SHASTA LAKE
WATER RESOURCES INVESTIGATION
TECHNICAL REPORT

Volume I. Natural Resource Characterization

Draft–July 2004

U. S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Mid-Pacific Region

North State Resources, Inc.

Bureau of Reclamation

Shasta Lake Water Resources Investigation Technical Report:
Volume I Natural Resource Characterization
July 2004

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Executive Summary

EXECUTIVE SUMMARY

The executive summary will be prepared with a subsequent revision to this report.

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Section 1 Introduction

Section 1

INTRODUCTION

The U.S. Bureau of Reclamation, Mid-Pacific Region (Reclamation), is currently conducting feasibility investigations for the proposed Shasta Dam Enlargement Project. North State Resources, Inc. (NSR) prepared this draft report to provide Reclamation with baseline information intended to characterize elements of the natural environment that could be affected by the proposed enlargement. The report characterizes the geomorphology of 13 riverine reaches upstream of Shasta Lake that would periodically be inundated by Shasta Lake if the height of Shasta Dam is increased. It also describes and evaluates existing erosional features that are associated with the shoreline of the lake at the current full-pool elevation of 1,070 feet mean sea level (msl). In addition, it characterizes the biological environment of the area that would be subject to inundation, including vegetation, wildlife habitat, and wildlife species.

1.1 Project Background

Shasta Dam and Lake are part of California's Central Valley Project (CVP), which is administered by Reclamation. The CVP provides water for agricultural, urban, and fish and wildlife uses throughout much of California. Nearly half of this water is stored in Shasta Lake, with Trinity, Millerton, and Folsom Lakes storing most of the remainder. **Figure 1-1** portrays the location of Shasta Lake relative to the other CVP dams and facilities in the northern Sacramento Valley.

Shasta Dam is a curved, gravity-type concrete structure with a crest height of 533 feet above the Sacramento River channel bed and a total height above its foundation of 602 feet. The dam has a crest width of 41 feet 5 in. and a length of 3,460 feet. Shasta Lake currently has a total storage capacity of 4,552,000 acre-feet. The seasonal flood-control storage space in Shasta Lake is 1.3 million acre-feet. Releases from Shasta Lake flow into, and are moderated by, Keswick Reservoir, located 5 miles west of the city of Redding. The Shasta power plant consists of five main generating units and two station service turbines.

Prior to the passage of the Central Valley Project Improvement Act (CVPIA) in 1992, several studies had addressed the possibility of enlarging Shasta Dam but no definitive proposal was developed. The CVPIA, however, redefined the purposes of the CVP and focused attention on rebalancing the demands for use of CVP water among competing beneficial uses. In 1999, Reclamation prepared an appraisal-level study and report to review the estimated costs of a range of enlargement options and to identify issues that would affect project feasibility. That report recommended that additional studies be conducted focusing on "low-raise" options.

The 2000 Record of Decision (ROD) for the Environmental Impact Statement/Environmental Impact Report on the CALFED Bay-Delta Program expanded this comprehensive approach to reducing conflicts over California's limited water supplies and addressing the state's long-term water needs while solving the environmental problems associated with the San Francisco Bay/Sacramento–San Joaquin Delta. The ROD identified four interrelated and interdependent program goals: water supply reliability, water quality, ecosystem restoration, and levee system integrity.

Water storage is one of 11 program elements identified in the ROD to meet these goals. Under the water storage element, CALFED is evaluating increased surface and ground water storage and other water management strategies. Enlargement of Shasta Lake was one of two surface water storage projects selected in the ROD for further evaluation during Phase I of the CALFED program.

Reclamation will consider several enlargement alternatives that respond to the water storage and ecosystem restoration objectives outlined in the ROD. The primary approach to meeting these objectives is centered on modifying the structure and increasing the crest height of Shasta Dam. Previous analyses have shown that a 6.5-foot increase in the height of the dam would increase Shasta Lake's water storage capacity by 290,000 acre-feet.

1.2 Organization of Report

This internal draft report satisfies the requirements of Task 7 (Technical Report) of Reclamation Task Order No. 01A020210D issued to NSR. This report is intended to provide Reclamation with information on the resources addressed in NSR's scope of work (SOW), including information obtained under Task Order No. 01A320210D. Task 8 will consist of analyzing impacts on the resources characterized in this report. Task 8 will be performed after an interim draft of this technical report is reviewed by the appropriate resource agencies and the agencies have identified the impacts to be addressed.

This report consists of seven volumes. Volume I is a narrative accompanied by figures and tables that characterizes selected natural resource components of the physical and biological environment adjacent to the current Shasta Lake shoreline and along 13 riverine reaches that would be subject to inundation if Shasta Dam is enlarged. Volumes II through VII constitute an atlas of geographic information system (GIS) maps that correspond to the resources evaluated in Volume I.

Volume I is organized into seven sections and appendices, as follows:

- Section 1, Introduction, provides the background of the proposed Shasta Lake enlargement project and describes the organization of the document.

- Section 2, Environmental Study Limits, describes the methods used to delineate the project boundaries for this report and describes certain anomalies in the data.

- Section 3, Physical Environment, characterizes the geomorphology of 13 riverine reaches that would be subject to inundation if the dam is raised and identifies the locations, types, and severity of erosional features observed along the 420-mile Shasta Lake shoreline. This section also describes the methods used to derive these characterizations.

- Section 4, Biological Environment, characterizes the vegetation and wildlife resources within the environmental study limits (ESL) and the methods used to derive the characterizations. The chapter describes the types and locations of vegetation in the ESL, characterizes habitat for a diverse suite of wildlife species, and identifies special-status floral and faunal species that will require special consideration. Focused floristic investigations were conducted along the 13 riverine reaches, as well as the Squaw Creek and Big Backbone Arms of Shasta Lake. Additionally, focused biological investigations for special-status species were conducted as part of an earlier pilot study along the Squaw Creek and Big Backbone Arms of Shasta Lake.

- Section 5, Impacts Analysis, will be prepared after Reclamation and other federal and state resource agencies have reviewed the information in the interim draft report and determined the impacts to be analyzed. The impacts analysis will be incorporated into interim report to be prepared in August 2004.

- Section 6, References, provides complete citations for all references cited in this report.

- Section 7, Acronyms and Abbreviations, contains an alphabetical list of acronyms and abbreviations used in the text. The list is on an 11- by 17-inch foldout to provide the reader with a convenient reference while reading the document.

- Appendices

For ease of reading, all of the figures and photographs in Volume I are presented at the ends of the sections. Tables, however, follow their first reference in the text.

The atlas is organized into six volumes, each corresponding to a specific area or arm of Shasta Lake. **Figure 1-2** identifies the location and geographic extent of the features included in the ESL for this report. **Table 1-1** shows the volume that applies to each area or arm of the lake.

Table 1-1
Atlas Volumes

Volume	Shasta Lake Area/Arm
Volume II	Main Body of Lake
Volume III	Big Backbone Creek Arm
Volume IV	Sacramento River Arm
Volume V	McCloud River Arm
Volume VI	Squaw Creek Arm
Volume VII	Pit River Arm

Each volume of the atlas was developed to ensure that comprehensive coverage is provided for the applicable area at a meaningful scale (1" = 600'). An atlas sheet index is provided for each volume; the index illustrates the organization and geographical orientation of each sheet in the volume. Sheets are numbered sequentially in an upstream direction and are edge-matched to provide continuity. The downstream sheet displays the lower boundary of the area or arm as a definitive line. This line was used to provide a consistent approach for field investigations, information management, and reporting purposes. It is not intended to serve as a definitive geographic representation of referenced features. The upstream sheet displays the upper boundary of the ESL as identified in the project GIS.

Each volume of the atlas contains four map sequences that correspond to sections of the narrative in Volume I. These map sequences are:

1. Environmental Study Limits
2. Shoreline Erosion Potential
3. Plant Series
4. WHR Habitat Type

References in the text to the atlas are shown as follows: (see Atlas, Vol. II, 2-4). The “2” in this example corresponds to the map sequence (i.e., Shoreline Erosion Potential) and the “4” corresponds to the sheet number.

1.3 Future Studies

NSR is under contract to Reclamation to perform additional studies for the proposed enlargement of Shasta Dam. The results of these studies will be included in an interim draft report and a final report.

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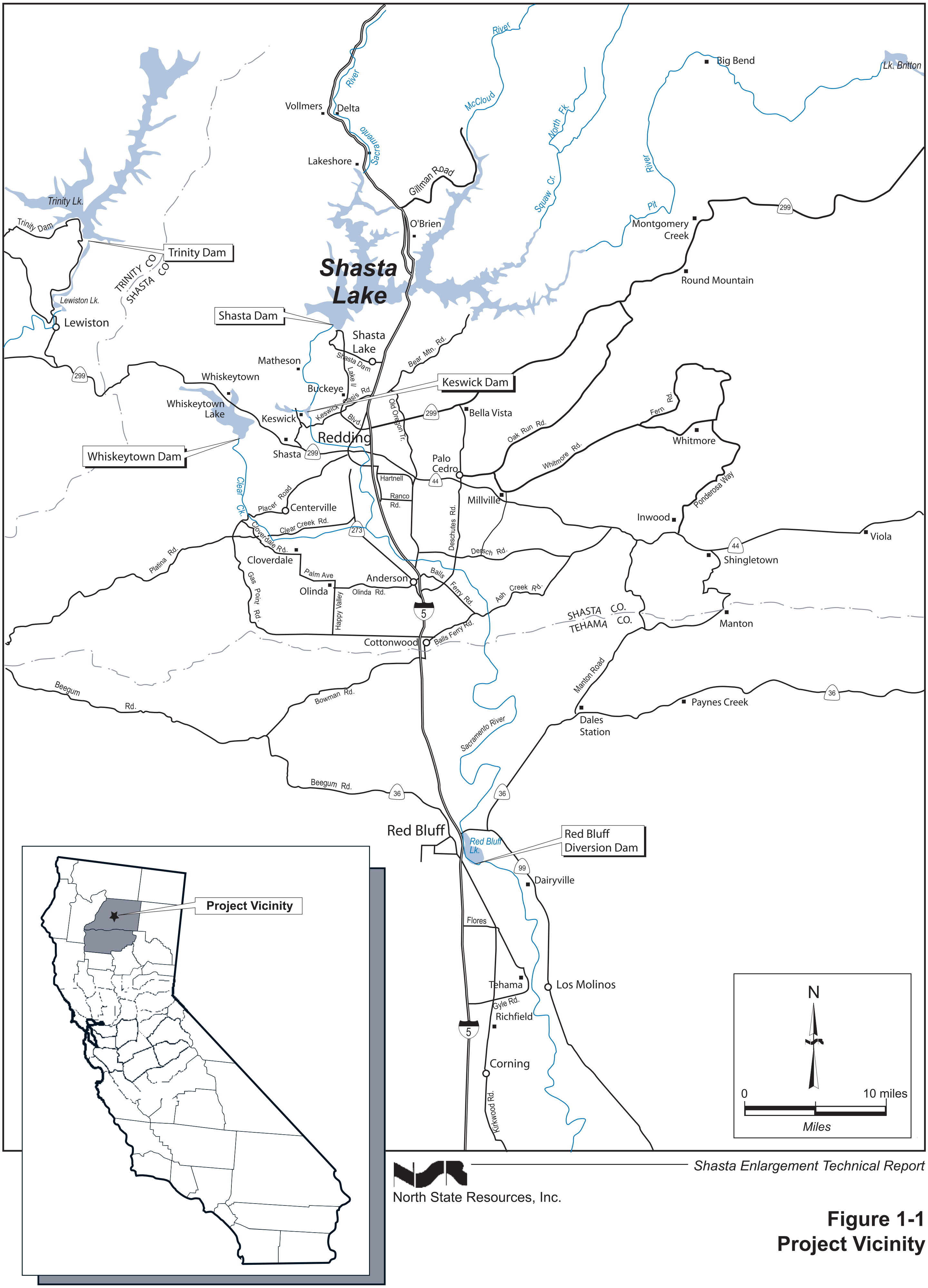

10022 - Biological Surveys and Impact Analyses for Potential Shasta Dam Enlargement/Graphics/Fig_1-1_Project_Vicinity.pdf 12/3/03 tanderson

Shasta Enlargement Technical Report

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Figure 1-1
Project Vicinity

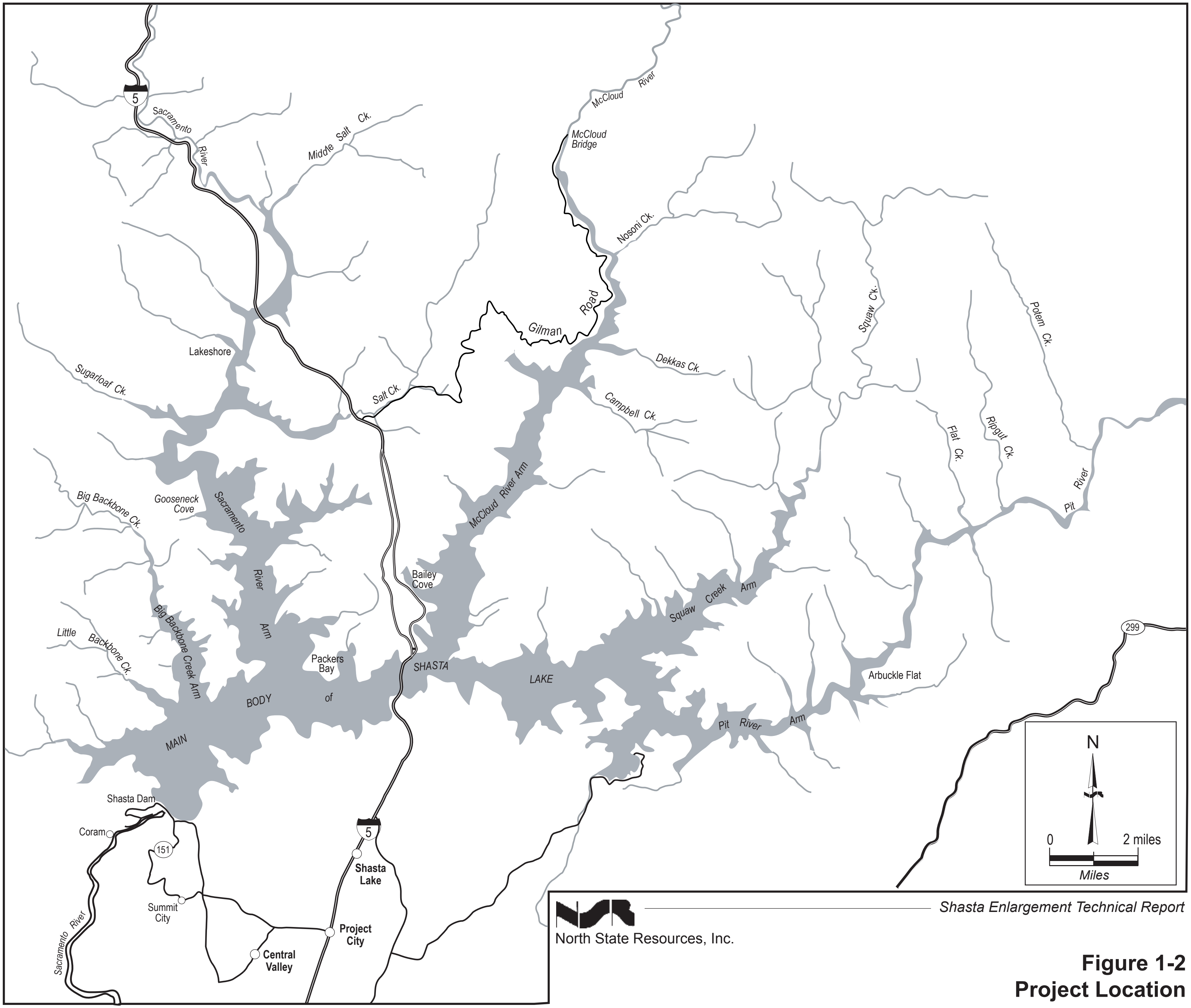

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Figure 1-2
Project Location

Section 2 Environmental Study Limits

Section 2

ENVIRONMENTAL STUDY LIMITS

2.1 Introduction

Before the onset of field studies, NSR delineated the environmental study limits (ESL) to establish the project boundaries. The ESL was intended to constrain the geographic extent of technical investigations to the area immediately upslope of the present shoreline of Shasta Lake that would be subject to inundation under various enlargement scenarios.

The base map for all subsequent work used low-elevation (1" = 7,200') color aerial photographs to generate high-resolution (6-in pixel) orthophotographs of Shasta Lake and the surrounding area. A total of 768 orthophotographs in MrSID format were used to generate the GIS layer for the ESL, which encompasses Shasta Lake's more than 420 miles of shoreline.

To provide a comprehensive and seamless visual image of the landscapes and features in and adjacent to the ESL, ESRI software products were used to prepare shapefiles. In conjunction with the MrSID imagery, NSR used topographic information provided by Reclamation (in AutoCAD format) to prepare the ESL boundaries. These boundaries were superimposed on the digital orthophotographs to represent the lower- and upper-elevation boundaries of the ESL. The lower boundary corresponds to the full-pool elevation defined by Reclamation (1,070 ft msl contour line). Reclamation established the upper boundary using the 1,090 foot msl contour line around the entire lake. These linear boundaries are portrayed on each sheet in the six volumes of the Atlas.

To examine the physical and biological resources along riverine reaches that would be subject to inundation if Shasta Dam is enlarged, the ESL incorporates reaches of 13 streams and rivers that are tributary to Shasta Lake. These reaches were selected to represent the diverse characteristics of the rivers and streams that flow into Shasta Lake. Criteria used for selecting these reaches included size, location, aquatic values, geologic terrain, and watershed area. The upstream boundary of each reach is a recognizable geographic feature shown on a U.S. Geological Survey (USGS) map upstream of the predicted 1,090 foot msl contour. Recognizable geographic features included tributary confluences, waterfalls, and road crossings. In some circumstances, the ESL extended upstream beyond the 1,090-foot contour as much as 1,000 feet. **Table 2-1** identifies the 13 riverine reaches and the geographic feature used to define the upstream boundary. The table also shows the length of the reach within the ESL.

2.2 Methods

NSR was provided with 2-foot-interval elevation contour data for the Shasta Lake area by Reclamation’s photogrammetry division. The elevation contours were derived photogrammetrically from orthophotography that was flown and processed by Pacific Western

Technologies, Ltd. The contours cover approximately 14,400 acres between the lake water surface elevation of 1,012.5 feet msl at the time of the aerial surveys and an elevation of 1,200 feet msl. The contour data encompass the entire lake shoreline and were provided in AutoCAD DWG format.

Table 2-1
Riverine Reaches in ESL

Riverine Reach	Upstream Boundary	Reach Length (mi)
Little Backbone Creek	Unnamed Tributary	0.753
Big Backbone Creek	Oak Opening Creek	0.757
Sugarloaf Creek	Unnamed Tributary	0.509
Upper Sacramento River	Dog Creek	0.792
Middle Salt Creek	Albert Creek	0.343
Salt Creek	Fall Creek	0.696
Nosoni Creek	North Nosoni Creek	0.984
Dekkas Creek	Unnamed Tributary	0.843
Campbell Creek	Unnamed Tributary	0.340
Squaw Creek	Winnibulli Creek	0.557
Flat Creek	Unnamed Tributary	0.486
Ripgut Creek	Unnamed Tributary	0.358
Potem Creek	Potem Falls	0.812

Table 2-2 shows the acres included in the ESL for each arm of Shasta Lake as well as the main body of the lake.

Table 2-2
Shoreline ESL Acres

Area/Arm	Acres[1]
Main Body of Lake	459.86
Big Backbone Creek Arm	91.68
Sacramento River Arm	735.58
McCloud River Arm	402.82
Squaw Creek Arm	295.73
Pit River Arm	519.90
Total Area	**2,505.57**

[1]Acres generated from NSR project GIS

The DWG files were imported to the ESRI ArcMap GIS environment, and the 1,070-foot, 1,080-foot, and 1,090-foot elevation lines were queried and extracted as separate ESRI shapefiles from the existing CAD contour data. The three elevation lines were edited to produce continuous contours and then converted to polygon features for each area or arm of the lake. These polygon features were then cleaned and built to define topology in ESRI's ArcInfo Workstation environment. The resulting features were converted back to shapefiles, from which NSR produced polygon shapefiles representing areas of the ESL defined by the 1,070-foot and 1,090-foot elevations as lower and upper bounds, as well as polygon shapefiles representing alternate ESL areas defined by 1,070-foot and 1,080-foot elevations. These ESL layers were produced separately for the main body of the lake and for each arm, as were composite layers representing the entire lake.

Appendix A provides additional information concerning the methods used to define the ESL.

2.3 ESL Elevation Anomalies

It is apparent upon inspection of the photogrammetrically-generated elevation contours that, in many areas of the Shasta Lake shoreline, the contour most closely representing the current maximum pool elevation of 1,070 feet is not in perfect congruence with the actual highest shoreline, as defined by the vegetation line and wave cut feature. While some deviation from a perfect "bathtub ring" is to be expected for these ecological indicators of inundation, anomalies in the elevation model as represented by the contour data are apparent. This perceived deviation of contour elevation accuracy from the "real-world" location of vegetation lines and the wave-cut shoreline features affects the accuracy of the ESL, habitat, vegetation, and shoreline erosion maps in the Atlas.

The most common type of perceived contour elevation anomaly occurs where an apparent artifact in the contour line intersects curvature in the vegetated shoreline as a straight line segment. This type of artifact has been observed in the contour data at various places along the shoreline at all three critical ESL elevations (1,070, 1,080, and 1,090 feet). Additionally, there are places where the contours close to form "islands" where, in fact, continuous dense vegetation extends from the shoreline to the area defined by the contours as islands. Finally, in some areas, the contour lines are simply a poor match for the shape of the shoreline in that area. Anomalies of all three types appear most common where shoreline and adjacent hillslope areas have low slope gradients. While these apparent anomalies do not occur everywhere along the shoreline, they are generally systematic in placing the 1,070-foot contour upslope of the "true" position of the maximum pool elevation. Rarely do contours extend lake-ward of the visible vegetation line.

NSR has developed several hypotheses that may account for the presence and pattern of contour anomalies in the terrain model. It seems probable that the anomalies were introduced because there is insufficient ground-based elevation control in some areas to adequately resolve the shape and elevation of the shoreline. Differences between vegetation canopy elevation and the exposed shoreline elevation may be poorly estimated, especially where control points are distant. The height of the vertical eroded shoreline bluff at the highest wave-cut elevation may also be incorporated inaccurately in the terrain model. If the bluff heights were often underestimated, the effect would be to frequently displace the position of the 1,070-foot contour up slope onto the vegetated hillslope area, which is the most common anomaly pattern seen.

Orthophotographic correction for relief and radial displacement at the terrain surface displaces the position of the vegetation drip line, and the position of the drip line may not correspond with the true position of the shoreline. Nonetheless, in a number of shoreline areas, it is quite apparent that the vegetation line seen on the orthophotos is a better representation of the actual maximum pool elevation than the 1,070-foot contour is. While NSR recognizes that the elevation model represents the highest quality of terrain data available for this project, the presence of these anomalies may affect the accuracy of the information provided in this report.

Principally, it is apparent that anomalies observed in the Atlas between the ESL as defined by the contour data and the areas of potentially eroded shoreline, vegetation, and habitat described in this report would be significant if the ESL were defined based on field criteria for demarcation of the shoreline. In fact, the vegetation and wildlife habitat were field-mapped based on the vegetation line on the aerial photography. There are a fair number of areas around the lake where substantial portions of some field-mapped polygons were omitted from the GIS layers because the 1,070-foot lower boundary truncated the vegetated area apparent on the aerial photo. A number of field-mapped habitat and vegetation polygons were omitted entirely because they were down slope of the plotted position of the 1,070-foot contour. Additional information is provided in Appendix B, Discussion of ESL Contour Anomalies. NSR tracked these omitted polygons and will provide a list of them in a subsequent draft of this report.

The ESL area for the Squaw Creek Arm was visually corrected to provide a better match between the 1,070-foot contour and the apparent shoreline in the orthophotographs. Consequently, no polygon areas were omitted in the Squaw Creek Arm ESL area. However, there was no visual basis for correcting any errors in the 1,080-foot or 1,090-foot contours, which in many cases parallel the 1,070-foot contour line. Therefore, the 1,070-foot contour was often extended while the upslope contours were not, which likely resulted in inflated acreages for the polygons in question. The estimated increase in acreage for the Squaw Creek Arm ESL area after correcting the 1,070-foot contour is approximately 20 percent. Without a visual basis for correcting upslope contours, there is no way to provide a corrected acreage as well as a corrected shoreline. Therefore, we now believe that the best method would be to simply use the contours as provided to define the ESL, recognizing that there is a certain degree of inaccuracy in the reported results. In subsequent drafts of this report, this information will be revised, if necessary.

Section 3 Physical Environment

Section 3

PHYSICAL ENVIRONMENT

This section describes selected elements of the physical environment of Shasta Lake. Section 3.1 discusses the fluvial geomorphic features and processes of the 13 riverine reaches that are tributary to Shasta Lake. It also describes the general setting, discusses the methods used to formulate a detailed characterization of each reach, and briefly summarizes the patterns suggested by the data. Section 3.2 provides a general discussion of geology, meteorology, and geomorphology as they relate to the erosional processes and features associated with Shasta Lake. In addition, the section describes the approach used to characterize the shoreline erosion observed at Shasta Lake and reports the findings of this reconnaissance-level inventory.

The climate in the project vicinity is predominantly Mediterranean, although the size and location of Shasta Lake influence local meteorological conditions. Rainfall records provided by Reclamation indicate that the average annual precipitation is 61.6 inches per year and that average temperatures range from about 50° F. in winter to about 90° F. in summer.

The watershed area upstream of Shasta Dam encompasses 6,665 square miles.

Reclamation routinely updates the Operational Criteria and Procedures (OCAP) for Shasta Dam to ensure that the dam is operated to meet CVPIA and other legal and regulatory requirements. These requirements directly affect the ability of Reclamation to manage the water-surface elevation of Shasta Lake throughout the water year. The water-surface elevation of Shasta Lake is also influenced by a variety of other factors, including water year type, seasonal demands for water and requirements for various beneficial uses both on-site and downstream, and the level and timing of inflows. In particular, the meteorological influences on water-surface elevations have been extremely variable over time.

Under current practices, Reclamation operates Shasta Dam to meet OCAP requirements. Shasta Dam is operated with water-surface elevations of between 965 ft (msl) and 1,070 ft to ensure optimum use of Shasta Lake for power generation, fish and wildlife conservation, recreation, water supply, and flood control purposes.

Since it was constructed in 1945, Shasta Lake has been subjected to a variety of climatic events, including extensive droughts and extreme floods. **Figure 3-1** illustrates the cyclic nature of water-surface elevations since 1988. It indicates that Shasta Lake has approached full-pool conditions several times in the past 25 years. Since 1988, the average water-surface elevation of Shasta Lake has been 1,005 ft msl.

The annual drawdown of the lake begins in late spring, and the lowest lake elevation normally occurs in late fall or early winter. The lowest drawdown on record was 836 ft msl on September 14, 1977 (U.S. Forest Service 1986).

The operation of Shasta Dam results in recurring fluctuations in the water-surface elevation. These fluctuations have the potential to affect the physical features and geomorphic processes of the rivers and creeks that are captured by Shasta Dam and the associated shoreline of Shasta Lake.

The riverine reaches that contribute flow, sediment, and a combination of organic and inorganic materials to the lacustrine environment are as diverse as the watersheds from which they emanate. The approximately 420 miles of shoreline also contributes water, sediment, and other materials directly to the waters of Shasta Lake though a variety of geomorphic processes. In this section, the riverine and shoreline environments are characterized in order to understand the relationships between these environments and an increase in the water-surface of Shasta Lake.

Any increase in the full-pool water-surface elevation will result in inundation of tributaries that have reestablished a temporary, albeit dynamic base-level since 1945. The rivers and creeks that contribute material to Shasta Lake vary in form and functionality and provide a high degree of ecological diversity in terms of flora and fauna. With more than 1,300 identified riverine features (U.S. Forest Service 2003a) Reclamation recognized the need to understand some fundamental aspects of the relationships between these riverine features and the fluctuating lacustrine environment of Shasta Lake. The fluvial geomorphic characterization of selected riverine reaches provides a stratified approach to understanding the physical features and processes that distinguish these rivers and creeks.

Based on the information provided in previous studies, Reclamation recognizes that shoreline erosion has the potential to affect other aspects of the human environment, including infrastructure, improvements, and management activities. A systematic approach to characterizing the extent and magnitude of shoreline erosion offers the opportunity to understand the ecological relationships affected by this phenomenon.

3.1 Geomorphology of Selected Riverine Reaches

3.1.1 METHODS

Overview

To help understand the potential impacts to the rivers and creeks that are tributary to Shasta Lake, fluvial geomorphic assessments were conducted on the 13 riverine reaches described in Section 2. These assessments were performed over 19 field days between July 14, 2002, and October 5, 2003. The longitudinal profiles were used to stratify and characterize discrete reaches. These surveys were initiated at the stream-lake interface and extended upstream to the ESL boundary to ensure adequate characterization of the potentially affected reach.

Aquatic habitat units were delineated for each riverine study reach. Canyon wall to canyon wall cross-sections were surveyed as necessary to both illustrate geomorphic conditions at representative locations within each field-delineated geomorphic subreach and to provide dimensions to verify field-judged channel classifications of each subreach, according to both the Rosgen (1996) and Montgomery-Buffington (Montgomery and Buffington 1993) channel classification schemes. Characterization of channel-bed substrate and identification of individual gravel-sized sediment deposits were periodically incorporated with pebble counts (Wolman 1954). This information quantified the distribution of the channel bed framework and pocket-gravel sediment-sizes.

Stream discharge was measured for nine of the 13 riverine reaches. The lack of suitable locations or existing gage data precluded measurements on Salt Creek, the Sacramento River, Big Backbone Creek, and Squaw Creek. Temporary and permanent survey benchmarks were installed and periodically documented with photographs along each study reach.

Longitudinal Profile Surveys

A longitudinal channel-bed and water-surface profile was surveyed for each riverine reach, as described in the preceding paragraph. Except for the Upper Sacramento River and Salt Creek, the water-surface elevation at the interface served as the river stationing control (Station 0+00 ft) and known elevation benchmark (elevation in ft msl according to hourly lake level gage records). Because complete digital orthophoto and digital elevation contour data are lacking for the Upper Sacramento River and Salt Creek, an existing USGS gage datum was used for the Upper Sacramento River study reach and an arbitrary datum was established for Salt Creek. The fill prism of Interstate 5, which serves as a grade control between Shasta Lake and Salt Creek, prevented the use of the water-surface elevation as a datum.

Longitudinal profile survey data were collected using an auto level surveying instrument, stadia rod, and hip chain. The density of profile data and the location of individual profile shots were determined to quantify lengths of individual aquatic habitat units in the study reach in accordance with the habitat delineation methods in USDA Forest Service R-5 Fish Habitat Relationships Technical Bulletin (McCain et al. 1990). In general, the survey included one elevation at the upstream and one elevation at the downstream end of each individual habitat unit to measure the length of the habitat. Additional shots were taken to increase the detail in the longitudinal profile for long pool and run habitat units with non-uniform bed profiles. Additional survey shots were taken within long pools to define maximum pool depth and other attributes. For pools, the average wetted width, and the estimated areal percentage distribution of the following sediment size classes present on the bed were recorded: bedrock, boulder, cobble, gravel, sand, silt, and organic material.

A hip chain was used to measure river stationing of individual shots. Additional shots were surveyed as necessary to correctly resolve slope breaks on the channel bed and water surface profile and to more thoroughly characterize the profile of individual pool and run habitats. At each shot location, water depth was recorded to the nearest 0.1 ft and the size class of the dominant bed material (primarily boulders) and presence/absence of other material size classes were documented.

Hip chain and stadia intercepts were used to measure river stationing of all out-of-channel turning point, cross-section locations, and permanent benchmark shots. Stadia intercepts were used to calculate final cumulative river stationing for the study reach and station values for all permanent benchmarks and temporary turning point markers established in this study. Instrument set-up and turning point marker locations were placed as near as possible to the centerline of the channel such that the distances recorded from the auto level would sufficiently correspond to actual distances along the centerline of the creek. Incremental hip chain data were used to calculate final river stationing for habitat unit delineations and individual channel bed shot stations on the longitudinal profile.

Temporary turning point markers were marked with environmental survey marking paint and identified using a paint spot and turn number on a boulder or other semi-permanent feature. Turning points are established on exposed in-channel boulders throughout the study reaches an average of 367 ft apart. With the exception of Big Backbone Creek and Squaw Creek (2002 season), permanent benchmarks were periodically surveyed and monumented with factory-numbered, round, blue metallic badges, or “shiners,” on prominent mid-channel boulders along the study reach and at the upstream end of the surveys.

With the exception of Salt Creek, each survey was closed by surveying from the upstream-most turning point marker or permanent benchmark downstream to the turning point marker nearest the reservoir. All surveys closed to within an elevation of 0.03 feet Salt Creek is separated from Shasta Lake by a spillway-controlled impoundment immediately upstream from the Interstate 5 fill prism. The Salt Creek longitudinal profile was initiated at the arbitrary impoundment surface elevation at the Salt Creek interface.

Aquatic Habitat Unit Delineation

Individual aquatic habitat units were delineated using the basin-wide habitat classification methods set forth by the USDA Forest Service R-5 Fish Habitat Relationships Technical Bulletin (McCain et al. 1990). Specifically, the study reaches were delineated using the following aquatic habitat types: cascade, riffle, pool, run, step run, step pool, and falls/step. The length of each habitat unit is at least one channel width in length.

Channel Classification and Geomorphic Subreach Delineation

Many of the study reaches were less than about 3,000 ft long and were entirely bedrock and boulder-bedded streams continuously confined by bedrock canyon walls with narrow floodplains; entire study reaches could therefore be reasonably classified as one channel type under both the Rosgen (1996) and Montgomery and Buffington (1993) classification schemes. That is, entire study reaches were sufficiently steep, coarse-bedded, and confined to simplify channel classification under standard schemes that were developed for a broader range of slope, substrate size, and confinement parameter values, intended for broadest application in lower-gradient streams. Nonetheless, field observations in conjunction with slope calculations, and the presence/absence of bedforms were used to classify study reaches and subreaches, if applicable, under the Montgomery-Buffington classification scheme. This scheme classifies channels into bedrock, colluvial, braided, cascade, step-pool, pool-riffle, plane-bed, and regime classifications. Periodic field measurements and visual estimates of bankfull and flood-prone width and depth were made to conform to the Rosgen channel classification scheme.

Cross-Section Surveys and Subreach Characterization

Cross-sections were surveyed at locations specifically selected to illustrate the range of geomorphic subreaches identified in the study reach. This information was incorporated into the data set used to classify the stream channels under the referenced schemes. Cross-sections were monumented with temporary benchmarks near the channel and surveyed from canyon wall to canyon wall These benchmarks were identified with either flagging, 12-inch spikes, or, more typically, environmental spray paint marks on bedrock outcrops. Shot locations were selected along the cross-sectional profile to characterize the overall ground and water surface profile shape, including transitions between profile slope and terrace, bar, and subsurface sediment facies. General riparian vegetation and substrate conditions were noted graphically in the field for use in rendering final cross-section charts for contextual purposes. Estimated slopes on canyon walls were used to provide geomorphic context to the channel cross-section.

In conjunction with the channel cross-section surveys, general observations of riparian vegetation conditions and geomorphology–vegetation interactions were recorded. Cross-section surveys portray idealized riparian vegetation conditions at selected sites. Ground photographs made from monumented benchmarks illustrate current vegetation conditions and could be incorporated into a monitoring program in the future.

Visual observations were made of geomorphic features in and adjacent to the channel. These observations focused on depositional features important to the aquatic and riparian communities. They included channel bed and exposed mid-channel bars, pocket gravels, point bars, and channel margin deposits, and potentially suitable salmonid spawning sites. In conjunction with these observations, surface sediment pebble counts (Wolman 1954) were performed on in-channel boulder-cobble channel bed framework materials, and on both submerged and exposed gravel deposits deemed representative of typical bedload sediment composition or potentially suitable spawning gravel.

Digital Orthophotos and Geomorphic Mapping

Digital orthophotographs and digital elevation contour data were available for part of all of the 13 study reaches except the Upper Sacramento River and Salt Creek. These sources were used to prepare field maps for use during the longitudinal profile surveys. For larger tributaries, including Big Backbone Creek and Squaw Creek, the combination of wider canyon floor and channel bed conditions and incomplete canopy cover allowed for precisely locating and field-mapping individual survey shots, pebble counts, cross-section endpoints, etc. With the exception of Little Backbone Creek (which is subject to acid-mine drainage), the riverine reaches have limited openings in the canopy, thereby reducing the ability to use orthophotos for field mapping. In these instances, orthophotos were used to map the reaches currently subjected to inundation, beginning with Station 0+00 feet Longitudinal water surface profiles were prepared using the digital contour elevation data to validate the interpretive quality in the upstream reaches.

3.1.2 CHARACTERIZATIONS

Little Backbone Creek

The Little Backbone Creek watershed (**Figure 3-3**) drains an approximately 4.6-square-mile area in the southwestern portion of the ESL, and enters the main body of Shasta Lake (see Atlas, Vol. II, 1-6) about 2.5 miles NNE of Shasta Dam. The watershed, including the study reach, is underlain almost entirely by metavolcanic bedrock, primarily porphyritic and non-porphyritic rhyolite. The upper watershed includes lesser amounts of pyroclastic (primarily volcanic and tuff breccia and some volcanic conglomerate) and volcaniclastic (primarily tuff and tuffaceous shale) rocks, as can be found exposed in the upper tributary streambeds, as well as an isolated outcropping of Kennett limestone exposed on the ridge forming sections of the east-northeastern and southern watershed boundaries. The measured discharge of Little Backbone Creek within the ESL (at Station 5+60 ft) was 1.9 cubic ft per second (cfs) at 12:00 p.m. on July 31, 2003 (**Table 3-1**). South Fork Little Backbone Creek contributed approximately 10 to 15 percent of the measured discharge and appeared heavily affected by acid mine drainage (**Figure 3-3**). Extreme chemical discoloration of the channel bed and banks, apparently due to acid-mine drainage, occurs throughout the South Fork and the downstream reach of Little Backbone Creek. Discoloration was observed from the Shasta Lake water surface (Station 0+00) on July 31, 2003 (elevation 1031.07 ft msl) upstream to a permanent benchmark (BM-80) installed at Station 10+43 ft and elevation 1,114 ft msl (**Table 3-2**) near the base of Little Backbone Creek Falls at approximately Station 10+90 ft (**Figure 3-4**).

Table 3-1
Summary of Stream Discharge Measurements, Riverine Reaches
2002 - 2003

Name	Date Surveyed *From*	*To*	Measured Discharge (cfs)	Date of Discharge Measurement	Drainage Area (sq mi)	Ratio (cfs/sq mi)
Little Backbone Creek	7/31/2003	7/31/2003	1.89	7/31/2003	4.6	0.41
Big Backbone Creek	7/18/2002	7/19/2002	nd	nd	30.2	nd
Sugarloaf Creek	7/30/2003	7/30/2003	3.47	7/30/2003	10.4	0.33
Upper Sacramento River	10/3/2003	10/4/2003	252	10/3/2003	53.5	4.82
Middle Salt Creek	7/28/2003	7/29/2003	3.74	7/28/2003	17.8	0.21
Salt Creek	10/5/2003	10/5/2003	nd	nd	9.6	nd
Nosoni Creek	7/20/2003	7/20/2003	4.28	7/20/2003	13	0.33
Dekkas Creek	7/19/2003	7/19/2003	0.86	7/19/2003	3.8	0.23
Campbell Creek	7/21/2003	7/21/2003	0.85	7/21/2003	4.8	0.18
Squaw Creek	7/14/2002	7/16/2002	nd	nd	57.8	nd
Flat Creek	7/17/2003	7/17/2003	0.58	7/17/2003	5.5	0.11
Rip Gut Creek	7/18/2003	7/18/2003	1.03	7/18/2003	5.3	0.19
Potem Creek	10/2/2003	10/2/2003	4.78	10/2/2003	11.9	0.40

In the study reach, Little Backbone Creek is a steep (6 to 8 percent slope), single-thread bedrock and boulder-bed channel confined within a 35- to 45-ft-wide steep-sided canyon with no floodplain or fluvial terrace deposits. Bedrock falls, cascades, and plunge pools form the majority of the channel

Table 3-2
Benchmark, Turning Point Marker Locations and Elevations, Little Backbone Creek
July 31, 2003

Turning Point Number	Station from Reservoir Surface (ft)	Elevation Above MSL (ft)
RES WSE	0	1,031.07
TP1	2+48	1,051.96
TP2	4+93	1,066.84
TP3	7+01	1,087.12
TP4	8+81	1,103.80
BM80	10+43	1,114.18
	Reservoir Water-Surface Elevation	1,031.07

Notes: Downloaded from: http://cdec.water.ca.gov/cgi-progs/queryDaily SHS

bed, except for locations where colluvial boulder rockfall deposits create steep boulder riffles and exposed boulder bars or shallow, gravel-bedded run habitats in the inundated reach. Falls and cascades make up approximately 20 percent of the total aquatic habitat (**Figure 3-5**), and bedrock substrate underlies about 23 percent of the total stream length (**Figure 3-6**). Plunge pools and associated run and glide habitats make up 58 percent of total aquatic habitats, with large gravel, cobbles, coarse woody debris, and sand substrates (40 percent of total substrate observations). Pools are typically 15 ft wide and up to 5.2 ft deep (**Table 3-3**). The remaining 21 percent of aquatic habitat is riffle with boulder-dominated substrates controlled by local colluvial boulder rockfall deposits (37 percent of total substrate observations).

Table 3-3
Average Pool Width, Depth, and Substrate Distribution, Little Backbone Creek

					Areal Percentage of Substrate in Pool Bed							
Pool No.	**Station at Top of Pool (ft)**	**Elevation at Top of Pool (ft)**	**Maximum Depth (ft)**	**Average Width (ft)**	**BR (%)**	**Bo (%)**	**Co (%)**	**Gr (%)**	**Sa (%)**	**Si (%)**	**Org (%)**	**Total (%)**
1	0+40	1,030.61	5.2	15	30	20		20			30	100
2	1+61	1,044.31	3.4									
3	2+54	1,045.18	5.7	12	10	20		60			10	100
4	4+81	1,061.16	3.4	10	20	40	10	30				100
5	6+13	1,068.54	3.7	15	10	10	10	70				100
6	6+81	1,076.62	4.1									
7	7+25	1,080.86	4.6	15	40	30	10	20				100
8	8+87	1,097.94	2.7	15	50	30	10	10				100
9	9+97	1,105.55	4.3	18	10	20	20	50				100

Notes: BR=bedrock, Bo=boulders, Co=cobbles, Gr=gravel, Sa=sand, Si=silt, Org=organic material

Bed framework materials in alluvial stream sections are primarily made up of colluvial boulders from local rockfall deposits with a typical median diameter of 300 to 350 millimeters (mm) (**Table 3-4**). Bed framework materials appear to be very infrequently mobilized. However, volcanic breccia boulders with diameters of up to 400 mm found near Station 9+00 ft were fluvially transported from South Fork Little Backbone Creek several thousand ft upstream. Small cobble and gravel deposits representative of frequently mobilized bed materials in the study reach are very limited.

Coverage by alluvium and gravel-sized sediment is generally greater in lower-gradient stream sections with boulder bars present. In the inundated reach, sedimentation effects appear to increase overall alluvial coverage and depositional area of small cobble and gravels-sized materials. The entire channel bed is covered with cobble and gravel-sized materials downstream from about Station 2+30 feet Pools upstream from about Station 4+70 ft (elevation 1,061 ft msl) are devoid of fine sediment and organic debris on the bed, and pools upstream from about 6+70 ft (elevation 1,077 ft msl) have substantially more exposed bedrock (**Table 3-3**).

Table 3-4
Summary of Channel Bed Material and Gravel Deposit Observations and Pebble Count Measurements, Little Backbone Creek
July 31, 2003

River Station (ft)	Elevation MSL(ft)	Material/Deposit Type	Material/Deposit Location	Deposit Area (sq ft)	D_{84} (mm)	D_{50} (mm)	D_{16} (mm)	Embed-dedness
1+00	1,043	bed framework	mid-ch	na	1056	360	80	na
1+90	1,047	bed surface	mid-ch	na	64	37	--	high
2+00	1,047	bed surface	(PC 1) mid-ch	na	71	31	15	high
2+63	1,051	pool tailout	mid-ch	325	90	16	--	mod
3+00	1,053	channel margin	rt bk	150	8	3	1	low
3+15	1,054	boulder lee	rt bk	100	--	30	--	low
5+00	1,067	bed framework	(PC 2) mid-ch	na	720	308	72	na
5+10	1,068	pocket gravel	(PC 3) rt bk	120	54	28	15	low
5+50	1,072	pocket gravel	rt bk	80	--	25	--	low

Annual flood scour appears to limit near-channel riparian vegetation to widely-spaced sedge (*Carex* spp.) that colonizes protected channel margin deposits. Upland vegetation is rooted as low as water surface elevation plus 5 feet. Lack of dense riparian vegetation allowed for excellent orthophoto resolution of aquatic habitat and channel bed and bar features in the study reach. However, orthophoto-derived elevation contour data did not correctly resolve channel bed and water surface profiles (see **Figure 3-4**).

Little Backbone Creek in the study reach can be divided into two representative geomorphic subreaches. Reach 1 is the inundated sedimentation-affected reach extending from Shasta Lake (Station 0+00) upstream to longitudinal profile survey Station 4+30 (approximately 1,063 ft msl). Reach 1, which has a 6.1 percent slope, is a primarily bedrock and boulder-bedded reach with lake delta deposits partially covering the channel bed, forming near-channel boulder bars and elevated terraces flanking the channel (Photo LBC-1). A bedrock outcrop at Station 0+67 ft forms a cascade and plunge pool near the downstream end of the study reach and confirms that the 6.1 percent slope is controlled by the pre-reservoir bedrock bed profile, and not by net reservoir sedimentation. Cross-Section 1, surveyed at Station 1+94 ft, illustrates the typical dimensions of Reach 1 (**Figure 3-7**). The low-flow channel is approximately 20 ft wide and plane-bedded with large gravel moderately to highly embedded, with sand forming the frequently mobile bed matrix (Photo LBC-2). These matrix materials overlie the infrequently mobilized channel bed framework made up of partially reworked colluvial boulder lag deposit and smaller amounts of fluvially transported boulders, similar to poorly sorted boulder bar materials exposed along the channel margins (Photo LBC-3). Photo LBC-2 also shows channel bed framework materials exposed along both channel margins at Cross-Section 1. Low-flow discharge (1.9 cfs) is sufficient to transport silt and organic materials from the channel thalweg but both submerged channel margins and perched boulder bar surfaces are embedded with fines and organic materials deposited as the lake water surface steadily decreased over the summer. These substrate embeddedness conditions are typical for Reach 1.

A pebble count measurement conducted at the location shown in Photo LBC-2 (Pebble Count 1) estimated the median bed material size to be 31 mm (**Table 3-4**). The surface grain size distribution measured at Pebble Count 1 appears representative of frequently mobilized bed material or typical bedload material in the study reach. In the upstream portion of Reach 1, there are some isolated deposits of minimally embedded small gravel. For example, Photo LBC-3 shows a small-diameter, minimally embedded gravel deposit and a small amount of coarse organic material along the right bank channel margin near Station 3+00 and elevation 1,054 ft msl.

Reach 2 is typical of pre-lake conditions for the entire study reach. Reach 2, with an 8.3 percent slope, is a primarily bedrock and partially boulder-bedded channel contained within a confined bedrock canyon (**Figure 3-4**). Bedrock falls, cascades, and deep plunge pools form the majority of the channel bed and aquatic habitat in Reach 2 with lesser amounts of boulder-bedded riffle and shallow cobble- and boulder-bedded run habitats in intervening reaches (**Figure 3-4**). Cross-Section 2 surveyed at Station 5+62 ft illustrates typical channel bed conditions in Reach 2 (**Figure 3-8**). At Cross-Section 2, the low-flow channel is approximately 10 ft wide and plane-bedded with minimally embedded cobble and large gravel forming the frequently mobilized bed materials deposited at the pool tailout at the head of the downstream boulder riffle (Photo LBC-4). Photo LBC-5 shows the cobble and boulder materials forming the bed framework and channel margin gravel deposit materials near Cross-Section 2. Pebble Count 3 was conducted on pocket gravel deposits partially submerged in boulder riffle edgewater and partially exposed on the boulder bar surface near Station 5+10 feet The median diameter of these pocket gravel materials was 28 mm (**Table 3-4**). The size distribution of this sample appears typical of frequently mobilized bedload materials in Reach 2. Pebble Count 2 was conducted on the largely immobile submerged bed framework materials in the boulder riffle near Station 5+00 ft (Photo LBC-6). The sample area contained a shallow veneer of gravel materials, but the median diameter of bed materials in the boulder riffle was 308 mm, reflecting the domination of the boulder riffle framework materials by large colluvial clasts.

Both Reach 1 and Reach 2 would be classified as “A1” channel sections according to the Rosgen channel classification scheme (Rosgen 1996). The entire study reach would be classified as “cascade” according to the Montgomery-Buffington classification scheme (Montgomery and Buffington 1993).

Big Backbone Creek

Big Backbone Creek watershed (**Figure 3-9**) drains an approximately 30.2-square-mile area situated in the western portion of the ESL and enters into the Big Backbone arm of Shasta Lake (see Atlas, Vol. III,1-5) about 5.1 miles north of Shasta Dam. The middle and upper watershed is underlain almost entirely by meta-sediments, primarily the Bragdon chert-pebble and quartz conglomerate with lesser amounts of black siliceous shale and greywacke (**Figure 3-2**). The upper South Fork Big Backbone Creek also cuts through volcaniclastic tuff and tuffaceous shale and metavolcanic Balaklala rhyolite characteristic of the Little Backbone Creek watershed. Similarly, the lower portion of the watershed including the 7,880-ft-long study reach is primarily underlain by the Balaklala rhyolite that is also present in the Little Backbone Creek watershed, as well as lesser amounts of greenstone and Kennett limestone.

The Big Backbone Creek longitudinal profile survey and study reach for this assessment began at the upstream end of Shasta Lake (Station 0+00 ft) on July 18, 2002 (elevation 1,022.68 ft msl) and extended about 7,880 ft upstream to the ESL at the confluence of Oak Opening Creek (elevation 1,119.18 ft msl) on July 19, 2002 (**Table 3-5**). This reach is a mildly sinuous, primarily small boulder- and large cobble-bedded single-thread and locally braided pool-riffle-run and step-run alluvial stream with a relatively uniform and moderately steep channel bed slope of 1.2 percent (**Figure 3-10**). The 30-55-ft wide bankfull channel is confined within a bedrock canyon by vertical bedrock channel banks along outside channel bends and elevated, steeply-sloped terrace-like floodplains along inside bends.

Within the bankfull channel, the 15-35-ft-wide low-flow channel is locally confined by colluvial boulder lag deposits and almost continuously confined by narrow lateral and point bars with bar framework materials dominated by large cobbles and small boulders with lesser amounts of gravel. Big Backbone Creek is lower gradient and more alluvial than all of the tributaries assessed in this study, with the exception of Upper Sacramento River. Pool-riffle-run aquatic habitat units comprise 75 percent of the study reach length and step-run habitats 25 percent (**Figure 3-11**). There were five bedrock steps and one boulder cascade habitat that together made up less than one percent of study reach length. Pools averaged about 20 ft wide and 2.8 ft deep with maximum pool widths and depths up to 46 ft and 8.9 ft, respectively (**Table 3-6**).

Small boulders and large cobbles dominated channel bed framework and matrix materials throughout the study reach except for several isolated pool tailout deposits (**Figure 3-12**). Pebble count measurements and visual estimates made throughout the study reach indicate that bed framework and matrix materials were significantly coarser than exposed and submerged bar materials (**Table 3-7**). The measured median diameter (D_{50}) of bar materials varied from 39 mm to 90 mm and averaged 64.5 mm. The D_{50} of bed materials varied from 44 mm to 250 mm and averaged 107 mm. These data show a strong downstream fining trend from Station 45+30 ft (elevation 1,072 ft msl) downstream to Station 11+25 ft (elevation 1,040 ft msl). Boulder- and cobble-sized bed framework materials and gravel-sized matrix materials averaging about 100 mm and bar materials averaging about 65 mm appear to be representative of relatively frequently mobilized bedload materials in the study reach, probably about every 2-3 years. Deposits of more frequently mobilized bedload materials were

Table 3-5
Benchmark and Turning Point Marker Locations and Elevations, Big Backbone Creek
July 18-19, 2002

Turning Point Number	Station from Reservoir Surface (ft)	Elevation Above MSL (ft)
TP1	1+45	1,023.93
TP2	11+25	1,034.58
TP3	20+71	1,044.58
TP4	25+87	1,049.98
TP5	28+06	1,054.00
TP6	32+57	1,059.00
TP7	36+07	1,062.77
TP8	38+63	1,068.68
TP9	41+71	1,069.66
TP10	45+42	1,073.81
TP11	48+18	1,076.63
TP12	52+16	1,080.89
TP13	54+68	1,084.16
TP14	56+50	1,086.36
TP15	58+60	1,089.99
TP16	60+05	1,092.70
TP17	62+85	1,095.36
TP18	66+49	1,100.56
TP19	68+10	1,104.14
TP20	70+47	1,107.25
TP21	73+30	1,113.54
TP22	75+83	1,117.33
TP23	78+30	1,119.98
TP24	79+85	1,122.07
Reservoir Water Surface Elevation		1,022.68

Notes: Downloaded from: http://cdec.water.ca.gov/cgi-progs/queryDaily SHS

located in pool tailouts and pocket gravel deposits on the submerged bed and exposed bars. The median diameter of gravel-dominated pool tailout deposits varied from 20 mm to 60 mm, and averaged 33 mm. The median diameter of individual pocket gravel deposits varied from 20 mm to 30 mm and averaged 23 mm. Few pocket gravel deposits exceeding 50 square ft in area were identified in the study reach. More typically, the channel bed in individual boulder-dominated runs contained numerous relatively small and shallow pocket gravel deposits. Overall, these data and field observations suggest that the median diameter (D_{50}) of at least annually mobilized bedload materials is about 20 to 30 mm, but the supply of these materials to the study reach is relatively low. Although the presence of potentially suitable spawning gravel deposits may have been expected given the lower-gradient alluvial nature of the Big Backbone Creek study reach, bed and bar materials were generally too coarse and poorly sorted to provide suitable spawning, and pool tailout and the number of potentially suitable pocket gravel deposits in the study reach was limited to less than 10-15 in number. The largest deposit of well-sorted medium gravel-sized sediment in the study reach

Table 3-6
Average Pool Width, Depth and Max Pool Width and Depth, Big Backbone Creek

Pool #	Station at Top of Pool (ft)	Elevation at Top of Pool (ft)	Maximum Depth (ft)	Average Depth (ft)	Average Width (ft)	Max Wetted Width (ft)	Pool Substrate Characterization
1	3+85	1,019.18	4.7	3.1	20	23	sm bldrs to coarse sand; high embed
2	18+25	1,036.13	5.9	3.9	31	46	sm bldrs to coarse sand; high embed
3	19+55	1,037.63	5.4	3.6	27	33	sm bldrs to coarse sand; high embed
4	23+00	1,042.20	2.5	1.6	20	26	lg cobbs to med sand; mod embed
5	23+42	1,042.78	3.5	2.3	14	14	lg cobbs to med sand; mod embed
6	24+55	1,045.81	2.2	1.8	20	24	fine gravel; low embed
7	25+02	1,046.02	3.0	2.2	14	20	sm cobbs to coarse sand; mod embed
8	25+77	1,047.12	4.7	3.1	11	12	sm cobbs to coarse sand; mod embed
9	31+38	1,054.20	2.4	1.6	18	23	sm cobbs to coarse sand; mod embed
10	32+14	1,054.62	1.5	1.2	19	22	sm cobbs to coarse sand; mod embed
11	34+14	1,058.03	2.3	1.9	28	37	sm cobbs to coarse sand; mod embed
12	35+40	1,059.39	2.9	2.2	19	23	sm cobbs to coarse sand; mod embed
13	39+03	1,066.74	2.9	2.2	29	37	sm cobbs to coarse sand; mod embed
14	45+24	1,070.56	4.1	4.0	21	25	coarse gravel to med sand; low embed
15	49+94	1,076.55	5.3	3.5	25	35	sm bldrs to lg gravel; low embed; cobbs tailout
16	51+74	1,076.67	4.5	3.0	18	18	sm bldrs to lg gravel; low embed; cobbs tailout
17	53+38	1,079.45	4.4	2.9	15	17	med cobbs to coarse gr; tail-out grades to fine gr
18	56+53	1,083.89	8.9	5.9	28	33	mixed; lg cobbs uniformly graded to fine gr tailout
19	59+53	1,087.99	4.9	2.8	22	29	med bldrs to large cobbs; high embed
20	67+31	1,100.05	3.3	2.4	12	13	large cobbs to sm cobbs; low embed
21	68+08	1,101.72	2.4	2.1	12	14	large cobbs to sm cobbs; low embed
22	71+14	1,104.89	3.6	2.3	27	30	large cobbs to large gr; mod embed
23	74+46	1,110.39	4.3	3.7	32	40	large cobbs to large gr; mod embed

(comprising about half of the potentially suitable spawning gravel area in the study reach) was a broad mid-channel pool tailout deposit at Station 55+80 ft (elevation 1,086 ft msl) immediately downstream of a 8.9-ft-deep bedrock scour pool at Station 56+20 ft (**Figure 3-10**). A redd was observed at the pool tailout riffle crest at the time of the survey. The pebble count measured size distribution of the bed surrounding the redd was 40 mm (D_{84}), 19 mm (D_{50}), and 9 mm (D_{16}).

