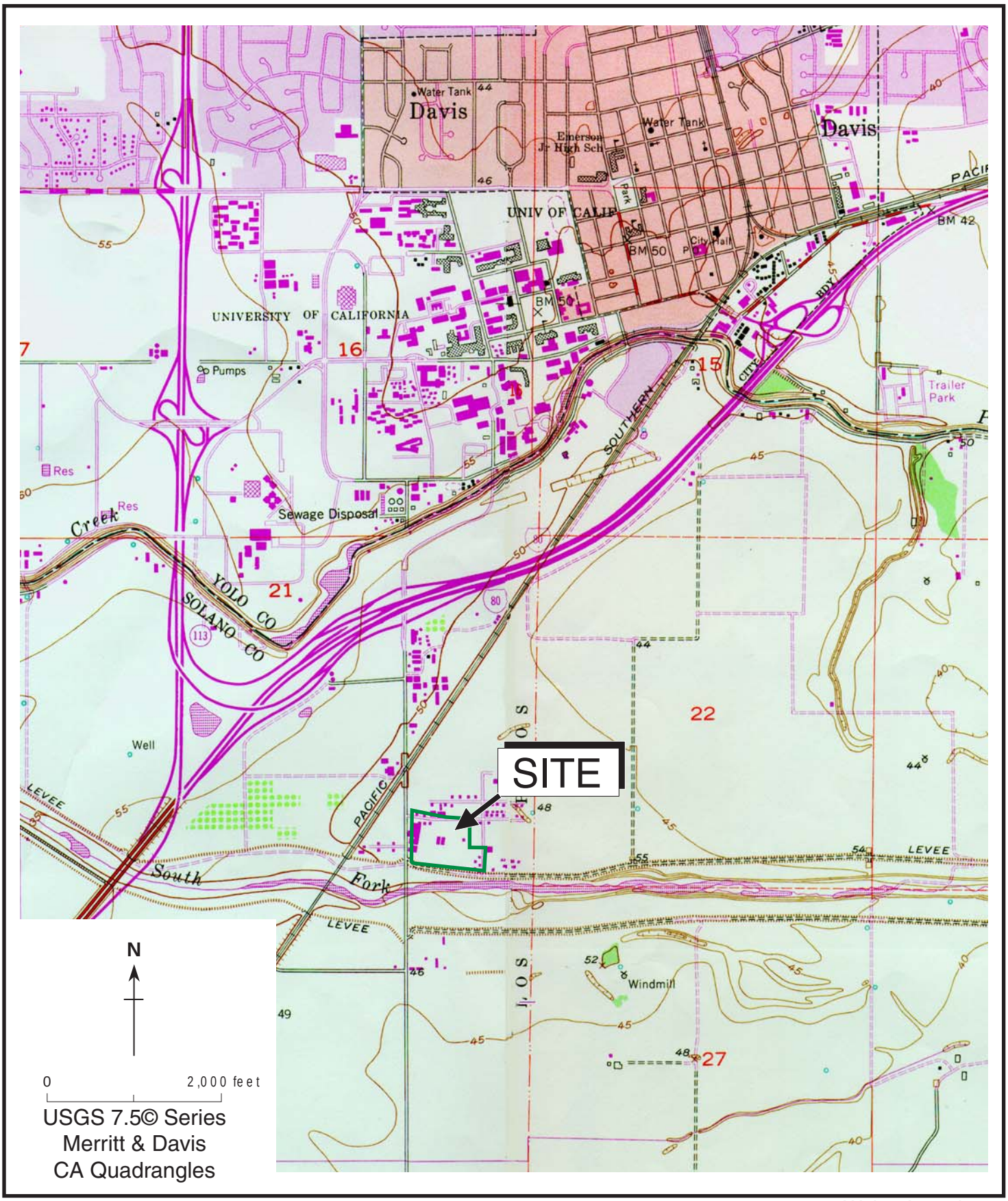


Figure 1-1. LEHR/SCDS Site and UC Davis Location Map.

Weiss Associates

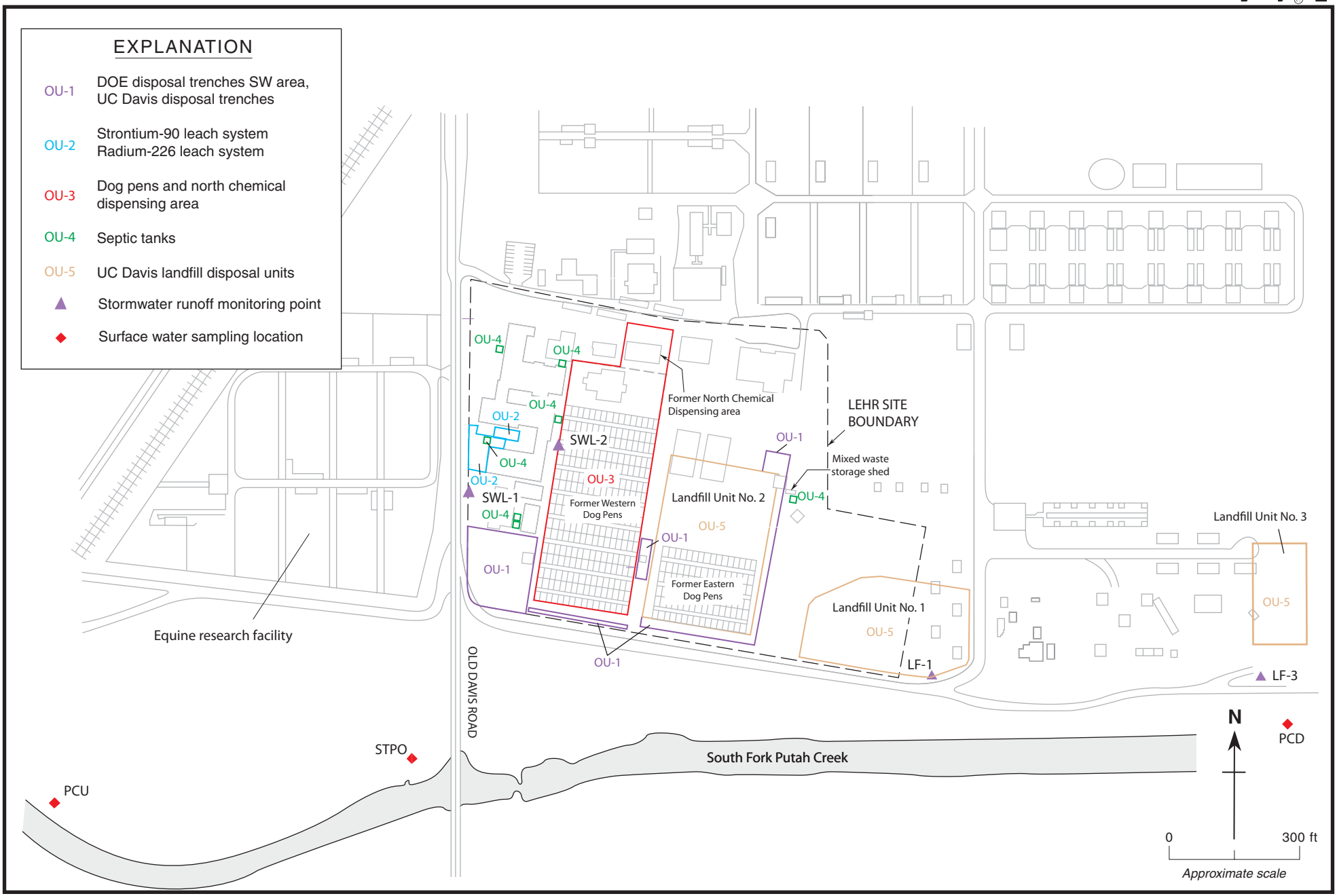


Figure 1-2. LEHR Operable Unit Locations, Storm Water Runoff Monitoring Points and Surface Water Sampling Points

Figure 1-3. Potential and Known Source Areas.

Weiss Associates

L801-097.ai

07/30/97

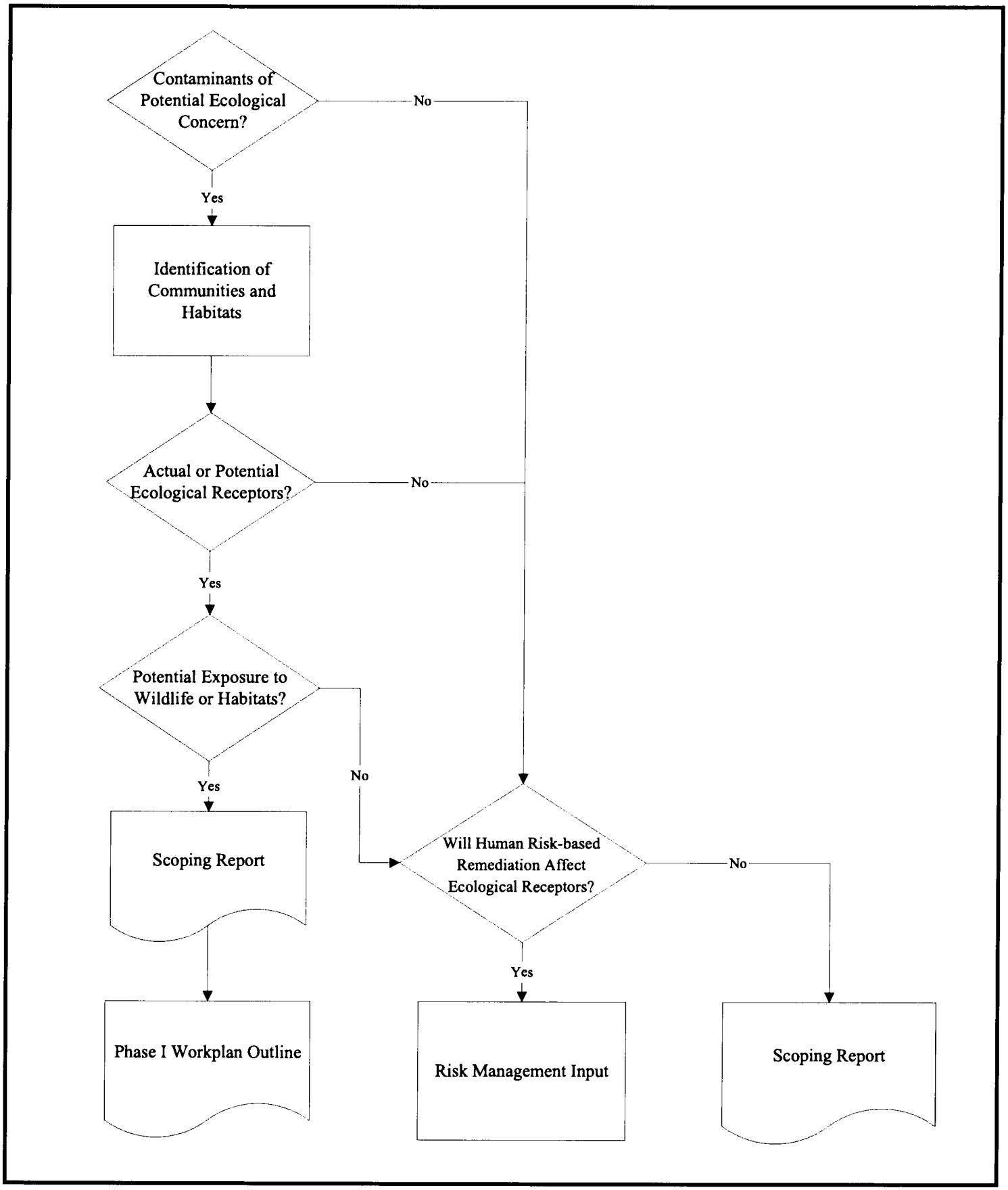


Figure 1-4. Ecological Scoping Assessment Flowchart

Weiss Associates

2. SITE CHARACTERIZATION

The first phase of this Ecological Scoping Assessment includes the following Site characterization components:

- Data compilation;
- Media evaluation; and,
- Identification of COPECs and ROPECs.

2.1 Data Compilation

The data used in this evaluation consist of all data collected and analyzed by appropriate procedures and methodologies, validated by established EPA data validation procedures, and recorded in the Site database with no substantial errors or omissions of information. Appropriate data collection procedures are outlined in the Remedial Investigation/Feasibility (RI/FS) Workplan for the Site Environmental Restoration (Dames and Moore 1994). Sample analysis methodologies are certified procedures as established by the USEPA Contract Laboratory Program. Data validation procedures are from the United States Environmental Protection Agency (USEPA) Contract Laboratory Program national functional guidelines for data review as outlined in the RI/FS Workplan. Data containing substantial untraceable omissions or errors was corrected or removed from the database before proceeding to identify contaminants of concern and determine the concentration terms.

In general, the data included for DOE OU surface and subsurface soil consists of data collected during the Limited Field Investigation (IT Corporation, 1996), the December 1994 soil investigation and three surface soil samples collected from OU-1 in June 1995.

Analytic data from the Phase II Site Characterization Report (Dames and Moore, 1993), were not used in this assessment because:

- The Phase II Data was analyzed by SW 846 analytical methods rather than USEPA Contract Laboratory Program methods as stated in the Phase II report;
- The Phase II Data was not validated using the USEPA Contract Laboratory Program national functional guidelines for data review; and,
- The Phase II data was not available in electronic form in the Site database.

The following specific data comprises the data sets that were used for this evaluation:

- OU-1 surface soil (0 to 3 feet below ground service [ft bgs]): eight s collected during the Limited Field Investigation (LFI) between July 23, 1996 and August 2, 1996, and three soil samples collected on June 1, 1995;
- OU-1 subsurface soil (≥ to 3 ft bgs): 60 samples collected during the LFI, between July 23, 1996, and August 27, 1996;
- OU-2 surface soil: four samples collected during the LFI, on August 27, 1996;
- OU-2 subsurface soil: 58 samples collected during the LFI, between August 6, 1996 and August 21, 1996;
- OU-3 surface soil: 18 samples collected during the December 1994 soil investigation, inclusive dates December 7, 1994 to December 14, 1994. In addition, 15 soil samples collected on July 31, 1996;
- OU-3 subsurface soil: 26 samples collected during the December 1994 soil investigation, inclusive dates December 7, 1994 to December 14, 1994;
- OU-4 surface soil: One sample collected on June 9, 1995. OU-4 sources are all subsurface (so this does not represent a data gap with respect to the risk evaluation);
- OU-4 subsurface soil: seven samples collected during LFI, between August 16, 1996 and August 19, 1996;
- Surface water: Putah Creek stations PCU, STPO, PCD: 26, 27 and 25 quarterly monitoring samples, respectively, collected from each station between November 9, 1990 and May 29, 1996; and
- Storm water runoff stations SWL-1 and SWL-2: eight samples collected between November 15, 1994 and March 12, 1996.

Additionally, sediment, surface water and fish bioassay analytic data from the recent Agency for Toxic Substances and Disease Registry (ATSDR) report, *Fish Sampling in Putah Creek, 1996, Laboratory for Energy-Related Health Research, Davis CA* (ATSDR, 1997b), were reviewed.

2.2 Media Evaluation

This section identifies environmental media of ecological concern. Environmental media are considered to be of ecological concern if:

- Biota can be exposed to the media through direct contact;
- Contaminants in the media have the potential to transfer to other media with which biota can come in contact; or
- There is a potential for exposure of biological receptors through the food web pathway (bioaccumulation).

The data set to be used to determine media of ecological concern is the same as that used in the *Draft Final Determination of Risk-Based Action Standards for DOE Areas.* Environmental media considered are:

- Surface soil;
- Subsurface soil;
- Ground water;
- Surface water, as impacted by storm water runoff;
- Ponded storm water;
- Surface air;
- Subsurface air; and
- Putah Creek sediment.

2.2.1 Surface Soil

Surface soil is a medium of ecological concern. Surface soil sample analytical data indicates that COPECs and ROPECs are present. Since biological receptors such as burrowing owls and animals that hunt or forage on the ground surface are in direct contact with Site surface soil, the potential for exposure to COPECs and ROPECs exists. Therefore, surface soil is carried forward as a medium of concern.

In this memorandum, surface soil data are those from less than three feet below ground surface (ft bgs). The three-foot depth was selected due to the historical attempts to control rodent populations at the Site. By tilling the surface soil, habitat should be destroyed, thereby controlling rodent populations. It is unlikely that soil from a three-foot depth or below will be mechanically lifted to the ground surface by tilling operations.

2.2.2 Subsurface Soil

Subsurface soil is a medium of ecological concern. For subsurface soil, all substances detected in shallow subsurface soil samples were evaluated. In this Scoping Assessment, soil between 3 and 12 ft bgs is considered to be the portion of the soil column potentially accessible to burrowing receptors and burrow-inhabiting receptors, specifically the important prey group, burrowing mammals. However, due to the presence of vegetation capable of accumulating COPECs/ROPECs an additional 3 ft bgs (Mike Woods, 1997, personal communication), the functional definition of subsurface soil is extended from between three and 12 ft bgs to between three and 15 ft bgs. It should be noted that the shallow portion of the soil column is utilized by Site ecological receptors to a much greater extent than deeper subsurface media and that the 12 ft bgs delineation, itself a conservative boundary, was made more conservative by extending the limit to 15 ft bgs. Subsurface soil will only carried forward as a potentially direct exposure route to burrowing and burrow inhabiting biota capable of accessing the 3 to 12 ft bgs portion of the

soil column, and vegetation capable of accessing soil via root systems at depths to 15 ft bgs. For all other organisms, subsurface soil will be considered an ecologically significant medium only in that potential indirect food web exposure exists.

2.2.3 Ground Water

Ground water is not a medium of significant ecological concern at the Site. *Deminimus* ground water levels at the Site vary from 28 ft bgs in winter to 48 ft bgs in summer (DOE, 1996). In general, tree roots spread outward proportionally to the size of their canopy and do not reach depths greater that 15 ft bgs. Additionally, plant uptake of soil moisture primarily occurs through root hairs that are concentrated in the upper three feet of the soil column (Mike Woods, 1997, personal communication). Due to the depth to ground water at the Site and the limited depth of a typical plant/tree root system, it is not likely that direct uptake of ground water by plants will be a significant exposure route to study area biota.

In addition, Putah Creek is a "losing" stream in the vicinity of the Site, therefore ground water beneath the Site does not discharge to the creek (DOE, 1996). Because the depth to ground water at the Site is beyond the root growth pattern of Site vegetation and because ground water does not directly discharge to or otherwise influence Putah Creek, there is no potential for introduction of COPECs/ROPECs into the Putah Creek ecosystem via ground water, and it thus was dropped from further consideration in this Scoping Assessment

2.2.4 Surface Water

Surface water is a medium of ecological concern based on the potential for impact to Putah Creek via storm water runoff from DOE Areas. Direct sampling of surface water in Putah Creek has been conducted. Surface water samples have been collected from two sampling points; one located upstream from the Site (PCU) and one located downstream (PCD). Water samples have also been collected at the UC Davis treatment plant outfall (STPO). Figure 1-2 shows sampling locations. These data, while valuable, do not allow evaluation of the impact from DOE Areas on Putah Creek surface water since it characterizes in-stream contaminant levels that may have many upstream sources other than DOE Areas.

Storm water sampling data are direct measurements of potential DOE related impacts to Putah Creek. Storm water sample data for DOE Areas of the Site are from two storm water sampling points. Storm water sampling point SWL-1 is a lift station on the west side of the Site that discharges to Putah Creek. Storm water from the primarily paved portion of the Site, including the eastern side of the Animal Hospital Buildings and the area near the former Western Dog Pens, is sampled at a second sampling location, SWL-2. This water is then routed to the SWL-1 lift station and subsequently discharged to Putah Creek. In sum, a portion of OU-2 (Strontium/Radium Leach System) and OU-4 (Septic Tanks) drains to Putah Creek via a lift station at SWL-1. Storm water runoff from the remainder of DOE Areas, including a small portion of OU-2, OU-3 (Western Dog Pens) and OU-1 (DOE Southwest Trenches Area and the DOE Disposal Box) ponds and percolates into Site soil, or evaporates. Storm water has been

observed to pond at OU-1 (DOE Disposal Trenches) during the wet season. Storm water run-off patterns are shown in Attachment A (Dames and Moore, 1997).

Two additional storm water monitoring points, LF-1 and LF-3, are monitored by UC Davis in OU-5, UC landfill units 1 and 3 respectively. In these areas, storm water either collects or percolates into the soil, is directed to the sanitary sewer or is discharged to Putah Creek via culverts and a drainage ditch. Since these monitoring points are not in DOE Areas of the Site, they are not evaluated in this Scoping Assessment but are presented in Figure 1-2 for reference.

2.2.5 Ponding Storm Water

Storm water ponded on the Site surface is a potential medium of ecological concern for limited areas of the Site. Generally, storm water is either diverted off-site or percolates into Site soil as described above and in Attachment A. However, in limited areas of the Site, specifically the Southwest Trenches Area, contaminants present in Site surface soil could solubilize into ponded storm water, or be present as suspended particulates. Storm water has been observed to pond for extended periods of time in this area during the rainy season. During these wet winter months the potential for exposure to COPECs and ROPECs via ponding storm water exists. Therefore, ponded storm water is carried forward as a medium of potential concern into Section 4 of this report.

2.2.6 Air

Air is also a medium of ecological concern. Although no direct data exist for the air medium, preliminary review of surface and subsurface soil analytic data indicates that COPECs and ROPECs with the potential for resuspension or volatilization into the air exist in Site soil. These airborne particulates and vapors could potentially be inhaled by Site biota in burrows and on the ground surface. In addition, airborne particulates may be ingested following redeposition by Site biota in both of the aforementioned habitats. Therefore, the potential for direct exposure and indirect food web exposure to COPECs and ROPECs exists and the air medium is carried forward into Section 4 of the report.

2.2.7 Sediment

Sediment in Putah Creek is also considered a medium of potential ecological concern. Due to flood conditions during the field reconnaissance stage of this study in December 1997, creek sediment samples were not collected. However, sediment data were collected in a separate study conducted by ATSDR in August and September, 1996 (ATSDR, 1997a). Samples were collected from 4 locations within the south fork of Putah Creek:

- Location #1 - downstream of Old Davis Road and adjacent to the Site
- Location #2 - one mile downstream of Old Davis Road

- Location #3 - two miles downstream of Old Davis Road
- Location #4 – Approximately 2 miles upstream of Old Davis Road near the Stevenson Bridge Road crossing

A sample location map from the ATSDR report is presented in Attachment B. Because DOE did not conduct the survey, DOE can not be fully confident of either the methods or the results. However, the analytic data were reviewed and the results noted. After review of the ATSDR data, Site storm water data, and Site surface soil data, it was determined that Putah Creek sediments may contain COPECs and ROPECs contributed by DOE Areas. Therefore, sediment is carried forward as a medium of ecological concern into Section 4 of this report.

2.3 Identification of Contaminants of Potential Ecological Concern and Radionuclides of Potential Ecological Concern

Ecologically significant contaminants are those that may pose a risk to non-human endpoints. Selection criteria were developed to determine COPEC concentrations and ROPEC activity levels to be carried through the Scoping Assessment. Tables 2-1 through 2-6 present the results of the COPEC and ROPEC identification process for surface soil, subsurface soil and storm water. The results are sorted by media, chemical or radionuclide, and by compound.

2.3.1 Surface Soil and Subsurface Soil

The selection process for COPECs and ROPECs in Site soil is outlined in Figure 2-2. The screening process for COPECs and ROPECs in Site soil were similar to the conservative method used in the *Determination of Risk-Based Action Standards for DOE Areas.* However, due to the relatively small acreage of the Site, and the habits of many of the associated animal species, analytic data for each medium is combined into one data set, rather than segregated by OU.

Generally, classes of compounds detected in Site soil include;

- Pesticides;
- Volatile Organic Compounds (VOCs);
- Semi-volatile Organic Compounds (SVOCs);
- Metals; and
- Radionuclides.

In addition, the phthalate esters were detected. For purposes of this report, phthalate esters were included in the SVOC class based on similar chemical properties. Phthalate esters are carried forward as SVOCs through the remainder of the Scoping Assessment. Complete results of this evaluation appear in Tables 2-1, through 2-4. COPECs and ROPECs identified in this section are carried forward into Section 4 of this report.

2.3.2 Surface Water

The only significant transport mechanism from DOE source areas (Site soil) to Putah Creek is through surface erosion during a rainfall event followed by runoff to the creek. Therefore storm water analytic data were evaluated to estimate any DOE contributions to surface waters. The selection process for COPECs and ROPECs in surface water is outlined in Figure 2-3. In general COPECs and ROPECs in Site surface soil are considered the starting data set for the surface water evaluation. If a COPEC or ROPEC is not above background or the method detection limits/minimum detectable activity in Site surface soil, then it is dropped from further consideration. Those constituents that are carried forward were next evaluated in terms of:

- Detection in storm water;
- Concentration or activity;
- Detection limits/minimum detectable activity; and
- Relevant Ambient Water Quality Criteria (AWQC) (CRWQCB, 1996).

Constituents present in Site soil above background or method detection limits/minimum detectable activity and detected in storm water have been carried forward in the Scoping Assessment as COPECs and ROPECs for surface water. Additionally, constituents not detected in storm, but with detection limits/activity levels that are greater than relevant AWQC have also been carried through the Scoping Assessment. Relevant AWQC were selected as instantaneous or one-hour maximum values for each compound, taking the lowest of either the federal AWQC for the protection of Aquatic Organisms, or Numerical Water Quality Objectives for California Inland Surface Water Plan. Finally, constituents not detected in storm water with method detection limits that are less than relevant AWQC have been dropped from further consideration. Classes of compounds identified as COPECs and ROPECs include pesticides, VOCs, metals and radionuclides.

Complete results of this evaluation appear in Tables 2-5 and 2-6. COPECs and ROPECs identified in this section are carried forward into Section 4 of this report.

2.3.3 Ponded Storm Water

The methodology for determining COPECs and ROPECs in Site storm water is identical to the methodology used for determining COPECs and ROPECs in surface water. Classes of compounds identified as COPECs and ROPECs in ponded storm water include pesticides, VOCs, metals, and radionuclides.

Results of the surface water evaluation, representing COPECs and ROPECs in storm water, were carried forward into Section 4 of this report.

2.3.4 Air

As discussed in Section 2.2.6, air data were not available for analysis. Some pesticides, SVOCs, metals and radionuclides identified as COPECs and ROPECs in Site soil have the potential to become resuspended as particulates in ambient and subsurface air. In addition, VOCs and the ROPEC radium-226 (in the form of radon gas, a daughter product of radium-226), have the potential to migrate into ambient and subsurface air. Therefore all pesticides, SVOCs, metals and radionuclides identified as COPECs and ROPECs in surface and subsurface soil with the potential for resuspension and VOCs and ROPECs with the potential to migrate into surface and subsurface air were carried forward as COPECs and ROPECs for the air media, into Section 4 of this report.

2.3.5 Putah Creek Sediment

Sediment analysis was not performed as part of this Ecological Scoping Assessment, nor are sediment data available from earlier Site investigation activities as discussed in Section 2.2.7. However, in an independent study, ATSDR sampled sediments from four locations along Putah Creek (ATSDR, 1997a). Sampling locations are discussed in Section 2.2.7 and shown in Attachment B. The National Air and Radiation Environmental Laboratory (NAREL) in conjunction with ATSDR conclude that "Radionuclide, metal and organic concentrations in sediments collected from Putah Creek are not appreciably elevated as compared to background concentrations or typical radionuclide concentrations in soil except for mercury found at Site #1 (near the Site)..." (ATSDR, 1997a). Sediment results from the ATSDR report are presented in Attachment B. Mercury was detected at 1.0 ppm, slightly above the background concentration of 0.49 ppm, in Site soil and was not detected in DOE storm water at detection limits lower than AWQC. Based on the low concentration of mercury in Site soil and lack of mercury detections in DOE storm water, it is likely that DOE is not a significant contributor to the mercury detected in Putah Creek sediments. It should also be noted that in the ATSDR report several potential sources for contamination in Putah Creek other than the Site are identified including other UC Davis departments located upstream, the sewage treatment plant outfall, and the University Landfill located near the County Road 98 crossing of Putah Creek.

2.3.6 Other Media

No direct sampling of fish or invertebrates from Putah Creek has been conducted by DOE. Due to excessive rains during the Site visit of 1996/97 it was not possible to collect fish and invertebrate samples for tissue analysis during this Scoping Assessment. However, fish and invertebrates were collected, composited and analyzed by NAREL as part of the ATSDR fish sampling report. Results of this study were intended measure the potential bioaccumulation of COPECs and ROPECs in fish and invertebrate species in Putah Creek. Because the ATSDR data were not collected in accordance with EPA fish and invertebrate sampling protocols and DOE did not conduct the survey, DOE can not be fully confident of either the methods or the results. Results for fish and invertebrate tissue from the ATSDR report are presented in Attachment B.

ATSDR indicates that "The radionuclide, metal and organic concentrations in fish collected from Putah Creek are not appreciably elevated as compared to background concentrations and screening values except for HG-203 at Site #1 and mercury and lead at Site #1, #2 and #3." As previously discussed, mercury was not detected significantly above background in Site soil nor was mercury detected above AWQC. Furthermore, several potential sources of contamination in Putah Creek have been identified upstream of the Site. Based on results of the Site surface soil and storm water analyses and uncertainties in the ATSDR report, it is unlikely that DOE is responsible for mercury and mercury isotopes detected in Putah Creek composited fish and invertebrate samples. Therefore mercury was dropped from this Scoping Assessment. However, the ATSDR data, the Site storm water data, and Site surface soil data indicate that DOE may be contributing to lead in Putah Creek fish and invertebrate composite samples. Since DOE collected and validated data were not available, classes of compounds determined to be significant for Site soil and storm water were carried forward into Section 4 of this report.

2.4 Conclusions

Surface soil, subsurface soil, ground water, surface water, ponding storm water, surface and subsurface, air and sediment were evaluated for their ecological significance. All media, with the exception of ground water, were determined to be ecologically significant.

Chemical data for the Site were reviewed to identify COPECs and ROPECs in each ecologically significant medium. Surface soil and subsurface soil sample analytical results were compared to background levels previously established in the *Draft Determination of Risk-Based Action Standards for DOE Areas*. A total of 18 COPECs and 11 ROPECs have been identified in Site surface soil. A total of 57 COPECs and 15 ROPECs have been identified in Site subsurface samples. Results are presented in Tables 2-1 through 2-4.

Surface water and ponded storm water COPECs and ROPECs were determined by evaluating Site surface soil data and DOE storm water data. A total of 11 COPECs and 14 ROPECs have been identified in DOE storm water. Because runoff from Site surface soil in Site storm water represents the source term for the DOE contribution to the surface waters of Putah Creek, the decision criteria were the same for ponded storm water and surface water. Results are presented in Tables 2-5 and 2-6.

No sediment or fish/invertebrate data have been collected by DOE. However, data available from ATSDR indicate that except for mercury, no metals, radionuclides, pesticides, VOCs or SVOCs were detected above background or typical radionuclide levels in Putah Creek sediments and, except for lead and mercury, no metals, radionuclides, pesticides, VOCs or SVOCs, were detected at significant levels in Putah Creek fish/invertebrates.

No data were available for air. Therefore, all COPECs and ROPECs in surface and subsurface soil with the potential to either volatilize or be resuspended were carried forward as COPECs and ROPECs for the air medium.

Table 2-1. Contaminants of Potential Ecological Concern (COPEC) in Surface Soil (0 to 3ft bgs).

Analyte	Units	Sitewide Number Sampled	Sitewide Number Detected	Sitewide Min []	Sitewide Max []	Min Detection Limit	Max Detection Limit	Background	Max Location	OU-specific 95% UCL	OU-specific RME	COPEC ?
General Chemical												
Formaldehyde	mg/kg	8	2	0.35	1.6	0.12	1	N/A	OU-1	NC	1.6	Yes
Metals												
Antimony	mg/kg	23	3	0.25	0.38	0.22	1.1	0.74a	OU-1	NC	<BKG	No
Arsenic	mg/kg	23	22	1.7	8.4	2	10	9.46	OU-3	7.91	<BKG	No
Barium	mg/kg	23	23	27.1	205	9.9	200	237	OU-3	155.94	<BKG	No
Beryllium	mg/kg	23	19	0.23	0.52	0.99	5	0.66	OU-3	0.43	<BKG	No
Cadmium	mg/kg	23	1	0.28	0.28	1.1	1.1	0.46a	OU-1	NC	<BKG	No
Chromium	mg/kg	27	27	24	230	2	23.7	178	OU-1	NC	230	Yes
Chromium, Hexavalent (+6)	mg/kg	32	18	0.034	0.22	0.2	0.27	0.099	OU-1	NC	0.22	Yes
Cobalt	mg/kg	23	23	4.4	24	0.99	50	29	OU-1	NC	<BKG	No
Copper	mg/kg	23	23	8.3	62	0.99	25	50	OU-1	NC	62	Yes
Iron	mg/kg	23	23	6300	42200	11	110	42000	OU-3	38753.3	<BKG	No
Lead	mg/kg	23	23	1.8	21	0.6	6.7	10.1	OU-1	NC	21	Yes
Manganese	mg/kg	23	23	124	882	3	34	720	OU-3	677.91	<BKG	No
Mercury	mg/kg	23	18	0.1	1	0.09	0.2	0.49	OU-3	NC	1	Yes
Molybdenum	mg/kg	23	3	0.47	0.88	0.99	1.1	2b	OU-1	NC	<BKG	No
Nickel	mg/kg	23	23	32.8	318	0.99	40	326	OU-3	256.41	<BKG	No
Selenium	mg/kg	23	4	0.49	0.84	1.1	5	1	OU-1	NC	<BKG	No
Vanadium	mg/kg	23	23	12	72	0.99	10	73	OU-1	NC	<BKG	No
Zinc	mg/kg	23	23	21	130	4	20	82	OU-3	78.41	<BKG	No
Pesticides and PCBs												
4,4'-DDD	mg/kg	24	5	0.0033	0.24	0.0037	0.099	N/A	OU-1	NC	0.24	Yes
4,4'-DDE	mg/kg	24	2	0.0013	0.014	0.0037	0.0038	N/A	OU-1	NC	0.014	Yes
Alpha-BHC	mg/kg	24	1	0.011	0.011	0.0019	0.0019	N/A	OU-3	NC	0.011	Yes
Alpha-Chlordane	mg/kg	24	14	0.0025	0.8	0.0018	0.049	N/A	OU-1	NC	0.8	Yes

Table 2-1. Contaminants of Potential Ecological Concern (COPEC) in Surface Soil (0 to 3ft bgs).

Analyte	Units	Sitewide Number Sampled	Sitewide Number Detected	Sitewide Min []	Sitewide Max []	Min Detection Limit	Max Detection Limit	Background	Max Location	OU-specific 95% UCL	OU-specific RME	COPEC ?
Pesticides and PCBs												
Chlordane	mg/kg	15	15	0.014	15	0.042	0.87	N/A	OU-3	3.01	3.0	Yes
Delta-BHC	mg/kg	24	1	0.0014	0.0014	0.0019	0.0019	N/A	OU-3	NC	0.0014	Yes
Gamma-BHC	mg/kg	22	1	0.0018	0.0018	0.0019	0.0019	N/A	OU-3	NC	0.0018	Yes
Gamma-Chlordane	mg/kg	24	14	0.0012	0.74	0.0018	0.049	N/A	OU-1	NC	0.74	Yes
Heptachlor	mg/kg	23	1	0.0066	0.0066	0.0018	0.0018	N/A	OU-3	NC	0.0066	Yes
Semivolatile Organics												
Bis(2-Ethylhexyl)phthalate	mg/kg	11	4	0.031	0.1	0.35	0.4	N/A	OU-1	NC	0.1	Yes
Di-n-Butylphthalate	mg/kg	12	2	0.13	0.13	0.35	0.4	N/A	OU-3	NC	0.13	Yes
Volatile Organics												
Acetone	mg/kg	10	3	0.003	0.006	0.011	0.012	N/A	OU-2	NC	0.006	Yes

Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Background concentration calculations presented in Attachment B of the Draft Final Determination of Risk-Based Action Standards for DOE Areas (DOE, 1997b).
OU = Operable Unit
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
NC = Not calculated, OU-specific data set <10 samples.
RME = Reasonable maximum exposure concentration of data for worst-case OU.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution for worst-case OU.
<BKG = Site concentration is lower than background, not a COPEC.
N/A = Not available. No background data available for this analyte.
mg/kg = milligrams per kilogram

Table 2-2. Radionuclides of Potential Ecological Concern (ROPEC) in Surface Soil (0 to 3ft bgs).

Isotope	Units	Sitewide Number Sampled	Sitewide Number >MDA	Sitewide Minimum Activity a	Sitewide Maximum Activity	Sitewide Minimum MDA	Sitewide Maximum MDA	Background	Maximum Location	OU-specific 95% UCL	OU-specific RME	ROPEC?
Radionuclides												
Actinium-228	pCi/g	44	43	0.27 ±0.11	0.66 ±0.23	0.089	0.5	0.71	OU-1	0.53	<BKG	No
Americium-241	pCi/g	5	2	0.005 ±0.015	0.024 ±0.022	0.018	0.027	N/A	OU-2	NC	0.024	Yes
Bismuth-212	pCi/g	44	29	-0.6 ±0.34	0.62 ±0.32	0.087	1	N/A	OU-3	0.4	0.4	Yes
Bismuth-214	pCi/g	44	43	0.14 ±0.16	0.73 ±0.19	0.052	0.23	0.57	OU-3	0.45	<BKG	No
Carbon-14	pCi/g	25	3	-4.6 ±8.3	11.3 ±4	0.58	12	0.87	OU-3	3.67	3.6	Yes
Cesium-137	pCi/g	44	11	-0.013 ±0.02	23 ±2.3	0.022	0.11	0.053	OU-1	5.89	5.8	Yes
Cobalt-60	pCi/g	44	0	-0.023 ±0.024	0.028 ±0.02	0.019	0.13	0.016	OU-3	0.01	<BKG	No
Lead-210	pCi/g	44	1	-2 ±7.9	5.4 ±9.4	0.93	16	N/A	OU-1	1.88	1.8	Yes
Lead-212	pCi/g	44	44	0.266 ±0.047	0.72 ±0.11	0.043	0.16	0.74	OU-3	0.56	<BKG	No
Lead-214	pCi/g	44	44	0.263 ±0.094	0.7 ±0.11	0.046	0.21	0.75	OU-3	0.53	<BKG	No
Plutonium-241	pCi/g	5	0	-0.4 ±2.4	1.5 ±2.5	2.1	3.9	N/A	OU-2	NC	1.5	Yes
Potassium-40	pCi/g	44	44	6.3 ±1.2	13 ±1.7	0.29	1.6	13.6	OU-3	11.63	<BKG	No
Radium-223	pCi/g	27	0	-0.35 ±0.2	0.47 ±0.68	0.48	1.7	N/A	OU-1	NC	0.47	Yes
Radium-226	pCi/g	75	38	-0.38 ±0.61	1.73 ±0.36	0.087	2	0.77	OU-2	NC	1.7	Yes
Strontium-90	pCi/g	44	17	-0.8 ±1.1	20.3 ±1.3	0.31	2	N/A	OU-1	6.94	6.9	Yes
Thallium-208	pCi/g	44	42	0.059 ±0.063	0.272 ±0.093	0.025	0.12	0.21	OU-3	0.17	<BKG	No
Thorium-228	pCi/g	1	1	0.55 ±0.13	0.55 ±0.13	0.11	0.11	0.71	OU-1	NC	<BKG	No
Thorium-230	pCi/g	1	1	0.57 ±0.11	0.57 ±0.11	0.034	0.034	0.8	OU-1	NC	<BKG	No
Thorium-232	pCi/g	1	1	0.51 ±0.11	0.51 ±0.11	0.037	0.037	0.64	OU-1	NC	<BKG	No
Thorium-234	pCi/g	44	0	0.03 ±0.75	0.94 ±0.43	0.85	6.4	N/A	OU-1	0.66	0.66	Yes
Tritium	pCi/g	2	1	-2.7 ±5	91.1 ±8.4	3.5	10	0.023	OU-1	NC	91	Yes
Uranium-233/234	pCi/g	1	1	0.489 ±0.08	0.489 ±0.08	0.026	0.026	0.66	OU-1	NC	<BKG	No
Uranium-235	pCi/g	45	1	-0.16 ±0.24	0.14 ±0.15	0.017	0.47	0.071	OU-3	0.03	<BKG	No
Uranium-238	pCi/g	1	1	0.418 ±0.073	0.418 ±0.073	0.018	0.018	0.63	OU-1	NC	<BKG	No

Table 2-2. Radionuclides of Potential Ecological Concern (ROPEC) in Surface Soil (0 to 3ft bgs).

Isotope	Units	Sitewide Number Sampled	Sitewide Number >MDA	Sitewide Minimum Activity a	Sitewide Maximum Activity	Sitewide Minimum MDA	Sitewide Maximum MDA	Background	Maximum Location	OU-specific 95% UCL	OU-specific RME	ROPEC?

pCi/g = Picocuries per gram.
MDA = Minimum detectable activity.
Background concentration calculations presented in Attachment B of the Draft Final Determination of Risk-Based Action Standards for DOE Areas (DOE, 1997b).
a = Negative value reported when background activity greater than measured activity.
NC = Not calculated, OU-specific data set <10 samples.
RME = Reasonable maximum exposure concentration of data for worst-case OU.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution for worst-case OU.
<BKG = Site concentration is lower than background, not a ROPEC.
N/A = Not available. No background data available for this analyte.
OU = Operable Unit.

Table 2-3. Contaminants of Potential Ecological Concern (COPEC) in Subsurface Soil (> or = 3ft bgs).