Table 3-7
Summary of Channel Bed Material and Gravel Deposit Observations and Pebble Count Measurements, Big Backbone Creek
July 18-19, 2002

River Station (ft)	Elevation MSL (ft)	Material/ Deposit Type	Material/Deposit Location	Deposit Area (sq ft)	D_{84} (mm)	D_{50} (mm)	D_{16} (mm)	Embed-dedness
11+25	1,033	bar framework	(PC 1A) lt bk		95	39	13	
11+25	1,037	bed framework	(PC 1B) mid-ch in run		166	85	34	
19+70	1,038	bed framework	(PC 2) mid-ch in step-run		89	44	23	
23+80	1,047	bar framework	(PC 3) lt bk		198	90	20	
31+65	1,054	bed framework	(PC 4) mid-ch in run		233	127	47	
42+50	1,069	bed framework	(PC5) mid-ch in step-run		303	133	15	
44+60	1,071	pool tailout	(PC 6) rt bk	200	47	20	10	low
45+30	1,072	bed framework	mid-ch in riffle		--	250	--	low
47+20	1,074	pocket gravel	mid-ch in run	100	--	20	--	low
52+50	1,081	pool tailout	(PC 7) rt bk		194	60	21	
55+80	1,085	pool tailout	(PC 8) mid-ch at sp redd		41	19	9	
60+30	1,090	pocket gravel	(PC 9) lt bank bar		59	28	14	
65+20	1,097	pocket gravel	(PC 10) lt bk bar		33	21	12	
66+90	1,098	bed framework	(PC 11) mid-ch in run		301	169	61	
73+80	1,110	pocket gravel	lt bk point bar	100	--	20	--	low
74+45	1,111	pocket gravel	rt bk in boulder lee	45	--	20	--	low
75+80	1,114	pocket gravel	mid-ch in step-run	30	--	25	--	mod
77+90	1,118	pocket gravel	mid-ch in glide	150	--	30	--	mod

Pool bed substrate materials were dominated by small boulders and cobbles generally similar to channel bed materials in run habitats but with a somewhat larger percentage of gravel-sized and sand-sized materials in the matrix. There were very few occurrences of bedrock bed exposures. A matrix or veneer of gravel and sand-sized materials was present in all pools in the study reach dominated by sand-sized materials in the downstream portion of the study reach, at and downstream from Station 45+24 ft (elevation 1,071 ft msl), and by medium to large gravel-sized materials upstream (**Table 3-6**).

Riparian vegetation and aquatic habitat cover was extremely limited in the inundation and sedimentation impacted zone in the locally braided downstream portion of the Big Backbone Creek study reach. Downstream from about Station 20+45 ft (elevation 1,042 ft msl) there was virtually no young riparian vegetation established near the channel and fewer than 1 mature riparian tree specimen per 300 ft channel length. Photo BBC-1 shows channel bed and vegetation conditions present near Cross-Section 1 (**Figure 3-13**). Between Station 20+45 ft and Station 25+00 ft moderately dense riparian vegetation dominated by young willows was established along channel margins and channel banks (Photo BBC-2) and on limited exposed gravel- and cobble-bar deposits (**Figure 3-14**).

A broad gradually-sloped fine-grained terrace spans the canyon floor throughout the Big Backbone Creek study reach downstream from Station 37+00 ft (elevation 1,064 ft msl) (see, *e.g.*, **Figure 3-14** and **Figure 3-14**). The terrace deposit appears to be dynamic in nature associated with frequent inundation, subjected to backwater effects and supports virtually no riparian vegetation. The longitudinal channel bed and water surface profile (**Figure 3-10**) shows the present surface elevation of the terrace relative to the channel bed. Beginning near Station 25+00 (elevation 1,046 ft msl) the amount of near-channel riparian vegetation and resulting aquatic microhabitat cover and general riparian canopy cover increases significantly, still dominated almost entirely by young willows. The relative elevation of the flanking terrace unit decreases in this vicinity and there is evidence of scouring floodplain flows on the terrace, but little riparian vegetation. The channel bed form is locally widened and braided in a portion of this reach near elevation 1,055 ft msl between Station 26+68 ft and Station 28+92 ft (Reach 3). Riparian vegetation in this reach is dominated almost entirely by relatively young, even-aged willow with scattered young (up to about 3-5 years old) alders and cottonwoods on mid-channel island bars and channel banks.

A full canopy of mature riparian vegetation was present throughout the entire upper portion of the Big Backbone Creek study reach beginning at the upstream terminus of the fine-grained terrace unit, near Station 35+00 ft (elevation 1,061 ft msl). The channel bed form was also locally wide and braided in a 703-ft-long reach beginning near the upstream from the head of the terrace unit and extending up to about Station 41+17 ft (elevation 1,067 ft msl). The entire active channel bed area in the braided reach was colonized by mature riparian trees, primarily alders. The majority of discharge was contained in the main channel, but alluvial groundwater discharge and minimal overflow produced standing water and minimal discharge in several narrow cobble-bedded side channels and off-channel pools. Several off-channel pools appeared to provide year-round pool habitat and there were numerous woody debris jams and pocket gravel deposits in the braided side channels. The full riparian canopy continued throughout the study reach upstream from this locally braided reach and channel banks became nearly continuously dominated by mature alders. In addition, near-channel riparian vegetation dominated by sedge and Indian rhubarb was continuously present along alluvial and bedrock channel margins and exposed and shallow submerged bar surfaces (Photo BBC-3). Figures 3-16 and 3-17 show typical riparian vegetation conditions, channel bed, floodplain form, and dimensions in the upstream portion of the study reach.

The Big Backbone Creek study reach can be delineated into ten geomorphic subreaches (comprising six channel types) according to the Rosgen classification scheme and six geomorphic subreaches (comprising two channel types) according to the Montgomery-Buffington system (**Figure 3-10**). Entrenchment ratio measured at ten surveyed cross-sections (floodprone width divided by bankfull width) varied from 1.3 to 3.6 and averaged 2.4, and bankfull width-to-depth ratio varied from 4.1 to16.6 and averaged 10.9. About 32 percent of the study, reach length is comprised of three channel reaches (all downstream from Station 41+17 ft, elevation 1,067 ft) that could be classified as braided "D2" channel reaches (**Figure 3-18**). Nineteen percent of the study reach could be classified as "E2" channel reaches and fifteen percent of the study reach, all upstream from Station 68+59 ft (elevation 1,106 ft msl) could be classified as "C2" channel reaches. Accordingly, 33 percent of the study reach could be classified as "braided" channel types and 67 percent "pool-riffle" channel types under the Montgomery-Buffington system.

Sugarloaf Creek

Sugarloaf Creek watershed (**Figure 3-19**) drains an approximately 10.4-square-mile area situated in the western portion of the ESL and enters into the Sacramento Arm of Shasta Lake about 4.1 miles north of Shasta Dam (see Atlas, Vol. IV. 1-14). The watershed including the study reach is underlain entirely by the Bragdon unit, which consists of shale, greywacke, and minor conglomerate metasediments. The study reach for this assessment extended 2,434 ft upstream from the Sugarloaf Creek-Shasta Lake interface (Station 0+00 ft) at 08:45 July 30, 2003 (elevation 1,031.76 ft msl) to a permanent benchmark (BM79) installed at Station 24+34 ft (**Table 3-8**). The measured discharge of Sugarloaf Creek within the ESL (at Station 12+83 ft) was 3.47 cfs at 10:00 am, July 30, 2003 (**Table 3-1**).

Table 3-8
Benchmark and Turning Point Marker Location and Elevations, Sugarloaf Creek
July 30, 2003

Turning Point Number	Station from Reservoir Surface (ft)	Elevation Above MSL (ft)
RES WSE	0	1,031.76
TP1	5+09	1,040.75
TP2	9+78	1,059.68
TP3	11+82	1,067.78
TP4	13+98	1,071.25
TP5	17+31	1,079.51
TP6	19+37	1,082.32
TP7	22+64	1,087.56
BM 79	24+34	1,091.26
Reservoir Water Surface Elevation		1,031.76

Note: Downloaded from: http://cdec.water.ca.gov/cgi-progs/queryDaily SHS

Sugarloaf Creek in the study reach is a uniformly 2 percent slope single-thread bedrock and boulder-bed channel confined within a 30- to 50-ft-wide steep-sided canyon with narrow lateral boulder bars and narrow floodplains, where present. Shallow boulder-dominated riffles and gravel-bedded pools form the majority of the channel bed (*e.g.*, Photo SGC-1), except for an approximately 550-ft-long 4-

percent-slope bedrock cascade and plunge pool stream section between Station 8+00 ft and Station 13+50 ft (**Figure 3-20**). The intervening bedrock cascade reach makes up about 23 percent of the study reach length. Overall, 27 percent of the study reach is cascade habitat (**Figure 3-21**), and about 21 percent of the study reach channel bed is dominated by bedrock substrate (**Figure 3-27**). The low-flow channel is 10 to 20 ft wide and pools are typically 12 to 15 ft wide (**Table 3-9**). Pools are typically 2 to 3 ft deep but up to 4.5 ft deep below boulder-bedded cascade habitats forced by woody debris jams and up to 8.6 ft deep in the bedrock cascade-plunge pool section (**Table 3-9**).

Table 3-9
Average Pool Width, Depth, and Substrate Distribution, Sugarloaf Creek

					Areal Percentage of Substrate in Pool Bed							
Pool #	**Station at Top of Pool (ft)**	**Elevation at Top of Pool (ft)**	**Maximum Depth (ft)**	**Average Width (ft)**	**BR (%)**	**Bo (%)**	**Co (%)**	**Gr (%)**	**Sa (%)**	**Si (%)**	**Org (%)**	**Total (%)**
1	1+50	1,032	2.6	15	10	20		70				100
2	2+62	1,034	4.0	15	10	40		50				100
3	4+51	1,037	4.6	12	30	20		50				100
4	8+91	1,047	5.7	12	40				10		50	100
5	9+51	1,050	8.6	13	25	5		50	20			100
6	10+50	1,061	2.5	13	20	30		50				100
7	13+30	1,068	3.7	11	30	30	10	30				100
8	14+26	1,070	1.9									
9	15+30	1,073	1.1									
10	16+55	1,077	1.7	15	30	30		40				100
11	17+50	1,078	4.5	17	20	20		60				100
12	18+87	1,080	1.8	15	10	10	10	70				100
13	22+93	1,085	3.7	17	25	30	5	40				100

Note: *BR=bedrock, Bo=boulders, Co=cobbles, Gr=gravel, Sa=sand, Si=silt, Org=organic material

The grain size distribution of channel bed and lateral bar framework materials are similar and contain mixed grain sizes, primarily small boulders, cobbles, and gravel and lesser amounts of medium and large boulders. The D_{84} of bed and bar framework materials is typically 70 to 120 mm and the D_{50} is typically 50 to 75 mm (**Table 3-10**) except for a bed section near Station 19+10 dominated by finer matrix substrates (about 8 to 10 mm). Bed and bar framework materials including boulder bar and boulder riffle materials appear to be relatively frequently mobilized, perhaps during peak flows occurring every 3-5 years. Frequently mobilized bed materials (*e.g.*, representative of bedload transported by the average annual flood) generally form a very shallow veneer of matrix materials where present, primarily pool substrates and as pocket gravel deposits. About 31 percent of the study reach channel bed length is underlain by gravel-dominated substrates (**Figure 3-22**), primarily in pools and pool tailouts and broader low-gradient riffles and runs downstream from somewhat steeper boulder riffle and cascade habitats. Most pools in the study reach are dominated by gravel-sized sediment (**Table 3-9**). Visual and pebble count measurements of pocket gravel deposits on the channel bed and bar surfaces along the study reach indicates that the D_{50} of frequently mobilized bedload materials is about 8 to 20 mm (**Table 3-10**). Well-sorted gravel-sized sediment deposits are uncommon in the study reach, with the greatest concentration and total area of pocket gravels in the bedrock cascade section between Station 8+00 and 12+00 (Photo SGC-2). Extensive gravel deposits result from highly irregular channel boundaries, particularly near Station 10+00 feet Pebble count measurements determined the D_{84} and D_{50} of these well-sorted materials were 30 mm and 15 mm, respectively, with virtually no fine sediment present (embeddedness). These materials are similar in size distribution to typical frequently mobilized bedload materials found elsewhere in the study reach.

Table 3-10
Summary of Channel Bed Material and Gravel Deposit Observations and Pebble Count Measurements, Sugarloaf Creek
July 30, 2003

River Station (ft)	Elevation MSL (ft)	Material/ Deposit Type	Material/Deposit Location	Deposit Area (sq ft)	D_{84} (mm)	D_{50} (mm)	D_{16} (mm)	Embed-dedness
0+50	1,032	bed surface	mid-ch	na	--	10	--	high
3+10	1,038	bar framework	rt bk	na	95	60	--	high
3+10	1,038	pocket gr	rt bk bar	20	--	9	--	high
5+10	1,040	bed framework	mid-ch riffle	na	90	75	--	low
7+00	1,044	pocket gr	mid-ch	30	--	20	--	high
8+20	1,047	pocket gr	mid-ch	50	--	35	--	high
9+00	1,052	pocket gr	mid-ch	60	--	3	--	low
10+00	1,061	pocket gr	(PC 1) rt bank	100	30	15	8	low
10+10	1,061	pocket gr	lt bk	80	--	15	--	low
10+40	1,063	pocket gr	lt bk	60	--	13	--	low
15+40	1,073	pocket gr	mid-ch	80	--	17	--	low
16+20	1,076	bar framework	rt bk bar	100	--	50	--	low
16+20	1,076	bar framework	lt bk bar	100	--	70	--	low
16+30	1,075	bed framework	mid-ch	na	70	50	--	low
18+00	1,081	bed framework	mid-ch	na	120	--	--	low
19+10	1,080	bed surface	mid-ch	300	25	9	6	low
19+20	1,083	bar framework	rt bk bar	na	80	--	--	low
19+20	1,083	pocket gr	rt bk bar	80	--	8	--	low
20+00	1,084	pocket gr	mid-ch	numerous	--	9	--	low
21+60	1,086	pocket gr	rt bk	numerous	--	13	--	low

Annual flood scour appears to limit establishment of riparian vegetation on near-channel exposed boulder bar surfaces. California dogwood and mature alders line most channel banks and narrow floodplain surfaces, where present, and sedge and Indian rhubarb dominate near-channel vegetation and partially cover bar surfaces and shallow edgewater and backwater areas.

Sugarloaf Creek in the study reach can be divided into three representative geomorphic subreaches. Reach 1 is the 2-percent-slope inundated reach extending from Shasta Lake (Station 0+00 ft) upstream to Station 8+12 ft (elevation 1,048 ft msl) immediately below the bedrock cascade-plunge pool stream section (Reach 2). Reach 1 is a 30- to 35-ft-wide boulder-bedded riffle and pool reach with shallow boulder bar deposits, no floodplains, and sparse riparian vegetation (Photo SGC-3). Cross-Section 1 surveyed at Station 3+10 ft illustrates the typical channel bed and bar form and dimensions of Reach 1 (**Figure 3-23**). The size of bed and bar matrix materials in Reach 1 is very similar to the rest of the study reach but a large percentage of the bed and bar surface materials are highly embedded by fine matrix materials. A shallow veneer of sand, silt, and organic detritus covers the channel bed along channel margins apart from a narrow channel thalweg where low-flow discharge is generally sufficient to transport these materials. Pool depth and bed substrate in Reach are similar to the rest of the study reach (**Table 3-9**), indicating that pool sedimentation is generally not significant. A bedrock outcrop in the bed at Station 3+75 ft confirms that the channel bed slope in Reach 1 has not been significantly reduced by reservoir sedimentation effects. Reach 1 would be classified as "G2" according to the Rosgen channel classification scheme (Rosgen 1996) and "plane-bed" according to the Montgomery-Buffington classification scheme (Montgomery and Buffington 1993).

Reach 2 is a 4-percent-slope bedrock-bedded cascade-plunge pool reach extending 544 ft upstream from Station 8+12 ft in the inundation zone to Station 13+54 ft (elevation 1,070 ft msl). Cross-Section 2 surveyed at Station 12+63 ft illustrates representative channel bed conditions and dimensions in Reach 2 (**Figure 3-24**). Pools are generally somewhat more narrow and deep than the alluvial portions of the study reach (**Table 3-9**). In-channel storage of frequently mobile bedload materials including well-sorted gravel sized sediment deposits is much greater in Reach 2 than the rest of the study reach (**Table 3-10**). Reach 2 would be classified as "A1" according to the Rosgen channel classification scheme (Rosgen 1996) and "cascade" according to the Montgomery-Buffington classification scheme (Montgomery and Buffington 1993).

Reach 3 is typical of pre-lake conditions for alluvial portions of Sugarloaf Creek. Reach 3 is a 2-percent-slope single-thread bedrock and boulder-bed channel confined within a 35- to 50-ft-wide steep-sided canyon with narrow lateral boulder bars and narrow floodplains. Shallow boulder-dominated riffles and gravel-bedded pools form the majority of the channel bed. The grain size distribution of channel bed and lateral bar framework materials are similar and contain mixed grain sizes, primarily small boulders, cobbles, and gravel and lesser amounts of medium and large boulders (Photo SGC-1). Cross-Section 3 surveyed at Station 22+67 ft illustrates typical channel and floodplain form and dimensions in Reach 3 (**Figure 3-25**). Sugarloaf Creek flows along the toe of the right bank canyon wall throughout Reach 3. The toe of the right bank canyon wall shows evidence of periodic slope failures, chronic downslope soil creep, and chronic but not severe bank erosion at the toe. Note that the Sugarloaf Creek study reach contained more household garbage than tributaries assessed in this study, due to the presence of a roadway above the stream along both canyon walls. Reach 3 would be classified as "G2" according to the Rosgen channel classification scheme (Rosgen 1996) and "plane-bed" according to the Montgomery-Buffington classification scheme (Montgomery and Buffington 1993).

Upper Sacramento River

The Upper Sacramento River watershed (**Figure 3-26**) drains approximately 53.5-square-mile area into the Sacramento Arm of Shasta Lake (see Atlas, Vol. IV, 1-28) about 14.7 miles NNE of Shasta Dam. The watershed in the study reach and its vicinity is underlain almost entirely by the Bragdon unit of metasedimentary shale and greywacke. The study reach for this assessment extended approximately 9,800 ft from its beginning at elevation 1,066 ft msl on the channel bed about 895 ft downstream from the USGS gage, Sacramento River at Delta, California (USGS Gage ID No. 11342000) (**Figure 3-26**). This assessment did not include surveys of the channel downstream from the Shasta Lake full pool elevation (1,070 ft msl). The USGS-measured discharge of Upper Sacramento River was 258 cfs at 10:00am October 3, 2003 (**Table 3-1**) and remained 258 cfs throughout the two-day survey. Permanent benchmark monuments were not installed at the downstream and upstream ends of the survey but were installed at four locations within the study reach (approximately 1,960 ft apart) to facilitate future survey comparisons (**Table 3-11**).

Table 3-11
Benchmark and Turning Point Marker Location and Elevations, Upper Sacramento River
October 3-4, 2003

Turning Point Number	Station from Reservoir Surface (ft)	Elevation Above MSL (ft)
TP1	7+42	1,079.35
USGS GAGE #11342000	8+95	1,075.00
TP2	16+47	1,082.79
BM-52	16+59	1,085.88
TP3	25+73	1,088.63
TP4	36+97	1,093.62
TP5	38+10	1,093.36
TP6	51+41	1,097.25
TP7	62+92	1,108.41
TP8	72+24	1,112.06
BM-51	77+06	1,118.62
TP9	80+94	1,119.17
BM-50	83+77	1,122.66
TP10	87+64	1,122.56
BM-49	92+79	1,123.76
USGS GAGE #11342000 Datum Elevation above NGVD29		1,075.00

Note: Downloaded from: http://waterdata.usgs.gov/ca/nwis/nwismap/?site_no=11342000&agency_cd=USGS

The Upper Sacramento River in the study reach is a 0.6-percent-slope, mildly sinuous single-thread boulder- and large cobble-bedded pool-riffle stream (**Figure 3-27**). Its 60- to 110-ft-wide low-flow channel is confined within a 190- to 230-ft-wide bedrock walled canyon, the entirety of which is active channel; the average active channel width is about 210 feet Point and lateral bars alternating from left bank to right bank positions are typically 100 to 130 ft wide and composed of similar sized boulder and cobble materials. Alluvial bar features were locally absent and patchy due to presence of shallow bedrock outcrops. Gravel and sand overbank materials are limited to areas away from the stream either on higher exposed bar surfaces, or on wide, stable, gradually-sloping banks with dense stands of mature riparian trees. Pool, riffle, and run habitats formed 20, 32, and 48 percent of the study reach length, respectively (**Figure 3-28**). There were no occurrences of other aquatic habitat types in the study reach. Pools are spaced approximately 1,600 ft apart or about 7.5 active channel widths. The average pool width varies from about 25 to 80 ft (**Table 3-12**), with the narrowest and deepest pools controlled by bedrock canyon wall outcrops in the bed along outside bends (*e.g.,* near Station 15+50 ft, Station 50+00 ft, and Station 69+00).

Table 3-12
Average Pool Width, Depth, and Substrate Distribution, Upper Sacramento River

					Areal Percentage of Substrate in Pool Bed							
Pool No.	**Station at Top of Pool (ft)**	**Elevation at Top of Pool (ft)**	**Maximum Depth (ft)**	**Average Width (ft)**	**BR (%)**	**Bo (%)**	**Co (%)**	**Gr (%)**	**Sa (%)**	**Si (%)**	**Org (%)**	**Total (%)**
1	00+96	1,064.91	6.0	40		50	40	10				100
2	15+65	1,079.49	12.0									
3	50+31	1,092.19	18.4	25	40	20	5		35			100
4	69+76	1,103.06	7.5	11	20	60	20					100
5	81+34	1,114.09	4.0									
6	91+12	1,115.35	9.9	80		20	20	15	45			100
7	96+59	1,118.42	5.0		40	30	20	10				100

Notes: *BR=bedrock, Bo=boulders, Co=cobbles, Gr=gravel, Sa=sand, Si=silt, Org=organic material

Boulders and cobbles dominated channel bed materials in riffles and runs, comprising 67 percent and 16 percent of the dominant substrate materials in the study reach, respectively (**Figure 3-29**). Bedrock dominated the channel bed in 11 percent of the study reach, primarily in pools forced by bedrock outcrops along outside channel bends. The typical size distribution of channel bed framework materials was between 25 mm and 300 mm. The pebble count measurement on the channel bed at Cross-Section 6 appears to be representative of typical channel bed framework materials and frequently mobilized bedload materials in the study reach. The D_{50} of this bed material sample was 75 mm (**Table 3-13**). The measured median grain size of submerged channel bed materials averaged 76 mm and varied from 27 mm to 122 mm throughout the study reach, reflecting material size differences between mid-channel and channel margin locations and longitudinal position of the samples (*i.e.*, in riffles or runs). The size distribution of exposed near-channel point bar materials varied from 15 mm to 318 mm, with an average median grain size of 123 mm, 62 percent greater than submerged channel bed materials. This difference is probably explained by the presence of frequently mobile bedload materials as matrix materials on the channel bed and general absence of these materials within or on the point bar framework materials. That is, while both point bar and channel bed framework materials are emplaced by larger, less frequent floods, submerged channel bed materials also contain a shallow veneer of matrix materials that are emplaced by average annual peak flows and lower magnitude, longer duration flows. Channel bed substrate present in pools largely reflected the overall size distribution in the study reach as well as the increased presence of bedrock substrates due to bedrock-forced pools along outside channel bends (**Table 3-12**). Most pools in the study reach were virtually devoid of appreciable sand and fine-grained sediment deposits as near-bed flow velocities were evidently great enough during summer low-flow conditions to transport fine materials through typical pool habitats. Exceptions were the very deep pool at a tight channel bend near Station 50+00 ft, and a particularly long, deep pool near Station 90+00 feet The very deep pool at Delta forms where the flow path attacks the left bank canyon wall at an acute angle, causing both very deep pool conditions and non-uniform flow conditions and hydraulic shadows within the pool. The very long, deep pool near Station 90+00 ft is controlled by bedrock outcrops upstream near Station 94+00 ft and downstream nr Station 80+00 feet Flow through this pool was uniform but exceptionally slow and deep during low-flow conditions.

Table 3-13
Summary of Channel Bed Material and Gravel Deposit Observations and Pebble Count Measurements, Upper Sacramento River
October 3-4, 2003

River Station (ft)	Elevation MSL (ft)	Material/ Deposit Type	Material/ Deposit Location	Deposit Area (sq ft)	D_{84} (mm)	D_{50} (mm)	D_{16} (mm)	Embed-dedness
11+47	1,081	point bar surface	(PC 1) lt bk bar	na	246	159	56	low-mod
36+97	1,092	ch bed surface	(PC 2) rt bk margin	na	220	80	38	low-mod
59+34	1,105	ch bed surface	(PC 3) lt bk margin	na	331	122	32	low-mod
75+39	1,118	point bar surface	(PC4A) lt bk bar	na	318	86	20	low-mod
75+39	1,115	ch bed surface	(PC 4B) lt bk margin	na	105	27	12	low-mod
80+75	1,120	point bar surface	(PC 5) rt bk bar	na	307	125	15	low-mod
93+93	1,118	ch bed surface	(PC 6) mid-ch	na	223	75	25	low-mod

Figures 3-30 through 3-35 illustrate channel and bar form, dimensions, general substrate, and riparian vegetation conditions at six cross-sections surveyed throughout the study reach. Annual flood scour generally limits establishment of near-channel riparian vegetation on point and lateral bars (*e.g.*, Photo USR-1). However, primarily sedge and Indian rhubarb and to a lesser degree young willow trees cover a significant portion of near-channel exposed bar area and associated shallow edgewater habitats (*e.g.*, Photo USR-2), particularly in lower-gradient shallow run habitats such as the bedrock-controlled deep and shallow run complex between Station 27+75 ft (elevation 1,091 ft msl) and Station 47+57 ft (1,094 ft msl). Frequent flood scour and elevation above alluvial groundwater table also appear to limit establishment of mature riparian trees on upper bar surfaces. Medium-density stands of trees dominated by 3-4-year old willows and younger trees have colonized large percentages of lower elevation boulder-cobble bars, including the patchy alluvial cover overlying shallow bedrock and forming extensive backwater pool habitats along the left bank in the lower-gradient run complex (see **Figure 3-31**), and stringers along top of elevated boulder-cobble bars in the reach between Station 50+00 ft and Station 75+39 ft at the head of the bar (see, *e.g.*, **Figure 3-32** and **Figure 3-33**). Dense stands of young vegetation dominated by willow have also colonized low elevation mid-channel bars, such as at Cross-Section 4 at Station 80+75 ft (**Figure 3-34**).

Mature riparian trees appear to be generally limited to isolated stable areas protected from high flows such as stable rip-rap slopes at the base of the right bank railroad embankment and rather steeply-sloped sandy overbank areas along bedrock protected canyon walls, particularly along inside bends and in straight, wide reaches. A railroad embankment fill prism contains rip-rap that encroaches on the right bank floodplain and channel area along the entire study reach (see Figures 3-30 through 3-35). In most places, the largely stable rip-rap slope is vegetated by mature riparian trees, including cottonwood, although large portions of the rip-rap slope are exposed by frequent scour along outside channel bends.

The entire Upper Sacramento River study reach would be classified as “C2” according to the Rosgen channel classification scheme (Rosgen 1996) and “pool-riffle” according to the Montgomery-Buffington classification scheme (Montgomery and Buffington 1993).

Middle Salt Creek

Middle Salt Creek watershed (**Figure 3-36**) drains an approximately 17.8-square-mile area and enters the Sacramento River Arm of Shasta Lake about 15 miles north of Shasta Dam (see Atlas, Vol. IV, 1-26). The watershed, including the study reach, is underlain by the Paleozoic Bragdon shale and greywacke metasedimentary rocks with minor conglomerate.

The study reach for this assessment (**Figure 3-36**) extended from the confluence of Middle Salt Creek and Shasta Lake on July 28, 2003 (elevation 1,033.33 ft msl) upstream to Station 48+72 ft (elevation 1,090 ft msl) (**Table 3-14**). The measured discharge of Middle Salt Creek within the ESL (at Station 13+90 ft) was 3.74 cfs at 13:30 on July 28, 2003 (**Table 3-1**).

Table 3-14
Benchmark and Turning Point Marker Location and Elevations, Middle Salt Creek July 28-29, 2003

Turning Point Number	Station from Reservoir Surface (ft)	Elevation Above MSL (ft)
RES WSE	0+00	1,033.33
TP1	10+48	1,045.32
TP2	14+38	1,051.38
TP3	18+58	1,054.43
TP4	24+48	1,059.79
TP5	29+23	1,065.06
TP6	34+32	1,069.51
BM-68	40+80	1,078.76
TP8	45+12	1,083.64
TP9	48+72	1,089.92
Reservoir Water Surface Elevation		1,033.33

Note: Downloaded from: http://cdec.water.ca.gov/cgi-progs/queryDailySHS

Middle Salt Creek in the study reach is a relatively low-gradient (1.0 to 1.4 percent slope), single-thread plane-bed channel, dominated by shallow boulder-bed riffle and run habitats downstream, and deep, slow runs, pools, and short bedrock and boulder cascades in the slightly steeper and less alluvial upstream section (**Figure 3-37**). Shallow riffle and run habitats made up about 46 percent of the study reach length, and pools made up 40 percent (**Figure 3-38**). Cascades made up 13 percent, and step-run and step-pool habitats made up only about 1 percent of the study reach length. Pools were typically 15 to 25 ft wide and about 3 ft deep, with maximum depths varying from 1.6 ft to 8.7 ft in upstream bedrock cascade plunge-pool habitats **(Table 3-15**). Boulder and cobble substrates dominated 64 percent of the reach length, and bedrock substrate dominated 11 percent (**Figure 3-39**).

Table 3-15
Average Pool Width, Depth, and Substrate Distribution, Middle Salt Creek

					Areal Percentage of Substrate in Pool Bed							
Pool #	Station at Top of Pool (ft)	Elevation at Top of Pool (ft)	Maximum Depth (ft)	Average Width (ft)	BR (%)	Bo (%)	Co (%)	Gr (%)	Sa (%)	Si (%)	Org (%)	Total (%)
1	4+21	1,033	5.1	30	30	40		30				100
2	9+66	1,039	3.9	25	30	40		20		5	5	100
3	10+73	1,042	3.3	25	50	20	30					100
4	20+05	1,054	1.6	20		80	10	10				100
5	25+67	1,060	1.3	nd								
6	28+08	1,061	2.0	25	30	10		60				100
7	28+88	1,062	2.1	25	30	20		50				100
8	31+37	1,065	1.8	20		70	20	10				100
9	35+15	1,066	3.7	35	25	25	10	40				100
10	36+32	1,072	2.4	20		50	20	30				100
11	37+30	1,074	1.8	15	20	50	15	15				100
12	39+41	1,074	1.6	25	10	60	20	10				100
13	40+49	1,075	1.7	nd								
14	43+73	1,081	6.0	15	30	30	20	20				100
15	44+79	1,082	2.5	15		60	20	20				100
16	46+20	1,083	2.0	15	10	50	20	20				100
17	48+31	1,088	8.7	25	30	40	20	10				100

Note: *BR=bedrock, Bo=boulders, Co=cobbles, Gr=gravel, Sa=sand, Si=silt, Org=organic material

The grain size distribution of channel bed and bar framework materials in the inundated portion of the study reach appeared representative of bedload materials mobilized every 2 to 3 years, with median diameters ranging from 70 to 120 mm and averaging about 80 to 90 mm (**Table 3-16**). The grain size distribution of bed framework material was relatively uniform throughout the study reach, although substantially more mixed and less embedded with sand- and silt-sized sediments in the upstream portion of the study reach. Although there were few deposits of well-sorted gravel-sized sediment in the study reach, frequently mobilized bedload materials present on the bed generally fell into two distinct median-diameter classes, 50 mm and 15 mm. Dominant pool substrates were mixed and variable throughout the study reach with few obvious trends (**Table 3-15**).

Table 3-16
Summary of Channel Bed Material and Gravel Deposit Observations and Pebble Count Measurements, Middle Salt Creek
July 28-29, 2003

River Station (ft)	Elevation MSL (ft)	Material/ Deposit Type	Materia/ Deposit Location	Deposit Area (sq ft)	D_{84} (mm)	D_{50} (mm)	D_{16} (mm)	Embed-dedness
5+50	1,038	cobble bar	rt bk	na	130	95	--	high
10+20	1,043	pool tailout splay	rt bk	120	--	50	--	mod
14+60	1,050	bed surface	mid-ch in riffle	na	--	70	--	mod
17+00	1,052	bed framework	mid-ch in riffle	na	--	120	--	na
17+00	1,052	pocket gravels	mid-ch in riffle	na (numero us)	--	13	--	mod-high
24+00	1,058	bed surface	mid-ch	na	170	--	--	na
27+44	1,061	pool tailout splay	lt bk	50	20	3	--	mod
32+30	1,067	bed surface	mid-ch	na	110	--	--	na
32+30	1,067	pocket gravels	mid-ch	90	--	12	--	low
35+47	1,071	bed surface	(PC 1) mid-ch	na	238	67	6	na

The Middle Salt Creek study reach can be divided into two representative geomorphic subreaches. Reach 1 is a 1.0 percent slope plane-bed reach extending from the creek-lake interface through a portion of zone that is periodically inundated by the lake to Station 11+00 ft (elevation 1,046 ft msl). Reach 1 is dominated by shallow, boulder-bedded riffle-run habitats (Photo MSC-1) and short bedrock cascade–plunge pool sections near Station 3+50 ft and Station 10+50 ft (**Figure 3-63**). Typical bed and bar framework materials had an estimated median diameter of about 95 mm and were extensively embedded with silt- and sand-sized materials. Numerous small, poorly sorted and highly embedded gravel deposits were observed. One relatively well-sorted, moderately embedded gravel deposit was documented on the right bank immediately downstream from the bedrock plunge pool near Station 10+20 feet Pools in Reach 1 are controlled by locally steep bedrock cascades, and the low-flow discharge was sufficient to minimize fine sediment in pool substrates. There was almost no riparian vegetation in Reach 1. The channel was slightly entrenched, with a moderate width-to-depth ratio. Reach 1 would be classified as both "C2" according to the Rosgen channel classification scheme (Rosgen 1996) and "plane-bed" according to the Montgomery-Buffington classification scheme (Montgomery and Buffington 1993).

Reach 2 of the Middle Salt Creek study reach is a 1.0 percent slope plane-bed reach extending from Station 11+00 ft upstream to Station 28+38 feet This reach is similar in channel dimensions but more alluvial than Reach 1 and contains a limited number of shallow boulder- and sand-bedded pools, and a significantly greater density of early successional riparian vegetation (Photo MSC-2, Photo MSC-3). Cross-Section 1 surveyed at Station 14+46 ft (**Figure 3-40**) shows the typical form and dimensions of channel, bar, floodplain, and lake inundation terrace surfaces in Reach 2. Although Reach 2 has a slightly greater entrenchment and width-to-depth ratios, it shares the classifications of Reach 2 as “C2” and “plane-bed.”

Reach 3 of the Middle Salt Creek study reach is a 1.4 percent slope, 25- to 30-ft-wide bedrock and boulder-bed channel dominated by shallow boulder-cobble riffles and runs, short bedrock and boulder cascades and long, slow pools (Photo MSC-4). Cross-Section 3 surveyed at Station 35+47 ft shows typical channel bed and floodplain form in shallow boulder-cobble runs in Reach 3 (**Figure 3-41**). Pebble count 1 measured the grain size distribution of channel bed framework and matrix materials present at Cross-Section 3. The D_{84} was 238 mm and the D_{50} was 67 mm. The riparian corridor was narrow in Reach 3, with mixed conifer vegetation adjacent to the channel. This reach was moderately entrenched with a moderate width-to-depth ratio and would be classified as “B1c” and “plane-bed.”

Salt Creek

The Salt Creek watershed (**Figure 3-42**) drains an approximately 9.6-square-mile area and enters the Sacramento River Arm of Shasta Lake (see Atlas, Vol. IV, 1-18) about 9 miles NNE of Shasta Dam.. The watershed, including the study reach, is almost entirely underlain by the Paleozoic Bragdon shale and greywacke metasedimentary bedrock with minor conglomerate. The study reach for this assessment extended 5,376 river ft upstream from the downstream end of free-flowing Salt Creek, where it flows into an impoundment immediately upstream from the Interstate 5 fill prism (Photo STC-1). Using orthophoto-generated elevation data provided by Reclamation, the water surface elevation of the spillway-controlled impoundment was estimated to be 1,060 ft for the purposes of this assessment, or approximately 45.7 ft above the Shasta Lake water surface on October 2, 2003 (elevation 1,014.29 ft msl) (**Table 3-17**).

The study reach is a uniformly low-gradient (0.6 percent slope), single-thread, 30- to 50-ft wide pool-riffle channel that is primarily gravel bedded, transitioning into a wider cobble- and small boulder-bedded pool-riffle reach and then into a narrower bedrock and boulder-bed plane-bed channel near the U.S. Forest Service boundary near Station 47+00 ft (elevation 1,085 ft msl) and upstream (**Figure 3-43**). Almost half of the study reach length is made up of pool habitats and the other half is split between riffle and run habitats; the pool-riffle-run ratio was about 5:3:2 (**Figure 3-44**). There were no step-run, step-pool, cascade, or falls/step habitats in the study reach. Gravel- and sand-sized substrates dominated about 65 percent of the study reach, and only 32 percent was dominated by boulder and cobble substrates and 5 percent by bedrock (**Figure 3-45**), in approximately the same distribution as the representative geomorphic subreaches. Pool substrates were dominated by gravel and sand in the downstream half of the study reach and were increasingly coarse-bedded upstream from Station 39+00 ft (**Table 3-18**).

Table 3-17
Benchmark and Turning Point Marker Location and Elevations, Salt Creek
October 5, 2003

Turning Point Number	Station from Impoundment Water Surface (ft)	Approximate Elevation (ft)
Impoundment WSE	0+00	1060.00
TP1	17+32	1072.76
TP2	21+00	1073.22
TP3	23+59	1074.05
TP4	27+55	1077.94
TP5	33+87	1078.34
TP6	37+52	1080.86
TP7	42+10	1083.76
TP8	45+06	1085.63
TP9	49+11	1086.72
TP10	53+86	1093.07
	Reservoir Water Surface Elevation	1,014.29

Note: Downloaded from: http://cdec.water.ca.gov/cgi-progs/queryDaily SHS

Table 3-18
Average Pool Width, Depth, and Substrate Distribution, Salt Creek

					Area Percentage of Substrate in Pool Bed							
Pool #	**Station at Top of Pool (ft)**	**Elevation at Top of Pool**	**Maximum Depth (ft)**	**Average Width (ft)**	**BR (%)**	**Bo (%)**	**Co (%)**	**Gr (%)**	**Sa (%)**	**Si (%)**	**Org (%)**	**Total (%)**
1	3+76	1,056.79	3.3	18				60	20	5	15	100
2	6+11	1,058.44	2.7	12				60	20	10	10	100
3	6+99	1,058.83	1.3	9				85			15	100
4	8+60	1,060.55	2.2	15				65	20	10	10	100
5	9+60	1,060.48	2.8	15				70	20	10		100
6	10+10	1,061.02	1.5	14				75		15	10	100
7	10+73	1,062.52	3.0	15				75		15	10	100
8	11+32	1,062.76	2.3	11				70		20	10	100
9	11+81	1,063.00	1.8	13				70		20	10	100
10	13+08	1,063.45	1.8	11				70		20	10	100
11	14+59	1,064.04	3.4	16			45	35	10	5	5	100
12	16+49	1,064.85	1.1	12				75	25			100
13	17+30	1,065.91	2.6	15			45	35	15		5	100
14	18+91	1,066.83	2.8	25			20	80				100

Table 3-18
Average Pool Width, Depth, and Substrate Distribution, Salt Creek
(Continued)

					Area Percentage of Substrate in Pool Bed							
Pool #	**Station at Top of Pool (ft)**	**Elevation at Top of Pool**	**Maximum Depth (ft)**	**Average Width (ft)**	**BR (%)**	**Bo (%)**	**Co (%)**	**Gr (%)**	**Sa (%)**	**Si (%)**	**Org (%)**	**Total (%)**
15	20+18	1,063.74	5.1	25		20	10	70				100
16	21+87	1,066.69	3.5	20		10	30	60				100
17	24+29	1,067.82	3.6	25			20	60	20			100
18	26+25	1,069.57	1.5	20		10	50	40				100
19	28+82	1,069.49	2.7	30		5	15	60	20			100
20	33+07	1,070.78	3.0	25		5	15	60	20			100
21	36+55	1,073.66	2.7	25		10	10	70	10			100
22	39+31	1,075.48	3.3	20		35	25	35	5			100
23	41+05	1,075.72	1.7	20	5	70	5	15	5			100
24	44+13	1,078.29	2.0	20	40	20	20	10	10			100
25	46+75	1,079.56	5.7	nd	25	15	45		10	5		100

Note: *BR=bedrock, Bo=boulders, Co=cobbles, Gr=gravel, Sa=sand, Si=silt, Org=organic material

Bedrock pools were only partially covered with alluvial materials near the upstream end of the study reach. The bed was dominated by frequently mobilized bedload materials downstream from about Station 30+00. The median grain size of bed materials in riffles downstream from Station 30+00 ranged from 11 mm to 60 mm with a slight downstream fining trend, and averaged 29 mm (**Table 3-19**).

The study reach can be divided into three distinct and representative geomorphic subreaches. Reach 1 is a 0.6 percent slope gravel-bedded pool-riffle channel slightly to moderately incised within a wide floodplain evidently influenced by fluctuating water levels in the I-5 impoundment in conjunction with the fluctuating water-surface level of Shasta Lake. The downstream 376-ft-long reach was essentially flat-water habitat controlled by a functional beaver dam near Station 0+90 ft (Photo STC-2). With distance upstream from Station 3+76 ft, the bed is increasingly coarser and less embedded. The width and relative elevation of gravel bars increase markedly near Station 12+30 (Photo STC-3) (near elevation 1,069 ft msl), where there is evidence of distributary flood scour channels debouching onto the wide right-bank floodplain, presumed to be a function of the hydraulic control of the Interstate 5 impoundment. This appears to be one of the broadest areas of contiguous riparian habitat within the riverine reaches described in this report. Reach 1 is slightly entrenched, with a low width-to-depth ratio, and would be classified as an “E4” channel according to the Rosgen scheme and a “pool-riffle” stream using the Montgomery-Buffington system.

Reach 2 is a 0.6 percent slope pool-riffle reach that begins near Station 30+51 ft, where the median size of bed materials increases markedly and the valley width is more restricted than downstream (Photo STC-4). The channel in Reach 2 is moderately entrenched, with a moderate width-to-depth ratio and would be classified as a “B3” and “pool-riffle” stream reach. Reach 3 is a 0.6 percent slope

Table 3-19
Summary of Channel Bed Material and Gravel Deposit Observations and Pebble Count Measurements, Salt Creek
October 5, 2003

River Station (ft)	Approximate Elevation (ft)	Material/ Deposit Type	Material/ Deposit Location	Deposit Area (sq ft)	D_{84} (mm)	D_{50} (mm)	D_{16} (mm)	Embed-dedness
4+00	1061.32	ch bed surface	riffle	na	--	55	--	mod-high
4+31	1061.28	ch bed surface	riffle	na	--	11	--	mod-high
4+91	1061.23	ch bed surface	riffle	na	--	15	--	mod
5+35	1061.23	ch bed surface	riffle	na	--	13	--	mod
6+72	1062.85	ch bed surface	riffle	na	--	18	--	mod
7+18	1063.34	ch bed surface	riffle	na	--	25	--	mod
7+78	1065.46	ch bed surface	riffle	na	--	25	--	mod
7+95	1065.56	ch bed surface	riffle	na	--	22	--	mod
8+85	1064.01	ch bed surface	riffle	na	--	20	--	mod
9+79	1066.21	ch bed surface	riffle	na	--	24	--	mod
10+27	1065.52	ch bed surface	riffle	na	--	27	--	mod
10+88	1067.06	ch bed surface	riffle	na	--	28	--	mod
11+52	1067.31	ch bed surface	riffle	na	--	28	--	mod
12+27	1068.56	ch bed surface	riffle	na	--	30	--	mod
13+68	1067.06	ch bed surface	riffle	na	--	14	--	mod
15+50	1069.42	ch bed surface	riffle	na	--	50	--	mod
16+68	1070.88	ch bed surface	riffle	na	--	45	--	low-mod
25+03	1073.51	ch bed surface	riffle	na	--	60	--	low-mod
28+00	1073.01	ch bed surface	top of riffle	(PC 1)	118	60	25	low-mod
29+40	1074.76	ch bed surface	riffle	na	--	50	--	low-mod
38+93	1077.41	ch bed surface	run	na	--	110	--	low-mod
38+93	1077.41	pocket gr in run	mid-ch	na (numero us)	--	8	--	low-mod

boulder- and increasingly bedrock-bedded reach. It is increasingly confined along the right bank canyon wall and elevated forested terraces along the left bank (Photo STC-5). Reach 3 would be classified as “B1” and“B2” under the Rosgen classification scheme and “plane-bed” under the Montgomery-Buffington scheme.

Nosoni Creek

The Nosoni Creek watershed (**Figure 3-46**) drains an approximately 13.0-square-mile area and enters the McCloud River Arm of Shasta Lake (see Atlas, Vol. V, 1-17) about 17 miles northeast of Shasta Dam. The western portion of the watershed, including the study reach, is underlain by middle Pliocene tuffaceous mudstone and sandstone of the Nosoni Unit. The central portion of the watershed is underlain by mafic flows and tuff and lesser amounts of mudstone of the middle Pliocene Dekkas Unit. The entire upper watershed is underlain by Tertiary shale and siltstone and lesser amounts of limestone of the Pit Unit. A small outcropping of Pliocene quartz diorite occurs near the mouth of Nosoni Creek where it enters the McCloud River Arm of Shasta Lake downstream from the study reach. The study reach for this assessment (**Figure 3-46**) extended from Shasta Lake at 10:00 a.m. on July 20, 2003 (elevation 1,039.38 ft msl) to a permanent benchmark (BM-90) installed at Station 22+09 ft (**Table 3-20**). The measured discharge of Nosoni Creek within the ESL was 4.28 cfs on July 20, 2003 (**Table 3-**1).

Table 3-20
Benchmark and Turning Point Marker Location and Elevations, Nosoni Creek
July 20, 2003

Turning Point Number	Station from Reservoir Surface (ft)	Elevation Above MSL (ft)
RES WSE	0+00	1,039.38
TP1	7+06	1,056.54
TP2	10+27	1,065.52
TP3	13+12	1,071.20
TP4	15+43	1,078.49
TP5	17+69	1,087.10
TP6	20+21	1,095.28
BM-90	22+09	1,104.70
Reservoir Water Surface Elevation		1039.38

Note: Downloaded from http://cdec.water.ca.gov/cgi-progs/queryDaily SHS

In the study reach, Nosoni Creek is a 2.3 to 4.0 percent slope single-thread bedrock and boulder-bed channel confined within a 100- to 150-ft-wide moderately steep-sided canyon with narrow lateral boulder bars and narrow floodplains, where present (**Figure 3-47**). Bedrock and boulder-bedded cascades and runs and gravel-bedded pools form the majority of the channel bed. Overall, 37 percent of the study reach is cascade habitat and 33 percent is pool habitat (**Figure 3-48**). Riffles, step-runs, and step-pools make up less than 1 percent of the study reach. Twenty-one percent of the study reach is dominated by bedrock substrate, and 68 percent is dominated by boulders and cobbles (**Figure 3-49**). Fourteen percent of the channel bed is dominated by gravel, primarily in pool habitats. The wetted channel at low-flow is less than 10 ft wide in bedrock cascade reaches and 15- to 35-ft wide in many long shallow pools in the upstream bedrock-dominated portion of the reach (**Table 3-21**).

Table 3-21
Average Pool Width, Depth, and Substrate Distribution, Nosoni Creek

					Areal Percentage of Substrate in Pool Bed							
Pool #	**Station at Top of Pool (ft)**	**Elevation at Top of Pool (ft)**	**Maximum Depth (ft)**	**Average Width (ft)**	**BR (%)**	**Bo (%)**	**Co (%)**	**Gr (%)**	**Sa (%)**	**Si (%)**	**Org (%)**	**Total (%)**
1	3+03	1,045.40	3.5	nd								
2	6+96	1,053.73	4.1	nd								
3	9+16	1,058.08	2.7	nd								
4	10+88	1,062.18	4.0	nd								
5	14+15	1,070.24	3.6	nd								
6	15+35	1,074.53	4.0	nd								
7	16+56	1,080.70	4.2	25	20	40		40				100
8	17+49	1,084.44	2.0	35	30	30		40				100
9	20+21	1,091.33	3.9	14	50	30		20				100
10	21+60	1,097.97	5.9	nd								

Note: *BR=bedrock, Bo=boulders, Co=cobbles, Gr=gravel, Sa=sand, Si=silt, Org=organic material

The grain size distribution of channel bed framework materials was generally mixed and extremely variable in the study reach. Bed framework materials in the inundated portion of the study reach were uniformly sized and appeared representative of bedload materials mobilized every 2 to 3 years, with median diameters ranging from 80 to 150 mm and averaging about 95 to 100 mm (**Table 3-22**). The presence of numerous very large colluvial boulders, bedrock outcrops, or very irregular bedrock bed boundaries generally controls the location and size of alluvial materials. Cascade habitats were generally bedrock bedded with large boulder substrates and numerous pocket gravels deposited in boulder lees and as pool tailout splays along channel margins. Run habitats were generally small boulder and cobble bedded and interspersed with very large colluvial boulders and numerous pocket gravel deposits along irregular channel margin boundaries. Field observations indicated that pools were almost entirely gravel-bedded with well-sorted gravel-sized substrates upstream from Station 9+66 ft and poorly-sorted and grading to sand-sized sediments with sand-sized veneers in pools within the inundated reach. Pools in the upstream portion of the study reach were primarily bedrock and boulder-bedded with partial coverage by clean gravel substrates as tailout deposits and splays on either channel margin (**Table 3-21**). The size distribution of well-sorted gravels in the upstream pools was similar to the size distribution of pocket gravels (**Table 3-22**), and appeared representative of frequently (i.e., annually) mobilized bedload materials. Photo NC-1 shows a shallow pocket gravel deposit near Station 11+35 ft (elevation 1,067 ft msl) composed of the two distinct populations. Pebble Count 1 estimated that the median diameter (D_{50}) of the finer bedload population was about 19 mm, similar to the size of materials dominating pool substrates (**Table 3-22**). Pebble Count 2 estimated that the D_{50} was about 43 mm, similar to the size of perched pocket gravels along channel margins elsewhere in the study reach. Nosoni Creek appeared to have the greatest amount of pocket gravels and well-sorted gravel-sized bed sediment of all of the riverine reaches assessed in this study, probably reflecting greater overall supply of gravel-sized sediment.

Table 3-22
Summary of Channel Bed Material and Gravel Deposit Observations and Pebble Count Measurements, Nosoni Creek
July 20, 2003

River Station (ft)	Elevation MSL(ft)	Material/Deposit Type	Material/Deposit Location	Deposit Area (sq ft)	D_{84} (mm)	D_{50} (mm)	D_{16} (mm)	Embed-dedness
4+80	1,051	bed framework	mid-ch in run	na	--	100	--	high
4+80	1,051	pocket gravel	mid-ch in run	numerous	--	25	--	high
8+90	1,059	bed surface	mid-ch in pool	~1800	--	6	--	high
9+80	1,062	pocket gravel	rt bk bar	120	--	15	--	low-mod
9+70	1,062	pocket gravel	lt bk ch margin	60	--	15	--	low-mod
10+25	1,062	bed surface	mid-ch in pool	~3000	45	25	6	low-mod
10+50	1,063	pocket gravel	rt bk ch margin	90	45	25	10	low
10+60	1,063	pocket gravel	rt bk ch margin	80	35	20	10	low
11+00	1,066	pocket gravel	lt bk bar	170	75	35	20	low
11+35	1,067	pocket gravel	lt bk bldr lee	60	40	22	8	low
14+00	1,072	pocket gravel	rt bk bldr lee	150	75	45	20	low
16+20	1,082	pocket gravel	(PC 1) rt bk bldr lee	120	33	19	8	low
16+20	1,083	pocket gravel	(PC 2) rt bk bldr lee	90	77	43	22	low
19+70	1,095	pocket gravel	lt bk ch margin	130	60	35	15	low

The study reach can be delineated into three representative geomorphic subreaches. Reach 1 is an inundated reach with a 2.3-percent-slope ch extending upstream to Station 13+66 feet Reach 1 is a 20- to 25-ft wide plane-bed reach dominated by long, shallow boulder-bedded runs and short riffles, with narrow boulder bars composed of similar sized materials (Photo NC-2). Although low-flow discharge was sufficient to transport fine materials from the center of the channel, channel bed margins, and boulder bar surfaces, extensive embeddedness was observed on the alluvial features along the channel margins. Cross-Section 1 surveyed at Station 4+81 ft illustrates channel form and dimensions in the downstream portion of Reach 1 (**Figure 3-50**). Reach 1 is virtually devoid of woody riparian vegetation downstream from about Station 5+50 ft (elevation 1,052 ft msl). **Figure 3-51** and **Figure 3-52** illustrate channel form and dimensions in the upper portion of Reach 1. Photo NC-3 shows highly embedded pool substrate conditions near Cross-Section 3 at Station 8+94 ft (elevation 1,059 ft msl). Upstream from about Station 9+66 ft (elevation 1,063 ft msl), substrate embeddedness decreases significantly, and the density and maturity of riparian vegetation increase significantly. Reach 1 would be classified as both “B2” according to the Rosgen channel classification scheme (Rosgen 1996) and “plane-bed” according to the Montgomery-Buffington classification scheme (Montgomery and Buffington 1993).

Reach 2 is a 4.0-percent-slope bedrock and boulder-bed cascade reach interspersed with relatively shallow plunge pools and runs (Photo NC-4). Cross-Section 4 surveyed at Station 18+80 ft shows representative channel form and dimensions in a section of Reach 2 extending from about Station 18+00 to about Station 20+00 that is locally wider and contains extensive and recently scoured boulder bar deposits (**Figure 3-53**). A lack of low-gradient plane-bed conditions and long pool habitats limits the presence of gravel-sized sediments to numerous pocket gravel deposits in boulder lees and channel margins (**Table 3-22**). Reach 2 would be classified as "B1a" according to the Rosgen channel classification scheme and "cascade" according to the Montgomery-Buffington scheme.

Dekkas Creek

The Dekkas Creek watershed (**Figure 3-54**) drains an approximately 3.8-square-mile area and enters the McCloud River Arm of Shasta Lake (see Atlas, Vol. V, 1-13) about 15.5 miles northeast of Shasta Dam. The majority of the watershed, including the study reach, is underlain by middle Pliocene tuffaceous mudstone and sandstone of the Nosoni unit, and the upper eastern portion of the watershed is underlain by mafic flows and tuff and lesser amounts of mudstone of the Dekkas Unit of the same age. There are small portions of quartz diorite and McCloud limestone on the western side of the watershed where Dekkas Creek enters the McCloud River Arm of Shasta Lake. The study reach for this assessment (**Figure 3-54**) extended from Shasta Lake on July 19, 2003 (elevation 1,039.91 ft msl) to a permanent benchmark (BM-92) installed at Station 13+38 ft (**Table 3-23**). The measured discharge of Dekkas Creek within the ESL at Station 8+30 ft was 0.86 cfs at 14:30 July 19, 2003 (**Table 3**-1).

Table 3-23
Benchmark and Turning Point Marker Location and Elevations, Dekkas Creek
July 19, 2003

Turning Point Number	Station from Reservoir Surface (ft)	Elevation Above MSL (ft)
RES WSE	0+00	1,039.91
TP1	5+26	1,059.06
TP2	7+33	1,068.81
TP3	8+66	1,073.80
TP4	9+73	1,081.11
TP5	11+81	1,093.99
BM-92	13+38	1,103.16
Reservoir Water Surface Elevation	1,039.91	

Note: Downloaded from: http://cdec.water.ca.gov/cgi-progs/queryDaily?SHS

Dekkas Creek in the study reach is a 3.7 to 6.4 percent slope 25- to 35-ft wide bedrock and boulder-bed channel dominated by shallow boulder-bedded riffle-run sequences in the moderately steep downstream reach and bedrock cascade-plunge pool sequences in the steep upper reach (**Figure 3-55**). The channel is confined throughout the lower reach by fine-grained terrace deposits resulting from Shasta Lake inundation and backwater effects, and throughout the upper reach by bedrock canyon walls and debris-flow lag deposits. Fifty-three percent of the study reach is made up of cascade and falls/step habitat (**Figure 3-56**). Thirty-seven percent of the bed is dominated by bedrock substrates (**Figure 3-57**). Together, cascade/falls/step and pool habitats make up 85 percent of the study reach. The lower 541-ft-long section of the study reach was dry, and aquatic habitat was not delineated for this reach or included in the habitat distribution results. Most pools were associated with steep bedrock cascade-plunge pool sequences in the upper portion of the study reach (**Table 3-24**). Pool substrates were strongly dominated by clean bedrock, averaging more than 60 percent of pool substrate area in the upstream portion of the study reach, with only patchy coverage by boulders and lesser amounts of cobble and gravel. Bed framework materials were dominated by medium-sized boulders with a median diameter (D_{50}) of about 130-160 mm throughout the study reach (**Table 3-25**). Pocket gravel deposits were numerous but very small, with the largest deposits of gravel-sized sediment at the point bar deposit near Station 8+15 ft (elevation 1,072 ft msl), which is influenced by lake sedimentation, and a channel margin pocket gravel deposit near Station 10+54 feet.