Analyte	Units	Sitewide Number Sampled	Sitewide Number Detected	Sitewide Min []	Sitewide Max []	Min Detection Limit	Max Detection Limit	Background	Max Location	OU-specific 95% UCL	OU-specific RME	COPEC ?
General Chemical												
Formaldehyde	mg/kg	73	2	1.4	2.2	1	1	N/A	OU-4	NC	2.2	Yes
Metals												
Antimony	mg/kg	84	13	0.25	2.2	0.22	1.2	0.74a	OU-1	0.94	0.94	Yes
Arsenic	mg/kg	96	96	0.84	9.7	1.9	10	9.46	OU-1	6.62	<BKG	No
Barium	mg/kg	96	96	13	270	9.7	200	237	OU-1	180.26	<BKG	No
Beryllium	mg/kg	85	78	0.26	0.55	0.97	5	0.66	OU-3	0.47	<BKG	No
Cadmium	mg/kg	96	7	0.27	7.1	0.98	1.5	0.46a	OU-1	NC	7.1	Yes
Chromium	mg/kg	144	144	7.1	300	2	47	178	OU-2	124.56	<BKG	No
Chromium, Hexavalent (+6)	mg/kg	128	26	0.034	0.29	0.2	0.5	0.099	OU-3	0.16	0.16	Yes
Cobalt	mg/kg	96	96	0.66	29	0.97	50	29	OU-1	21.73	<BKG	No
Copper	mg/kg	96	96	7.4	890	0.97	25	50	OU-1	104.46	100	Yes
Iron	mg/kg	96	96	520	46600	9.9	250	42000	OU-3	41319.32	<BKG	No
Lead	mg/kg	96	96	2.7	74	0.65	9.2	10.1	OU-1	13.16	13	Yes
Manganese	mg/kg	96	96	29	1010	2.9	76	720	OU-3	705.75	<BKG	No
Mercury	mg/kg	96	69	0.11	5.2	0.09	0.2	0.49	OU-1	0.65	0.65	Yes
Molybdenum	mg/kg	96	64	0.25	5.9	0.97	1.5	2b	OU-1	0.96	<BKG	No
Nickel	mg/kg	96	96	7	420	0.98	40	326	OU-1	238.98	<BKG	No
Selenium	mg/kg	96	24	0.46	1.6	0.99	5	1	OU-1	1.09	1.0	Yes
Silver	mg/kg	96	4	0.2	2.7	0.98	1	0.52a	OU-1	NC	2.7	Yes
Thallium	mg/kg	96	1	0.26	0.26	1.1	1.1	1.36a	OU-1	NC	<BKG	No
Vanadium	mg/kg	96	96	2.6	82	0.97	5	73	OU-1	61.16	<BKG	No
Zinc	mg/kg	96	96	15	730	3.9	92	82	OU-1	139.67	140	Yes
Pesticides and PCBs												
4,4'-DDD	mg/kg	97	22	0.00032	0.14	0.0033	0.035	N/A	OU-1	0.04	0.04	Yes
4,4'-DDE	mg/kg	97	8	0.00069	0.014	0.0036	0.0039	N/A	OU-1	NC	0.014	Yes

Table 2-3. Contaminants of Potential Ecological Concern (COPEC) in Subsurface Soil (> or = 3ft bgs).

Analyte	Units	Sitewide Number Sampled	Sitewide Number Detected	Sitewide Min []	Sitewide Max []	Min Detection Limit	Max Detection Limit	Background	Max Location	OU-specific 95% UCL	OU-specific RME	COPEC ?
Pesticides and PCBs												
4,4'-DDT	mg/kg	97	3	0.0018	0.0037	0.0036	0.0039	N/A	OU-1	NC	0.0037	Yes
Alpha-Chlordane	mg/kg	97	39	0.00056	1.7	0.0017	0.18	N/A	OU-1	0.19	0.19	Yes
Arochlor-1260	mg/kg	46	2	1	1.3	0.033	0.033	N/A	OU-1	NC	1.3	Yes
Dieldrin	mg/kg	97	7	0.00041	0.07	0.0034	0.0037	N/A	OU-1	NC	0.07	Yes
Endosulfan I	mg/kg	97	3	0.0002	0.002	0.0018	0.002	N/A	OU-1	NC	0.002	Yes
Endosulfan Sulfate	mg/kg	97	1	0.011	0.011	0.0036	0.0036	N/A	OU-1	NC	0.011	Yes
Gamma-Chlordane	mg/kg	97	39	0.00067	1.9	0.0017	0.18	N/A	OU-1	0.21	0.21	Yes
Heptachlor	mg/kg	97	7	0.0013	0.096	0.0017	0.0018	N/A	OU-1	NC	0.096	Yes
Heptachlor Epoxide	mg/kg	97	1	0.0013	0.0013	0.0018	0.0018	N/A	OU-1	NC	0.0013	Yes
Methoxychlor	mg/kg	97	1	0.0011	0.0011	0.018	0.018	N/A	OU-1	NC	0.0011	Yes
Semivolatile Organics												
2-Methylnaphthalene	mg/kg	125	5	0.16	1900	0.34	1800	N/A	OU-1	NC	1900	Yes
Acenaphthene	mg/kg	125	5	0.44	3300	0.37	1800	N/A	OU-1	NC	3300	Yes
Anthracene	mg/kg	125	7	0.021	1500	0.37	1800	N/A	OU-1	NC	1500	Yes
Benzo(a)anthracene	mg/kg	125	9	0.022	660	0.33	1800	N/A	OU-1	NC	660	Yes
Benzo(a)pyrene	mg/kg	125	7	0.029	140	0.37	18	N/A	OU-1	NC	140	Yes
Benzo(b)fluoranthene	mg/kg	125	6	0.054	96	0.37	1800	N/A	OU-1	NC	96	Yes
Benzo(g,h,i)perylene	mg/kg	125	4	0.044	8.8	0.38	6.7	N/A	OU-2	NC	8.8	Yes
Benzo(k)fluoranthene	mg/kg	125	6	0.027	36	0.37	18	N/A	OU-1	NC	36	Yes
Bis(2-Ethylhexyl)phthalate	mg/kg	124	43	0.019	7.8	0.33	2.6	N/A	OU-2	0.82	0.82	Yes
Carbazole	mg/kg	125	5	0.099	410	0.34	18	N/A	OU-1	NC	410	Yes
Chrysene	mg/kg	125	11	0.019	630	0.33	1800	N/A	OU-1	NC	630	Yes
Di-n-Butylphthalate	mg/kg	125	4	0.031	1.2	0.35	1.2	N/A	OU-2	NC	1.2	Yes
Di-n-Octylphthalate	mg/kg	125	2	0.021	0.037	0.36	0.38	N/A	OU-1	NC	0.037	Yes
Dibenzo(a,h)anthracene	mg/kg	125	5	0.052	18	0.34	18	N/A	OU-1	NC	18	Yes

Table 2-3. Contaminants of Potential Ecological Concern (COPEC) in Subsurface Soil (> or = 3ft bgs).

Analyte	Units	Sitewide Number Sampled	Sitewide Number Detected	Sitewide Min []	Sitewide Max []	Min Detection Limit	Max Detection Limit	Background	Max Location	OU-specific 95% UCL	OU-specific RME	COPEC ?
Semivolatile Organics												
Dibenzofuran	mg/kg	125	5	0.34	2100	0.34	1800	N/A	OU-1	NC	2100	Yes
Diethyl Phthalate	mg/kg	125	1	0.12	0.12	0.4	0.4	N/A	OU-2	NC	0.12	Yes
Fluoranthene	mg/kg	125	10	0.026	4000	0.33	1800	N/A	OU-1	NC	4000	Yes
Fluorene	mg/kg	125	5	0.54	3100	0.34	1800	N/A	OU-1	NC	3100	Yes
Indeno(1,2,3-cd)pyrene	mg/kg	125	5	0.045	27	0.38	18	N/A	OU-1	NC	27	Yes
Naphthalene	mg/kg	125	5	0.12	2600	0.34	1800	N/A	OU-1	NC	2600	Yes
Pentachlorophenol	mg/kg	125	2	0.63	0.66	6.4	6.4	N/A	OU-1	NC	0.66	Yes
Phenanthrene	mg/kg	125	10	0.026	9500	0.34	1800	N/A	OU-1	NC	9500	Yes
Pyrene	mg/kg	125	12	0.023	3900	0.33	1800	N/A	OU-1	NC	3900	Yes
Volatile Organics												
2-Butanone	mg/kg	117	9	0.003	0.008	0.011	0.012	N/A	OU-2	NC	0.008	Yes
2-Hexanone	mg/kg	118	1	0.075	0.075	0.0099	0.0099	N/A	OU-1	NC	0.075	Yes
Acetone	mg/kg	82	32	0.003	1.2	0.0099	1.2	N/A	OU-1	0.23	0.23	Yes
Benzene	mg/kg	133	7	0.001	0.005	0.00099	0.012	N/A	OU-2	NC	0.005	Yes
Carbon Tetrachloride	mg/kg	118	1	0.004	0.004	0.012	0.012	N/A	OU-1	NC	0.004	Yes
Ethylbenzene	mg/kg	133	1	1.2	1.2	1.2	1.2	N/A	OU-1	NC	1.2	Yes
Methylene Chloride	mg/kg	118	1	0.004	0.004	0.011	0.011	N/A	OU-1	NC	0.004	Yes
Styrene	mg/kg	118	1	0.8	0.8	1.2	1.2	N/A	OU-1	NC	0.8	Yes
Toluene	mg/kg	133	4	0.0017	0.49	0.00098	0.012	N/A	OU-1	NC	0.49	Yes
Xylenes (Total)	mg/kg	118	2	0.003	6.2	0.01	1.2	N/A	OU-1	NC	6.2	Yes

Table 2-3. Contaminants of Potential Ecological Concern (COPEC) in Subsurface Soil (> or = 3ft bgs).

Analyte	Units	Sitewide Number Sampled	Sitewide Number Detected	Sitewide Min []	Sitewide Max []	Min Detection Limit	Max Detection Limit	Background	Max Location	OU-specific 95% UCL	OU-specific RME	COPEC ?

Min [] = Minimum detected concentration in data set.
Max [] = Maximum detected concentration in data set.
Background concentration calculations presented in Attachment B of the Draft Final Determination of Risk-Based Action Standards for DOE Areas (DOE, 1997b).
OU = Operable Unit
a = Twice the maximum detected value from the background data set.
b = Detection limit of background data set (no concentrations detected).
NC = Not calculated, OU-specific data set <10 samples.
RME = Reasonable maximum exposure concentration of data for worst-case OU.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution for worst-case OU.
<BKG = Site concentration is lower than background, not a COPEC.
N/A = Not available. No background data available for this analyte.
mg/kg = milligrams per kilogram

Table 2-4. Radionuclides of Potential Ecological Concern (ROPEC) in Subsurface Soil (> or = 3ft bgs).

Isotope	Units	Sitewide Number Sampled	Sitewide Number >MDA	Sitewide Minimum Activity a	Sitewide Maximum Activity	Sitewide Minimum MDA	Sitewide Maximum MDA	Background	Maximum Location	OU-specific 95% UCL	OU-specific RME	ROPEC?
Radionuclides												
Actinium-228	pCi/g	119	109	-0.53 ±0.47	5.5 ±6	0.089	9.1	0.71	OU-1	0.69	<BKG	No
Americium-241	pCi/g	50	25	0 ±0	0.95 ±0.42	0.01	0.22	N/A	OU-2	0.07	0.07	Yes
Bismuth-212	pCi/g	119	46	-2.9 ±5.1	1.5 ±6.6	0.072	18	N/A	OU-1	0.32	0.32	Yes
Bismuth-214	pCi/g	119	113	-1.3 ±1.2	6.52 ±0.57	0.05	6.3	0.57	OU-2	1.51	1.5	Yes
Carbon-14	pCi/g	100	2	-6.3 ±5.3	117 ±14	3	37	0.87	OU-1	3.32	3.3	Yes
Cesium-137	pCi/g	119	5	-0.81 ±0.74	0.434 ±0.082	0.021	2.4	0.053	OU-2	0.04	<BKG	No
Cobalt-60	pCi/g	119	0	-0.44 ±0.74	0.07 ±0.16	0.019	2.4	0.016	OU-1	0.0	<BKG	No
Lead-210	pCi/g	119	13	-49 ±88	61 ±98	0.91	160	N/A	OU-1	3.37	3.3	Yes
Lead-212	pCi/g	118	111	-1 ±3.1	1.2 ±1.2	0.043	4.7	0.74	OU-1	0.51	<BKG	No
Lead-214	pCi/g	118	112	-0.6 ±1.2	7.73 ±0.6	0.046	4.8	0.75	OU-2	1.79	1.7	Yes
Plutonium-241	pCi/g	50	0	-2.1 ±2.5	2.1 ±2.1	2	4.7	N/A	OU-2	0.38	0.38	Yes
Potassium-40	pCi/g	118	111	-2 ±4.4	16.7 ±2.2	0.29	38	13.6	OU-1	10.38	<BKG	No
Radium-223	pCi/g	98	0	-9 ±12	0.37 ±0.36	0.4	38	N/A	OU-2	0.05	0.05	Yes
Radium-226	pCi/g	246	194	-3 ±18	106.2 ±5.8	0.043	47	0.77	OU-2	4.69	4.6	Yes
Strontium-90	pCi/g	148	80	-0.5 ±0.47	16700 ±840	0.22	35	N/A	OU-1	848.95	850	Yes
Thallium-208	pCi/g	118	108	-1.7 ±1.9	0.6 ±1.4	0.022	3.1	0.21	OU-1	0.17	<BKG	No
Thorium-228	pCi/g	2	2	0.71 ±0.14	0.76 ±0.13	0.09	0.092	0.71	OU-1	NC	0.76	Yes
Thorium-230	pCi/g	2	2	0.54 ±0.11	0.66 ±0.11	0.042	0.044	0.8	OU-1	NC	<BKG	No
Thorium-232	pCi/g	2	2	0.496 ±0.1	0.71 ±0.11	0.033	0.04	0.64	OU-1	NC	0.71	Yes
Thorium-234	pCi/g	119	2	-10 ±24	39.5 ±7.7	0.85	75	N/A	OU-1	2.35	2.3	Yes
Tritium	pCi/g	7	0	-2.2 ±5.2	2.8 ±2.7	1.6	20	0.023	OU-1	NC	2.8	Yes
Uranium-233/234	pCi/g	2	2	0.461 ±0.08	0.616 ±0.092	0.026	0.033	0.66	OU-1	NC	<BKG	No
Uranium-235	pCi/g	120	2	-7.8 ±5.8	2.6 ±3.2	0.017	11	0.071	OU-1	0.12	0.12	Yes
Uranium-238	pCi/g	2	2	0.511 ±0.082	0.556 ±0.087	0.017	0.025	0.63	OU-1	NC	<BKG	No

Table 2-4. Radionuclides of Potential Ecological Concern (ROPEC) in Subsurface Soil (> or = 3ft bgs).

Isotope	Units	Sitewide Number Sampled	Sitewide Number >MDA	Sitewide Minimum Activity a	Sitewide Maximum Activity	Sitewide Minimum MDA	Sitewide Maximum MDA	Background	Maximum Location	OU-specific 95% UCL	OU-specific RME	ROPEC?

pCi/g = Picocuries per gram.
MDA = Minimum detectable activity.
Background concentration calculations presented in Attachment B of the Draft Final Determination of Risk-Based Action Standards for DOE Areas (DOE, 1997b).
a = Negative value reported when background activity greater than measured activity.
NC = Not calculated, OU-specific data set <10 samples.
RME = Reasonable maximum exposure concentration of data for worst-case OU.
95% UCL = 95% upper confidence level of the mean of detected data, assuming normal distribution for worst-case OU.
<BKG = Site concentration is lower than background, not a ROPEC.
N/A = Not available. No background data available for this analyte.
OU = Operable Unit.

Table 2-5. Identification of Contaminants of Potential Ecological Concern (COPEC) in Surface Water.

Analyte	Units	Putah Creek Upstream (PCU) Max []	Putah Creek Downstream (PCD) Max []	UCD Treatment Plant Outfall (STPO) Max []	Site Storm Water (SWL-1, SWL-2) Max []	USEPA Water Quality Criteria a, b	Site Surface Soil above BKG?	Decision Code	COPEC?
General Chemical									
Formaldehyde	mg/L	ND <500	0.37	2.1	ND <1	None	Yes	5	Yes
Metals									
Antimony	mg/L	0.1	0.07	0.11	0.156	0.088	No	1	No
Arsenic	mg/L	0.0065	0.0074	0.0074	0.0016	0.360	No	1	No
Barium	mg/L	0.114	0.12	0.147	0.0097	None	No	1	No
Beryllium	mg/L	0.006	0.006	0.006	ND <0.02	None	No	1	No
Cadmium	mg/L	0.002	0.002	0.002	ND <0.001	0.011	No	1	No
Chromium	mg/L	0.06	0.08	0.11	0.0072	0.180 h	Yes	2	Yes
Chromium, Hexavalent (+6)	mg/L	0.043	0.042	0.045	0.01	0.015	Yes	2	Yes
Cobalt	mg/L	0.01	0.0012	0.002	ND <0.01	None	No	1	No
Copper	mg/L	0.04	0.05	0.03	0.0098	0.040	Yes	2	Yes
Iron	mg/L	0.301	0.317	0.506	0.909	1.0	No	1	No
Lead	mg/L	0.0073	0.01	0.0112	0.0384	0.170	Yes	2	Yes
Manganese	mg/L	0.0124	0.0132	0.0218	0.0192	None	Yes	1	No
Mercury	mg/L	0.0009	0.00027	0.00063	ND <0.0002	0.0021	Yes	4	No
Molybdenum	mg/L	0.06	0.05	0.11	ND <0.01	None	No	1	No
Nickel	mg/L	0.07	0.31	0.13	0.006	3.1	No	1	No
Selenium	mg/L	ND <0.01	0.0038	0.054	ND <0.003	0.020	No	1	No
Silver	mg/L	ND <0.04	0.08	0.08	ND <0.01	0.016	No	1	No
Thallium	mg/L	0.09	0.08	0.1	ND <0.01	0.040	No	1	No
Vanadium	mg/L	0.0134	0.02	0.0123	0.0029	None	No	1	No
Zinc	mg/L	0.06	1.19	0.1	0.112	0.250	Yes	2	Yes
Pesticides and PCBs									
4,4'-DDD	mg/L	0.000022	0.000093	0.000051	ND <0.000022	0.0011 e	Yes	4	No
4,4'-DDE	mg/L	0.000005	0.000005	0.000012	ND <0.000022	0.0011 e	Yes	4	No
4,4'-DDT	mg/L	0.000015	ND <0.0001	ND <0.0001	ND <0.000022	0.0011 c	No	1	No
Aldrin	mg/L	ND <0.00005	0.000037	0.000015	ND <0.000011	0.003 c	No	1	No
Alpha-BHC	mg/L	0.000055	0.000038	0.000042	ND <0.000011	0.0020 f	Yes	4	No

Table 2-5. Identification of Contaminants of Potential Ecological Concern (COPEC) in Surface Water.

Analyte	Units	Putah Creek Upstream (PCU) Max []	Putah Creek Downstream (PCD) Max []	UCD Treatment Plant Outfall (STPO) Max []	Site Storm Water (SWL-1, SWL-2) Max []	USEPA Water Quality Criteria a, b	Site Surface Soil above BKG?	Decision Code	COPEC?
Pesticides and PCBs									
Alpha-Chlordane	mg/L	ND <0.00005	ND <0.000051	0.000017	0.000015	0.0024 d	Yes	2	Yes
Beta-BHC	mg/L	0.000024	0.000008	0.000042	ND <0.000011	0.0020 f	No	1	No
Delta-BHC	mg/L	0.000055	0.000012	0.00035	ND <0.000011	0.0020 f	Yes	4	No
Dieldrin	mg/L	0.000015	0.000043	0.000027	ND <0.000022	0.0025 c	No	1	No
Endosulfan I	mg/L	0.000103	0.000062	0.000055	ND <0.000011	0.00022 c	No	1	No
Endosulfan II	mg/L	0.000007	ND <0.0001	0.000007	ND <0.000022	0.00022 c	No	1	No
Endrin	mg/L	ND <0.0001	ND <0.0001	0.000056	ND <0.000022	None	No	1	No
Endrin Aldehyde	mg/L	ND <0.0001	0.000041	ND <0.0001	ND <0.000022	None	No	1	No
Gamma-BHC	mg/L	0.000026	0.000019	0.000066	ND <0.000011	0.0020 c	Yes	4	No
Gamma-Chlordane	mg/L	ND <0.00005	ND <0.000051	ND <0.00005	0.000013	0.0024 d	Yes	2	Yes
Heptachlor	mg/L	0.000026	0.000032	0.000018	ND <0.000011	0.00052 c	Yes	4	No
Semivolatile Organics									
2-Chlorophenol	mg/L	ND <0.012	ND <0.011	0.0046	ND <0.01	None	No	1	No
4-Nitrophenol	mg/L	ND <0.029	ND <0.029	ND <0.029	0.0008	None	No	1	No
Benzyl Butyl Phthalate	mg/L	ND <0.012	ND <0.011	ND <0.012	0.002	0.003	No	1	No
Bis(2-Chloroisopropyl)Ether	mg/L	ND <0.0057	0.0036	0.0057	NS	None	No	1	No
Bis(2-Ethylhexyl)phthalate	mg/L	0.021	0.0126	0.021	0.001	0.360	Yes	2	Yes
Di-n-Butylphthalate	mg/L	0.13	0.059	0.0049	ND <0.01	None	Yes	5	Yes
Diethyl Phthalate	mg/L	0.002	0.001	0.001	ND <0.01	None	No	1	No
Pyrene	mg/L	ND <0.012	ND <0.011	ND <0.012	0.0007	None	No	1	No
Volatile Organics									
1,1,1-Trichloroethane	mg/L	ND <0.0038	ND <0.0038	0.00033	ND <0.001	None	No	1	No
Acetone	mg/L	0.02	0.018	0.036	0.017	None	Yes	2	Yes
Benzene	mg/L	ND <0.0044	ND <0.0044	ND <0.0044	0.0001	None	No	1	No
Bromochloromethane	mg/L	ND <0.001	ND <0.001	0.00098	ND <0.001	None	No	1	No
Bromodichloromethane	mg/L	0.0071	0.0058	0.013	ND <0.001	None	No	1	No
Bromoform	mg/L	ND <0.0047	0.0012	0.0075	0.0003	None	No	1	No
Chloroform	mg/L	0.019	0.014	0.033	ND <0.001	1.240 g	No	1	No

Table 2-5. Identification of Contaminants of Potential Ecological Concern (COPEC) in Surface Water.

Analyte	Units	Putah Creek Upstream (PCU) Max []	Putah Creek Downstream (PCD) Max []	UCD Treatment Plant Outfall (STPO) Max []	Site Storm Water (SWL-1, SWL-2) Max []	USEPA Water Quality Criteria a, b	Site Surface Soil above BKG?	Decision Code	COPEC?
Volatile Organics									
Dibromochloromethane	mg/L	0.0027	0.0034	0.0091	ND <0.001	None	No	1	No
Ethylbenzene	mg/L	ND <0.0072	ND <0.0072	ND <0.0072	0.0007	0.00018	No	1	No
Methylene Chloride	mg/L	ND <0.0028	0.0033	0.04	ND <0.002	5.5	No	1	No
Toluene	mg/L	ND <0.006	0.0017	ND <0.006	0.00099	None	No	1	No
Xylenes (total)	mg/L	ND <0.001	ND <0.001	ND <0.001	0.0008	None	No	1	No

Table 2-5. Identification of Contaminants of Potential Ecological Concern (COPEC) in Surface Water.

Analyte	Units	Putah Creek Upstream (PCU) Max []	Putah Creek Downstream (PCD) Max []	UCD Treatment Plant Outfall (STPO) Max []	Site Storm Water (SWL-1, SWL-2) Max []	USEPA Water Quality Criteria a, b	Site Surface Soil above BKG?	Decision Code	COPEC?

Notes:
Max [] = Maximum detected concentration in data set.
UCD = University of California, Davis.
a = United States Environmental Protection Agency (USEPA) National Ambient Water Quality Criteria (AWQC) Freshwater Aquatic Life Protection maximum concentration, 1 hour average, April 1996 and California Inland Surfce Water Plan, Aquatic Life Protection maximum concentration, 1 hour average.
In case of discrepancy between Federal and State, lower concentration reported.
b = Metals concentrations based on average surface water hardness of 250 mg/L CaCO3.
c = Instantaneous maximum value.
d = Ambient Water Quality Criteria reported for Chlordane. Chlordane is comprised of alpha and gamma isomers.
e = Concentration for DDT used.
f = Concentration for g-BHC (Lindane) reported.
g = Value set at chronic toxicity level, USEPA AWQC.
h = Value for Chromium III reported, USEPA AWQC.
NS = Not sampled.
BKG = Background concentration, presented in attachment B of the Draft Final Determination of Risk-Based Action Standards for DOE Areas (DOE, 1997b).

Assumptions/Limitations:
Data set used for surface water analysis based on sampling events from 11/9/90 to 5/29/96.
Data set used for Site storm water based on sampling events from 11/15/94 to 3/12/96.
Contract required detection limits reported, instrument detection limits may be lower.
Constituents present in soils at >3ft bgs do not contribute to surface water discharge to Putah Creek.

Decision Codes:
1 = Not present above BKG or method detection limits in site surface soils. Not considered a COPEC.
2 = Detected in site soil and detected in storm water. Considered a COPEC.
3 = Detected in site soil, not detected in storm water and method detection limit > Ambient Water Quality Criteria. Considered a COPEC.
4 = Detected in site soil, not detected in storm water and method detection limit < Ambient Water Quality Criteria. Not considered a COPEC.
5 = Detected in site soil, not detected in storm water and no Ambient Water Quality Criteria. Considered a COPEC.

Table 2-6. Identification of Radionuclides of Potential Ecological Concern (ROPEC) in Surface Water.

Isotope	Units	Putah Creek Upstream (PCU) Maximum Activity ±Error a	Putah Creek Downstream (PCD) Maximum Activity ±Error	UCD Treatment Plant Outfall (STPO) Maximum Activity ±Error	Site Storm Water (SWL-1, SWL-2) Maximum Activity ±Error	USEPA Water Quality Criteria b	Site Surface Soil >MDA	Decision Code	ROPEC ?
Radionuclides									
Actinium-228	pCi/L	17.8 ±7	12 ±22	7.4 ±9.6	18 ±21	None	Yes	2	Yes
Americium-241	pCi/L	0.039 ±0.035	0.051 ±0.038	0.097 ±0.075	0.033 ±0.027	None	Yes	2	Yes
Bismuth-212	pCi/L	14 ±16	9 ±42	5 ±38	33 ±49	None	Yes	2	Yes
Bismuth-214	pCi/L	21 ±14	33 ±47	17.2 ±6.1	4 ±12	None	Yes	2	Yes
Carbon-14	pCi/L	122 ±31	68 ±56	88 ±82	32 ±83	None	Yes	2	Yes
Cesium-134	pCi/L	1.7 ±3.5	2 ±15	1.8 ±3.6	1.4 ±4	None	No	1	No
Cesium-137	pCi/L	2.7 ±1.9	2.8 ±4.9	2.6 ±5.1	4.1 ±6.3	None	Yes	2	Yes
Cobalt-57	pCi/L	1 ±2.5	6.2 ±9.9	1.2 ±2.4	1 ±2.7	None	No	1	No
Cobalt-60	pCi/L	7 ±17	2.5 ±3.9	5.9 ±4.8	2.7 ±3.9	None	No	1	No
Lead-210	pCi/L	160 ±250	190 ±290	90 ±280	100 ±290	None	Yes	2	Yes
Lead-212	pCi/L	16 ±47	33 ±40	4.8 ±5.3	6.6 ±9.5	None	Yes	2	Yes
Lead-214	pCi/L	15 ±4.9	17.5 ±5.3	12.9 ±4.9	7 ±11	None	Yes	2	Yes
Plutonium-241	pCi/L	7.2 ±3.3	1 ±2.5	6.7 ±2.9	1 ±3	None	No	1	No
Potassium-40	pCi/L	320 ±330	41 ±73	42 ±77	42 ±71	None	Yes	2	Yes
Radium-223	pCi/L	-28 ±7.1	33 ±20	13 ±19	NS	None	No	1	No
Radium-226	pCi/L	10 ±120	0.86 ±0.24	31 ±56	90 ±120	None	Yes	2	Yes
Strontium-90	pCi/L	6.9 ±3.1	4.2 ±3.2	5.4 ±3.2	0.24 ±0.34	None	Yes	1	No
Thallium-208	pCi/L	22 ±32	16 ±25	6.3 ±7.1	7.4 ±7.6	None	Yes	2	Yes
Thorium-234	pCi/L	50 ±120	330 ±310	40 ±100	36 ±71	None	No	1	No
Tritium	pCi/L	1341 ±604	2030 ±320	1724 ±512	150 ±220	None	Yes	2	Yes
Uranium-235	pCi/L	15 ±27	40 ±110	17 ±25	14 ±27	None	Yes	2	Yes

Table 2-6. Identification of Radionuclides of Potential Ecological Concern (ROPEC) in Surface Water.

Isotope	Units	Putah Creek Upstream (PCU) Maximum Activity ±Error a	Putah Creek Downstream (PCD) Maximum Activity ±Error	UCD Treatment Plant Outfall (STPO) Maximum Activity ±Error	Site Storm Water (SWL-1, SWL-2) Maximum Activity ±Error	USEPA Water Quality Criteria b	Site Surface Soil >MDA	Decision Code	ROPEC ?

Notes:
a = Negative value reported when background activity is greater than measured activity.
b = US Environmental Protection Agency National Ambient Water Quality Criteria (AWQC) Freshwater Aquatic Life Protection maximum concentration, 1 hour average, April 1996 and California Inland Surface Water Plan, Aquatic Life Protection maximum concentration, 1 hour coverage.
In case of discrepancy between Federal and State, lower concentration reported.
NS = Not sampled.
MDA = Minimum detectable activity.
pCi/L = Picocuries per liter.

Assumptions/Limitations:
Data set used for surface water analysis based in sampling events from 11/9/90 to 5/29/96.
Data set used for Site storm water based on sampling events from 11/15/94 to 3/12/96.
ContractrRequired detection limits reported and used in surface soil MDA evaluation, instrument detection limits may be lower.
Constituents present in soils at >3ft bgs do not contribute to surface water discharge to Putah Creek.

Decision Codes:
1 = Not present above BKG in site surface soils. Not considered a ROPEC.
2 = Present in site soils above BKG and detected in storm water. Considered a ROPEC.

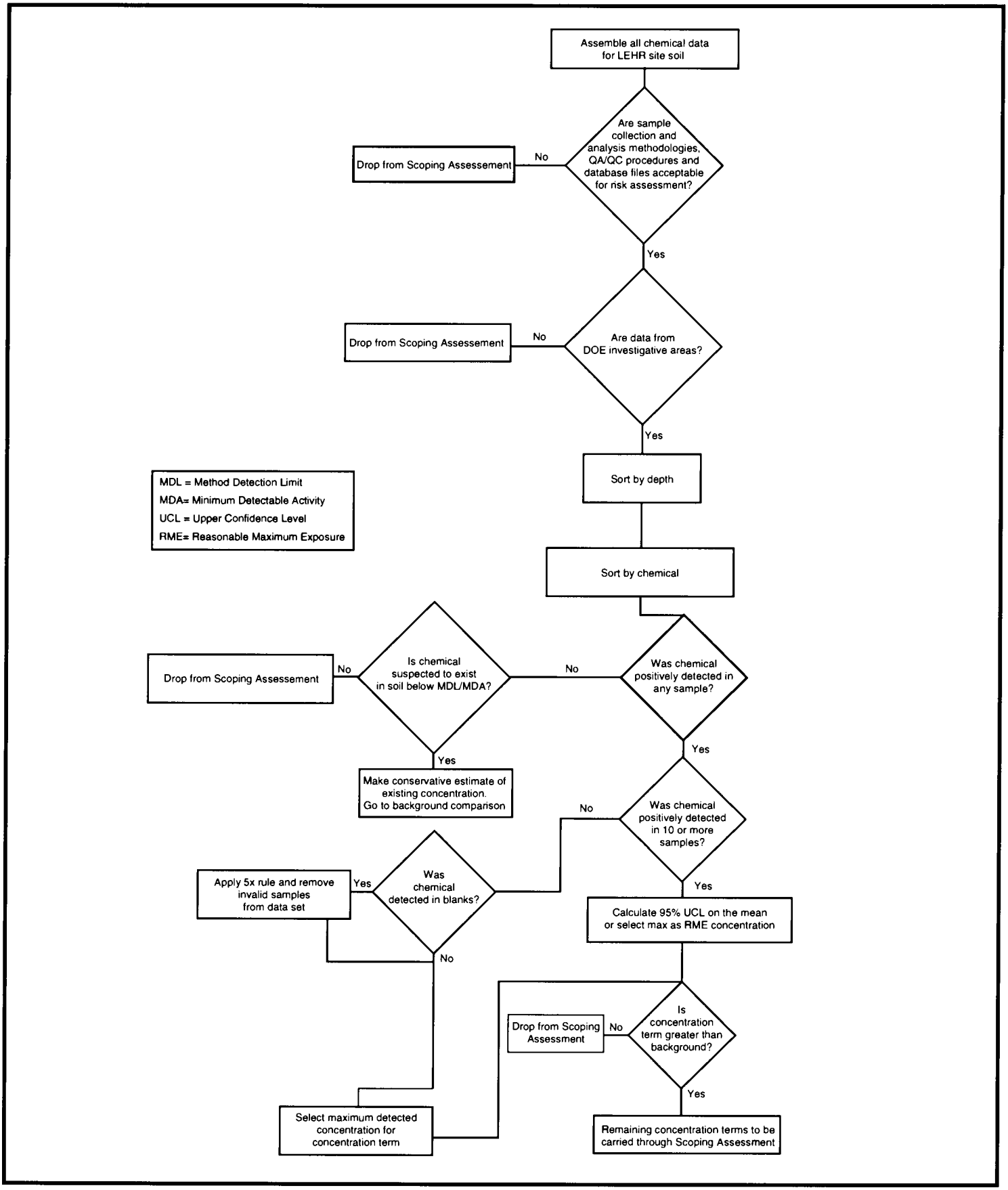
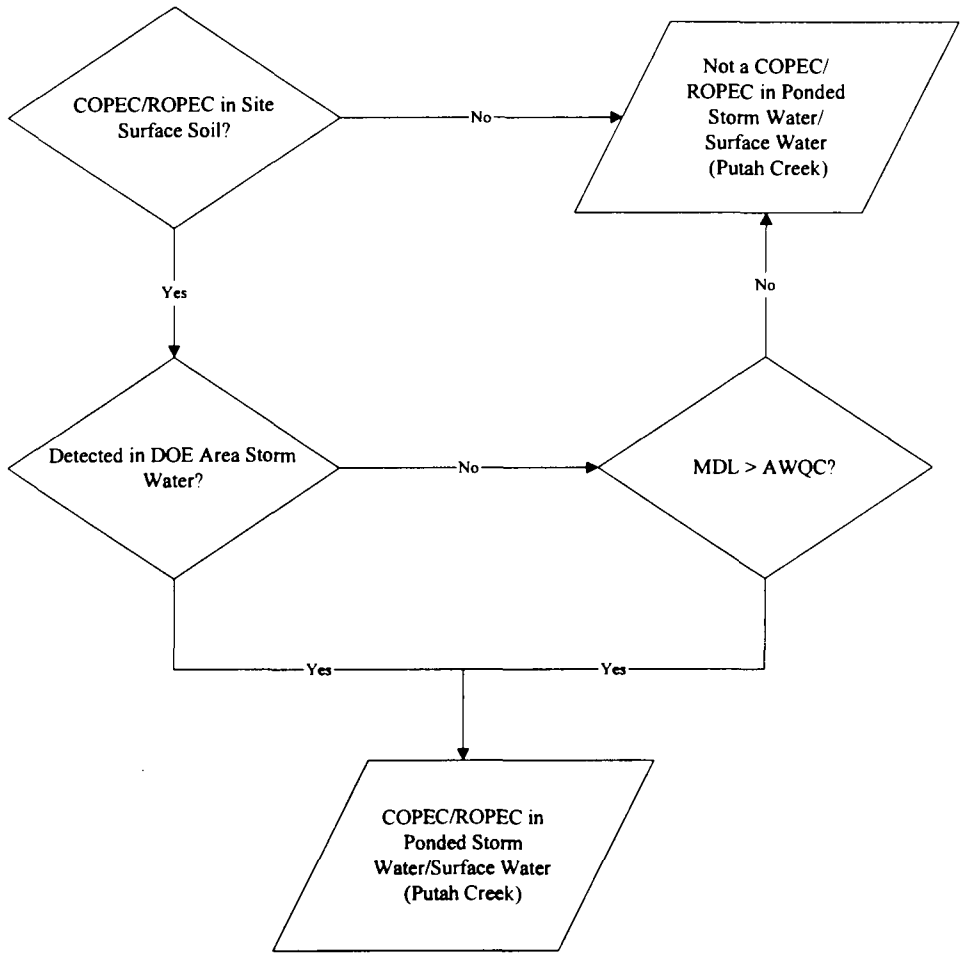


Figure 2-1. Flowchart for Determining the Soil Concentration Term to be Carried Through the Ecological Scoping Assessment.

Weiss Associates



MDL = Method Detection Limit
COPEC = Chemical of Potential Ecological Concern
ROPEC = Radionuclide of Potential Ecological Concern
AWQC = Ambient Water Quality Criteria

Figure 2-2. Identification of COPECs/ROPECs in Ponded Storm Water and Surface Water (Putah Creek).

J:\DOE\4000\A1C\PROTOCOLS\DRAWINGS\FIG2_2a.VSD 07/30/97

3. BIOLOGICAL CHARACTERIZATION

3.1 Introduction

This section describes the next stage of the Ecological Scoping Assessment, the biological characterization of the Site. The objective of the biological characterization is to delineate ecosystems and determine if potential ecological receptors exist within the study area. Results of this characterization will provide the basis for the potential exposure pathway analysis conducted in Section 4 of this report.

In conformance with National Environmental Protection Act (NEPA) guidelines (DOE, 1993) and DTSC guidelines (DTSC, 1996a, b), a biological characterization of the Site and vicinity was performed. Terrestrial and aquatic biologists assisted in the collection of field data. This biological characterization includes:

- Identification and evaluation of plant communities and habitats;
- Identification and evaluation of terrestrial and aquatic communities;
- Characterization of spatial and temporal distribution of ecological components (i.e. habitat distribution, home range areas, seasonal migration habits, etc.); and
- Assessment of ecosystem attributes influencing the distribution and nature of contamination.

Inventories of special status plant and animal species known or expected to occur at the Site and vicinity are presented in Tables 3-1 and 3-2 at the end of this section. Detailed maps of vegetation/habitats and locations of special status species on the Site and within a one mile radius are presented in Figure 3-1 and 3-2, respectively. Photographs of several vegetation/habitat types and evidence of animal habitation of the Site and vicinity appear in Figures 3-3 through 3-8. Preliminary tabulated inventories of expected and/or detected plant and animal species, locally housed raptors and Putah Creek fish species are presented in Attachments C, D, E, and G of this report. Explanations of special status sensitivity codes are presented in Attachment F and field observation notes are presented in Attachment H.

3.2 Methods

3.2.1 Database Search

Prior to Site reconnaissance, lists of special status plant and animal species and habitats were compiled through a review of the following resources:

- California Natural Diversity Data Base (CNDDB);
- California Native Plant Society's inventory of rare and endangered vascular plants of California (Skinner and Pavlik, 1995);
- UC Davis Long Range Development Plan - Environmental Impact Report (EIR) (UC Davis, 1994);
- UC Davis Wastewater Treatment Plant Replacement Project (WTPRP) EIR (UC Davis, 1996);
- California Department of Fish and Game's (CDFG) Special Plant list, Special Animal list and Endangered, Threatened and Rare Animals of California and Endangered and Threatened and Rare Plants of California (CDFG, 1996; CDFG, 1994; CDFG, 1997a; CDFG, 1997b);
- U.S. Fish and Wildlife Service's (USFWS) Endangered and Threatened Wildlife and Plants (USFWS, 1994), and Endangered and Threatened Species Plant and Animal Taxa; Proposed Rule (USFWS, 1996);
- Bird Species of Special Concern in California: an Annotated List of Declining or Vulnerable Bird Species (Remsen, 1978);
- Mammalian Species of Special Concern in California (Williams, 1986);
- Amphibian and Reptile Species of Special Concern in California (Jennings and Hayes, 1994);
- Fish Species of Special Concern in California (Moyle *et al.*, 1995); and
- Interviews with U.S. Fish and Wildlife Service staff.

Results of the database search are shown in Tables 3-1 and 3-2 and were used to target special status species and habitats during Site reconnaissance.

3.2.2 Field Reconnaissance

A field survey was conducted to characterize and describe aquatic and terrestrial habitats and actual or potential ecological receptors at the Site including:

- Identification of Site-specific terrestrial and wetland habitats and their relative extent;

- Evaluation of off-site habitats within one mile of the Site that may be affected by Site-related contamination or remediation activities;
- Identification of wildlife areas, preserves, parks etc. within one mile of the Site;
- Identification of species and/or signs of species activity at the Site (i.e. tracks, nests, burrows, etc.);
- Identification of special status species and habitats observed at or near the Site;
- Identification of types of communities present; and
- Identification of species indicative of normal functioning of ecosystems potentially present on-site.

Terrestrial surveys of the Site and vicinity were conducted on January 14 and January 29-30, 1997. Daytime and nighttime wildlife surveys were conducted on January 29 and February 11, 1997. Aquatic and riparian habitat surveys were conducted on January 17. Surveys were conducted by walking parallel transects over the entire Site. Day and night surveys were conducted to identify wildlife species active during different times of the day. The assessment of all distinct habitats within a one-mile radius of the Site was performed by conducting a combination of windshield and foot surveys. Distinctive habitats such as water bodies, marshes, woodlands and uncultivated lands were surveyed in more detail on foot. A visual survey of off-site aquatic habitats associated with the South Fork of Putah Creek was conducted by walking both banks upstream and downstream from the Site. All identifiable plant species and animal observations were recorded and habitats mapped. Field notes from these surveys are presented in Attachment H of this report.

The intent of this survey was to provide a reconnaissance-level evaluation of on-site and off-site habitat types. The surveys were conducted during a single season (winter) and may not be optimal for the detection of all commonly occurring plant and wildlife species. Neither focused plant or wildlife surveys nor animal trapping studies were performed as part of this study. The surveys were not intended to conform to survey protocols for potentially occurring special-status animal species. Furthermore, walking detailed transects over the off-site study area was not warranted because much of these areas consist of actively cultivated fields. A combination of windshield and foot surveys was adequate to characterize these areas.

Due to the timing of the reconnaissance surveys, this study does not conform with CDFGs Guidelines for assessing the effects of proposed developments on rare and endangered plants and plant communities (CDFG, 1984). In addition, due to high water levels of the South Fork of Putah Creek at the time of the survey, thorough sampling of fish and benthic macroinvertebrates was not practical. Even if sampling had been possible, species abundance and diversity would have been low due to the volume and velocity of water flowing in the creek (Molles, 1985; Erman *et al.*, 1988). During high flows when volume and velocity of water are high, fish tend to disperse to find shelter, making meaningful sampling extremely difficult. Instead, an extensive search for historical data on fish and invertebrates for Putah Creek was conducted. Sources include published literature and personal communications with regional

experts and agency officials. Over a period of 15 years from 1980 to 1995, researchers and students at UC Davis have established an extensive list of fish species occurring along the lower reaches of Putah Creek (UC Davis, 1996). Because these data have been compiled over a period of many years, they provide a more complete assessment of the fish populations of Putah Creek than could have been achieved during a single season survey.

3.3 Physical Setting

The Site is located in a rural area in the Sacramento Valley (Figure 1-1). The land within a one-mile radius of the Site is owned both privately and by UC Davis, and is used for animal research, agriculture, and recreation. Immediately adjacent to the Site to the east and west are UC Davis-owned research facilities. Privately-owned lands within one mile to the south and east of the Site include permanent residences and agricultural properties. Approximately 75 percent of the surrounding land in the general vicinity of the Site are used for agriculture. Major crops include fruits, nuts, and grains. Approximately 40 percent of the agricultural land in the Site vicinity is irrigated, and some of the nearby lands are used for cattle grazing (DOE, 1988).

The Site and adjacent areas lie within the Californian Floristic biotic province (Munz and Keck, 1968). A biotic province is defined as an area which "covers a considerable and continuous geographic area and is characterized by the occurrence of one or more important ecological associations that differ, at least in proportional area covered, from the ecological associations of adjacent provinces. In general, biotic provinces are characterized also by peculiarities of vegetation type, ecological climax, flora, fauna, climate, physiography, and soil (Dice, 1943). The Californian biotic province encompasses the area of California west of the Sierra Nevada and the southern mountains. It includes the interior valleys and surrounding hills in the central and northern parts of the state, the southern coastal area, and the Coast Range south of San Francisco Bay (Munz and Keck, 1968).

Although no streams, wetlands, or vernal pools have been identified on the Site, Putah Creek is an adjacent, high-quality riparian habitat which provides important nesting and foraging areas for raptors, deer, and other wildlife (DOE, 1996). Putah Creek is one of the largest streams draining the east Coast Range within the Sacramento River drainage. The South Fork of Putah Creek is located directly adjacent to the southern boundary of the Site. In this reach of the stream, Putah Creek is a warmwater, intermittent stream (UC Davis, 1996). The riparian areas of the Yolo Basin serve as critical wildlife habitat for a number of special-status plant and animal species (DOE, 1996).

3.3.1 History of Site Use

The Atomic Energy Commission (AEC) first sponsored radiological studies on laboratory animals at UC Davis in the early 1950s. The Laboratory for Energy-Related Health Research was initially situated on the main campus but was relocated South of the Main campus in 1958(Figure 1-1) by the AEC. Research at the Site through the mid-1980s focused on the health effects from chronic exposures to radionuclides, primarily strontium-90 and radium-226,

using beagles to simulate radiation effects on humans. Other related research was conducted at the Site concurrent with these long-term studies. In the early 1970s, a cobalt-60 irradiator facility was constructed on the Site to study the effects in beagles of chronic exposure to gamma radiation.

A campus landfill, used from the 1940s until the mid-1960s, is located in the southeast corner of the Site, and extends a few tens of feet beyond the east border of the Site. Also at the Site are several low-level radioactive waste burial areas. UC Davis and DOE research waste were buried in these areas until 1974, in compliance with regulations in effect at the time.

In 1988, pursuant to a MOA between the U.S. Department of Energy and the University of California, DOE's Office of Energy Research initiated activities to close out the research program at the Site, with the goal of returning the facilities and Site to UC Davis after remediation is complete.

3.3.2 Climate

The climate is temperate with mild winters and warm summers. The mean winter and summer temperatures are 46.9 degrees Fahrenheit (^{o}F) and 73.0^{o}F, respectively. The average daily minimum in winter is 37.6^{o}F and the average daily maximum in summer is 92.3^{o}F (NOAA, 1985; DOE, 1988). The mean annual precipitation at the Davis 2 WSW station, located approximately 5 miles northwest of the Site, was 17.0 inches from data collected between 1908 and 1990 (National Climatic Data Center).

3.3.3 Meteorology

The dominant wind direction is from the south with most winds along a north - south axis. During the winter months (Oct. – Apr.) the wind directions vary with a similar frequency from the north and south. During the summer months (May – Sept.) the predominant wind direction is from the south. The average windspeed for the Site is approximately 2.2 m/s (5 mph).

3.3.4 Geologic Setting

Sediments below the Site and vicinity consist primarily of silt and clay with localized interfingered coarse-grained sediments to a depth of approximately 180 bgs. The depths and major types of sedimentary units encountered below the Site are:

- 0 to 80 ft bgs: interbedded silt, clay and sand with some sand and gravel channel deposits.
- 80 to 135 ft bgs: cobbles and gravels.
- 135 to 143 ft bgs: clay with some silt.

3.3.5 Ground Water Hydrology

Ground water generally flows from the Sacramento Valley sides towards the valley axis. In the vicinity of the Site, regional ground water generally flows east from the Coast Ranges towards the Sacramento River (Dames & Moore, 1993).

At various depths beneath the valley floor, fresh water gives way to saline water as a result of entrapment during the deposition of sediments in a marine environment. The depth to the base of fresh water in the Sacramento Valley varies from 400 ft to over 3,000 ft, and is 2,600 to 3,100 ft bgs at Davis (California Department of Oil & Gas, 1982).

The uppermost distinct aquifer beneath the Site has been divided into two hydrostratigraphic units (HSUs), based on the stratigraphy of the sediments at the Site, and the associated ground water flow and contaminant migration characteristics (Dames & Moore, 1994). HSU-1 consists predominantly of fine-grained clay, silt and sand and extends from the water table to between 76 and 88 ft bgs. HSU-2 consists of sand and gravel and extends from the bottom of HSU-1 to between 114 and 130 ft bgs. Well drillers' logs indicate that a 90-foot-thick clay unit separates HSU-2 from a second aquifer (HSU-3) below (Dames & Moore, 1996).

Ground water levels in 1995 varied from approximately 28 ft bgs in winter to 48 ft bgs in summer. Generally, there is a 20- to 30-foot seasonal fluctuation in the depth-to-ground water beneath the Site caused predominantly by the net agricultural extraction in the summer.

The lateral gradient across the Site within HSU-1 and HSU-2 typically ranges from 0.0004 ft/ft to 0.0015 ft/ft and is predominantly northeast, although it can occasionally be east-southeast. Vertical gradient between HSU-1 and HSU-2 are variable in January through March, downward from April through August and generally upward from September through December (Dames & Moore, 1993).

3.3.6 Surface Water

The east-flowing South Fork of Putah Creek borders the southern portion of the Site and is separated from the Site by the north levee of the creek. In 1948, the U.S. Army Corps of Engineers modified the South Fork and dammed the North Fork, so that all water in Putah Creek now flows in the South Fork. Putah Creek is a "losing" stream in the Site vicinity. Therefore Putah Creek water may impact shallow ground water beneath the Site, but not vice-versa (DOE, 1996).

Flow in the South Fork of Putah Creek is regulated by releases from Monticello Dam at Lake Berryessa and from the Putah Diversion Dam, located about 18 and 14 miles west of the Site, respectively. Based on data from 1980 through 1991, flows several miles upstream from the Site typically range from 0.1 cubic ft per second (cfs) to about 3 cfs, although flows as high as 15,500 cfs (in March 1983) have been reported (Dames & Moore, 1994). In the reach bordering the Site, flow in the South Fork of Putah Creek is supplemented by discharge from the UC Davis Wastewater Treatment Plant. Based on data from a gauge near Old Davis Road, flow

rates for the reach bordering the Site ranged from 0.17 to 148 cfs from 1989 to 1995. High flows were observed during the winter of 1996/1997. Exact flow data were not available because the gauge near Old Davis Road was not in operation during the flood event (personal communication, 1997, Roland Sanford, Solano County Water Resources Agency).

As shown on federal flood maps, the 100-year flood is confined within the Putah Creek levees at the southern boundary of the Site. The Site lies in the Federal Emergency Management Administration (FEMA) Zone C, the area expected to experience minimal flooding.

3.3.7 Topography and Drainage

The Site is situated on gently sloping terrain with an average elevation of 50 ft above mean sea level. The land surface slopes to the east/northeast at approximately 5 ft/mile with a Site-wide relief of about 2 ft (DOE, 1996). See Section 2.2.4 and Attachment A of this report for a detailed description of storm water runoff, collection and discharge.

3.4 Plant Communities and Habitats

The Site is situated within the Yolo Basin in the southern Sacramento Valley. Although a majority of land in the region has been converted to agricultural uses and altered by the construction of levees, it once supported extensive areas of riparian woodland, prairie and tulle marsh. These native plant communities are now restricted primarily to narrow bands along modified stream courses or in isolated upland patches. Despite these extensive alterations a number of habitats persist (Figure 3-1 and 3-2). Habitats are defined as assemblages of natural features of the landscape that are characterized by similar ecological factors such as vegetation, hydrology, pedology, and climate (Cheatham and Haller, 1975). For the purposes of this ecological Scoping Assessment, vegetation assemblages will be used to delineate habitats. Photos of several vegetation/habitat types are in Figures 3-3 through 3-8.

Habitat types delineated on the Site and within the study area include:

- Cultivated fields;
- Ruderal/non-native grassland;
- Ruderal/landscaped;
- A eucalyptus grove;
- Great Valley mixed riparian woodland;
- Great Valley willow scrub;
- Valley freshwater marsh; and
- Open water (Putah Creek).

Although eucalyptus, Great Valley willow scrub and Valley freshwater marsh are important habitat types, their presence in the study area is minimal and were dropped from the Scoping Assessment.

3.4.1 On-Site

The Site consists of highly modified lands supporting buildings, parking areas, former landfill sites and former dog pens. Areas not currently occupied by structures or covered with paving support ruderal vegetation, non-native grassland, landscaping (primarily horticultural trees) and bare ground. Distribution of habitats on-site is delineated in Figure 3-1. Although areas not shaded or otherwise delineated are not occupied by a dominant plant assemblage, vegetation is still sparsely present and may be foraged (Figure 3-3). Therefore, these sparsely covered and highly disturbed areas were carried forward in the Scoping Assessment.

3.4.1.1 Ruderal/Non-Native Grassland

Ruderal/non-native grassland habitat occurs throughout the study area on vacant lots, long-fallow agricultural fields (off-site only) and areas that have been graded and abandoned. Non-native grassland is generally found in open areas in valleys and foothills throughout coastal and interior California (Holland, 1986). It typically occurs on soil consisting of fine-textured loams or clays that are somewhat poorly drained. Ruderal/non-native grassland consists of weedy vegetation that has recolonized disturbed sites from which most of the native annual and perennial plants have been removed. It is dominated by non-native annual grasses, weedy annual and perennial forbs and scattered native herbaceous species.

Within the study area, the most prevalent species occurring within this community include wild oats (Avena spp.), black mustard (Brassica nigra), brome grasses (Bromus spp.), yellow star thistle (Centaurea solstitialis), miner's lettuce (Claytonia perfoliata), willow herb (Epilobium brachycarpum), doveweed (Eremocarpus setigerus), filaree (Erodium spp.), jimson-weed (Datura sp.), hare barley (Hordeum murinum ssp. leporinum), annual bluegrass (Poa annua), Russian thistle (Salsola sp.), common groundsel (Senecio vulgaris), milk thistle (Silybum marianum), Johnson grass (Sorghum halapense), and common chickweed (Stellaria media), among others.

3.4.1.2 Buildings and Structures

Although not a vegetation type, buildings and structures are commonly used by animal species to nest, roost and perch. Therefore, buildings and structures are considered a habitat type and were therefore carried forward in the Scoping Assessment (Figure 3-3).

3.4.1.3 Ruderal/Landscaped

Ruderal/Landscaped habitat consist of infrequently maintained or unmaintained areas that have been planted in part with horticultural trees and shrubs. Within the study area, this habitat type is common around buildings, along roadsides, and adjacent to cultivated fields. In

addition to the herbaceous species occurring in the ruderal/non-native grassland habitat, described above, common shrub and tree species found in ruderal landscaped areas include oleander (Nerium oleander), aleppo pine (Pinus halepensis), Monterey pine (Pinus radiata), white mulberry (Morus alba), walnut (Juglans spp.), Tasmanian blue gum, black locust (Robinia pseudo-acacia), Valley oak (Quercus lobata), cork oak (Quercus suber), common firethorn (Pyracantha angustifolia) and coast redwood (Sequoia sempervirens), among others. Intensively maintained landscaped areas associated with the UC Davis campus, such as the arboretum, support a wide variety of horticultural trees, shrubs, bedding plants and lawn areas. These areas were not surveyed in detail and are not included in the species lists.

3.4.2 Off-Site

Lands immediately surrounding the Site to the west, north and east consist of cultivated fields, animal (horse and goat) enclosures and research facilities. The predominant vegetation consists of ornamental trees and other landscaping, and small patches of ruderal/non-native grassland. No extensive, uncultivated plant communities occur within a one-mile radius to the west, north or east.

To the south, however, the Site is bordered by ruderal/non-native grassland and a narrow band of Great Valley mixed riparian forest associated with both banks of the South Fork of Putah Creek. South of the creek, the privately owned lands support active agriculture, a few residences with ornamental tree and shrub plantings and a small eucalyptus grove. No extensive stands of uncultivated plant communities occur south of the creek levee within a one-mile radius of the Site. Habitat/vegetation types identified off-site include three identified on-site and an additional five for a total of eight.

3.4.2.1 Eucalyptus Grove

This non-native plant community has become naturalized throughout coastal and inland California since eucalyptus trees were first brought to the state in the late 1850s. Numerous species of the genus were imported for their horticultural interest and their potential utility as a fast-growing hardwood. Groves of eucalypti were first planted in the vicinity of Berkeley and later planted in groves throughout the Central Coast and into southern California. Because climatic conditions in the western half of the state are very similar to the range of many of the imported species of eucalypti, the planted groves managed to persist and spread without cultivation. It is estimated that there are between 600 and 800 species of Eucalyptus, about 18 of which have become fairly widespread in California. The most common and widely grown species is Tasmanian blue gum (Eucalyptus globulus). Tasmanian blue gum and another commonly found species, river red gum (Eucalyptus camaldulensis) form a single grove surrounded by cultivated fields south of the South Fork of Putah Creek. In addition, numerous river red gum trees have become established along the banks of the South Fork of Putah Creek.

3.4.2.2 Great Valley Mixed Riparian Forest

Great Valley mixed riparian forest is a tall, dense winter-deciduous forest, typically with a fairly well closed canopy. It consists of any of several species of tall riparian trees with an understory of shade-tolerant shrubs and lianas. It occurs on low gradient floodplains with fine-textured alluvial soil, usually away from active river channels but subject to periodic flooding. It is distributed on depositional streams throughout the Central Valley below 500 feet in elevation. It was once extensive in the Sacramento and San Joaquin valleys, where it has since been cleared for agriculture, flood control and urban expansion.

Within the study area, Great Valley mixed riparian forest consists of a narrow, poorly developed bands along the banks of the South Fork and North Fork of Putah Creek. It is comprised of such tree species as walnut (Juglans spp.), Fremont cottonwood (Populus fremontii), valley oak (Quercus lobata), Oregon ash (Fraxinus latifolia), California box elder (Acer negundo ssp. californicum), red willow (Salix laevigata), arroyo willow (Salix lasiolepis), shining or Pacific willow (Salix lucida ssp. lasiandra), sandbar willow (Salix exigua), black willow (Salix gooddingii) and Mexican elderberry (Sambucus mexicana).

Great Valley mixed riparian forest within the study area most closely conforms to the Mixed Willow Series as described in Sawyer and Keeler-Wolf (1995) and palustrine forested or shrub-scrub wetland as described in Cowardin, *et al.* (1979).

3.4.2.3 Great Valley Willow Scrub

Great Valley willow scrub typically consists of a dense, shrubby, streamside thicket dominated by any of several species of willows. An herbaceous understory may be present or not. This native plant community occurs close to river channels on fine-grained sand and gravel bars with a high water table. It is distributed along all the major rivers and most smaller streams throughout the Great Central Valley watershed below 1,000 feet in elevation (Holland, 1986).

Within the study area, Great Valley willow scrub consists of dense stands on the shore of a detention pond at the intersection of Interstate 80 and State Route 113. Patches of willows also occur along the South Fork of Putah Creek, intermixed with Great Valley mixed riparian forest, described above. Dominant species occurring within the study area include red willow (Salix laevigata), arroyo willow (Salix lasiolepis), shining or Pacific willow (Salix lucida ssp. lasiandra), sandbar willow (Salix exigua) and black willow (Salix gooddingii).

Great Valley willow scrub conforms to the Narrowleaf Willow, Black Willow, Arroyo Willow, Pacific Willow, and Red Willow series as described in Sawyer and Keeler-Wolf (1995) and palustrine shrub-scrub wetland as described in Cowardin *et al.* (1979).

3.4.2.4 Valley Freshwater Marsh

Valley freshwater marsh typically occurs in low-lying sites that are permanently flooded with fresh water and lacking significant current. It is found on nutrient-rich mineral soil that is saturated for all or most of the year. This vegetation community is best developed where surface flow is slow or stagnant or where the water table is so close to the surface as to saturate the soil

from below. Valley freshwater marsh is distributed along coastal and inland valleys near river mouths and around the margins of lakes, springs and streams (Holland, 1986). This vegetation community characteristically forms a dense vegetative cover dominated by native, perennial, emergent monocots 1-15 feet high that reproduce by underground rhizomes.

Within the study area, Valley freshwater marsh was detected in an isolated detention pond at the intersection of Interstate 80 and State Route 113, approximately 3,300 feet to the northwest of the Site. This habitat is dominated by narrow-leaf cattail (Typha angustifolia) and broad-leaf cattail (Typha latifolia). While scattered stands of this plant community are expected along the South Fork of Putah Creek, none was evident at the time of the present surveys due to high water levels. No stands of Valley freshwater marsh are expected within the North Fork of Putah Creek within the study area because the channel has been highly modified and its banks lined with concrete and rip-rap.

This native plant community conforms to the Cattail Series as classified by Sawyer and Keeler-Wolf (1995) and palustrine emergent freshwater wetland as described in Cowardin *et al.* (1979).

3.4.2.5 Putah Creek (Open Water)

Putah Creek is one of the largest streams within the Sacramento River drainage (UC Davis, 1996). The South Fork of the creek, running adjacent to the southern border of the Site, is an artificial channel built to divert flood waters from the City of Davis (Jones & Stokes Associates, 1992). It is an intermittent stream containing only scattered pools during dry years. In the past, drought conditions have completely dried out the lower portions of the creek, resulting in significant fish and invertebrate kills (Marchetti and Moyle, 1995). The relatively narrow and straight stream channel is characterized by slow flows and shallow water levels during much of the year. The stream substrate is composed of sand and other fine sediments, making it an inadequate spawning Site for anadromous fish. The riparian vegetation associated with the South Fork of Putah Creek is dominated by several species of willow, cottonwood, valley oak and eucalyptus, providing some vegetative cover to the active stream channel in spring. The dominant instream vegetation in aquatic habitats like lower Putah Creek is an attached filamentous alga in the genus Periphyton. During summer months when surface waters are limited to the low flow channel, only portions of the stream are shaded by riparian vegetation. Water temperatures during summer may rise considerably, providing reduced habitat for warm water fish and invertebrates.

3.4.3 Special-Status Natural Communities

Special-status natural communities are those that are considered rare in the region, support sensitive plant or animal populations, or receive regulatory protection. In addition, the CNDDB has designated a number of communities as rare; these communities are given the highest inventory priority (Holland, 1986; CDFG, 1984).

Wetlands and riparian habitats are considered to be sensitive and declining resources by several regulatory agencies including the USFWS, CDFG and the CRWQCB. Permit provisions of the Clean Water Act regulating dredge and fill operation are enforced by the U.S. Army Corps of Engineers (ACOE) and USEPA, with technical input from the USFWS, the Natural Resource Conservation Service (NRCS), and the National Marine Fisheries Service (NMFS). The ACOE exerts jurisdiction over "waters of the U.S." which include territorial seas, tidal, and non-tidal waters in addition to wetlands and drainages that support wetland vegetation, exhibit ponding or scouring, show obvious signs or channeling, or have discernible banks and high water marks.

The ACOE considers wetlands to be important to the public interest by performing vital functions. Wetlands serve significant biological functions by providing nesting, breeding, foraging, and spawning habitat for a wide variety of resident and migratory animal species. Wetlands also provide for the movement of water and sediments, ground-water recharge, water purification, storage of storm runoff, recreation and transportation.

3.4.3.1 On-Site

No naturally occurring special-status natural communities occur at the Site. A small patch of Valley needlegrass grassland occurs at the southern edge of the Landfill Unit No. 3 (Figure 3-1). This habitat was created by personnel at the UC Davis Raptor Center in 1994 to enhance the environment around the burrowing owl enclosure (B. Stedman, personal communication). Although this plant community type is considered a special-status natural community by the CNDDB, the stand on-site would not be regarded as a significant biological resource because it was planted on a Site that did not previously support similar habitats.

3.4.3.2 Off-Site

Three special-status natural communities occur within the study area. These include Great Valley mixed riparian forest, Great Valley willow scrub and Valley freshwater marsh. Great Valley mixed riparian forest within the study area is considered a sensitive plant community by the CNDDB. In addition, portions of this plant community might meet the federal definition of wetlands. Great Valley willow scrub and Valley freshwater marsh are also considered sensitive plant communities by the CNDDB and would be classified as wetlands. Impacts to wetlands are regulated under state and federal laws. In addition, both the North Fork and South Fork of Putah Creek qualify as waters of the U.S.; impacts are similarly regulated.

3.5 Expected/Observed Species

A variety of animal species were expected and/or observed in the study area. Resident burrowing mammals detected on-site include California ground squirrel, California vole, Botta's pocket gopher and house mouse. Common predatory mammals and reptiles likely to forage on-site include coyote, gray fox, red fox, house cat, gopher snake and western terrestrial garter snake. Common predatory birds likely to forage on-site include red-tailed hawk, red-shouldered hawk, American kestrel, great-horned owl and barn owl. Common fish expected in the creek

include largemouth bass, green sunfish, carp and catfish. Fish-feeding animals likely to occur in the South Fork of Putah Creek include river otter, beaver and muskrat

A preliminary tabulated inventory of expected and/or detected plant and animal species, locally housed raptors and Putah Creek fish species are presented in appendices C, D, E, and G. Inventories of known or suspected special status plant and animal species at the Site and vicinity are presented in Tables 3-1 and 3- 2.

3.6 Expected/ Observed Special Status Species

Special-status species are given particular consideration during the Site biological survey and in the ecological Scoping Assessment as a whole. Special-status species are defined for the purposes of this study under Species Acts, and species that are considered sufficiently rare by the scientific community to qualify for such a listing.

Special-status plants are species that fall in the following categories:

- Plants listed or proposed for listing as threatened or endangered under the federal Endangered Species Act (50 Code of Federal Regulations (CFR) 17.12 listed plants and other proposed species notices in the Federal Registrar (FR);
- Plants that are candidates for possible future listing as threatened or endangered under the federal Endangered Species Act (61 FR 40, Feb. 28, 1996);
- Plants listed or proposed for listing by the State of California as threatened or endangered under the California Endangered Species Act (14 California Code of Regulations (CCR) 670.5);
- Plants listed under the California Native Plant Protection Act (California Fish and Game Code, Section 1900 et seq.);
- Plants that meet the definitions of rare or endangered CEQA (CEQA Guidelines Section 15380);

Special-status animals are species that fall in the following categories:

- Animals that are listed or proposed for listing as threatened or endangered under the federal Endangered Species Act (50 CFR 17.11) listed animals and other proposed species notices in the Federal Register;
- Animals that are candidates for possible future listing as threatened or endangered under the federal Endangered Species Act (61 FR 40, Feb. 28, 1996);
- Species of concern to the USFWS;
- Migratory nongame birds of management concern to the UFWS;

- Animals listed or proposed for listing by the State of California as threatened or endangered under the California Endangered Species Act [14 CCR 670.5];
- Animals that meet the definitions of rare or endangered under CEQA (CEQA Guidelines Section 15380);
- Animals fully protected in California under the California Fish and Game Code, Section 3511 (birds), 4700 (mammals), and 5050 (reptiles and amphibians).

3.6.1 Special Status Plants

A total of 32 special-status plant species known or expected to occur in the region of the study area. A complete list of those plant species, their legal status, habitat affinities, flowering times and life forms is included in Table 3-1. An explanation of sensitivity codes is provided in Attachment F.

3.6.1.1 On-Site

Of the 32 special-status plant species known or expected to occur in the project region, none were detected or have been recorded at the Site. Due to the highly disturbed condition of the Site and the lack of suitable habitat, no special-status plant species are expected to occur on-site. Although northern California black walnut (Juglans californica var. hindsii) does occur at and near the Site, these trees are not naturally occurring and would not be regarded as a significant biological resource. It is believed that they were either planted for ornament or have sprouted from former orchard plantings. English walnut, the common eating walnut, also occurs in the project vicinity.

3.6.1.2 Off-Site

Of the 32 special-status plant species known or suspected to occur in the project region, none were detected or have been recorded in the vicinity of the Site and none are considered to have a high potential for occurrence. Two species, Sanford's arrowhead (Sagittaria sanfordii) and rose-mallow (Hibiscus lasiocarpus) are considered to have a moderate potential for occurrence within the study area. Marginally suitable habitat is present for these marsh species along the banks of the South Fork of Putah Creek. Although northern California black walnut does occur within the study area, these trees are not naturally occurring and would not be regarded as a significant biological resource.

3.6.2 Special Status Animal Species

The database search results indicate that total of 70 special status animal species have been recorded in the region or may inhabit the study area. These special status species were targeted in the biological survey. The potential for occurrence, observance and special status of

these study area target wildlife species are summarized in Table 3-2. An explanation of sensitivity codes is provided in Attachment F.

3.6.2.1 On-Site

A total of 14 special status wildlife species are considered to have a moderate to high potential to inhabit or forage on the Site. The remaining 56 target species are not considered to have any potential for occurrence on-site. Special-status animals detected at the Site include burrowing owl, northern harrier and white-tailed kite.

3.6.2.2 Off-Site

In addition to the 14 special-status species mentioned above, 18 special-status animal species (for a total of 32), have been recorded in the vicinity or are considered to have a moderate to high potential for occurrence within the study area. Special-status animals known to naturally occur in the vicinity include the sharp-shinned hawk, ferruginous hawk, and the golden eagle. In addition, the adjacent riparian habitat along the banks of the South Fork of Putah Creek has the potential to support Sacramento anthicid beetle, Antioch mutilid wasp, Delta June beetle and Sacramento Valley tiger beetle. The creek itself has a moderate potential to support Pacific lamprey. Valley elderberry longhorn beetle (Desmocerus californicus demorphus) is dependent on elderberry trees (Sambucus sp.) for every stage of its life cycle. They are most abundant where elderberry trees grow in well developed riparian forests. Although scattered elderberries are present within the Site boundaries, those plants along Putah Creek are more likely to harbor the species. Potentially suitable habitat for Valley elderberry longhorn beetle is present in the former eastern dog pens, former western dog pens, immediately south of Landfill Unit No. 3, near the southeastern corner of the UC Davis Raptor Center parking lot and along the north bank of the South Fork of Putah Creek (Figures 3-1 and 3-2).

The remaining 38 target species are not considered to have any potential for occurrence within the off-site study area. Additionally, 18 special status bird species are housed at the UC Davis Raptor Center. Because these birds are captive and do not forage on-site, they have been eliminated form further consideration in the Scoping Assessment. A complete list of bird species that are currently and have been historically housed at the UC Davis Raptor Center is provided in Attachment G.

3.7 Conclusions

In order to evaluate potential exposure pathways, a biological survey was conducted to identify potential ecological receptors. Findings of the biological survey include:

- Eight vegetation/habitat types are present on- and off-site;
- 14 special status wildlife species including invertebrates were observed or have the potential to occur on the Site;

- A total of 32 special status wildlife species, including invertebrates and fish, were observed or have the potential to occur within the study area as a whole;
- No significant special status plant species were identified on-site;
- Two special status plant species have a moderate potential to occur off-site;
- No special status plant communities were identified on-site; and
- Three special status plant communities were identified off-site.

Results of this biological characterization indicate that biological receptors are present or have the potential to occur both on-site and off-site. Therefore, results of this biological characterization were carried forward to Section 4 of this report.

Table 3-1. Special-Status Plant Species Known or Suspected To Occur at the Site and Vicinity.

Scientific Name Common Name	Status[1]		Habitat Affinities and Reported Localities in the Project Area	Blooming Period/ Life Form	Potential for Occurrence Onsite or in Project Area
Alismataceae					
Sagittaria sanfordii Sanford's arrowhead	Federal State CNPS	SC CEQA 1B:2-2-3	Assorted shallow freshwater marshes and swamps. Known from Shasta to Fresno counties and Marin County.	May-Aug Perennial herb (rhizomatous)	None onsite: no suitable habitat present. Moderate offsite: suitable habitat present.
Apiaceae					
Lilaeop masonii Mason's lilaeopsis	Federal State CNPS	SC CR 1B:2-2-3	Intertidal brackish and freshwater marshes along streambank. Recorded in the San Joaquin and Sacramento River Delta and lower Napa River channel.	April-Oct Perennial herb	None onsite or offsite: no suitable habitat present onsite or in project vicinity.
Perideridia gairdneri ssp. Gairdneri Gairdner's yampah	Federal State CNPS	SC CEQA? 4:1-2-3	Mesic sites in broadleafed upland forest, chaparral, coastal prairie, Valley/foothill grassland, vernal pools. Found from the Bay Area and San Joaquin Valley to the Oregon border. Endangered in the southern portion of its range.	June-Oct Perennial herb	None onsite: no suitable habitat present onsite or in project vicinity.
Brassicaceae					
Lepidium latipes var. *heckardii* Heckard's pepper-grass	Federal State CNPS	none CEQA 1B:3-2-3	Valley/foothill grassland on alkaline flats. Restricted to Yolo County.	April-May Annual herb	None onsite: no suitable habitat Low offsite: marginally suitable habitat present.
Campanulaceae					
Downingia pusilla dwarf downingia	Federal State CNPS	none CEQA 2:1-2-1	Mesic sites in Valley/foothill grassland and vernal pools. Occurs from Sonoma and Napa counties through the Sacramento Valley and Sierra foothills.	Mar-May Annual herb	None onsite: no suitable habitat Low offsite: marginally suitable habitat present
Legenere limosa legenere	Federal State CNPS	SC CEQA 1B:2-3-3	Vernal pools. Recorded from Lake and Napa counties throughout the Sacramento Valley. Believed extinct in Sonoma and Stanislaus counties.	May-June Annual herb	None onsite or offsite: no suitable habitat in study area.

Table 3-1 Special-Status Plant Species Known or Suspected To Occur at the Site and Vicinity (Continued).

Scientific Name Common Name	Status[1]		Habitat Affinities and Reported Localities in the Project Area	Blooming Period/ Life Form	Potential for Occurrence Onsite or in Project Area
Chenopodiaceae					
Atriplex cordulata heartscale	Federal State CNPS	SC CEQA 1B:2-2-3	Chenopod scrub, Valley/foothill grassland, on somewhat alkaline or saline hard-packed soils. Recorded from Alameda County throughout the Central Valley from Glenn to Kern counties. Presumed extinct in Contra Costa and San Joaquin counties.	May-Oct Annual herb	None onsite or offsite: no suitable habitat present in study area.
Atriplex coronata var. coronata crownscale	Federal State CNPS	none CEQA? 4:1-2-3	Chenopod scrub, Valley/foothill grassland on alkaline soils. Known from the northern San Joaquin Valley, Central Coast, and eastern San Francisco Bay.	Apr-Oct Annual herb	None onsite or offsite: no suitable habitat present in study area.
Atriplex depressa *brittlescale*	Federal State CNPS	none CEQA 1B:2-2-3	Chenopod scrub, playas and Valley/foothill grassland on alkaline and clay soils. Occurs from Solano County throughout the Sacramento and San Joaquin Valleys. Presumed extinct in Stanislaus County.	May-Oct Annual herb	None onsite or offsite: no suitable habitat present in study area.
Atriplex joaquiniana San Joaquin spearscale	Federal State CNPS	SC CEQA 1B:2-2-3	Chenopod scrub, Valley/foothill grassland and alkali meadows. Occurs from Solano County throughout the Sacramento and San Joaquin valleys. Presumed extinct in Santa Clara, San Joaquin and Tulare counties.	April-Sept Annual herb	None onsite or offsite: no suitable habitat present in study area.
Fabaceae					
Astragalus breweri Brewer's milk-vetch	Federal State CNPS	none CEQA? 4:1-2-3	Meadows and grassy hillsides, oak woodland, chaparral, often on serpentinite or volcanic soils. Known from Marin, Mendocino, Lake, Sonoma, Colusa, Napa and Yolo counties.	April-June Annual herb	None onsite: no suitable habitat present. Low offsite: marginally suitable habitat present.
Astragalus rattanii var. jepsonianus Jepson's milk vetch	Federal State CNPS	none CEQA 1B:2-2-3	Cismontane woodland and Valley/foothill grasslands, often on serpentinite. Recorded from Colusa, Glenn, Lake, Napa, Tehama and Yolo counties.	April-June Annual herb	None onsite or offsite: no suitable habitat present in study area.

Table 3-1 Special-Status Plant Species Known or Suspected To Occur at the Site and Vicinity (Continued).

Scientific Name Common Name	Status[1]		Habitat Affinities and Reported Localities in the Project Area	Blooming Period/ Life Form	Potential for Occurrence Onsite or in Project Area
Astragalus tener var. *ferrisiae* alkali milk vetch	Federal State CNPS	SC CEQA 1B:3-3-3	Vernally mesic meadows, Valley/foothill grasslands on sub-alkaline flats. Extant in Butte County; presumed extinct in Solano, Colusa and Yolo counties.	April-May Annual herb	None onsite or offsite: no suitable habitat present in study area.
Astragalus tener var. *tener* alkali milk vetch	Federal State CNPS	none CEQA 1B:3-2-3	Playas, Valley/foothill grasslands, on adobe clay and alkaline vernal pools. Extant in Merced, Solano and Yolo counties. Extinct throughout the Bay Area and San Joaquin Valley.	March-June Annual herb	None onsite or offsite: no suitable habitat present in study area.
Lathyrus jepsonii var. *jepsonii* Delta tule pea	Federal State CNPS	SC CEQA 1B:2-2-3	Freshwater and brackish marshes. Occurs throughout the Sacramento-San Joaquin River delta, San Francisco Bay, and Central Valley.	May-Sept. Perennial herb	None onsite: no suitable habitat present. Low offsite: marginally suitable habitat present.
Trifolium amoemum showy Indian clover	Federal State CNPS	Fpe CEQA 1B:3-3-3	Valley/foothill grasslands, in sunny open sites, sometimes on serpentinite. Rediscovered in Sonoma County in 1993, believed extinct in Alameda, Mendocino, Marin, Napa, Santa Clara and Solano counties.		
Grossulariaceae					
Ribes victoris Victor's gooseberry	Federal State CNPS	none CEQA? 4:1-1-3	Mixed evergreen forest, redwood forest, and chaparral in canyons. Known from Mendocino, Marin, Napa, Solano and Sonoma counties.	Mar-April Deciduous shrub	None onsite or offsite: no suitable habitat present in study area.
Juglandaceae					
Juglans californica var. *hindsii* Northern California black walnut	Federal State CNPS	SC CEQA 1B:3-3-3	Riparian forests and riparian woodlands. Known from only two extant populations in Napa and Contra Costa counties. Presumed extinct in Sacramento, Solano and Yolo counties. Widely naturalized in Cismontane Calif., used as a rootstock for *J. regia*.	April-May Deciduous tree	None onsite or offsite: no natural stands present (see text).

Table 3-1 Special-Status Plant Species Known or Suspected To Occur at the Site and Vicinity (Continued).

Scientific Name Common Name	Status[1]		Habitat Affinities and Reported Localities in the Project Area	Blooming Period/ Life Form	Potential for Occurrence Onsite or in Project Area
Liliaceae					
Calochortus pulchellus Mt. Diablo fairy-lantern	Federal State CNPS	none CEQA 1B:2-2-3	Chaparral, Cismontane woodland, Valley/foothill grassland. Known from Contra Costa and possibly Solano counties.	April-June Perennial herb (bulbiferous)	None onsite: no suitable habitat present. Low offsite: marginally suitable habitat present.
Fritillaria liliacea fragrant fritillary	Federal State CNPS	SC CEQA 1B:1-2-3	Coastal prairie, coastal scrub, Valley/foothill grassland near the coast, on clay or serpentinite. Known from throughout the Central Coast from Sonoma to Monterey counties and the San Francisco Bay Area.	Feb-April Perennial herb (bulbiferous)	None onsite: no suitable habitat present. Low offsite: marginally suitable habitat present.
Fritillaria pluriflora adobe lily	Federal State CNPS	SC CEQA 1B:1-2-3	Chaparral, Cismontane woodland, Valley/foothill grassland, often on adobe soils. Recorded from throughout the northern Sacramento Valley to Napa.	Feb-April (bulbiferous)	None onsite: no suitable habitat present. Low offsite: marginally suitable habitat present.
Malvaceae					
Hibiscus lasiocarpus rose-mallow	Federal State CNPS	none CEQA 2:2-2-1	Freshwater marshes. Restricted to the Sacramento-San Joaquin River Delta.	June-Sept Perennial herb (rhizomatous)	None onsite: no suitable habitat present. Moderate offsite: suitable habitat present.
Poaceae					
Neostafa colusana Colusa grass	Federal State CNPS	FPT CE 1B:1-3-3	Restricted to large, northern claypan vernal pools with alkaline soils that remain flooded until early summer. Known from Merced, Solano, Stanislaus and Yolo counties; presumed extinct in Colusa County.	May-July Annual herb	None onsite: no suitable habitat present. Low offsite: marginally suitable habitat present.
Tuctoria mucronata Crampton's tuctoria	Federal State CNPS	FE CE 1B:3-3-3	Restricted to vernal pools. Known from only three occurrences near Jepson Prairie and Davis. Reported in Solano and Yolo counties.	April-July Annual herb	None onsite: no suitable habitat present. Low offsite: marginally suitable habitat present.

Table 3-1 Special-Status Plant Species Known or Suspected To Occur at the Site and Vicinity (Continued).

Scientific Name Common Name	Status[1]		Habitat Affinities and Reported Localities in the Project Area	Blooming Period/ Life Form	Potential for Occurrence Onsite or in Project Area
Polemoniaceae					
Navarretia leucocephala ssp. *bakeri* Baker's navarretia	Federal State CNPS	none CEQA 1B:2-2-3	Cismontane woodland, lower montane coniferous forest, mesic meadows, Valley/foothill grassland, vernal pools. Known from Tehama, Colusa, Lake, Mendocino, Solano, Sonoma, Santa Clara, Marin, and Napa counties.	May- July Annual Herb	None onsite: no suitable habitat present. Low offsite: marginally suitable habitat present.
Ranunculaceae					
Delphinium recurvatum recurved larkspur	Federal State CNPS	SC CEQA 1B:1-2-3	Chenopod scrub, Cismontane woodland and Valley/ foothill grassland, in alkaline places. Restricted to the Central Valley from Colusa to Kern counties, San Luis Obispo.	Mar-May Perennial herb	None onsite: no suitable habitat present. Low offsite: marginally suitable habitat present.
Myosorus minimus ssp. *apus* little mousetail	Federal State CNPS	SC CEQA? 3:2-3-2	Alkaline vernal pools. Recorded throughout the Central Valley.	March-June Annual herb	None onsite: no suitable habitat present. Low offsite: marginally suitable habitat present.
Ranunculus lobbii Lobb's aquatic buttercup	Federal State CNPS	none CEQA? 4:1-2-3	Mesic sites in Cismontane woodland, Valley/foothill grassland, North Coast coniferous forest and vernal pools. Known from the San Francisco Bay Area to Mendocino and Napa counties.	March-May Annual herb (aquatic)	None onsite: no suitable habitat present. Low offsite: marginally suitable habitat present.
Scrophulariaceae					
Cordylanthus mollis ssp. *hispidus* hispid bird's-beak	Federal State CNPS	SC CEQA 1B:2-3-3	Meadows, playas, Valley/foothill grassland on alkaline sites. Recorded from Alameda, Kern, Merced, Placer and Solano counties.	June-Sept Annual herb (hemiparasite)	None onsite or offsite: no suitable habitat present in study area.
Cordylanthus palmatus palmate-bracted bird's-beak	Federal State CNPS	FE CE 1B:3-3-3	Chenopod scrub, foothill/Valley grassland (alkaline sites). Known from Springtown and three small populations in the Central Valley.	May-Oct Annual herb (hemiparasite)	None onsite or offsite: no suitable habitat present in study area.
Gratiola heterosepala Boggs Lake hedge-hyssop	Federal State CNPS	none CE 1B:1-2-2	Marshes along lake margins, vernal pools on clay. Occurs from the Sacramento Valley to the Modoc Plateau, central Sierra foothills and interior of the North Coast Ranges.	April-Aug Annual herb	None onsite: no suitable habitat present. Low offsite: marginally suitable habitat present.