Table 3-24
Average Pool Width, Depth, and Substrate Distribution, Dekkas Creek

					Areal Percentage of Substrate in Pool Bed							
Pool #	**Station at Top of Pool (ft)**	**Elevation at Top of Pool (ft)**	**Maximum Depth (ft)**	**Average Width (ft)**	**BR (%)**	**Bo (%)**	**Co (%)**	**Gr (%)**	**Sa (%)**	**Si (%)**	**Org (%)**	**Total (%)**
1	6+79	1,064.20	1.3	12								
2	7+61	1,067.99	1.5	nd								
3	8+36	1,070.16	1.9	nd								
4	9+24	1,072.84	1.9	nd								
5	9+72	1,078.35	2.8	13	50	50						100
6	9+90	1,080.44	1.3	12	50	30		20				100
7	10+18	1,080.95	1.3	10	80	20						100
8	10+60	1,082.59	2.1	8	80		10	10				100
9	11+33	1,086.11	3.6	20	90	5		5				100
10	12+34	1,094.17	1.9	12	30	50	20					100

Note: *BR=bedrock, Bo=boulders, Co=cobbles, Gr=gravel, Sa=sand, Si=silt, Org=organic material

Table 3-25
Summary of Channel Bed Material and Gravel Deposit Observations and Pebble Count Measurements, Dekkas Creek
July 19, 2003

River Station (ft)	Elevation MSL (ft)	Material/ Deposit Type	Material/ Deposit Location	Deposit Area (sq ft)	D_{84} (mm)	D_{50} (mm)	D_{16} (mm)	Embed-dedness
4+00	1,052	bed framework	ch bed	na	--	130	--	high
8+15	1,072	point bar	left bank	~1300	--	60	--	low
9+50	1,076	pocket gravels	ch bed	numerous x 5-10	--	8	--	low
10+25	1,081	pocket gravels	ch bed	numerous x 5-10	--	10	--	low
10+45	1,083	pocket gravel	lt bk ch margin	50	--	30	--	low
14+50	~1,115	bed framework	ch bed	na	--	160	--	na

The study reach can be divided into two representative geomorphic subreaches. Reach 1 is a 3.7 percent slope 25- to 35-ft wide boulder-bed channel extending from Shasta Lake upstream to about Station 8+66 ft near elevation 1,072 ft (Photo DC-1). In the downstream 550-ft portion of Reach 1, Dekkas Creek is plane-bed and cut in a broad deposit of coarse gravel- and sand-dominated materials resulting from periodic inundation by Shasta Lake, creating elevated terraces flanking the channel on both sides (Photo DC-2). Cross-Section 1 shows channel bed, bar, and terrace form and dimensions at Station 3+72 ft (**Figure 3-58**), where Dekkas Creek is moderately entrenched in the lake delta deposits and has a low width-to-depth ratio. The channel bed was dry on July 19 up to approximately Station 5+40 ft, upstream from which young woody riparian vegetation (primarily willows) was established on boulder bar surfaces near the water's edge and young willows and alders and a few mature alders were established on the higher channel banks and on top of fine-grained terraces on both sides of the channel. Cross-Section 2 surveyed upstream at Station 7+94 ft transects the broad fine-grained right bank terrace near its upstream end (**Figure 3-59**). The Dekkas Creek canyon begins to narrow rapidly upstream from the area of Cross-Section 2 (Photo DC-1) and becomes extremely confined by a nearly vertical bedrock canyon wall along the right bank and debris flow deposits and resulting forested elevated terraces and irregular near-channel lag materials along the left bank. Cross-Section 3 surveyed at Station 8+15 ft (**Figure 3-60**) illustrates channel and bar form and dimensions at the upstream end of Reach 1, where a broad, stable, moderately embedded gravel-dominated point bar is established that has been colonized by a dense, uniform-age stand of alders. Reach 1 is moderately entrenched with an average ratio of 1.8. Recognizing that the moderate entrenchment ratio is the result of lake sedimentation effects, Reach 1 is classified in this assessment as a “G2” and “plane-bed” stream reach.

Reach 2 is a 6.4 percent slope 25- to 35-ft-wide bedrock and boulder-bed channel dominated by long bedrock cascade-plunge pool sections and shorter intervening shallow plane-bed boulder-bed pool-riffle-run sequences with exposed boulder bars and numerous but small pocket gravel deposits (Photo DC-3). Cross-Section 4 surveyed at Station 9+52 ft (**Figure 3-61**) shows typical channel bed form and confinement in Reach 4, with confinement by a near-vertical bedrock canyon wall along the right bank and by scoured debris flow deposits and resulting forested elevated terraces and irregular near-channel lag materials along the left bank. The percentage coverage and depth of coarse debris flow lag materials and resulting dominance of boulder-cascade and step-pool habitats increase dramatically upstream from the study reach (Photo DC-4).

Campbell Creek

The Campbell Creek watershed (**Figure 3-62**) drains an approximately 4.8-square-mile area situated immediately to the south of Dekkas Creek in the central portion of the ESL and enters the McCloud River Arm of Shasta Lake (see Atlas, Vol. V, 1-10) about 15 miles northeast of Shasta Dam). Nearly the entire watershed, including the study reach, is underlain by tuffaceous mudstone and sandstone of the middle Pliocene Nosoni Unit. A small area of McCloud limestone outcrops along the southwestern watershed boundary.. The study reach for this assessment (**Figure 3-62**) extended from Shasta Lake on July 21, 2003 (elevation 1,038.66 ft msl) to Station 17+57 ft (**Table 3-26**). The measured discharge of Campbell Creek within the ESL was 0.85 cfs on July 21, 2003 (**Table 3-**1).

Table 3-26 Benchmark and Turning Point Marker Location and Elevations, Campbell Creek July 21, 2003		
Turning Point Number	**Station from Reservoir Surface (ft)**	**Elevation Above MSL (ft)**
RES WSE	0+00	1,038.66
TP1	4+00	1,055.26
TP2	7+16	1,060.92
TP3	10+32	1,069.99
TP4	12+99	1,077.82
TP5	14+94	1,082.17
TP6	16+26	1,087.97
TP7	17+57	1,092.53
TP8	19+78	1,101.25
BM-84	22+86	1,111.00
Reservoir Water Surface Elevation		1,038.66

Note: Downloaded from: http://cdec.water.ca.gov/cgi-progs/queryDaily SHS

The study reach is an almost uniformly 3.6 percent slope 40- to 50-ft-wide bedrock and boulder-bed stream dominated by cascade-plunge pool and shallow riffle-run sequences (**Figure 3-63**, Photo CC-1). Forty-percent of the study reach aquatic habitat was cascade and falls/step, twenty-six percent pool, and 34 percent riffle-run, with no step-run or step-pool habitats identified (**Figure 3-64**). Bedrock substrates dominated 11 percent of the study reach length, and boulders and cobbles 75 percent, with the remaining eight percent gravel substrates (**Figure 3-65**). Pools were typically 12- to 15-ft wide and relatively shallow, not exceeding 3.0 ft, with mixed substrates from clean bedrock to gravel-sized sediment (**Table 3-27**). There were no significant trends in dimensions or substrate evident along the study reach length.

Table 3-27 Average Pool Width, Depth, and Substrate Distribution, Campbell Creek												
					Areal Percentage of Substrate in Pool Bed							
Pool #	**Station at Top of Pool (ft)**	**Elevation at Top of Pool (ft)**	**Maximum Depth (ft)**	**Average Width (ft)**	**BR (%)**	**Bo (%)**	**Co (%)**	**Gr (%)**	**Sa (%)**	**Si (%)**	**Org (%)**	**Total (%)**
1	7+96	1,057.32	3.0	nd								
2	11+33	1,068.97	1.0	nd								
3	11+79	1,070.20	1.0	11	30	20	10	40				100
4	12+82	1,073.72	2.5	13	10	40		50				100
5	13+45	1,076.55	1.3	nd								
6	17+37	1,088.66	2.3	17	10	40	30	20				100
7	19+18	1,097.03	2.0	15		50	20	30				100
8	19+73	1,099.57	1.5	nd								
9	20+38	1,100.45	2.8	12		60	10	30				100
10	21+10	1,104.55	2.2	13	10	40	20	30				100

Note: *BR=bedrock, Bo=boulders, Co=cobbles, Gr=gravel, Sa=sand, Si=silt, Org=organic material

Alluvial bed and bar framework deposits were nearly continuous and contained mixed grain sizes dominated by medium boulders with 84th percentile and median grain sizes ranging from 120 to 280 mm and 75 to 105 mm, respectively (**Table 3-28**). These materials were not significantly colonized by riparian vegetation and appeared to be mobilized about every 2 to 3 years. Deposits of annually mobilized bedload materials appeared to be composed of two distinct size classes, with median diameters of 8 to 10 mm and 40 to 50 mm. Pocket gravel deposits were both more numerous and substantially less embedded upstream from Station 8+97 ft near a steep riffle habitat occurring between elevation 1,061 and 1,068 ft msl (**Figure 3-63**).

Table 3-28
Summary of Channel Bed Material and Gravel Deposit Observations and Pebble Count Measurements, Campbell Creek
July 30, 2003

River Station (ft)	Elevation MSL (ft)	Material/ Deposit Type	Material/ Deposit Location	Deposit Area (sq ft)	D_{84} (mm)	D_{50} (mm)	D_{16} (mm)	Embed-dedness
3+50	1,051	bed framework	ch bed	na	280	105	--	high
4+00	1,053	pocket gr	ch bed	few x 5-10	--	8-10	--	high
5+75	1,060	pocket gr	ch bed	numerous x 5	--	<4	--	mod
8+00	1,061	bed framework	ch bed	na	120	75	25	high
10+00	1,067	bed framework	mid-ch in riffle	na	--	95	--	low
10+00	1,068	bar framework	point bar	180	--	85	--	low
10+00	1,068	pocket gr	on bar	30	--	15	--	low
10+00	1,068	pocket gr	on bar	20	--	40	--	low
10+50	1,069	pocket gr	ch bed	numerous x 10-20	--	20	--	low
12+55	1,072	pocket gr	rt ch margin	60	28	18	8	low
18+50	1,095	boulder bar	mid-ch	~5000	170	95	--	low

By virtue of its nearly uniform slope and canyon width, Campbell Creek in the study reach could reasonably be considered one indivisible geomorphic subreach. Notably, there were two stream sections with distinct geomorphic conditions that would not be considered individual subreaches because they were not substantially longer than 5 to 7 channel widths. These were the 285-ft-long 0.1 percent slope shallow pool habitat between Station 6+12 ft and 8+97 ft evidently affected by Shasta Lake inundation and backwater effects (Rosgen channel type “B1c”), and the 112-ft-long boulder bar emplaced between Station 17+56 ft and 18+68 feet However, for the purposes of this assessment, the study reach can be divided into two geomorphic subreaches to reflect the significant difference in riparian vegetation density and bed substrate embeddedness downstream and upstream from Station 8+97 near a range of elevations between 1,061 ft and 1,067 ft msl (**Figure 3-63**). Accordingly, Reach 1 is a 3.6 percent bedrock and boulder-bed stream reach extending from Shasta Lake upstream to Station 8+97 ft, with partially eroded elevated fine-grained terrace deposits flanking the channel on the left bank downstream from Station 6+12 ft (Photo CC-2) and a section of flat shallow pool habitat with wide overbank areas (Photo CC-3) between Station 6+12 ft and 9+87 ft (elevation 1,061 ft). Cross-Section 1 surveyed at Station 3+38 ft shows channel bed, bar, and terrace form and dimensions in the lower portion of Reach 1 (**Figure 3-66**). The terrace remnant forming the left bank was evidently eroded at least 10 lateral ft between the Reclamation orthophoto flight date and the July 2003 field survey, suggesting that the channel width in Reach 1 is cyclic in response to periodic lake sedimentation. The channel in Reach 1 was entrenched with a low width-to-depth ratio and can be classified "G1" or "G2" using the Rosgen classification and "plane-bed" using the Montgomery-Buffington classification.

Reach 2 is a 3.6 percent slope boulder-bed stream reach that appears representative of pre-Shasta Lake conditions in the entire study reach (Photo CC-1). Cross-Section 2 surveyed at Station 13+32 illustrates typical channel bed and bar form in Reach 2 (**Figure 3-67**). A local bedrock-controlled valley constriction near Station 17+56 ft produces an elevated mid-channel boulder bar deposit immediately upstream and extending up to Station 18+68 feet Mature alders on the boulder bar deposit indicate that it was completely scoured and emplaced several decades ago (Photo CC-4). Campbell Creek is dry upstream from the permanent benchmark established at the upstream end of the survey at Station 22+68 ft (elevation 1,111.00 ft msl), with all of the flow (about 0.85 cfs) contributed by a narrow steep tributary on the right (north) bank. The channel in Reach 2 was entrenched with a low width-to-depth ratio and can be classified "G2" using the Rosgen classification and "plane-bed" using the Montgomery-Buffington classification.

Squaw Creek

The Squaw Creek watershed (**Figure 3-68**) drains a 57.8-square-mile area and enters the Squaw Creek Arm of Shasta Lake about 17 miles ENE of Shasta Dam (see Atlas, Vol. VI, 1-8). There are six major geologic units underlying the Squaw Creek watershed trending north to south. The middle Pliocene Dekkas unit underlies the western edge of the watershed. To the east, the Triassic Pit metasedimentary shale and siltstone outcrops in the channel bed and canyon walls throughout the study reach. Further east, Squaw Creek intersects two thin units of Triassic age: a fossiliferous Hosselkus limestone and the Brock argillite. Upstream and to the east of these units, the stream dissects andesitic, volcaniclastic, and pyroclastic rocks of the Modin unit, also of Triassic age. The most eastern geologic unit consists of the Jurassic metasedimentary Potem unit composed of argillite and tuffaceous sandstone. The study reach for this assessment (**Figure 3-69**) extended from Shasta Lake on July 14, 2002 (elevation 1,025.79 ft msl) upstream to river Station 64+42 ft at elevation 1,096.23 ft msl **(Table 3-29)**.

The study reach is a 1.1 percent slope 30- to 50-ft wide channel confined within a narrow bedrock canyon (**Figure 3-69**). The majority of the study reach is dominated by long, deep, slow sand-bedded pools between short bedrock steps and cascades. Fifty-two percent of the study reach is made up of pool habitat (**Figure 3-70**), and 39 percent of the bed is dominated by sand-sized substrates (**Figure 3-71**). Virtually all sand-dominated substrates were found in pools. Pool widths ranged from 16 to 62 ft and averaged about 35 ft, and Pool depths ranged from 2 to 8 ft and averaged 5 ft (**Table 3-30**). Maximum pool depths ranged from 2.5 to 15 ft and averaged about 8 feet. Sand-sized substrates dominated an average of 48 percent of all pool substrates, with silt and organic materials at 6 and 1 percent, respectively. Coarser materials and bedrock (3 percent) made up the balance of pool

Table 3-29
Benchmark and Turning Point Marker Locations and Elevations, Squaw Creek
July 14-16, 2002

Turning Point Number	Station from Reservoir Surface (ft)	Elevation Above MSL (ft)
RES WSE	0+00	1,025.79
TP1	na	na
TP2	4+38	1,028.23
TP3	8+20	1,027.50
TP4	11+06	1,028.33
TP5	18+78	1,036.31
TP6	20+86	1,036.08
TP7	27+42	1,048.97
TP8	31+15	1,049.04
TP9	34+32	1,057.85
TP10	34+68	1,057.93
TP11	38+58	1,066.45
TP12	41+41	1,073.33
TP13	na	na
TP14	46+23	1,078.88
TP15	49+94	1,080.68
TP16	56+07	1,088.48
TP17	59+57	1,092.38
TP18	64+32	1,098.68
Reservoir Water Surface Elevation		1,025.79

Notes: Downloaded from: http://cdec.water.ca.gov/cgi-progs/queryDaily SHS

substrates. Long sand-bedded step-pool reaches are mixed with boulder-bedded riffle-run, cascade-run, and step-run reaches with lateral bars. Locally, coarse colluvial materials and lag deposits create short cascades and irregular channel bank surfaces. The lag deposits create narrow, relatively stable benches along canyon edges in straight reaches that trap large cobble and smaller alluvial material, and support mature woody riparian vegetation above the reservoir-influenced zone. Colluvial lag near the water surface elevation creates complex edgewater “boulder garden” habitat with dense cover provided by sedge (*Carex* spp.). Pool tailouts and riffle heads were often dominated by medium to fine gravel and provided what appeared to be suitable spawning habitat at low-flow discharge (**Table 3-31**). A natural bedrock step at long profile station 39+58 ft (elevation 1,065 ft) creates a 10-ft high cascade reach that appears to be an obstacle to upstream fish migration. Salt Creek enters Squaw Creek at Station 59+07 ft (elevation 1,091 ft msl), about 50 ft upstream from the 1,090-ft-ESL boundary.

By virtue of its relatively uniform slope, punctuated by short bedrock falls/step elevation drops, this reach could reasonably be considered one indivisible geomorphic subreach classified as a “G1c” channel using the Rosgen classification scheme. However, for the purposes of this assessment and considering the gradient of riparian vegetation, bed alluviation, and substrate embeddedness present in the study reach as a result of cyclic inundation by Shasta Lake, the study reach can be divided into five subreaches (**Figure 3-69**). All of the subreaches are entrenched with low width-to-depth ratios and could be classified as “G1c” channel types, except Reach 4, with its local 2.5 percent slope. Furthermore Reach 5 could reasonably be considered a “G2c” channel type as well as “G1c” with its increased presence of boulder-bedded step-run and riffle-run-pool sequences between isolated bedrock outcrops.

Reach 1 is a 0.4 percent slope bedrock and boulder-bedded channel extending from Shasta Lake up to Station 12+94 feet The entire 35- to 45-ft wide active channel width in the lower 400- to 500-ft long section of Reach 1 (photo SQC-1) is alluviated and mildly sinuous with shallow plane-bed conditions, alternating bars, and highly embedded substrates typical of conditions suggested in a review of the digital orthophotographs of Squaw Creek used in the Atlas. A pebble count of the bar surface at Station 1+30 ft shows some similarity to other pebble counts measured throughout the reach. The exception was the addition of fine sediments dominating the surface matrix and veneer (**Table 3-31**). Massive alluviation in the downstream portion of Reach 1 accounts for its locally decreased channel bed slope compared to likely pre-Shasta Lake conditions. Cross-Section 1 (**Figure 3-72**) and Cross-Section 2 (Figure-73) illustrate channel form and dimensions in Reach 1 (Photo SQC-2). There was no riparian vegetation present in Reach 1, and the bed and bar materials were moderately to highly embedded with fine matrix and veneer materials. Reach 2 is a 1.3 percent slope bedrock and colluvial boulder-dominated reach extending upstream to a massive colluvial boulder deposit and resulting cascade-pool section near Station 22+96 feet Cross-Section 3 and Cross-Section 4 (**Figure 3-74**) illustrate channel form and dimensions in Reach 2. There was no riparian vegetation present in Reach 2, and bar materials were moderately to highly embedded with fine matrix and veneer materials.

Reach 3 is a 0.4 percent slope reach composed entirely of a sequence of deep, slow sand-bedded pools. A broad gravel-bedded pool tailout near the downstream end is controlled by colluvial boulder deposits at the upstream end of Reach 2. Pebble count results on the bed surface at a pool tailout-riffle head section near Station 27+10 ft (elevation 1,045 ft msl) were similar to other deposits throughout the study reach, but with the addition of a moderate amount of fine sediments dominating the surface matrix and veneer **(Table 3-31)**.

Reach 4 is a 2.5 percent slope reach made up of long, deep, slow sand- and gravel-bedded pools and relatively long, steep boulder-cascade sections situated within two prominent channel bends with point bars along inside bends. Cross-Section 6 (**Figure 3-75**) shows channel bed and bar conditions at a bend and point bar in Reach 4. Exposed bar surfaces in Reach 4 were colonized nearly uniformly by sparse stands of young, even-aged willows. Pebble count results showed that the median diameter of coarse alluvial materials on the point bar surface at Cross-Section 6 (elevation 1,059 ft msl) was about 162 mm, with low embeddedness by fine sediments and no presence of a fine sediment veneer (**Table 3-31**). Another pebble count measurement in Reach 4 at a pool tailout-riffle head deposit at Station 42+00 ft (elevation 1,071) determined that the 84th, 50th, and 16th percentile diameters were 195 mm, 106 mm, and 43 mm, respectively.

Reach 5 is a 1.0 percent slope reach dominated by long sand- and gravel-bedded bedrock pools in the downstream portion of the reach, transitioning to more boulder-dominated step-run and riffle-run

Table 3-30
Average Pool Width, Depth, and Max Pool Width and Depth, Squaw Creek

							Areal Percentage of Substrate in Pool Bed							
Pool #	**Station at Top of Pool (ft)**	**Elevation at Top of Pool (ft)**	**Maximum Depth (ft)**	**Average Depth (ft)**	**Average Width (ft)**	**Max Wetted Width (ft)**	**BR (%)**	**Bo (%)**	**Co (%)**	**Gr (%)**	**Sa (%)**	**Si (%)**	**Org (%)**	**Total (%)**
1	5+90	1,025.78	2.5	2.0	26	33	5	5	5	5	40	30	10	100
2	11+07	1,025.53	7.5	5.0	33	33	5	5	5	5	50	25	5	100
3	16+24	1,032.44	4.0	3.0	33	33	0	25	20	20	15	20	0	100
4	21+21	1,033.39	5.0	3.0	39	46	0	30	15	5	40	0	0	100
5	22+41	1,037.69	4.8	4.0	39	48	5	60	15	5	5	0	0	100
6	25+33	1,042.60	7.0	3.5	52	59	0	5	5	40	45	5	0	100
7	30+70	1,043.80	12.0	7.5	42	65	0	20	5	10	50	15	0	100
8	32+94	1,042.29	7.5	7.5	30	40	0	10	5	5	70	10	0	100
9	39+33	1,053.79	14.0	8.0	39	52	0	20	25	30	10	0	0	100
10	47+42	1,073.98	15.0	7.5	39	52	0	0	5	20	65	0	0	100
11	48+82	1,064.93	14.0	6.5	62	72	0	0	5	25	70	0	0	100
12	50+87	1,077.88	2.5	2.5	26	26	5	25	5	10	55	0	0	100
13	56+57	1,085.28	7.5	4.8	34	52	10	10	5	15	60	0	0	100
14	58+97	1,083.88	6.0	3.0	37	37	5	25	5	5	55	0	0	100
15	60+82	1,088.28	7.0	5.0	30	33	0	20	0	5	75	0	0	100
16	61+82	1,090.28	4.0	2.5	16	16	5	30	5	10	55	0	0	100
17	63+42	1,090.03	9.0	5.5	31	33	10	25	5	10	50	0	0	100
18	64+22	1,085.63	8.0	4.8	20	35	5	30	10	5	50	0	0	100

Note: BR=bedrock, Bo=boulders, Co=cobbles, Gr=gravel, Sa=sand, Si=silt, Org=organic material

Table 3-31
Summary of Channel Bed Material and Gravel Deposit Observations and Pebble Count Measurements, Squaw Creek
July 14-16, 2003

River Station (ft)	Elevation MSL (ft)	Material/ Deposit Type	Material/ Deposit Location	Deposit Area (sq ft)	D_{84} (mm)	D_{50} (mm)	D_{16} (mm)	Embed-dedness
1+30	1,024	lateral bar	(PC 1) rt bk	na	126	56	<8	high
13+20	1,029	lateral bar	(PC 3) rt bk	na	185	102	<8	mod
19+70	1,032	lateral bar	(PC 4) lt bk	na	91	<8	<8	high
27+10	1,045	ch bed	(PC 5) mid-ch in riffle	na	138	47	9	mod
34+30	1,056	point bar	(PC 6) lt bk	na	BR	162	57	low
42+00	1,071	ch bed	(PC 7) mid-ch in riffle	na	195	106	43	low
47+90	1,078	ch bed	(PC 8) mid-ch in riffle	na	179	72	22	low

pool habitats in the relatively straight upper section of the reach, terminating upstream from the ESL boundary. Cross-Section 8 (**Figure 3-76**) shows channel bed and bar conditions in a partially gravel-bedded pool in the downstream section of the reach, and Cross-Section 10 (**Figure 3-77**) shows channel bed and bar conditions in a run habitat immediately downstream from the Salt Creek tributary inlet near the upstream end of Reach 5. The presence of nearly continuous boulder- and cobble-dominated bars lining both canyon walls in the upstream, straight portion of Reach 5 coincides with a significantly increased presence of dense mature riparian vegetation, dominated by alder, ash, and maple.

Flat Creek

Flat Creek watershed (**Figure 3-78**) drains an approximately 5.5-square-mile area situated in the eastern portion of the ESL and enters the Pit River Arm of Shasta Lake about 20.5 miles ENE of Shasta Dam (see Atlas, Vol. VII, 19). The entire central and eastern portion of the watershed including the study reach is underlain by the Modin andesitic volcaniclastic and pyroclastic rocks and lesser amounts of conglomerate. The upper watershed bordering the Squaw Creek basin to the west is underlain by the Hosselkus limestone. The study reach for this assessment (**Figure 3-78**) extended from Shasta Lake on July 17, 2003 (elevation 1,041.38 ft msl) to Station 15+25 ft at elevation 1,092.80 ft msl (**Table 3-32**). The measured discharge of Flat Creek within the ESL was 0.58 cfs on July 17, 2003 (**Table 3-**1).

Flat Creek in the study reach is a uniformly 2.3 percent slope channel dominated by shallow boulder-bed riffle and run habitats with narrow, stable lateral boulder bars and shallow bedrock pools punctuated by very steep bedrock falls and cascade-plunge pool reaches. (**Figure 3-79**).

Table 3-32 Benchmark and Turning Point Marker Location and Elevations, Flat Creek July 17, 2003		
Turning Point Number	**Station from Reservoir Surface (ft)**	**Elevation Above MSL (ft)**
RES WSE	0+00	1,041.38
TP1	6+08	1,056.17
TP2	7+87	1,059.74
TP3	10+33	1,064.23
TP4	11+26	1,065.15
TP5	12+24	1,067.38
TP6	13+01	1,069.46
TP7	14+41	1,078.02
TP8	15+56	1,094.93
Reservoir Water Surface Elevation		1,041.38

Note: Downloaded from: http://cdec.water.ca.gov/cgi-progs/queryDaily?SHS

Twenty percent of the study reach is made up of cascade and falls/step habitat and 78 percent by shallow pool-riffle-run sequences (**Figure 3-80**). The pool-riffle-run ratio was approximately 7:4:5. Bedrock was overwhelmingly the dominant substrate in the study reach, making up about 61 percent of the study reach length (**Figure 3-81**). Boulders and cobbles dominated 23 percent of the study reach length. Gravel and silt dominated 16 percent of the study reach, almost entirely in the downstream portion of the reach. Pools were typically 10- to 20-ft wide and very shallow with the exception of the 5.1-ft-deep plunge pool at the base of the upstream bedrock cascade section (**Table 3-33**). Maximum pool depths downstream from the 5.1-ft-deep pool ranged from 0.4 to 2.1 ft and averaged about 1.5 feet

Table 3-33
Average Pool Width, Depth, and Substrate Distribution, Flat Creek

					Areal Percentage of Substrate in Pool Bed							
Pool #	**Station at Top of Pool (ft)**	**Elevation at Top of Pool (ft)**	**Maximum Depth (ft)**	**Average Width (ft)**	**BR (%)**	**Bo (%)**	**Co (%)**	**Gr (%)**	**Sa (%)**	**Si (%)**	**Org (%)**	**Total (%)**
1	0+60	1,040.13	1.3	nd								
2	0+90	1,042.88	1.1	nd								
3	2+40	1,047.28	1.5	nd								
4	5+30	1,052.43	0.5	nd								
5	5+55	1,053.23	0.4	nd								
6	5+80	1,053.88	0.7	nd								
7	6+64	1,055.76	0.9	nd								
8	10+11	1,061.12	2.1	20	80			5	15			100
9	10+74	1,063.26	1.8	15	80			15	5			100

Table 3-33
Average Pool Width, Depth, and Substrate Distribution, Flat Creek
(Continued)

					Areal Percentage of Substrate in Pool Bed							
Pool #	**Station at Top of Pool (ft)**	**Elevation at Top of Pool (ft)**	**Maximum Depth (ft)**	**Average Width (ft)**	**BR (%)**	**Bo (%)**	**Co (%)**	**Gr (%)**	**Sa (%)**	**Si (%)**	**Org (%)**	**Total (%)**
10	11+49	1,064.28	1.2	10	60			25	15			100
11	12+72	1,066.88	0.6	nd								
12	13+02	1,066.93	1.7	10	85							
13	13+55	1,069.94	1.7	nd								
14	14+27	1,069.19	5.1	nd								
15	15+25	1,092.83	1.1	11		40		60				100

Note: *BR=bedrock, Bo=boulders, Co=cobbles, Gr=gravel, Sa=sand, Si=silt, Org=organic material

Bar framework materials in the downstream portion of the Flat Creek study reach were cobble-dominated with a typical median diameter (D_{50}) of about 60 mm (**Table 3-34**). These materials were highly embedded with fine sediment and organic material in the upper surface of the bar. There were numerous small, reasonably well-sorted pocket gravel deposits on downstream bar surfaces that averaged 6 to 10 mm in median diameter. Throughout the study reach, there were no gravel-sized sediment deposits large enough in area or median diameter to be measured using the pebble count method (Wolman 1954).

Table 3-34
Summary of Channel Bed Material and Gravel Deposit Observations and Pebble Count Measurements, Flat Creek
July 17, 2003

River Station (ft)	**Elevation MSL (ft)**	**Material/ Deposit Type**	**Material/ Deposit Location**	**Deposit Area (sq ft)**	**D_{84} (mm)**	**D_{50} (mm)**	**D_{16} (mm)**	**Embed-dedness**
1+50	1,044	pocket gravel	lt bk bar	numerous x 20	--	6-10	--	low-mod
3+30	1,051	bar framework	rt bk bar	na	95	60	15	high
9+40	1,061	pool tailout	ch margin	30	--	6	--	low-mod
11+40	1,064	pool tailout	ch margin	90	--	18	--	low

The study reach can be divided into two representative geomorphic subreaches (**Figure 3-79**). Reach 1 is a uniformly 2.3 percent slope channel dominated by shallow plane-bed boulder- and cobble-bed riffle and run habitats with numerous infrequently mobilized colluvial boulders and narrow, stable lateral boulder bars (Photo FC-1). Upstream from about Station 7+00 ft, there were numerous shallow bedrock pools with limited and patchy alluvial coverage dominated by sand and fine gravel (Photo FC-2). Gravel- and sand-sized materials were also present in bed framework matrix materials in shallow riffle-run habitats, but pocket gravel deposits were restricted to numerous but very small patches of fine gravel. The only well-sorted gravel deposits larger than about 20 square ft were located on wide cobble bars in the downstream portion of Reach 1, downstream from Station 2+50 ft near elevation 1,048 ft msl. Cross-Section 1 surveyed at Station 3+30 ft (**Figure 3-82**) illustrates channel and bar form and dimensions in the wider alluvial downstream portion of Reach 1 (Photo FC-3). The channel in the vicinity of Cross-Section 1 has a moderate width-to-depth ratio and would be classified “F2” or “F3” using the Rosgen scheme.

Similar to the transition seen in Rip Gut Creek, as one moves upstream through the study reach, riparian vegetation remains limited to a few isolated willows and annual growth of sedge until the canopy rapidly closes and becomes very dense and dominated by California dogwood beginning near Station 7+50 feet The canyon floor loses its alluvial character near Station 7+50 feet Cross-Section 2 surveyed at Station 11+82 ft illustrates typical Reach 1 conditions upstream from Station 7+50 ft (**Figure 3-83**), with a bedrock and boulder-dominated bed with narrow stable bars and a dense low-hanging riparian canopy (Photo FC-1). Dense vegetation limited access and the ability to photograph the reach. The channel in the vicinity of Cross-Section 2 was entrenched with a low width-to-depth ratio and would be classified as “G1” or “G2” using the Rosgen classification. Overall, Reach 1 would be classified as an “F2” or “G2” channel type using the Rosgen classification scheme and “plane-bed” using the Montgomery-Buffington classification, and could arguably be split between Reach 1a “F2” downstream from Station 7+50 ft (elevation 1,056 ft msl) and “G2” upstream.

Reach 1 terminates upstream at Station 13+95 at the downstream end of a bedrock cascade plunge pool section where Reach 2 begins (**Figure 3-79**). Reach 2 is a 105-ft-long 21 percent slope bedrock falls/cascade-plunge pool reach (Photo FC-4) that would be classified as an “A1” channel section using the Rosgen classification scheme and “bedrock” using the Montgomery-Buffington classification.

Rip Gut Creek

The Rip Gut Creek watershed (**Figure 3-84**) drains an approximately 5.3-square-mile area and drains into the Pit River Arm of Shasta Lake about 21 miles ENE of Shasta Dam (see Atlas, Vol. VII, 1-19). The entire watershed, including the study reach, is underlain by the Modin andesitic volcaniclastic and pyroclastic rocks and lesser amounts of conglomerate, similar to the Flat Creek watershed. The study reach for this assessment (**Figure 3-84**) extended from Shasta Lake on July 18, 2003 (elevation 1,040.71 ft msl) upstream to permanent benchmark BM-94 established at Station 17+38 ft at elevation 1,111.35 ft msl (**Table 3-35**). The measured discharge of Rip Gut Creek within the ESL was 1.03 cfs on July 18, 2003 (**Table 3-**1).

Rip Gut Creek in the study reach is primarily a 2.7 to 3.7 percent slope channel confined within a steep-sided bedrock canyon, and dominated by shallow, partially alluviated boulder-bed riffle and run habitats with intervening 10 to 17 percent slope bedrock cascade plunge-pool reaches (**Figure 3-85**). Twenty-eight percent of the study reach is made up of cascade and falls/step habitat and 72 percent by shallow pool-riffle-run sequences (**Figure 3-86**). The pool-riffle-run ratio was approximately 7:3:5. Bedrock was overwhelmingly the dominant substrate in the study reach, making up about 49 percent of the study reach length (**Figure 3-87**). Boulders and cobbles dominated 28 percent of the study reach length. Gravel and organic materials dominated 23 percent of the study reach, almost entirely in pools and along the downstream lake sedimentation-impacted portion of the reach. Pools were typically 6- to 20-ft wide with the exception of the 50-ft-wide plunge pool at the base of the upstream bedrock cascade section (**Table 3-36**). Maximum pool depths, including the bedrock plunge pools, ranged from 1.6 to 6.0 ft and averaged about 3.4 feet

Table 3-35
Benchmark and Turning Point Marker Location and Elevations, Ripgut Creek
July 18, 2003

Turning Point Number	Station from Reservoir Surface (ft)	Elevation Above MSL (ft)
RES WSE	0+00	1,040.71
TP1	1+67	1,058.95
TP2	4+40	1,066.15
TP3	6+03	1,071.54
TP4	8+70	1,084.94
TP5	10+13	1,104.52
TP6	10+80	1,107.61
BM-94	12+65	1,111.35
Reservoir Water Surface Elevation		1,040.71

Note: Downloaded from: http://cdec.water.ca.gov/cgi-progs/queryDaily SHS

Table 3-36
Average Pool Width, Depth, and Substrate Distribution, Ripgut Creek

					Areal Percentage of Substrate in Pool Bed							
Pool #	Station at Top of Pool (ft)	Elevation at Top of Pool (ft)	Maximum Depth (ft)	Average Width (ft)	BR (%)	Bo (%)	Co (%)	Gr (%)	Sa (%)	Si (%)	Org (%)	Total (%)
1	0+20	1,043.46	3.1	20	40	30	30					100
2	0+40	1,049.21	2.1	6							100	100
3	1+73	1,057.07	3.1	15	10	10		60			20	100
4	5+62	1,068.26	1.3	15	30	20		50				100
5	7+37	1,070.98	6.0	50	40		30	10		10	10	100
6	8+52	1,078.63	5.4	17	45	30		25				100
7	9+82	1,097.07	4.6	nd	60	10	30					100
8	11+43	1,106.90	3.0	nd	100							100
9	12+28	1,108.20	1.6	nd	80			20				100

Note: *BR=bedrock, Bo=boulders, Co=cobbles, Gr=gravel, Sa=sand, Si=silt, Org=organic material

Bed framework materials in alluviated sections of the study reach were dominated by small boulders with typical median diameters (D_{50}) of about 75 mm (**Table 3-37**). The upper surface matrix materials were moderately to minimally embedded with fine sediment and organic materials.. There were numerous very small, reasonably well-sorted pocket gravel deposits on the channel bed surface throughout the study reach, probably representative of frequently mobilized bedload materials, averaging about 5 to 10 mm in median diameter. In the downstream portion of the reach, there were two to three larger pocket gravel deposits along channel margins with a typical median diameter of 8 to 15 mm. Upstream, there were numerous and larger pocket gravel deposits with somewhat coarser materials in the upstream portion of the study reach. These deposits had a typical median diameter of 20 to 30 mm (**Table 3-37**).

Table 3-37
Summary of Channel Bed Material and Gravel Deposit Observations and Pebble Count Measurements, Ripgut Creek
July 18, 2003

River Station (ft)	Elevation MSL (ft)	Material/ Deposit Type	Material/ Deposit Location	Deposit Area (sq ft)	D_{84} (mm)	D_{50} (mm)	D_{16} (mm)	Embed-dedness
1+50	1,057	gravel bar	lt bk	200	16	8	4	mod
1+80	1,060	pocket gravel	lt bk	60	--	15	--	low-mod
2+50	1,062	bed framework	mid-ch	na	110	75	25	low
3+75	1,064	pocket gravel	numerous	5-10	--	11	--	low
5+10	1,067	pocket gravel	numerous	5-10	--	15	--	low
10+10	1,100	pocket gravel	numerous	20-40	--	25	--	low
10+70	1,106	gravel bar	lt bk	150	--	30	--	low
11+00	1,108	gravel bar	rt bk	100	--	25	--	low

Rip Gut Creek in the study reach can be divided into four representative geomorphic subreaches, two steep bedrock cascade reaches and two moderately steep bedrock and boulder-cobble riffle-run reaches with limited shallow pools. Reach 1 is a very steep 17 percent slope bedrock cascade plunge-pool reach extending from Shasta Lake upstream to Station 0+97 ft near elevation 1,057 ft msl (Photo RC-1). Reach 1 is an “A1” reach according to the Rosgen classification scheme and a “cascade” or “bedrock” channel type according to the Montgomery-Buffington system.

Reach 2 is a 2.7 percent slope primarily bedrock channel nearly completely covered with a shallow veneer of alluvial materials dominated by small boulders and cobbles and numerous large and infrequently mobilized colluvial boulders (Photo RC-2). Gravel- and -sand-sized materials were present in bed framework matrix materials, but pocket gravel deposits were small, yet numerous patches. The only well-sorted gravel deposits larger than about 20 square ft were located in the downstream portion of Reach 2, downstream from Station 1+80 ft near elevation 1,060 ft msl (Photo RC-3). Cross-Section 1 surveyed at Station 1+50 ft (**Figure 3-88**) transects the only pool deeper than 1.3 ft in Reach 2. The left bank is stabilized by the narrow bedrock constriction in Reach 1, and was colonized by mature alders.

Similar to the transition seen in Flat Creek as one moves upstream through the study reach, riparian vegetation remains limited to a few isolated willows and annual growth of sedge until the canopy rapidly closes and becomes very dense and dominated by California dogwood beginning near Station 3+50 feet. The canyon floor also becomes somewhat less alluvial near Station 3+50 feet Dense vegetation limited access and the ability to photograph the reach. Overall, the transition in canyon alluviation and riparian vegetation density probably reflects impacts of cyclic inundation by Shasta Lake operations. The wider, more alluvial section of Reach 2 between Station 0+97 ft and approximately Station 3+50 ft could alternatively be classified an “F2” channel type. Cross-Section 2 surveyed at Station 5+24 ft (**Figure 3-89**) illustrates channel and narrow bar conditions in the upper portion of Reach 2, which could be classified "G1" or "G2" and "plane-bed." Reach 3 is a 330-ft-long 10 percent slope bedrock cascade channel that would be classified as an "A1" reach according to the Rosgen classification scheme and a "cascade" or "bedrock" channel type according to the Montgomery-Buffington system (Photo RC-4). Reach 4 is a 3.7 percent slope primarily bedrock channel nearly completely covered with a shallow veneer of alluvial materials dominated by small boulders and cobbles and numerous large and infrequently mobilized colluvial boulders. Reach 4 is similar to Reach 2 overall, but not as straight and with a variable and locally wider canyon width. There was also abundant woody debris in Reach 4, contributing to increased overall channel complexity and more abundant and diverse pocket gravel deposits on shallow bedrock channels. Reach 4 is entrenched with a relatively low width-to-depth ratio and would be classified as "G1" or "G2" using the Rosgen classification scheme and "plane-bed" using the Montgomery-Buffington system.

Potem Creek

Potem Creek watershed (**Figure 3-90**) drains an approximately 11.9-square-mile area and drains into the Pit River Arm of Shasta Lake about 24 miles ENE of Shasta Dam (see Atlas, Vol. VII, 1-22). The entire central portion of the watershed, including the study reach, is underlain by the Arvison volcaniclastic and pyroclastic rocks of Jurassic age. The upper watershed to the west of the study reach is underlain by the Triassic-aged Modin unit of andesitic, volcaniclastic, and pyroclastic rocks. The Modin unit is continuous throughout the Rip Gut Creek and Flat Creek study reaches. The study reach for this assessment (**Figure 3-90**) extended from the right bank of the Pit River, which was free-flowing on October 2, 2003 (elevation 1,028.10 ft msl), to a permanent benchmark (BM-53) established immediately below Potem Falls at Station 28+81 ft and elevation 1,135.36 ft msl (**Table 3-38**). The measured discharge of Potem Creek within the ESL was 4.78 cfs on October 2, 2003 (**Table 3-**1).

Table 3-38
Benchmark and Turning Point Marker Location and Elevations, Potem Creek
July 2, 2003

Turning Point Number	Station from Pit River (ft)	Elevation Above MSL (ft)
PIT RIVER WSE	0+00	1,028.07
TP1	3+39	1,035.88
BM-57	5+51	1,044.09
TP2	5+99	1,046.24
TP3	10+24	1,058.31
BM-56	10+89	1,061.06
TP4	14+10	1,072.55
TP5	17+71	1,085.51
BM-55	18+15	1,087.61
TP6	19+79	1,093.00
BM-54	19+79	1,093.00
TP7	23+20	1,107.32
TP8	26+19	1,120.79
BM-53	28+81	1,135.36
	Benchmark Elevation	1,033.00

Note: Benchmark elevation from orthophoto

The study reach is a 3.5 to 5.7 percent slope channel dominated by shallow boulder-bed riffle and run habitats in the downstream portion of the reach and bedrock and sandy gravel bedded pools and bedrock-boulder cascades in the upstream portion of the reach (**Figure 3-91**). Twenty-six percent of the study reach length is made up of cascade habitat, most of which was located upstream from Station 24+50 ft, and forty-three percent of the study reach length was made up of riffle habitat (**Figure 3-92**). Bedrock dominated the channel bed along about 20 percent of the study reach, and boulder-cobble substrates dominated 51 percent (**Figure 3-93**).

Table 3-39
Average Pool Width, Depth, and Substrate Distribution, Potem Creek

					Areal Percentage of Substrate in Pool Bed							
Pool #	**Station at Top of Pool (ft)**	**Elevation at Top of Pool (ft)**	**Maximum Depth (ft)**	**Average Width (ft)**	**BR (%)**	**Bo (%)**	**Co (%)**	**Gr (%)**	**Sa (%)**	**Si (%)**	**Org (%)**	**Total (%)**
1	9+82	1,052.47	2.1	nd								
2	17+04	1,079.06	1.3	25	15	15	10	20	40			100
3	20+08	1,089.70	2.3	15	15	20	15	10	40			100
4	23+84	1,107.37	2.0	14	70				30			100
5	25+12	1,109.46	4.5	38	25	5		35	35			100
6	29+81	1,109.20	25.0	85								

Note: *BR=bedrock, Bo=boulders, Co=cobbles, Gr=gravel, Sa=sand, Si=silt, Org=organic material

Gravel and sand materials made up fully 29 percent the study reach substrate materials, almost entirely in bedrock pools. Pools were typically 14- to 25-ft wide in the study reach (**Table 3-39**) and 38-85 ft wide in the upstream bedrock cascade/falls-plunge pool section of the study reach (Reach 4).

Bar framework materials in the downstream portion of the Potem Creek study reach were cobble- and gravel-dominated with a typical median diameter (D_{50}) of about 40 mm (**Table 3-40**), and were moderately embedded with fine sediment. There were numerous small and not well-sorted pocket gravel deposits along channel margins, probably representative of frequently mobilized bedload materials, averaging about 6 to 8 mm or less in median diameter. Only one gravel-sized sediment deposit was large enough to apply the pebble count method (Wolman 1954). This feature was in the upstream end of the reach near Station 26+50 ft (**Table 3-40**).

The study reach can be divided into four representative geomorphic subreaches. Reach 1 is a 0.3 percent slope shallow boulder- and sand-bedded reach cut in the lake sedimentation-affected Pit River floodplain extending 250 ft from the Pit River right bank to the Pit River's right bank canyon wall (Photo PC-1). Reach 2 is a 3.5 percent slope shallow boulder- and cobble-bedded riffle-run reach extending from Station 2+50 ft to about Station 9+82 ft (bed elevation 1,053 ft msl). Cross-Section 1 surveyed at Station 7+00 illustrates channel and floodplain form and dimensions in Reach 2, with its wide left bank floodplain with frequently scoured multiple flood scour channels and mixed grain size bars and levees with uniformly young woody riparian trees dominated by willow (**Figure 3-94**). The wetted channel was about 12 to 15 ft wide at low-flow discharge and the bankfull channel is about 40 to 50 ft wide.

Table 3-40
Summary of Channel Bed Material and Gravel Deposit Observations and Pebble Count Measurements, Potem Creek
October 2, 2003

River Station (ft)	Elevation MSL (ft)	Material/ Deposit Type	Material/ Deposit Location	Deposit Area (sq ft)	D_{84} (mm)	D_{50} (mm)	D_{16} (mm)	Embed-dedness
5+35	1,043	pocket gravel	rt bk bar	400	65	40	11	mod
7+01	1,048	pocket gravel	rt ch margin	10	--	30	--	low
9+90	1,052	pocket gravel	lt ch margin	40	16	8	4	low
16+50	1,080	bed framework	ch bed	na	700	220	--	na
17+90	1,084	pocket gravel	rt ch margin	20	--	6	--	mod-high
22+90	1,103	pocket gravel	numerous	5-10	--	6	--	mod-high
26+50	1,121	pocket gravel	rt ch margin	30	18	8	3	low-mod

The channel in Reach 2 is slightly entrenched with a low width/depth ratio and would be classified as a "E2" channel using the Rosgen scheme and a "plane-bed" channel using the Montgomery-Buffington system.

Reach 3 is also a 3.5 percent slope bedrock and boulder-bed channel that begins near Station 9+82 where the bedrock canyon narrows abruptly from about 200 ft to between 90-100 ft and extends upstream to about Station 24+68 ft (elevation 1,112 ft msl). The bedrock bed in Reach 2 is variably and partially covered by a shallow lag of boulders and large cobbles forming shallow riffle and step-run habitats and narrow lateral boulder bars and limited floodplains dominated by mature alders and California dogwood (Photo PC-2). Boulder-cobble bed and bar framework and matrix materials were virtually devoid of gravel-sized sediments and there were very few pocket gravel deposits in the reach. Annual flood scour is sufficient to prevent establishment of woody riparian vegetation on near-channel boulder bar surfaces. Indian rhubarb dominated all near-channel surfaces in the reach (Photo PC-3). There were a number of shallow pools with clean bedrock and sandy gravel beds and limited amounts of boulder and cobble substrates in the upper section of Reach 3. Cross-Section 2 surveyed near the head of a bedrock pool at Station 20+07 ft illustrates channel bed and bar form and dimensions representative of Reach 3, although short sections of Reach 3 were 10 to 15 ft wider (**Figure 3-95**). The channel bed in the pool was 50 percent covered with sandy gravel and 35 percent covered with boulders and cobbles. The wetted width was about 17 ft and the bankfull width was about 40 ft at Cross-Section 2. There were wide mid-channel boulder bars and split flow in both the downstream 150 ft and upstream 150-200 ft of Reach 3. Overall, the channel in Reach 3 is moderately entrenched with a relatively low width/depth ratio and would be classified as a "B2" channel using the Rosgen scheme and a "plane-bed" channel using the Montgomery-Buffington system.

Reach 4 is a 5.7 percent slope primarily bedrock-bed cascade reach with deep, wide plunge pools that extends from Station 24+68 upstream to BM-53 installed immediately downstream from Potem Falls (Photo PC-4). The channel in Reach 4 is entrenched with a moderate width/depth ratio but by virtue of its steep slope would be classified as an "A1" channel using the Rosgen scheme. Reach 4 would be classified as a "cascade" or "bedrock" channel using the Montgomery-Buffington system.

3.1.3 SUMMARY

The riverine reaches described in the preceding section represent a diverse sample of the rivers and streams that are tributary to Shasta Lake. Although the data suggest that each channel has unique ecological components, most of the reaches share similarities regardless of their size or geographic location.

The following are observations concerning the relative stability of the riverine reaches:

- All the reaches except Big Backbone Creek and the Sacramento River are underlain by shallow bedrock. They are therefore relatively stable streams that do not undergo much change in response to average floods.
- Although they occur infrequently, debris flows have the potential to substantially affect these shallow-bedrock reaches, as is evident in Dekkas Creek.
- The Sacramento River and Big Backbone Creek are relatively dynamic in the sense that the channel bed has the potential to undergo physical changes in response to a moderate flood.
- Although Big Backbone Creek and Squaw Creek have similar watershed areas, Squaw Creek has more bedrock reaches than Big Backbone Creek and is therefore inherently more stable.

The following are observations concerning the effects of inundation on the riverine reaches immediately adjacent to Shasta Lake:

- Shasta Lake has a variety of effects on the inundations zones of the riverine reaches. These effects, which range from subtle to extreme, include substrate embeddedness, channel form changes in the extreme lower portions of the stream reaches, alluviation (increased coverage by alluvial materials on the canyon floor), and vegetation in terms of species present and their densities.
- The relationship between increased alluvial materials on the canyon floor and the periodic reoccurrence of riparian vegetation appears to increase the potential for an unstable environment in terms of scour, channel widening, and siltation.
- The impacts of inundation are somewhat different for each reach, depending on the aforementioned variables. For example, all of the reaches exhibited a lack of vegetation near their confluence with the lake. However, the distance upstream at which the vegetation ended was different for each reach, with the distance depending on stream-specific variables, such as type of substrate, degree of alluviation (both areal percentage covered and depth), and presence or absence of bed-forms.

3.2 Shasta Lake Potential Shoreline Erosion

The investigation of shoreline erosion was intended to use the observations of existing erosional features to project the type, location, and magnitude of potential shoreline erosion under various enlargement scenarios. Subsequent revisions of this report will include detailed observations for selected sites and discuss potential shoreline erosion in a spatial and temporal context.

Shoreline erosion along Shasta Lake has been a concern to Reclamation, the U.S. Forest Service (USFS), and private landowners for several decades because substantial erosion can threaten structures and other improvements located near the lake. Although erosion is a natural process in fluvial and lacustrine environments, the regulation of the water-surface elevation (**Figure 3-1**) of Shasta Lake as part of CVP operations has altered these natural processes along the Shasta Lake shoreline.

The presence of important natural resources adjacent to the current shoreline of Shasta Lake presents the potential for environmental impacts at a variety of locations. Although Shasta Lake is a regulated reservoir, the aesthetic and recreational values associated with its 420 miles of shoreline are substantial. In addition, the effects of erosion of the Shasta Lake shoreline on heritage resources have been a source of concern for more than 50 years. The limited assessments of the heritage resources associated with the shoreline of Shasta Lake hat few, if any, of these sites have been unaffected by the operation or use of Shasta Lake (U.S. Forest Service 1986).

3.2.1 Geology and Geomorphology

Shasta Lake is situated geographically at the interface between the Central Valley, Klamath Mountains, and Cascades physiographic and geomorphic provinces. Rocks representing the dominant geologic types of all three provinces are present in the vicinity of Shasta Lake and are shown on Figure 3-2. The aerial extent of the rock units described in the following paragraphs is based on this geologic map.

Shasta Lake is predominantly underlain by rocks of the Eastern Belt of the Klamath, mountains primarily metamorphic rocks of the Redding Formation and associated intrusive plutons. Redding Formation metamorphic rocks and associated igneous plutons constitute over 85 percent of the rocks in the general Shasta Lake area. Intrusive rocks make up less than 5 percent of the rocks in the map area, but are well represented on the Shasta Lake shoreline, particularly in the south-central area of the lake. Mesozoic intrusive dikes are scattered in the western portion of the map area. Mineralized areas have historically been mined for a variety of economically valuable minerals, including copper, gold, and tungsten, in the contact zones between the intrusive and metamorphic units.

A small area of Cretaceous Chico Formation, consisting of Great Valley marine sedimentary rocks, occurs near Jones Valley Creek, a tributary to the Pit River Arm of Shasta Lake. Although this rock unit occurs in the immediate vicinity, it is not exposed along the shoreline of the lake.

Volcanic rocks of the Cascades volcanic province are present in the map area, predominantly in the eastern areas near the Pit River Arm and along the upper Sacramento River Arm. These rocks comprise approximately 3 percent of the map area. Volcaniclastic rocks, mudflows, and tuffs of the Tuscan Formation occur in the Pit River area; localized volcanic deposits are found in isolated locations.

The geomorphic expression of this widely varying lithologic framework is likewise highly diverse, and substantially influences the ecological characteristics of the Shasta Lake shoreline and upland areas. This diversity is expressed in topographic features, including the type, rate, and magnitude of erosional processes. The soils developed from these rock units have distinct and characteristic properties that can affect vegetation patterns and disturbance mechanisms at multiple scales.

3.2.2 Climatic Conditions

Although there is a general understanding of the causal mechanisms associated with shoreline erosion, there is no documentation available to characterize the relationship between these mechanisms and the observable erosion on Shasta Lake. Studies performed elsewhere indicate that wind-driven waves are significant erosive agents on large reservoirs (Ferguson 1999). The wakes of powerboats are a secondary source of erosive waves. Although the erosive force of boat-driven waves is widely recognized, their total erosive effect has not been documented on Shasta Lake.

Wave height is measured from peak to trough, so the elevation of the top of a wave is half the wave's height above the nominal lake level. Wind-driven waves are formed when prolonged strong wind sets the water in motion. Monthly records available for Shasta Dam indicate that wind speeds range from 0 to 30 miles per hour (mph) throughout the year and that occasional gusts in excess of 60 mph accompany strong storm systems. At a given wind speed, wave height and erosive energy increase with *fetch*, the distance over which wind friction operates on open water.

Wave heights on Shasta Lake can vary with location (personal observation, Paul Uncapher, North State Resources, Inc., 2003), and are influenced by wind direction and sustained speeds. Higher waves can occur with wind events of long duration. Wave height also varies with water depth: Deep water makes higher waves, and shallow water makes lower waves. One- to two-foot waves can be common on Shasta Lake, with waves up to about 6 ft in conjunction with very high winds in the longest fetch, the McCloud River Arm. Thus, on Shasta's exposed shorelines where the fetch is greatest, the height and erosive energy of waves can be substantial. The evidence of erosion is most dramatically visible in these exposed places.

On the shores of Shasta Lake, the fetch may be as much as 5 miles in the main body and along the McCloud River and Squaw Creek arms. The fetch is much less, usually less than 1 mile, in the lake's numerous inlets and coves. While these areas typically do not experience high waves, evidence of erosion is observable.

People who live and work around the lake have reported that the strongest winds and highest waves occur in winter (pers. comms., Zustak 2003 and Anderson 2003). The geographic orientation of Shasta Lake provides distinct wind patterns in different areas of the lake. In summer, wind direction is predominantly southerly, with winds associated with strong temperature gradients and thermal conditions. In winter, storms control the direction and intensity of wind and waves, and the predominant direction is southerly in conjunction with Pacific storm fronts. In the northern Sacramento Valley, strong, persistent winds are common following the passage of cold fronts. Documentation of the importance of fetch associated with these winds, and of the association of wind speed and direction with lake level, could be the subject of further research using weather and lake-level records.

3.2.3 METHODS

A systematic approach was developed to identify, document, map, and characterize potential shoreline erosion sites around the entire lake. Operating under the hypothesis that potential erosion is likely to occur in areas where ongoing erosion is observed, NSR identified all observable erosion features that could be mapped on high-resolution color aerial photos provided by Reclamation. The minimum size of a map unit was defined to be 500 linear ft (estimated), although smaller units were mapped in some cases.

Because of accessibility issues, NSR observed the shoreline from boats to identify each mappable unit. All field investigations were conducted under the direct supervision of an NSR geomorphologist. Map units were identified by arm and by right or left bank in a downstream direction. Each map unit was located as a polygon on the appropriate aerial photo, using referenced mylar overlays. The aerial photos have a scale of 1:7,200, and digitizing was performed at this scale or larger. No ESL boundaries were delineated on the field photos; rather, the projected erosion areas were indicated with a line drawn along the shoreline on the overlay, with hatch-marks to divide areas of differing erosion characteristics.

Each map unit area was designated as an erosion site with a unique alphanumeric code (e.g., ML-1 = McCloud, Left 1). Also, unlike on the maps displayed in Sections 3 and 4 of the Atlas, shoreline erosion was mapped as observed, and not continuously along the shoreline. To facilitate producing the Atlas, uncolored polygons in Section 2 of the Atlas reflect non-eroding areas under the criteria established for the project. In conjunction with the attributed polygon, a data sheet was completed for each map unit. This data sheet (Shoreline Erosion Reconnaissance Inventory, Appendix C,) was used to create a database in conjunction with the project GIS. The methods applied to prepare the shoreline erosion elements of the project GIS are described in Appendix A.

Although the database includes a number of parameters that could be incorporated into a discussion of impacts, this report used a simplified classification scheme to characterize the existing shoreline. In Section 2 of the Atlas, Shoreline Erosion Potential), the polygons are identified using the Erosion Severity attribute contained in the database. As a qualitative indicator of severity, this attribute was defined as low, moderate, or high. Generally, these ratings can be equated to the vertical height of the wave-cut slope. **Table 3-41** shows the correlation between erosion severity and slope height.

Representative examples of these erosional features are provided at the end of this section. **Photos of**, **Low Severity**, **Moderate Severity** and **High Severity Erosion** are intended to provide a visual perspective of the variety of erosional features associated with the shoreline of Shasta Lake.

Table 3-41 Erosion Severity	
Erosion Severity	**Eroded Slope Height**
Low	0-3 ft
Moderate	3-6 ft
High	6+ ft

3.2.4 Observations

Because of Shasta Lake's large area and its diversity of landscapes, NSR characterized the erosional features for the main body and the arms of Shasta Lake. For ease of reference, **Table 3-42** summarizes the overall results of the erosion mapping.

Table 3-42 Shasta Lake Erosion Severity Summary			
Erosion Severity	**Number of Sites**	**Acres**	**Percent of ESL Area**
Low	764	568.99	51%
Moderate	527	636.01	32%
High	259	187.08	17%

The acres shown on **Table 3-42** reflect the actual boundaries of mapped polygons with definitive erosional features. The field investigation identified 1,550 discrete sites that encompassed 1,119 acres in the shoreline component of the ESL. This total equals 44 percent of the entire shoreline of Shasta Lake.

In order to characterize the relative magnitude, density, and distribution of erosional features, **Table 3-43** through **Table 3-48** provide information specific to the main body and specific arms of Shasta Lake.

Table 3-43 Erosional Features – Main Body of Lake						
Erosion Severity	**Area (ac)**	**Percent of Shoreline**	**Number of Polygons**	**Size of Polygons**		
				Min.	**Max.**	**Mean**
Low	120.30	26	198	.002	2.879	.607
Moderate	90.34	20	150	.014	2.909	.602
High	61.58	13	95	.004	2.21	.648
Total	272.23	59				

Table 3-44
Erosional Features – Big Backbone Creek Arm

Erosion Severity	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
Low	28.16	31	40	.170	1.887	.070
Moderate	9.41	10	17	.218	1.139	.554
High	7.65	8	9	.047	2.842	.850
Total	45.24	49				

Table 3-45
Erosional Features – Sacramento River Arm

Erosion Severity	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
Low	136.76	19	150	.002	7.222	.912
Moderate	90.27	12	106	.067	2.519	.851
High	49.16	7	63	.074	3.046	.780
Total	276.20	38				

Table 3-46
Erosional Features – McCloud River Arm

Erosion Severity	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
Low	100.34	25	126	.007	2.789	.796
Moderate	78.55	20	120	.002	1.589	.654
High	35.37	9	58	.001	1.638	.609
Total	214.27	54				

Table 3-47
Erosional Features – Squaw Creek Arm

Erosion Severity	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
Low	59.47	20	58	.207	4.966	1.025
Moderate	29.59	10	29	.191	3.448	1.020
High	24.21	8	20	.165	4.740	1.210
Total	113.29	38				

Table 3-48
Erosional Features – Pit River Arm

Erosion Severity	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
Low	123.92	24	192	.036	5.509	.645
Moderate	64.83	12	105	.102	2.754	.617
High	9.08	2	14	.142	2.296	.649
Total	197.83	38				

3.2.5 SUMMARY

The documentation of erosional features along the shoreline of Shasta Lake suggests that the influence of causal mechanisms—wind waves, boat wakes, and lake level fluctuations—on a highly diverse landscape should be considered in the evaluation of enlargement scenarios. The information indicates that the potential for additional shoreline erosion exists, although the location, extent, and magnitude cannot be assessed without additional studies.

Subsequent revisions to this report will incorporate information obtained through limited field sampling of selected erosional features. Field data collected within the Squaw and Big Backbone Creek arms will be used to characterize discrete features in a semi-quantitative fashion. It is expected that these data will be used in the large-scale-impacts assessment that will be incorporated into the August 2004 revision of this report.

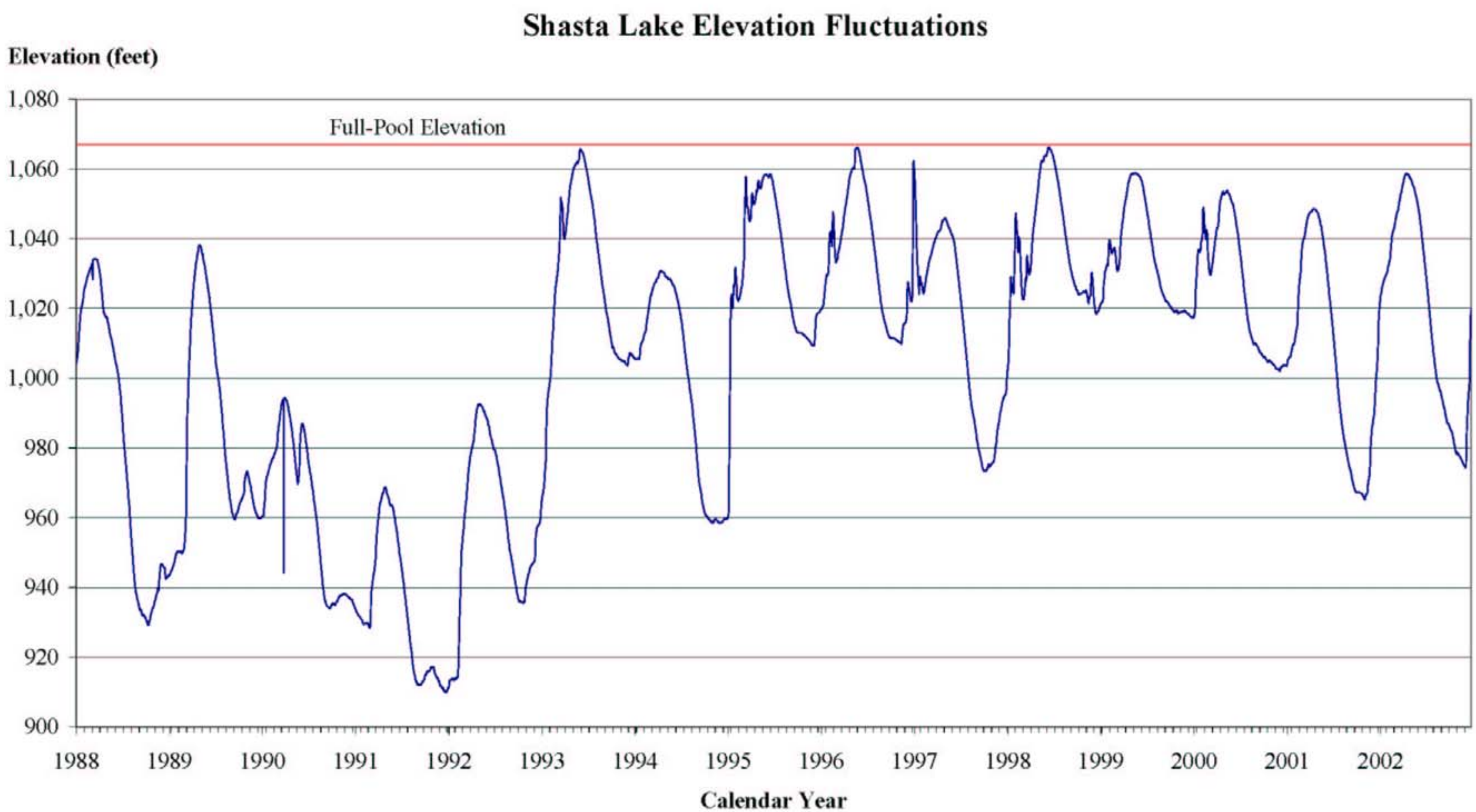
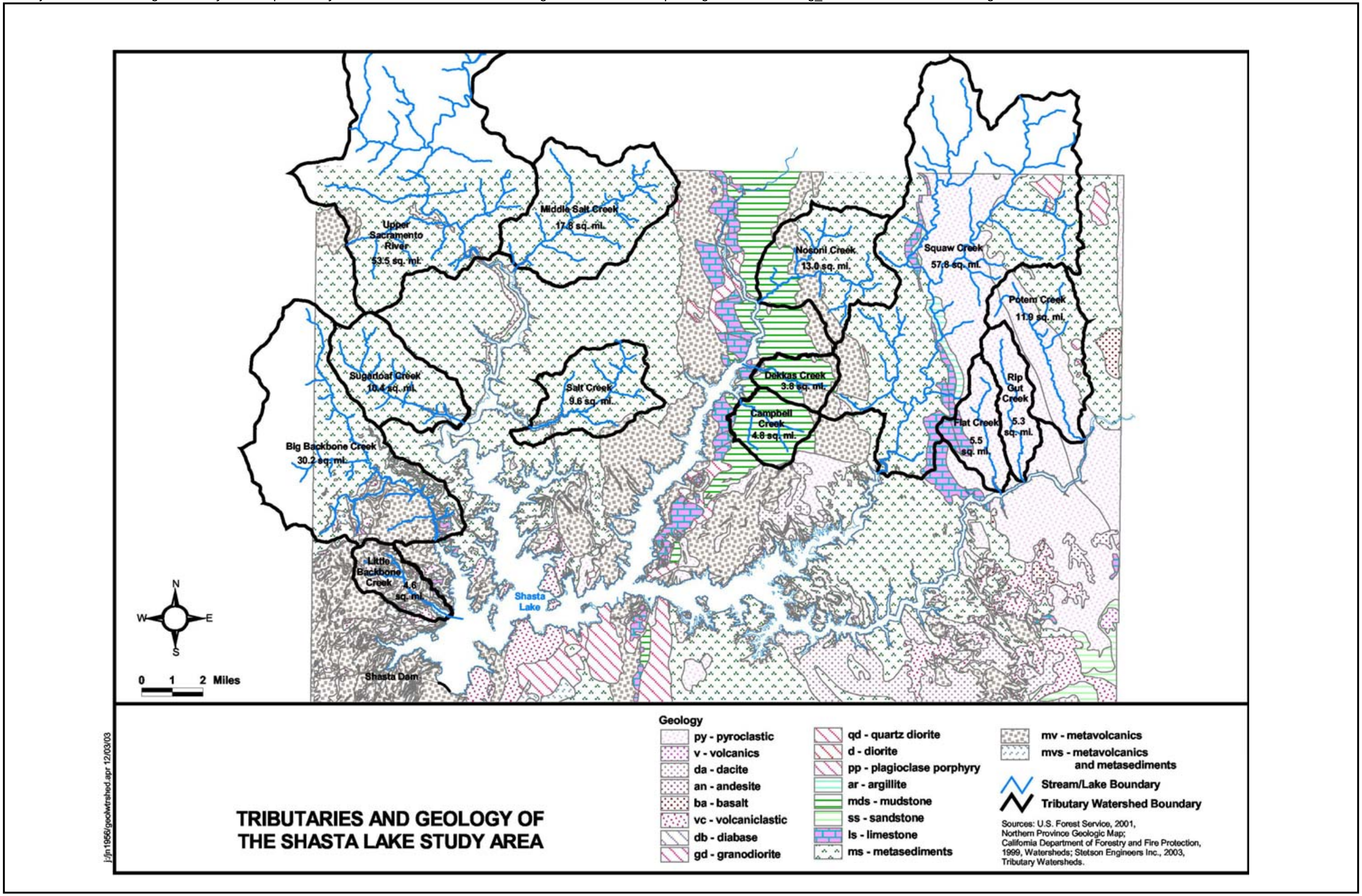


Figure 3-1
Shasta Lake Elevation Fluctuations



North State Resources, Inc.

Figure 3-2
Tributaries and Geology of the Shasta Lake Study Area

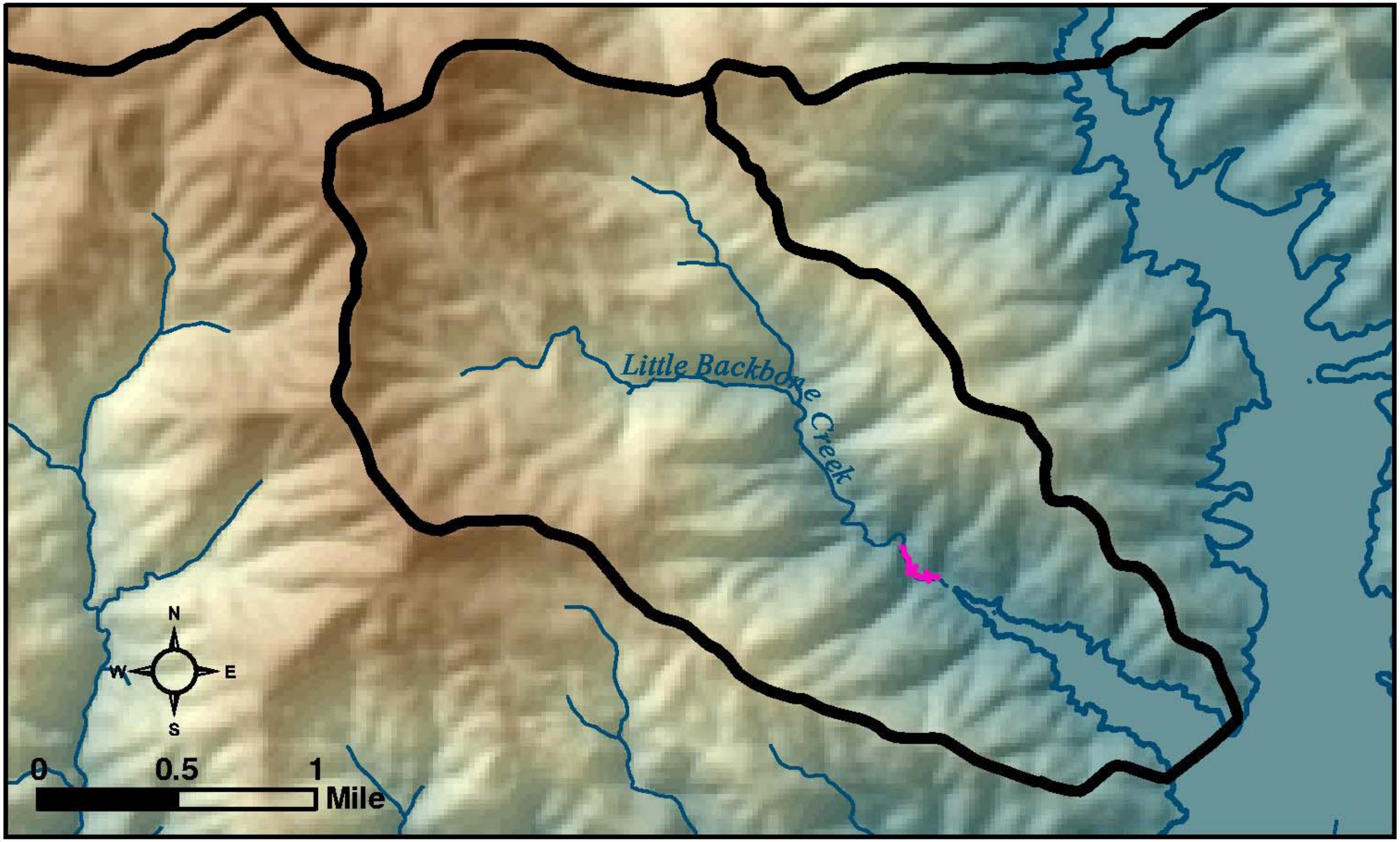


Figure 3-3
Little Backbone Creek Watershed

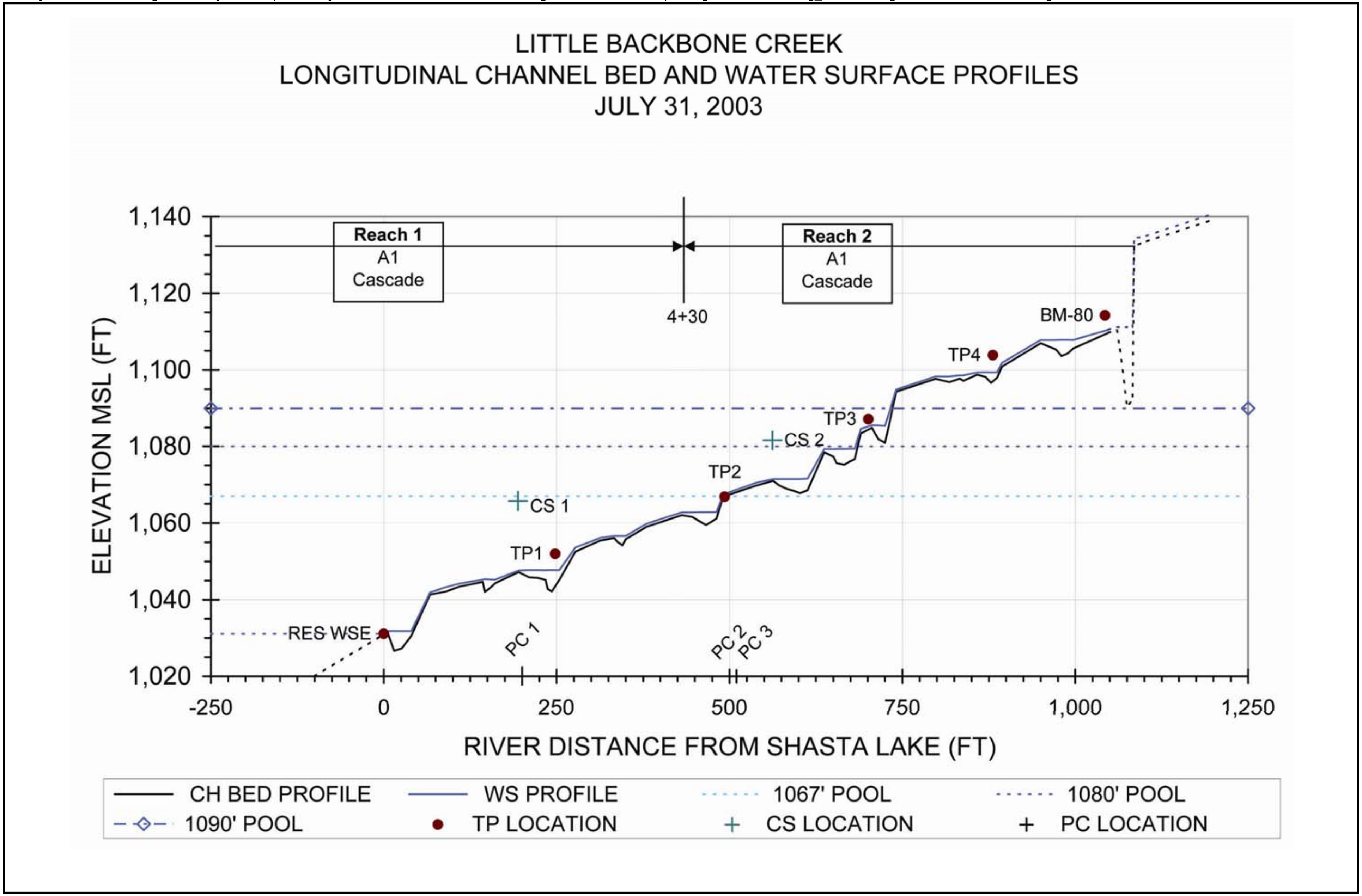


Figure 3-4
Little Backbone Creek Longitudinal Profile

Figure 3-5 Little Backbone Creek Aquatic Habitat Distribution

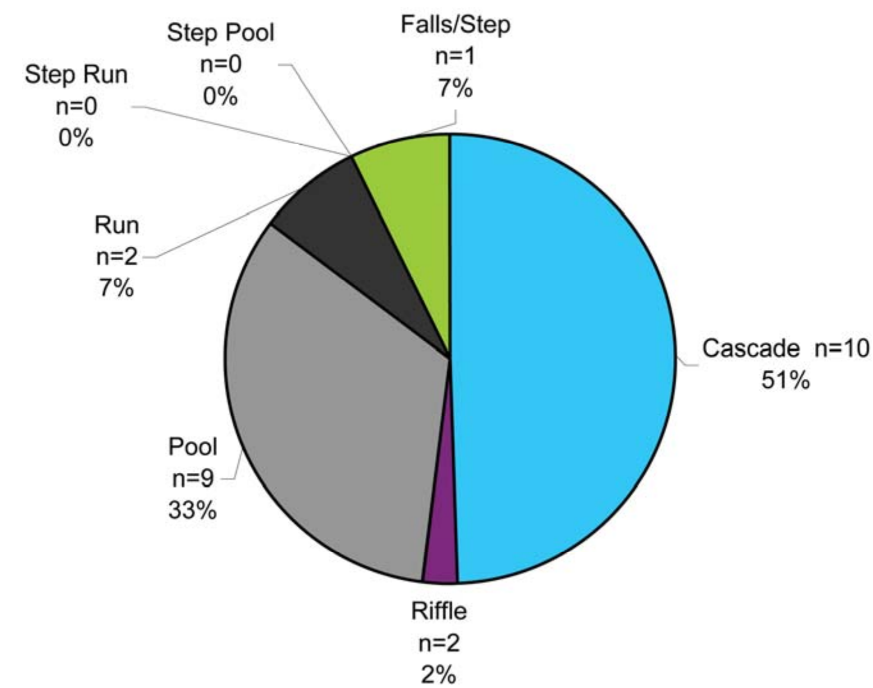


Figure 3-6 Little Backbone Creek Dominant Substrate Distribution

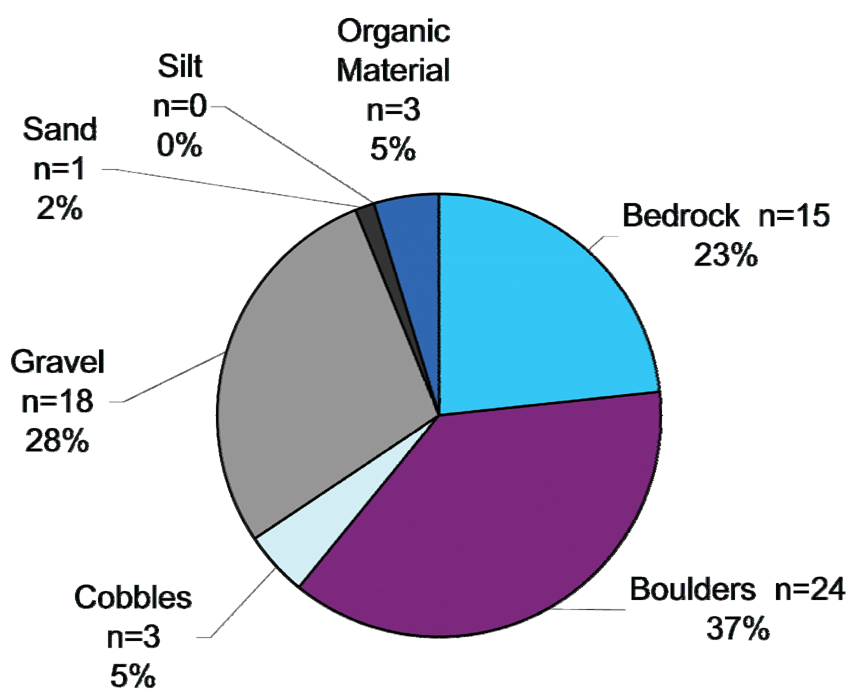


Figure 3-5
Little Backbone Creek Aquatic Habitat Distribution
Figure 3-6
Little Backbone Creek Dominant Substrate Distribution

Figure 3-7 Little Backbone Creek Cross Section #1

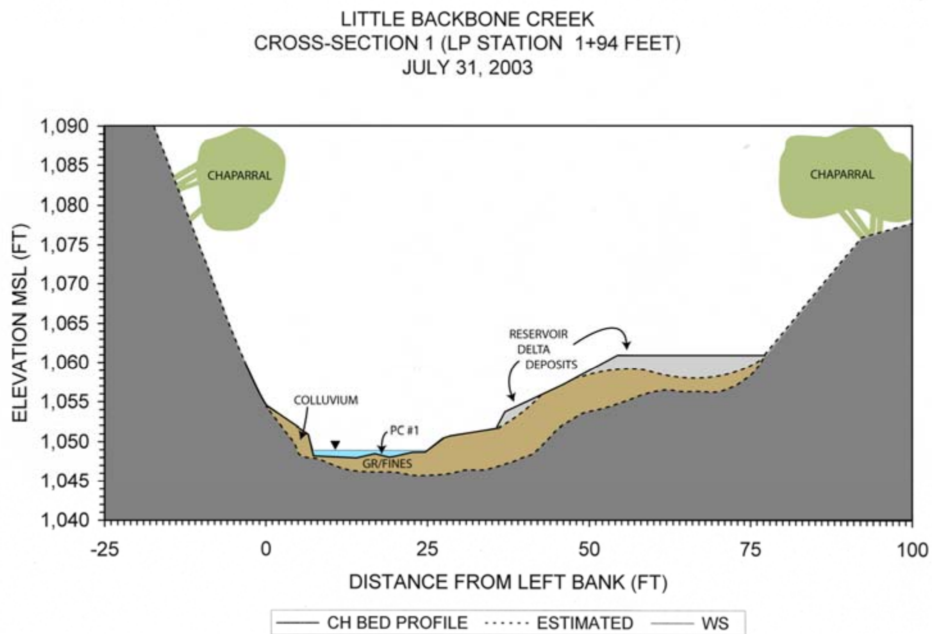


Figure 3-8 Little Backbone Creek Cross Section #2

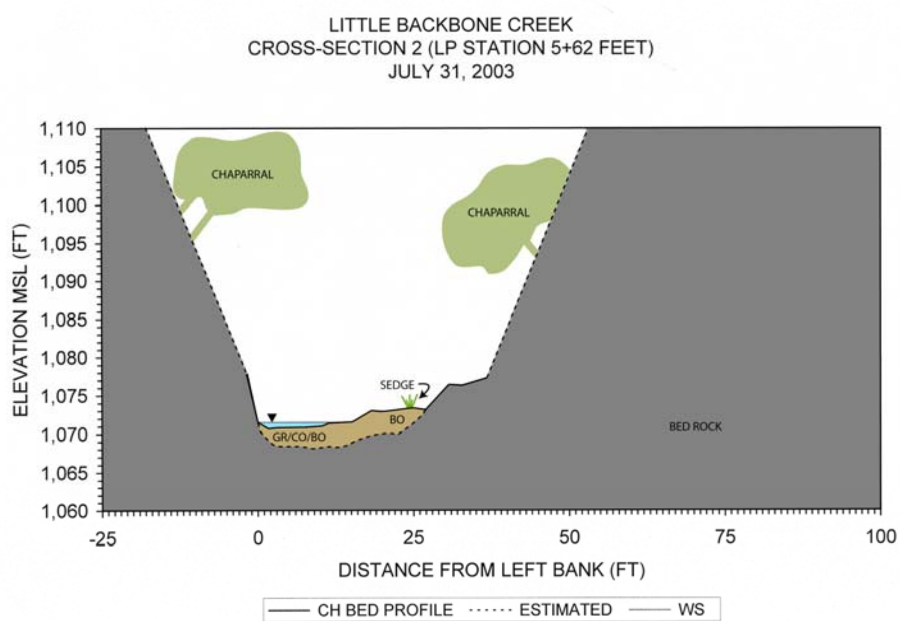


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Figure 3-7
Little Backbone Creek Cross Section #1
Figure 3-8
Little Backbone Creek Cross Section #2

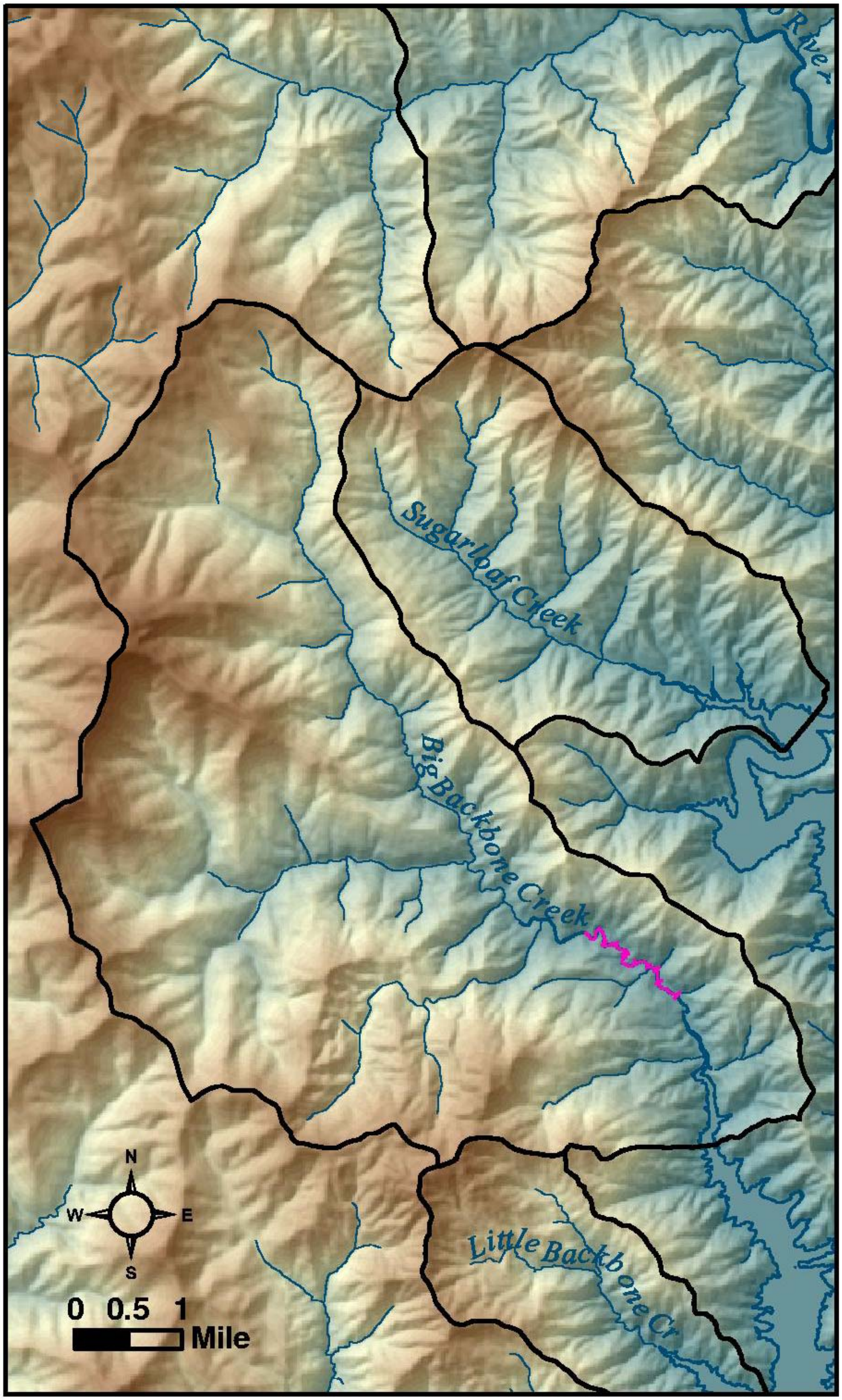

Figure 3-9
Big Backbone Creek Watershed

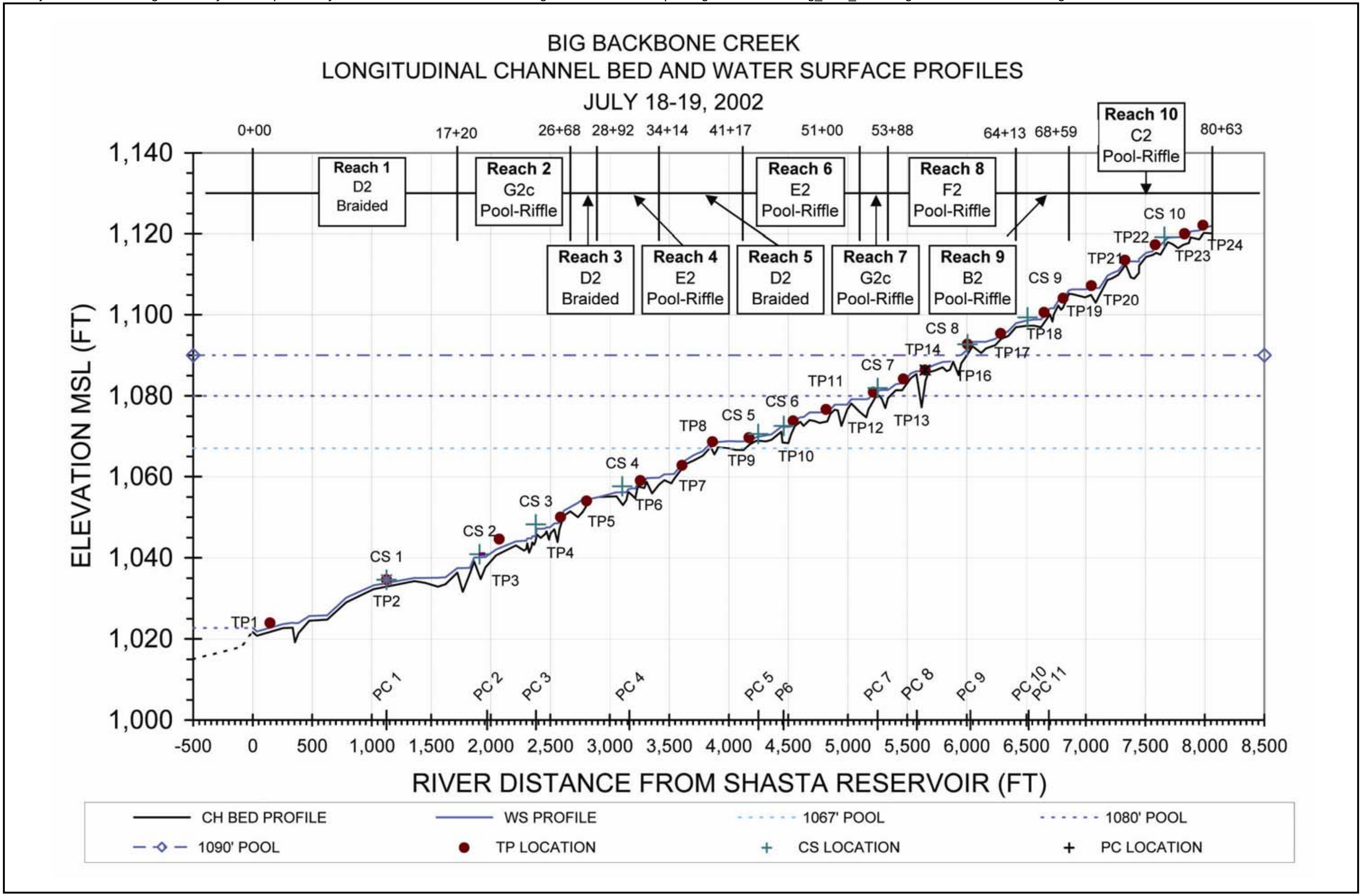

Figure 3-10
Big Backbone Creek Longitudinal Profile

Figure 3-11 Big Backbone Creek Aquatic Habitat Distribution

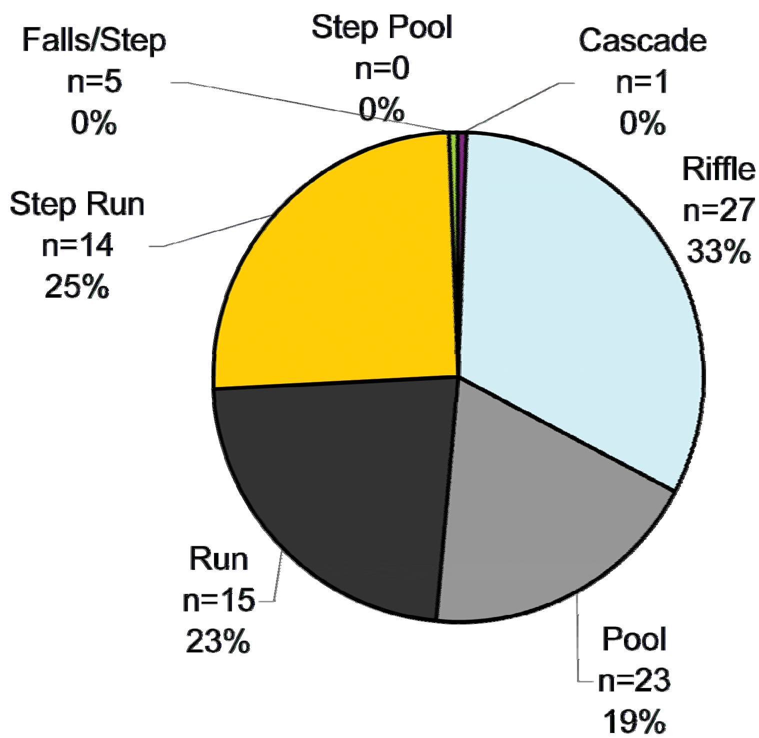

Figure 3-12 Big Backbone Creek Dominant Substrate Distribution

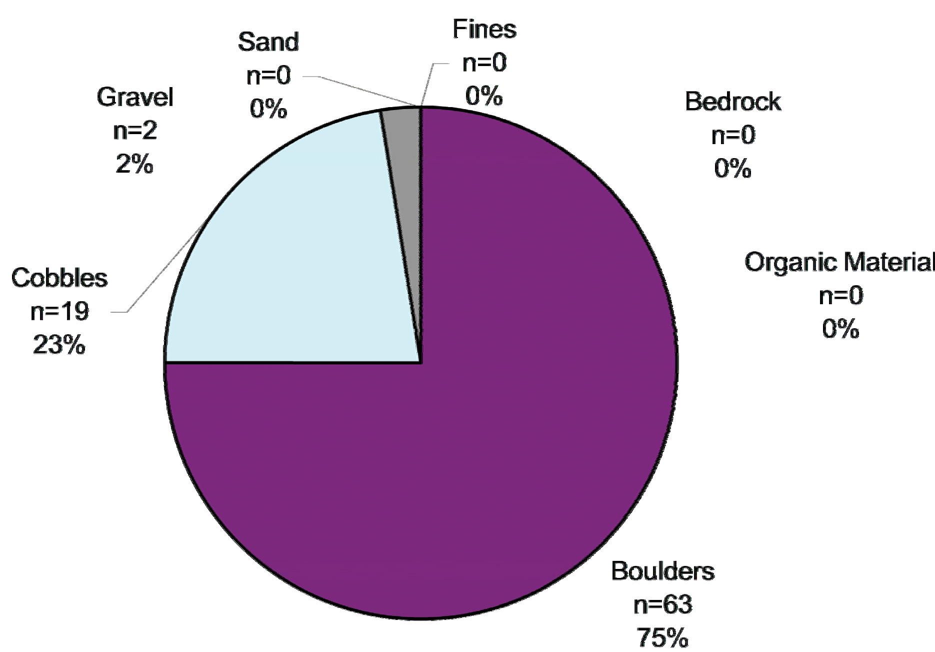

Figure 3-11
Big Backbone Creek Aquatic Habitat Distribution
Figure 3-12
Big Backbone Creek Dominant Substrate Distribution

Figure 3-13 Big Backbone Creek Cross Section #1

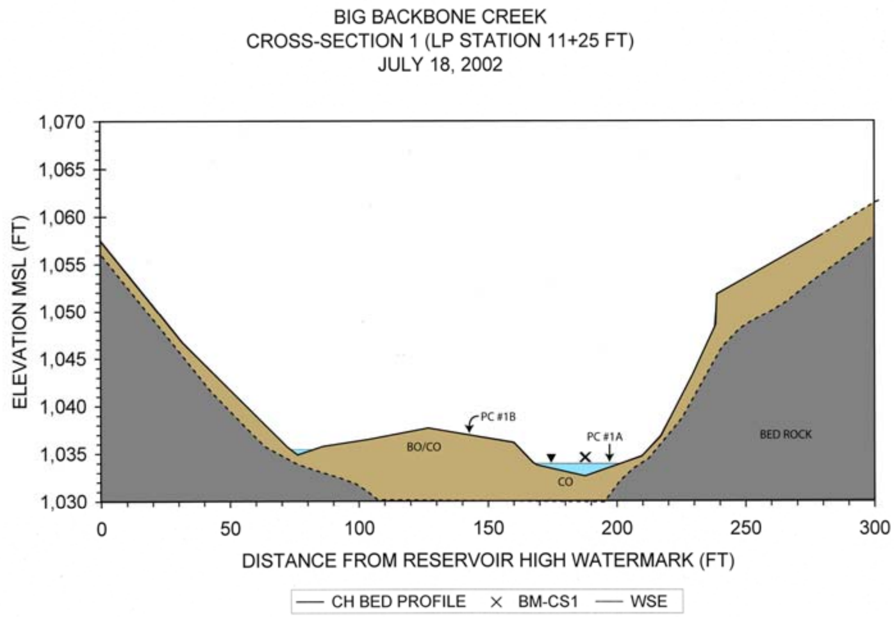

Figure 3-14 Backbone Creek Cross Section #3

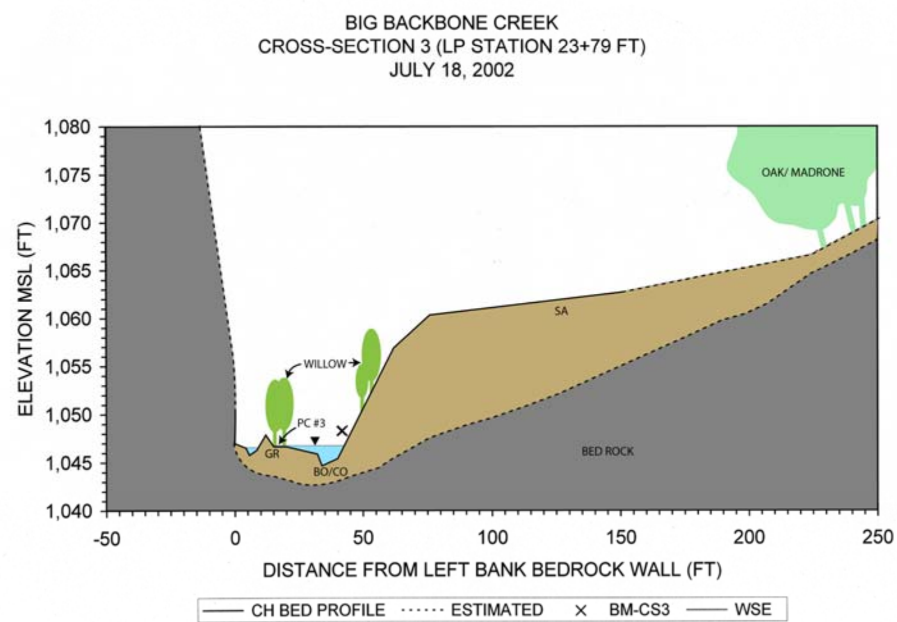

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Figure 3-13
Big Backbone Creek Cross Section #1
Figure 3-14
Big Backbone Creek Cross Section #3

Figure 3-15 Big Backbone Creek Cross Section #4

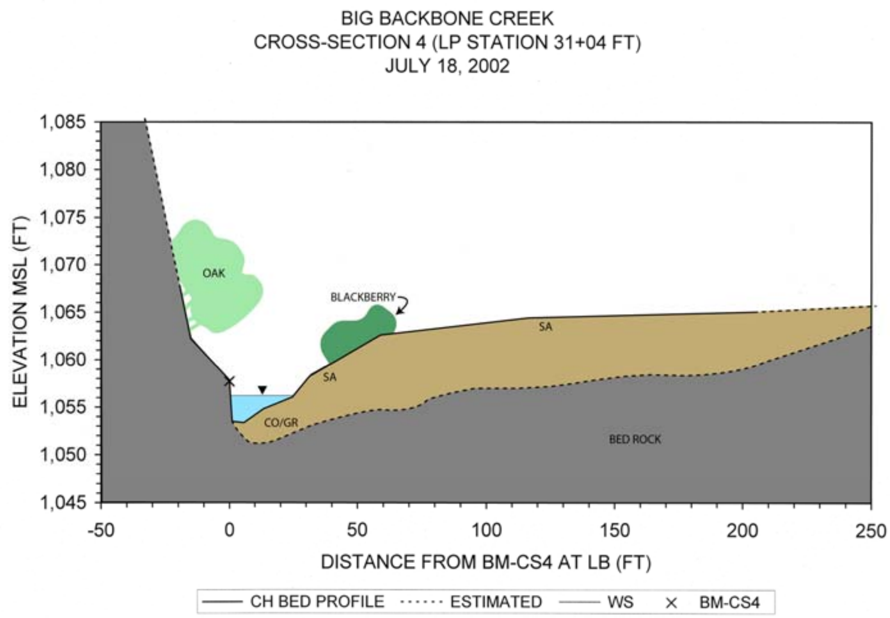


Figure 3-16 Backbone Creek Cross Section #5

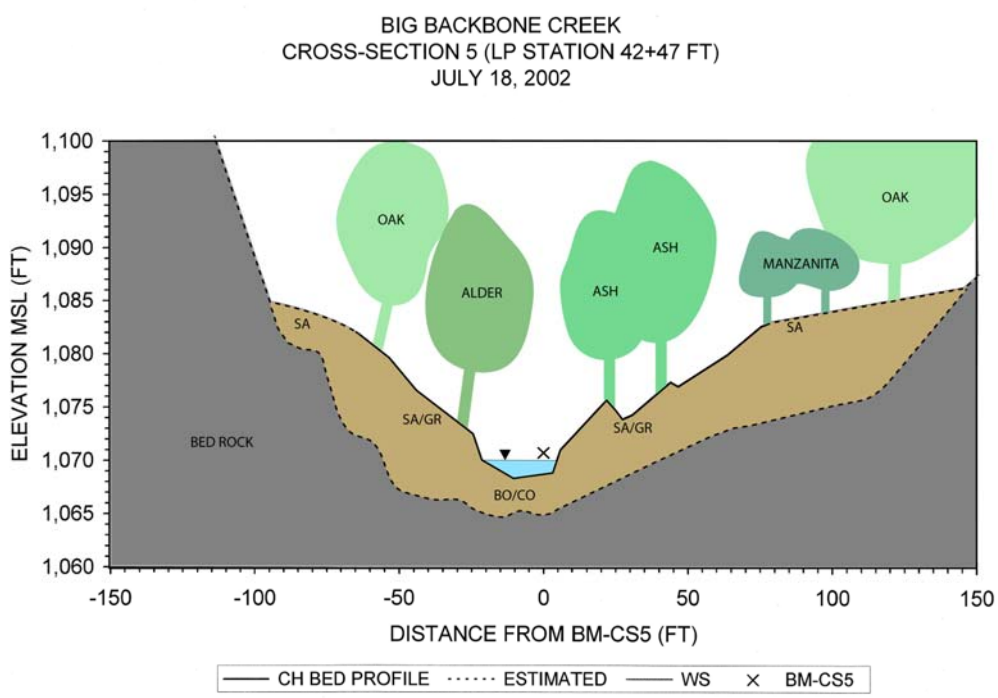


Figure 3-15
Big Backbone Creek Cross Section #4
Figure 3-16
Big Backbone Creek Cross Section #5

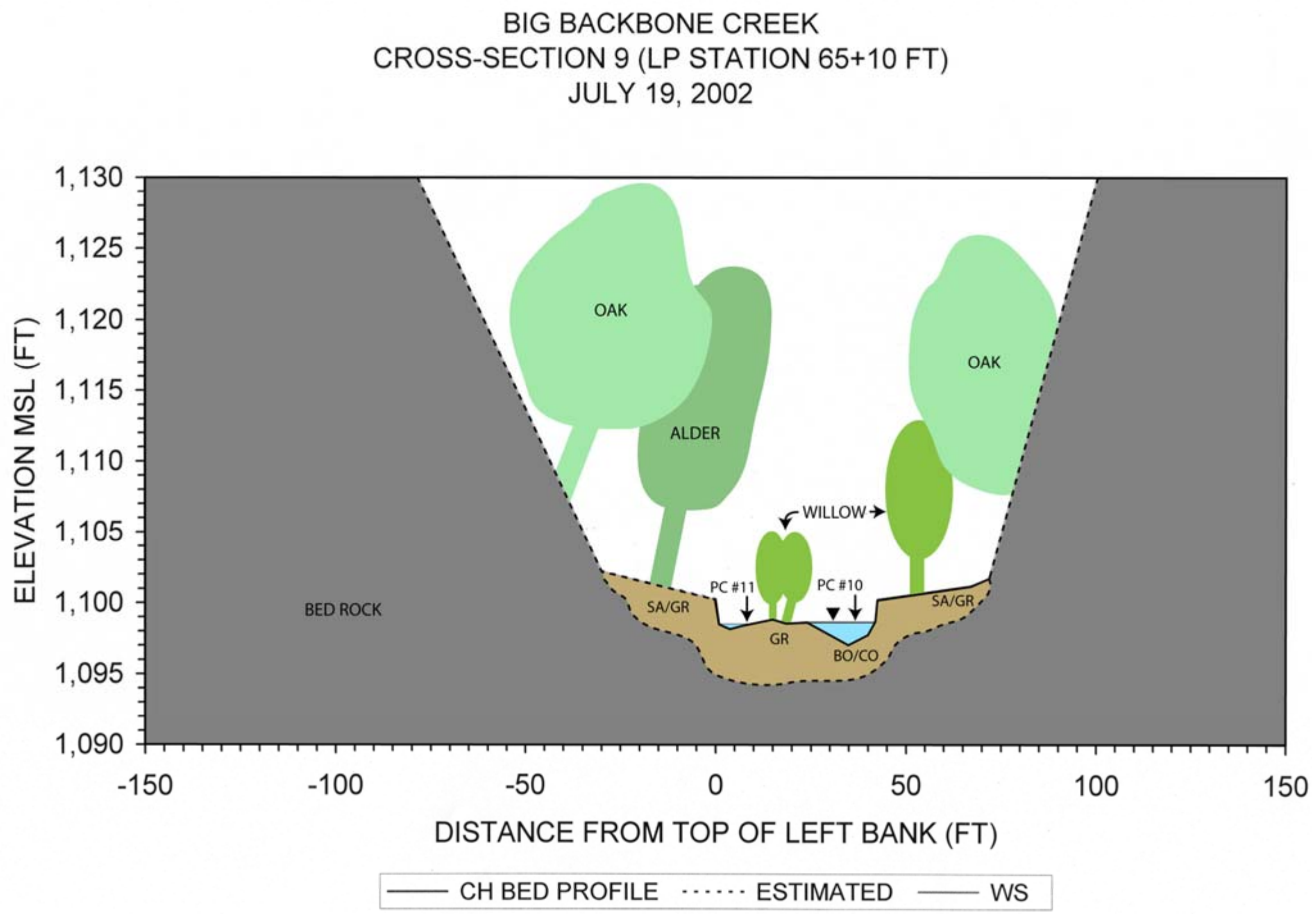
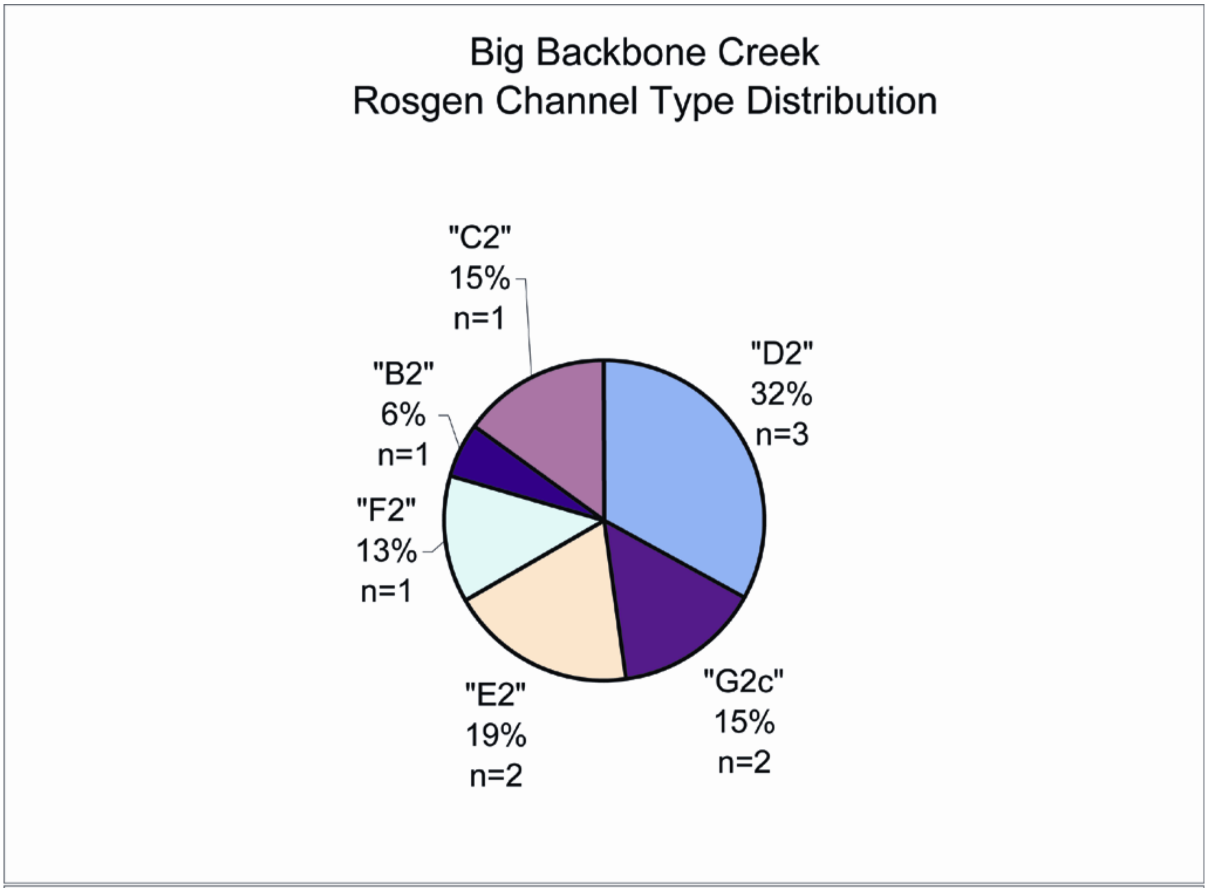