Table 3-1 Special-Status Plant Species Known or Suspected To Occur at the Site and Vicinity (Continued).

Scientific Name Common Name	Status[1]		Habitat Affinities and Reported Localities in the Project Area	Blooming Period/ Life Form	Potential for Occurrence Onsite or in Project Area
Limosella subulata Delta mudwort	Federal State CNPS	none CEQA 2:2-3-1	Marshes and swamps, muddy or sandy intertidal flats in the Sacramento and San Joaquin river deltas.	May-Aug Perennial herb (stoloniferous)	None onsite or offsite: no suitable habitat present in study area.

Notes:
[1] Explanation of sensitivity status codes provided in Appendix E.
TEXT = Special-status species observed or expected to occur offsite.

Table 3-2. Special-Status Animal Species Known or Suspected to Occur at the Site and Vicinity.

Scientific Name Common Name	Status[1]		Habitat Affinities and Reported Localities in the Project Area	Potential for Occurrence On-Site or in Project Area
Invertebrates				
Anthiscus antiochensis Antioch Dunes Anthicid Beetle	Federal State	SC none	Extinct. Formerly inhabited sandy substrate at the Antioch Dunes.	None onsite or offsite: no suitable habitat present within study area.
Anthiscus sacramento Sacramento Anthicid Beetle	Federal State	SC none	Inhabits sandy substrate among willows in riparian habitats. Known from Sacramento, Solano and Butte counties and upper Putah Creek in Yolo County.	None onsite. Low to Moderate offsite: suitable habitat present along South Fork of Putah Creek.
Branchinecta conseratio Conservancy Fairy Shrimp	Federal State	FE none	Inhabits astatic pools located in swales formed by old, braided alluvium and filled by winter and spring rains, lasting until June. Endemic to grasslands in the northern 2/3 of the Central Valley. Recorded from Jepson Prairie.	Low offsite: aquatic habitats in vicinity are not suitable.
Branchinecta lynchi Vernal Pool Fairy Shrimp	Federal State	FT none	Inhabits vernal pools in grasslands in the Central Valley, Coast Ranges and South Coast Mountains. Active between December and May.	None onsite or offsite: No vernal pools in vicinity of project site.
Cicindela hirticollis abrupta Sacramento Valley Tiger Beetle	Federal State	SC none	Open sandy areas among willows in riparian habitats. Occurs in the lower Sacramento Valley. Recorded in the Sacramento and American rivers and Cache Creek. Not recorded in project vicinity.	None onsite. Low to Moderate offsite: suitable habitat present along South Fork of Putah Creek.
Desmocerus californicus demorphus Valley Elderberry Longhorn Beetle	Federal State	FT none	Riparian and oak savanna habitats. Requires elderberry (*Sambucus* spp.) as host plants. Inhabits streamsides in the Central Valley below 3,000 feet.	Low onsite: marginally suitable habitat present. High offsite: abundant suitable habitat present.
Lepidurus packardi Vernal Pool Tadpole Shrimp	Federal State	FE none	Inhabits vernal pools in grassland habitats in the Central Valley between Shasta County and Merced County. Eggs hatch within a month of inundation, adults present until pools dry in the spring.	None onsite or offsite: No vernal pools in vicinity of project site.
Mimosula pacifica Antioch Multilid Wasp	Federal State	SC none	Sand deposits along rivers. Distributed throughout the Sacramento/San Joaquin River Delta. Not recorded in project vicinity.	None onsite. Low to Moderate offsite: suitable habitat present along South Fork of Putah Creek.

Table 3-2 Special-Status Animal Species Known or Suspected to Occur at the Site and Vicinity (Continued).

Scientific Name Common Name	Status[1]		Habitat Affinities and Reported Localities in the Project Area	Potential for Occurrence On-Site or in Project Area
Plyphylla stellata Delta June Beetle	Federal State	SC none	Inhabits sandy areas in riverine habitats. Occurs in the Sacramento/San Joaquin River Delta. Not recorded in project vicinity.	None onsite. Moderate offsite: moderately suitable habitat present in Putah Creek.
Proceratium californicum Valley Oak Ant	Federal State	SC none	Riparian valley oak woodland. Recorded from isolated locations throughout California. Recorded from Yolo County, but not from project vicinity.	None onsite or offsite: no suitable habitat present within study area.
Smithistruma reliquia Ancient Ant	Federal State	SC none	Inhabits riparian valley oak woodland. Known from Yolo County. Not recorded from project vicinity.	None onsite or offsite: no suitable habitat present within study area.
Birds				
Accipiter cooperi Cooper's Hawk (nesting site only)	Federal State Audubon	MB SSC Blue List	Nests primarily in deciduous riparian forests. May also occupy dense canopied forests from gray pine-oak woodland to ponderosa pine. Forages in open woodlands. Not known to nest in Yolo County.	Moderate onsite: limited foraging habitat present. Detected offsite: species is a regular winter resident in region
Accipiter striatus Sharp-shined Hawk	Federal State Audubon	MB SSC blue list	Dense canopy pine or mixed conifer forests and riparian habitats. Permanent resident in the Sierra Nevada, Cascade, Klamath, and North Coast Ranges as well as along the coast from Marin to Monterey counties.	Low onsite: limited foraging habitat present. Moderate offsite: may occur as an occasional winter visitor.
Agelaius tricolor Tricolored Blackbird	Federal State Audubon	SC, MB SSC none	Nests in dense freshwater marshes with cattail or tules. Forages in grasslands. Largely endemic to California . Permanent resident in the Central Valley and along the coast from Marin to San Diego counties. Also known from Lake, Sonoma and Solano counties.	None onsite. Moderate offsite: may occur as an occasional visitor. No suitable nesting habitat present.
Aquila chrysaetos Golden Eagle (nesting/wintering sites only)	Federal State Audubon	MB SSC none	Forages in a variety of habitats including grasslands, chaparral and oak woodland supporting abundant mammals. Nests on cliffs and escarpments and tall trees.	Low onsite: marginal foraging habitat present. Moderate offsite: may occur as a winter visitor.

Table 3-2 Special-Status Animal Species Known or Suspected to Occur at the Site and Vicinity (Continued).

Scientific Name Common Name	Status[1]		Habitat Affinities and Reported Localities in the Project Area	Potential for Occurrence On-Site or in Project Area
Ardea herodius Great Blue Heron (rookery site only)	Federal State Audubon	MB * none	Nests in large trees including *Eucalyptus* and fir. Often colonial. Known from San Francisco Bay.	Low onsite: marginal habitat present. Detected offsite: individuals only. No rookeries present nor expected.
Asio flammeus... Short-eared Owl (nesting only)	Federal State Audubon	MB SSC Blue List	Found in salt and freshwater swamps, lowland meadows, irrigated alfalfa fields. Nests in tules and tall grasslands. Needs daytime seclusion. Nests on dry ground in depressions concealed by vegetation. Regularly observed north of Davis.	Moderate onsite and offsite: may forage in region; no appropriate nesting habitat present.
Athene cunicularia hypugea Western Burrowing Owl	Federal State Audubon	SC, MB SSC SC	Open, dry grasslands, deserts, prairies, farmland and scrublands with abundant active and abandoned mammal burrows. Occurs in lowlands throughout California. Nested on UC Davis campus until recently.	Low onsite: Nesting at Raptor Center and on banks of drainage canal. May forage onsite. Suitable habitat offsite.
Branta canadensis leucopareia Aleutian Canada Goose	Federal State Audubon	FT, MB none none	One of eleven recognized subspecies. Winters in wetlands, grasslands and cultivated fields.	None onsite. Moderate offsite: potential foraging habitat in vicinity.
Buteo regalis Ferruginous Hawk	Federal State Audubon	SC, MB SSC SC	Forages over open terrain in plains and foothills where there are abundant ground squirrels or other small mammals. Does not nest in California.	Low onsite: limited foraging habitat present. Moderate offsite: may occur as an occasional winter visitor.
Buteo swainsoni Swainson's Hawk	Federal State Audubon	MB CT SC	Nests in oaks or cottonwoods in or near riparian habitat. Forages in grasslands and agricultural fields. Highest nesting densities are in Yolo County. Common throughout the lower Sacramento and San Joaquin valleys.	High onsite. Detected offsite: over 30 recorded nest sites within ½ mile of UC Davis. Nests along Putah Creek.
Casmerodius albus Great Egret (rookery site only)	Federal State Audubon	MB * none	Nests in large trees near water. Forages in marshes and mudflats.	Low onsite. Moderate offsite: detected in Putah Creek.

Table 3-2 Special-Status Animal Species Known or Suspected to Occur at the Site and Vicinity (Continued).

Scientific Name Common Name	Status[1]		Habitat Affinities and Reported Localities in the Project Area	Potential for Occurrence On-Site or in Project Area
Charadrius montanus Mountain Plover	Federal State Audubon	C SSC none	Nests on arid plains and short-grass prairies in Western Great Plains and Great Basin; Winters in open, arid habitats, as well as fallow fields.	Low onsite. Moderate offsite: may occur as winter resident.
Circus cyaneus Northern Harrier (nesting)	Federal State Audubon	MB SSC blue list	Inhabits open habitats including grasslands and agricultural fields; is known to roost communally. Known as winter and breeding resident from the vicinity of Davis.	Moderate onsite. Detected offsite: forages over study area. No nesting habitat onsite.
Coccyzus americanus occidentalis Western Yellow Billed Cuckoo	Federal State Audubon	MB CE blue list	Nests in dense riparian forests with a dense understory of willows. Preferred foraging habitat consists of cottonwoods as the dominant overstory species. Nearby populations are recorded along the upper Sacramento and lower Feather rivers.	None onsite or offsite: no suitable nesting habitat present within study area.
Dendroica petechia brewsteri California Yellow Warbler	Federal State Audubon	MB SSC SC	Nests in riparian areas dominated by willows, cottonwoods, sycamores or alders and in mature chaparral. May also inhabit oak and coniferous woodlands and urban areas near stream courses.	Moderate onsite and offsite: occurs as a regular migrant. Not expected to nest in study area.
Egretta thula Snowy Egret (rookery site only)	Federal State Audubon	MB * none	Nests in dense marshes or low trees. Forages in marshes, ponds, mudflats and fields.	Low onsite. Moderate offsite: Detected in Putah Creek.
Elanus leucurus White-tailed Kite (nesting sites only)	Federal State Audubon	none * none	Inhabits foothills and valleys of central and southern California. Nests in oak woodlands and riparian habitats. Forages in marshlands and grasslands.	Moderate onsite: potential nesting habitat on site. Detected offsite.
Empidonax traillii brewsteri Little Willow Flycatcher	Federal State Audubon	SC, MB CE SC	Inhabits riparian areas and wet meadows with abundant willows for breeding. Occurs in isolated areas in the foothills of the Sierra Nevada.	None onsite or offsite: no suitable nesting habitat present. Not recorded in site vicinity.
Eremophila alpestris actia California Horned Lark	Federal State Audubon	MB SSC none	Nests on ground in open grassland. Known from vicinity of San Francisco Bay.	High onsite. Detected offsite: suitable foraging habitat onsite and adjacent.

Table 3-2 Special-Status Animal Species Known or Suspected to Occur at the Site and Vicinity (Continued).

Scientific Name Common Name	Status[1]		Habitat Affinities and Reported Localities in the Project Area	Potential for Occurrence On-Site or in Project Area
Falco columbarius Merlin	Federal State Audubon	MB SSC SC	Winters in open country often along coast near concentrations of shorebirds. Known from vicinity of San Francisco Bay.	Low onsite and offsite: possible foraging migrant. No suitable nesting habitat onsite or offsite.
Falco mexicanus (nesting) Prairie Falcon	Federal State Audubon	MB SSC none	Nests in cliffs and forages in open, arid and semi-arid habitats and marshes. Occurs as a permanent resident throughout California.	Low onsite and offsite: may occur as an occasional migrant.
Falco peregrinus anatum American Peregrine Falcon	Federal State Audubon	FE, MB CE none	Nests and roosts on protected ledges of high cliffs, usually adjacent to lakes, rivers or marshes. Permanent resident in the North and South Coast Ranges. Winters in the Central Valley southward through the Transverse and Peninsular Ranges. Not known to nest in Yolo County.	Low onsite and offsite: may occur as an occasional migrant or winter visitor.
Grus canadensis tabida Greater Sandhill Crane	Federal State Audubon	MB CT none	Summers in open terrain near shallow freshwater lakes or marshes. Winters in plains and valleys near bodies of fresh water. Breeds from Sierra County northward to east side of the Cascade Range. Winters in the Central Valley and southern Imperial County.	None onsite. Low offsite: a rare visitor to the area. No suitable foraging habitat present.
Haliaeetus leucocephalus Bald Eagle	Federal State Audubon	FT CE none	Nests in tall trees, often near water in Pacific Northwest and Canada. Winters in a variety of habitats. Occurs in project vicinity as a transient.	Low onsite and offsite: may occur as an occasional migrant.
Icteria virens Yellow-breasted Chat	Federal State Audubon	MB SSC none	Nests in dense riparian habitats dominated by willows, alders, ash, blackberry and grapevines. Uncommon migrant in California. Known to nest in Sonoma, Mendocino, El Dorado, Shasta and Yolo counties.	Low onsite and offsite: may occur as an occasional migrant. No suitable nesting habitat present.
Lanius ludovicianus Loggerhead Shrike	Federal State Audubon	SC, MB SSC Blue List	Open grasslands at margins of woodland and scrub habitats. Requires abundant lookout perches such as fence posts. Resident and winter visitor in lowlands and foothills throughout California.	Moderate onsite and offsite: suitable nesting habitat present. Observed in study area.

Table 3-2 Special-Status Animal Species Known or Suspected to Occur at the Site and Vicinity (Continued).

Scientific Name Common Name	Status[1]		Habitat Affinities and Reported Localities in the Project Area	Potential for Occurrence On-Site or in Project Area
Numenius americanus Long-billed Curlew	Federal State Audubon	MB SSC SC	Nests at high elevations in grasslands adjacent to lakes or marshes. Winters along the coast on mudflats or in interior valleys in grasslands and agricultural fields.	Low onsite and offsite: uncommon visitor in agricultural fields.
Nyctocorax nycticorax Black-crowned Night Heron (rookery site only)	Federal State Audubon	MB * none	Forages in marshes, streams and ponds. Active at night. Roosts communally during the day.	Low onsite. Moderate offsite: potential nesting/roosting sites present. Detected in Putah Creek.
Pandion haliaetus Osprey	Federal State Audubon	none SSC none	Nests in snags or cliffs, usually near water. Forages on fish. Nests along north coast, Cascades, and Sierra Nevada, winters along coast of central and southern California.	Low onsite and offsite: occasional visitor along Putah Creek.
Phalacrocorax auritus Double Crested Cormorant (Rookery Site)	Federal State Audubon	MB SSC none	Nests in colonies on coastal cliffs and offshore islands and on lake margins in the interior of the state. Nesting colonies recorded on the San Mateo-Hayward bridge, south San Francisco Bay.	None onsite. Low offsite: detected in Putah Creek. No suitable nesting sites.
Plegadis chihi White-faced Ibis (rookeries only)	Federal State Audubon	SC, MB SSC none	Breeds in freshwater marsh habitats in Great Plains and Great Basin. Winters in marsh habitats in Central Valley of California	None onsite. Low offsite: does not breed in vicinity; may occur as occasional winter migrant.
Riparia riparia Bank Swallow (nesting colonies only)	Federal State Audubon	MB CT none	Nests in colonies on sandy cliffs near water, marshes, lakes, streams, and the ocean. Forages in fields. Largest remaining populations occur along the Sacramento River from Tehama to Sacramento counties. Also found along the Feather and lower American rivers and in the Ownens Valley. Breeding populations also present along the coast from San Francisco to Monterey counties.	None onsite or offsite: no suitable nesting habitat present. Not recorded in project vicinity.
Reptiles				
Clemmys marmorata marorata Northwestern Pond Turtle	Federal State	SC SSC	Permanent, slow-moving creeks a with mud or rocky bottom and densely vegetated shoreline. Inhabits woodlands, grasslands and open forests. Occurs from the Oregon border to the San Francisco Bay and inland throughout the Sacramento Valley.	None onsite. High offsite: suitable habitat present in South Fork of Putah Creek. Recorded in project vicinity.

Table 3-2 Special-Status Animal Species Known or Suspected to Occur at the Site and Vicinity (Continued).

Scientific Name Common Name	Status[1]		Habitat Affinities and Reported Localities in the Project Area	Potential for Occurrence On-Site or in Project Area
Phrynosoma coronatum frontale California Horned Lizard	Federal State	SC SSC	Occurs in scrub and grassland on sandy soils. Active above ground between April and October. Prey primarily on native ant species. Known historically from vicinity of Davis.	Low onsite and offsite: no suitable habitat in vicinity of project site.
Thamnophis gigas Giant Garter Snake	Federal State	FT CT	Inhabits sloughs, canals and small water courses with grassy banks and emergent vegetation. Requires high ground for basking and escape during winter flooding. Known from the Central Valley from Fresno north to the Sutter Buttes.	None onsite. Moderate offsite: recorded in the South Fork of Putah Creek within study area in 1976. Habitat is marginally suitable.
Amphibians				
Ambystoma californiense California Tiger Salamander	Federal State	C SSC	Breeds in temporary ponds and vernal pools; aestivates in small mammal burrows. Recorded from vicinity of Davis.	None onsite. Low offsite: no appropriate breeding habitat in project vicinity.
Rana aurora draytonii California Red-legged Frog	Federal State	FT SSC	Permanent stream pools, ponds and creeks with emergent and/or riparian vegetation. May aestivate in rodent burrows during dry periods. Restricted to Coastal areas and coastal mountains from Marin to San Diego counties.	None onsite. Low offsite: believed extirpated from the Sacramento Valley.
Scaphiopus hammondii Western Spadefoot Toad	Federal State	SC SSC	Breeds in temporary pools following winter and spring rains; larvae transform within 3 - 11 weeks; aestivates in burrows in loose soil; Historically recorded from vicinity of Winters.	None onsite. Low offsite: no suitable breeding habitat present.
Mammals				
Antrozous pallidus Pallid Bat	Federal State	none SSC	Roosts in hollow trees, rock outcrops, buildings and bridges. Forages primarily on ground-dwelling arthropods.	Low onsite. Moderate offsite: suitable foraging and roosting habitat along Putah Creek.
Corynorhinus (Plecotus) townsendii Townsend's Big-eared Bat	Federal State	SC SSC	Roosts in caves and buildings. Maternal colonies very sensitive to disturbance by humans; forages in woodlands and grasslands, primarily on moths.	Low onsite. Moderate offsite: suitable foraging and roosting habitat along Putah Creek.

Table 3-2 Special-Status Animal Species Known or Suspected to Occur at the Site and Vicinity (Continued).

Scientific Name Common Name	Status[1]		Habitat Affinities and Reported Localities in the Project Area	Potential for Occurrence On-Site or in Project Area
Eumops perotis californicus California Mastiff Bat	Federal State	SC SSC	Roosts in rock outcrops, occasionally buildings. Forages on moths, beetles and crickets. May travel up to 25 miles from roost to foraging area.	Low onsite. Moderate offsite: suitable foraging and roosting habitat along Putah Creek.
Myotis ciliolabrum Small-footed Myotis Bat	Federal State	SC none	Roosts in caves, mine tunnels, crevices in rocks and buildings, generally near forested areas. Feeds low among trees or over shrubs. Distributed from interior California through the Great Plains states to the east coast.	Low onsite and offsite: potentially suitable foraging and roosting habitat present in study area.
Myotis evotis long-eared bat	Federal State	SC none	Inhabits forested areas, roosts in building or trees. Occasionally found in caves. Does not occur in large colonies. Distributed throughout the western U.S.	Low onsite and offsite: potentially suitable foraging and roosting habitat in study area
Myotis thysanoides Fringed Myotis Bat	Federal State	SC none	Roosts in colonies in caves, attics of old buildings, snags and cliffs. Distributed throughout the western U.S. and into Mexico.	Low onsite and offsite: potentially suitable foraging and roosting habitat present in study area.
Myotis volans Long-legged Myotis	Federal State	SC none	Roosts colonially in snags, buildings and small pockets and crevices in rock ledges. Distributed throughout the western U.S., Mexico and Canada.	Low onsite and offsite: potentially suitable foraging and roosting habitat in study area
Myotis yumanensis Yuma Myotis Bat	Federal State	SC none	Roosts colonially in caves, tunnels and buildings. Inhabits arid regions. Distributed throughout the western U.S., Mexico and Canada.	Low: potentially suitable foraging and roosting habitat present onsite and offsite.
Neotoma fuxcipes riparia San Joaquin Valley Woodrat	Federal State	SC SSC	Inhabits brushy and forested areas in riparian habitats. Builds nests in trees, snags and along logs. Occurs along the San Joaquin, Stanislaus and Tuolumne rivers; not known from project area.	Low onsite and low offsite: no suitable habitat along Putah Creek; requires undisturbed creek terrace vegetation.
Perognathus inornatus San Joaquin Pocket Mouse	Federal State	SC SSC	Inhabits grassland and scrub habitats in Central and San Joaquin Valleys.	None onsite and offsite: no suitable habitat in study area.

Table 3-2 Special-Status Animal Species Known or Suspected to Occur at the Site and Vicinity (Continued).

Scientific Name Common Name	Status[1]		Habitat Affinities and Reported Localities in the Project Area	Potential for Occurrence On-Site or in Project Area
Taxidea taxus American Badger	Federal State	none *	Inhabits open grasslands, savannas and mountain meadows near timberline. Require abundant burrowing mammals, their principal food source, and loose, friable soils. Believed restricted in California to the Central Valley and adjacent lowlands to the west.	Moderate onsite and offsite: an individual was seen at LEHR by UCD personnel in 1996.
Fish				
Acipenser medirostris Green Sturgeon	Federal State	SC CT	Anadromous. Inhabits estuaries of large rivers. Migrates far inland to spawn. Spawns during spring in rivers in deep, cold, fast-moving water. Only known to spawn in the Sacramento and Klamath rivers. Estuaries serve as nurseries. Adults are mostly marine, spending limited time in estuaries and rivers. Occurs from Alaska to Baja California.	None onsite or offsite: no suitable habitat present in Putah Creek.
Archoplites interruptus Sacramento Perch	Federal State	none watch	This warm water, lacustrine species formerly inhabited sloughs, slow-moving rivers and lakes of the Central Valley. It is now mostly restricted to reservoirs and farm ponds. It is associated with submerged or emergent vegetation, which is essential for young. The species is native to the Sacramento, San Joaquin, Salinas and Pajaro rivers.	None onsite. Low offsite: existing habitat is not considered suitable. Species might have historically occurred in lower Putah Creek.
Hypomesus transpacificus Delta Smelt	Federal State	FT CT	Inhabits open brackish and fresh water of large channels. Spawns during spring in sloughs and channels in the upper Delta. Spawning has also been recorded in Montezuma Slough and Suisun Bay. Occurs from Isleton on the Sacramento River and Mossman on the San Joaquin River to Suisun Bay.	None onsite or offsite: no suitable habitat present in Putah Creek.
Lampetra ayresi River Lamprey	Federal State	SC watch	Anadromous. Spawns during spring in clear gravel riffle pools in coastal streams. Young metamorphose upriver from salt water and enter the ocean in the following late spring. Restricted to coastal streams from Alaska to the San Francisco Bay. In Calif., the species is only recorded the Sacramento-San Joaquin rivers and the Russian River.	None onsite. Low offsite: marginally suitable habitat present in Putah Creek offsite.

Table 3-2 Special-Status Animal Species Known or Suspected to Occur at the Site and Vicinity (Continued).

Scientific Name Common Name	Status[1]		Habitat Affinities and Reported Localities in the Project Area	Potential for Occurrence On-Site or in Project Area
Lampreta tridentata Pacific Lamprey	Federal State	SC none	Anadromous. Spawns during spring in clear, gravel riffle pools in clear, coastal streams. Adults feed in the ocean. Distributed from Alaska to the Santa Ana River.	None onsite. Moderate offsite: suitable habitat present in Putah Creek.
Oncorhyncus mykiss irideus Steelhead (Rainbow) Trout (Summer-run)	Federal State	FPE CT	Anadromous. Inhabits cold headwaters, creeks, and small to large rivers and lakes with swift, shallow water and clean, loose gravel for spawning. Requires large pools during summer months. Spawns in spring. Occurs throughout the Pacific coast of the U.S. Migrates throughout the SF Bay.	Very low offsite: while steelhead are likely to migrate through Putah Creek, the presence of summer- run fish is highly unlikely.
Oncorhyncus tshawtscha winter-run Chinook (King) Salmon	Federal State	FE CT	Anadromous. Inhabits open ocean and coastal streams. Adults move upstream Jan.-June and begin spawning in April. Downstream migrant smolts move past Red Bluff Aug- Oct. Limited entirely to the Sacramento River system.	None onsite or offsite: no suitable habitat present in Putah Creek.
Oncorhyncus tshawtscha spring-run Chinook (King) Salmon	Federal State	none CE	Anadromous. Inhabits open ocean and coastal streams. Adults move upstream Mar.-July and begin spawning in August. Limited entirely to the Sacramento River system.	None onsite. Low offsite: marginally suitable habitat present in Putah Creek. The presence of spring-run fish is highly unlikely
Pogonichthys macrolepidotus Sacramento Splittail	Federal State	FPT CT	Inhabits both fresh and brackish water. Adults spawn on flooded vegetation after storms from Jan.-May. Larvae remain in shore vegetation until late summer. Recorded in Sacramento, Sutter, Yolo and Stanislaus counties.	None onsite. Low offsite: marginally suitable habitat present in Putah Creek. Presence is unlikely.
Spirinchus thaleichthys Longfin Smelt	Federal State	SC CE	This native species inhabits estuaries and bays near to shore. It occurs along the Pacific coast from Alaska to the Monterey Bay. In the San Francisco Bay, its main populations are in San Pablo Bay. It ascends coastal streams from Oct. to Dec. to spawn. It is an important forage species.	None onsite or offsite: no suitable habitat present in Putah Creek.

Notes:
[1] Explanation of sensitivity status codes provided in Appendix D.
TEXT Special status with moderate to high potential to inhabit and/or forage on the LEHR site and vicinity.

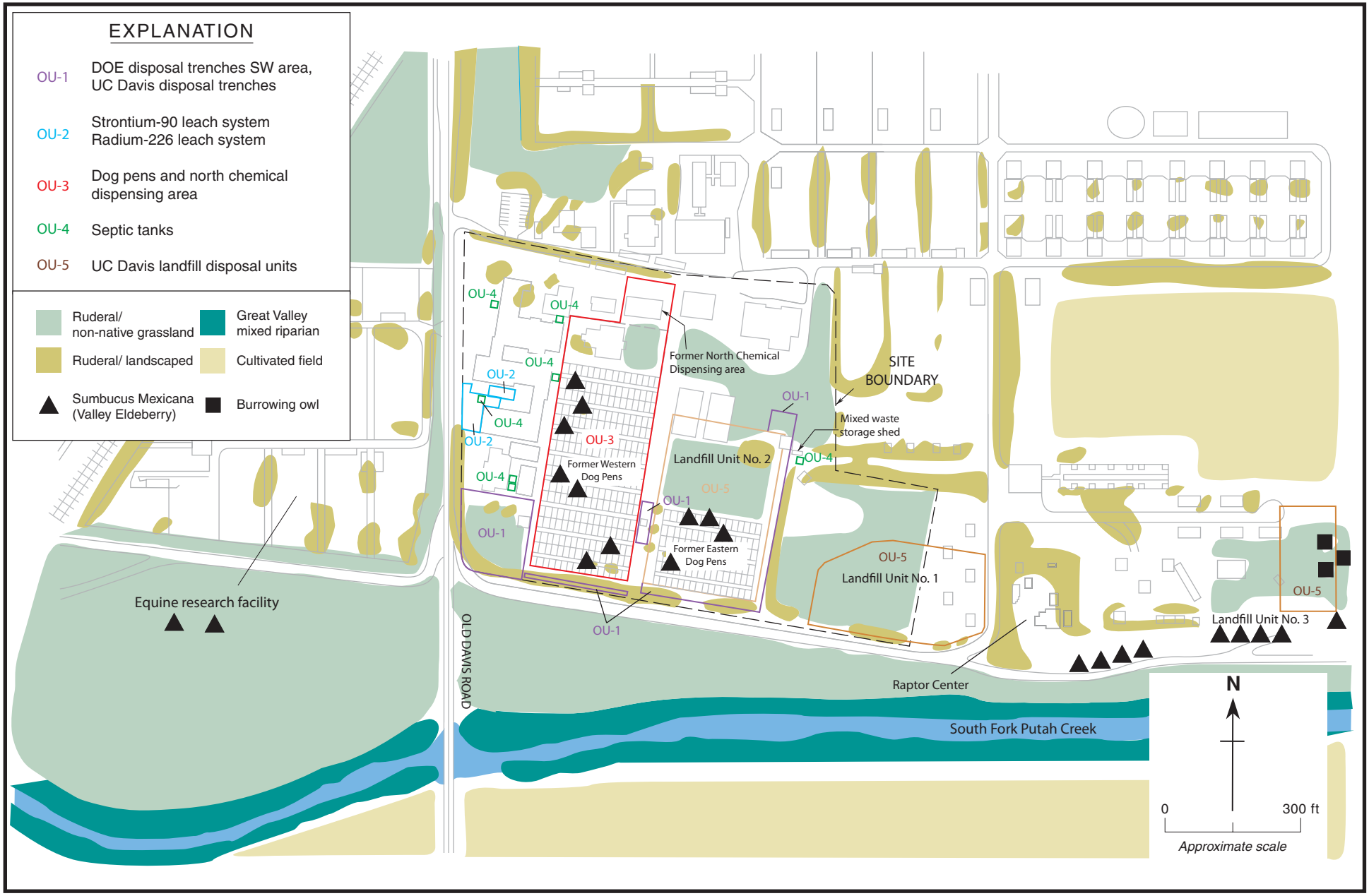


Figure 3-1. Site Vegetation/Habitat Characterization.

Weiss Associates

a1c-003.ai

07/30/97

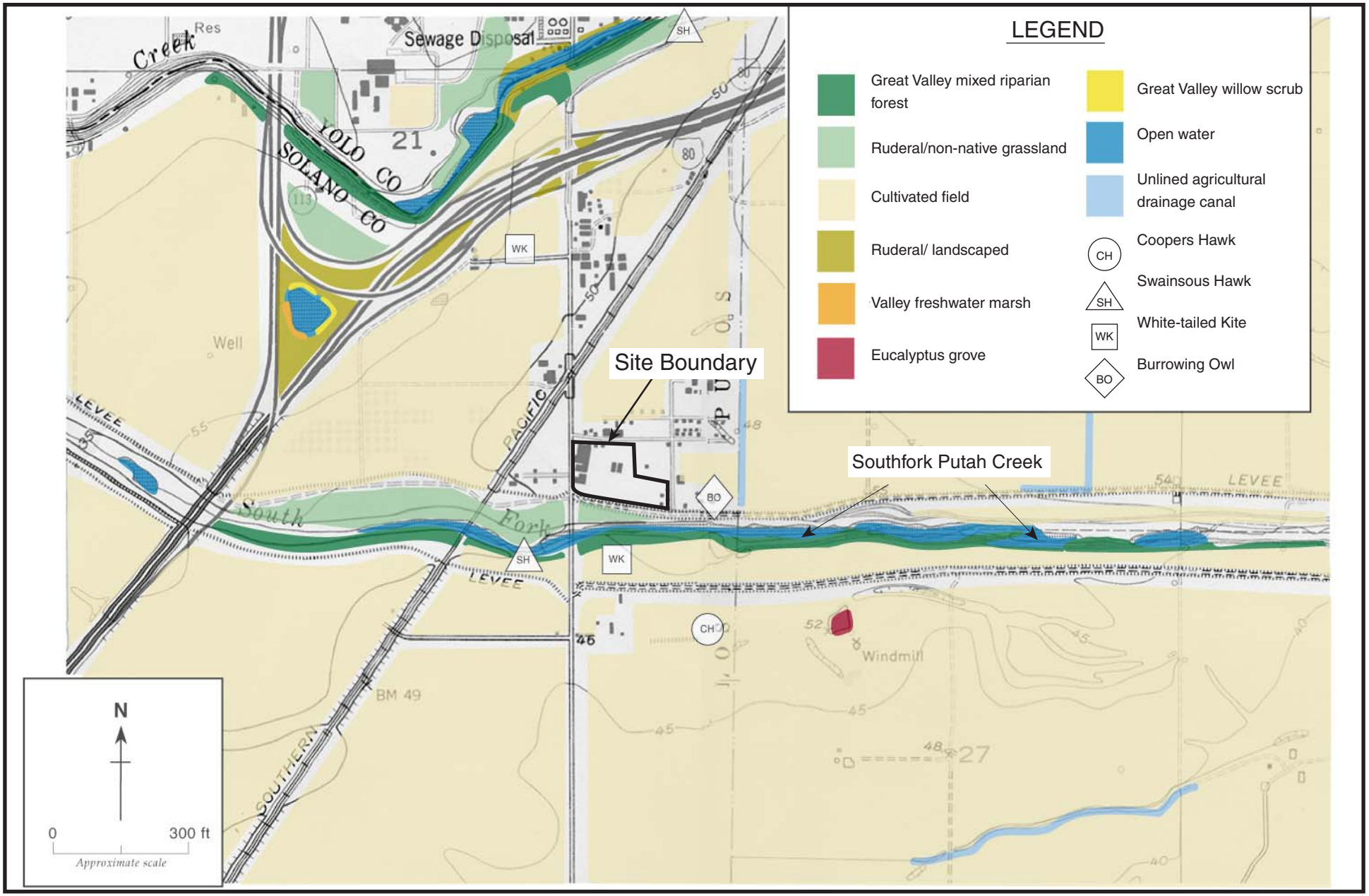


Figure 3-2. Site Vicinity Vegetation/Habitat Characterization.

Weiss Associates

Figure 3-5:
Evidence of Burrowing Mammals on the Site.
Photo taken during Winter 96/97.

Figure 3-6:
Habitats Present Within 1 Mile Radius of LEHR Site Boundary: Ruderal/Non-native Grassland, Great Valley Mixed Riparian Forest, and Putah Creek During High Water.
Photo taken of Putah Creek during winter 96/97.

Figure 3-3:
Habitats Occuring Within the Site Boundary: Sparsley covered bare ground, buildings and structures and Ruderal/Landscaped in background.
Photo taken looking east from within western dog pens, during winter 96/97.

Figure 3-4:
Habitats Occuring Within the Site Boundary: Ruderal/non-native Grassland, Ruderal/Landscaped Trees and Potential Valley Eldeberry Longhorn Beetle Habitat.
Photo taken looking south at northeast corner of eastern dog pens, during winter 96/97.

Figure 3-7:
Habitats Occurring Within 1 Mile of the Site Boundary: Cultivated Fields and an Unlined Agricultural Drainage Canal.
Photo taken looking north during winter 96/97.

Figure 3-8:
Former Fox or Skunk Burrow on Bank of Unlined Agricultural Drainage Canal, Currently Occupied by Burrowing Owls. Constructed Burrowing Owl Mounds Adjacent to UCD Landfill Unit 3 in Background. Within 1 Mile Radius of the Site Boundary.
Photo taken looking east during winter 96/97.

4. EXPOSURE PATHWAY ASSESSMENT

4.1 Introduction

The results of the Site characterization indicate that COPECs and ROPECs are present in ecologically significant media. The biological characterization indicates that biological receptors are present or have the potential to occur on and in the vicinity of the Site. Therefore, the results of the Site characterization and the biological characterization have been carried forward into the exposure pathway assessment.

The objective of the exposure pathway assessment is to identify the potential for contact between environmental receptors and COPECs and ROPECs in any medium and by any exposure route. Both indirect and direct exposure pathways are evaluated. All potentially ecologically significant media are considered. Components of this potential exposure pathway assessment include:

- Segregating observed and/or expected species into appropriate habitats and receptor groups;
- Constructing generalized food web showing the flow of energy, materials and potential contaminants through trophic levels (bioaccumulation);
- Developing conceptual Site models to identify the probable migration processes of COPECs and ROPECs from release sites and source media;
- Identifying potential direct and indirect exposure pathways between study area wildlife and COPECs and ROPECs based on the relationships described in the generalized food web and the conceptual Site models; and
- Determining significant exposure pathways for specific exposure groups and COPECs/ROPECs.

4.2 Exposure Group Selection

Due to the diversity of wildlife and the limited objectives of the Scoping Assessment, a complete evaluation of exposure to COPECs and ROPECs of every potentially affected species was not warranted. Instead, functional groups were used to represent species potentially exposed to COPECs and ROPECs at the Site. Biological functional groups are based on function within the ecosystem, potential for exposure to various media, and physiologic and taxonomic similarities. For purposes of this report the terms functional group and exposure group are interchangeable.

Tables 4-1 and 4-2 present the species identified as occurring or with the potential to occur on or near the Site, listed by the exposure group to which they were assigned. Special status species are highlighted on the tables. Once defined, the exposure groups were assigned to habitats on-site and off-site as established in Section 3 of this report, the biological survey. In this study, the following exposure group definitions were used.

On-site and Off-site

- Amphibians – Includes summering amphibians, such as the Pacific tree frog, dependent on water for reproductive purposes.
- Bats - The only true flying mammal, bats prey primarily on flying insects. An example of a species within the exposure group expected to occur at the Site is the California myotis.
- Burrowing Mammals – Members of this group are important prey species to raptors, reptiles and predatory mammals. Mammals, such as the California ground squirrel, are assigned to this category based primarily on borrowing activity rather than dietary criteria.
- Burrowing Owls - A unique, special status bird of prey, this diurnal owl colonizes abandoned burrowing mammal tunnels.
- Granivorous Birds - Seed eating birds, such as the golden-crowned sparrow, spend a large portion of time foraging for seeds on the ground surface.
- Insectivorous Birds - Insect eating birds, such as the killdeer and the Northern flicker, forage on ground and in vegetation for prey species.
- Omnivorous Birds - Insect and seed eating birds, such as the special status California horned lark, forage on the ground and in trees.
- Predatory Mammals - Top terrestrial predators such as the coyote and the special status American badger. Prey species include burrowing mammals, reptiles and a variety of other food items.
- Raptors - These birds of prey are the top predators of the region, feeding on a diverse set of prey species including frogs, snakes, ground squirrels, fish and small birds. An example of special status species in this exposure group observed in the study area include the white-tailed kite and the Northern harrier.
- Reptiles - Several snake, lizard and turtle species potentially inhabit the study area, including the gopher snake and the western fence lizard. Potentially occurring special status species in this exposure group include the giant garter snake and the Western pond turtle.
- Terrestrial Plants – Land plants, such as the Valley Oak and Valley Eldeberry.

Off-site only:

- Aquatic Mammals - These mammals spend the majority of their lifecycle associated with riparian habitats and water, consuming vegetative matter, benthic invertebrates and fish. Examples of expected or observed species include the river otter and beaver.
- Herbivorous Mammals - These mammals consume vegetative matter only. The only species classified as a herbivorous mammal with the potential to occur on or near the Site is the mule deer. Toxicity studies indicate the herbivorous mammals incidentally ingest large quantities of soil along with grasses and acorns that they prefer (LLNL, 1994).
- Piscivorous Birds - Fish eating birds, observed species include the Belted Kingfisher.
- Wading Shore Birds - This group of birds spend time slowly wading through shallow waters waiting to impale a passing fish, frog or crayfish. Observed special status species include the great blue heron.
- Water Fowl - Birds with flat, "duck" bill primarily used to strain submerged vegetation. An example of an observed species in this exposure group is the mallard.
- Benthic/Pelagic Invertebrates - Worm, insect, snail and crustacean-like organisms free floating and also associated with the benthos. Extremely tolerant of adverse environmental conditions and are the main food source of many fish species. An example of a crustacean in this exposure group is commonly referred to as the crayfish.
- Fish - Invertebrate and vegetation-eating fish, common species in Putah Creek include the green sunfish and the Sacramento blackfish.
- Predatory Fish - Fish species likely to ingest larger prey items including other fish, amphibians, crustaceans and occasionally bats. An example of a likely species inhabiting Putah Creek is the smallmouth bass.
- Aquatic/Riparian Plants – Riparian (river bank) plants include the cottonwood and aquatic (instream) plants include alga in the genus *periphyton*.

The complete inventory of observed or potentially occurring on-site and off-site exposure groups is presented in Tables 4-1 and 4-2.

4.3 Food Web Analysis

A generalized food web has been developed to determine how identified COPECs and ROPECs may affect ecological components of the Site as the result of food web links (NRC, 1986; U.S. EPA, 1992) and is shown in Figure 4-1. The food web describes the structure of the biological community in terms of primary producers and successive levels of consumers. These

successive producer and consumer groups are also commonly known as trophic levels. This transfer of material and energy from one trophic level to another is communicated with the use of arrows. Energy and nutrients flow with the direction of the arrow, from primary producers to primary consumer and successive orders of consumers.