Figure 3-17
Big Backbone Creek Cross Section #9



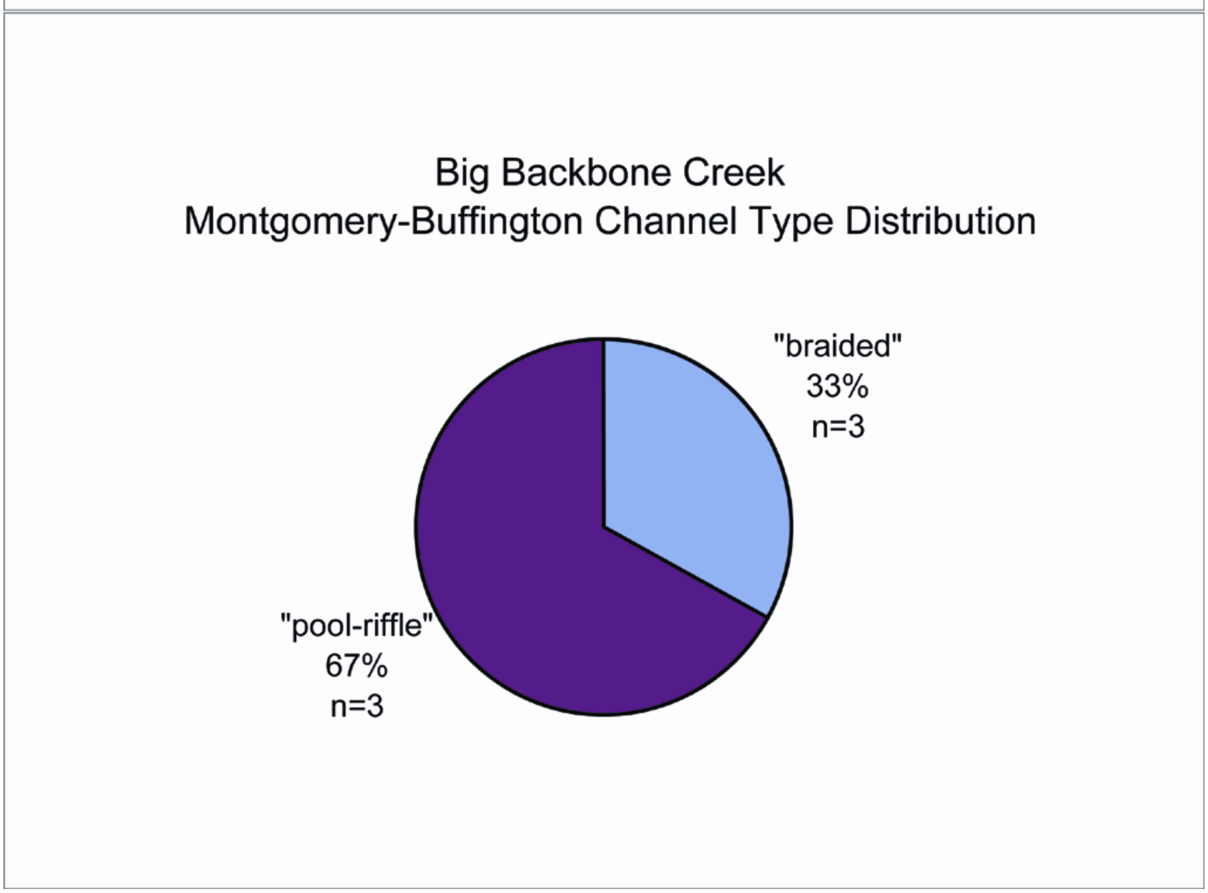


Figure 3-18
Big Backbone Creek Channel Characterization

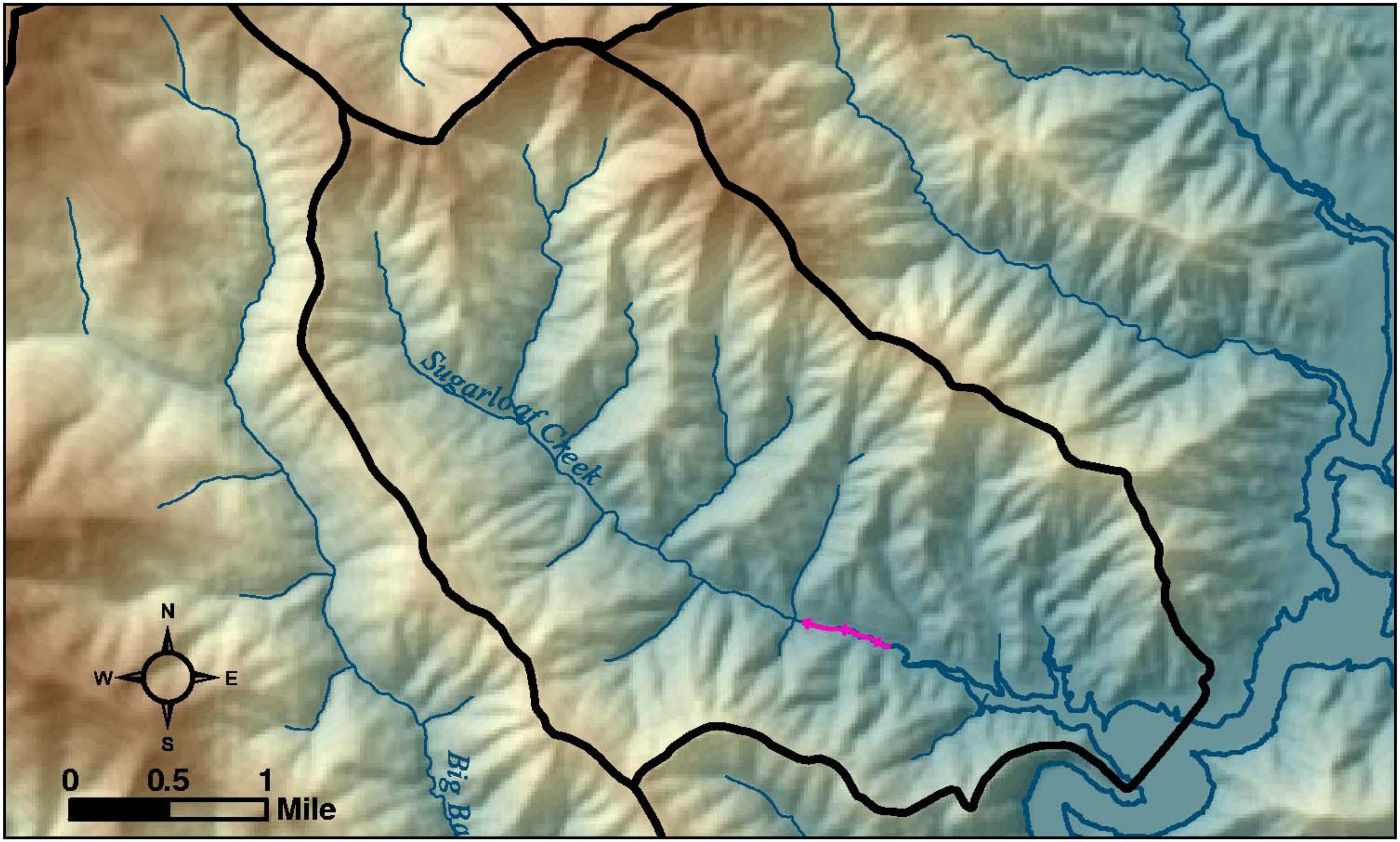


Figure 3-19
Sugarloaf Creek Watershed

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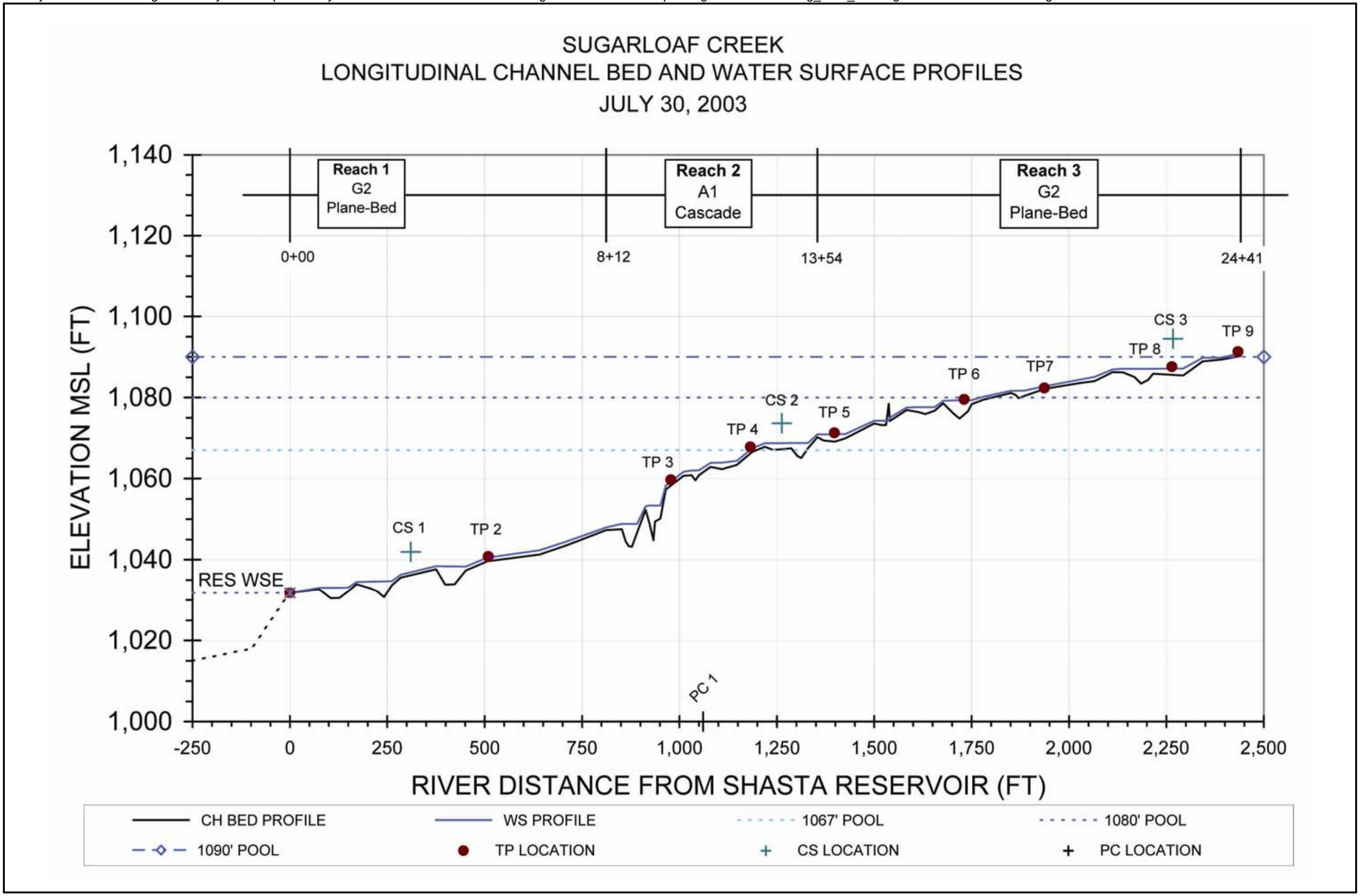

Figure 3-20
Sugarloaf Creek Longitudinal Profile

Figure 3-21 Sugarloaf Creek Aquatic Habitat Distribution

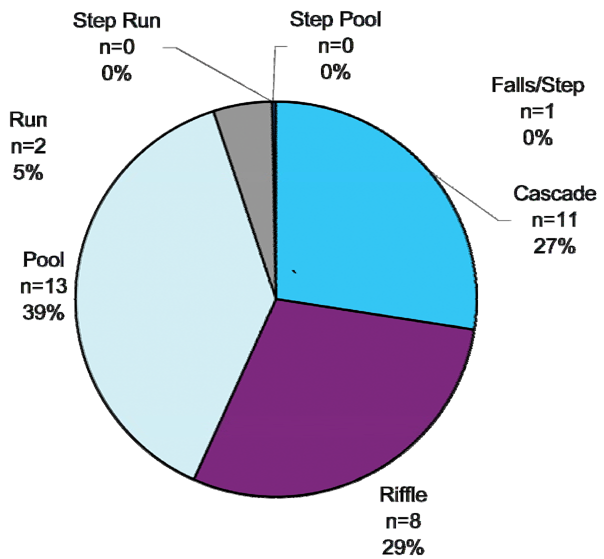

Figure 3-22 Sugarloaf Creek Dominant Substrate Distribution

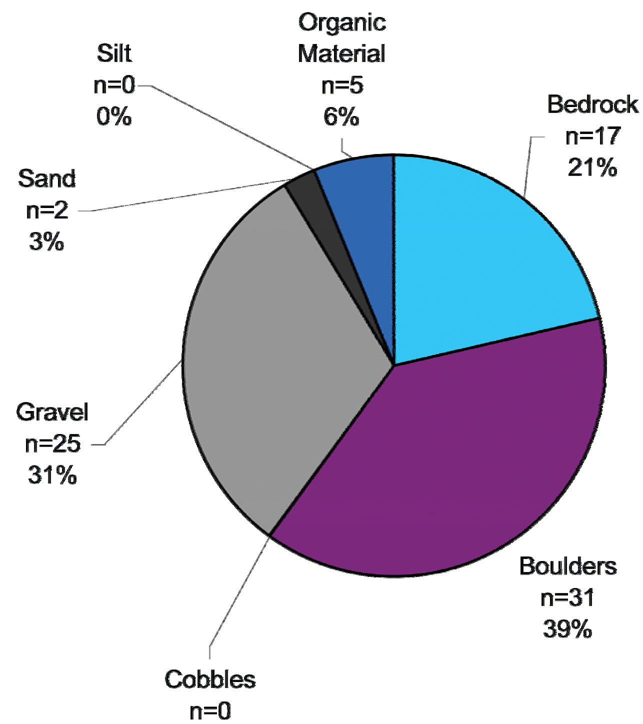

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Figure 3-21
Sugarloaf Creek Aquatic Habitat Distribution
Figure 3-22
Sugarloaf Creek Dominant Substrate Distribution

Figure 3-23 Sugarloaf Creek Cross Section #1

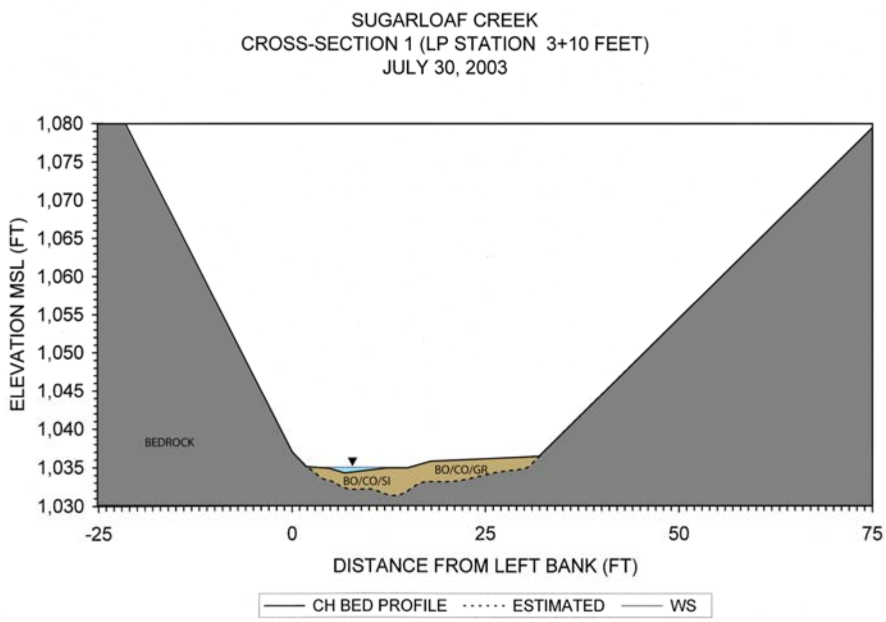

Figure 3-24 Sugarloaf Creek Cross Section #2

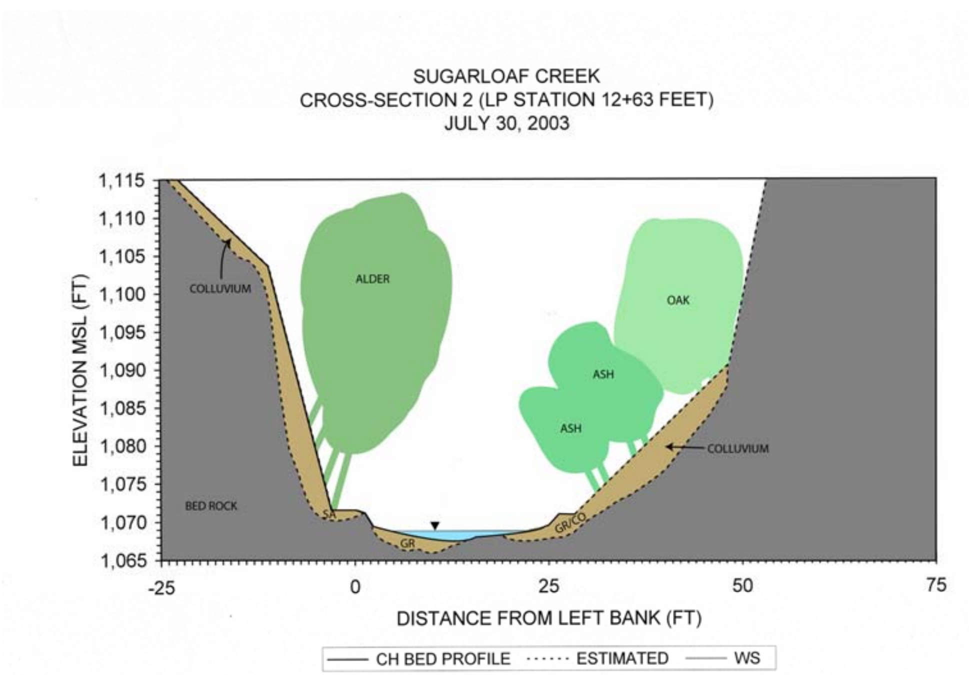

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Figure 3-23
Sugarloaf Creek Cross Section #1
Figure 3-24
Sugarloaf Creek Cross Section #2

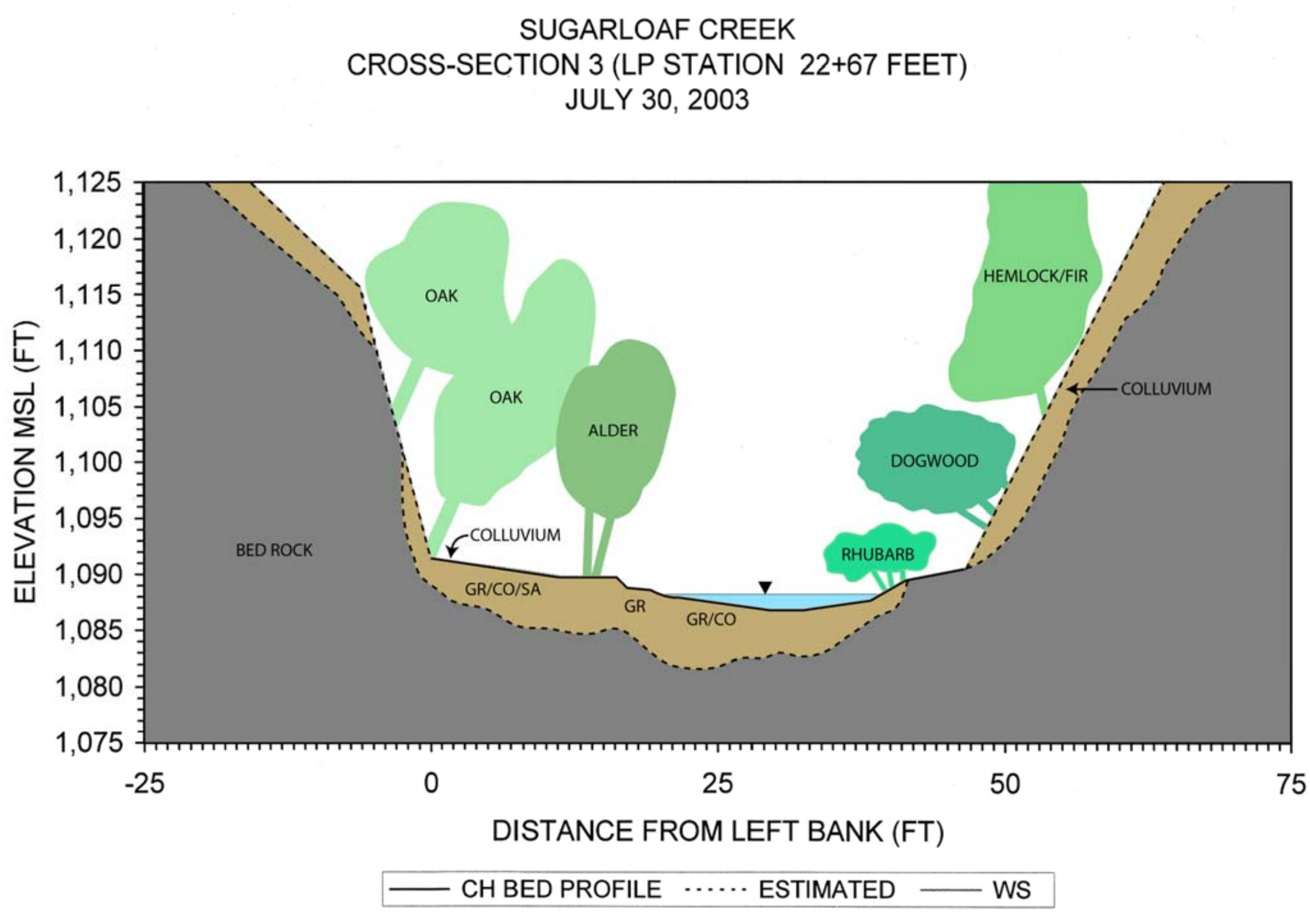


Figure 3-25
Sugarloaf Creek Cross Section #3

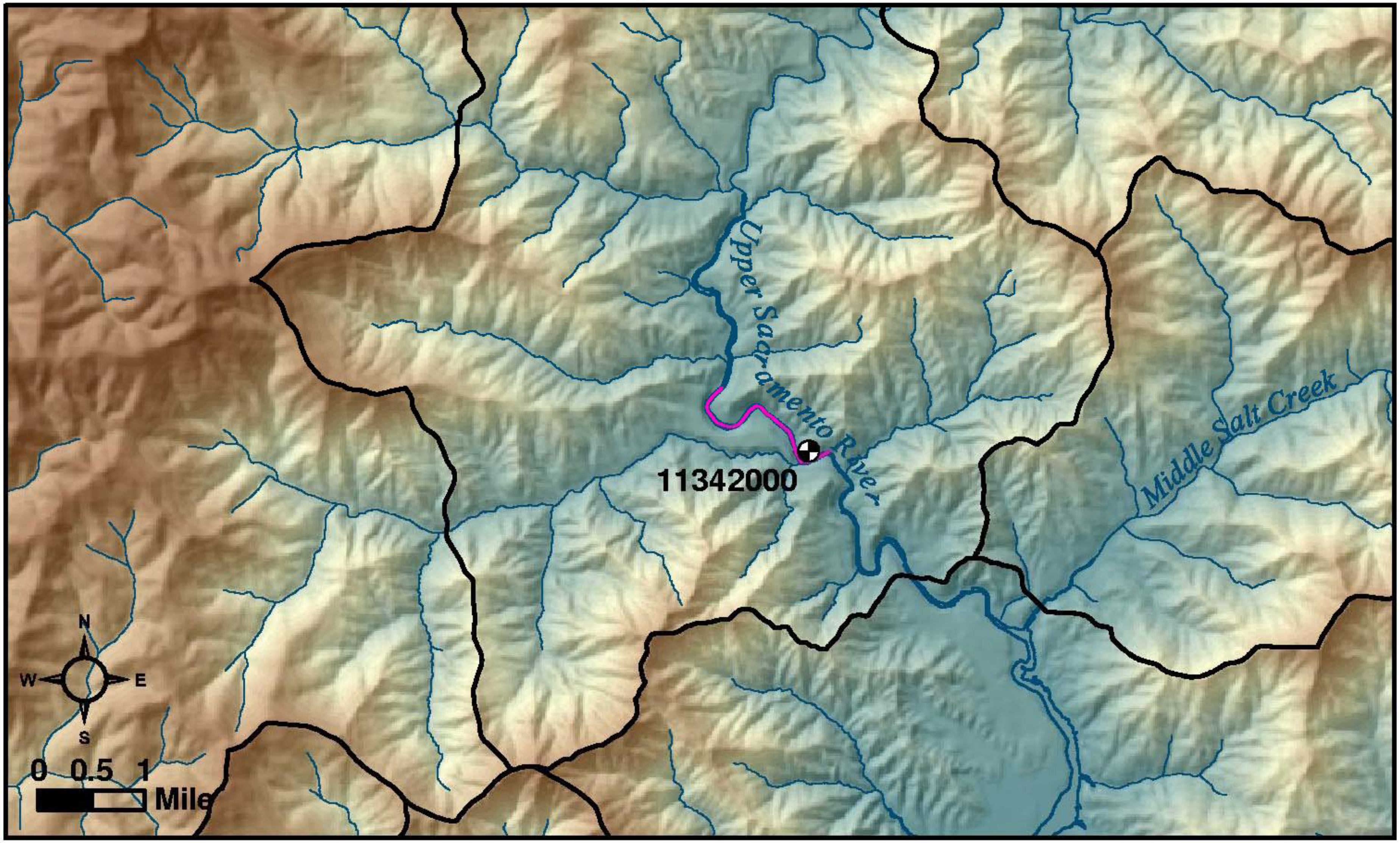


Figure 3-26
Upper Sacramento River Watershed

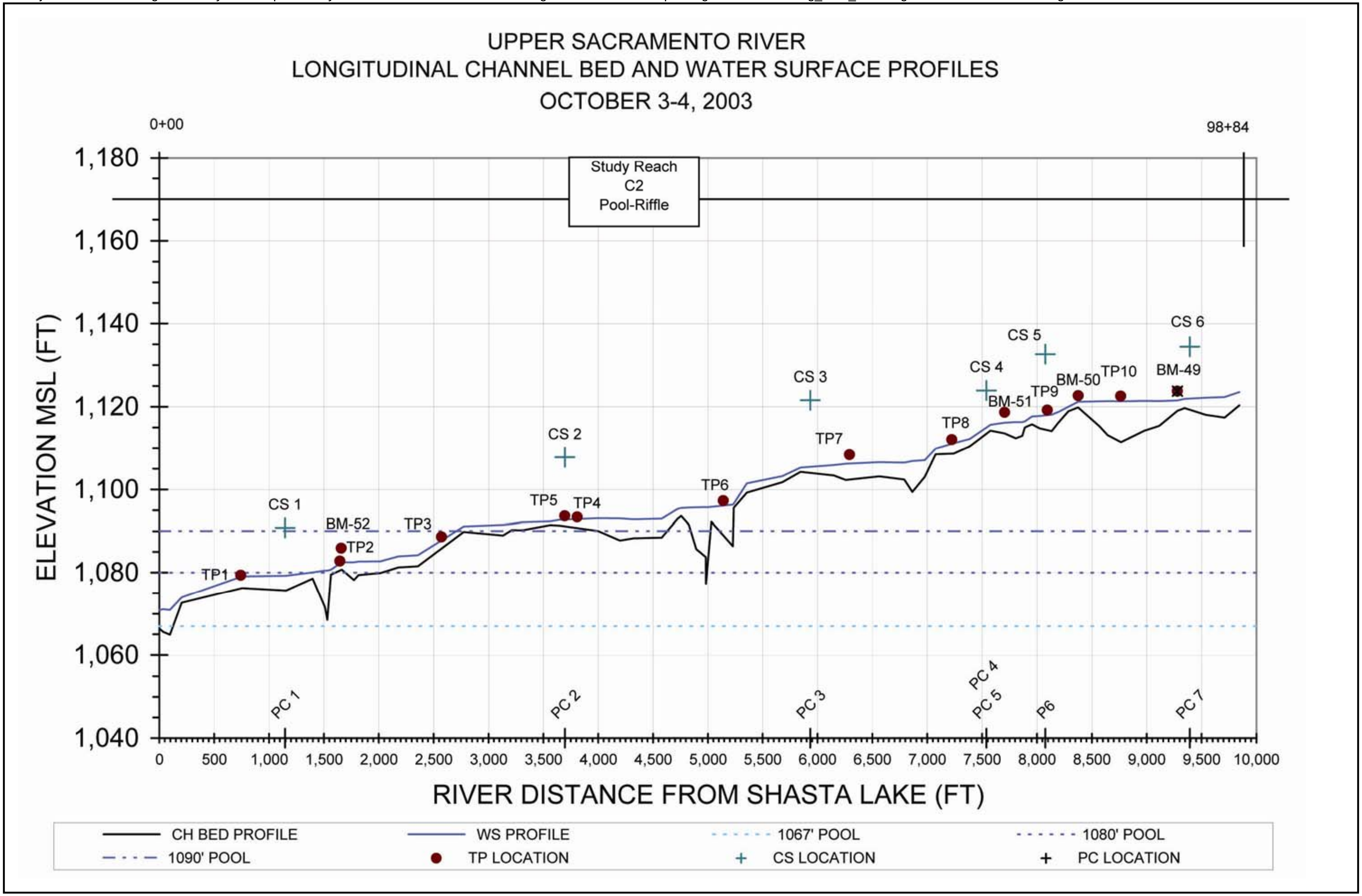
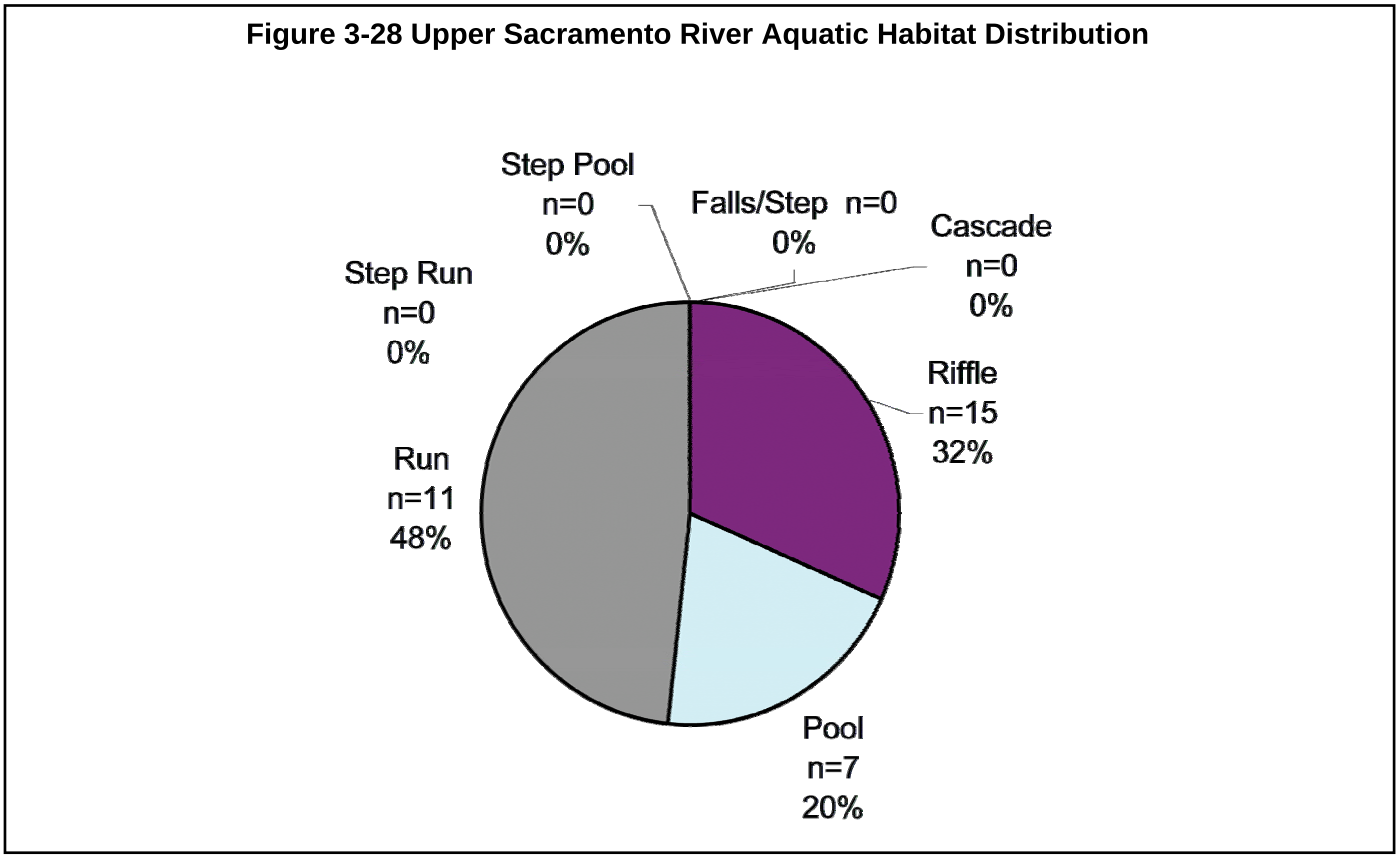


Figure 3-27
Upper Sacramento River Longitudinal Profile



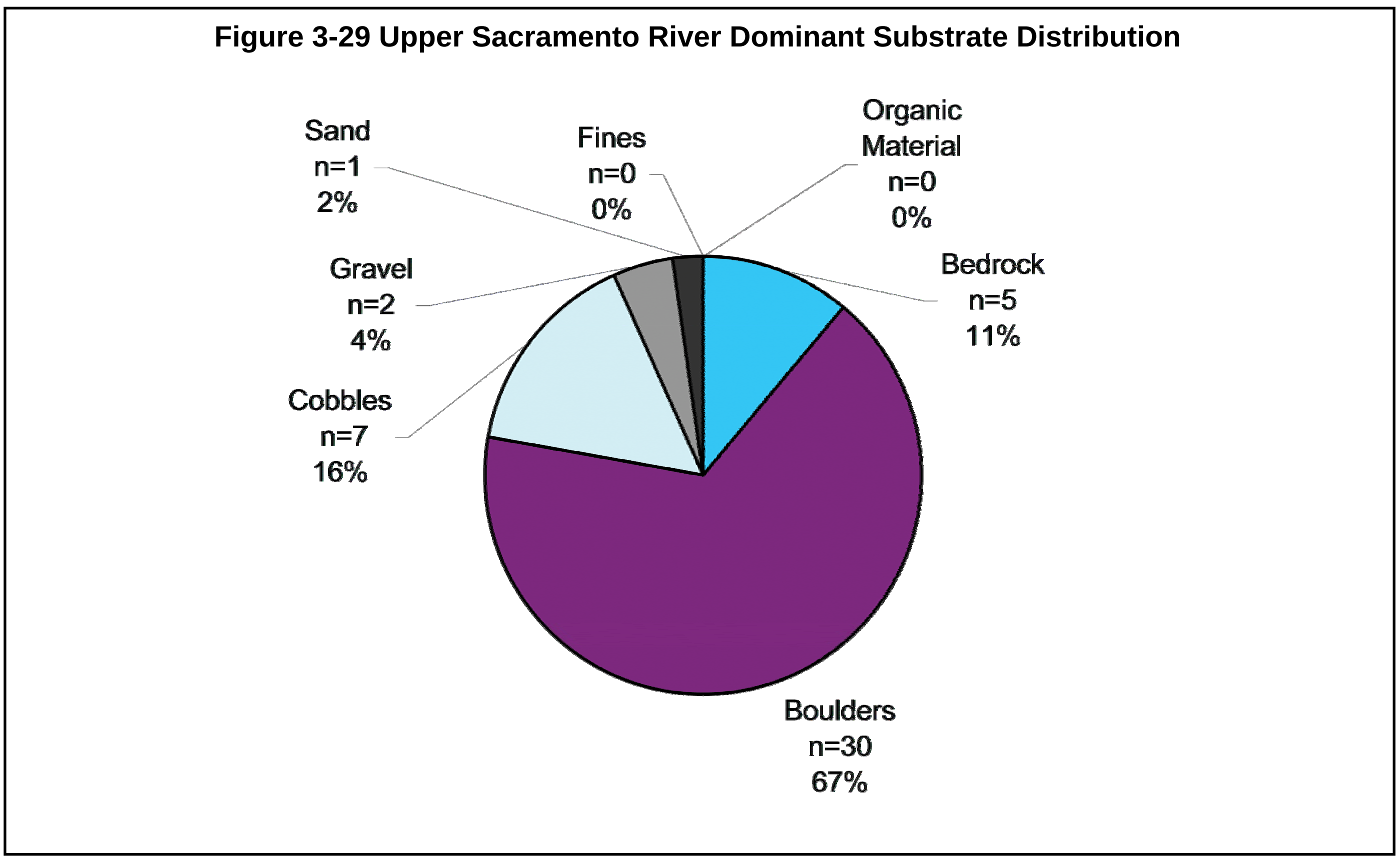


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Figure 3-28
Upper Sacramento River Aquatic Habitat Distribution
Figure 3-29
Upper Sacramento River Dominant Substrate Distribution

Figure 3-30 Upper Sacramento River Cross Section #1

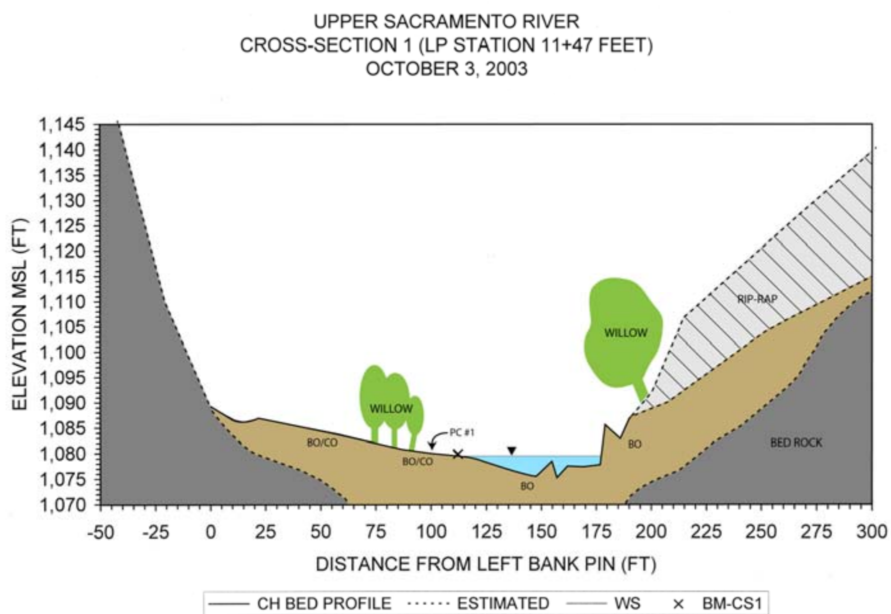

Figure 3-31 Upper Sacramento River Cross Section #2

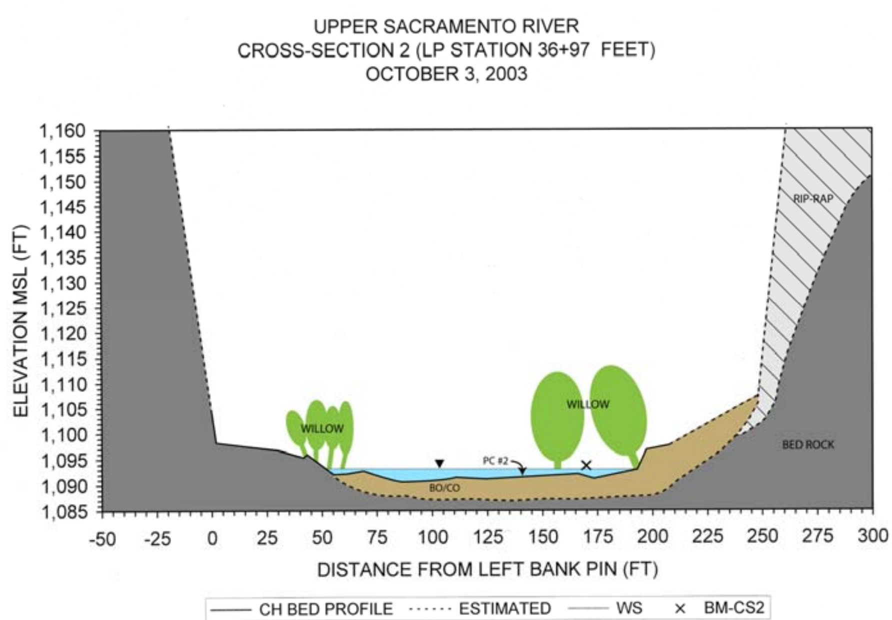

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Figure 3-30
Upper Sacramento River Cross Section #1
Figure 3-31
Upper Sacramento River Cross Section #2

Figure 3-32 Upper Sacramento River Cross Section #3

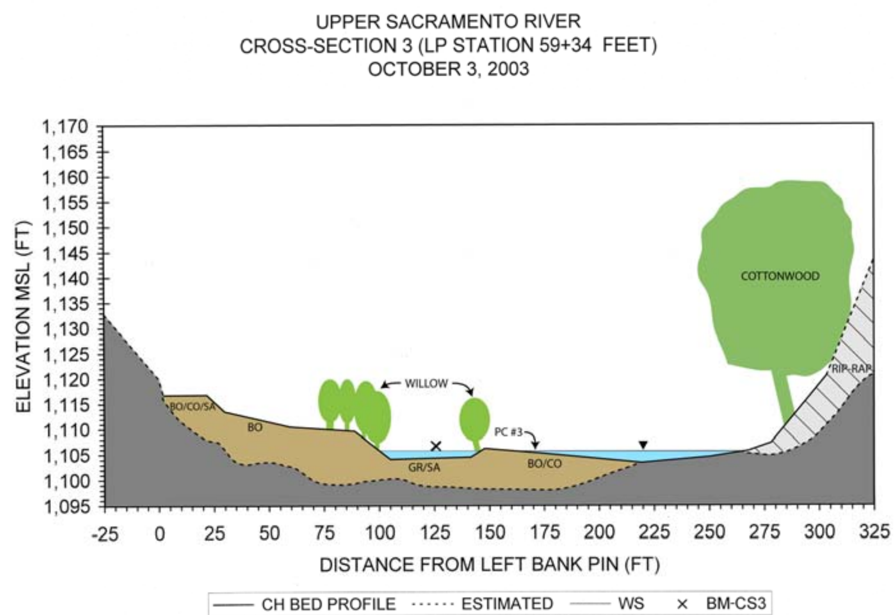

Figure 3-33 Upper Sacramento River Cross Section #4

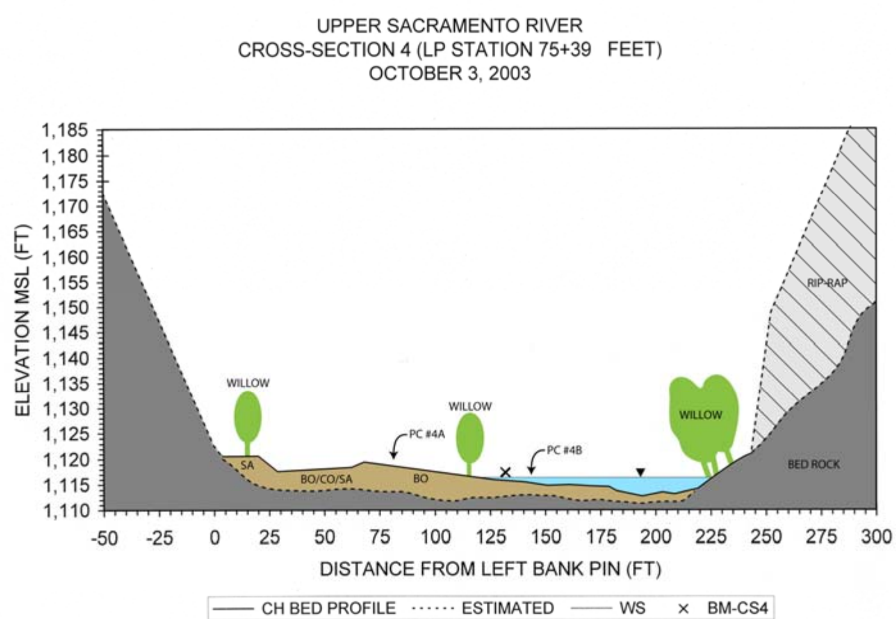

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Figure 3-32
Upper Sacramento River Cross Section #3
Figure 3-33
Upper Sacramento River Cross Section #4

Figure 3-34 Upper Sacramento River Cross Section #5

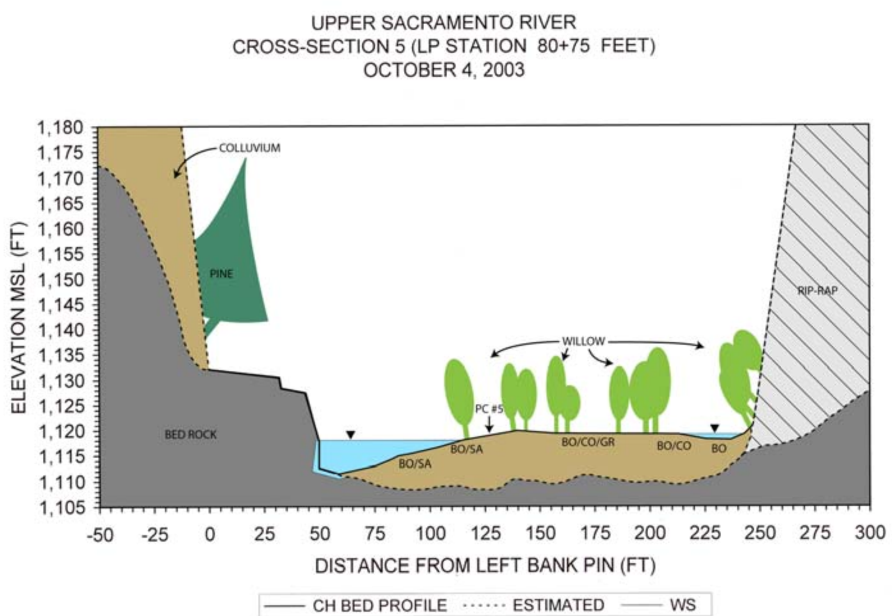

Figure 3-35 Upper Sacramento River Cross Section #6

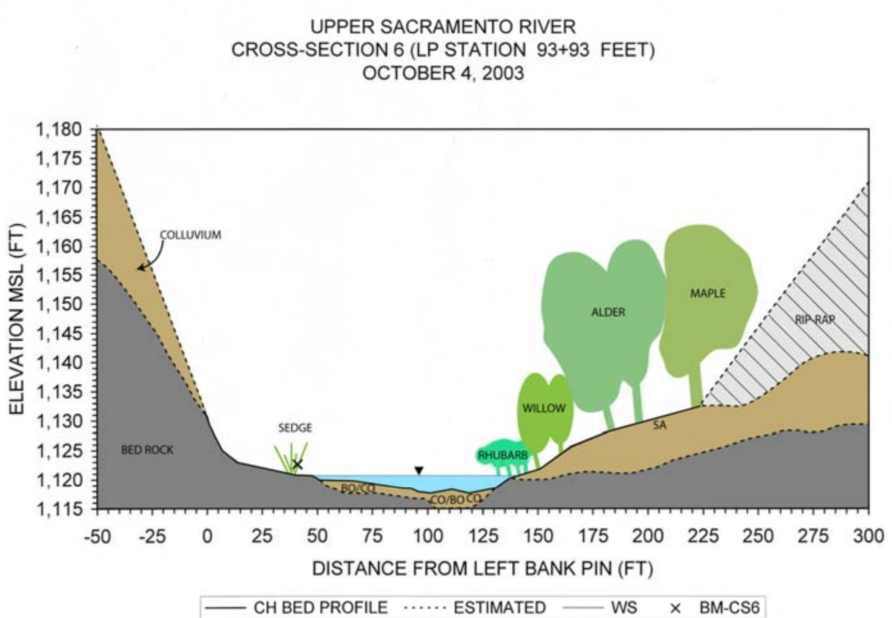

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Figure 3-34
Upper Sacramento River Cross Section #5
Figure 3-35
Upper Sacramento River Cross Section #6

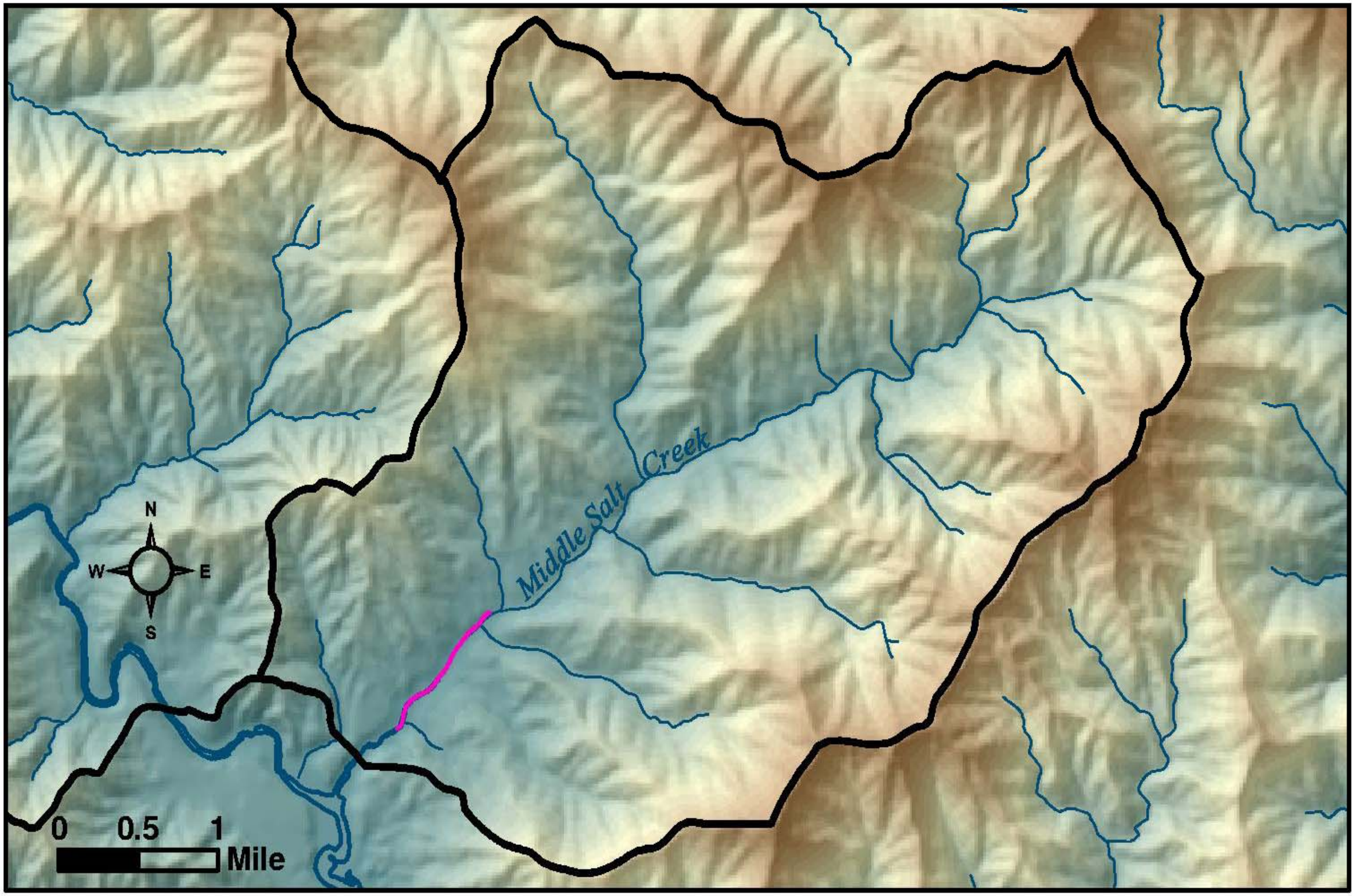

Figure 3-36
Middle Salt Creek Watershed

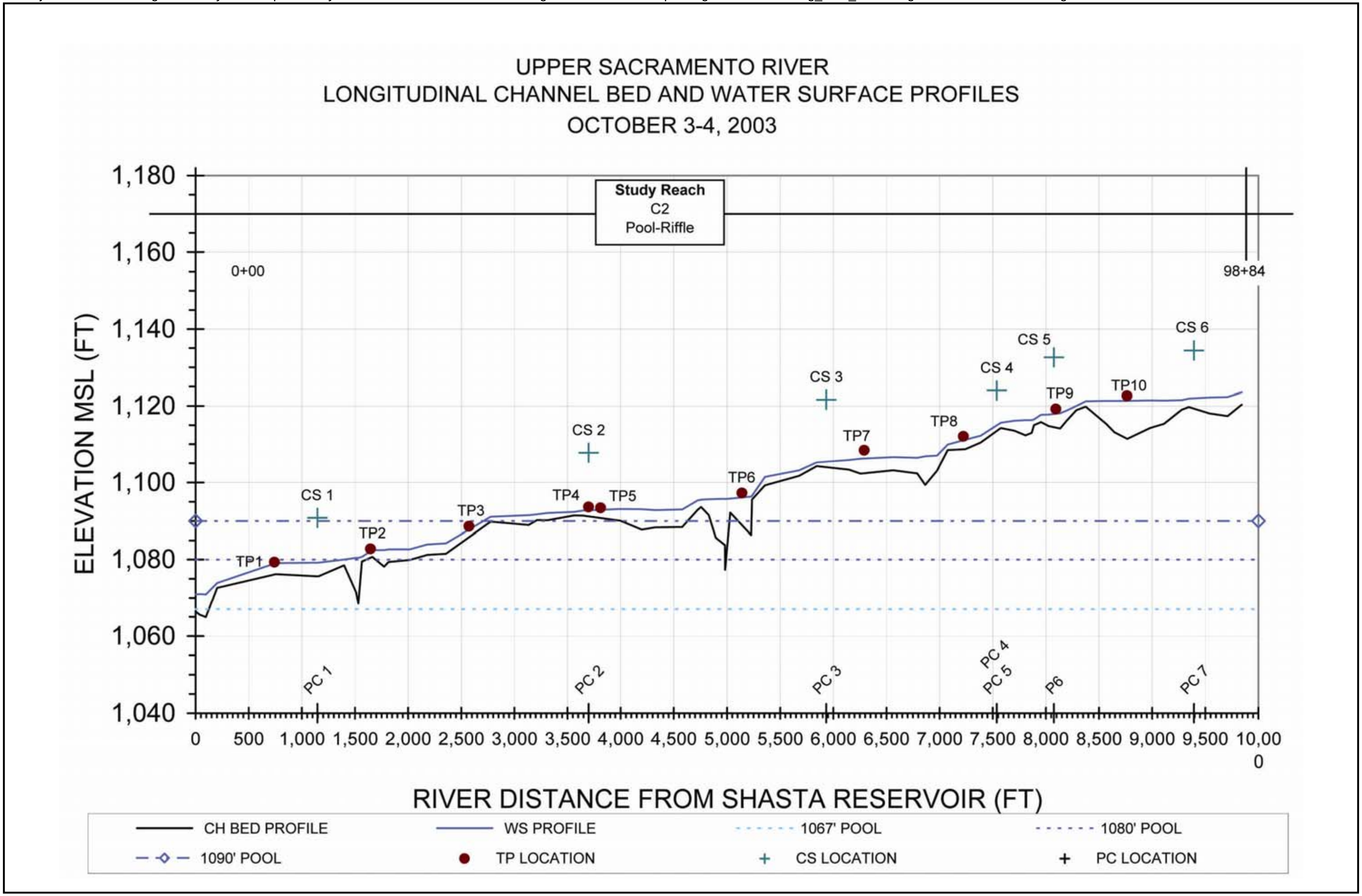

Figure 3-37
Middle Salt Creek Longitudinal Profile

Figure 3-38 Middle Salt Creek Aquatic Habitat Distribution

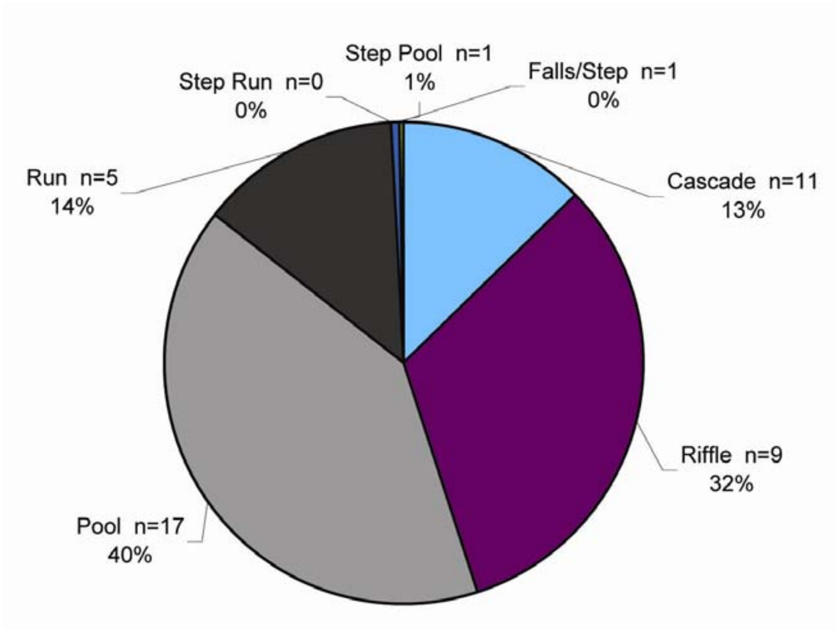

Figure 3-39 Middle Salt Creek Dominant Substrate Distribution

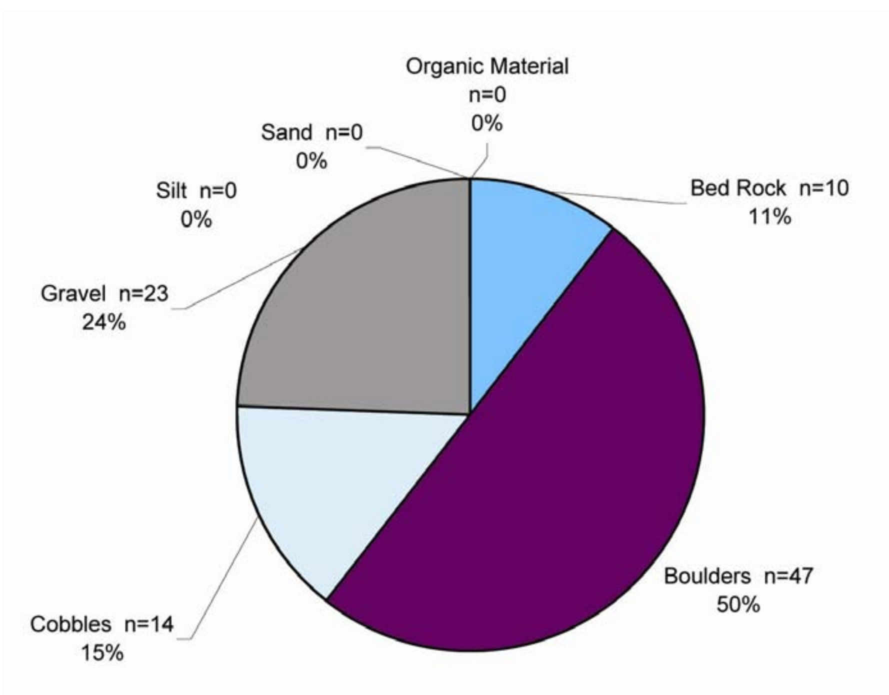

Figure 3-38
Middle Salt Creek Aquatic Habitat Distribution
Figure 3-39
Middle Salt Creek Dominant Substrate Distribution