The food web was constructed using the information obtained during the biological characterization of the Site and vicinity. In order to accommodate the diversity of species and to clarify feeding relationships in the study area, organisms were combined into functional groups as discussed in section 4.2. Additionally, the food web was constructed by describing the combined feeding relationships of both the aquatic ecosystem associated with Putah Creek and the terrestrial ecosystems associated with the Site and surrounding lands because of the likely cross-over of functional groups, particularly higher order predators.

A total of 20 exposure groups have been evaluated and linked through food web relationships. The food web is organized horizontally and vertically. First, the food web is generally horizontally divided between aquatic and terrestrial based ecosystems. The left side of Figure 4-1 represents the terrestrial based ecosystems of the Site and surrounding lands and the right side of the figure represents aquatic based ecosystem of Putah Creek and adjacent riparian habitat. Next the figure is organized based by trophic level. In order to make the transfer of energy and nutrients from each trophic level clear, each trophic level and associated energy/nutrient transfer arrows were assigned distinct colors. Soil, sediment, decaying organic matter and water occupy the lowest, and largest level of the food web. The next trophic level represents the primary producers commonly known as plants. Successive orders of consumers occupy higher trophic levels in the food web. The highest order consumers are the predatory mammals and the raptors. These tertiary- and sometimes quaternary-order consumers have greatest potential to suffer the affects of bioaccumulation of contaminants. The food web analysis is presented in Figure 4-1.

4.4 Development of Conceptual Site Models

Conceptual models have been developed to address potential intermedia and intramedia transport processes for COPECs and ROPECs in ecologically significant media in order to define potential exposure routes in the study area. The fundamental assumptions incorporated into the conceptual models are that COPECs and ROPECs may migrate from their source area to an exposure point. For the purposes of evaluating fate and transport processes, individual COPECs were grouped into classes of compounds based on similar chemical properties (Tables 2-1 through 2-6). If the source area differed from the exposure point, a conceptual Site model was used to address the potential intermedia migration processes at the Site. The conceptual models have been developed based on:

- Physical properties of identified environmental media;
- Physical and chemical characteristics of COPECs and ROPECs; and
- Transport/contaminant migration processes that may affect COPECs and ROPECs in media of ecological concern.

These conceptual Site models were developed to account for migration processes with the potential to affect Site contaminants and to define possible exposure routes for the Site. The conceptual Site models are described below.

4.4.1 Conceptual Models

Five conceptual models are discussed below:

Conceptual Model 1: Contaminants bound to surface soil particles may be transported from the source area on resuspended particulates and redeposited at a distance.

Assumptions:

- Surface soil is defined as the uppermost 3 ft of the soil column.
- The COPECs and ROPECs identified in surface soil include radionuclides, pesticides, metals, and SVOCs listed in Tables 2-1 and 2-2.
- Pesticides, metals, and radionuclides are the contaminants of concern most likely to be transported while adsorbed to surface soil particles. Transport of VOCs and SVOCs adsorbed to resuspended soil particulates is not a significant migration pathway.
- VOCs are not likely to be transported via this migration pathway as VOCs bound to soil particles would likely volatilize during resuspension and transport of soil particles.
- Surface soil is subject to weathering and wind action, the principal mechanism for suspension of soil particles in the atmosphere.
- The transfer of soil to the atmosphere is affected by environmental factors such as extent of vegetative cover, variability of terrain, and precipitation.
- Density of resuspended soil particles will be highest near the soil/air interface.
- Density of resuspended soil particles will decrease with height above the soil/air interface increases.
- Dispersion of resuspended soil particles will occur.
- As a result of dispersion, the density of resuspended soil particles with sorbed contaminants in air will decrease with distance from the source area.
- Similarly, the density of resuspended soil particles with sorbed contaminants, which are redeposited, will decrease with distance from the source area.

Conceptual Model 2: VOCs that are present in on-site subsurface soil volatilize into subsurface air.

Assumptions:

- Subsurface soil is defined as soil between 3 and 15 ft bgs.
- Only VOCs listed in Table 2-3 and radium are of concern in this model. Metals, pesticides, and most radionuclides do not volatilize significantly from subsurface soil with the exception of radium. Radium may degrade to radon and migrate into subsurface air as radon gas.
- Contaminants may volatilize from subsurface soil into subsurface air (e.g. in burrow holes).
- Only shallow subsurface soil (between 3 and 12 ft bgs) is actively utilized by animals.
- This conceptual model applies to on-site soil only. Contaminants are not present in off-site subsurface soil.

Conceptual Model 3: VOCs that are present in on-site surface soil volatilize into ambient air.

Assumptions:

- Surface soil is defined as the uppermost 3 ft of the soil column.
- Only VOCs listed in Table 2-3 and radium are of concern in this model. Metals, pesticides, and most radionuclides do not migrate significantly from surface soil with the exception of radium. Radium may degrade to radon and migrate into surface air as radon gas.
- Contaminants may volatilize from surface soil into ambient air.
- Significant dilution of contaminant vapors in ambient air is likely to occur due to mixing.
- This conceptual model applies primarily to on-site soil. Contaminants are not present in significant concentrations in surface soil off-site.

Conceptual Model 4: Contaminants migrate from soil to surface water through dissolution in storm water. Storm water accumulates on-site or discharges to Putah Creek surface waters.

Assumptions:

- Contaminants may be dissolved in rainwater during storm events.
- Storm water may accumulate and pond in topographically low areas on-site.
- Storm water runoff from some DOE Areas is primarily discharged to Putah Creek via lift station #1 (SWL-1).
- Contaminants identified in storm water sampling points SWL-1 and SWL-2 include pesticides, VOCs, SVOCs, metals and radionuclides listed in Tables 2-5 and 2-6.

- Contaminants detected in storm water sampling points SWL-1 and SWL-2 are representative of the contaminants which are dissolved in storm water from DOE OU soil and transported to Putah Creek surface waters.

Conceptual Model 5: Contaminants enter the food chain through direct exposure to contaminated media or ingestion of a contaminated food source.

Assumptions:

- Contaminants are directly ingested, inhaled or absorbed from contaminated media by wildlife through processes described in conceptual models listed above.
- Contaminant uptake by plants may occur to a significant degree primarily in the upper 3 ft of the soil column.
- Contaminated plant tissue is ingested by wildlife.
- Contaminants ingested directly from contaminated media or indirectly though the consumption of plant material or prey species may bioaccumulate in the tissue or organs of consumer species. Contaminants move through the food web through predation of contaminated wildlife.
- Pesticides and some metals (i.e. lead) tend to bioaccumulate.

4.5 Identification of Potentially Complete Exposure Pathways

The objective of the exposure pathway assessment is to identify the potential for contact between the environmental receptors and COPECs/ROPECs in any medium of ecological concern and by any exposure route. An exposure pathway was identified as potentially complete unless it was demonstrated that:

- There were no contaminants of concern in the source media;
- There was no transport mechanism for the contaminant to a point of exposure;
- No point of contact existed for the contaminant and potential receptors; or
- No exposure route exists at the point of contact.

The methodology used to assess exposure pathways, identify potentially complete exposure pathways, and to preliminarily determine the significance of these potentially complete pathways is discussed below.

4.5.1 Methodology

The potential for exposure for all biota which are present or potentially present at the Site, as identified in the biological characterization, were evaluated. In the evaluation of potential exposure, the following factors were considered:

- Organisms that may actually or potentially be exposed to contaminants at the Site as described in the biological characterization;
- Significant contaminant migration routes as defined by the conceptual models;
- Spatial scale of exposure;
- Site-specific geophysical, physical, and chemical conditions affecting exposure as described in the Site characterization; and
- Physical and chemical characteristics of COPECs/ROPECs that influence fate and transport.

Biota were organized into major ecological functional groups and the COPECs and ROPECs into classes of compounds (VOCs, pesticides, etc.) for the purpose of exposure pathway analysis as discussed in Section 3.2.

The following exposure pathways by which biota may be exposed to contaminants of potential concern in environmental media were evaluated to determine if they are potentially complete:

- Direct uptake of COPECs/ROPECs by vegetation;
- Direct dermal contact with contaminated soil, sediment, or water;
- Direct ingestion of contaminated water;
- Direct ingestion of contaminated soil or sediment;
- Direct inhalation of contaminated airborne particles;
- Direct inhalation of contaminated vapors present in subsurface and ambient air; and
- Indirect exposure via ingestion of contaminants through food-chain links (i.e. consumption of vegetation or prey items containing COPECs and ROPECs).

For indirect exposure routes, such as exposure through consumption of food items, particular consideration was given to COPECs and ROPECs with physical parameters which indicate a potential for persistence and bioaccumulation.

The significance of the potentially complete exposure pathways was evaluated by: 1) comparing the areas of the Site identified as containing COPECs/ROPECs in environmental media to expected or observed exposure groups, 2) ranking the potential for the exposure group to be exposed to contaminants through a particular exposure pathway, and 3) evaluating the significance of COPEC/ROPEC groups in specific exposure scenarios.

4.5.2 Identification of Complete Exposure Pathways

The exposure pathway analysis is presented in Figure 4-2 and summarizes:

- Contaminant source media and COPECs/ROPECs detected in that media, transport mechanisms;
- Exposure routes;
- Ecological receptors (exposure groups); and
- Assessment of exposure pathway completeness, as well as the rationale on which the assessment was based.

At least one potentially complete exposure pathway was identified for all ecological exposure groups actually or potentially occurring on or near the Site.

Wildlife can be exposed to COPECs/ROPECs in surface soil as a result of incidental or direct ingestion, and/or through dermal absorption. It is known that wildlife can consume significant quantities of soil in their diet (Kruelen and Jaeger, 1984). While some species actively consume soil, most species ingest soil as a result of grazing or feeding habits.

Dermal exposure through absorption of COPECs/ROPECs in soil can occur for biological receptors that come in contact with contaminated soil while burrowing/tunneling or as a result of grooming/resting habits.

COPECs/ROPECs may be present in ambient air or air within subsurface burrows as a result of volatilization from contaminated soil and/or adsorbed to resuspended soil particles. Exposure to COPECs/ROPECs in may occur through inhalation and ingestion of the resuspended surface soil particles and/or inhalation of contaminated vapor.

COPECs and ROPECs were identified in storm water runoff samples collected at the Site. In general, storm water residence time on-site is minimal, but because storm water has been observed to collect and pond in topographically low portions of the Site, exposure to COPECs and ROPECs in ponded storm water may occur to Site biota via ingestion or through dermal contact.

The presence of COPECs and ROPECs in storm water runoff from the Site that feeds directly to the surface waters of Putah Creek indicate a potential for exposure to COPECs and ROPECs in surface water and sediment by aquatic organisms. Putah Creek may also be utilized by various terrestrial invertebrates, reptiles, birds, and mammals; therefore exposure to COPECs and ROPECs in surface water by some terrestrial wildlife can be expected.

In addition to exposure to COPECs/ROPECs in abiotic media (i.e. soil, water, and air), wildlife can also be exposed to COPECs/ROPECs as a result of food-chain links. The food web analysis described in Section 4.3 was used to evaluate potential exposure pathways via the food-chain.

Aquatic and riparian plants may uptake contaminants from this surface water body, representing a potential exposure pathway for aquatic or riparian plant species. Terrestrial plants may be exposed to COPECs/ROPECs in on-site surface and subsurface soil. Direct uptake of contaminants from surface and subsurface soil moisture by the roots of native and introduced plant species found within contaminated areas can be expected. In addition, plants may be

directly exposed to contaminants as a result of particulate deposition onto foliage. However, no threatened or endangered plant species are located within areas with identified soil contamination. Most plants within these contaminated areas are non-native introduced species.

In general, contaminated ground water is not a media of ecological concern at the Site. Due to the significant depth to ground water at the Site (28 ft to 48 ft bgs), the fact the Putah Creek is a losing stream, and the limited root depth of study area vegetation, there is not considered to be a complete exposure pathway for COPECs/ROPECs in ground water to plants or wildlife.

4.5.3 Discussion of Relative Potential Significance of Complete Exposure Pathways

The relative potential significance of the various complete exposure pathways was determined by 1) comparing the areas of the Site identified as containing COPECs and ROPECs in environmental media to expected or observed plant and animal species, 2) making a relative ranking of the potential for the ecological exposure group to be exposed through a particular exposure pathway, and 3) evaluating the relative significance of COPEC/ROPEC chemical groups in specific exposure scenarios.

Although a potentially complete pathway may exist for a receptor group to be exposed to a COPEC or ROPEC, the exposure through this pathway may not be equally significant for all functional groups listed (Figure 4-2). The potential for exposure via a specific pathway may also vary depending on whether the exposure occurs on- or off-site. For example, the potential for ingestion of contaminated soil is much higher for biological receptors who spend a significant portion of their time in contact with surface or subsurface soil (i.e. burrowing mammals) than for an organism that may occasionally ingest small quantities of soil during feeding. In addition, a receptor will have a greater potential for ingesting contaminated soil if its habitat is located on-site in proximity to a contaminant source area, than would a similar animal living off-site.

Due to this large variability in the potential for exposure, the significance of each potentially complete exposure pathway for ecological groups listed as potential receptors via that pathway was evaluated and ranked (Tables 4-3 and 4-4). A "high" ranking indicates that it is highly probable that most species within the exposure group will be exposed to contaminants via that specific exposure pathway. A "low" ranking indicates that it is unlikely that most species within the exposure group will be significantly exposed to contaminants via the exposure pathway. A ranking range (i.e., high to low) indicates that exposure may vary from species to species within the receptor group depending on habitat, feeding/foraging habits, and other species-specific variables. "NA" indicates that a potentially complete exposure pathway does not exist for that exposure group. Rankings were based on generally available knowledge and may differ for specific species in each receptor group.

Similarly, although COPECs and ROPECs may have the potential to migrate via a particular pathway, the extent to which this occurs may vary significantly depending on specific chemical characteristics. For example, although a particular chemical may have been identified as a COPEC in surface soil, if that chemical has a low potential to be absorbed dermally, then

dermal contact with contaminated soil is not likely to be a significant exposure pathway for that chemical. The significance of each potentially complete exposure pathway for chemical groups listed as COPECs and ROPECs in media was evaluated and ranked (Table 4-5). A "high" ranking indicates that most compounds within that chemical group have a significant potential to migrate via the exposure pathway listed. A ranking range (i.e., high to low) indicates migration potential is variable depending on the specific chemical with the group. "NA" indicates that a migration route from the source to the point of contact does not exist for that chemical group.

The rankings shown in Tables 4-3, 4-4, and 4-5 are preliminary determinations of potential significance based on general knowledge of the exposure groups and the COPEC/ROPEC chemical classes. There will be both species- and chemical-specific variations within the groups presented. A range of rankings (i.e., low to high) have been presented for groups which exhibit a range of species- and/or chemical-specific variations which affect the pathway significance.

4.5.3.1 Significant Soil Exposure Pathways

Dermal exposure through absorption of COPECs/ROPECs in soil is a significant pathway for biological receptors that spend a significant portion of their time in contact with on-site surface and shallow subsurface soil (i.e. reptiles, amphibians, terrestrial invertebrates, and burrowing mammals and raptors). Incidental ingestion of subsurface soil as a result of digging, grooming and feeding habits of these exposure groups is also likely.

Pesticides, metals, and radionuclides are the most potentially significant contaminants of concern for exposure through dermal contact with on-site surface and subsurface soil due to the higher concentrations of these contaminants in this media and the tendency for dermal absorption of these contaminants to occur. Pesticides, metals, and radionuclides are also potentially significant contaminants of concern for exposure through ingestion of on-site and subsurface soil.

The magnitude of exposure of biological receptors to COPECs/ROPECs in soil is, in part, dependent on the location of the exposure. For example, exposure to surface soil in the vicinity of a source area is likely to be more significant than exposure to surface soil which contains contaminated soil particles which were resuspended by winds, transported by air, and redeposited at a distance.

Inhalation of contaminated vapors and/or soil present in subsurface air is a significant pathway only for mammals and raptors that burrow or nest in on-site subsurface soil. Only VOC COPECs and radium are considered in the inhalation exposure pathway for contaminated vapors because SVOCs, metals, pesticides, and radionuclides other than radium do not volatilize significantly from soil. Radium may decay and volatilize into subsurface air as radon gas. Pesticides, metals, and radionuclides are the potentially significant contaminants of concern for inhalation of subsurface dust.

Inhalation of vapor-phase contaminants in ambient air is not expected to be a significant pathway due to mixing and dilution. Inhalation of contaminants adsorbed to resuspended surface soil is a significant pathway primarily for those exposure groups who come in close contact with

surface soil through grazing/feeding or other habits such as amphibians, herbivorous mammals, and granivorous, insectivorous, and omnivorous birds; in other words, those that stir up dust during their normal activities. Pesticides, metals, and radionuclides are the potentially significant contaminants of concern for this exposure pathway. Transport of VOCs and SVOCs adsorbed to resuspended soil particulates is not a significant migration pathway.

In general, the potential for exposure through soil-related pathways is higher on-site than off-site due to the fact that contaminant concentrations at off-site locations will be significantly lower than on-site as a function of the transport mechanism.

4.5.3.2 Significant Surface Water and Aquatic Food Chain Exposure Pathways for Putah Creek

Ingestion of contaminated surface water is typically a significant exposure pathway for 1) aquatic organisms 2) biological receptors who spend a significant portion of their time in contact with surface water (i.e. water fowl and wading shore birds), and 3) terrestrial organisms whose primary source of water is surface water intake (i.e. predatory mammals). This exposure pathway is also typically significant for amphibians during their developmental stage that generally occurs in surface waters. Food-chain exposure is potentially a significant pathway for fish and exposure groups, such as water fowl, wading shore birds, and aquatic mammals whose primary food source is fish and/or invertebrates in Putah Creek.

The potential for significant, the Site-related exposures to occur for aquatic organisms via the Putah Creek surface water exposure pathways is evaluated here in a semi-quantitative fashion, in part because of the recent attention given to surface water-related exposure pathways by ATSDR. ATSDR (1996) concluded that, with the exception of lead and mercury, chemical and radionuclide contaminant levels in Putah Creek surface water, sediments, and fish do not pose a significant risk. Contaminants present in certain DOE Area surface soil have the potential to migrate to Putah Creek via erosion and runoff during storm events. Therefore, it is relevant to examine here whether or not the DOE Areas at the Site could be contributing significantly to lead and mercury concentrations in Putah Creek surface water, and in fish through bioconcentration.

UC Davis has prepared a Site wide drainage map (Attachment A) that delineates on-site drainage areas. This analysis indicates that of the DOE Areas, surface water runoff in a portion of OU1, the Southwest Trenches, and a portion of OU-2, the Radium/Strontium treatment areas, discharges to Putah Creek. The total drainage area for the DOE Areas of the Site that shed surface water runoff to Putah Creek is approximately 4 acres. This area includes parking lots and buildings outside the boundaries of the DOE Areas. Section 2 of this report identifies lead as a contaminant of concern in OU1 Site surface soil, with a maximum concentration of 21 mg/kg, slightly above the background concentration of about 11 mg/kg. Mercury is also present in OU1 surface soil, but not at concentrations significantly above the naturally-occurring background level. Further, on-site storm water samples collected from this drainage area show lead present at a maximum concentration of about 38 ug/l, below USEPA National Ambient Water Quality Criteria for Freshwater Aquatic Life Protection. Mercury has not been detected in storm water runoff samples from the DOE Areas, at a detection limit an order of magnitude less than the

USEPA NAWQC. Based on these data, it appears that the DOE Areas of the Site that contribute surface water runoff to the creek do not result in any significant contribution of mercury to the creek above that which might be expected from naturally occurring background soil.

In order to evaluate the significance of the DOE Area contribution of lead to the creek, surface water runoff volume was conservatively estimated using Site-specific 1994 and 1995 storm event (rainfall) data coupled with a calculation algorithm from the Superfund Exposure Assessment Manual (EPA, 1988). Putah Creek streamflow data from the Old Davis Road gauging station was obtained from the same period, and an average and worst-case dilution factor was calculated. The dilution factor estimates the amount that Site DOE Areas storm water is diluted upon entering Putah Creek. Comparison of the DOE storm water concentration data, as adjusted by the conservative dilution factor, and the available data for the upstream and downstream Putah Creek surface water sampling locations, shows that on a concentration basis, DOE storm water runoff represents less than 10% of the total lead concentration measured in Putah Creek. More relevant is examination of lead mass loading to the creek from DOE storm water runoff. Putah Creek flow data were coupled with Putah Creek surface water monitoring data from the upstream and downstream locations (PCU and PCD, respectively) to calculate total mass loading of lead in the creek on an annual basis for 1994 and 1995. Similarly, DOE storm water lead concentration data were coupled with the conservative estimate of storm water runoff flow to estimate lead mass loading to the creek for both 1994 and 1995. Based on average and maximum concentrations of lead measured in the creek and in storm water, the DOE Area contribution to lead mass contribution in Putah Creek was calculated to be between 0.07% and 0.09%. These data and calculations are included in Attachment E of the *Draft Final Determination of Risk-Based Action Standards for DOE Areas*. We conclude that the contribution of lead from DOE portions of the Site to Putah Creek via storm water runoff is insignificant based on this analysis.

Further, careful review of the Site drainage map included in Attachment A shows that only a limited portion of any of the DOE Areas has surface drainage resulting in discharge to the creek. Storm water ponds and infiltrates over the majority of the DOE Areas, according to the drainage map developed by UC Davis' contractor. Only a portion of the surface soil in OU1 and OU2 sheds water resulting in surface runoff. Therefore, it is unlikely that this small volume of surface water from DOE Areas is a significant source of contamination, specifically lead, to Putah Creek.

Based on this analysis, while the presence of contaminants in Putah Creek surface waters might, if analyzed quantitatively, be of ecological concern, it appears that the contribution from the DOE Areas at the Site to contaminant levels found in the creek is small, and likely not significant. Therefore, for this Scoping Assessment, the relative significance of surface water related exposure pathways is low.

4.5.3.3 Surface Water Exposure Pathway for On-site Ponded Water

Although ponding of storm water following heavy rains has been documented on-site in a portion of OU1 (DOE disposal trenches, south west area), this does not represent a significant surface water exposure pathway. There are only a few exposure groups that are expected to be

exposed to this ponded water with a limited duration of potential exposure. A limited number of metals (chromium, copper, mercury, and lead), the pesticides alpha/gamma chlordane and 4,4-DDD, and radionuclides are present as COPECs and ROPECs in surface soil in OU1. These compounds may dissolve in ponded on-site surface water in OU1, but the significance of these compounds for the of ingestion or dermal contact exposure pathways are considered to be low due to the short residence time of this water on-site.

4.5.3.4 Sediment Exposure Pathway

Dermal exposure through absorption and/or ingestion of contaminated sediment in Putah Creek is a potentially significant pathway for: 1) aquatic organisms who live in or on sediment (i.e. benthic invertebrates and bottom feeding fish, 2) aquatic reptiles, and 3) water fowl or wading birds who may ingest significant quantities of sediment during feeding. However, radionuclide, metal, and organic compound concentrations in sediment collected from Putah Creek during the ATSDR study were not appreciably elevated compared to background concentrations or relevant standards and guidelines except for mercury (ATSDR, 1997). Elevated concentrations of mercury were detected in Putah Creek sediment collected from one sample location (Site #1) in the ATSDR study. The ATSDR report concluded that mercury detected in sediments from Site #1 could potentially bioaccumulate in aquatic organisms. Elevated mercury levels were detected in fish samples collected from Putah Creek. However, mercury was detected in DOE Area soil just above background (1 ppm compared to 0.49 ppm) and was not detected in DOE Area storm water at detection limits below relevant EPA AWQC.

4.5.3.5 Terrestrial Food-Chain Exposure Pathways

Exposure via food-chain links is a significant pathway for higher order terrestrial consumers such as predatory mammals and raptors. However, the magnitude of exposure through this pathway is highly dependent on the degree to which their prey has bioaccumulated contaminants in their tissue. Food-chain exposure is considered as a significant pathway for pesticide COPECs due to their tendency to bioaccumulate, and possibly for some metals.

4.5.3.6 Exposure Pathways for Plants

Direct uptake of contaminants from on-site surface and subsurface soil moisture by the roots of terrestrial plants located within contaminant source areas may be a potentially significant exposure pathway. The significance of this exposure will decrease with distance from contaminant source areas. Pesticides, metals, and radionuclides are the most significant contaminants of concern for exposure of terrestrial plants to soil contaminants. However, no threatened or endangered terrestrial plant species have been identified in an on-site area with soil contamination. Most on-site terrestrial plants are non-native, introduced species.

Uptake of contaminants from sediments in Putah Creek by aquatic plants may be a significant exposure pathway for mercury. Elevated concentrations of mercury were detected in sediment collected from a sampling station in Putah Creek as part of the ATSDR study. However, mercury was detected in DOE Area soil just above background (1 ppm compared to 0.49 ppm) and was not detected in DOE Area storm water at detection limits below US EPA AWQC.

Direct uptake of contaminants in the Putah Creek surface water may be a significant exposure pathway for aquatic or riparian plant species. A limited number of metals, the pesticide chlordane, and radionuclides were identified as potentially significant COPECs/ROPECs for uptake of surface water by aquatic/riparian plants.

4.5.3.7 Summary of Significant Exposure Pathway Analysis

Table 4-6 summarizes the most significant exposure pathways for observed or expected exposure groups and the chemical groups to which these receptors are most likely to be exposed, or for which exposure may likely result in significant impact.

Other species-specific factors that may be considered in determining the significance of exposure pathways are:

- Home range of organisms or percentage of time they spend on-site. Migratory animals or organisms that typically inhabit a geographically large territory will spend less time in contact with contaminated media at the Site.
- Habitat. For example, organisms whose primary habitat is located off-site will have significantly less potential for exposure than those organisms whose primary habitat is located on-site and/or in close proximity to contaminant source areas.
- Feeding and/or foraging habits.
- Food sources.
- Grooming and resting habits.
- Primary water sources. For example, ingestion of surface water will not be a significant exposure pathway for organisms whose primary source of water is through prey or plant material (i.e. pocket mouse).

These species-specific elements are typically accounted for more fully in the calculation of risk/hazard as part of a Phase I Predictive Assessment. However, the objective of this Scoping Assessment is to identify potentially complete exposure pathways and make a preliminary determination as to the significance of those exposure pathways relative to the COPECs and ROPECs identified for the Site and exposure groups which are present or with the potential to occur on or near the Site. It is important to note that the presence of complete exposure pathways for specific exposure groups does not necessarily mean there is a risk/hazard presented by exposure of these functional groups to Site contaminants.

4.6 Conclusions

Results of the exposure pathway analysis, include:

- 11 exposure groups identified on-site/off-site;
- 9 exposure groups identified off-site;
- Potential food web links were identified;

- Transport mechanisms are potentially present by which contaminants may migrate from a source area to exposure points;
- There are potential points of contact between contaminants and potential biological receptors;
- There are potentially complete exposure routes at the point of contact;
- 7 exposure pathways evaluated;
- 6 complete exposure pathways on-site; and
- 7 complete exposure pathways off-site.

The exposure pathway analysis indicates that potentially complete exposure pathways exist at the Site whereby biological receptors may be exposed to contaminated media based on current site characterization data. Through the evaluation of significant exposure pathways at the Site, it was determined that although a potentially complete exposure pathway may exist for a functional group to be exposed to a COPEC or ROPEC, exposure through this pathway may not be equally significant for all functional groups or contaminant classes. In addition, the location of the exposure point (i.e. on-site vs. off-site), may significantly affect the magnitude of exposure. The presence of complete pathways by which biological receptors may be exposed to contaminated media is not, however, necessarily equivalent to the presence of significant risk or hazard to these receptors. Further, some exposure pathways that are currently potentially complete are likely to be eliminated following remedial action at the site.

Table 4-1. Summary of On-Site Habitats and Potential Ecological Receptors.

Habitat Type	Area (% of Site)	Exposure Group[a]	Expected Species	Observed Species	Relative Occurrence	Fed/CA Status[b]
Ruderal/Non-native Grassland	222,400 sf 5.1 acres (27%)					
		Amphibian				
			Western Toad	-	uncommon	none
			Pacific Tree Frog	-	common	none
		Bats				
			Big Brown Bat	-	uncommon	none
			California Myotis	-	uncommon	none
		Burrowing Mammal				
			CA Ground Squirrel	x	common	none
			CA Vole	-	common	none
			House Mouse	-	common	none
			W. Harvest Mouse	-	uncommon	none
			Bottas Pocket Gopher	x	common	none
			Black-tailed Jackrabbit	x	common	none
			Audubon's Cottontail	x	common	none
		Granivorous Bird				
			Mourning Dove	x	common	MB
			House Finch	x	common	MB
			Rock Dove	x	common	MB
			Golden-crowned Sparrow	x	common	MB
			White-crowned Sparrow	x	common	MB
		Insectivorous Bird				
			Black Phoebe	x	common	none
		Omnivorous Bird				
			Red-winged Blackbird	-	common	MB
			Hermit Thrush	x	uncommon	MB
			Killdeer	x	common	MB
			American Crow	x	common	MB
			CA Horned Lark	**x**	**uncommon**	**SC,MB/ SSC**
			Brewer's Blackbird	x	common	MB

Table 4-1. Summary of On-Site Habitats and Potential Ecological Receptors (continued).

Habitat Type	Area (% of Site)	Exposure Group[a]	Expected Species	Observed Species	Relative Occurrence	Fed/CA Status[b]
			Dark-eyed Junco	x	common	MB
Ruderal/Non-native Grassland (continued)		Omnivorous Bird (cont'd)	California Towhee	x	common	none
			Western Meadowlark	x	common	MB
			European Starling	x	common	none
			American Robin	x	common	MB
		Predatory Mammal				
			Coyote	x	uncommon	none
			Opossum	-	uncommon	none
			Striped Skunk	x	common	none
			Raccoon	x	common	none
			Red Fox	-	uncommon	none
			Gray Fox	-	uncommon	MB
		Raptor	**Short-eared Owl**	**-**	**uncommon**	**MB/SSC**
			Great Horned Owl	x	uncommon	MB
			Barn Owl	x	uncommon	MB
			Red-tailed Hawk	x	common	MB
			Northern Harrier	**x**	**common**	**MB/SSC**
			White-tailed Kite	**x**	**common**	**MB/SSC**
			American Kestrel	x	common	MB
		Reptile				
			Gopher Snake	-	uncommon	none
			Western Fence Lizard	-	common	none
Ruderal/ Landscaped	61,300 sf 1.4 acres (26%)	Granivorous Bird				
			House Finch	x	common	MB
			Hermit Thrush	x	uncommon	MB
			Rock Dove	x	common	none
			Golden-crowned Sparrow	x	common	MB
			White-crowned Sparrow	x	common	MB
			Red Crossbill	x	uncommon	MB
			Mourning Dove	x	common	MB/-

Table 4-1. Summary of On-Site Habitats and Potential Ecological Receptors (continued).

Habitat Type	Area (% of Site)	Exposure Group[a]	Expected Species	Observed Species	Relative Occurrence	Fed/CA Status[b]
Ruderal/ Landscaped (continued)		Insectivorous Bird				
			Northern Flicker	x	uncommon	MB
			Ruby-crowned Kinglet	x	common	MB
			Black Phoebe	x	common	MB
			Red-breasted Nuthatch	x	uncommon	MB
			House Wren	x	uncommon	MB
		Omnivorous Bird				
			Anna's Hummingbird	x	Common	MB
			Scrub Jay	x	common	MB
			American Crow	x	common	MB
			California Towhee	x	common	none
			Western Meadowlark	x	common	MB
			European Starling	x	common	none
			American Robin	x	common	MB
			Yellow-rumped Warbler	x	common	MB
			Dark-eyed Junco	x	common	MB
			Yellow-billed Magpie	x	common	MB
			Rufous-sided Towhee	x	uncommon	MB
		Raptor				
			Coopers Hawk	**x**	**uncommon**	**MB/SSC**
			Great Horned Owl	x	uncommon	MB
			Barn Owl	x	uncommon	MB
			Red-tailed Hawk	x	common	MB
			American Kestrel	x	uncommon	MB
Buildings and Structures	100,900sf, 2.3 acres, (12%)					
		Bats				
			Townsend's Big-eared Bat	**-**	**uncommon**	**SC/SSC**
			Pallid Bat	**-**	**uncommon**	**SSC**

Table 4-1. Summary of On-Site Habitats and Potential Ecological Receptors (continued).

Habitat Type	Area (% of Site)	Exposure Group[a]	Expected Species	Observed Species	Relative Occurrence	Fed/CA Status[b]
Buildings and Structures (continued)			**California Mastiff Bat**	-	**uncommon**	**SC/SSC**
			Big Brown Bat	-	common	none
			California Myotis	-	common	none
		Granivorous Bird				
			House Finch	x	common	MB
			House Sparrow	-	common	none
			Rock Dove	x	common	none
		Raptor	Barn Owl	x	common	MB

- = Expected Species
x = Species observed during biological site survey conducted in Jan/Feb 1997.
a = Terrestrial invertebrate species not listed, not in scope of site reconnaissance
b = See Attachment F for an explanation of status codes.
TEXT = Special status species, likely representative species selection.

Table 4-2. Summary of Off-Site Habitats and Potential Ecological Receptors.

Habitat Type	Exposure Group[a]	Expected Species	Observed Species	Relative Occurrence	Fed/CA Status[b]
Ruderal/Non-native Grassland					
	Amphibian				
		Western Toad	-	uncommon	none
		Pacific Tree Frog	-	common	none
	Bats				
		Big Brown Bat	-	uncommon	none
		California Myotis	-	uncommon	none
	Burrowing Mammal				
		CA Ground Squirrel	x	common	none
		CA Vole	-	common	none
		House Mouse	-	common	none
		W. Harvest Mouse	-	uncommon	none
		Bottas Pocket Gopher	x	common	none
		Black-tailed Jackrabbit	x	common	none
		Audubon's Cottontail	x	common	none
	Burrowing Owl				
		Burrowing Owl	**x**	**uncommon**	**SC, MB/SSC**
	Granivorous Bird				
		Mourning Dove	x	common	MB
		House Finch	x	common	MB
		Rock Dove	x	common	MB
		Golden-crowned Sparrow	x	common	MB
		White-crowned Sparrow	x	common	MB
	Insectivorous Bird				
		Black Phoebe	x	common	none
	Omnivorous Bird				
		Red-winged Blackbird	-	common	MB
		Hermit Thrush	x	uncommon	MB
		Killdeer	x	common	MB
		American Crow	x	common	MB
		CA Horned Lark	**x**	**uncommon**	**SC,MB/SSC**
		Brewer's Blackbird	x	common	MB

Table 4-2. Summary of Off-Site Habitats and Potential Ecological Receptors (continued).

Habitat Type	Exposure Group[a]	Expected Species	Observed Species	Relative Occurrence	Fed/CA Status[b]
Ruderal/Non-native Grassland (continued)	Omnivorous Bird (cont'd)	Dark-eyed Junco	x	common	MB
		California Towhee	x	common	none
		Western Meadowlark	x	common	MB
		European Starling	x	common	none
		American Robin	x	common	MB
	Predatory Mammal	Coyote	x	uncommon	none
		Opossum	-	uncommon	none
		Striped Skunk	x	common	none
		Raccoon	x	common	none
		Red Fox	-	uncommon	none
		Gray Fox	-	uncommon	MB
	Raptor	**Short-eared Owl**	**-**	**uncommon**	**MB/SSC**
		Great Horned Owl	x	uncommon	MB
		Barn Owl	x	uncommon	MB
		Red-tailed Hawk	x	common	MB
		Northern Harrier	**x**	**common**	**MB/SSC**
		White-tailed Kite	**x**	**common**	**MB/SSC**
		American Kestrel	x	common	MB
	Reptile	Gopher Snake	-	uncommon	none
		Western Fence Lizard	-	common	none
Ruderal/ Landscaped	Granivorous Bird	House Finch	x	common	MB
		Hermit Thrush	x	uncommon	MB
		Rock Dove	x	common	none
		Golden-crowned Sparrow	x	common	MB
		White-crowned Sparrow	x	common	MB
		Red Crossbill	x	uncommon	MB
		Mourning Dove	x	common	MB/-

Table 4-2. Summary of Off-Site Habitats and Potential Ecological Receptors (continued).

Habitat Type	Exposure Group[a]	Expected Species	Observed Species	Relative Occurrence	Fed/CA Status[b]
Ruderal/ Landscaped (continued)	Insectivorous Bird				
		Northern Flicker	x	uncommon	MB
		Ruby-crowned Kinglet	x	common	MB
		Black Phoebe	x	common	MB
		Red-breasted Nuthatch	x	uncommon	MB
		House Wren	x	uncommon	MB
	Omnivorous Bird				
		Anna's Hummingbird	x	Common	MB
		Scrub Jay	x	common	MB
		American Crow	x	common	MB
		California Towhee	x	common	none
		Western Meadowlark	x	common	MB
		European Starling	x	common	none
		American Robin	x	common	MB
		Yellow-rumped Warbler	x	common	MB
		Dark-eyed Junco	x	common	MB
		Yellow-billed Magpie	x	common	MB
		Rufous-sided Towhee	x	uncommon	MB
	Raptor				
		Coopers Hawk	**x**	**uncommon**	**MB/SSC**
		Great Horned Owl	x	uncommon	MB
		Barn Owl	x	uncommon	MB
		Red-tailed Hawk	x	common	MB
		American Kestrel	x	uncommon	MB
Buildings and Structures					
	Bats				
		Townsend's Big-eared Bat	-	**uncommon**	**SC/SSC**
		Pallid Bat	-	**uncommon**	**SSC**
		California Mastiff Bat	-	**uncommon**	**SC/SSC**

Table 4-2. Summary of Off-Site Habitats and Potential Ecological Receptors (continued).

Habitat Type	Exposure Group[a]	Expected Species	Observed Species	Relative Occurrence	Fed/CA Status[b]
Buildings and Structures (continuedd)		Big Brown Bat	-	common	none
		California Myotis	-	common	none
	Granivorous Bird				
		House Finch	x	common	MB
		House Sparrow	-	common	none
		Rock Dove	x	common	none
	Raptor	Barn Owl	x	common	MB
Cultivated Fields and Orchards	Burrowing Mammal				
		Bottas Pocket Gopher	x	common	none
		Black-tailed Jackrabbit	x	common	none
		Audubon's Cottontail	x	common	none
	Granivorous Bird				
		Golden-crowned Sparrow	x	common	MB
		White-crowned Sparrow	x	common	MB
	Omnivorous Bird				
		Red-winged Blackbird	-	common	MB
		Tricolored Blackbird	**-**	**uncommon**	**MB/SSC**
		Killdeer	x	common	MB
		American Crow	x	common	MB
		CA Horned Lark	**x**	**uncommon**	**MB/SSC**
		Brewer's Blackbird	x	common	MB
		Yellow-billed Magpie	x	common	MB
		Western Meadowlark	x	common	MB
		American Robin	x	common	MB
	Predatory Mammal				
		Striped Skunk	x	common	none
		Coyote	x	uncommon	none
	Raptor				
		Red-tailed Hawk	x	common	MB
		Northern Harrier	**x**	**common**	**MB/SSC**
		White-tailed Kite	**x**	**common**	**MB/SSC**

Table 4-2. Summary of Off-Site Habitats and Potential Ecological Receptors (continued).

Habitat Type	Exposure Group[a]	Expected Species	Observed Species	Relative Occurrence	Fed/CA Status[b]
		American Kestrel	x	common	MB
Cultivated Fields and Orchards (continued)	Reptile				
		Gopher Snake	-	uncommon	none
		Western Fence Lizard	-	common	none
Great Valley Mixed Riparian Forest	Amphibian				
		Western Toad	-	uncommon	none
		Pacific Treefrog	-	common	none
	Aquatic Mammal				
		Beaver	x	common	none
		River Otter	-	uncommon	none
	Bats				
		Big Brown Bat	-	common	none
		Western Red Bat	-	uncommon	none
		California Myotis	-	uncommon	none
		Yuma Myotis	-	uncommon	none
	Burrowing Mammal				
		California Vole	-	common	none
		House Mouse	-	common	none
		Deer Mouse	-	common	none
		Western Harvest Mouse	-	common	none
		Audubon's Cottontail	x	common	none
	Granivorous Bird				
		California Quail	x	common	none
		American Goldfinch	-	common	MB
		Lesser Goldfinch	x	common	MB
		Lark Sparrow	-	common	MB
		Lincoln's Sparrow	-	uncommon	MB
		Song Sparrow	x	common	MB
		Black-headed Grosbeak	-	uncommon	MB
		Chipping Sparrow	-	uncommon	MB
		Mourning Dove	-	common	MB
		Golden-crowned Sparrow	-	common	MB
		White-crowned Sparrow	-	common	MB

Table 4-2. Summary of Off-Site Habitats and Potential Ecological Receptors (continued).

Habitat Type	Exposure Group[a]	Expected Species	Observed Species	Relative Occurrence	Fed/CA Status[b]
Great Valley Mixed Riparian Forest (continued)	Herbivorous Mammal				
		Mule Deer	-	uncommon	none
	Insectivorous Bird				
		Killdeer	x	common	MB
		Marsh Wren	-	uncommon	MB
		Northern Flicker	x	common	MB
		Cliff Swallow	-	common	MB
		Acorn Woodpecker	-	uncommon	MB
		Ash-throated Flycatcher	-	uncommon	MB
		Nuttall's Woodpecker	x	common	MB
		Downy Woodpecker	-	uncommon	MB
		Barn Swallow	x	common	MB
		Red-breasted Nuthatch	x	common	MB
		No. Rough-winged Swallow	-	common	MB
		Tree Swallow	-	uncommon	MB
		Violet-green Swallow	-	common	MB
		Bewick's Wren	-	common	MB
		House Wren	x	common	MB
	Omnivorous Bird				
		Loggerhead Shrike	**-**	**uncommon**	**MB/SSC**
		Plain Titmouse	-	common	MB
		Anna's Hummingbird	-	Common	MB
		Scrub Jay		common	MB
		Hermit Thrush	x	uncommon	MB
		American Crow	x	common	MB
		Yellow-rumped Warbler	x	common	MB
		Black-throated Gray Warbler	-	uncommon	MB
		Brewer's Blackbird	x	common	MB
		Northern Oriole	-	common	MB
		Varied Thrush	-	uncommon	MB
		Dark-eyed Junco	x	common	MB
		California Gull	x	common	MB
		Ring-billed Gull	-	uncommon	MB
		Northern Mockingbird	-	common	MB
		Brown-headed Cowbird	-	common	MB

Table 4-2. Summary of Off-Site Habitats and Potential Ecological Receptors (continued).