Figure 3-40 Middle Salt Creek Cross Section #1

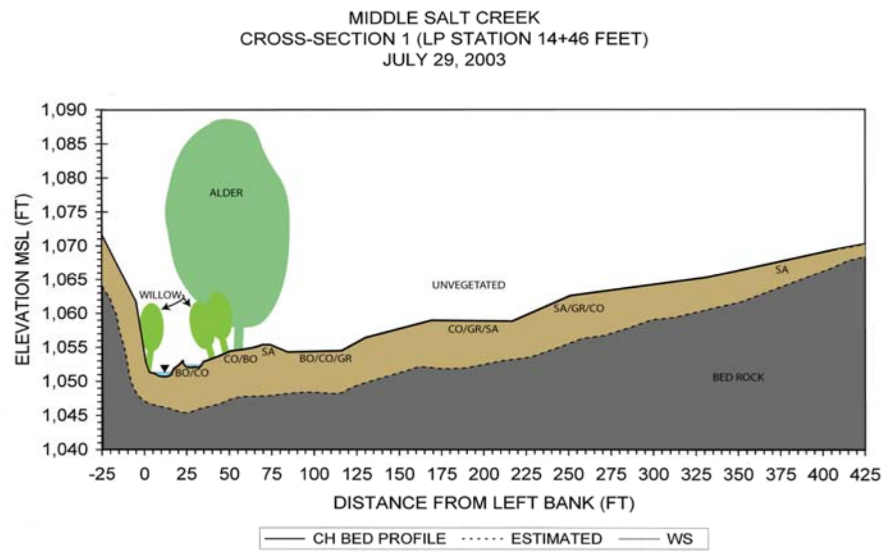

Figure 3-41 Middle Salt Creek Cross Section #3

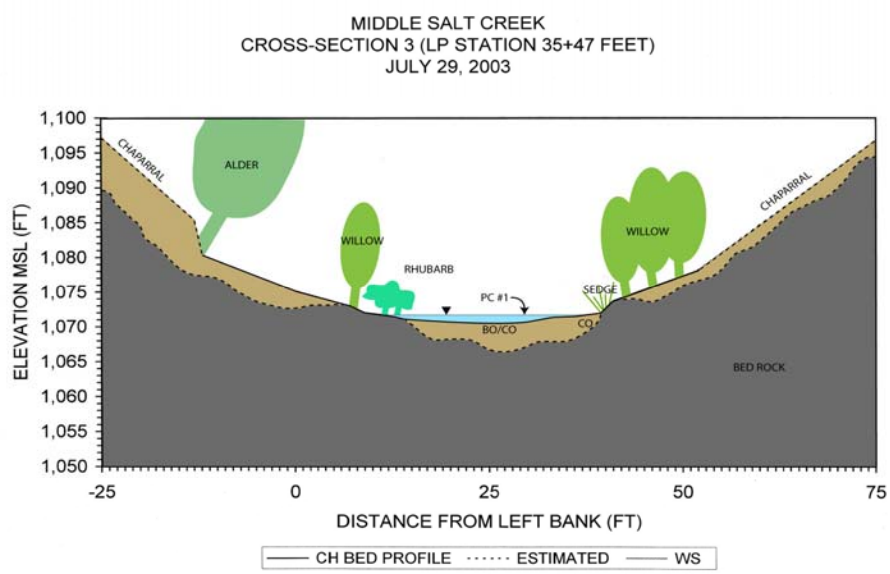

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Figure 3-40
Middle Salt Creek Cross Section #1
Figure 3-41
Middle Salt Creek Cross Section #3

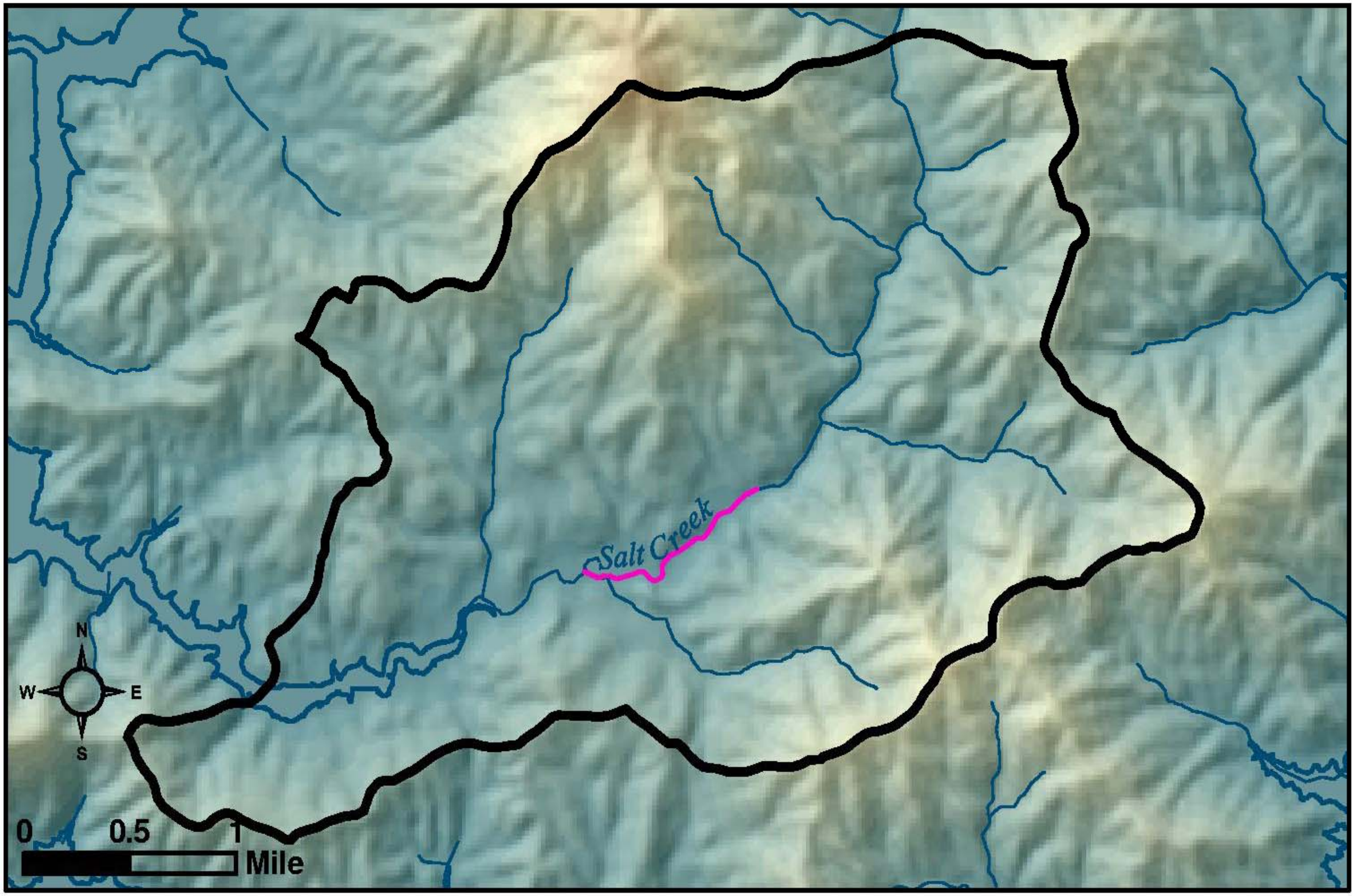

Figure 3-42
Salt Creek Watershed

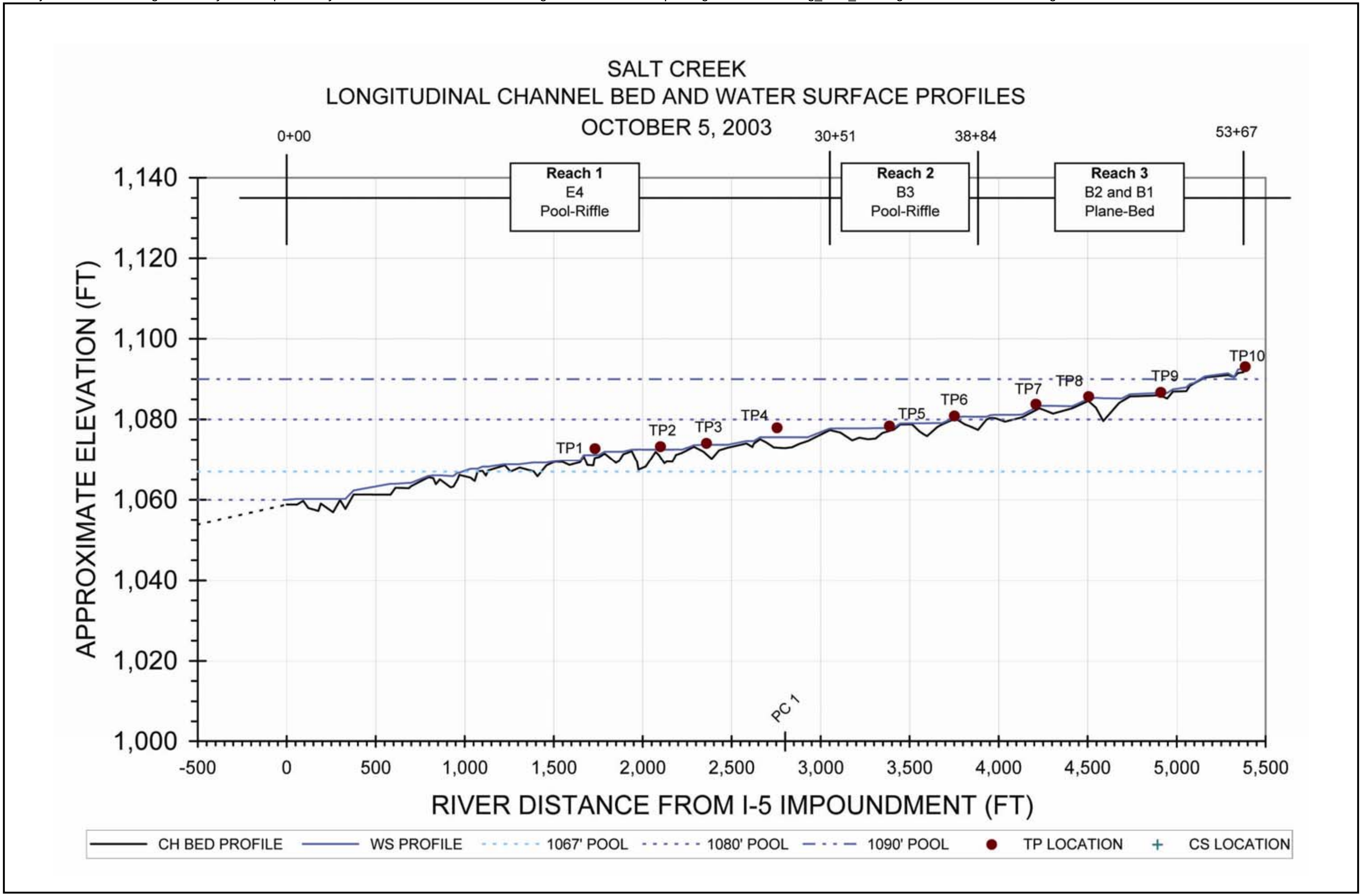

Figure 3-43
Salt Creek Longitudinal Profile

Figure 3-44 Salt Creek Aquatic Habitat Distribution

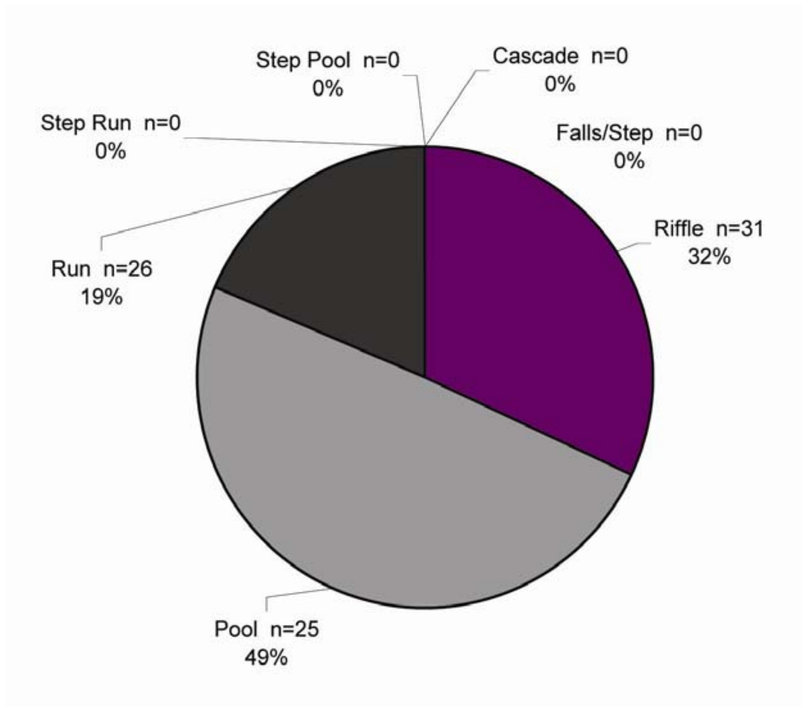

Figure 3-45 Salt Creek Dominant Substrate Distribution

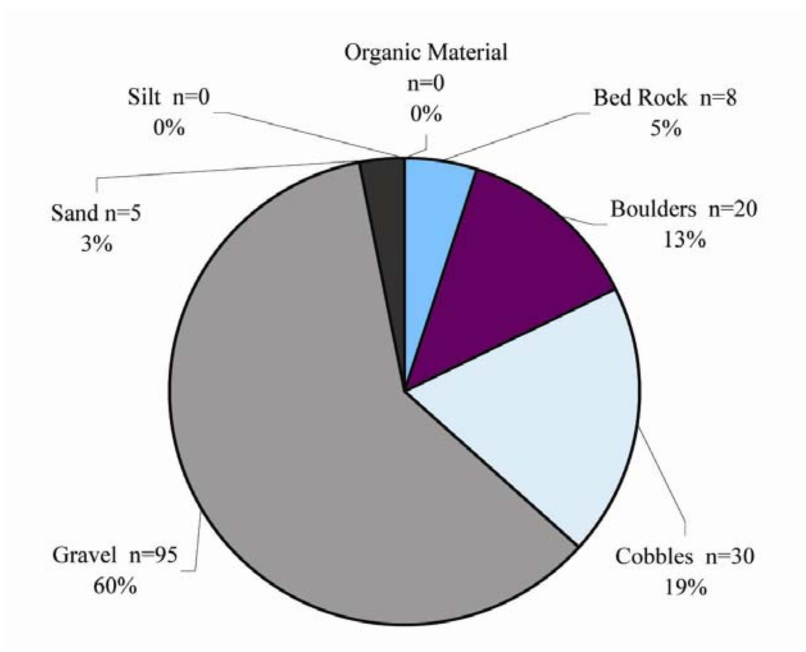

Figure 3-44
Salt Creek Aquatic Habitat Distribution
Figure 3-45
Salt Creek Dominant Substrate Distribution

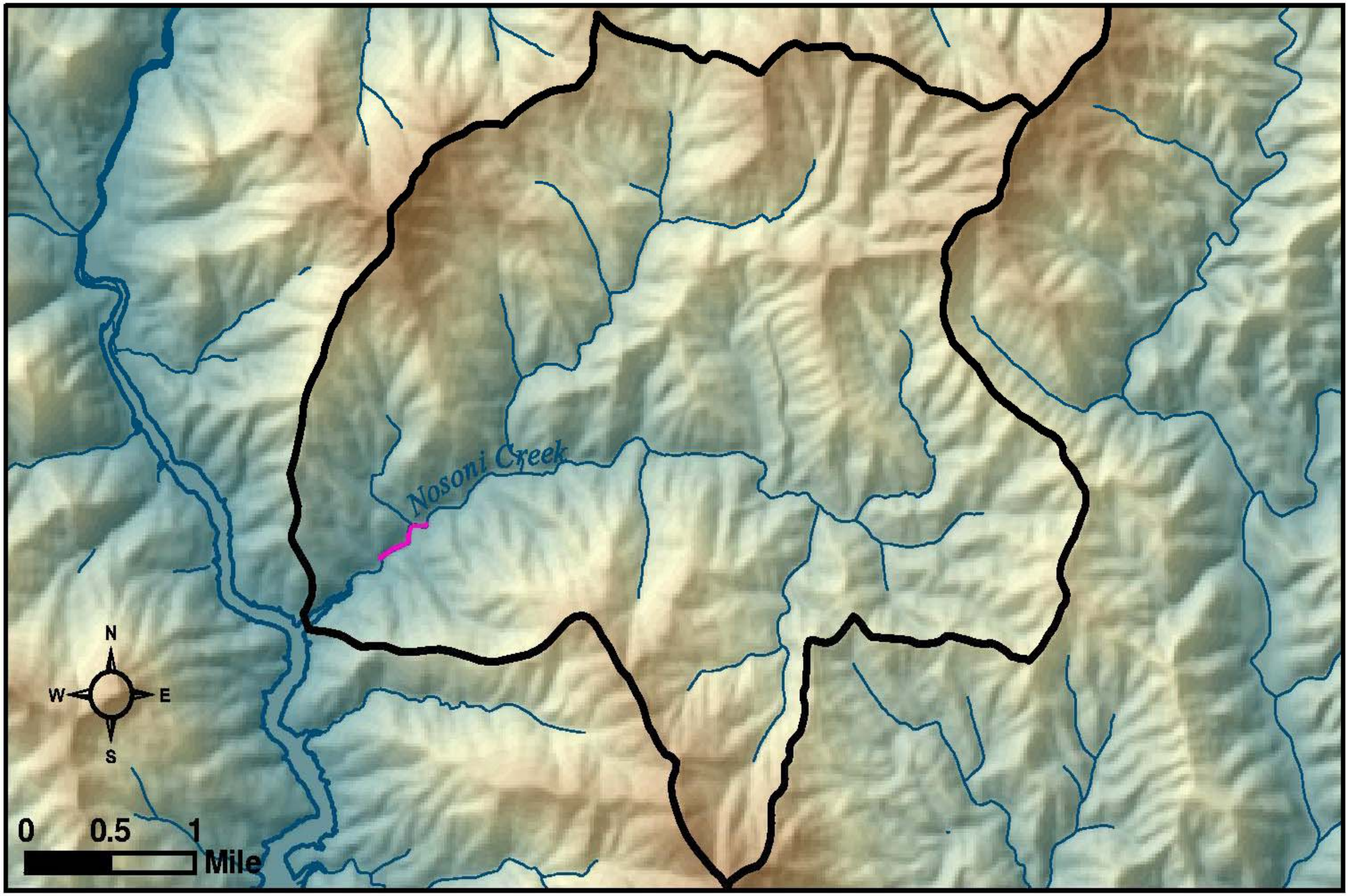

Figure 3-46
Nosoni Creek Watershed

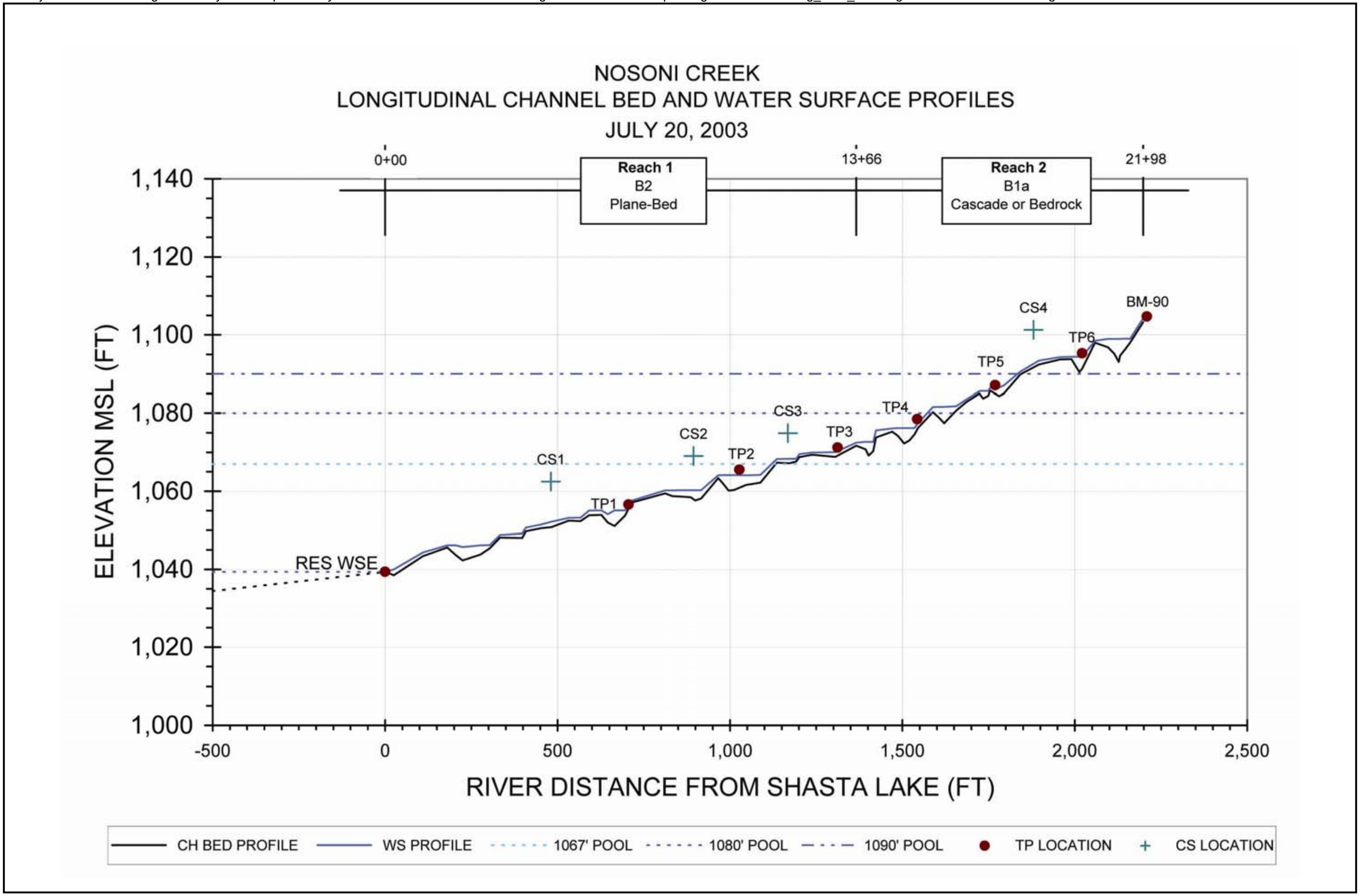

Figure 3-47
Nosoni Creek Longitudinal Profile

Figure 3-48 Nosoni Creek Aquatic Habitat Distribution

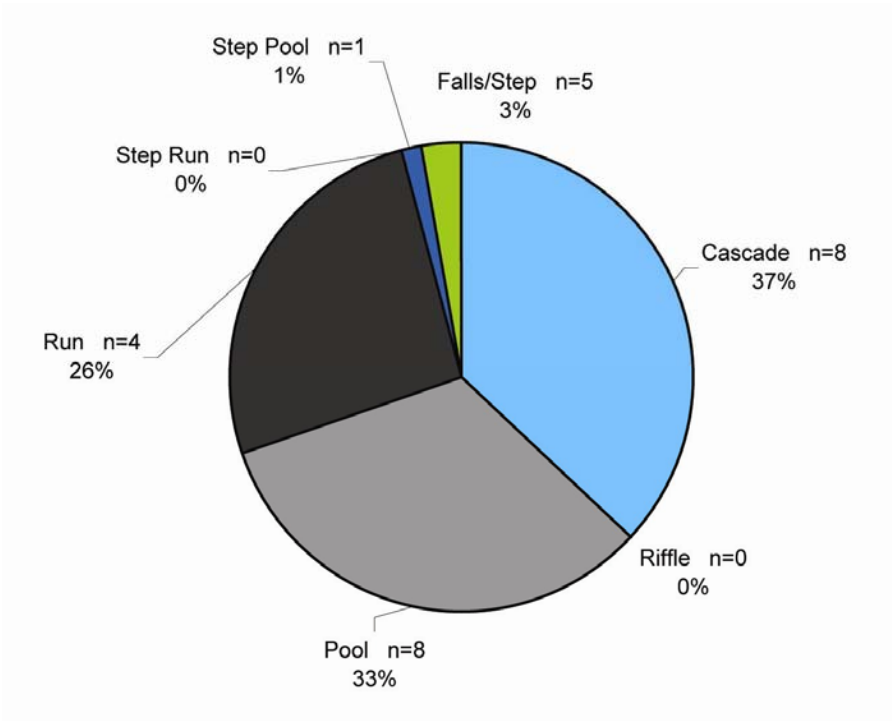

Figure 3-49 Nosoni Creek Dominant Substrate Distribution

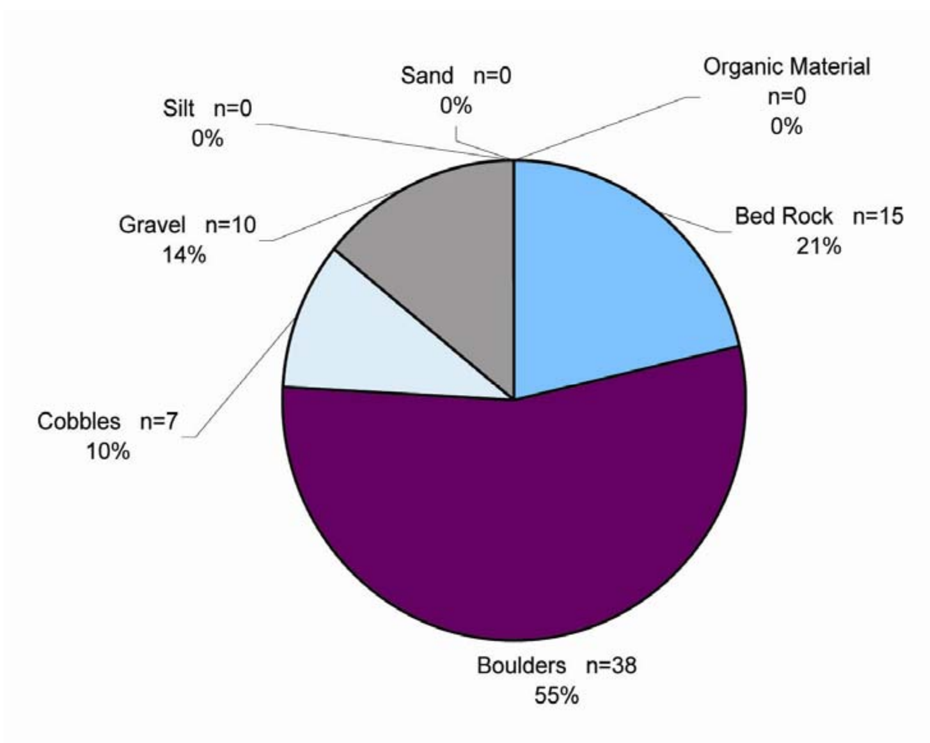

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Figure 3-48
Nosoni Creek Aquatic Habitat Distribution
Figure 3-49
Nosoni Creek Dominant Substrate Distribution

Figure 3-50 Nosoni Creek Cross Section #1

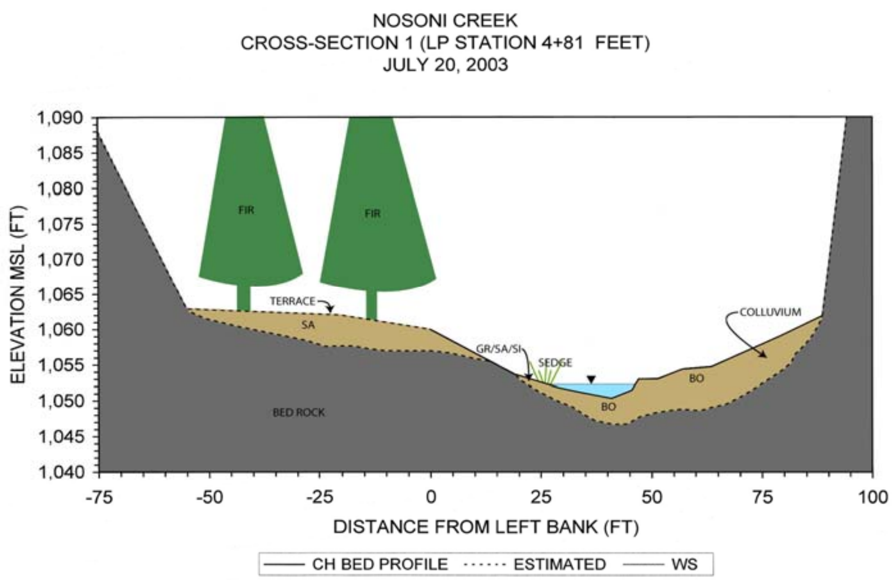

Figure 3-51 Nosoni Creek Cross Section #2

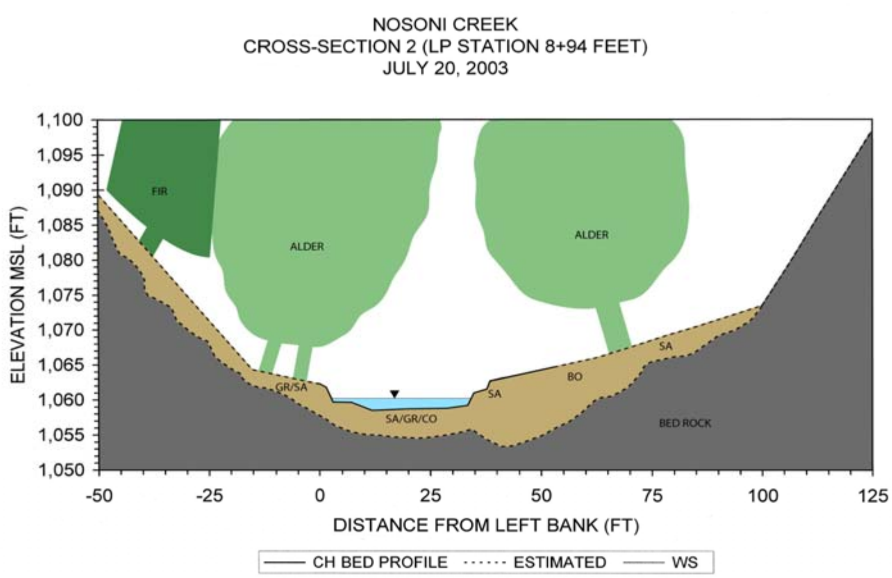

Figure 3-50
Nosoni Creek Cross Section #1
Figure 3-51
Nosoni Creek Cross Section #2

Figure 3-52 Nosoni Creek Cross Section #3

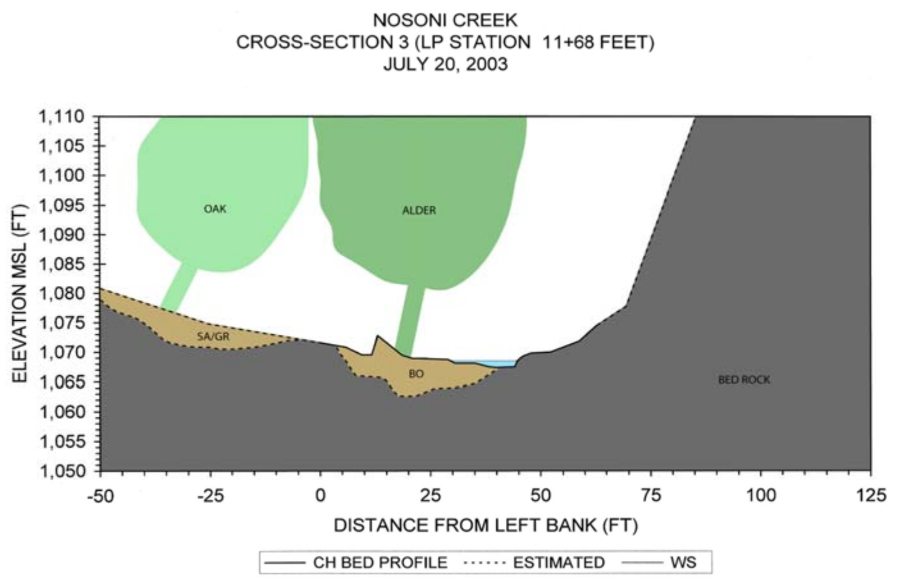

Figure 3-53 Nosoni Creek Cross Section #4

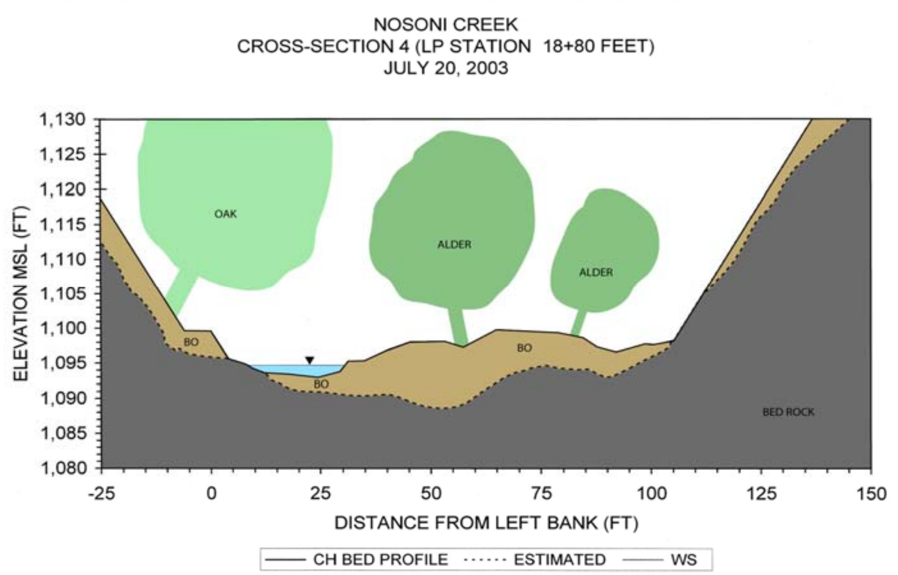

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Figure 3-52
Nosoni Creek Cross Section #3
Figure 3-53
Nosoni Creek Cross Section #4

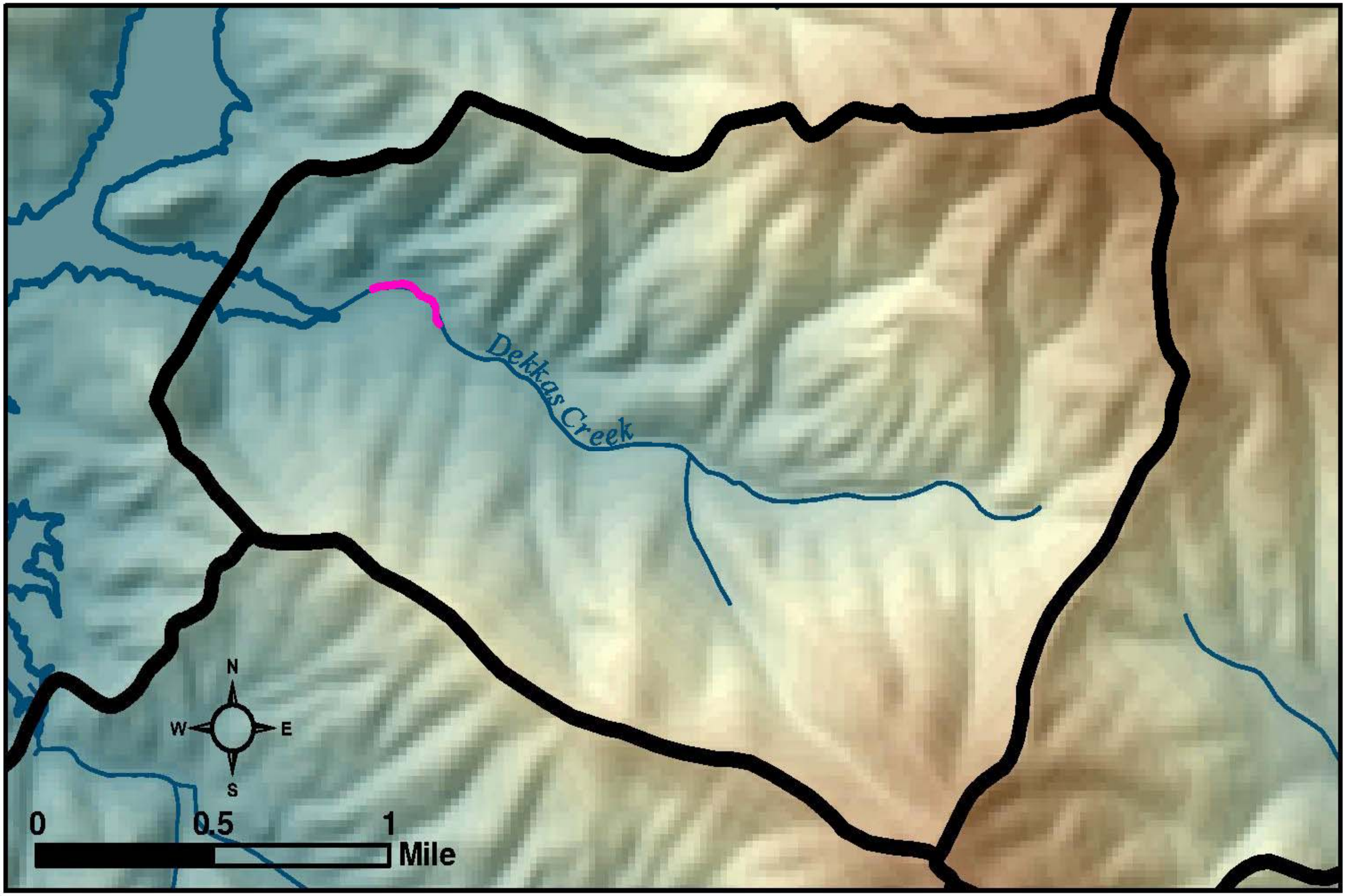

Figure 3-54
Dekkas Creek Watershed

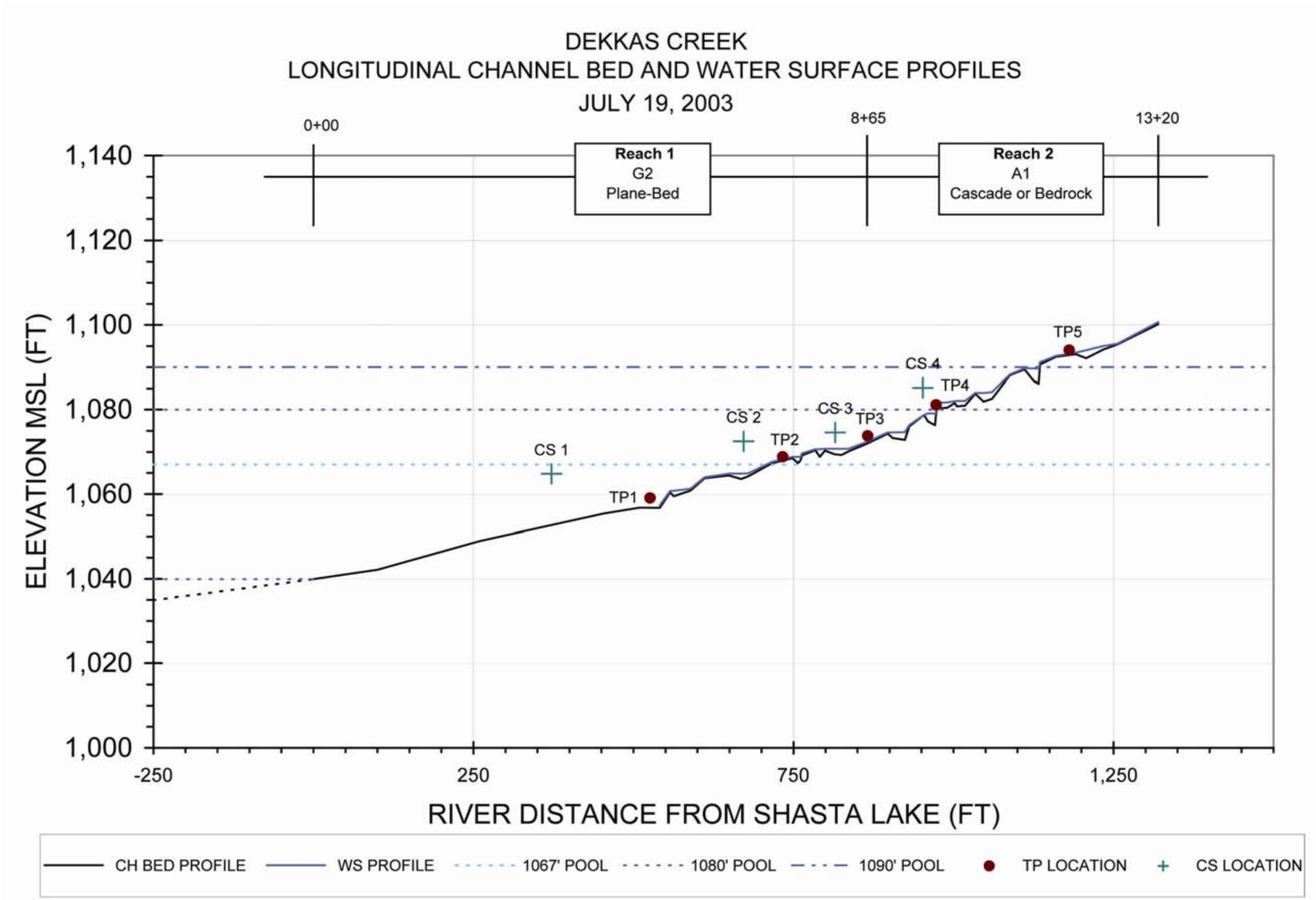

Figure 3-55
Dekkas Creek Longitudinal Profile

Figure 3-56 Dekkas Creek Aquatic Habitat Distribution

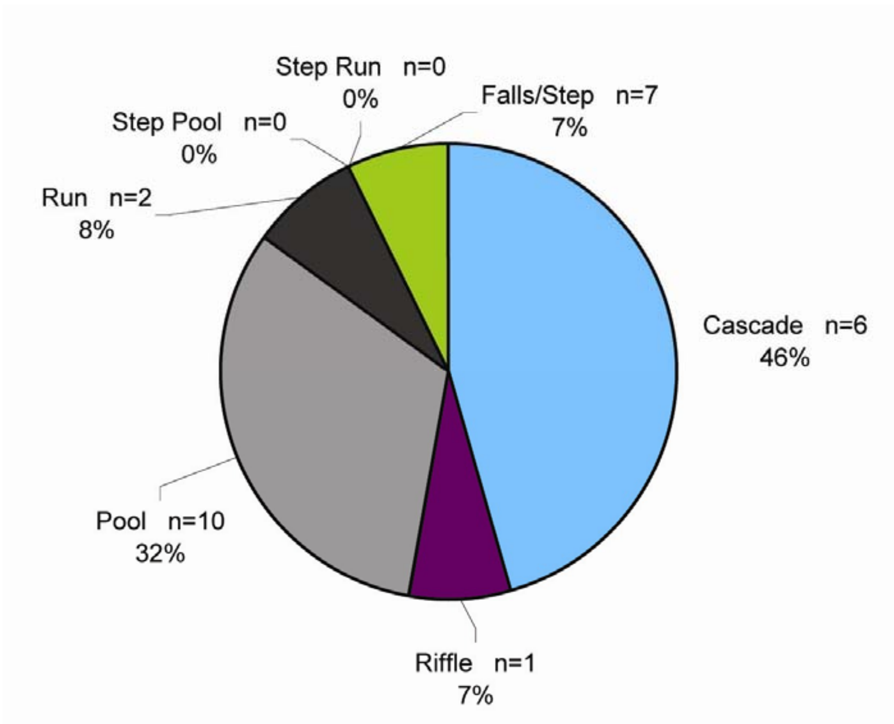

Figure 3-57 Dekkas Creek Dominant Substrate Distribution

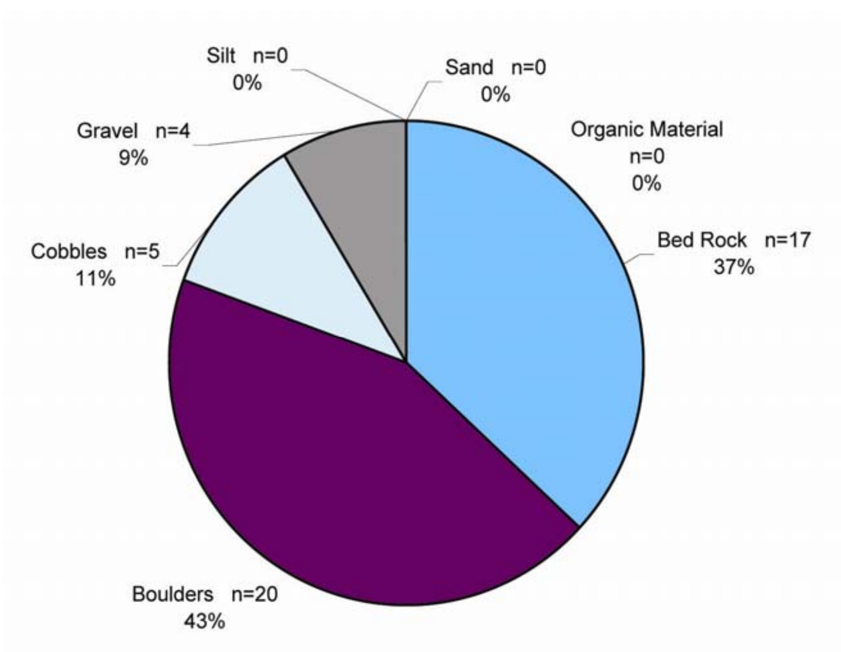

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Figure 3-56
Dekkas Creek Aquatic Habitat Distribution
Figure 3-57
Dekkas Creek Dominant Substrate Distribution

Figure 3-58 Dekkas Creek Cross Section #1

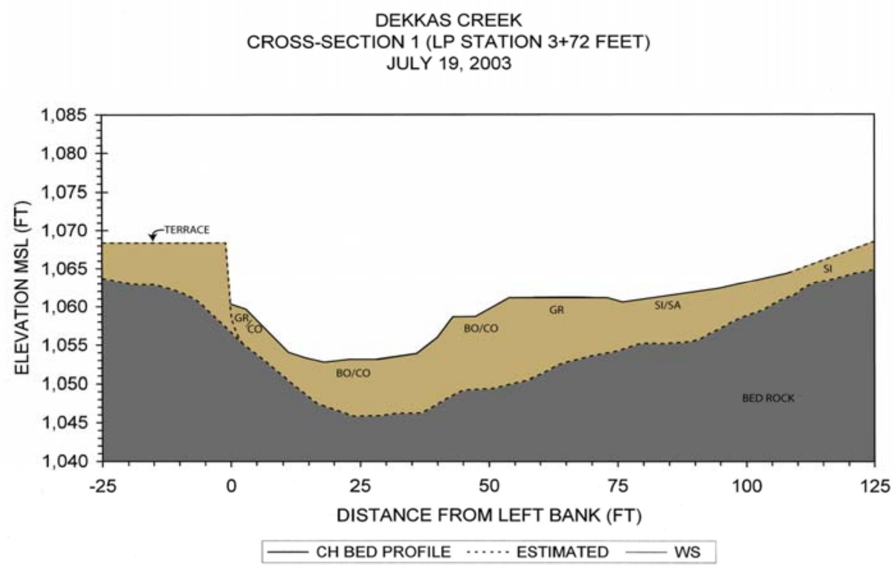

Figure 3-59 Dekkas Creek Cross Section #2

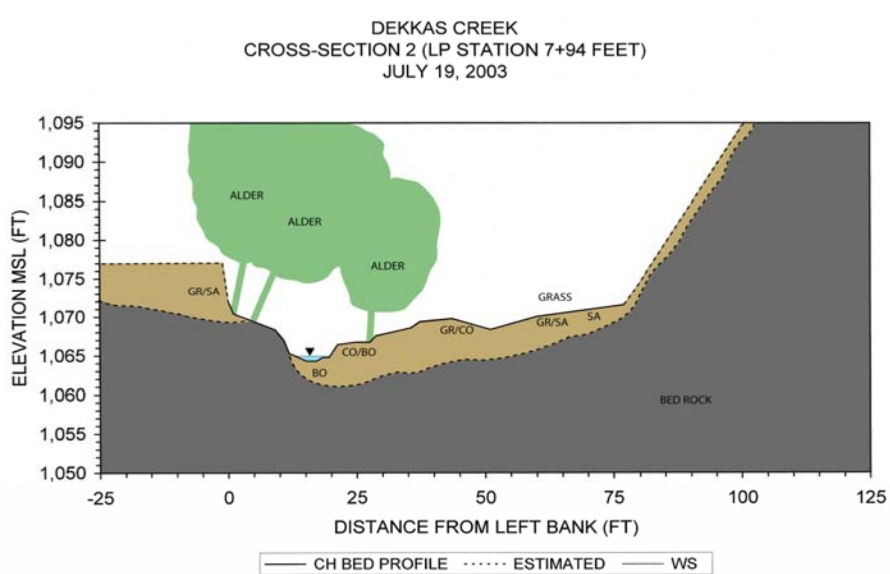

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Figure 3-58
Dekkas Creek Cross Section #1
Figure 3-59
Dekkas Creek Cross Section #2

Figure 3-60 Dekkas Creek Cross Section #3

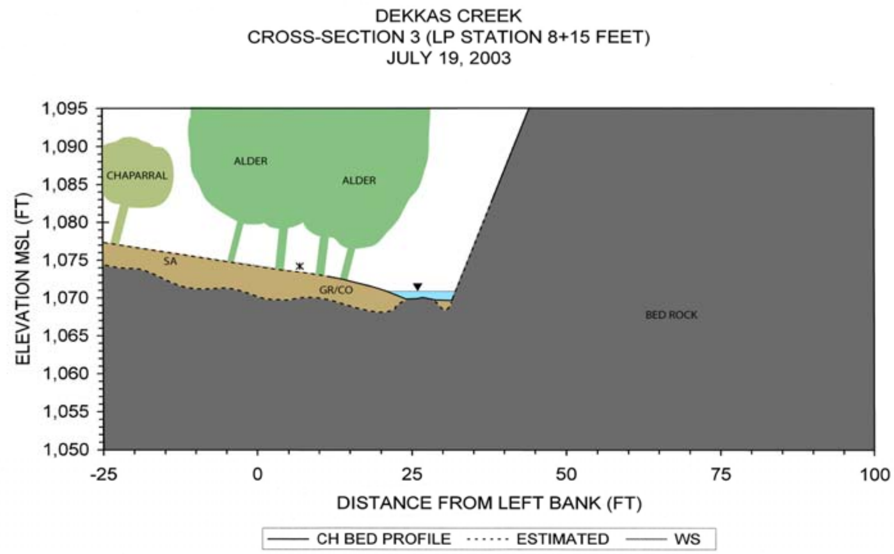

Figure 3-61 Dekkas Creek Cross Section #4

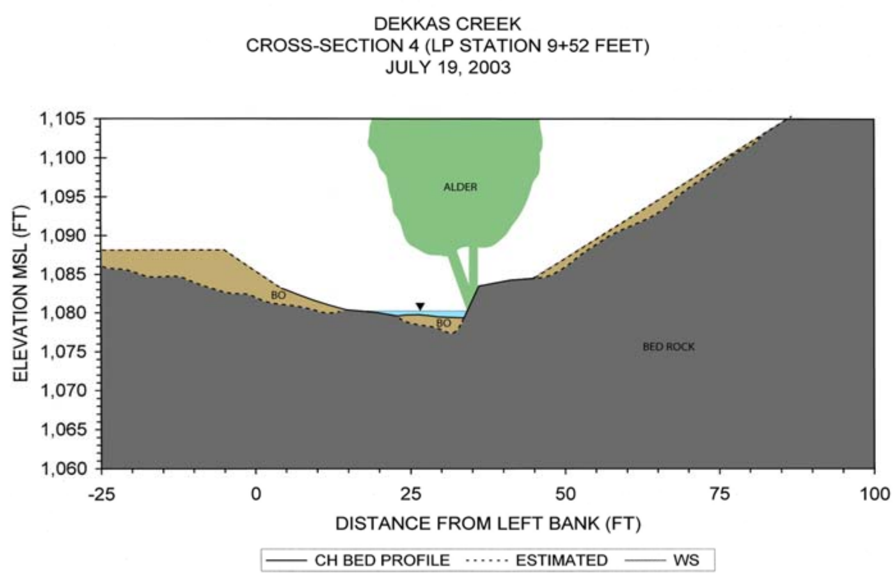

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Figure 3-60
Dekkas Creek Cross Section #3
Figure 3-61
Dekkas Creek Cross Section #4

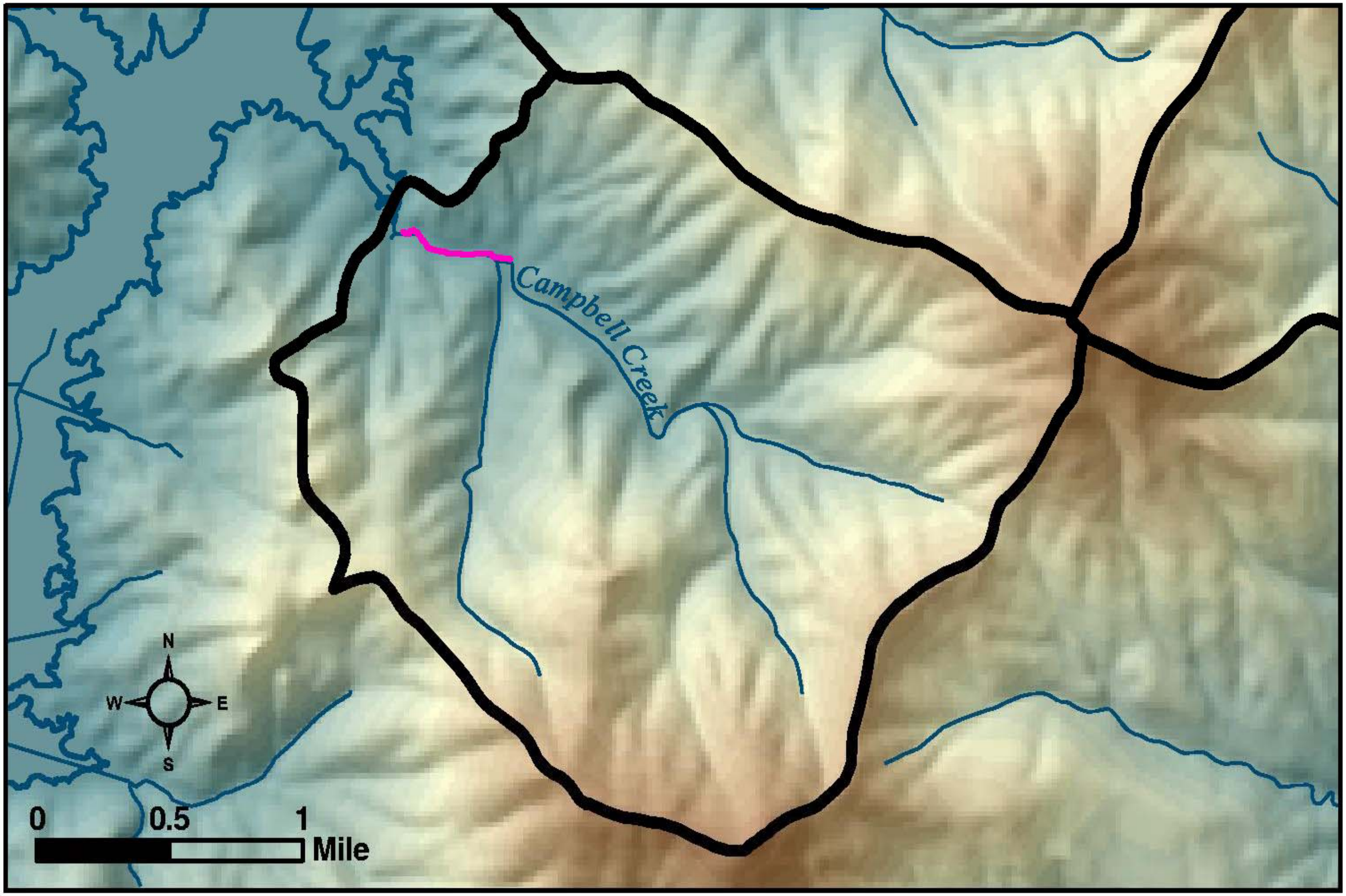

Figure 3-62
Campbell Creek Watershed

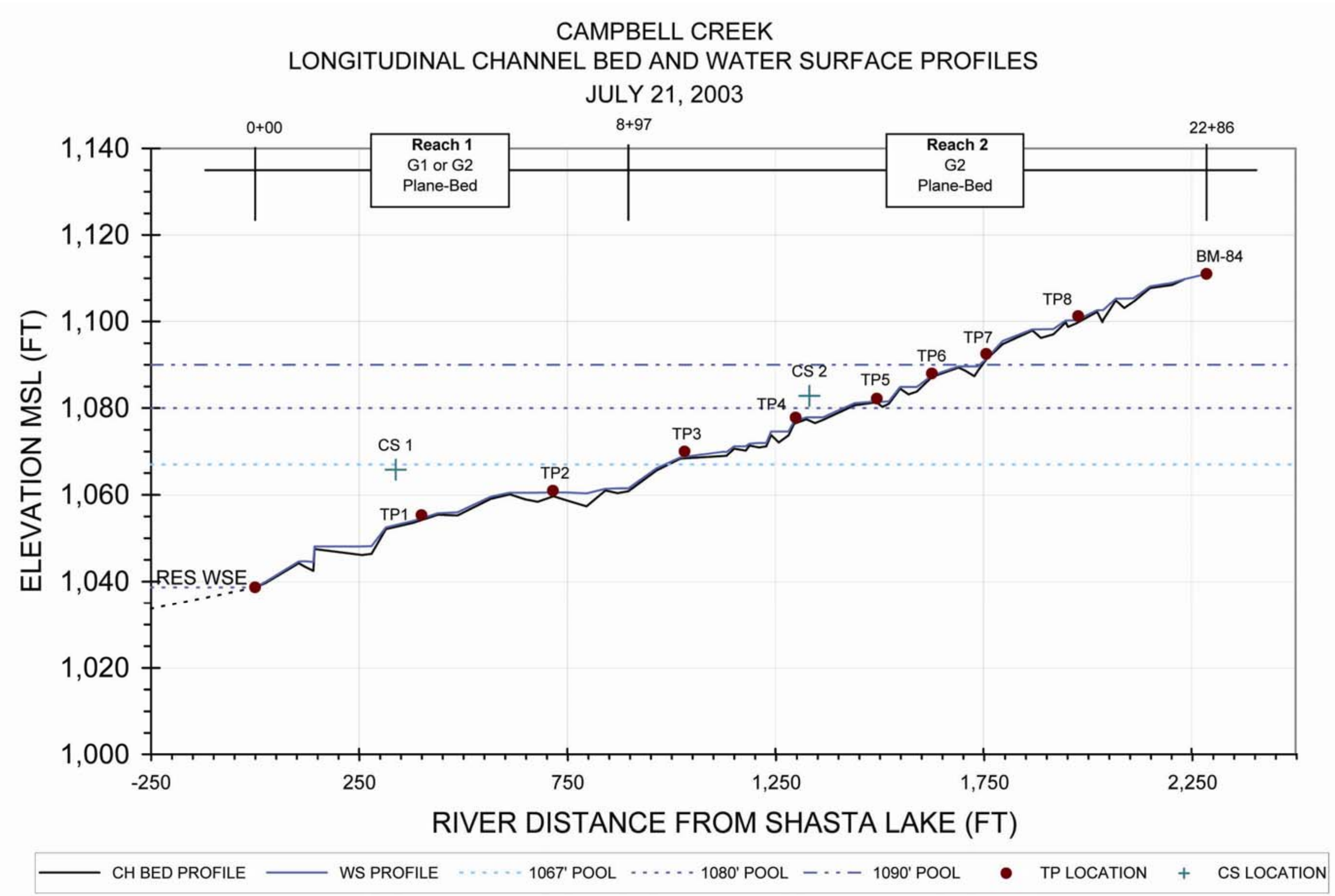

Figure 3-63
Campbell Creek Longitudinal Profile

Figure 3-64 Campbell Creek Aquatic Habitat Distribution

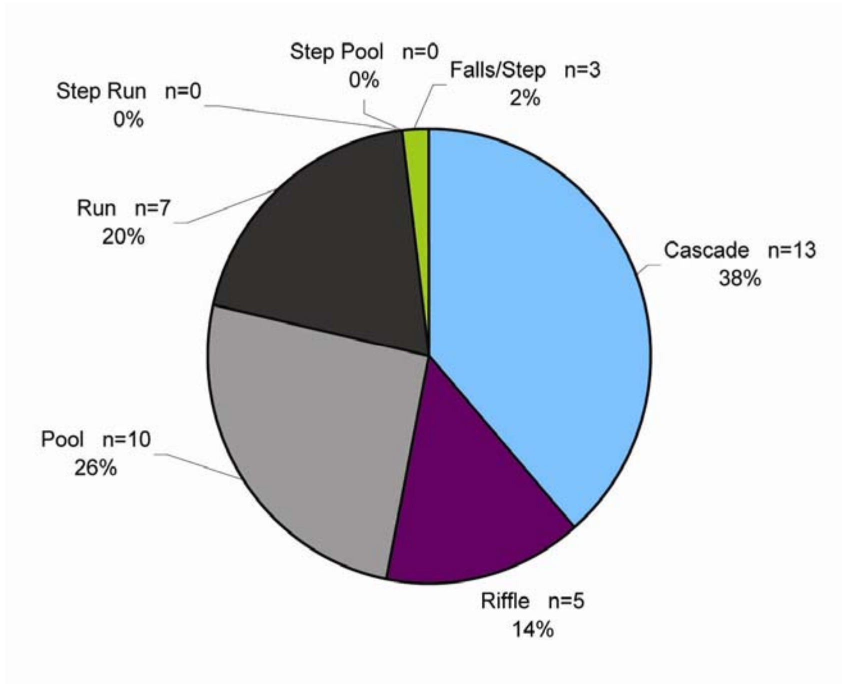

Figure 3-65 Campbell Creek Dominant Substrate Distribution

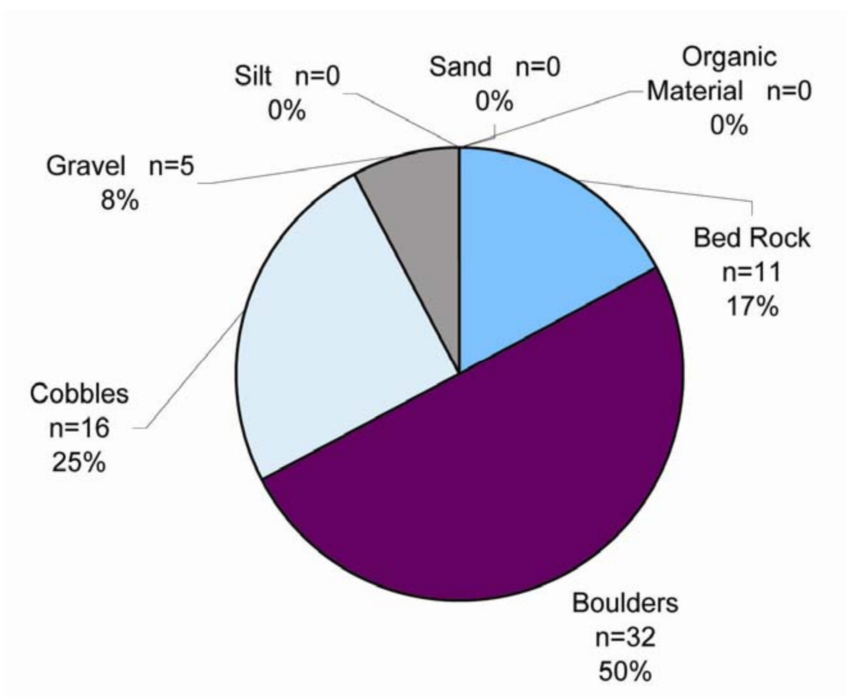

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Figure 3-64
Campbell Creek Aquatic Habitat Distribution
Figure 3-65
Campbell Creek Dominant Substrate Distribution

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Figure 3-66 Campbell Creek Cross Section #1

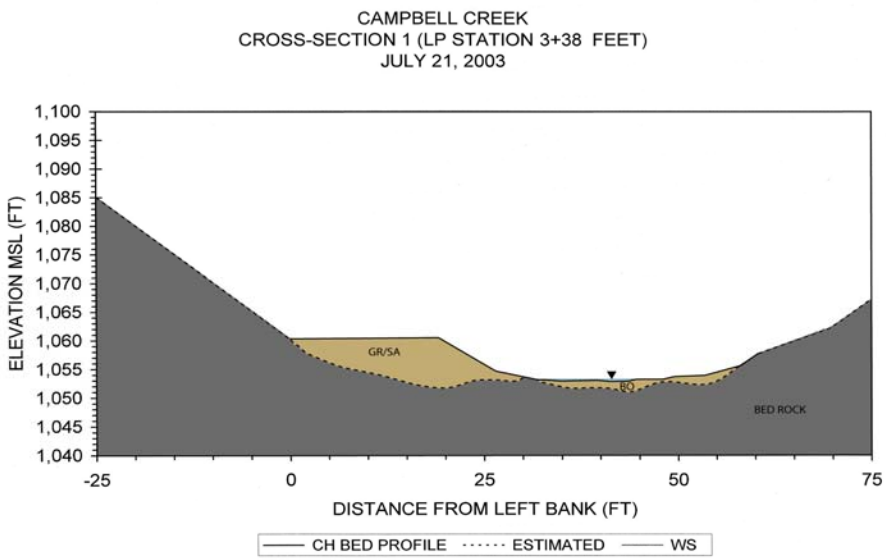

Figure 3-67 Campbell Creek Cross Section #2

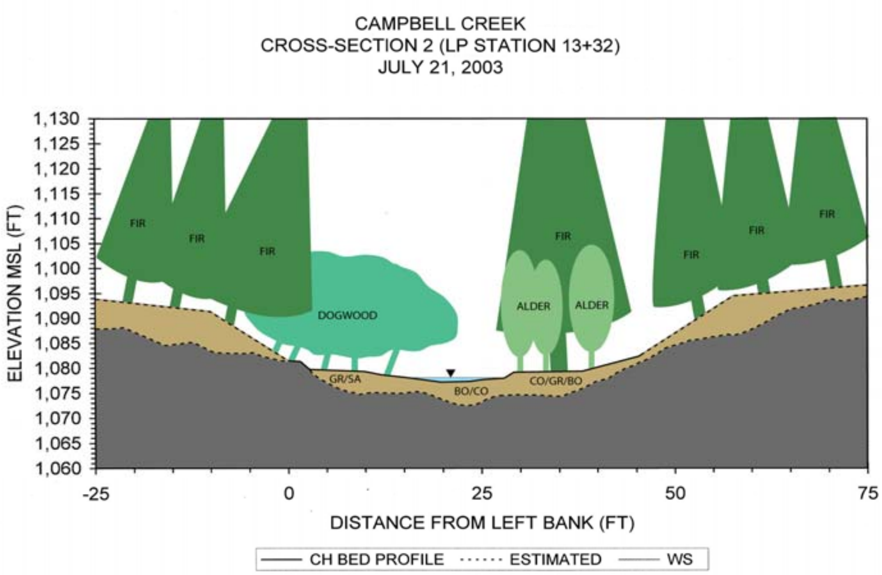

Figure 3-66
Campbell Creek Cross Section #1
Figure 3-67
Campbell Creek Cross Section #2

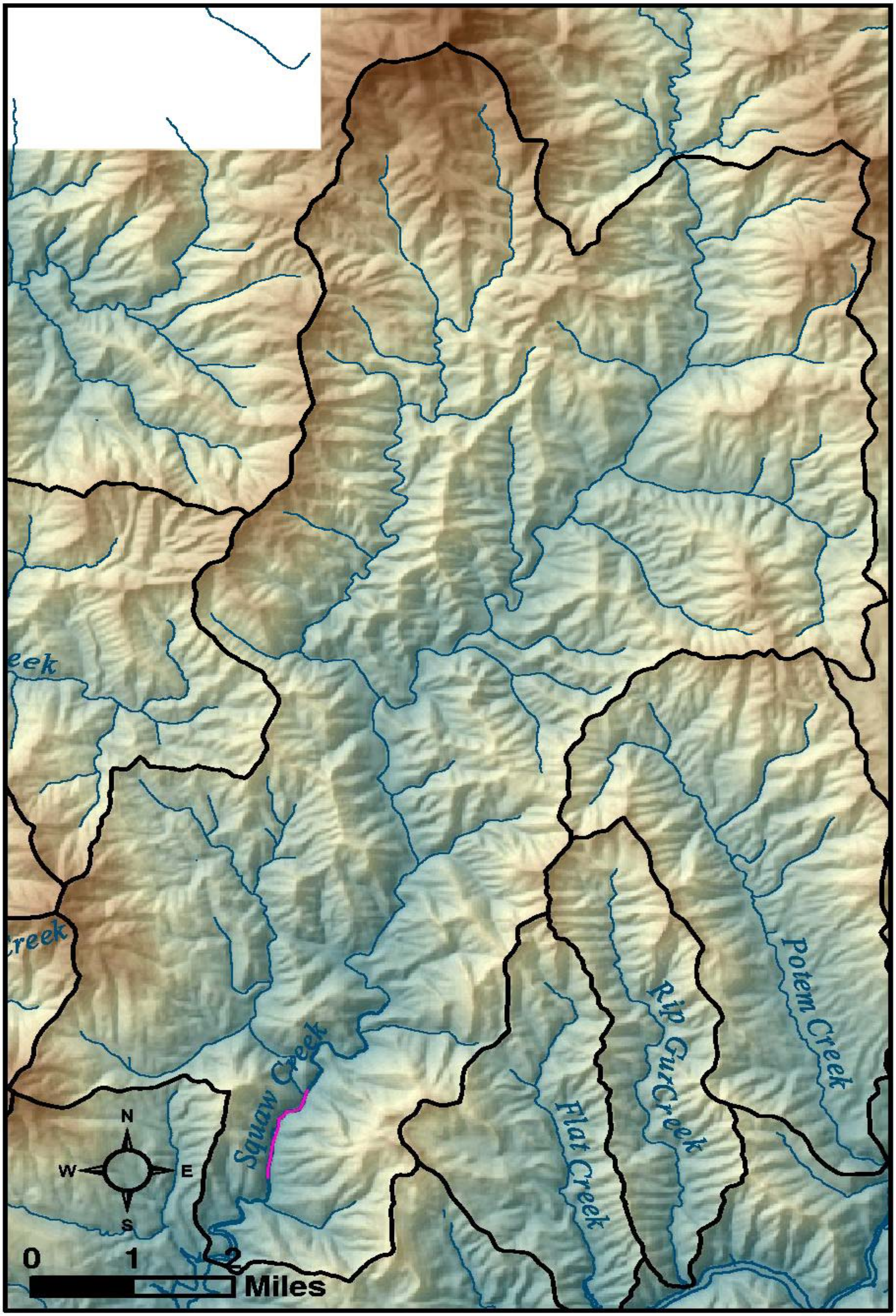

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Figure 3-68
Squaw Creek Watershed

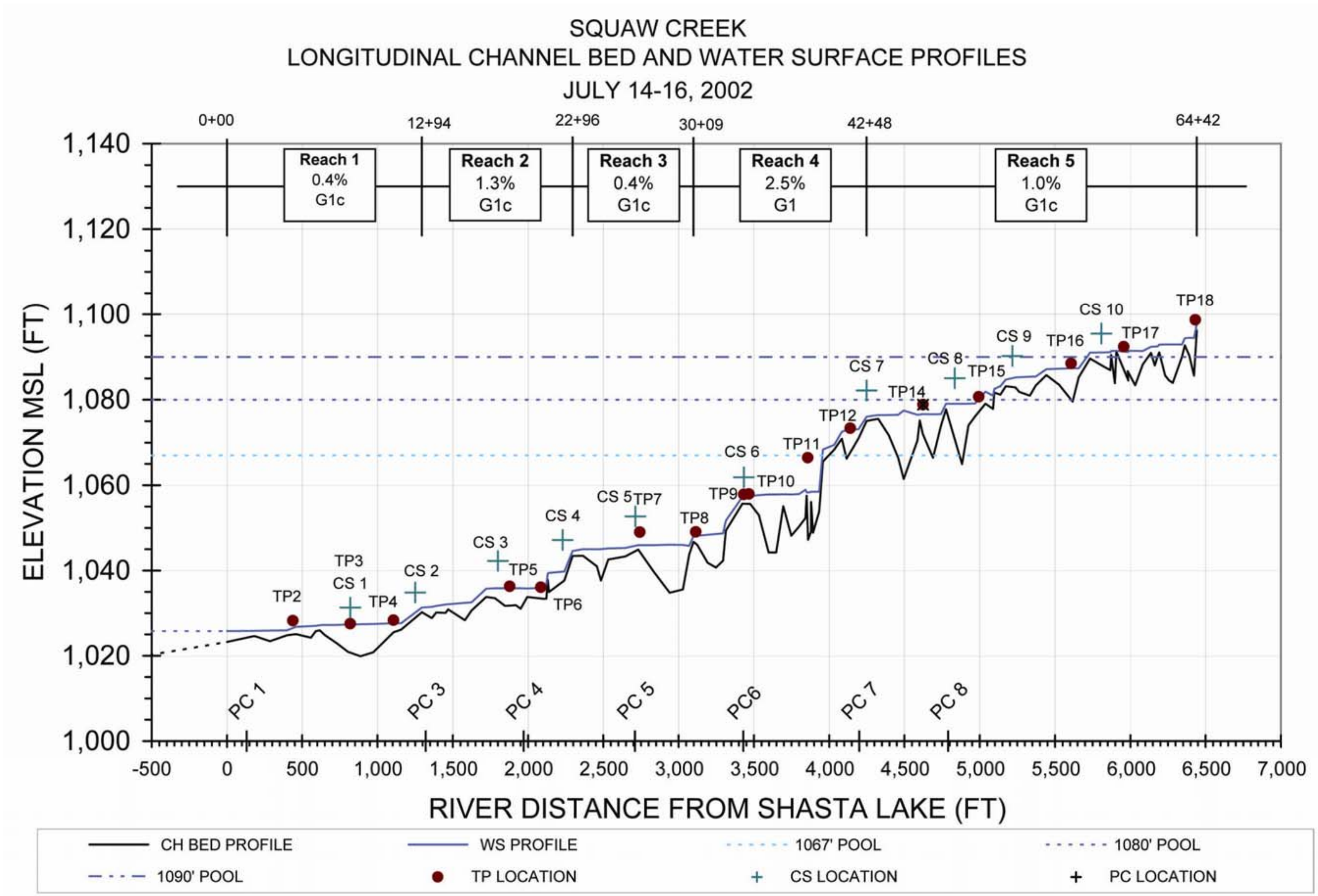

Figure 3-69
Squaw Creek Longitudinal Profile

Figure 3-70 Squaw Creek Aquatic Habitat Distribution

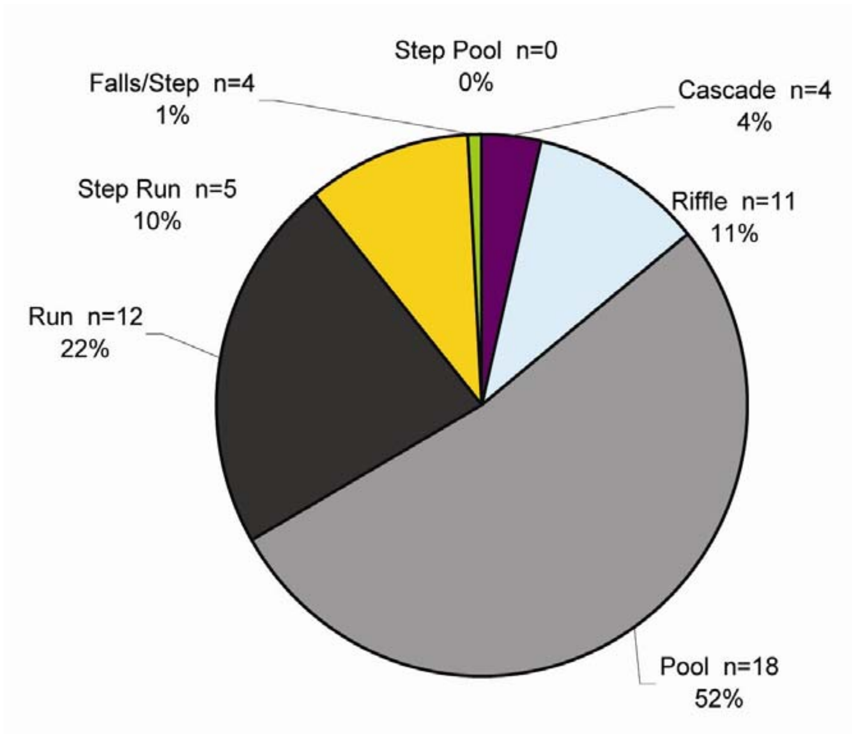

Figure 3-71 Squaw Creek Dominant Substrate Distribution

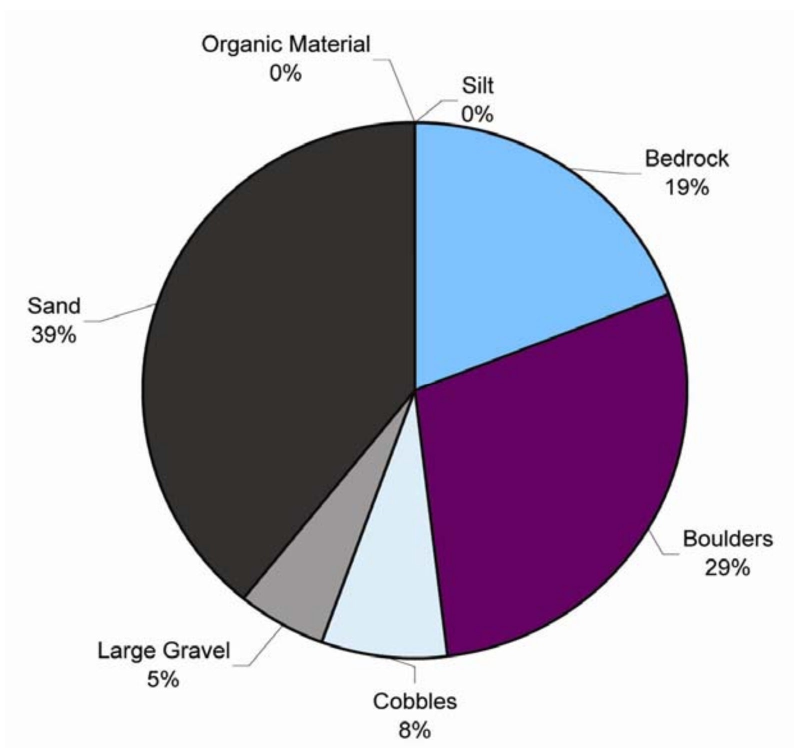

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Figure 3-70
Squaw Creek Aquatic Habitat Distribution
Figure 3-71
Squaw Creek Dominant Substrate Distribution

Figure 3-72 Squaw Creek Cross Section #1

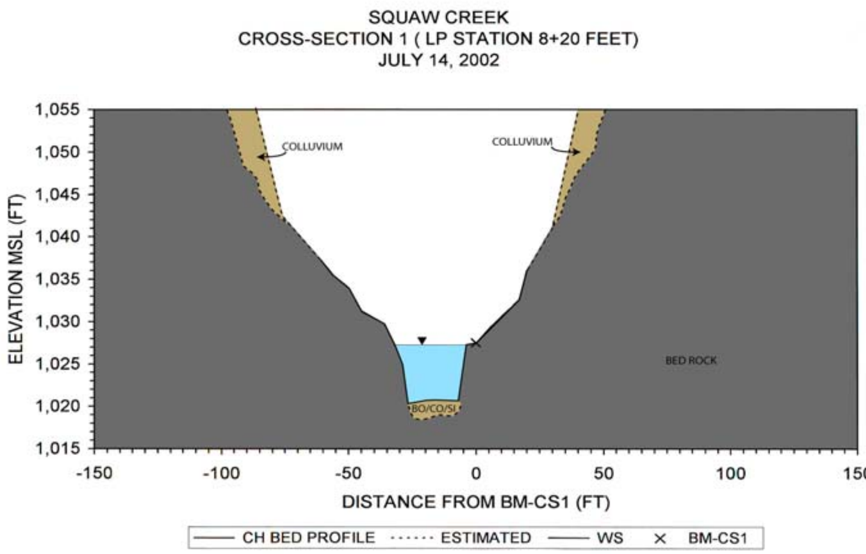

Figure 3-73 Squaw Creek Cross Section #2

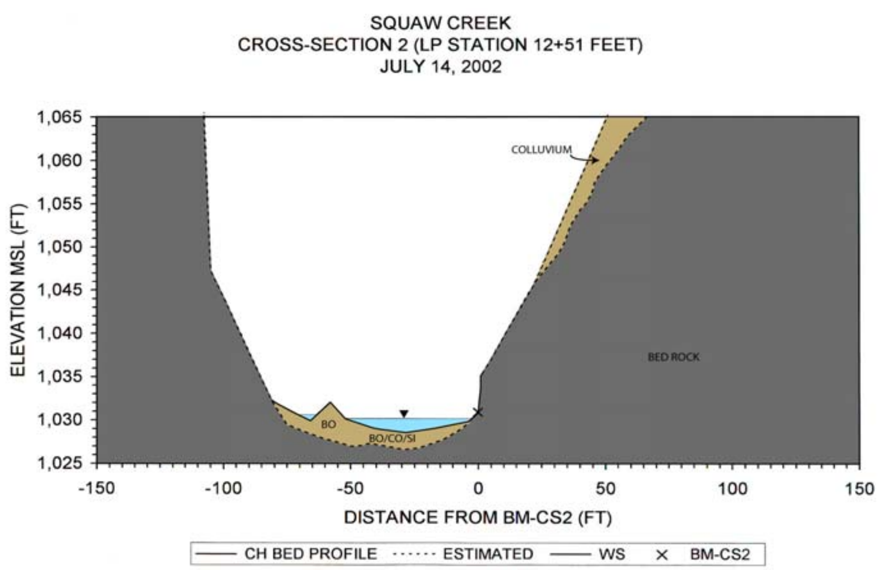

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Figure 3-72
Squaw Creek Cross Section #1
Figure 3-73
Squaw Creek Cross Section #2

Figure 3-74 Squaw Creek Cross Section #4

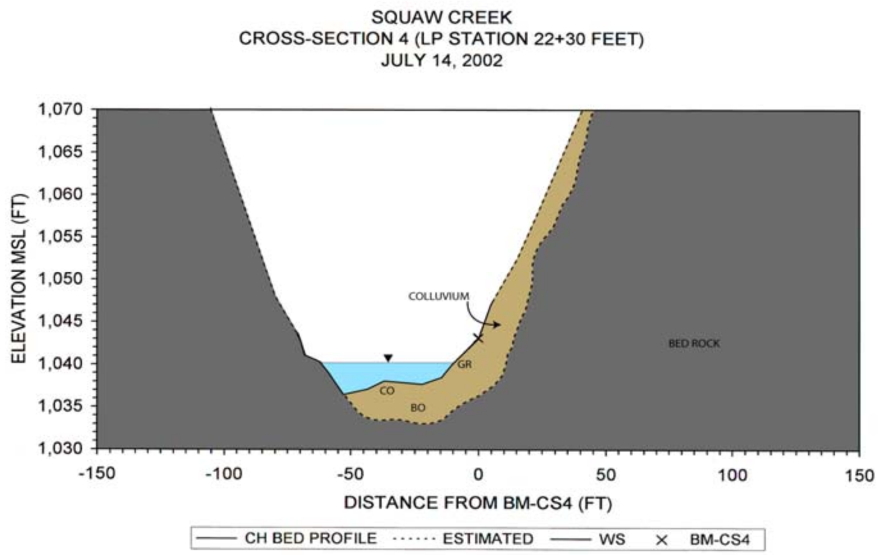

Figure 3-75 Squaw Creek Cross Section #6

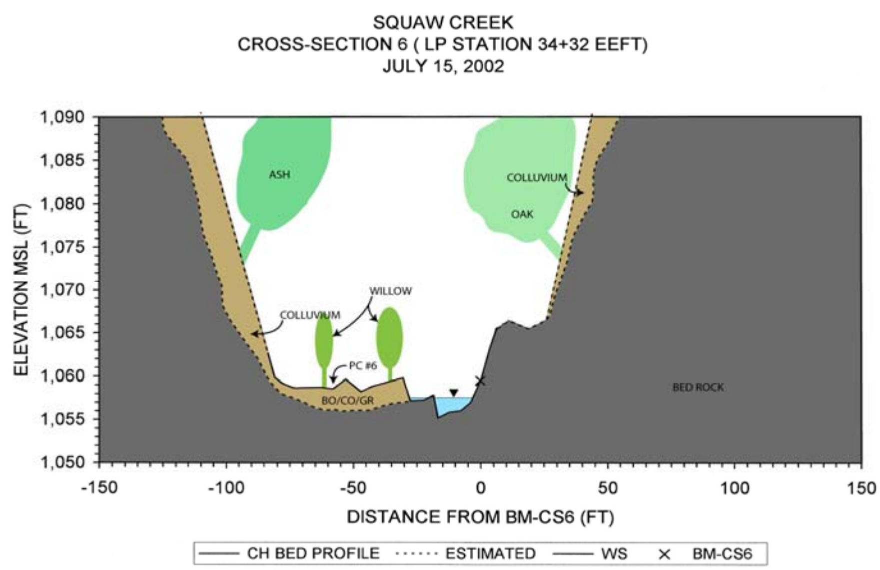

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Figure 3-74
Squaw Creek Cross Section #4
Figure 3-75
Squaw Creek Cross Section #6

Figure 3-76 Squaw Creek Cross Section #8

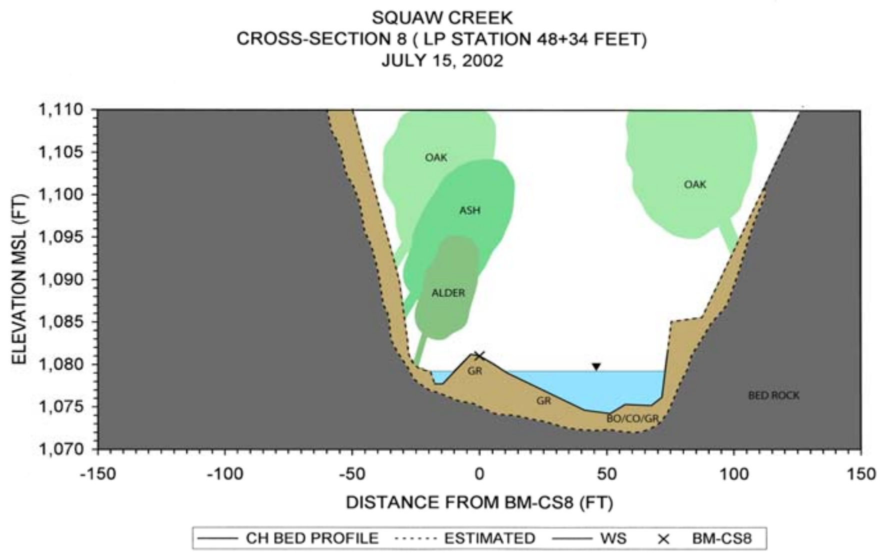

Figure 3-77 Squaw Creek Cross Section #10

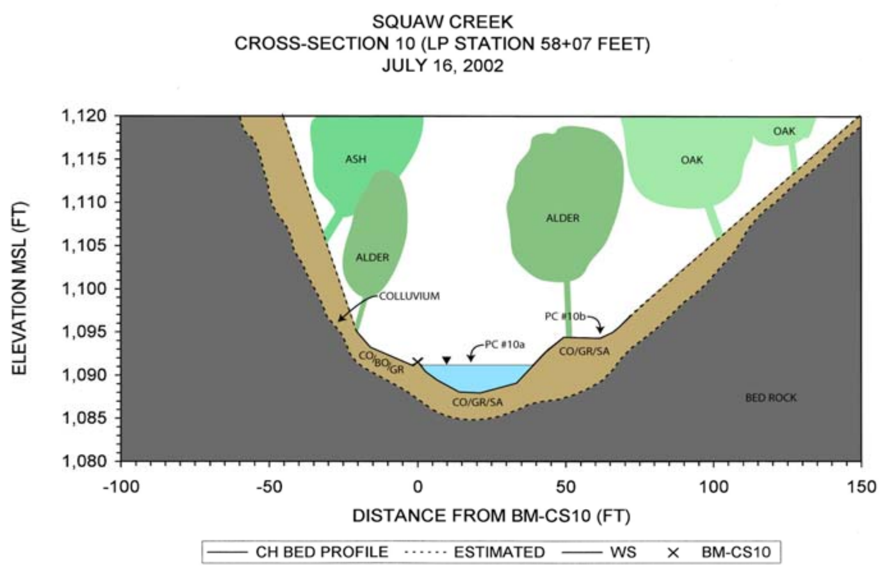

Figure 3-76
Squaw Creek Cross Section #8
Figure 3-77
Squaw Creek Cross Section #10

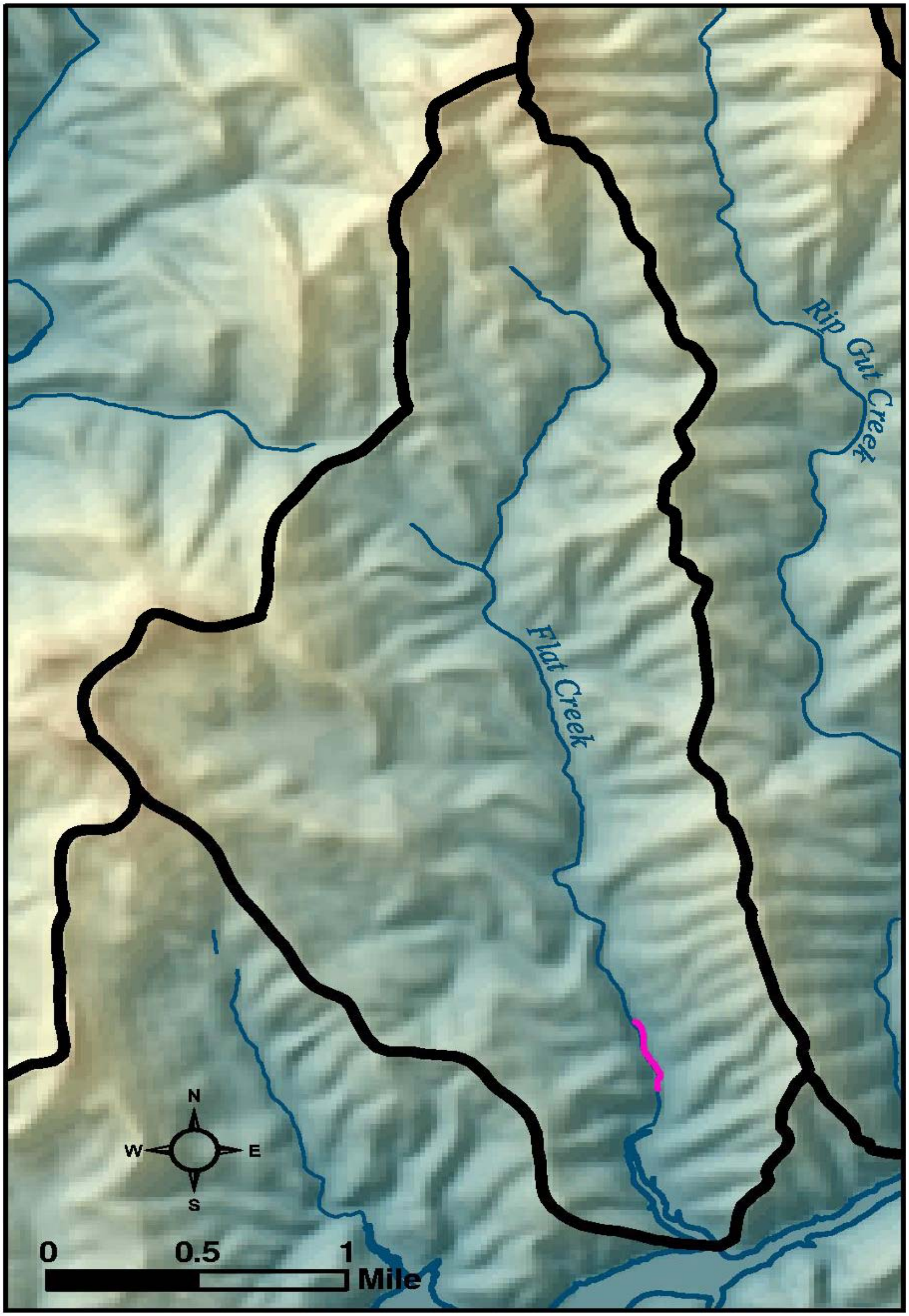

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Figure 3-78
Flat Creek Watershed

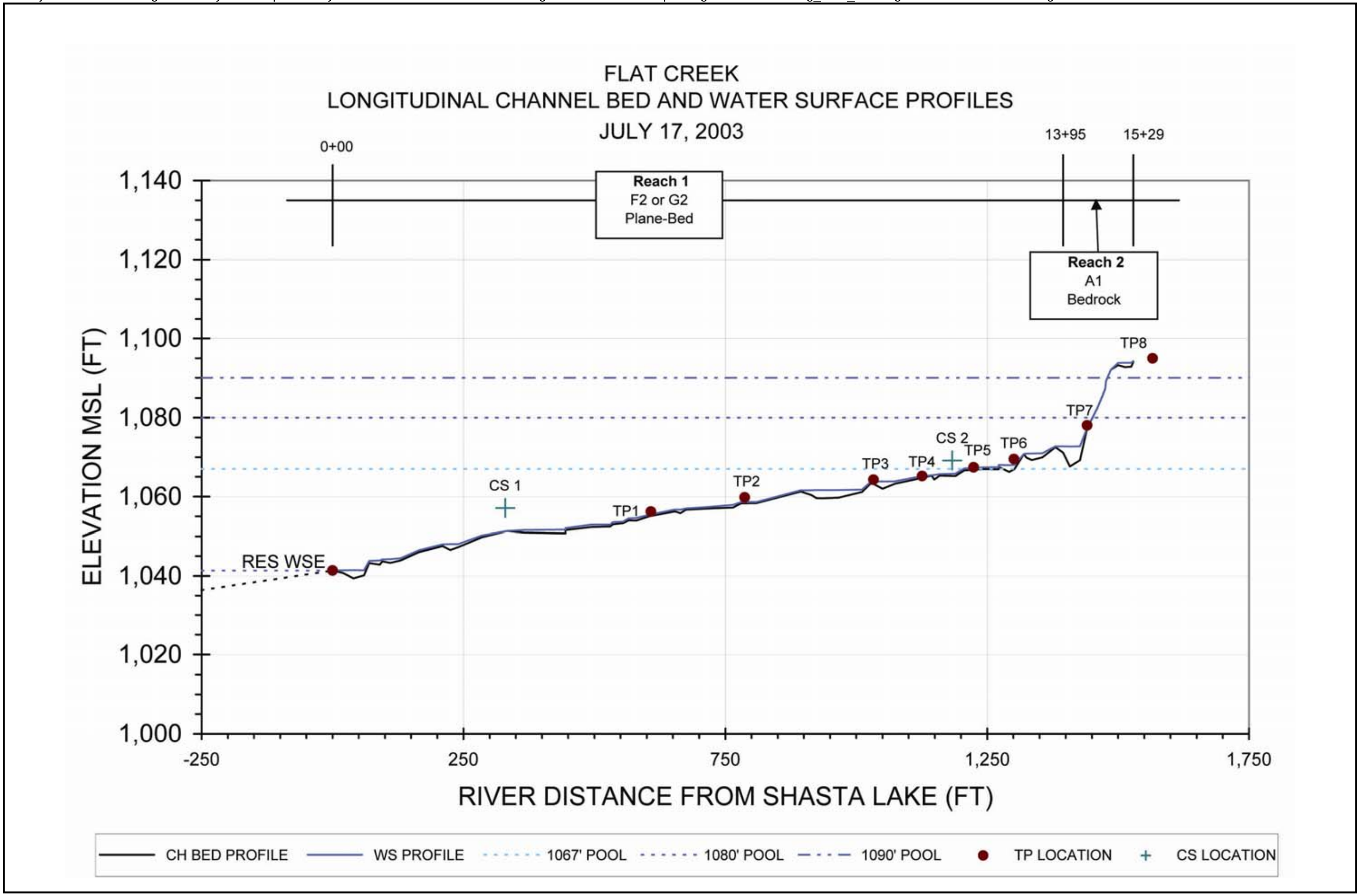

Figure 3-79
Flat Creek Longitudinal Profile

Figure 3-80 Flat Creek Aquatic Habitat Distribution

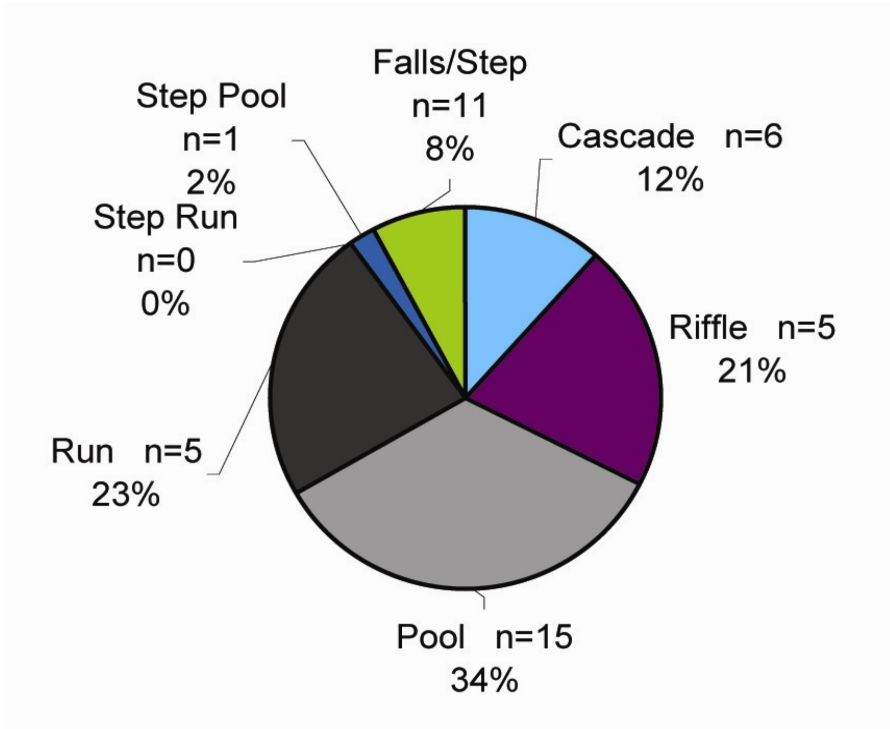

Figure 3-81 Flat Creek Dominant Substrate Distribution

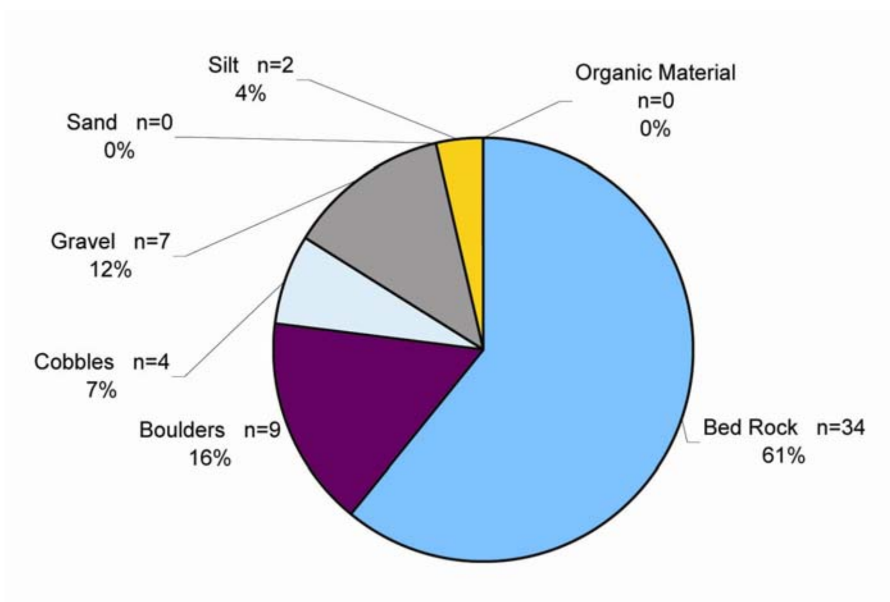

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Figure 3-80
Flat Creek Aquatic Habitat Distribution
Figure 3-81
Flat Creek Dominant Substrate Distribution

Figure 3-82 Flat Creek Cross Section #1

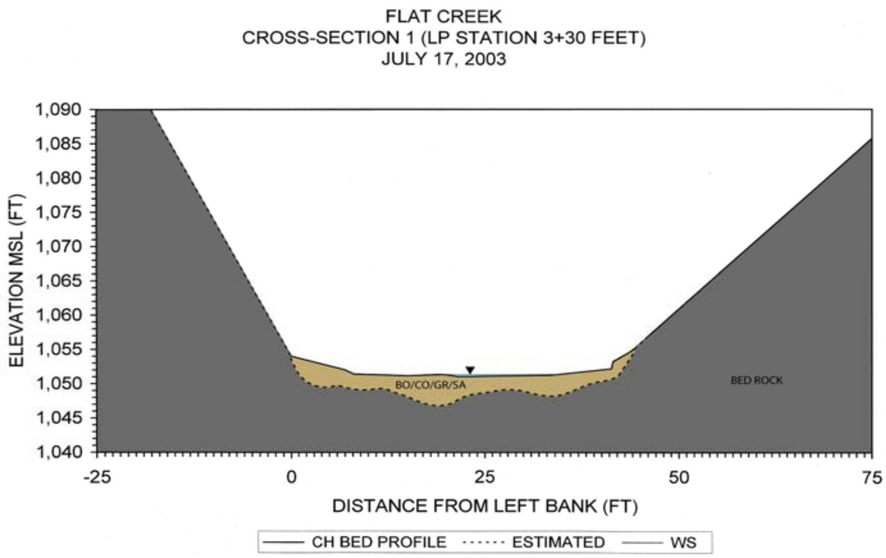

Figure 3-83 Flat Creek Cross Section #2

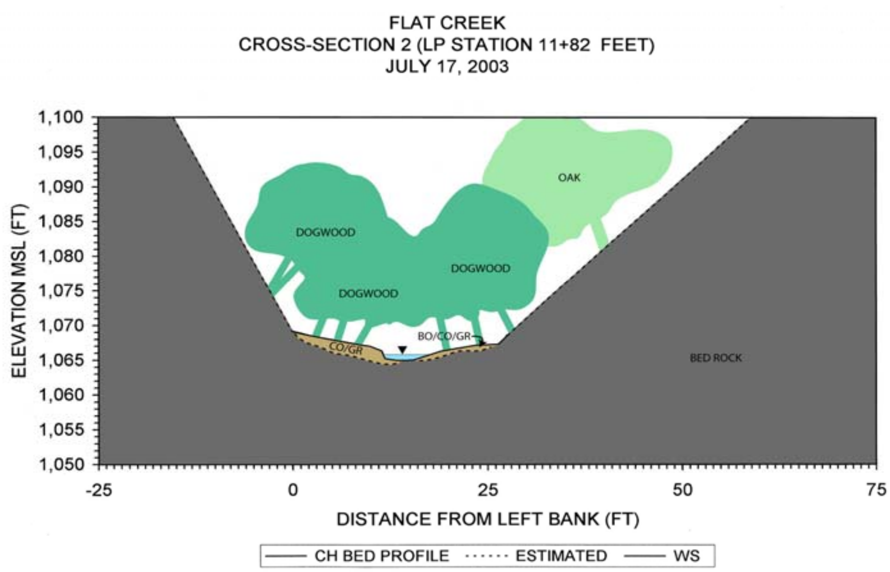

Figure 3-82
Flat Creek Cross Section #1
Figure 3-83
Flat Creek Cross Section #2

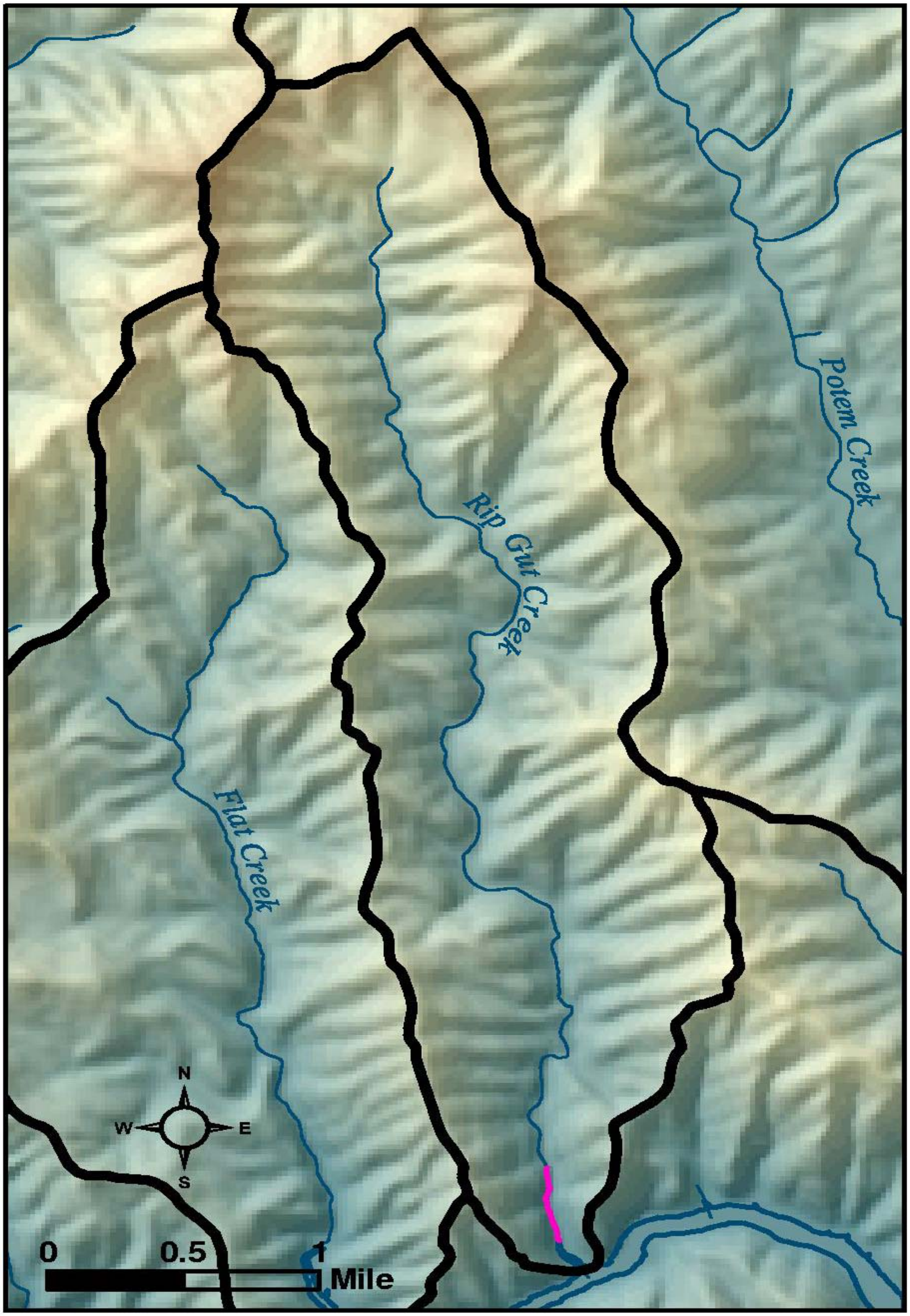

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Figure 3-84
Rip Gut Creek Watershed

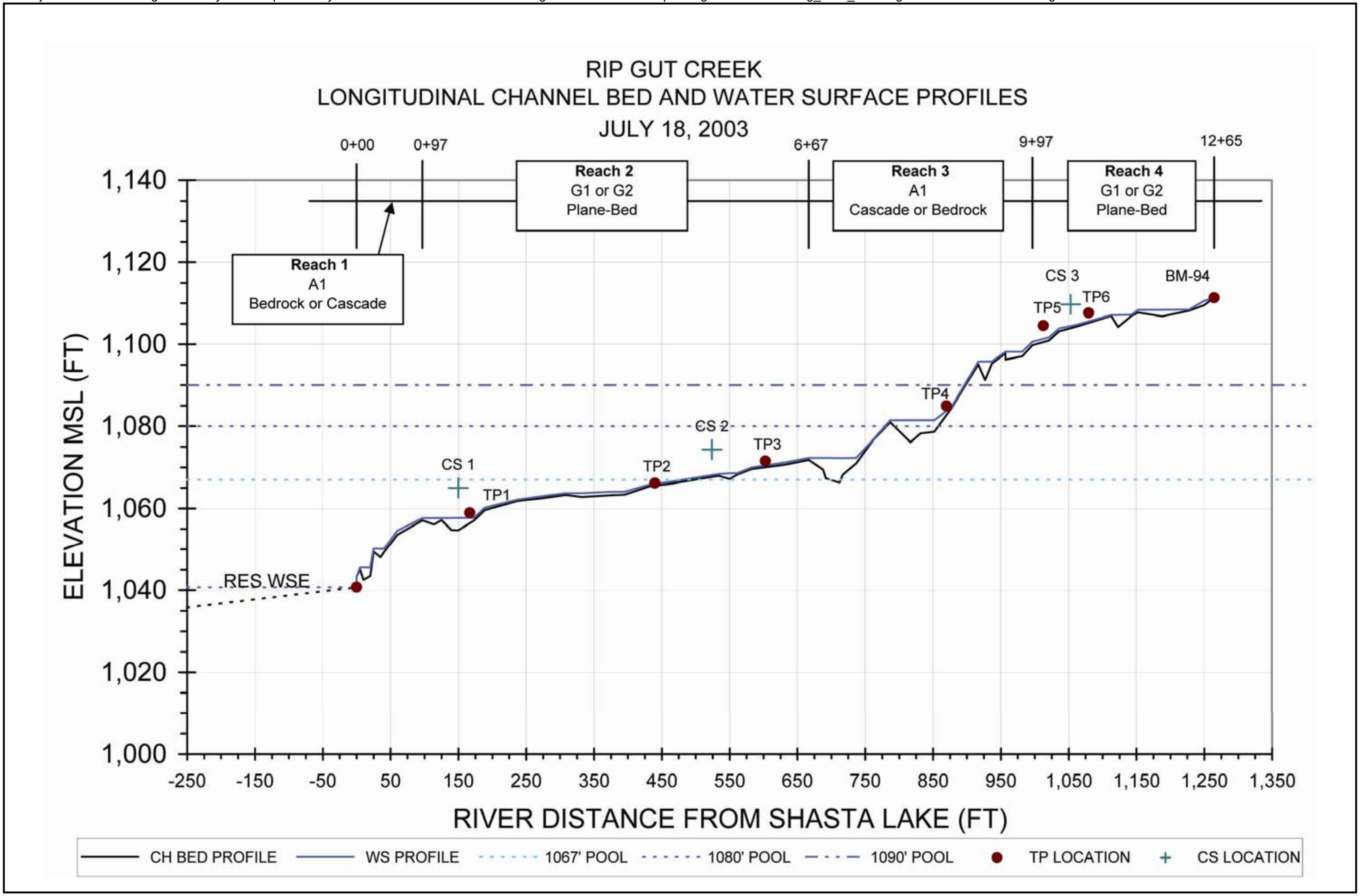

Figure 3-85
Rip Gut Creek Longitudinal Profile

Figure 3-86 Rip Gut Creek Aquatic Habitat Distribution

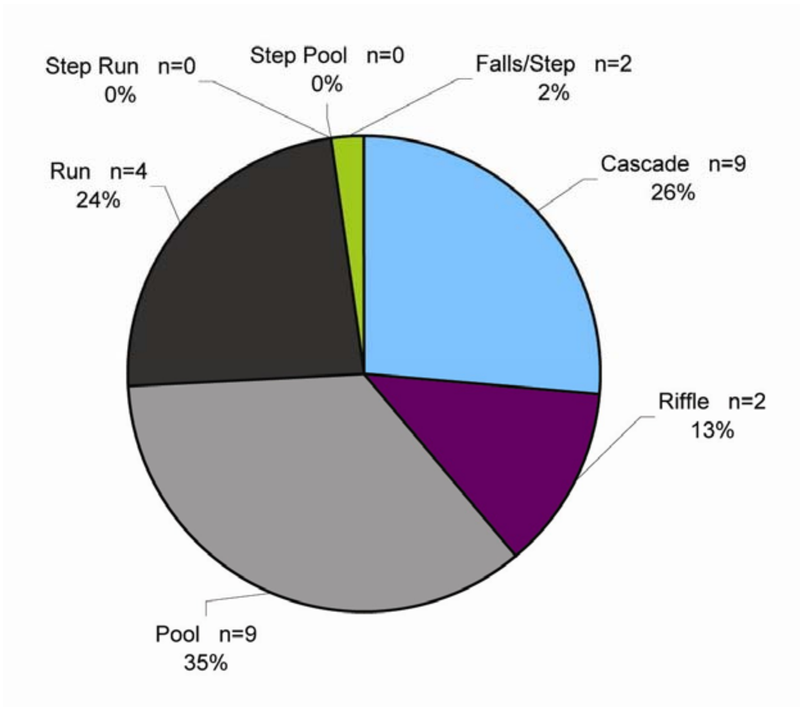

Figure 3-87 Rip Gut Creek Dominant Substrate Distribution

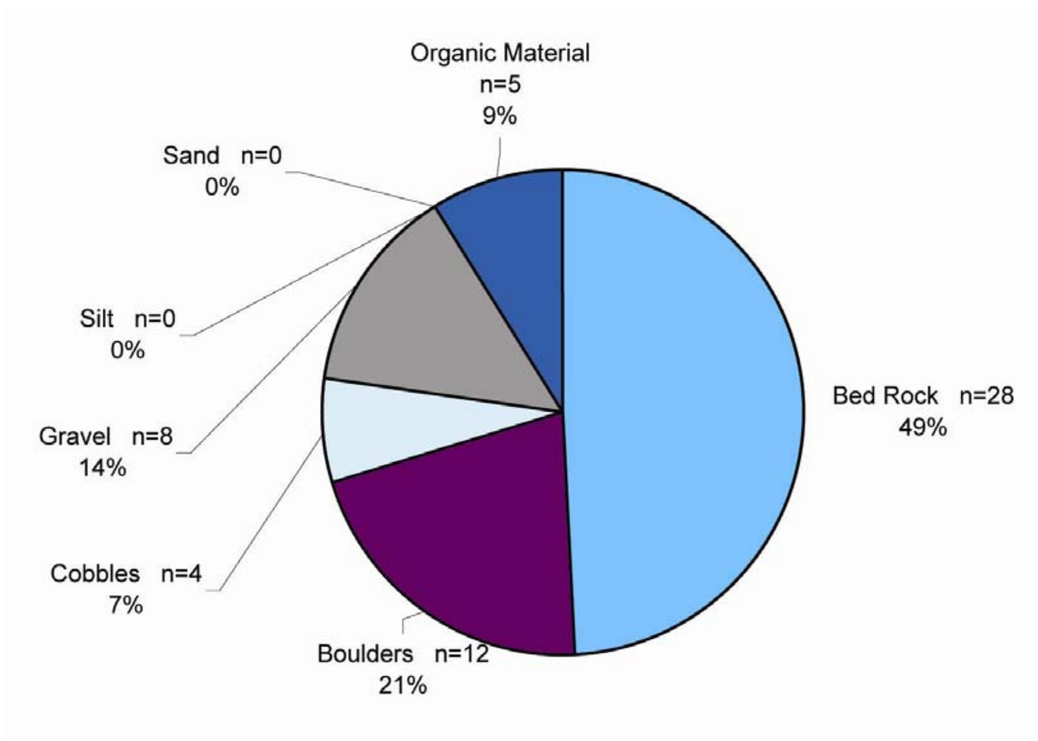

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Figure 3-86
Rip Gut Creek Aquatic Habitat Distribution
Figure 3-87
Rip Gut Creek Dominant Substrate Distribution