Habitat Type	Exposure Group[a]	Expected Species	Observed Species	Relative Occurrence	Fed/CA Status[b]
		Lazuli Bunting	-	common	MB
Great Valley Mixed Riparian Forest (continued)		Ring-necked Pheasant	-	uncommon	none
		Yellow-billed Magpie	x	common	MB
		California Towhee	x	common	none
		Rufous-sided Towhee	x	uncommon	MB
		Bushtit	-	common	MB
		Ruby-crowned Kinglet	x	common	MB
		Black Phoebe	x	common	MB
		Pays Phoebe	x	common	MB
		Mountain Bluebird	-	common	MB
		Western Bluebird	-	uncommon	MB
		European Starling	x	common	none
		American Robin	x	common	MB
		Western Kingbird	-	uncommon	MB
		Orange-crowned Warbler	-	common	MB
		Wilson's Warbler	-	common	MB
	Piscivorous Bird				
		Belted Kingfisher	x	uncommon	MB
		Forster's Tern	-	common	MB
	Wading Shore Bird				
		Green-backed Heron	-	uncommon	MB
		Common Snipe	-	uncommon	MB
		Great Egret	x	uncommon	MB
		Snowy Egret	x	common	MB
		Black-crowned Night Heron	x	common	MB
	Predatory Mammal				
		American Badger	-	uncommon	*
		Coyote	x	common	none
		Opossum	-	common	none
		Bobcat	-	uncommon	none
		Striped Skunk	x	common	none
		Long-tailed Weasel	-	uncommon	none
		Raccoon	x	common	none
		Ornate Shrew	-	uncommon	none
		Spotted Skunk	-	uncommon	none
		Gray Fox	-	uncommon	none
		Red Fox	-	uncommon	none
	Raptor				
		Coopers Hawk	**x**	**uncommon**	**MB/SSC**

Table 4-2. Summary of Off-Site Habitats and Potential Ecological Receptors (continued).

Habitat Type	Exposure Group[a]	Expected Species	Observed Species	Relative Occurrence	Fed/CA Status[b]
Great Valley Mixed Riparian Forest (continued)	Raptor (continued)	**Sharp-shinned Hawk**	-	**uncommon**	**MB/SSC**
		Golden Eagle	-	**uncommon**	**MB/SSC**
		Great Horned Owl	x	uncommon	MB
		Red-tailed Hawk	x	common	MB
		Red-shouldered Hawk	-	uncommon	MB
		Northern Harrier	**x**	**common**	**MB/SSC**
		White-tailed Kite	**x**	**common**	**MB/SSC**
		Merlin	-	**uncommon**	**MB/SSC**
		American Kestrel	x	common	MB
		Western Screech-owl	-	uncommon	MB
		Barn Owl	x	common	MB
	Reptile				
		Western Pond Turtle	-	**uncommon**	**SC/SSC**
		Racer	-	uncommon	none
		Gilbert's Skink	-	uncommon	none
		Southern Alligator Lizard	-	uncommon	none
		Common Kingsnake	-	uncommon	none
		Gopher Snake	-	uncommon	none
		Western Fence Lizard	-	common	none
		Western Terrestrial Garter Snake	-	common	none
		Giant Garter Snake	-	**uncommon**	**FT/CT**
		Side-blotched Lizard	-	common	none
	Water Fowl				
		Wood Duck	-	uncommon	MB
		Northern Pintail	-	uncommon	MB
		American Widgeon	-	uncommon	MB
		Green-winged Teal	-	uncommon	MB
		Northern Shoveler	-	uncommon	MB
		Cinnamon Teal	-	uncommon	MB
		Mallard	x	common	MB
		Gadwall	-	uncommon	MB
		Greater White-fronted Goose	-	uncommon	MB
		Lesser Scaup	-	uncommon	MB
		Ring-necked Duck	-	uncommon	MB
		Canada Goose	x	uncommon	MB
		Common Goldeneye	-	uncommon	MB
		American Coot	x	common	MB
		Common Moorhen	-	uncommon	MB

Table 4-2. Summary of Off-Site Habitats and Potential Ecological Receptors (continued).

Habitat Type	Exposure Group[a]	Expected Species	Observed Species	Relative Occurrence	Fed/CA Status[b]
Great Valley Mixed Riparian Forest (continued)	Water Fowl (continued)	Black-necked Stilt	-	uncommon	MB
		Common Yellowthroat	-	uncommon	MB
		Black-bellied Plover	-	uncommon	MB
		Common Merganser	-	uncommon	MB
		Bufflehead	-	uncommon	MB
	Wading Shore Bird				
		Western Sandpiper	-	common	MB
		Least Sandpiper	-	common	MB
		Virginia Rail	-	uncommon	MB
		American Avocet	-	uncommon	MB
		Greater Yellowlegs	-	uncommon	MB
		Spotted Sandpiper	-	uncommon	MB
		Long-billed Curlew	**-**	**uncommon**	**MB/SSC**
		Sora	-	uncommon	MB
		Great Blue Heron	**x**	**uncommon**	**MB/***
		Pied-billed Grebe	x	uncommon	MB
		Double-crested Cormorant	-	uncommon	MB
Creek	Benthic/Pelagic Invertebrates[c]				
		Diptera (family chronomide)	-	NA	none
		Trichoptera (family lepidostomatidai)	-	NA	none
		Oligocheata	-	NA	none
		Tubellaria	-	NA	none
		GasTrapoda	-	NA	none
		Amphipoda	-	NA	none
		Mollusca	-	NA	none
		Crustacea - crayfish	-	NA	none
	Fish				
		Pacific Lamprey	**-**	**uncommon**	**SC**
		Hitch	-	common	none
		Sacramento Blackfish	-	common	none
		American Shad	-	uncommon	none
		White Catfish	-	common	none
		Common Carp	-	common	none
		Black Bullhead	-	common	none
		Channel Catfish	-	common	none
		Green Sunfish	-	common	none
		White Crappie	-	common	none
		Sacramento Sucker	-	NA	none

Table 4-2. Summary of Off-Site Habitats and Potential Ecological Receptors (continued).

Habitat Type	Exposure Group[a]	Expected Species	Observed Species	Relative Occurrence	Fed/CA Status[b]
Creek (continued)	Fish (continued)	Three-spined Stickleback	-	NA	none
		Tule Perch	-	NA	none
		Sacramento Squawfish	-	NA	none
		Threadfin Shad	-	NA	none
		Mosquitofish	-	NA	none
		Brown Bullhead	-	NA	none
		Bluegill	-	NA	none
		Redear Sunfish	-	NA	none
		Mississippi Silverside	-	NA	none
		Golden Shiner	-	NA	none
		Bigscale Logperch	-	NA	none
		Fathead Minnow	-	NA	none
		Black Crappie	-	NA	none
	Predatory Fish	Rainbow Trout	-	uncommon	None
		Chinook Salmon	-	**uncommon**	**FE/CE**
		Smallmouth Bass	-	common	none
		Largemouth Bass	-	common	none
		Striped Bass	-	NA	none

Notes:
- = Expected Species
x = Species observed during biological site survey conducted in Jan/Feb 1997.
[a] = See Attachment F for an explanation of status codes.
[b] = Terrestrial invertebrate species not listed, not in scope of site reconnaissance.
[c] = Data not available due to exceedingly heavy rainfall and record-breaking floods, water levels in Putah Creek were too high to effectively conduct fish and benthic/pelagic invertebrate studies. Expected species list generated from personal communication with UC Davis research staff and published literature.
NA = Not available from researched sources.
TEXT = Special status species, likely representative species selection.

Table 4-3. Relative Significance of Exposure Pathways for Potential Animal Exposure Groups.

		Relative Significance of Exposure Pathway										
Receptor Groups	Location	Dermal contact with contaminated soil Onsite, redeposited soil Offsite	Ingestion of contaminated soil Onsite, redeposited soil Offsite	Inhalation of contaminated vapors/resuspended soil present in subsurface air	Inhalation of contaminated vapors in ambient air	Inhalation of contaminated resuspended surface soil particles	Ingestion of ponded storm water Onsite, surface water Offsite	Ingestion of sediments	Dermal contact with surface water	Dermal contact with sediment	Exposure via terrestrial foodweb	Exposure via aquatic food web
Terrestrial Invertebrates	Onsite	High	High	NA	NA	NA	Low to NA	NA	Low to NA	NA	NA	NA
	Offsite	Low to NA	Low to NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish/Predatory Fish	Onsite	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Offsite	NA	NA	NA	NA	NA	High	Low to high[a]	High	Low to high[a]	NA	High for predatory fish
Reptiles	Onsite	High	Low	NA for aquatic species; Low for terrestrial species	NA	NA for aquatic species; Low for terrestrial species	Low to NA	NA	Low to NA	NA	High	NA
	Offsite	Low to NA	NA	NA	NA	NA	Low to high[b]	Low to high[b]	Low to high[b]	Low to high[b]	Low	Low
Amphibians	Onsite	High	Low[c]	Low	NA	High	Low	NA	Low	NA	Medium to high[c]	NA
	Offsite	Low to NA	NA	NA	NA	Low to NA	Medium to high[d]	Low	High[d]	Low	Low	Low
Burrowing Mammals	Onsite	High	High	High	NA	High	NA to Low[a]	NA	Low	NA	Medium to high[c]	NA
	Offsite	NA	Low to NA	NA	NA	Low to NA	NA to Low[a]	NA	NA	NA	Low	NA
Herbivorous Mammals	Onsite	Medium	High	NA	NA	High	Low	NA	NA	NA	Medium to high (consumption of plants only)	NA
	Offsite	Low to NA	Low to NA	NA	NA	Low to NA	Medium	Low	NA	NA	Low	NA
Predatory Mammals	Onsite	Medium	Low to medium[a]	NA	NA	Medium to high[a]	Low	NA	NA	NA	High	Low
	Offsite	Low to NA	NA	NA	NA	Low to NA	High	NA	Low	NA	NA	NA
Bats	Onsite	NA	Low	NA	NA	Low	NA	NA	NA	NA	Medium to high[e]	NA
	Offsite	NA	NA	NA	NA	NA	Low	NA	NA	NA	NA	Low to NA
Aquatic Mammals	Onsite	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Offsite	NA	NA	NA	NA	NA	Low	Low	Low	Low	NA	Medium
Insectivorous Birds	Onsite	Medium to high[a]	High	NA	NA	Medium to high[a]	NA to low[a]	NA	NA to low	NA	Medium to High[a]	NA
	Offsite	NA to low[a]	Low to NA	NA	NA	NA to low[a]	Medium	NA	Medium	NA	NA	NA

Table 4-3. Relative Significance of Exposure Pathways for Potential Animal Exposure Groups (continued).

		Relative Significance of Exposure Pathway										
Receptor Groups	Location	Dermal contact with contaminated soil Onsite, redeposited soil Offsite	Ingestion of contaminated soil Onsite, redeposited soil Offsite	Inhalation of contaminated vapors/resuspended soil present in subsurface air	Inhalation of contaminated vapors in ambient air	Inhalation of contaminated resuspended surface soil particles	Ingestion of ponded storm water Onsite, surface water Offsite	Ingestion of sediments	Dermal contact with surface water	Dermal contact with sediment	Exposure via terrestrial foodweb	Exposure via aquatic food web
Granivorous Birds	Onsite	Medium to high	High	NA	NA	High	NA to low	NA	NA to low	NA	NA	NA
	Offsite	NA to low	Low to NA	NA	NA	Low	Medium	NA	Medium	NA	NA	NA
Raptors	Onsite	NA	NA	NA	NA	NA	NA to low	NA	NA	NA	High	NA
	Offsite	NA	NA	NA	NA	NA	Low	NA	Low	NA	NA	Medium
Burrowing Owls	Onsite	High	High	High	NA	High	NA to low[a]	NA	Low	NA	High	High
	Offsite	NA	NA	NA	NA	Low	NA to low[a]	NA	Low	NA	NA	Low
Water Fowl	Onsite	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Offsite	NA	NA	NA	NA	NA	Low	Medium	Low	Low	NA	Medium
Wading Shore Birds	Onsite	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Offsite	NA	NA	NA	NA	NA	Low	Medium	Low	Medium	NA	Medium
Piscivorous Birds	Onsite	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Offsite	NA	NA	NA	NA	NA	Low	Low	Low	Low	NA	High
Omnivorous Birds	Onsite	Medium to high[a]	High	NA	NA	Medium to high[a]	NA to low	NA	NA to low	NA	Medium	NA
	Offsite	NA to low[a]	Low to NA	NA	NA	NA to low[a]	Low	NA	Low	NA	Low	NA
Benthic/ Pelagic Invertebrates	Onsite	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Offsite	NA	NA	NA	NA	NA	Low	Medium	Low	Medium	NA	Medium

Notes:

[a] = Dependent on feeding/foraging, grooming, and resting habits and water sources of individual species
[b] = High for aquatic reptiles; low for terrestrial reptiles
[c] = Incidental ingestion only
[d] = High during developmental stages; medium for adults; also species dependent
[e] = Dependent on bioaccumulation potential of prey species and/or plant food source
High = Exposure pathway complete, potentially high exposure
Medium to high = Exposure pathway likely complete
Medium = Exposure pathway probably complete
Low = Exposure pathway unlikely complete
N/A = Not applicable, exposure pathway not complete

Table 4-4. Relative Significance of Exposure Pathways for Potential Plant Exposure Groups.

		Relative Significance of Exposure Pathway		
Exposure Groups	Location	Uptake from surface water	Uptake from sediment	Uptake from soil moisture
Aquatic/Riparian Plants	On-site	NA	NA	NA
	Off-site	Medium	High to medium	NA
Terrestrial Plants	On-site	NA	NA	Low to high[a]
	Off-site	NA	NA	NA

Notes:

[a] = Dependent on plant location: high for plants located in contaminant source areas
Low for plants not located in proximity of source areas
High = Exposure pathway complete, potentially high exposure
Medium to high = Exposure pathway likely complete
Medium = Exposure pathway probably complete
Low = Exposure pathway unlikely complete
N/A = Not applicable, exposure pathway not complete

Table 4-5. Relative Significance of Exposure Pathways for Potential COPECs and ROPECs.

Complete Exposure Pathway	Location[b]	Relative Significance of Exposure Pathway for COPECs and ROPECs[a] VOCs[c]	SVOCs	Pesticides[d]	Metals	Radionuclides
Dermal contact with contaminated soil on-site redeposited soil off-site	On-site	Low	Low	High to Medium	High to Medium	High to Medium
	Off-site	Low to NA	Low to NA	Low	Low	Low
Ingestion of contaminated soil on-site, redeposited soil off-site	On-site	Medium	Medium	High	High	High
	Off-site	NA	NA	Low to NA	Low to NA	Low to NA
Inhalation of contaminated vapors/soil present in subsurface air	On-site	High	NA	NA	NA	Low for radium, NA for other adionuclides
	Off-site	NA	NA	NA	NA	NA
Inhalation of contaminated vapors in ambient air	On-site	Low	NA	NA	NA	Low for radium, NA for other adionuclides
	Off-site	NA	NA	NA	NA	NA
Inhalation of contaminated resuspended surface soil particles	On-site	NA	Low to NA	Medium	Medium	Medium
	Off-site	NA	Low to NA	Low to NA	Low to NA	Low to NA
Ingestion of ponded storm water on-site, surface water (Putah Creek) off-site	On-site	Low to NA	Low to NA	Low	Low	Low
	Off-site	Low to NA	Low to NA	Medium	Medium	Medium
Dermal contact with ponded storm water on-site, surface water (Putah Creek) off-site	On-site	Low to NA	Low to NA	Low	Low	Low
	Off-site	Low to NA	Low to NA	Medium	Medium	Medium

Table 4-5. Relative Significance of Exposure Pathways for Potential COPECs and ROPECs (continued).

Complete Exposure Pathway	Location[b]	Relative Significance of Exposure Pathway for COPECs and ROPECs[a]				
		VOCs[c]	SVOCs	Pesticides[d]	Metals	Radionuclides
Ingestion of sediments	On-site	NA	NA	NA	NA	NA
	Off-site	Low to NA	Low to NA	Medium	Medium[e]	Medium
Dermal contact with sediments	On-site	NA	NA	NA	NA	NA
	Off-site	Low to NA	Low to NA	Medium	Medium[e]	Medium
Exposure via terrestrial food web	On-site	Low	Low	High	High	High
	Off-site	NA	NA	Low to NA	Low to NA	Low to NA
Exposure via aquatic food web	On-site	NA	NA	NA	NA	NA
	Off-site	NA	NA	High	High[e]	High
Plant uptake from surface water	On-site	NA	NA	NA	NA	NA
	Off-site	NA	NA	Medium	Medium	Low
Plant uptake from sediments	On-site	NA	NA	NA	NA	NA
	Off-site	NA	NA	High to Medium	High to Medium	Low
Plant uptake from soil moisture	On-site	NA		Medium	Medium	Low
	Off-site	NA	NA	NA	NA	NA

Notes:
a = Lists of individual site-specific COPECs/ROPECs are presented in Tables 2-1 through 2-6.
b = Concentration of COPECs/ROPECs greatly decreases with increasing distance from the site. In some cases concentration in site surface soil is very low; therefore, it is assumed that off-site migration is minimal.
c = VOC's do not bioaccumulate
d = Most organochlorine based pesticides are persistent and bioaccumulate
e = Some metals bioaccumulate
High = Exposure pathway complete, potentially high exposure
Medium to high = Exposure pathway likely complete
Medium = Exposure pathway probably complete
Low = Exposure pathway unlikely complete
N/A = Not applicable, exposure pathway not complete

Table 4-6. Potentially Significant Exposure Pathways.

Complete Exposure Pathway	Location	Potentially Significant Exposure Pathways for the LEHR Site Exposure Group	COPECs	ROPECs
Dermal contact with contaminated soil on-site, redeposited soil off-site	On-site	Terrestrial invertebrates, reptiles, aestivating amphibians, burrowing mammals, borrowing raptors, granivorous birds.	Pesticides, metals	Radionuclides
	Off-site	N/A or NS	N/A or NS	N/A or NS
Ingestion of contaminated soil on-site, redeposited soil off-site	On-site	Terrestrial invertebrates, burrowing mammals, herbivorous mammals, insectivorous birds, granivorous birds, burrowing raptors, omnivorous birds.	Pesticides, metals	Radionuclides
	Off-site	N/A or NS	N/A or NS	N/A or NS
Inhalation of contaminated vapors/soil present in subsurface air	On-site	Burrowing mammals, burrowing raptors.	VOCs	Radium only
	Off-site	N/A	N/A or NS	N/A
Inhalation of contaminated vapors in ambient air	On-site	N/A	NS	NS
	Off-site	N/A	N/A	N/A
Inhalation of contaminated resuspended surface soil particles	On-site	Amphibians, burrowing mammals, herbivorous mammals, some predatory mammals, granivorous, insectivorous, and omnivorous birds, burrowing raptors.	Pesticides, metals	Radionuclides
	Off-site	N/A or NS	N/A or NS	N/A or NS

Table 4-6. Potentially Significant Exposure Pathways (continued).

Complete Exposure Pathway	Location	Potentially Significant Exposure Pathways for the LEHR Site Exposure Group	COPECs	ROPECs
Ingestion of surface water (Ponded storm water on-site, Putah Creek off-site)	On-site	N/A or NS	N/A or NS	NS
	Off-site	Fish, predatory mammals, aquatic mammals, water fowl, wading shore birds, aquatic reptiles, and some amphibians.	Soluble pesticide: chlordane; Soluble metals: chromium, copper, lead	Radionuclides
Dermal contact with surface water (Ponded storm water on-site, Putah Creek off-site)	On-site	N/A or NS	N/A or NS	NS
	Off-site	Fish, water fowl, wading shore birds, aquatic mammals, aquatic reptiles and some amphibians.	Soluble pesticide: chlordane; Soluble metals: chromium, copper, lead	Radionuclides
Ingestion of sediments	On-site	N/A	N/A	N/A
	Off-site	Bottom feeding fish, aquatic reptiles, aquatic mammals, water fowl.	Pesticide: chlordane; Metals: chromium, copper, lead, mercury[a]	Radionuclides
Dermal contact with sediment	On-site	N/A	N/A	N/A
	Off-site	Bottom feeding fish, aquatic reptiles, aquatic mammals, water fowl, and wading shore birds.	Pesticide: chlordane; Metals: chromium, copper, lead, mercury[a]	Radionuclides

Table 4-6. Potentially Significant Exposure Pathways (continued).

Complete Exposure Pathway	Location	Potentially Significant Exposure Pathways for the LEHR Site Exposure Group	COPECs	ROPECs
Exposure via terrestrial food-chain	On-site	Reptiles, predatory mammals, bats, raptors, burrowing raptors, piscivorous birds, some amphibians, burrowing mammals, herbivorous mammals, insectivorous birds.	Pesticides, metals	Radionuclides
	Off-site	N/A or NS	N/A or NS	N/A or NS
Exposure via aquatic food-chain	On-site	N/A or NS	N/A	N/A
	Off-site	Fish, aquatic mammals, water fowl, and wading shorebirds.	Pesticides, metals	Radionuclides
Uptake from surface water	On-site	N/A	N/A	N/A
	Off-site	Aquatic plants.	Pesticide: chlordane; metals: chromium, copper, lead	Radionuclides
Uptake from sediment	On-site	N/A	N/A	N/A
	Off-site	Aquatic plants.	Pesticide: chlordane; Metals: chromium, copper, lead, mercury[a]	N/A
Uptake from soil moisture	On-site	Terrestrial plants.	Soluble pesticides, metals	Soluble Radionuclides
	Off-site	N/A	N/A	N/A

Notes:
High = Exposure pathway complete, potentially high exposure
Medium to high = Exposure pathway likely complete
Medium = Exposure pathway probably complete
Low = Exposure pathway unlikely complete
N/A = Not applicable, exposure pathway not complete
NS = Not a significant exposure pathway
a = Radionuclide, organic compound, and metal concentrations in sediment collected from Putah Creek were not appreciably elevated compared to background or relevant standards except for mercury. Mercury has not been significantly detected above background in DOE OU soil and has not been detected in storm water runoff at detection limits below EPA AWQC.

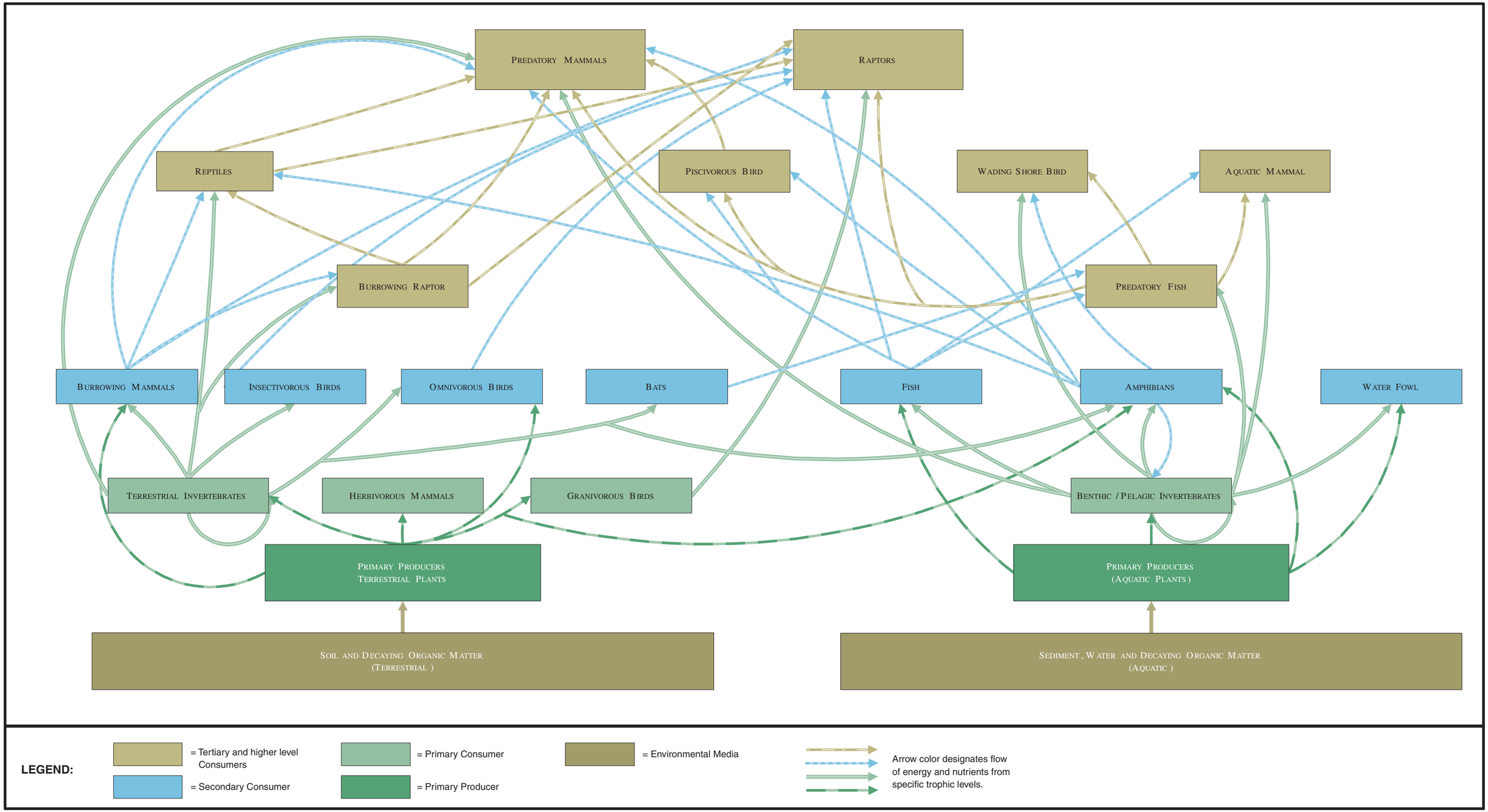


Figure 4-1. Food Web Analysis of Aquatic and Terrestrial Ecosystems.

Figure 4-2. Ecological Exposure Pathways Analysis.

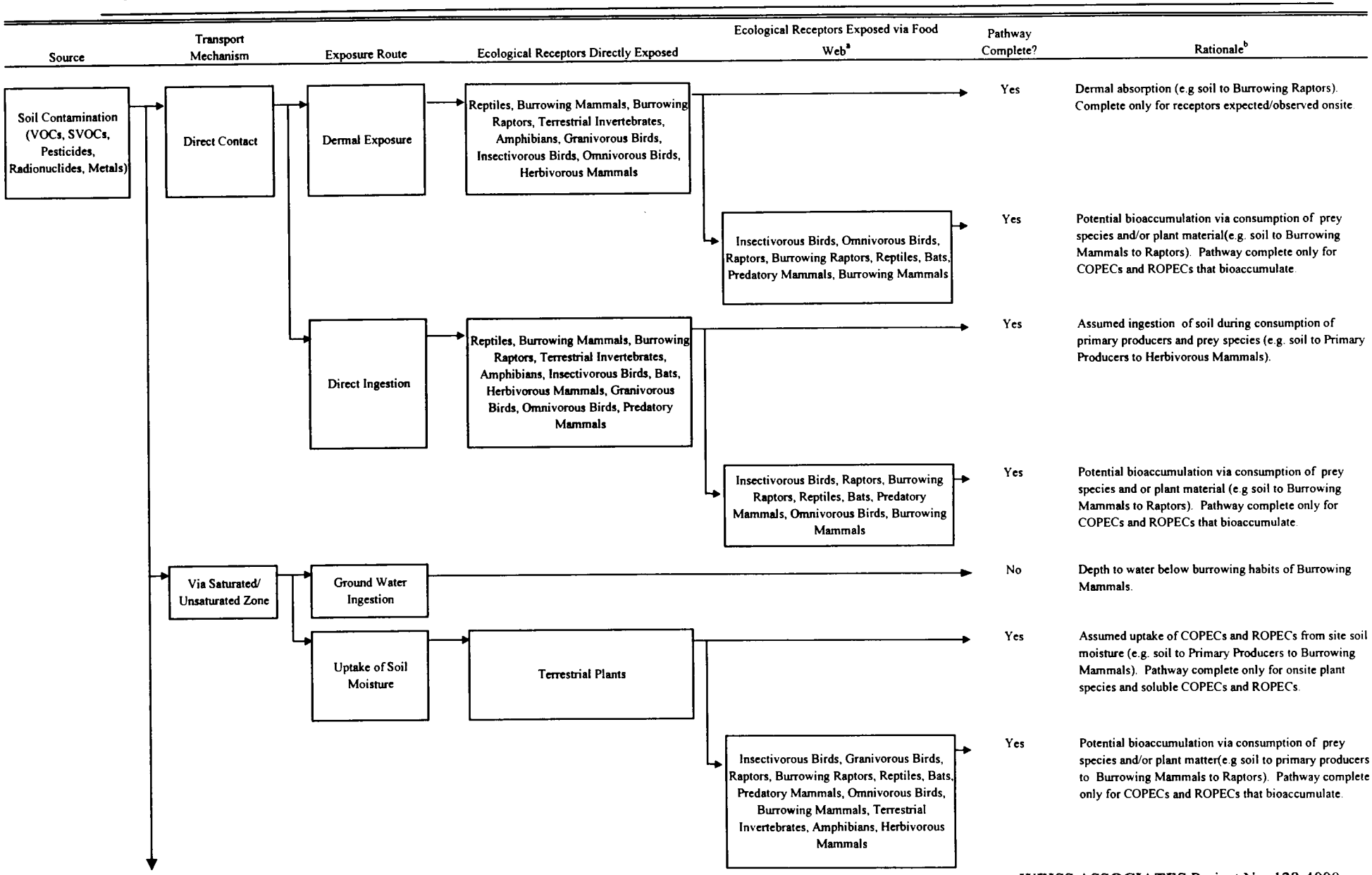


Figure 4-2. Ecological Exposure Pathways Analysis.

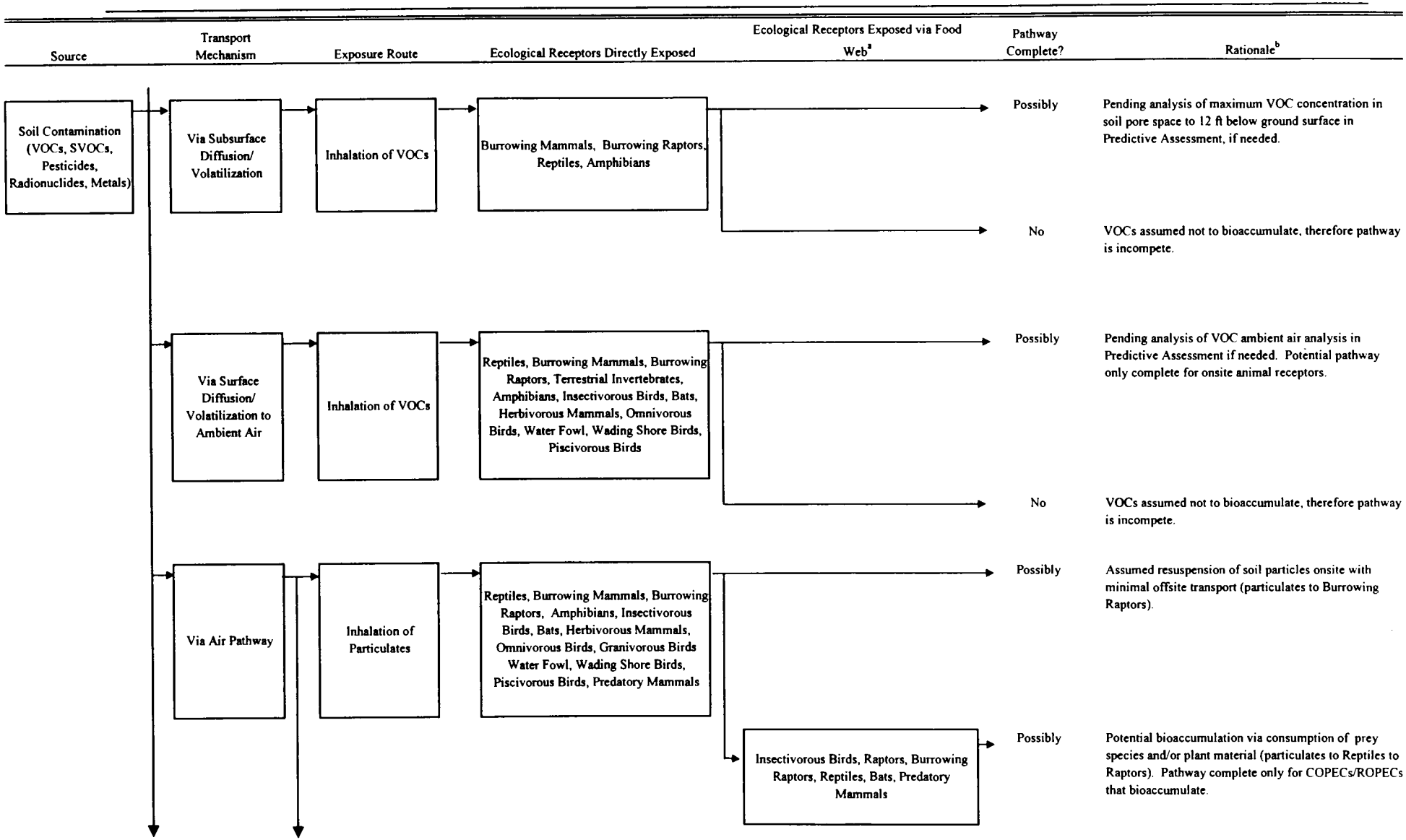


Figure 4-2. Ecological Exposure Pathways Analysis.

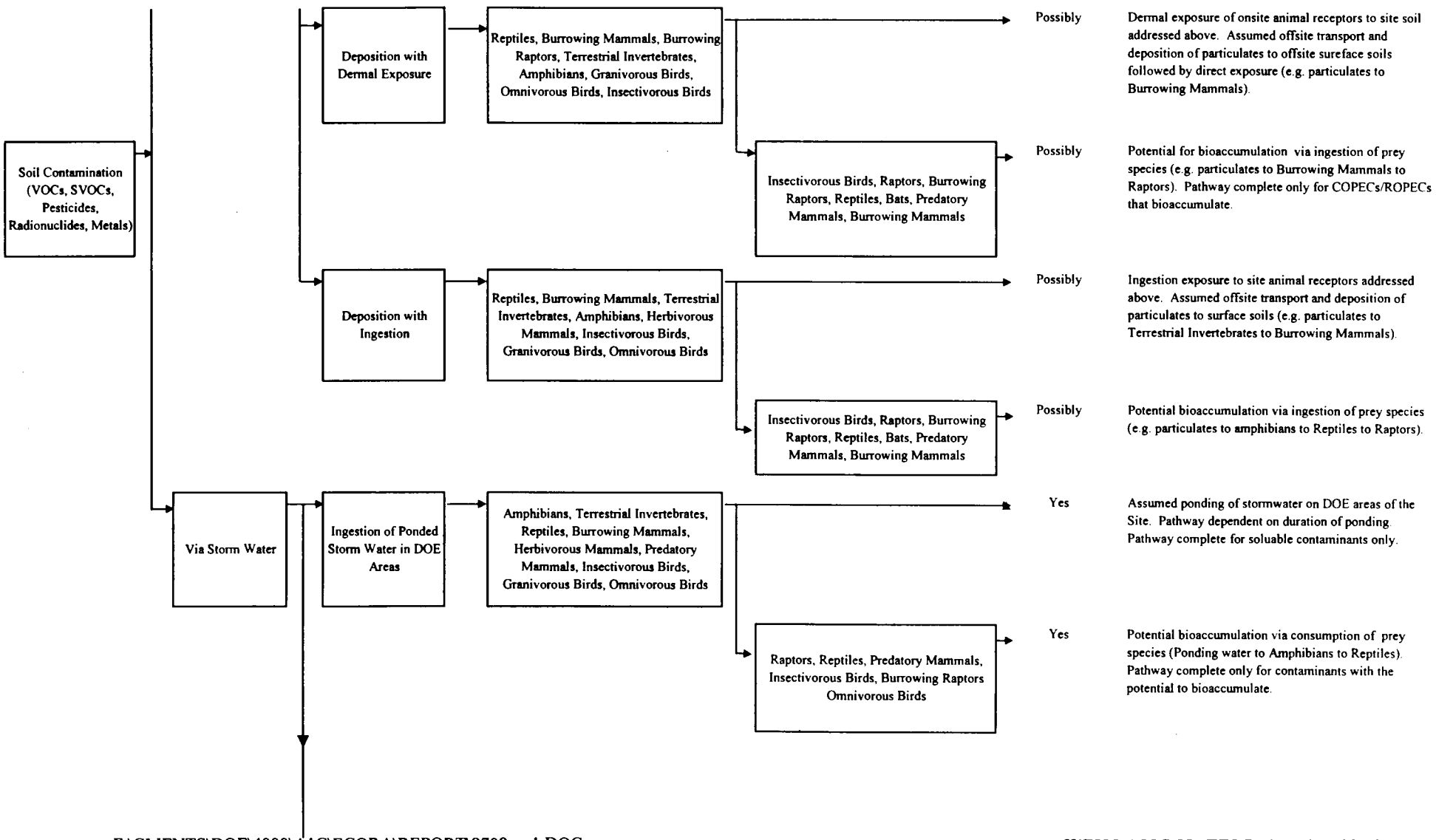


Figure 4-2. Ecological Exposure Pathways Analysis.

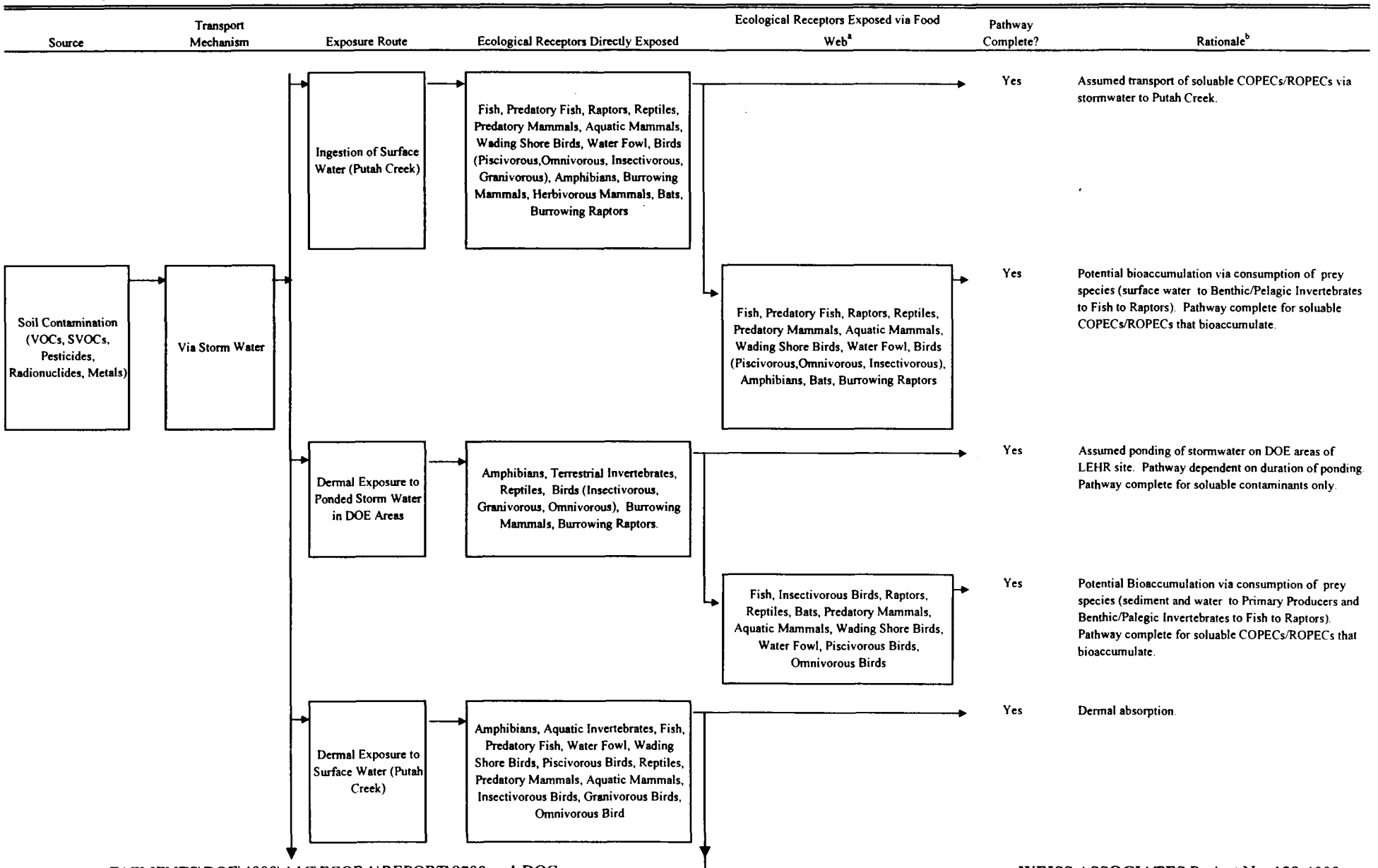
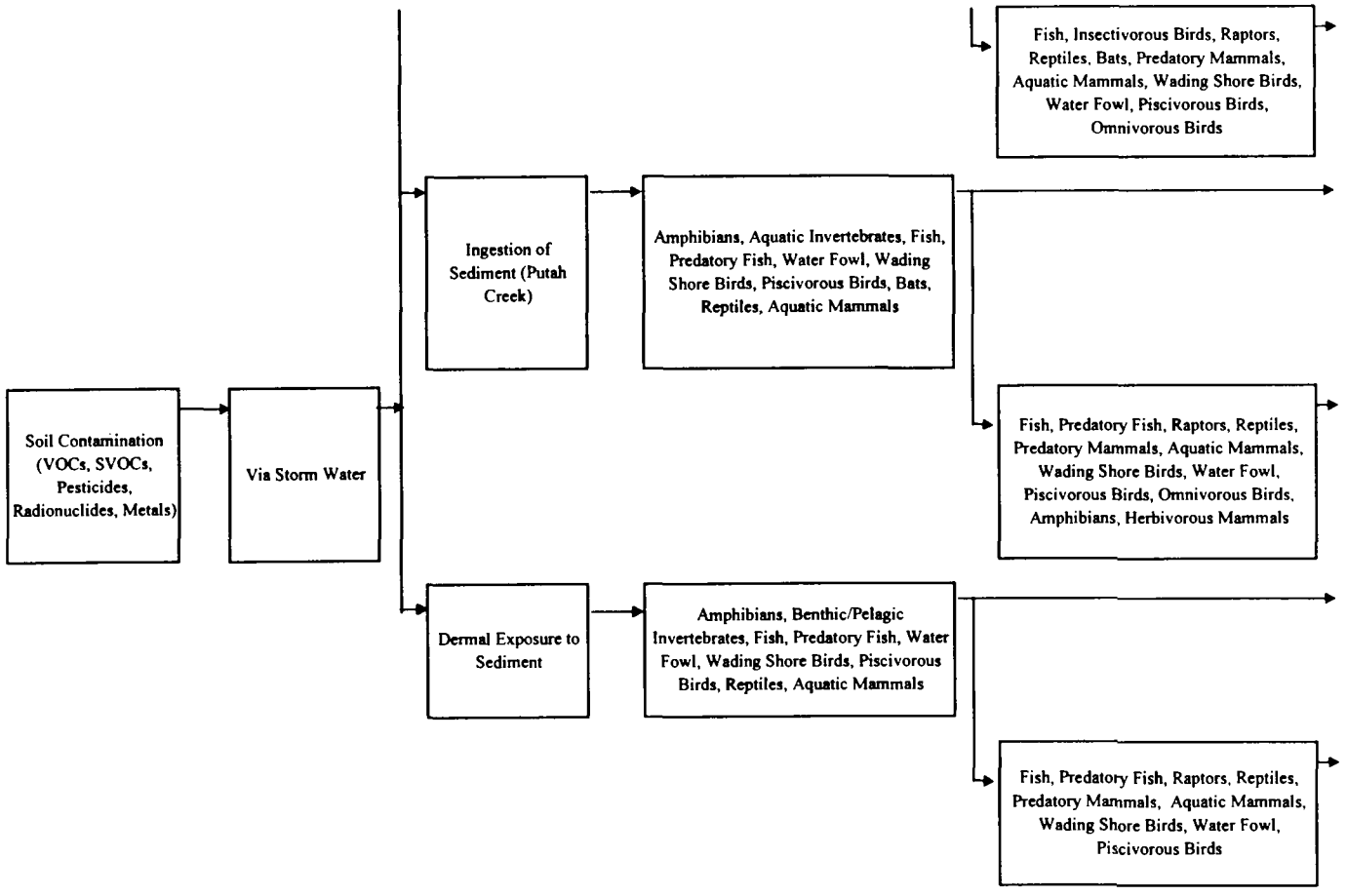


Figure 4-2. Ecological Exposure Pathways Analysis.



Pathway Complete?	Rationale[b]
Yes	Potential Bioaccumulation via consumption of prey species (sediment and water to Primary Producers and Benthic/Palegic Invertebrates to Fish to Raptors).
Yes	Assumed offsite transport of COPECs/ROPECs in sediment to Putah Creek via storm water runoff.
Yes	Potential bioaccumulation via consumption of prey species and/or plant material (sediment to Benthic/Pelagic Invertebrates to Fish to Raptors).
Yes	Assumed transport of sediments from LEHR site to Putah Creek via storm water runoff.
Yes	Potential bioaccumulation via consumption of prey species (sediment to Benthic/Pelagic Invertebrates to Fish to Predatory Fish to Raptors).

Notes:
Yes = Pathway is complete.
No = Pathway is incomplete.
Possibly = Pathway may be complete pending further analysis.

VOCs = Volatile Organic Compounds
COPEC = Contaminant of Potential Ecological Concern
ROPEC = Radionuclide of Potential Ecological Concern

a = See Figure 4-2 for detailed food web analysis
b = See Table 4-3 and 4-4 for Potential Significance of Exposure Pathways for Potential Exposure Groups, and see Table 4-5 for Potential Significance of Exposure Pathway for COPECs/ROPECs.

5. CONCLUSIONS

The steps outlined in the Site characterization, biological characterization and the exposure pathway analysis complete this Scoping Assessment. As a result of this assessment, it was determined that:

- COPECs and ROPECs are present in ecologically significant media at the Site.
- There are biological receptors inhabiting or with the potential to occur on or in the vicinity of the Site.
- Transport mechanisms are potentially present by which contaminants may migrate from the source area to exposure points.
- There are potential points of contact between contaminated media and potential biological receptors.
- There are potentially complete exposure routes at the point of contact.

The results of this Scoping Assessment will be used, in conjunction with the results of the *Determination of Risk-Based Action Standards*, to evaluate: 1) the potential for exposure of human and ecological receptors to contaminants in media at the DOE Areas, and 2) evaluate the necessity of implementing remedial measures to mitigate potential exposure. Should remedial measures prove necessary, the information and data collected as part of this Ecological Scoping Assessment may be used in the design and planning of remediation efforts to minimize impacts to biota at the Site.

This Scoping Assessment has 1) identified chemical and radioisotope contaminants of potential ecological concern (COPECs and ROPECs, respectively) present in media of potential ecological concern at the Site; 2) characterized on-site and near-Site ecological communities and habitat; 3) identified complete exposure pathways of potential environmental concern, and 4) provided a preliminary assessment of the relative potential significance of each complete exposure pathway with respect to receptor and contaminant groups. This analysis addressed contaminants and potential exposure pathways specific to the DOE Areas only; but is sitewide with respect to biological characterization.

This document is not intended to be a quantitative assessment of potential ecological risk at the Site. Quantitative evaluation of the actual risk or hazard associated with complete exposure pathways, if any, is typically evaluated during a Phase I Predictive Assessment and a Phase II Validation Study. These steps, if necessary, can be completed on a sitewide basis in the future. This Scoping Assessment does, however, provide preliminary information regarding the potential for ecological exposures that might result from the presence of contaminants in DOE OU Site soil, and as such may be used to evaluate the need for further, quantitative evaluation at a later point in time.

The conclusions of this ecological Scoping Assessment are:

- COPECs and ROPECs are present in ecologically significant media on-site.
- The biological characterization has identified both special-status and non-special status receptors both on-site and near Site.
- Viable transport mechanisms exist for some contaminants and groups of contaminants that may allow migration from the on-site source soil to exposure locations of concern. With respect to burrowing mammals and certain other receptor groups, exposure may occur directly at the source location.
- There are potentially complete exposure routes (inhalation, ingestion, etc.) present for certain receptor groups to certain contaminant groups both on-site and off-site. However, it is likely that certain potentially complete exposure pathways will be eliminated by remedial action(s) at the Site.
- The potential for food web exposures is present, specifically with regard to prey mammals present on-site, and thus exposed directly to contaminated surface soil, being consumed by raptors present both on-site and off-site.
- On-site exposures are likely more significant than off-site exposures for all exposure routes, due to the higher concentrations of contaminants present at the source areas versus at receptor locations where off-site transport or migration reduces the contaminant concentrations.
- The relative significance of exposure in different complete exposure pathways is a function of species-specific factors including home range, habitat, feeding/foraging habits, food sources, and water sources as well as contaminant transport characteristics and tendencies.

REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR), 1997a, Concentrations of Selected Radionuclides and Chemicals in Fish, Sediment, and Water, collected from the Putah Creek near the Former Laboratory for Energy-Related Health Research, Davis, California; prepared by USEPA-NAREZ, March 31.

ATSDR, 1997b, Health Consultation, Fish Sampling in Putah Creek, 1996, Laboratory for Energy-Related Health Research, Davis, California.

American Ornithologist's Union (AOU), 1983, Checklist of North American Birds, 6th Edition, American Ornithologist's Union, Washington, D.C. 877 pp.

ASTM, 1995, *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites,* Designation E 1739 – 95, Philadelphia, Pennsylvania.

Audobon Society, 1979, Field Guide to North American Birds, Western Region, Alfred A. Knopf, New York.

Audobon Society, 1983, Master Guide to Birding, Vol. 1 -- Loons to Sandpipers, Alfred A. Knopf, New York.

Audobon Society, 1983, Master Guide to Birding, Vol. 2 -- Gulls to Dippers, Alfred A. Knopf, New York.

Audobon Society, 1983, Master Guide to Birding, Vol. 3 -- Old World Warblers to Sparrows, Alfred A. Knopf, New York.

Barnthouse, L.W, G.W. Suter II, S.M. Bartell, J.J. Beauchamp, R.H. Gardner, E. Linder, R.V. O'Neil and A.E. Rosen, 1986, Users Manual for Ecological Risk Assessment, Oak Ridge National Laboratory, Oak Ridge, Tenn. (ORNL-6251).

Brower, James E., and Jerrod H. Zar, 1984, Field and Laboratory Methods for General Ecology, Second Edition, WCB Publishers, Dubuque, Iowa.

Burmaster, D.E., and R.H. Harris, 1993, The Magnitude of Compounding Conservation in Superfund Risk Assessments, Risk Analysis 13, pp. 131-134.

Burt, William Henry and Richard Philip Grossenheider, 1964. A field Guide to the Mammals, Riverside Press, Cambridge, Massachusetts.

California Air Resources Board, 1984, California Surface Wind Climatology, June, 1984.

California Burrowing Owl Consortium (CBOC). 1993, Burrowing Owl Survey Protocol and Mitigation Guidelines. Alviso, CA.

California Department of Fish and Game (CDFG). 1984, Guidelines for Assessing the Effects of Proposed Developments on Rare and Endangered Plants and Plant Communities. The Resources Agency, Sacramento.

CDFG, 1992, Annual Report on the Status of California State Listed Threatened and Endangered Animals and Plants. Sacramento, CA.

CDFG, 1994, Special Animals List. Natural Heritage Division, Natural Diversity Data Base. August.

CDFG, 1995, Staff Report on Burrowing Owl Mitigation. Sacramento, CA.

CDFG, 1996a, Print-out for the Davis and Merritt USGS quads. Natural Heritage Division, Natural Diversity Data Base. December 27.

CDFG, 1996b, Special Plants List. Natural Heritage Division, Natural Diversity Data Base. January.

CDFG, 1997a, Endangered, Threatened, and Rare Plants of California. Natural Heritage Division, Endangered Plant Program. January.

CDFG, 1997b, Endangered and Threatened Animals of California. Natural Heritage Division, Natural Diversity Data Base. January.

California Division of Oil and Gas (DOG), 1982, California Oil and Gas Fields, Northern California.

California Environmental Protection Agency (Cal-EPA), 1994, *Preliminary Endangerment Assessment Guidance Manual*. Department of Toxic Substances Control, Sacramento, California.

CalEPA, 1996a, Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities. Part A: Overview. Department of Toxic Substances Control, Human Ecological Risk Division. July 4.

CalEPA, 1996b, Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities. Part B: Scoping Assessment. and Department of Toxic Substances Control, Human and Ecological Risk Division. July 4.

California Regional Water Quality Control Board (CRWQCB), 1996, A Compilation of Water Quality Goals/CRWQCB, Central Valley Region, July 1995, updated 1996.

Cheatham, N. H. and J.R. Haller, 1975. An Annotated List of California Habitat Types, University of California Natural Land and Water Resources.

Cohen, J.E. 1978, Food Webs and Niche Space, Princeton University Press: Princeton, N.J.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979, Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 131 pp.

Cowherd, C., G. Muleski, P. Engelhart, and D. Gillette. 1985, *Rapid Assessment of Exposure to Particulate Emission from Surface Contamination.* EPA/600/8-85/002. Prepared for Office of Health and Environmental Assessment, U.S. Environmental Protection Agency, Washington, DC. NTIS PB85-192219 7AS.

Dames and Moore, 1993, Phase II Site Characterization Report, LEHR Environmental Restoration, UC Davis, California.

Dames and Moore, 1994, Remedial Investigation and Feasibility Study, the Site Environmental Restoration, UC Davis, California.

Dames and Moore, February 1996, Assessment of Remedial Options – Ground Water Extraction and Treatment, LEHR, UC Davis, California, 30 pp.

Dames and Moore, 1997, Site Drainage Map, LEHR, UC Davis, California.

Department of Water Resources (DWR), 1978, Evaluation of Ground Water Resources: Sacramento Valley, Bulletin 118-6, 136 pp.

DeSante, D. F. and E. D. Ruhlen. 1995, Draft Census of Burrowing Owls in California, 1991-1993. The Institute for Bird Populations, Point Reyes Station, California.

Dice, L. R., 1943, Biotic Provinces of North America, University of Michigan Press, Ann Arbor, MI.

Ellgas, R.A., 1996, "Establishing Site-Specific Cleanup Levels for Metals in Soil: Statistical Approach," Chapter 50 in *Contaminated Soil*, Volume 1, Amherst, Massachusetts: Amherst Scientific Publishers.

Erman, D. C., E. D. Andrews and M. Yoder-Williams. 1988, Effects of Winter Floods on Fishes in the Sierra Nevada. Can. J. Fish. Aquat. Sci. 45(12):2195-2200.

Gilbert, R.O., 1987, Statistical Methods for Environmental Pollution Monitoring, New York: Van Nostrand Reinhold.

Hayes, M. P. and M. R. Jennings, 1986, Decline of Ranid Frog Species in Western North America: are Bullfrogs (Rana catesbeiana) Responsible? Journal of Herpetology 20:490-509.

Hayes, M. P. and M. R. Jennings. 1988, Habitat correlates of Distribution of the California red-legged frog (Rana aurora draytonii) and the Foothill Yellow-legged Frog (Rana boylii): Implications for Management, in R.C Szaro, K.E. Severson, and D.R. Patton tech. corr.,

Management of Amphibians, Reptiles and Small Mammals in North America. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station. Gen. Tech. Rpt. RM-166.

Hickman, J.C. 1993, The Jepson Manual: Higher Plants of California. University of California Press, Berkeley, California. 1,400 pp.

Holland, R. 1986, Preliminary Descriptions of the Terrestrial Natural Communities of California. California Department of Fish and Game, The Resources Agency. 156 pp.

Howard, P.H. 1990, *Handbook of Environmental Fate and Exposure Data for Organic Chemicals.* Lewis Publishers, Chelsea Michigan.

IT Corporation, 1996, Work Plan for Limited Field Investigation, LEHR, UC Davis, California.

Jennings, M.R. 1983, An Annotated Checklist of the Amphibians and Reptiles of California. California Department of Fish and Game 69(3): 151-171.

Jennings, M. R. and M. P. Hayes, 1994, Amphibian and Reptile Species of Special Concern in California. Final report submitted to the California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, CA. Contract Number 8023.

Jones, J.K., D.C. Carter, H.H. Genoways, R.S. Hoffmann, and D.W. Rice. 1982, Revised Checklist of North American Mammals North of Mexico. Occasional Papers of the Museum, Texas Tech University 80: 1-22.

Jones & Stokes Associates. 1992, Final Hydrologic, Vegetation, and Fisheries Analysis for the U.S. Fish and Wildlife Service Putah Creek Resource Management Plan. July. (JSA 91-196) Sacramento, CA. Prepared for U.S. Fish and Wildlife Service, Sacramento, CA.

Marchetti, M. P. and P. B. Moyle. 1995, The case of Putah Creek Conflicting Values Complicate Stream Protection. Cal. Agri. Nov.-Dec. 1995:73-78.

McCafferty, W.P. 1981, Aquatic Entomology. Jones and Bartlett Publ. Boston, Mass.

Merritt, R.W. and K.W. Cummings (eds.). 1996, An Introduction to the Aquatic Insects of North America. 3rd. ed. Kendall/Hunt Publ. Co. Dubuque, Iowa.

Michaels, D. E., 1971, Log-Normal Analysis of Data for Plutonium in the Outdoors, in proceedings of Environmental Plutonium Symposium, held at LANL, August 4-5, 1971, Los Alamos National Laboratory, Los Alamos, N.Mex (LA-756).pp.105-111.

Miller, K. J. 1994, Endangered and Threatened Wildlife and Plants; Proposed Endangered Status for the California Red-legged Frog. Federal Register, 59: 22.

Miller, K. J., A. Willy, S. Larsen, and S. Morey. 1996, Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the California Red-legged Frog. Federal Register: Vol. 61, No. 101.

Molles, M. C., Jr. 1985, Recovery of a Stream Invertebrate Community from a Flash Flood in Tesuque Creek, New Mexico. Southwest. Nat. 30(2):279-287.

Moyle, P. B. 1973, Effects of Introduced Bullfrogs, Rana Catesbeiana, on the Native Frogs of the San Joaquin Valley, California. Copeia, 1973:18-22.

Munz, P.A. and D.D. Keck, 1968, A California Flora and Supplement, University of California Press, Berkeley, California.

National Climactic Data Center (NCDC), 1992, National Oceanic and Atmospheric Administration Database, information obtained through University of Nevada Desert Research Institute, Western Regional Climate Data Center (Davis 2 WSW station).

National Oceanic and Atmospheric Administration (NOAA), 1985, Local Climatological Data, 1985, Sacramento, California, ISSN 0198-0963, National Climatic Data Centers, Asheville, North Carolina.

National Research Council, 1986, Ecological Knowledge and Environmental Problem-Solving: Concepts and Case Studies, National Research Council, National Academy Press, Washington, D.C.

Pacific Northwest National Laboratory (PNNL), 1995, Data Needs for Detailed Evaluation of Presumptive Remedial Actions at the Laboratory for Energy-Related Health Research, University of California, Davis.

Peterson, Roger Tory, 1969, A Field Guide to Western Birds, Riverside Press, Cambridge Massachusetts.

Pianka, E.R. 1983, Evolutional Ecology , Harper and Row, New York, N.Y.

Plumpton, D. L. and R. S. Lutz. 1993, Nesting Habitat Use by Burrowing Owls in Colorado. The Journal of Raptor Research 27 (4):175-179.

Rathbun, G. B., M. R. Jennings, T. G. Murphey, and N. R. Siepel. 1993, Status and Ecology of Sensitive Aquatic Vertebrates in Lower San Simeon and Pico Creeks, San Luis Obispo County, California. Unpublished report, National Ecology Research Center, Piedras Blancas Research Station, San Simeon, California, 93452-0070. Cooperative Agreement 14-16-009-91-1909. 103 pp.

Remsen, H.V. 1978, Bird Species of Special Concern in California: an Annotated List of Declining or Vulnerable Bird Species. California Department of Fish and Game, The Resources Agency.

Sawyer, J.O. and T. Keeler-Wolf. 1995, A Manual of California Vegetation. California Native Plant Society, Sacramento. 471 pp.

Skinner, M.W. and B.M. Pavlik. 1995, Electronic Inventory of Rare and Endangered Vascular Plants of California. Fifth ed. update. California Native Plant Society, Sacramento, California.

Small, Arnold, 1974, The Birds of California, Winchester Press, New York, New York.

Stebbins, Robert J., 1966, A Field Guide to Western Reptiles and Amphibians,

Stebbins, R.C. 1985, A Field Guide to Western Reptiles and Amphibians. 2nd ed. Houghton Mifflin Company, Boston MA.

Tate, J. 1986, The Blue List for 1986. American Birds 40:227-236.

Thelander, C. G. and M. Crabtree, editors. 1994, Life on the Edge: a Guide to California's Endangered Natural Resources: Wildlife. Biosystems Analysis, Santa Cruz, California.

University of California, Davis (UC Davis). 1994, University of California, Davis Long Range Development Plan, 1994-2005, Environmental Impact Report. State Clearinghouse no. 94022005. Planning and Budget Office. Davis, CA.

UC Davis, 1996, Draft Environmental Impact Report, Wastewater Treatment Plant Replacement Project. State Clearinghouse nos. 95123027 and 96072024. Planning and Budget Office. Davis, CA. October.

UC Davis, 1996, Draft Environmental Impact Report, Waste Water Treatment Plant Replacement Project, University of California, Davis.

United States Department of Agriculture (USDA), Soil Conservation Service, 1977, Soil Survey of Solano County, California, 112 p.

USDA (USDA). 1977, Soil Survey of Solano County, California. Natural Resource Conservation Service. May.

USDA (USDA). 1990, List of Hydric Soil, Solano County, California. Natural Resource Conservation Service. November.

United States Department of Energy (DOE), 1988, Environmental Survey Preliminary Report, Laboratory for Energy-Related Health Research, University of California, Davis.

DOE, 1993, Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements. Office of NEPA Oversight. May.

DOE, 1995, Annual Site Environmental Report Calendar Year 1995 for the Laboratory for Energy-Related Health Research, University of California, Davis, 1995.

DOE, 1995, Annual Water Monitoring Report for the Laboratory for Environmental Health Research, University of California, Davis, 1995.

DOE, 1996, Draft Site Characterization Summary Report for the U.S. Department of Energy Areas at the Laboratory for Energy-Related Health Research, University of California, Davis.

DOE, 1997a, Draft Determination of Risk-Based Action Standards, July, 1997.

DOE, UC Davis, 1997b, Memorandum of Agreement between the United States Department of Energy and the Reports of the University of California regarding the investigation and remediation of the LEHR Site at UC Davis, California, June 23.

DOE, 1997, Draft Final One-Dimensional Vadose Zone Modeling for Laboratory for Energy-Related Health Research (the Site), University of California at Davis, CA. Prepared by Weiss Associates for DOE Oakland, March 1997.

United States Environmental Protection Agency (EPA), 1986, Quality Criteria for Water, Office of Water Regulations and Standards, Criteria and Standard Division, Washington, D.C. (EPA 440/5-86-001).

USEPA, 1988, *Superfund Exposure Assessment Manual.* EPA/540/1-88/001. Office of Emergency and Remedial Response, Washington, DC.

USEPA, 1988, Superfund Exposure Assessment Manual, EPA/540/1-88/001, OSWER Directive 9355.3-01, U.S. Environmental Protection Agency, Office of Remedial Response, Washington, D.C.

USEPA, 1989a, Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference, Environmental Research Laboratory, U.S. Environmental Protection Agency, Corvallis, Oregon,(EPA/600/3-89/013).

USEPA, 1989b, Risk Assessment Guidance for Superfund, Vol 1: Human Health Evaluation Manual, Interim Final, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. (EPA/540/1-89/002).

USEPA, 1989c, Ambient Water Quality Criteria for DDT, United States Environmental Protection Agency, Office of Water Regulations and Standards, Criteria and Standard Division, Washington, D.C. (EPA 440/5-80-038).

USEPA, 1990a, *Subsurface Contamination Reference Guide.* EPA/540/2-90/011. Office of Emergency and Remedial Response, Washington, DC.

USEPA, 1990b, *Exposure Factors Handbook.* EPA/600/8089/043. Office of Health and Environmental Assessment, Washington, DC.

USEPA, 1991, User's Guide for the Fugitive Dust Model (FDM) Revised. USEPA Region X, EPA-910/9-88/202R.

USEPA, 1991a, *Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals).* Publication 9285.7-01B. Office of Emergency and Remedial Response, Washington, DC. NTIS PB92-963333.

USEPA, 1991b, *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors.* Publication 9285.6-03. Office of Emergency and Remedial Response, Washington, DC. NTIS PB91-921314.

USEPA, 1992, Framework for Ecological Risk Assessment, Risk Assessment Forum, U.S. Environmental Protection Agency, Washington D.C. (EPA/630/R 92/001).

USEPA, 1992, *Supplemental Guidance to RAGS: Calculating the Concentration Term*, Office of Emergency and Remedial Response, Hazardous Site Evaluation Division, Intermittent Bulletin, Volume 1, Number 1, May.

USEPA, 1992a, *Technical Support Document for Land Application of Sewage Sludge; Volumes I and II.* Office of Water, Washington, DC. 822/R-93-001a,b.

USEPA, 1992b, *Dermal Exposure Assessment: Principles and Applications.* EPA/600/8-91/011B. Office of Health and Environmental Assessment, Washington, DC.

USEPA, 1994a, *Estimating Exposure to Dioxin-Like Compounds.* U.S. EPA Office of Research and Development, EPA/600/6-88/005B.

USEPA, 1994b, *Role of Ecological Assessment in the Baseline Risk Assessment.* OSWER Directive No. 9285.7-17. Office of Solid Waste and Emergency Response, Washington, DC.

USEPA, 1994c, *Superfund Chemical Data Matrix.* EPA/540/R-94/009. Office of Solid Waste and Emergency Response, Washington, DC. PB94-963506.

USEPA, 1995, *Health Effects Assessment Summary Tables* (HEAST): Annual Update, FY 1994. Environmental Criteria Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Cincinnati, OH.

USEPA, 1996a, *Soil Screening Guidance: Technical Background Document.* EPA/540/R-95/128. Office of Emergency and Remedial Response, Washington, DC. PB96-963502.

USEPA, 1996b, *Soil Screening Guidance: User's Guide.* EPA/540/R-96/018. Office of Emergency and Remedial Response, Washington, DC. PB96-963505.

USEPA, 1996c, *Integrated Risk Information System* (IRIS). Duluth, MN.

United States Fish and Wildlife Service (USFWS). 1994, Endangered and Threatened Wildlife and Plants. 50 CFR 17.11 & 17.12. August 20.

USFWS, 1996, Endangered and Threatened Wildlife and Plants; Animal Candidate Review for Listing as Endangered or Threatened Species; Proposed Rule. 50 CFR part 17. February 26.

USFWS, 1997a, Endangered and Threatened Species that May Occur in or be Affected by Projects in the Davis and Merrit Quads. Letter from W. White to M. Wood. January 23.

USFWS, 1997b, Listed and Proposed Endangered and Threatened Species and Candidate Species that May Occur in or be Affected by Projects in the area of the Saxon, Dixon, Taylor Monument, Grays Bend, Sacramento West, Woodland, Madison and Winters Quads. Letter from W. White to M. Wood. January 23.

Wilkinson, G.S. and K.R. Debben. 1980, Habitat Preferences of Wintering Diurnal Raptors in the Sacramento Valley. Western Birds 11:25-34.

Williams, D.F. 1986, Mammalian Species of Special Concern in California. California Department of Fish and Game. Wildlife Management Division Administrative Report 86-1. 112 pp.

PERSONS CONTACTED:

Carney, Heath J., Division of Environmental Studies. University of California, Davis, CA. E-mail communication with M. Podlech, January 28, 1997.

Erman, Nancy, Aquatic Ecologist. University of California, Davis, CA. Telephone conversation with M. Podlech, January 24, 1997.

Jennings, M. R., Research Associate. Department of Herpetology, California Academy of Sciences, San Francisco. 12 June 1994 - Speaker at seminar entitled "Biology and Management of Sensitive Amphibians and Reptiles of Central and Southern California." Central California Chapter of The Wildlife Society, Goleta, CA.

McGriff, Darleen, Natural Heritage Division. California Dept. of Fish and Game, Rancho Cordova, CA. Telephone conversation with M. Podlech, January 23, 1997.

Sanford, Roland, Solano County Water Resource Agency, Telephone conversation with J. Pekala, WA, May 1997.

Scott, Norman and G. Rathbun, U. S. Geological Survey, Peidras Blancas Field Station, San Simeon, California. 6 February 1997 Delivered paper entitled "What do we need to know to manage red-legged frogs." Annual Meeting of the Western Section of The Wildlife Society, San Diego, California.

Stedman, B., University of California, Davis Raptor Center. Telephone conversation with M. Wood. February 4, 1997.

Taylor, Steve, Fisheries Biologist. California Dept. of Fish and Game, Sacramento, CA. Telephone conversation with M. Podlech, January 22, 1997.

Westphal, Mike, Research Associate. Coyote Creek Riparian Station. Alviso, CA. 3 July 1995 - meeting.

Williams, Kevin Z., Manager, Putah Creek Reserve. Telephone conversation with M. Podlech, January 31, 1997.

Woods, Michael, Botanical Consulting Services. Telephone conversation with John Wolf, April 1997.

Wylie, G. D. U. S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, California. 7 February 1997- Delivered paper entitled "In search of the giant garter snake." Annual Meeting of the Western Section of The Wildlife Society, San Diego, California.

ACKNOWLEDGMENTS

The following Project personnel worked on the Draft Final Ecological Scoping Assessment for DOE Areas:

Name and Position	Responsibility
Michael Dresen the Site Program Manager, WA	Senior guidance and review, and quality assurance
Robert Devany the Site Project Manager, WA	Project management, guidance and review.
Salem Attiga Principal, EMS	Senior review
Mary Stallard the Site Quality Assurance, WA	Quality assurance
Carolyn Atwood Task Manager, WA	Task Manager, task coordination and technical guidance
Leslie Rueth Environmental Scientist, WA	Task technical performance, report writing
John Wolf Environmental Scientist, WA	Task technical performance, report writing
Malieka Bundy Database Technician, WA	Database management
Keith Commiskey Graphics, WA	Graphics
Elizabeth Carrier Project Administrator	Word processing, report coordination
Craig Adams Production Personnel, WA	Graphics and report production

LIST OF ACRONYMS

ACOE	United States Army Corps of Engineers
AEC	Atomic Energy Commission
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient Water Quality Criteria
BHC	Benzene Hexachloride
BKG	Background
CalEPA	California Environmental Protection Agency
CCR	California Code of Regulations
CDFG	California Department of Fish and Game
CERCLA	Comprehensive Environmental Response, Compensation and Liabilities Act
CFR	Code of Federal Regulations
Cfs	Cubic feet per second
CNDD	California Natural Diversity Database
CNPS	California Native Plant Society
Co-60	Cobalt 60
COPEC	Chemical of Potential Ecological Concern
CRWQCB	California Regional Water Quality Control Board
DDD	Dichlorodipheryldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DOE	Department of Energy
DTSC	Department of Toxic Substances Control
EE/CA	Engineering Evaluation/Cost Analysis
EIR	Environmental Impact Report
FEMA	Federal Emergency Management Administration
FR	Federal Register
Ft bgs	Feet below ground surface
HG-203	Mercury 203, Isotopic Mercury
HSU	Hydrostratigraphic Units
IT	International Technology Corporation

Kg	Kilogram
L	Liter
LFI	Limited Field Investigation
M/s	Meters per second
Max	Maximum
MDA	Minimum Detectable Activity
MDL	Method Detection-Limit
Mg	Milligram
Min	Minimum
MOA	Memorandum of Agreement
Mph	Miles per hour
NAREL	National Air and Radiation Environmental Laboratory
NEPA	National Environmental Protection Act
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NRCS	National Resource Conservation Service
PCB	Polychlorinated biphenyl
PCD	Putah Creek Downstream
pCi	Picocurie
PCU	Putah Creek Upstream
ppb	Parts per billion
ppm	Parts per million
QA/QC	Quality Assurance/Quality Control
RME	Reasonable Maximum Exposure
ROPEC	Radionuclide of Potential Ecological Concern
STPO	UC Davis Sewage Treatment Plant Outfall
SVOC	Semi-Volatile Organic Compound
UC Davis	University of California at Davis
UCL	Upper Confidence Level
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VOC	Volatile Organic Compound
WA	Weiss Associates
WTPRP	UC Davis Wastewater Treatment Plant Replacement Project

ATTACHMENT A

SITE DRAINAGE AREA MAP
DAMES & MOORE

LOCATION MAP
STORM WATER RUNOFF MONITORING POINTS
Revised Field Sampling Plan
LEHR/SCDS Environmental Restoration
Davis, California
FIGURE 16

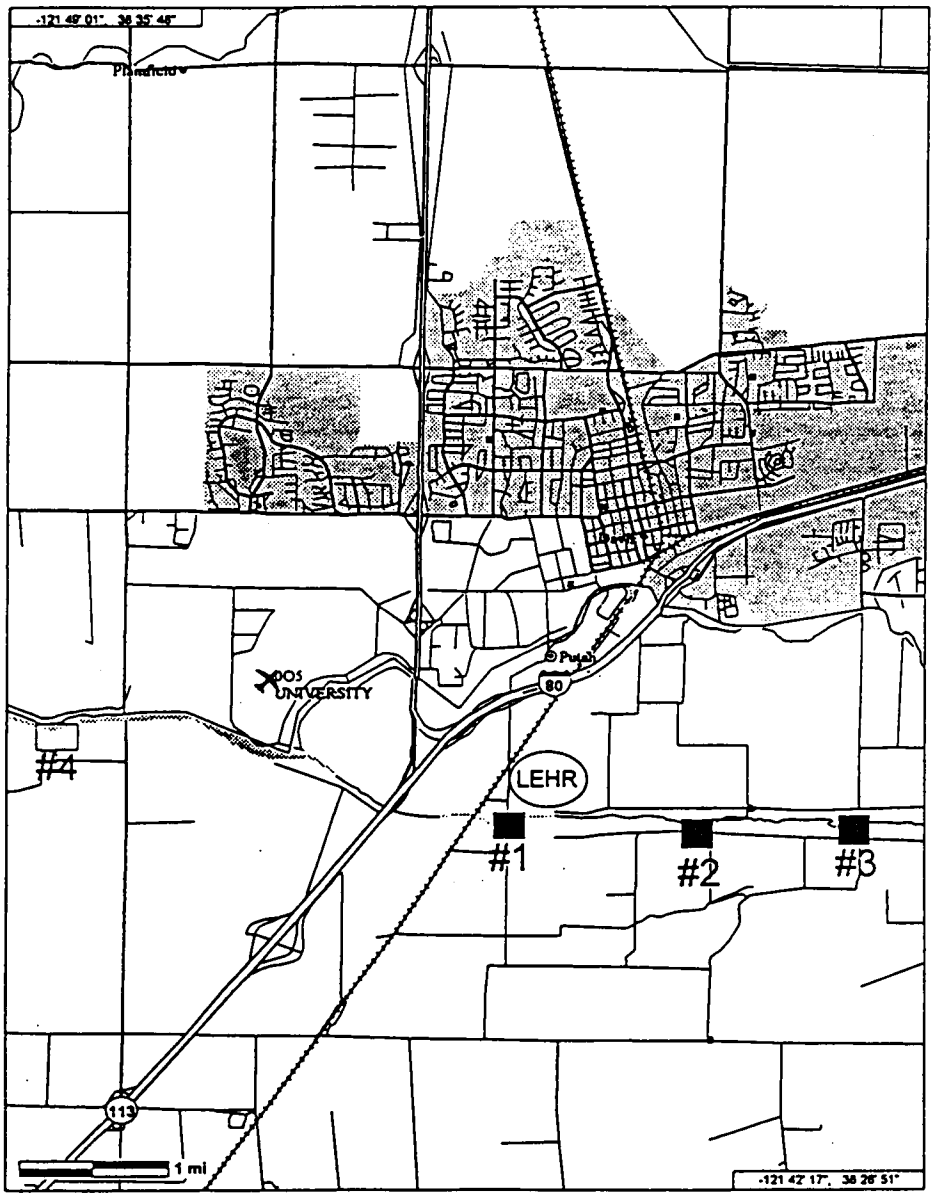
DAMES & MOORE
A DAMES & MOORE GROUP COMPANY

00234-255-7105-044 ah 7105C 4/14/97

ATTACHMENT B

SAMPLING LOCATIONS FROM ATSDR FISH SAMPLING REPORT

Figure 1. Map of LEHR Site and Putah Creek with Locations of the Four Sampling Sites



Note: Figure taken from the report *Concentrations of Selected Radionuclides and Chemicals in Fish, Sediment, and Water Collected from the Putah Creek near the Former Laboratory for Energy-Related Health Research, Davis California* (1997) compiled by the National Air and Radiation Environmental Laboratory (NAREL). This report was prepared for the Agency for Toxic Substances and Disease Registry (ATSDR).

ATTACHMENT C

PRELIMINARY LIST OF PLANT AND ANIMAL SPECIES DETECTED OR EXPECTED TO OCCUR AT THE SITE

Preliminary List of Plant and Animal Species Detected or Expected to Occur at the Site.

PLANTS

Family **Scientific Name**	**Common Name**
Amaranthaceae - Amaranth Family	
*Amaranthus albus**	tumbleweed
Apiaceae - Parsley Family	
*Conium maculatum**	poison hemlock
*Foeniculum vulgare**	sweet fennel
Apocynaceae - Dogbane Family	
*Nerium oleander**	common oleander
Asteraceae - Sunflower Family	
*Anthemis cotula**	dog mayweed
*Carduus pycnocephalus**	Italian thistle
*Centaurea solstitialis**	yellow star thistle
*Conyza canadensis**	horseweed
Gnaphalium sp.	pearly everlasting
*Lactuca serriola**	wild lettuce
*Senecio vulgaris**.	common groundsel
*Silybum marianum**	milk thistle
*Sonchus asper**	prickly sow-thistle
*Taraxacum officinale**	common dandelion
Boraginaceae - Borage Family	
Amsinckia menziesii var. *intermedia*	rigid fiddleneck
Brassicaceae - Mustard Family	
*Brassica nigra**	black mustard
*Capsella bursa-pastoris**	shepards purse
Caryophyllaceae - Pink Family	
*Stellaria media**	common chickweed
Caprifoliaceae - Honeysuckle Family	
Sambucus mexicana	blue elderberry
Chenopodiaceae - Goosefoot Family	
Salsola sp.*	Russian thistle
Cupressaceae - Cypress Family	
Juniperus sp.*	juniper
Euphorbiaceae - Spurge Family	
*Chamaesyce prostrata**	prostrate spurge
Eremocarpus setigerus	doveweed

Plants

Family **Scientific Name**	**Common Name**
Fabaceae - Pea Family	
Lupinus bicolor	lupine
*Medicago polymorpha**	bur-clover
Trifolium sp.	clover
Fagaceae - Oak Family	
Quercus agrifolia	coast live oak
Flacourtiaceae - Flacourtia Family	
*Xylosma congestum**	shiny xylosma
Geraniaceae - Geranium Family	
*Erodium botrys**	long-beaked storkbill
*Erodium cicutarium**	red-stemmed filaree
*Erodium moschatum**	white-stemmed filaree
*Geranium dissectum**	cranesbill
Juglandaceae - Walnut Family	
Juglans californica var. *hindsii*	California black walnut
*Juglans nigra**	black walnut
Lamiaceae - Mint Family	
*Lamium amplexicaule**	common henbit
*Marrubium vulgare**	horehound
Malvaceae - Mallow Family	
*Malva parviflora**	cheeseweed
Malvella leprosa	alkali-mallow
Martyniaceae - Unicorn-plant Family	
*Proboscidea louisianica**	common unicorn plant
Moraceae - Mulberry Family	
*Morus alba**	white mulberry
Myrtaceae - Myrtle Family	
*Eucalyptus globulus**	Tasmanian blue gum
Oleaceae - Olive Family	
*Olea europea**	olive
Onagraceae - Evening Primrose Family	
Epilobium brachycarpum	fireweed
Papaveraceae - Poppy Family	
Eschscholzia californica	California poppy
Pinaceae - Pine Family	
*Pinus halepensis**	aleppo pine
*Pinus radiata**	Monterey pine
Portulaceae - Purslane Family	
Claytonia perfoliata ssp. *perfoliata*	miner's lettuce
Poaceae - Grass Family	
*Avena fatua**	wild oat
*Bromus diandrus**	ripgut brome

Plants

Family **Scientific Name**	**Common Name**
Bromus hordeaceus•	soft chess
*Cynodon dactylon**	Bermuda grass
Hordeum murinum ssp. *leporinum*•	hare barley
*Lolium multiflorum**	Italian ryegrass
*Nassella pulchra**	purple needlegrass
*Paspalum dilatatum**	dallis grass
*Poa annua**	annual bluegrass
*Polypogon monspeliensis**	rabbitfoot grass
*Sorghum halepense**	Johnsongrass
*Vulpia myuros**	foxtail fescue
Rosaceae - Rose Family	
Cotoneaster pannosa•	cotoneaster
Prunus dulcis•	almond
Salicaceae - Willow Family	
Salix lasiolepis	arroyo willow
Scrophulariaceae - Figwort Family	
Kickxia spuria•	fluellin
Solanaceae - Nightshade Family	
Chamaesaracha nana	dwarf chamaesaracha
Datura sp.	jimson weed
Solanum nigrum•	black nightshade
Ulmaceae - Elm Family	
*Celtis occidentalis**	hackberry
Viscaceae - Mistletoe Family	
Phoradendron sp.	mistletoe

ANIMALS

Scientific Name	Common Name	Occurrence[1]
Birds		
Accipiter cooperi	Coopers Hawk	w**[2]
Accipiter striatus	Sharp-shinned Hawk	w[2]
Agelaius phoeniceus	Red-winged Blackbird	f
Agelaius tricolor	Tricolored Blackbird	f[2]
Anthus rubescens	American Pipit	w
Aphelocoma coerulescens	Scrub Jay	b,w**
Aquila chrysaetos	Golden Eagle	t[2]
Ardea herodias	Great Blue Heron	f[2]
Asio flammeus	Short-eared Owl	f[2]
Athene cunicularia hypugea	Western Burrowing Owl	b,w**[2]
Bombycilla cedrorum	Cedar Waxwing	w
Bubo virginianus	Great Horned Owl	b,w**
Buteo jamaicensis	Red-tailed Hawk	b,w**
Buteo lagopus	Rough-legged Hawk	t
Buteo lineatus	Red-shouldered Hawk	b,w
Buteo regalis	Ferruginous Hawk	t[2]
Buteo swainsoni	Swainson's Hawk	b**[2]
Butorides striatus	Green-backed Heron	b,w
Calypte anna	Anna's Hummingbird	b,w**
Callipepla californica	California Quail	b,w
Carduelis psaltria	Lesser Goldfinch	b,w**
Carduelis tristis	American Goldfinch	b,w**
Carpodacus mexicanus	House Finch	b,w**
Casmerodius albus	Great Egret	f[2]
Cathartes aura	Turkey Vulture	w
Catharus guttatus	Hermit Thrush	b,w**
Charadrius vociferus	Killdeer	f
Chondestes grammacus	Lark Sparrow	b,w
Circus cyaneus	Northern Harrier	f[2]
Colaptes auratus	Northern Flicker	b,w**
Columba livia	Rock Dove	b,w**
Corvus brachyrhynchos	American Crow	b,w**
Dendroica coronata	Yellow-rumped Warbler	w**
Dendroica nigrescens	Black-throated Gray Warbler	w
Egretta thula	Snowy Egret	f[2]
Elanus leucurus	White-tailed Kite	b,w**[2]
Eremophila alpestris	California Horned Lark	w[2]
Euphagus cyanocephalus	Brewer's Blackbird	f
Falco columbarius	Merlin	t[2]
Falco mexicanus	Prairie Falcon	t[2]
Falco sparverius	American Kestrel	b,w**

ANIMALS

Scientific Name	Common Name	Occurrence[1]
Hirundo pyrrhonota	Cliff Swallow	b
Hirundo rustica	Barn Swallow	b**
Icterus galbula	Northern Oriole	b
Ixoreus naevius	Varied Thrush	w
Junco hyemalis	Dark-eyed Junco	b,w**
Lanius ludovicianus	Loggerhead Shrike	b,w[2]
Loxia curvirostra	Red Crossbill	t**
Melanerpes formicivorus	Acorn Woodpecker	b,w
Melospiza lincolnii	Lincoln's Sparrow	w
Melospiza melodia	Song Sparrow	b,w**
Mimus polyglottos	Northern Mockingbird	b,w
Molothrus ater	Brown-headed Cowbird	b,w
Myiarchus cinerascens	Ash-throated Flycatcher	b
Parus inornatus	Plain Titmouse	b,w
Passer domesticus	House Sparrow	b,w
Passerculus sandwichensis	Savannah Sparrow	w
Pica nuttalli	Yellow-billed Magpie	b,w**
Picoides nuttalli	Nuttall's Woodpecker	b,w**
Picoides pubescens	Downy Woodpecker	b,w
Pipilo crissalis	California Towhee	b,w**
Pipilo erythrophthalmus	Rufous-sided Towhee	b,w**
Psaltriparus minimus	Bushtit	b,w**
Regulus calendula	Ruby-crowned Kinglet	w**
Sayornis nigricans	Black Phoebe	b,w**
Sayornis saya	Says Phoebe	w**
Sitta canadensis	Red-breasted Nuthatch	b,w**
Stelgidopteryx serripennis	No. Rough-winged Swallow	f
Sturnella neglecta	Western Meadowlark	b,w**
Sturnus vulgaris	European Starling	b,w**
Troglodytes aedon	House Wren	b,w**
Turdus migratorius	American Robin	b,w**.
Tyrannus verticalis	Western Kingbird	b
Tyto alba	Barn Owl	b,w**
Zenaidura macroura	Mourning Dove	b,w**
Zonotrichia atricapilla	Golden-crowned Sparrow	w**
Zonotrichia leucophrys	White-crowned Sparrow	w**

ANIMALS

Scientific Name	Common Name	Occurrence[1]
Mammals		
Canis latrans	Coyote	y**
Didelphis virginiana	Opposum	y
Eptesicus fuscus	Big Brown Bat	y
Felis domesticus	House Cat	y**
Lasiurus blossevillii (borealis)	Western Red Bat	y
Lepus californicus	Black-tailed Jackrabbit	y**
Lynx rufus	Bobcat	y
Mephitis mephitis	Striped Skunk	y**
Microtus californicus	California Vole	y
Mus musculus	House Mouse	y
Mustela frenata	Long-tailed Weasel	y
Myotis californicus	California Myotis	y
Myotis yumanensis	Yuma Myotis	y
Peromyscus maniculatus	Deer Mouse	y
Procyon lotor	Raccoon	y**
Reithrodontomys megalotis	Western Harvest Mouse	y
Spermophilus beecheyi	California Ground Squirrel	y**
Spilogale putorius	Spotted Skunk	y
Sylvilagus audubonii	Audubon's Cottontail	y**
Taxidea taxus	American Badger	y[2]
Thomomys bottae	Botta's Pocket Gohper	y**
Urocyon cinereoargenteus	Gray Fox	y
Vulpes vulpes	Red Fox	y**
Reptiles		
Gerrhonotus multicarinatus	Southern Alligator Lizard	y
Lampropeltis getulus	Common Kingsnake	y
Pituophis melanoleucus	Gopher Snake	y
Sceloporus occidentalis	Western Fence Lizard	y
Thamnophis elegans	Western Terrestrial Garter Snake	y
Amphibians		
Bufo boreas	Western Toad	y
Hyla regilla	Pacific Treefrog	y

* denotes nonnative species or species not naturally occurring onsite
? indicates uncertain identification due to condition of plant material
[1]Occurrence: b = breeding; f = foraging habitat; t = transient; w = wintering;
y = rear-round residents;
** = observed during 1997 surveys
[2] indicates sensitive taxon (see text)

ATTACHMENT D

PRELIMINARY LIST OF PLANT AND ANIMAL SPECIES DETECTED, EXPECTED TO OCCUR OR RECORDED AT THE SITE

Preliminary List of Plant and Animal Species Detected, Expected to Occur or Recorded in the Vicinity of the Site.

PLANTS

Family **Scientific Name**	**Common Name**
Aceraceae - Maple Family	
Acer negundo ssp. *californicum*	box elder
Amaranthaceae - Amaranth Family	
*Amaranthus albus**	tumbleweed
Amaranthus blitoides	pigweed
Anacardiaceae - Sumac Family	
Toxicodendron diversilobum	poison oak
Apiaceae - Parsley Family	
*Conium maculatum**	poison hemlock
*Foeniculum vulgare**	sweet fennel
Apocynaceae - Dogbane Family	
*Nerium oleander**	common oleander
Asteraceae - Sunflower Family	
Achyrachaena mollis	blow-wives
*Anthemis cotula**	dog mayweed
*Chamomilla suaveolens**	pineapple weed
*Carduus pycnocephalus**	Italian thistle
*Centaurea solstitialis**	yellow star thistle
*Cirsium vulgare**	bull thistle
*Conyza canadensis**	horseweed
Gnaphalium sp.	pearly everlasting
Grindelia camporum	Great Valley grindelia
Hemizonia fitchii	Fitch's spikeweed
Hemizonia pungens	common spikeweed
*Lactuca serriola**	wild lettuce
*Picris echioides**	bristly ox-tongue
*Senecio vulgaris**	common groundsel
*Silybum marianum**	milk thistle
*Sonchus asper**	prickly sow-thistle
*Sonchus oleraceus**	common sow-thistle
*Taraxacum officinale**	common dandelion
*Tragopogon porrifolius**	salsify
*Xanthium strumarium**	eastern cocklebur

PLANTS

Family **Scientific Name**	**Common Name**
Boraginaceae - Borage Family	
Amsinckia menziesii var. *intermedia*	rigid fiddleneck
Heliotropium curvassavicum	salt heliotrope
Brassicaceae - Mustard Family	
*Brassica nigra**	black mustard
*Capsella bursa-pastoris**	shepards purse
*Hirschfeldia incana**	Mediterranean mustard
Lepidium nitidum	peppergrass
*Lepidium perfoliatum**	common peppergrass
*Raphanus sativus**	wild radish
Caryophyllaceae - Pink Family	
Cerastium fontanum ssp. *vulgare**	mouse-eared chickweed
*Stellaria media**	common chickweed
Caprifoliaceae - Honeysuckle Family	
Sambucus mexicana	blue elderberry
Chenopodiaceae - Goosefoot Family	
Atriplex lentiformis ssp. *lentiformis*	big saltbush
*Chenopodium album**	lamb's quarters
*Chenopodium ambrosioides**	Mexican tea
Salsola sp.*	Russian thistle
Convolvulaceae - Morning-glory Family	
*Convolvulus arvensis**	field bindweed
Cucurbitaceae - Gourd Family	
Citrullus colocynthis var. *lanatus**	watermelon
Cupressaceae - Cypress Family	
Juniperus sp.*	juniper
Cyperaceae - Sedge Family	
Cyperus sp.	sedge
*Cyperus involucratus**	umbrella sedge
Scirpus acutus var. *occidentalis*	common tule
Euphorbiaceae - Spurge Family	
*Chamaesyce prostrata**	prostrate spurge
Eremocarpus setigerus	doveweed
Fabaceae - Pea Family	
*Lotus corniculatus**	bird's foot trefoil
Lupinus bicolor	lupine
Lupinus succulentus	succulent annual lupine
*Medicago polymorpha**	bur-clover
*Medicago sativa**	alfalfa
*Melilotus indica**	yellow sweet-clover
*Trifolium hirtum**	rose clover
Trifolium sp.	clover

PLANTS

Family **Scientific Name**	**Common Name**
Vicia sativa ssp. *sativa**	common vetch
Fagaceae - Oak Family	
Quercus agrifolia	coast live oak
Quercus lobata	Valley oak
*Quercus suber**	cork oak
Flacourtiaceae - Flacourtia Family	
*Xylosma congestum**	shiny xylosma
Geraniaceae - Geranium Family	
*Erodium botrys**	long-beaked storkbill
*Erodium cicutarium**	red-stemmed filaree
*Erodium moschatum**	white-stemmed filaree
*Geranium dissectum**	cranesbill
Hippocastanaceae - Buckeye Family	
Aesculus californica	California buckeye
Juglandaceae - Walnut Family	
Juglans californica var. *hindsii*	California black walnut
*Juglans nigra**	black walnut
Lamiaceae - Mint Family	
*Lamium amplexicaule**	common henbit
*Marrubium vulgare**	horehound
Malvaceae - Mallow Family	
*Malva parviflora**	cheeseweed
Malvella leprosa	alkali-mallow
Martyniaceae - Unicorn-plant Family	
*Proboscidea louisianica**	common unicorn plant
Moraceae - Mulberry Family	
*Morus alba**	white mulberry
Myrtaceae - Myrtle Family	
*Eucalyptus globulus**	Tasmanian blue gum
Oleaceae - Olive Family	
*Olea europea**	olive
Onagraceae - Evening Primrose Family	
Epilobium brachycarpum	fireweed
Papaveraceae - Poppy Family	
Eschscholzia californica	California poppy
Pinaceae - Pine Family	
*Pinus halepensis**	aleppo pine
*Pinus radiata**	Monterey pine
Platanaceae - Sycamore Family	
Platanus racemosa	California sycamore

PLANTS

Family **Scientific Name**	**Common Name**
Polygonaceae - Buckwheat Family	
*Polygonum arenastrum**	common knotweed
*Rumex crispus**	curly dock
Portulaceae - Purslane Family	
Calandrinia ciliata	red maids
Claytonia perfoliata ssp. *perfoliata*	miner's lettuce
*Portulaca oleraceus**	common purslane
Poaceae - Grass Family	
*Avena fatua**	wild oat
*Briza minor**	quaking grass
Bromus carinatus	California brome
*Bromus diandrus**	ripgut brome
*Bromus hordeaceus**	soft chess
*Cynodon dactylon**	Bermuda grass
Distichlis spicata	salt grass
*Echinochloa crus-galli**	barnyard grass
Hordeum brachyantherum ssp. *brachyanterum*	meadow barley
Hordeum murinum ssp. *leporinum**	hare barley
Leymus triticoides	creeping ryegrass
*Lolium multiflorum**	Italian ryegrass
*Nassella pulchra**	purple needlegrass
*Paspalum dilatatum**	dallis grass
*Phalaris minor**	littleseed canary grass
*Phalaris paradoxa**	paradox canary grass
*Poa annua**	annual bluegrass
*Polypogon monspeliensis**	rabbitfoot grass
*Sorghum halepense**	Johnsongrass
Sporobolus airoides	alkali sacaton
*Triticum aestivum**	cultivated wheat
*Vulpia myuros**	foxtail fescue
Rosaceae - Rose Family	
*Cotoneaster pannosa**	cotoneaster
Heteromeles arbutifolia	toyon
*Prunus domestica**	plum
*Prunus dulcis**	almond
*Raphiolepis indica**	India hawthorne
Rubiaceae - Madder Family	
Galium aparine	goose grass
Cephalanthus occidentalis var. *californicus*	California button willow

PLANTS

Family **Scientific Name**	**Common Name**
Salicaceae - Willow Family	
Populus fremontii ssp. *fremontii*	Fremont cottonwood
Salix exigua	narrow-leaved willow
Salix gooddingii	black willow
Salix laevigata	red willow
Salix lasiolepis	arroyo willow
Salix lucida var. *lasiandra*	lance-leaf willow
Scrophulariaceae - Figwort Family	
*Kickxia elatine**	sharp-leaved fluellin
*Kickxia spuria**	fluellin
Simarubaceae - Quassia Family	
*Ailanthus altissima**	tree of heaven
Solanaceae - Nightshade Family	
Chamaesaracha nana	dwarf chamaesaracha
Datura sp.	jimson weed
*Nicotiana glauca**	tree tobacco
*Solanum nigrum**	black nightshade
Typhaceae - Cattail Family	
Typha angustifolia	narrowleaf cattail
Typha latifolia	broadleaf cattail
Ulmaceae - Elm Family	
*Celtis occidentalis**	hackberry
Verbenaceae - Vervain Family	
Verbena lasiostachys	western vervain
Viscaceae - Mistletoe Family	
Phoradendron sp.	mistletoe
Vitaceae - Grape Family	
Vitis californica	California wild grape
*Vitis vinifera**	wine grape
Zygophyllaceae - Caltrop Family	
*Tribulus terrestris**	puncture vine

ANIMALS

Scientific Name	Common Name	Occurrence[1]
Birds		
Accipiter cooperi	Coopers Hawk	w**[2]
Accipiter striatus	Sharp-shinned Hawk	w[2]
Actitis macularia	Spotted Sandpiper	w
Agelaius phoeniceus	Red-winged Blackbird	b,w
Agelaius tricolor	Tricolored Blackbird	b,w[2]
Aix sponsa	Wood Duck	b,w
Anas acuta	Northern Pintail	w
Anas americana	American Widgeon	w
Anas carolinensis	Green-winged Teal	w
Anas clypeata	Northern Shoveler	w
Anas crecca	Green Winged Teal	w
Anas cyanoptera	Cinnamon Teal	w
Anas platyrhynchos	Mallard	b,w**
Anas strepera	Gadwall	w
Anser albifrons	Greater White-fronted Goose	w
Anthus rubescens	American Pipit	w
Aphelocoma coerulescens	Scrub Jay	b,w**
Aquila chrysaetos	Golden Eagle	t[2]
Ardea herodias	Great Blue Heron	f[2]
Asio flammeus	Short-eared Owl	e[2]
Athene cunicularia hypugea	Western Burrowing Owl	b,w**[2]
Aythya affinis	Lesser Scaup	w
Aythya collaris	Ring-necked Duck	w
Bombycilla cedrorum	Cedar Waxwing	w
Branta canadensis	Canada Goose	w**
Bubo virginianus	Great Horned Owl	b,w**
Bucephala albeola	Bufflehead	w
Bucephala clangula	Common Goldeneye	w
Buteo jamaicensis	Red-tailed Hawk	b,w**
Buteo lagopus	Rough-legged Hawk	t
Buteo lineatus	Red-shouldered Hawk	b,w
Buteo regalis	Ferruginous Hawk	t[2]
Buteo swainsoni	Swainson's Hawk	b**[2]
Butorides striatus	Green-backed Heron	b,w
Calidris mauri	Western Sandpiper	t
Calidris minutilla	Least Sandpiper	t
Calypte anna	Anna's Hummingbird	b,w**
Callipepla californica	California Quail	b,w
Carduelis tristis	American Goldfinch	b,w
Carduelis psaltria	Lesser Goldfinch	b,w**
Carpodacus mexicanus	House Finch	b,w**

ANIMALS

Scientific Name	Common Name	Occurrence[1]
Casmerodius albus	Great Egret	f**[2]
Cathartes aura	Turkey Vulture	w
Catharus guttatus	Hermit Thrush	b,w**
Ceryle alcyon	Belted Kingfisher	b,w**
Charadrius vociferus	Killdeer	b,w**
Chondestes grammacus	Lark Sparrow	b,w
Circus cyaneus	Northern Harrier	b,w**[2]
Cistothorus palustris	Marsh Wren	b,w
Colaptes auratus	Northern Flicker	b,w**
Columba livia	Rock Dove	b,w**
Corvus brachyrhynchos	American Crow	b,w**
Dendroica coronata	Yellow-rumped Warbler	w**
Dendroica nigrescens	Black-throated Gray Warbler	w
Egretta thula	Snowy Egret	f**[2]
Elanus leucurus	White-tailed Kite	b,w**[2]
Eremophila alpestris	California Horned Lark	w**[2]
Euphagus cyanocephalus	Brewer's Blackbird	b,w**
Falco columbarius	Merlin	t[2]
Falco mexicanus	Prairie Falcon	t[2]
Falco sparverius	American Kestrel	b,w**
Fulica americana	American Coot	b,w**
Gallinago gallinago	Common Snipe	b,w
Gallinula chloropus	Common Moorhen	b,w
Geothlypis trichas	Common Yellowthroat	b,w
Himantopus mexicanus	Black-necked Stilt	b,w
Hirundo pyrrhonota	Cliff Swallow	b
Icterus galbula	Northern Oriole	b
Ixoreus naevius	Varied Thrush	w**
Junco hyemalis	Dark-eyed Junco	b,w**
Lanius ludovicianus	Loggerhead Shrike	b,w**[2]
Larus californicus	California Gull	t
Larus delawarensis	Ring-billed Gull	t
Loxia curvirostra	Red Crossbill	t
Melanerpes formicivorus	Acorn Woodpecker	b,w
Melospiza lincolnii	Lincoln's Sparrow	w
Melospiza melodia	Song Sparrow	b,w**
Mergus merganser	Common Merganser	w
Mimus polyglottos	Northern Mockingbird	b,w
Molothrus ater	Brown-headed Cowbird	b,w
Myiarchus cinerascens	Ash-throated Flycatcher	b,w
Numenius americanus	Long-billed Curlew	w
Nycticorax nycticorax	Black-crowned Night Heron	b,w**[2]
Otus kennicotti	Western Screech-owl	b,w

ANIMALS

Scientific Name	Common Name	Occurrence[1]
Passer domesticus	House Sparrow	b,w
Passerculus sandwichensis	Savannah Sparrow	w
Passerina amoena	Lazuli Bunting	b,w
Phalacrocorax auritus	Double-crested Cormorant	w[2]
Phasianus colchicus	Ring-necked Pheasant	b,w
Pheucticus melanocephalus	Black-headed Grosbeak	b,w
Pica nuttalli	Yellow-billed Magpie	b,w**
Picoides nuttalli	Nuttall's Woodpecker	b,w**
Picoides pubescens	Downy Woodpecker	b,w
Pipilo crissalis	California Towhee	b,w**
Pipilo erythrophthalmus	Rufous-sided Towhee	b,w**
Pluvialis squatarola	Black-bellied Plover	w
Podilymbus podiceps	Pied-billed Grebe	w
Porzana carolina	Sora	b,w
Psaltriparus minimus	Bushtit	b,w**
Rallus limicola	Virginia Rail	b,w
Recurvirostra americana	American Avocet	b,w
Regulus calendula	Ruby-crowned Kinglet	w**
Riparia rustica	Barn Swallow	b**
Sayornis nigricans	Black Phoebe	b,w**
Sayornis saya	Says Phoebe	w**
Sialia currucoides	Mountain Bluebird	w**
Sialia mexicana	Western Bluebird	b,w
Sitta canadensis	Red-breasted Nuthatch	b,w**
Spizella passerina	Chipping Sparrow	b,w
Stelgidopteryx serripennis	No. Rough-winged Swallow	b
Sterna forsteri	Forster's Tern	w
Sturnella neglecta	Western Meadowlark	b,w**
Sturnus vulgaris	European Starling	b,w**
Tachycineta bicolor	Tree Swallow	b
Tachycineta thalassina	Violet-green Swallow	b
Thryomanes bewickii	Bewick's Wren	b,w
Tringa melanoleuca	Greater Yellowlegs	w
Troglodytes aedon	House Wren	b,w**
Turdus migratorius	American Robin	b,w**
Tyrannus verticalis	Western Kingbird	b
Tyto alba	Barn Owl	b,w**
Vermivora celata	Orange-crowned Warbler	w
Wilsonia pusilla	Wilson's Warbler	b,w
Zenaida macroura	Mourning Dove	b,w
Zonotrichia atricapilla	Golden-crowned Sparrow	w**
Zonotrichia leucophrys	White-crowned Sparrow	w**

ANIMALS

Scientific Name	Common Name	Occurrence[1]
Mammals		
Antrozous pallidus	Pallid Bat	y, f[2]
Canis latrans	Coyote	y**
Castor canadensis	Beaver	y**
Corynorhinus townsendii	Townsend's Big-eared Bat	y, f[2]
Didelphis virginiana	Opposum	y
Eptesicus fuscus	Big Brown Bat	y
Eumops perotis californicus	California Mastiff Bat	y, f[2]
Felis domesticus	House Cat	y**
Lasiurus blossevillii (borealis)	Western red Bat	y
Lepus californicus	Black-tailed Jackrabbit	y**
Lutra canadensis	River Otter	y
Lynx rufus	Bobcat	y
Mephitis mephitis	Striped Skunk	y**
Microtus californicus	California Vole	y
Mus musculus	House Mouse	y
Mustela frenata	Long-tailed Weasel	y
Myotis californicus	California Myotis	y
Myotis yumanensis	Yuma Myotis	y
Odocoileus hemionus	Mule Deer	y
Peromyscus maniculatus	Deer Mouse	y
Procyon lotor	Raccoon	y**
Reithrodontomys megalotis	Western Harvest Mouse	y
Sorex ornatus	Ornate Shrew	y
Spermophilus beecheyi	California Ground Squirrel	y**
Spilogale putorius	Spotted Skunk	y
Sylvilagus audubonii	Audubon's Cottontail	y**
Taxidea taxus	American Badger	y[2]
Thomomys bottae	Botta Pocket Gohper	y**
Urocyon cinereoargenteus	Gray Fox	y
Vulpes vulpes	Red Fox	y**
Reptiles		
Clemmys marmorata marmorata	Northwestern Pond Turtle	y[2]
Coluber constrictor	Racer	y
Crotalus viridis	Western Rattlesnake	y
Eumeces gilberti	Gilbert's Skink	y
Gerrhonotus multicarinatus	Southern Alligator Lizard	y
Lampropeltis getulus	Common Kingsnake	y
Phrynosoma coronatum	Coast Horned Lizard	y

ANIMALS

Scientific Name	Common Name	Occurrence[1]
Thamnophis elegans	W. Terrestrial Garter Snake	y
Thamnophis gigas	Giant Garter Snake	y[2]
Uta stansburiana	Side-blotched Lizard	y
Amphibians		
Ambystoma californiense	California Tiger Salamander	y[2]
Bufo boreas	Western Toad	y
Hyla regilla	Pacific Treefrog	y
Rana catesbeiana	Bullfrog	y
Scaphiopus hammondii	Western Spadefoot Toad	y
Terrestrial Invertebrates		
Desmocerus californicus demorphus	Valley Elderberry Longhorn Beetle	y[2]

* denotes nonnative species or species not naturally occurring onsite
? indicates uncertain identification due to condition of plant material
[1]Occurrence: b = breeding; f = foraging habitat; t = transient; w = wintering;
y = rear-round residents;
** = observed during 1997 surveys
[2] indicates sensitive taxon (see text)

ATTACHMENT E

FISH SPECIES RECORDED WITHIN THE UC DAVIS CAMPUS AREA

FISH SPECIES RECORDED WITHIN THE U. C. DAVIS CAMPUS AREA[1]

Scientific Name	Common Name
Native Fish Species	
Catostomus occidentalis	Sacramento Sucker
Gasterosteus aculeatus ssp.	Three-spined Stickleback[2]
Hysterocarpus traski	Tule Perch
Lampetra tridentata	Pacific Lamprey
Lavinia exilicauda	Hitch
Oncorhynchus mykiss	Rainbow Trout
Oncorhynchus tshawytscha	Chinook Salmon[3]
Orthodon microlepidotus	Sacramento Blackfish
Ptychocheilus grandis	Sacramento Squawfish
Non-native Fish Species	
Alosa sapidissima	American Shad
Ameriurus catus	White Catfish
Carassius auratus	Goldfish
Cyprinus carpio	Common Carp
Dorosoma petenense	Threadfin Shad
Gambusia affinis	Mosquitofish
Ictalurus melas	Black Bullhead
Ictalurus nebulosus	Brown Bullhead
Ictalurus punctatus	Channel Catfish
Lepomis cyanellus	Green Sunfish
Lepomis macrochirus	Bluegill
Lepomis microlophus	Redear Sunfish
Menidia audens	Mississippi Silverside
Menidia beryllina	Inland Silverside
Micropterus dolomieui	Smallmouth Bass
Micropterus salmoides	Largemouth Bass
Morone saxatilis	Striped Bass
Notemigonus crysoleucas	Golden Shiner
Percina macrolepida	Bigscale Logperch
Pimephales promelas	Fathead Minnow
Pomoxis annularis	White Crappie
Pomoxis nigromaculatus	Black Crappie

[1]Adapted from University of California, Davis (1996)

[2]The subspecies was not identified. *Gasterosteus aculeatus williamsoni* is listed as Endangered by the state and federal governments. However, there are no records for this subspecies in Putah Creek (McGriff, pers. comm., 1997).

[3]The winter-run chinook salmon, listed as Endangered by the state and federal governments, does not occur in Putah Creek (Taylor, pers. comm., 1997).

ATTACHMENT F

EXPLANATION OF SENSTIVITY STATUS CODES

EXPLANATION OF SENSITIVITY STATUS CODES

AGENCIES

USFWS = U.S. Fish and Wildlife Service
CDFG = California Department of Fish and Game
CNPS = California Native Plant Society
BLM = Bureau of Land Management
USFS = U.S. Forest Service

CALIFORNIA NATIVE PLANT SOCIETY DESIGNATIONS

List 1: Plants of highest priority
List 1A: Plants presumed extinct in California
List 1B: Plants rare and endangered in California and elsewhere
List 2: Plants rare and endangered in California but more common elsewhere
List 3: Plants about which additional data are needed
List 4: Plants of limited distribution

CNPS R-E-D Codes

R (Rarity)
1 = Rare, but found in sufficient numbers and distributed widely enough that the potential for extinction or extirpation is low at this time.
2 = Occurrence confined to several populations or to one extended population.
3 = Occurrence limited to one or a few highly restricted populations, or present in such low numbers that it is seldom reported.
? = More data are needed

E (Endangerment)
1 = Not endangered
2 = Endangered in a portion of its range
3 = Endangered throughout its range
? = More data are needed

D (Distribution)
1 = More or less widespread outside California
2 = Rare outside California
3 = Endemic to California
? = More data are needed

FEDERAL DESIGNATIONS

FE = listed as Endangered by the Federal Government
FT = listed as Threatened by the Federal Government
FPE = proposed as Endangered by the Federal Government
FTE = proposed as Threatened by the Federal Government
FSS = federal sensitive species, as listed by BLM and USFS
C[1] = Candidate; taxa for which USFWS has sufficient biological information to support a proposal to list as Endangered or Threatened).
SC[1] = Species of Concern
MB = migratory non-game birds of management concern to the USFWS; protected under the Migratory Bird Treaty Act.

[1]As of Feb. 28, 1996, all Category 1 candidate taxa are now regarded merely as Candidates. The USFWS ceased to maintains lists of Category 2 and Category 3 candidate taxa; Category 2 taxa are now regarded as Species of Concern.

CALIFORNIA DEPT. OF FISH AND GAME DESIGNATIONS

CE = Listed as Endangered by the State of California
CR = Listed as Rare by the State of California
CT = Listed as Threatened by the State of California
CPE = Proposed for listing as Endangered
SSC = California Species of Special Concern
• = taxa that are restricted in distribution, declining throughout their range, or associated with habitats that are declining in California.
CEQA = taxa which are considered to meet the criteria for listing as Endangered, Threatened or Rare by the CDFG; impacts to such taxa must be addressed in CEQA documents.
CEQA? = Taxa that might be locally significant; should be evaluated for consideration during preparation of CEQA documents, as recommended by the CDFG.

note: currently, all CNPS list 1B and 2 taxa are considered "Special Plants" by the CDFG.

ATTACHMENT G

RAPTORS HISTORICALLY AND CURRENTLY HOUSED AT UC DAVIS RAPTOR CENTER

Raptors Historically he
U. C. D:

Scientific Name	Common Name	Fed/CA Status[1]	Currently Present
Accipiter cooperii	Cooper's Hawk	MB/SSC	X
Accipiter gentilis	Northern Goshawk	SC,MB/SSC	-
Accipiter striatus	Sharp-shinned Hawk	MB/SSC	-
Aegolius acadicus	Northern Saw-whet Owl	MB/-	-
Aquila chrysaetos	Golden Eagle	MB/SSC	X
Asio otus	Long-eared Owl	MB/SSC	-
Asio flammeus	Short-eared Owl	MB/SSC	-
Bubo virginianus	Great Horned Owl	MB/-	X
Buteo jamaicensis	Red-tailed Hawk	MB/-	X
Buteo lagopus	Rough-legged Hawk	MB/-	-
Buteo lineatus	Red-shouldered Hawk	MB/-	X
Buteo regalis	Ferruginous Hawk	SC,MB/SSC	X
Buteo swainsoni	Swainson's Hawk	MB/CT	X
Cathartes aura	Turkey Vulture	MB/-	X
Circus cyaneus	Northern Harrier	MB/SSC	X
Elanus caeruleus	Black-shouldered kite	MB/*	-
Falco columbarius	Merlin	MB/SSC	X
Falco mexicanus	Prairie Falcon	MB/SSC	-
Falco peregrinus anatum	American Pergrine Falcon	FE,MB/SSC	X
Falco sparverius	American Kestrel	MB/-	X
Glaucidium gnoma	Northern Pygmy Owl	MB/-	-
Haliaeetus leucocephalus	Bald Eagle	FE/CE	X
Otus flammeolus	Flammulated Owl	MB/-	-
Otus kennecottii	Western Screech Owl	MB/-	X
Pandion haliaetus	Osprey	MB/SSC	-
Speotyto (=Athene) cunicularia	Burrowing Owl	MB/SSC	X
Strix nebulosa	Great Gray Owl	MB/CE	-
Strix occidentalis	Spotted Owl	SC,MB/SSC	X
Strix varia	Barred Owl	MB/-	X
Tyto alba	Common Barn-Owl	MB/-	X

[1] See Attachment F for explanation of Sensitivity Status Codes.

ATTACHMENT H

BOTANICAL CONSULTING SERVICES - FIELD NOTES

MICHAEL WOOD
BOTANICAL CONSULTING SERVICES

1912 Vicente Street
San Francisco, CA 94116
Tel: (415) 759-5021
Fax: (415) 759-5855

BIOLOGICAL SURVEY FIELD NOTES
FOR

LEHR - WEISS
(Project Name/Client)

Project No. _____

Reporters M. Wood w/ D. Laabs Dates 1/29 - 1/30/97

Weather Conditions start: Time _____ Temp 55 Wind 0-5 Sky foggy

end: Time _____ Temp 68 Wind 5-10 Sky clear

General Location: Davis, Calif. South of Hwy 80, on both sides of S. Fork Putah Creek.

Onsite Land Uses: Research facility contained w/in bldgs.

Surrounding Land Uses:

North Ag., Research facilities East Ag

South Ag. West Ag

Habitats/Dominant Species Ruderal, horticultural plantings, trees riparian woodland, non-native grassland

Level of Disturbance high Canopy low to high

Sensitive Species Detected __Yes ✓No (species detected) _____

Notes: _____

FIELD NOTES (Attached)

Project Name LEHR
Date 1/29/97
Page # 2

LF #1 - out - cobble field

planted NW corner w/ bldg - barrels 100% cover

Pinus Rabbrs Erod cicu

** Erod bot Cent sol * Pers sec

Bouteloua Epilob * Mont perf

Stellar med Lupinus Arte di

Sil mer Brus nig Av Fat

Surrounded by high fence

Melilotus Lep Oenothera tree

Senec vulg Cardaria alyss? Salsola

Sambucus Salix Elm

drums on pallets, concrete on pallets

Medicago dessicated Convolv

P 1, 2, 3

W side - field

Pinus Erod bot Erod cic

Erod mon Cent Sil mer

Brom nig Salsol Epilob

Poa Stel med Bouteloua

Medicago

Project Name LEHR
Date 1/29/97
Page # 3

West Dog Pen - 20% cover gravel, paved
*Sil nar Epilob Stel med
*Cent solt Sambuc Bro
Solanum Marrubium Lactuca
Gnaph Medicago Sen vulg
Malv parv Lamium Nerium
Iacpulen? ? ? Hard mar gar Av fat
Antirrhinum Conyza Clay part
P.568 pipes/fencing a pallet Card pyc

P.4 9.7 E dog pens SE corner

P. holop Almond Card pyc

OU-1 SW corner - dirt/gravel 75% cover
Pines Nerium * Sil nar
Pus on * Epilob Medic
* Erod cic mixed bot Sen vulg Moss
Cent sol Stel med Chenopodi
Av fat

Euc glob Olea Xylaria
Mulberry Pyracantha Juniperus
missile tree Cotoneaster Euc sid
Rdph ind Phot fres Liquidamb
Zyth

Project Name LEHR
Date 1/29/97
Page # 4

Field 2	100% lack	
Bro d.	Av Fct	Por
** Erig mac	* Stel	* Clayt
* Sil mar	Cord pyc	Cent sol
Epilob	Melv parv	* Amsink
Hord	Bras	drum weed
Lact	Salkal	Medic
Conyzc	Sonch asp	Rice
Salsol	A	Cyno dact
Pactum Stuc pinn/hal	Food mesh	Ams
Stel	Po sa	Clayt
Cardam	Lamium	
Salsa - green/yellow		
OU-5 Land fill #3		
B. owl	** Er mo	Sil mar
Medic	Epil	* Po av
Bro d.	Stel	chenc/ Cat?
Cent sol	Melv	Hord
Bras	Conyz	Probosc
Mal		

FIELD FORMS (con't.)

page 5 of ___
date 1/29/97
initials MW

Field Notes/Species List:

Pk + Pat Cantor
Calcadia cil — Orchards & row crops
lawn ground — grasses / forbs - intensively managed

'30 drainage canal - E
lined — cover culvert leading to creek below low. rd.
bare soil on banks little veg w/ rubble

1345 * Sen vulg — ** Bras nig — * Er cic
Er bot — Epilob — Sonch
Cil — Poa — Lup bi
Stel med — Cep bur — Bro di
* Cent sol — Er mon — Sonchus
- eg drain tiles
- eating coyote / fox burrow - adj to landfill site
ground squirrel's
surface runoff from landfill site
standing water at culvert only - heavily silted up
stream: clearly flows
jack rabbit — raccoon
skunk burrow / gr. sq.?
Av Fat — Xanth spin — Graph
Rum crisp — Panicum — Algae
Pacp dil — Dist spic — Lamium
- ditch to N in pasture - sprayed
Clept

FIELD FORMS (con't.)

page 6 of ___
date 1/29/97
initials MW

dup Ford 413411

Field Notes/Species List:

- Nbank at OU-5 Landfill 3
Sam mus Elac can Salix V. ock
2: pheasants Wh crowned sparrow
Lovem · Av fet Epil Cont sol Gil mer
Er mosch Disp Salsola Xanth
Bouts Lact sor Nicu glau ?
Box elder:
bl crowned n.h.-? gt. horned owl
mice Around dw Ambrosia
- Landfill #1
Salix · sparrow Elac can V. ock
brown leaves w/ Bram d. Av fet Bross nig Cont sol
- rip. veg not well developed
Canada goose 2 on creek
Ag ditch E of site · N of creek - standing water
Typh lat * Rorr nig * Epil.
* Lact Salsol Salix · 2 sapl
- maintained / sprayed banks sump pump
Cheph Cong 2. Rot
Antirh

FIELD FORMS (con't.)

page 7 of ___
date 1/29/97
initials MW

Field Notes/Species List:

East Kennels gravel - 10% cover
Sem - mature IIII
** Silm Av tot Almond
Bromdi Cent col Brac nig
Card pu

Putah Creek - LEHR Project
ICB Field Notes
January 17, 1997
8:35 AM

Mike Podlech, Jim Brown, Bill Jordan

- Fish and BMI sampling not possible due to high and fast water flows
- Water very turbid; sediments appear to be composed of mostly fines/sand/mud (possibly increased due to bridge construction/ retrofitting)
- Stream channel uniform and straight
- Riparian vegetation probably dense during spring/summer, but not far-reaching enough to shade low-flow channel during summer
- No apparent tributaries/inflows

AQUATIC SURVEY - M. Podlech

Dutch Creek - LEHR Project
Jan. 17, '97
8:35 am

Mike Podlech, Jim Brown, Bill Jordan

- Fish + BMI sampling not possible - H_2O too high + fast
- H_2O very turbid; sediments appear to be mostly fines/sand/mud (possibly increased due to bridge construction/retrofitting)
- stream channel uniform, straight
- riparian veg. probably dense during spring/summer but not far-reaching enough to shade low flow channel in summer
- no apparent tributaries/inflows

42

LEHR 1/24/97

- 2 Large stick nests in trees along Davis Rd opposite entrance to LEHR

- Drainage ditch at East edge of site - No H_2O - U. limb veg

- Old Landfill # 3 (SE corner) Artificial Burrow mounds + burrows

* Burrow Obs

- At Repair Rehabilitation Center GoEg PaEg SpOw NoHk CoHk FeHa SwHk, AmKe TuVu

- Survey area NW of Old Davis Rd + RR tracks

→ 2 Bd Ki perched in walnuts

- Pond is remove lined

- Pond from I-80 + 113 large, ringed w/ willows on S. Typha ~ 70% of edge Perennial Pond under behavior

43

LEHR 1/24/97

- South Fork Putah Cr
  South Levee Rd.
  GoEg McH BeKi Kng CoHk *

- Bridge over I-80
  Block construction w/ series of holes (vertical) water spaw starling - pot bar roost

- Rail road bridge over SF Putah - wooden. pot bat roosts

1915 Begin nocturnal surveys of LEHR Facilities

- BuOw
- Acid Contaminant
- GrHOw pair - breeding ?
- Sori Sl_k

1920 End surveys

Wildlife Survey – Dr. Laabs
Davis LEHR Jan 29 1997

0615 Leave SC
0900 Meet M. Wood on site
Meet Kim Swanson - DOE contact
Sign visitor forms - go over access
① – Access into Cobalt Area (OU-5)
Paved / Ruderal – Non-native
trees along perimeter
Ruderal area - CAGS Colony
Perimeter fence - chain link w/ 1/4" hardware cloth to 4' - aluminum flashing to top (~6')
CAGS have burrowed under in places
Drums stacked in central portion (on
② – Wash Dog Pen (OU-3) Formerly paved.
Now w/ some ruderal veg.
Some ground sq. activity
Gopher burrows
Few trees
Elderberry bush (single, small)
Piles of pipe in south

Davis LEHR 1/29/97

Species List

					Purch CK	Pers O T.80-113
	Birds					
1	Sc Ja	Ro Do	Mo Do		Mo Ho	Am Co
1,2	Di Ju	WC Sp 1,2	Bl Ki		Gr Eg	Ma Ho
1,2	Ho Wr	RB Nu	We Me		Gr Bl He	Gr Eg
1	Bl Ph	Re Cr	Y Rw		Sn Eg	Pi Gr
1	No Fl	Hu	Nu Wo		Bl Ki	AC Co
1	Am Cr	Lo He	Ho La		Co He	
	Br Bl	Sw Th			Y Rw	
	Eu Sp	Ye Ma				
1	Ru Ki	RT Hu				
1	Ho Fi	Am Ro				
	Mammals					
1	BT JR	Coyote				
1,2	CAGS	Raccoon				
	Cat	Ad Cat 2				
	Dog					
	Skunk	tracks 1" x 1" to 1 1/4 x 1 1/4				

Dean LEHR 2/11/97

0900 Leave SC w/ C Brown
0820 Arrive on site - Clear
- Begin bird survey @ Old Dam Rd
+ S F Punch Ck

GCSp AmCr RBNu RCKi NaWo
ReCr AmRo WoMe YBMa HoFi
KiIl MoDo SaPh AmKe RSTo
CaCo SeJa DEJu BrBl Bush
YRWa BSKi EuSt RoDo BlPh
McIl BCNH GHOw
GrEy NoMa ReKi
SnEy BuOr CaTo
GBHe SoSp WCSp
NoFl BnSw

Remove
Cover
- Remove scar

1115 End survey

1215 Survey N Fork Punch Ck
Concrete channel - Impacted trees
Additional only AmCo CoHa, HeTh
CaGu LeGr
AmHu VaTh
1330 End Survey