Figure 3-88 Rip Gut Creek Cross Section #1

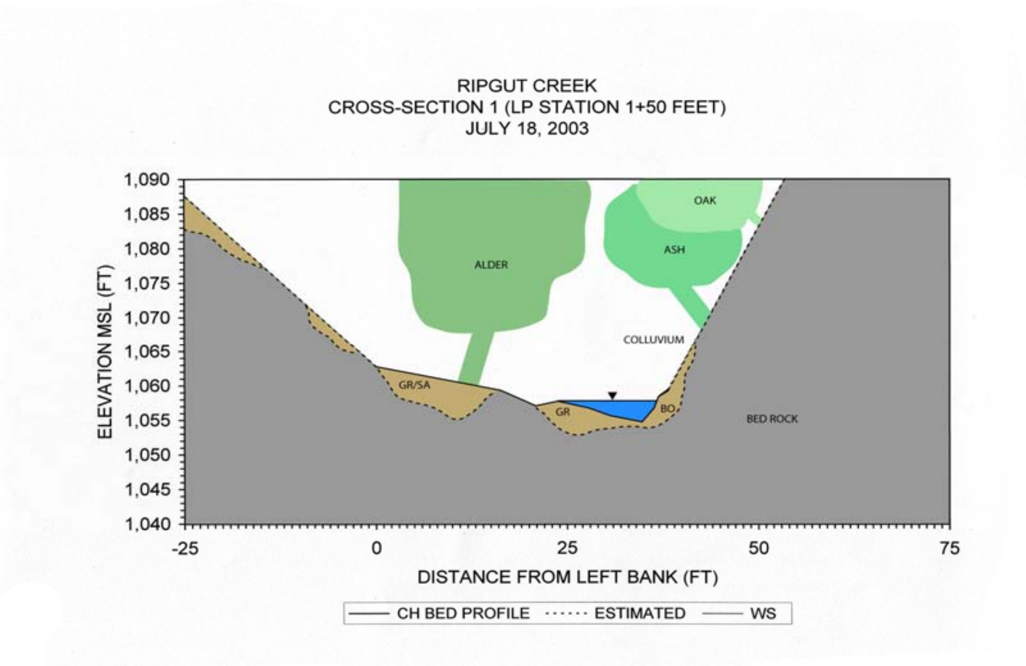
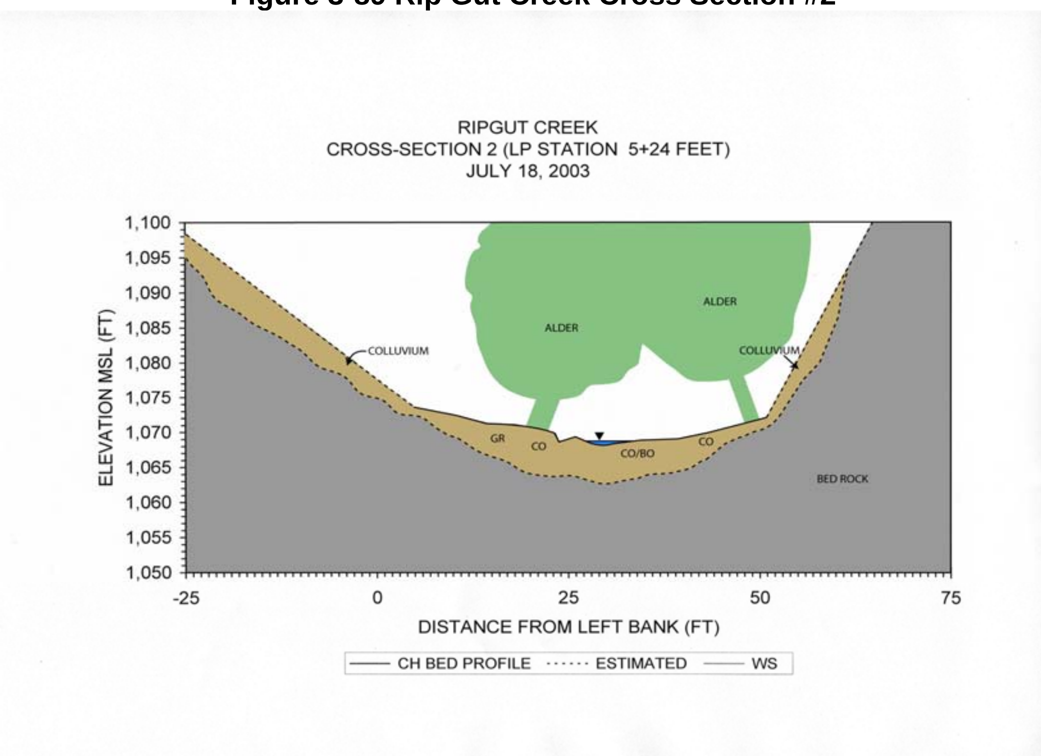


Figure 3-89 Rip Gut Creek Cross Section #2



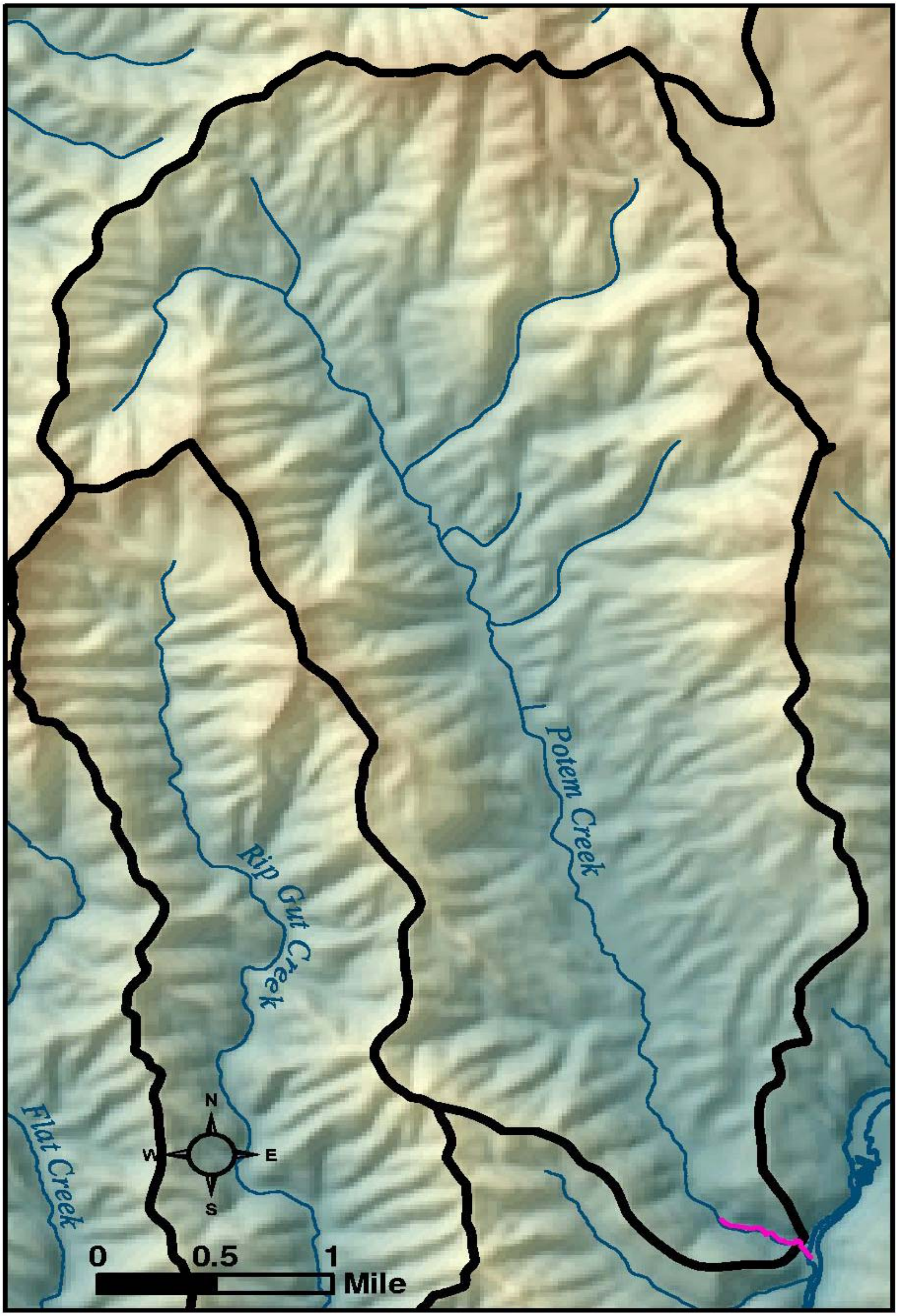


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Figure 3-90
Potem Creek Watershed

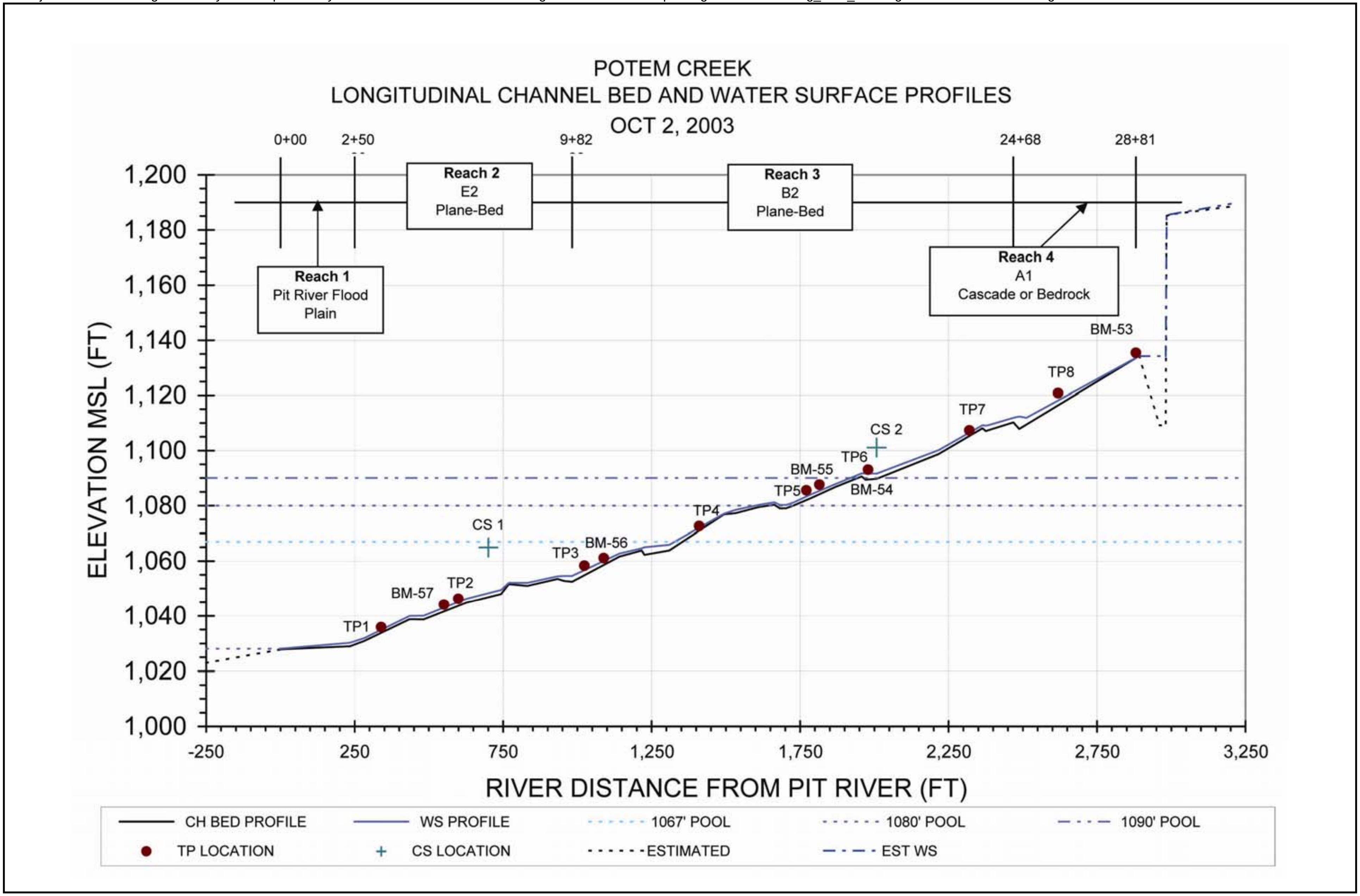

Figure 3-91
Potem Creek Longitudinal Profile

Figure 3-92 Potem Creek Aquatic Habitat Distribution

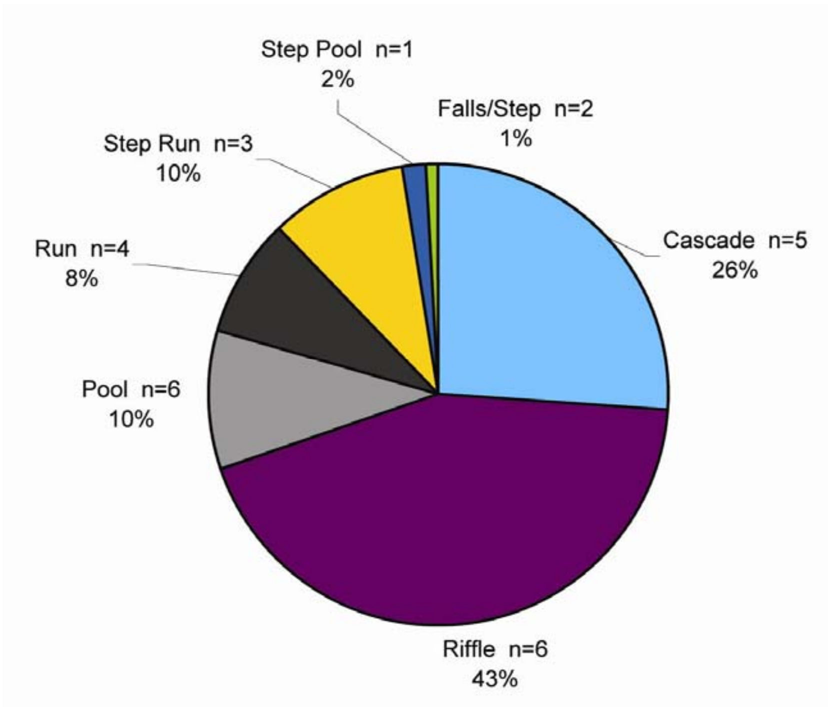

Figure 3-93 Potem Creek Dominant Substrate Distribution

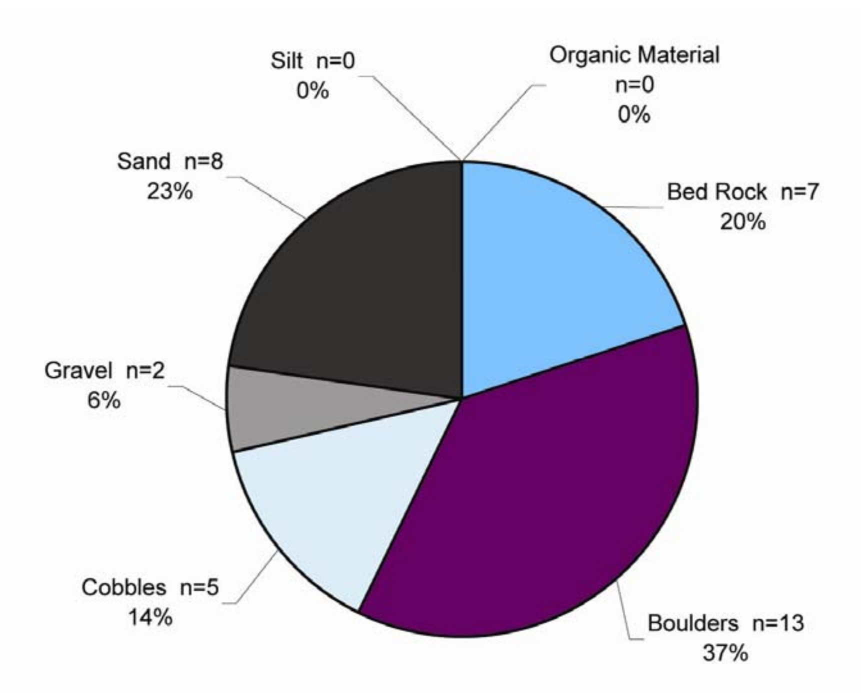

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Figure 3-92
Potem Creek Aquatic Habitat Distribution
Figure 3-93
Potem Creek Dominant Substrate Distribution

Figure 3-94 Potem Creek Cross Section #1

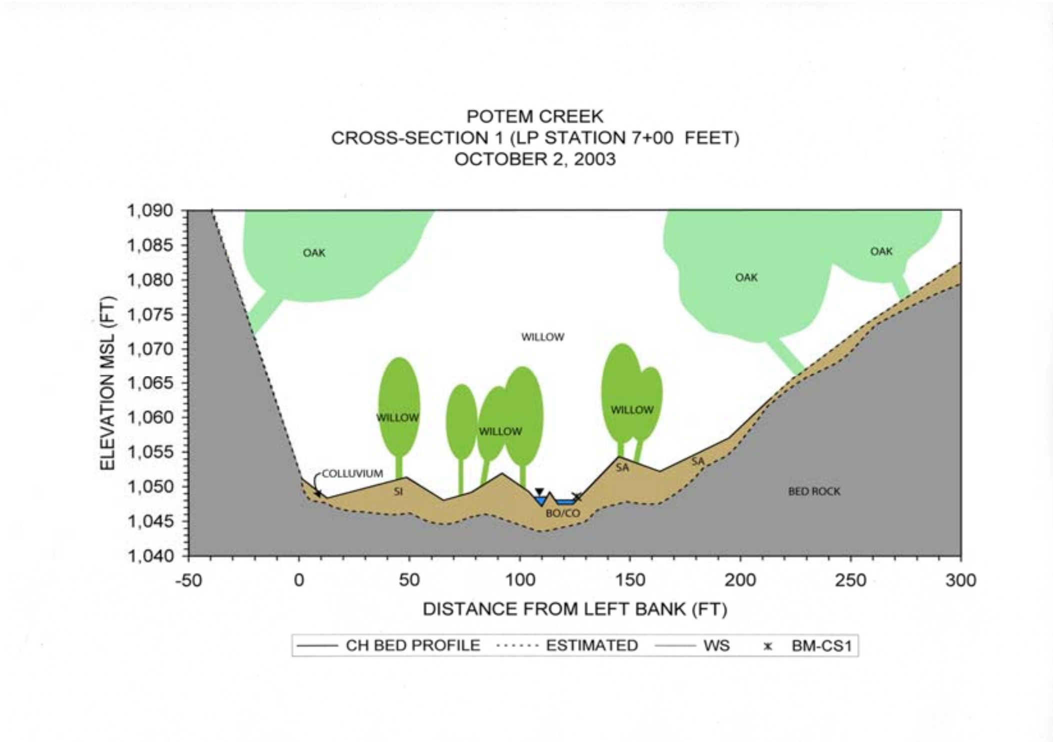

Figure 3-95 Potem Creek Cross Section #2

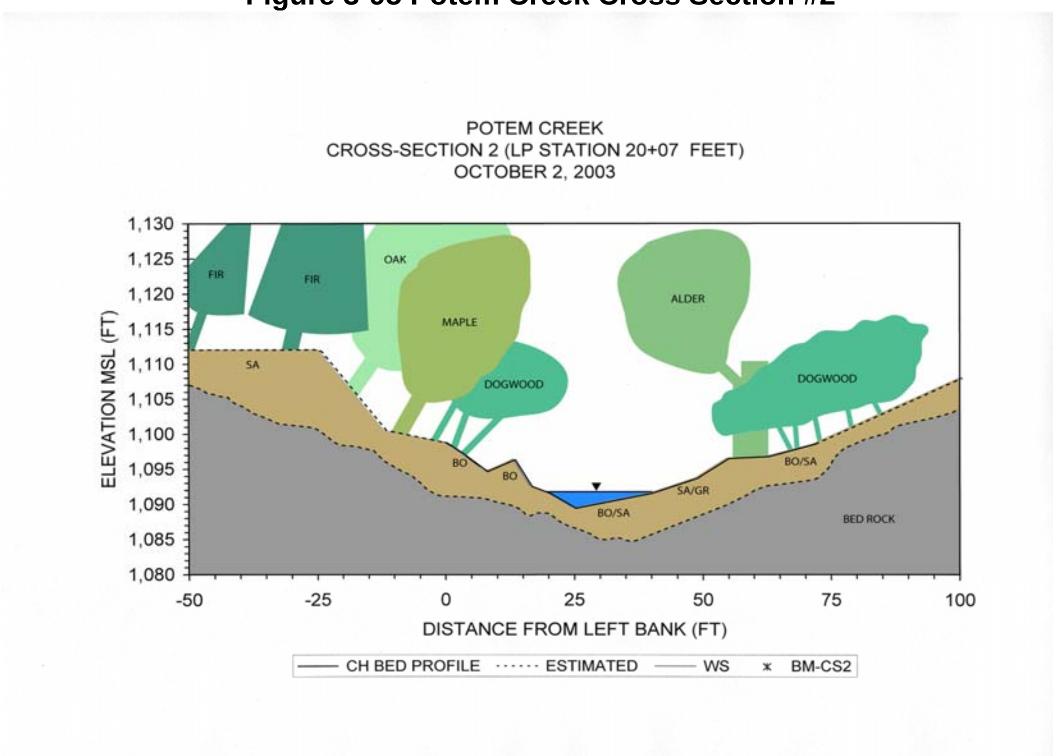

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Photo LBC-1

View downstream from right bank terrace top to Little Backbone Creek, July 31, 2003. Note reservoir delta deposits (terraces) typical of Reach 1. Cross-Section 1 is located at the survey instrument.

Photo LBC-2

Mid-channel bed material detail at LP STA 2+00, approximately 6 ft upstream from Cross-Section 1, Little Backbone Creek, July 31, 2003.

Photo LBC-3

Channel margin bed material detail at bedrock cascade nr LP STA 3+00, Little Backbone Creek, July 31, 2003. Note median grain size is approximately 3 mm and deposit is minimally embedded.

Photo LBC-4

View downstream from bedrock cascade nr LP STA 6+00 to pool and pool-tailout deposit nr LP STA 5+50. Note discharge measurement was made at the pool-tailout constriction in the background.

Photo LBC-5

Channel margin bed material detail at boulder riffle nr LP STA 5+50, Little Backbone Creek, July 31, 2003. Note approx. 90-mm breccia clast submerged on suface of colluvial bed framework (left) and approx. 25-mm median grain size exposed gravel deposit (r

Photo LBC-6

View from right bank to channel bed framework and matrix materials at boulder riffle nr LP STA 5+00, Little Backbone Creek, July 31, 2003. Note this is location of Pebble Count 3.

Photo BBC-1

View from mid-channel island bar nr LP STA 11+75 ft to right bank at Cross-Section 1, Big Backbone Creek, July 18, 2002.

Photo BBC-2

View from right bank terrace top nr LP STA 22+75 ft to left bank at Cross-Section 3, Big Backbone Creek, July 18, 2002.

Photo BBC-3

View upstream from mid-channel at Cross-Section 10 (LP STA 76+20), Big Backbone Creek, July 19, 2003.

Photo SGC-1

View upstream from right bank boulder bar nr LP STA 19+40 ft, Sugarloaf Creek, July 30, 2003

Photo SGC-2

View from right bank to left bank bedrock lee gravel deposit nr LP STA 10+00 ft, Sugarloaf Creek, July 30, 2003.

Photo SGC-3

View downstream from left bank boulder bar nr LP STA 3+75 ft to Cross-Section 1 at LP STA 3+10 ft, Sugarloaf Creek, July 30, 2003.

Photo USR-1

View downstream from left bank nr LP STA 12+71 ft to main channel, Upper Sacramento River, October 3, 2003. Note USGS stream gage at left bank in background.

Photo USR-2

View upstream from left channel margin nr LP STA 37+35 ft to main channel, Upper Sacramento River, October 3, 2003.

Photos USR-1, USR-2

Photo MSC-1

View upstream from left bank nr LP STA 6+50 ft to Middle Salt Creek, July 28, 2003.

Photo MSC-2

View upstream from left bank terrace top nr LP STA 13+00 ft, Middle Salt Creek, July 28, 2003.

Photo MSC-3

View downstream from mid-channel nr LP STA 27+50 ft, Middle Salt Creek, July 28, 2003.

Photo MSC-4

View upstream from mid-channel nr LP STA 37+00 ft, Middle Salt Creek, July 28, 2003.

Photo STC-1

View downstream to Interstate 5 impoundment from nr LP STA 0+00 ft, Salt Creek, October 5, 2003.

Photo STC-2

View upstream from mid-channel debris jam nr LP STA 3+76 ft to long backwater pool, Salt Creek, October 5, 2003.

Photo STC-3

View upstream from mid-channel nr LP STA 12+27 ft upstream to Salt Creek, October 5, 2003. Note wide elevated gravel bars.

Photos STC-1, STC-2, STC-3

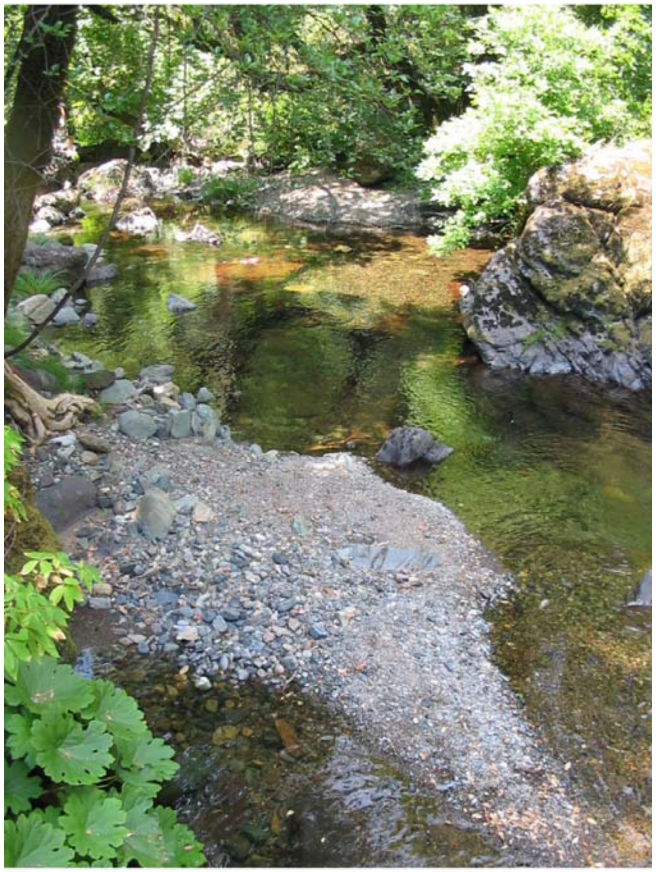
Photo STC-4

View upstream from mid-channel nr LP STA 34+63 ft to Salt Creek, October 5, 2003.

Photo STC-5

View upstream from mid-channel nr LP STA 10+25 ft to woody debris influenced pool at LP STA 10+56 ft, Salt Creek, October 5, 2003. Note that the maximum pool depth was 3.03 ft.

Photo NC-1



View downstream from left channel margin nr LP STA 11+45, Nosoni Creek, July 20, 2003.

Photo NC-2

View upstream from right bank nr LP STA 3+50 ft to Nosoni Creek, July 20, 2003.

Photo NC-3

View upstream from right bank channel margin nr LP STA 8+90 ft, Nosoni Creek, July 20, 2003.

Photo NC-4

View upstream from mid-channel nr LP STA 13+55 ft, Nosoni Creek, July 20, 2003.

Photo DC-1

View upstream from left bank nr LP STA 6+75 ft, Dekkas Creek, July 19, 2003.

Photo DC-2

View upstream from right bank nr LP STA 3+40 ft, Dekkas Creek, July 19, 2003.

Photo DC-3

View downstream from mid-channel nr LP STA 11+70 ft, Dekkas Creek, July 19, 2003.

Photo DC-4

View upstream from mid-channel nr LP STA 14+00 ft, Dekkas Creek, July 19, 2003.

Photo CC-1

View upstream from mid-channel nr LP STA 12+80 ft, Campbell Creek, July 21, 2003.
Note that Cross-Section 2 was surveyed across right bank bar in midground.

Photo CC-2

View downstream from left bank terrace nr LP STA 3+93 ft, near Cross-Section 1,
Campbell Creek, July 21, 2003.

Photo CC-3

View upstream from left bank channel margin nr LP STA 5+70 ft, Campbell Creek, July 21, 2003.

Photo CC-4

View upstream from nr LP STA 17+50 ft to mid-channel boulder bar deposit,
Campbell Creek, July 21, 2003. Note that there is split flow on both sides of bar along both canyon walls.

Photo SQC-1

View downstream from right bank nr reservoir high water mark to Squaw Creek nr LP STA 0+00 ft, July 14, 2002.

Photo SQC-2

View downstream from mid-channel nr LP STA 9+60 ft, Squaw Creek, July 14, 2002.

Photo FC-1

View upstream from mid-channel nr LP STA 11+30 ft, Flat Creek, July 17, 2003. Cross-Section 2 was surveyed across the channel in mid-ground.

Photo FC-2

View upstream from mid-channel nr LP STA 9+60 ft, Flat Creek, July 17, 2003.

Photo FC-3

View onto right bank boulder bar surface and channel from right canyon wall nr LP STA 3+30 ft, Flat Creek, July 17, 2003.

Photo FC-4

View upstream from left bank nr LP STA 13+95 ft, Flat Creek, July 17, 2003.

Photo RC-1

View downstream from permanent benchmark BM96 on right channel bank nr LP STA 0+50 ft to Shasta Lake, Ripgut Creek, July 18, 2003.

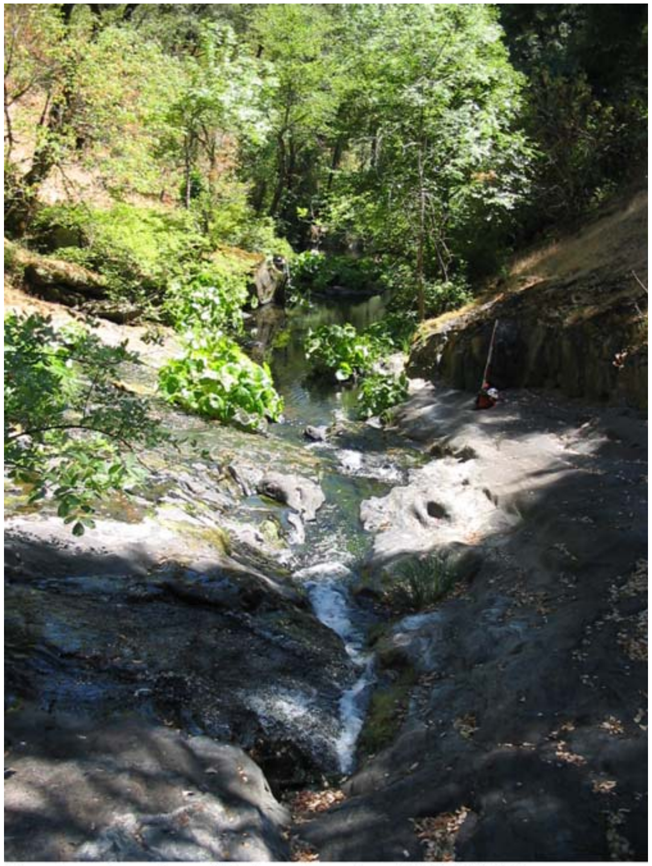
Photo RC-2

View upstream from mid-channel nr LP STA 3+35 ft, Ripgut Creek, July 18, 2003.

Photo RC-3

View downstream from left bank nr LP STA 1+50 ft near Cross-Section 1, Ripgut Creek, July 18, 2003.

Photo RC-4



View downstream from right channel margin nr LP STA 9+00 ft, Ripgut Creek, July 18, 2003.

Photo PC-1

View upstream from right bank nr LP STA 2+00 to confluence with Pit River, Potem Creek, October 2, 2003.

Photo PC-2

View upstream from mid-channel nr LP STA 12+20 ft, Potem Creek, October 2, 2003.

Photo PC-3

View upstream from mid-channel nr LP STA 14+00 ft, Potem Creek, October 2, 2003.

Photo PC-4

View of Potem Falls at LP STA 29+75 ft, Potem Creek, October 2, 2003. Note that discharge is about 4-5 cfs.

Photo Example 1

Low Severity Erosion

Photo Example 2

Low Severity Erosion

Photos of Low Severity Erosion

Photo Example 1

Moderate Severity Erosion

Photo Example 2

Moderate Severity Erosion

Photos of Moderate Severity Erosion

Photo Example 1

High Severity Erosion

Photo Example 2

High Severity Erosion

Photos of High Severity Erosion

Section 4 Biological Environment

Section 4

BIOLOGICAL ENVIRONMENT

4.1 Vegetation

This section describes the methods used to characterize vegetation communities and to develop a list of floral species of concern. It also provides characterizations of the vegetative communities found in the ESL, identifies potential floral species of concern, and describes the results of botanical surveys performed along two arms of Shasta Lake and upstream reaches of these arms as part of the earlier pilot study and along the other 11 riverine reaches as part of the current study.

4.1.1 METHODS

Plant Series Mapping

To characterize the plant community, NSR conducted an extensive mapping effort to classify and quantify existing vegetation and habitat within the ESL. All vegetation within the ESL was mapped and classified using the plant series classification system presented in *A Manual of California Vegetation* (MCV) (Sawyer and Keeler-Wolf 1995).

The MCV system classifies vegetation into a set of plant series types, or, in certain situations, unique stands or habitats. Plant series types are determined by plant species dominance or importance in the layer (tree, shrub, ground) with the greatest amount of cover. The MCV represents the most recent effort to provide a common and accepted vegetation classification system for use throughout California.

MCV plant series types were classified and mapped using 1:2400-scale color aerial photography provided by the Bureau of Reclamation. All vegetation mapping was performed in the field by ground truthing the ESL from boat or vehicle or by hiking to the site. MCV plant series types were identified within the ESL and then delineated onto the aerial photographs. The delineated boundaries were then digitized and generated in ArcGIS ArcView 8.2 software for display and data query purposes.

Botanical Surveys

NSR conducted botanical surveys for special-status floral species for the proposed project under two Reclamation task orders. The initial surveys were performed during 2002 within the Big Backbone Creek Arm and Squaw Creek Arm portions of the ESL. During 2003, additional surveys were conducted along 11 selected riverine reaches. All botany surveys were conducted in accordance with the technical methods prescribed by Nelson (1994). Each plant species encountered was identified to the level—either genus or species— necessary to determine if the plant could qualify as a special-status species. The botany surveys were conducted using Hickman (1993) as the standard reference for taxonomic nomenclature and identification.

4.1.2 CHARACTERIZATIONS

Vegetative Communities

The ESL is characterized by a variety of vegetation types typical of transitional mixed woodland and low-elevation forest habitats. MCV plant series types within the ESL are black oak, black willow, blue oak, brewer oak, California annual grassland, California buckeye, canyon live oak, cattail, deerbrush, Douglas-fir–ponderosa pine, foothill pine, Fremont cottonwood, knobcone pine, interior live oak, interior live oak shrub, mixed willow, Oregon white oak, ponderosa pine, sandbar willow, wedgeleaf ceanothus, white alder, and whiteleaf manzanita. The composition of dominant plant species and vegetation habitat within all these habitats varies, with dramatic changes often occurring in relation to aspect, slope, geologic substrate, or juxtaposition with other habitats. Elevations within the ESL range from approximately 1,070 to 1,200 feet, and the terrain is moderate to steep.

Maps of the MCV plant series are presented in Section 2 of each volume of the Atlas. Summaries of the MCV plant series types are presented in **Tables 4-1 through 4-6**. **Table 4.7** summarizes plant series types for the entire ESL. Photographs showing examples of the MCV plant series types are presented in Appendix D (Plant Series and Wildlife Habitat Photographs). General descriptions of each MCV plant series type are presented below.

The black oak plant series is characterized by moderate to dense stands of California black oak (*Quercus kelloggii*). This plant series is relatively common throughout the ESL. Understory associates include whiteleaf manzanita (*Arctostaphylos viscida*), poison oak (*Toxicodendron diversilobum*), snowdrop bush (*Styrax officinalis*), and buckbrush (*Ceanothus cuneatus*). The ground layer is open to dense and is dominated by various grasses and forbs.

Though a common associate within willow and other riparian plant series types in the ESL, black willow as a plant series type is uncommon within the ESL. This plant series is dominated by black (Goodding’s) willow (*S. gooddingii*). It occurs at only one location within the ESL, along the Sacramento River Arm.

The blue oak plant series occurs mainly as small inclusions within other more prevalent plant series types; however, moderate sized stands also occur. This plant series occurs at scattered locations along the Pit River Arm, and is dominated by open to moderate woodlands dominated by blue oak (*Q. douglasii*). Associated tree species include occasional interior live oak (*Q. wislizenii* var. *wislizenii*) and gray pine (*Pinus sabiniana*). The shrub layer is open or absent, and a moderate to dense forb layer dominates the understory.

The brewer oak plant series consists of moderate to very dense stands of Brewer oak (*Q. garryana* var. *breweri*), the shrub form of Oregon white oak (*Q. garryana* var. *garryana*). This plant series type is widespread throughout the ESL. Brewer oak stands are often nearly pure; occasionally, however, shrub species such as poison oak, whiteleaf manzanita, yerba santa (*Eriodictyon californicum*), buckbrush, bush poppy (*Dendromecon rigida*), silktassel (*Garrya fremontii*),

Table 4-1
Summary of Plant Series Types – Main Body of Lake

Plant Series Type	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
California annual grassland	0.58	0.13	3	0.14	0.28	0.19
Brewer oak	9.60	2.09	43	0.03	2.09	0.22
Deer brush	0.18	0.04	1	0.18	0.18	0.18
Interior live oak shrub	1.24	0.27	9	0.04	0.42	0.14
Wedgeleaf ceanothus	1.46	0.32	5	0.04	0.56	0.29
Whiteleaf manzanita	16.80	3.66	63	0.03	1.10	0.27
Black oak	71.25	15.52	97	0.01	11.45	0.73
Blue oak	1.27	0.28	3	0.16	0.78	0.42
Canyon live oak	9.59	2.09	45	0.03	0.89	0.21
Douglas fir-ponderosa pine	4.86	1.06	7	0.07	1.10	0.69
Foothill pine	53.95	11.75	78	0.002	5.00	0.69
Fremont cottonwood	0.06	0.01	1	0.06	0.06	0.06
Interior live oak	2.00	0.44	4	0.10	1.66	0.50
Knobcone pine	32.96	7.18	40	0.03	3.88	0.82
Mixed willow	1.54	0.33	19	0.01	0.67	0.08
Ponderosa pine	226.22	49.26	152	0.01	13.97	1.49
White alder	1.34	0.29	20	0.01	0.28	0.07
Urban[1]	22.05	4.80	6	2.28	7.25	3.67
Barren[1]	2.30	0.50	4	0.11	1.10	0.57
Total	459.25					

Notes: [1] WHR Wildlife Habitat Type (Mayer and Laudelslayer 1988), no corresponding plant series type included in *A Manual of California Vegetation* (Sawyer and Keeler-Wolf 1995).

deerbrush, skunkbrush (*Rhus trilobata*), and snowdrop bush occur in association with brewer oak.

California annual grassland is uncommon within the ESL, and occurs as small inclusions within other more prevalent plant series types or in areas subjected to previous disturbance. Dominant species include wild oat (*Avena fatua*), cheatgrass (*Bromus tectorum*), ripgut (*B. diandrus*), yellow starthistle (*Centaurea solstitialis*), squirreltail (*Elymus elymoides*), and European hairgrass (*Aira caryophyllea*).

Though a common associate within many plant series types within the ESL, California buckeye is uncommon within the ESL as a plant series type. This plant series is dominated by California buckeye (*Aesculus californica*). It occurs at only one location within the ESL, along the Doney Creek inlet (Sacramento River Arm).

Table 4-2
Summary of Plant Series Types – Big Backbone Creek Arm

Plant Series Type	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
Riverine[1]	0.88	0.96	1	0.88	0.88	0.88
California annual grassland	0.34	0.37	2	0.003	0.33	0.17
Brewer oak	0.27	0.30	3	0.07	0.10	0.09
Wedgeleaf ceanothus	1.96	2.14	2	0.42	1.54	0.98
Whiteleaf manzanita	11.17	12.19	23	0.02	1.38	0.49
Black oak	16.16	17.63	24	0.16	2.65	0.67
Canyon live oak	18.30	19.97	18	0.02	3.59	1.02
Knobcone pine	0.40	0.44	3	0.09	0.19	0.13
Mixed willow	1.46	1.60	36	0.001	0.47	0.04
Ponderosa pine	36.24	39.53	34	0.10	4.93	1.07
White alder	4.47	4.87	12	0.004	1.54	0.37
Total	91.67					

Notes: [1] WHR Wildlife Habitat Type (Mayer and Laudelslayer 1988), no corresponding plant series type included in *A Manual of California Vegetation* (Sawyer and Keeler-Wolf 1995).

The canyon live oak plant series is characterized by moderate to dense stands of canyon live oak (*Q. chrysolepis*). This plant series is relatively common throughout the ESL. Associated tree species include occasional California black oak. Understory associates include whiteleaf manzanita and poison oak. The ground layer is open to moderate and is dominated by various grasses and forbs.

The cattail plant series is uncommon within the ESL, occurring at only one location, along the upper reach of Salt Creek (Sacramento River Arm). This location consists of a fresh emergent marsh east of Interstate 5, at the Salt Creek/Shasta Lake confluence. This plant series is dominated by dense stands of narrow-leaved cattail (*Typha angustifolia*) and occupies portions of the fresh emergent marsh.

Deerbrush is a relatively common associate within chaparral and forest plant series types within the ESL; however, deerbrush is uncommon within the ESL as a plant series type. This plant series is dominated by deerbrush (*C. integerrimus*). It occurs at only one location within the ESL, along the Little Backbone Creek Inlet in a portion of a ponderosa pine stand burned by a recent wildfire.

Douglas-fir–ponderosa pine is the second-most common conifer plant series type within the ESL, and occurs in all parts of the ESL area, except for along the Big Backbone Creek Arm. This plant series is characterized by open to dense conifer stands dominated by Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*). Associated species include occasional sugar pine

Table 4-3
Summary of Plant Series Types – Sacramento River Arm

Plant Series Type	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
Riverine[1]	5.24	0.71	1	5.24	5.24	5.24
California annual grassland	4.17	0.57	10	0.05	1.07	0.42
Brewer oak	50.84	6.91	202	0.0001	2.54	0.25
Interior live oak shrub	10.05	1.37	41	0.02	0.78	0.25
Wedgeleaf ceanothus	2.11	0.29	8	0.06	0.65	0.26
Whiteleaf manzanita	99.49	13.53	181	0.03	3.35	0.55
Black oak	160.20	21.78	278	0.001	5.31	0.58
Black willow	0.02	0.001	1	0.02	0.02	0.02
California buckeye	0.2	0.03	1	0.20	0.20	0.20
Canyon live oak	53.80	7.32	152	0.002	4.09	0.35
Douglas-fir - ponderosa pine	28.49	3.87	33	0.02	4.54	0.86
Foothill Pine	51.29	6.97	87	0.005	8.33	0.59
Fremont cottonwood	0.07	0.01	1	0.07	0.07	0.07
Interior live oak	0.14	0.02	2	0.05	0.09	0.07
Knobcone pine	16.38	2.23	32	0.05	1.38	0.51
Mixed willow	15.03	2.04	34	0.001	4.54	0.44
Ponderosa pine	215.97	29.37	113	0.0002	11.25	1.91
White alder	8.94	1.22	47	0.0008	4.20	0.19
Barren[1]	13.01	1.77	23	0.01	3.18	0.57
Total	735.41					

Notes: [1] WHR Wildlife Habitat Type (Mayer and Laudelslayer 1988), no corresponding plant series type included in *A Manual of California Vegetation* (Sawyer and Keeler-Wolf 1995).

(*P. lambertiana*), incense cedar (*Calocedrus decurrens*), canyon live oak, and California black oak. Associated understory species vary and include Pacific dogwood (*Cornus nuttallii*), mock orange (*Philadelphus lewisii*), poison oak, snowdrop bush, and whiteleaf manzanita. The ground layer is open to moderate and is dominated by various grasses and forbs.

The foothill pine plant series is fairly common, occurring in all parts of the ESL area, except for along the Big Backbone Creek Arm. This plant series type is characterized by open to moderate stands of gray pine. Associated species include blue oak, canyon live oak, interior live oak, and California black oak. Shrub species are moderate to dense and include whiteleaf manzanita, western redbud (*Cercis occidentalis*), buckbrush, Brewer oak, poison oak, and yerba santa.

Table 4-4
Summary of Plant Series Types – McCloud River Arm

Plant Series Type	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
California annual grassland	0.94	0.23	5	0.01	0.51	0.19
Brewer oak	4.99	1.24	34	0.02	0.64	0.15
Interior live oak shrub	0.007	0.001	1	0.007	0.007	0.007
Sandbar willow	0.28	0.07	1	0.28	0.28	0.28
Wedgeleaf ceanothus	1.59	0.39	14	0.03	0.48	0.11
Whiteleaf manzanita	6.16	1.53	19	0.06	1.81	0.32
Black oak	46.80	11.62	77	0.02	3.40	0.61
Blue oak	0.70	0.17	4	0.11	0.22	0.17
Canyon live oak	42.00	10.42	93	0.006	3.07	0.45
Douglas-fir - ponderosa pine	47.80	11.87	48	0.0002	4.61	1.00
Foothill pine	11.85	2.94	26	0.02	1.18	0.46
Interior live oak	0.09	0.02	1	0.09	0.09	0.09
Knobcone pine	20.61	5.12	39	0.002	3.11	0.53
Mixed willow	0.16	0.04	1	0.16	0.16	0.16
Oregon white oak	1.01	0.25	6	0.02	0.50	0.17
Ponderosa pine	204.30	50.72	135	0.0007	15.88	1.51
White alder	2.37	0.59	31	0.002	0.61	0.08
Barren[1]	11.19	2.78	16	0.06	2.18	0.70
Total	402.82					

Notes: [1] WHR Wildlife Habitat Type (Mayer and Laudelslayer 1988), no corresponding plant series type included in *A Manual of California Vegetation* (Sawyer and Keeler-Wolf 1995).

Fremont cottonwood is an uncommon plant series type within the ESL, that occurs as a single stand of trees along the main body of the lake. Dominant species include Fremont cottonwood (*Populus fremontii*).

The knobcone pine plant series consists of open to dense knobcone pine (*Pinus contorta*) stands. This plant series is scattered throughout all portions of the ESL area. Knobcone pine often occurs at locations characterized by disturbances, including historic mining activities and past or recent wildfires. Dominant species include knobcone pine, with occasional canyon live oak, California black oak, ponderosa pine, and gray pine. The shrub layer is moderate to dense and is dominated by whiteleaf manzanita and poison oak. The ground layer varies and is dominated by various grasses and forbs.

Table 4-5
Summary of Plant Series Types – Squaw Creek Arm

Plant Series Type	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
Riverine[1]	1.41	0.48	1	1.41	1.41	1.41
Brewer oak	7.00	2.37	27	0.01	2.01	0.26
Sandbar willow	0.07	0.02	1	0.07	0.07	0.07
Wedgeleaf ceanothus	0.67	0.23	2	0.26	0.41	0.34
Whiteleaf manzanita	7.80	2.64	21	0.02	2.41	0.37
Black oak	2.48	0.84	7	0.07	0.96	0.35
Canyon live oak	33.06	11.19	42	0.0004	5.02	0.79
Douglas-fir – ponderosa pine	92.57	31.33	49	0.02	7.78	1.89
Foothill pine	23.76	8.04	17	0.005	4.80	1.40
Knobcone pine	57.12	19.33	34	0.013	7.21	1.68
Mixed willow	0.19	0.07	9	0.0001	0.15	0.02
Ponderosa pine	68.21	23.08	22	0.06	19.81	3.10
White alder	1.16	0.39	22	0.0001	0.40	0.05
Total	295.50					

Notes: [1] WHR Wildlife Habitat Type (Mayer and Laudelslayer 1988), no corresponding plant series type included in *A Manual of California Vegetation* (Sawyer and Keeler-Wolf 1995).

The interior live oak plant series is uncommon within the ESL. It occurs in several small areas along the Sacramento River Arm, Pit River Arm, McCloud River Arm, and the main body of the lake.

The interior live oak shrub plant series is relatively uncommon within the ESL and occurs mainly along the Sacramento River Arm; however, this plant series also occurs at scattered locations along the main body of the lake, the McCloud River Arm, and the Pit River Arm. This plant series is dominated by moderate to dense stands of the shrub form of interior live oak. Associated species include Brewer oak, whiteleaf manzanita, poison oak, and buckbrush.

Mixed willow is the most common willow plant series type within the ESL, occuring throughout the entire ESL area. Dominant species include red willow (*Salix laevigata*), Goodding's willow, shining willow (*S. lucida* ssp. *lasiandra*), arroyo willow (*S. lasiolepis*), and sandbar willow (*S. exigua*).

The Oregon white oak plant series is uncommon within the ESL and occurs as small inclusions within other more prevalent plant series types. This plant series is dominated by open to moderate woodlands dominated by Oregon white oak. Associated tree species include occasional canyon live oak, blue oak, and California black oak. The shrub layer is open or absent, and a moderate to dense forb layer dominates the understory.

Table 4-6
Summary of Plant Series Types – Pit River Arm

Plant Series Type	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
California annual grassland	1.05	0.20	9	0.006	0.37	0.12
Brewer oak	7.86	1.51	33	0.04	1.18	0.24
Interior live oak shrub	0.34	0.06	2	0.08	0.26	0.17
Wedgeleaf ceanothus	0.05	0.01	1	0.05	0.05	0.05
Whiteleaf manzanita	2.57	0.49	14	0.37	0.56	0.18
Black oak	4.59	0.88	13	0.08	0.90	0.35
Blue oak	6.48	1.25	16	0.008	1.48	0.41
Canyon live oak	92.60	17.81	95	0.04	6.05	0.97
Douglas-fir–ponderosa pine	135.69	26.10	86	0.002	10.78	1.58
Foothill pine	58.00	11.16	59	0.05	5.05	0.98
Interior live oak	1.07	0.21	3	0.23	0.42	0.36
Knobcone pine	72.28	13.90	36	0.02	8.53	2.01
Mixed willow	0.63	0.12	2	0.02	0.61	0.31
Oregon white oak	0.66	0.13	4	0.006	0.36	0.16
Ponderosa pine	130.41	25.08	77	0.0004	19.06	1.69
White alder	2.72	0.52	22	0.006	0.37	0.12
Urban[1]	1.37	0.26	5	0.002	1.20	0.27
Barren[1]	1.52	0.29	4	0.07	0.84	0.38
Total	519.88					

Notes: [1] WHR Wildlife Habitat Type (Mayer and Laudelslayer 1988), no corresponding plant series type included in *A Manual of California Vegetation* (Sawyer and Keeler-Wolf 1995).

Ponderosa pine is the most common conifer plant series type within the ESL and is scattered throughout all portions of the ESL area. This plant series is characterized by open to dense conifer stands dominated by ponderosa pine. Associated species include occasional Douglas-fir, sugar pine, incense cedar, canyon live oak, and California black oak. Associated understory species vary and include redbud, buckbrush, mock orange, poison oak, snowdrop bush, and whiteleaf manzanita. The ground layer is open to moderate and is dominated by various grasses and forbs.

Sandbar willow is an uncommon plant series, occurring at one location each along the McCloud River Arm and the Squaw Creek Arm. Dominant species include sandbar willow, with occasional red willow, Goodding's willow, shining willow, and arroyo willow.

Table 4-7
Summary of Plant Series Types – Entire Lake

Plant Series Type	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
Riverine[1]	7.53	0.30	3	0.88	5.24	2.51
California annual grassland	7.07	0.28	29	0.003	1.07	0.24
Brewer oak	80.57	3.22	342	0.0001	2.54	0.24
Deer brush	0.18	0.01	1	0.18	0.18	0.18
Interior live oak shrub	11.63	0.46	53	0.007	0.78	0.22
Sandbar willow	0.35	0.01	2	0.07	0.28	0.17
Wedgeleaf ceanothus	7.85	0.31	32	0.03	1.54	0.25
Whiteleaf manzanita	143.98	5.75	321	0.02	3.35	0.44
Black oak	301.48	12.04	496	0.0005	11.45	0.61
Black willow	0.02	0.001	1	0.02	0.02	0.02
Blue oak	8.46	0.34	23	0.01	1.48	0.37
California buckeye	0.20	0.01	1	0.20	0.20	0.20
Canyon live oak	249.35	9.96	445	0.0004	6.05	0.56
Douglas–fir - ponderosa pine	309.42	12.35	223	0.0002	10.78	1.39
Foothill pine	198.85	7.94	267	0.002	8.33	0.745
Fremont cottonwood	0.12	0.001	2	0.06	0.07	0.06
Interior live oak	3.30	0.13	10	0.05	1.66	0.33
Knobcone pine	199.76	7.98	184	0.002	8.53	1.86
Mixed willow	19.01	0.76	101	0.0001	4.54	0.19
Oregon white oak	1.67	0.07	10	0.006	0.50	0.17
Ponderosa pine	881.33	35.19	533	0.0002	19.81	1.65
White alder	20.98	0.84	154	0.0001	4.20	0.14
Urban[1]	23.42	0.94	11	0.002	7.25	2.13
Barren[1]	28.02	1.12	47	0.012	3.18	0.60
Total	2504.54					

Notes: [1] WHR Wildlife Habitat Type (Mayer and Laudelslayer 1988), no corresponding plant series type included in *A Manual of California Vegetation* (Sawyer and Keeler-Wolf 1995).

Wedgeleaf ceanothus occurs at scattered locations throughout the entire ESL area. This plant series is dominated by moderate to dense stands of buckbrush, also known as ceanothus. Associated species include whiteleaf manzanita, poison oak, western redbud, yerba santa, Brewer oak, birch-leaf mountain mahogany (*Cercocarpus betuloides*), and coffeeberry (*Rhamnus* sp.).

The white alder plant series occurs in the riparian vegetation found in many drainages throughout the ESL area. This plant series is characterized as narrow bands of vegetation occurring within and along the margins of river, stream, or other drainage features. Dominant species include white alder (*Alnus rhombifolia*), with occasional Oregon ash (*Fraxinus latifolia*), Pacific dogwood, big-leaf maple (*Acer macrophyllum*), sandbar willow, red willow, shining willow, and arroyo willow. Associated shrubs include spicebush (*Calycanthus occidentalis*), mock orange, California blackberry (*Rubus ursinus*), mugwort (*Artemisia douglasiana*), ninebark (*Physocarpus capitatus*), and western azalea (*Rhododendron occidentale*). Common lianas include California grape (*Vitis californica*), pipevine (*Aristolochia californica*), greenbriar (*Smilax californica*), and virgin's bower (*Clematis ligusticifolia*). The ground layer is open to dense and is dominated by sedges (*Carex* spp.) with various grasses and forbs.

Whiteleaf manzanita is the most common chaparral plant series type within the ESL and is scattered throughout all portions of the ESL area. Dominant species include whiteleaf manzanita. Associated species include occasional common manzanita (*A. manzanita*), western redbud, buckbrush, deerbrush, poison oak, birch-leaf mountain mahogany, interior live oak (shrub form), silktassel, bush poppy, yerba santa, and brewer oak.

Potential Floral Species of Concern

Within the ESL are a wide variety of vegetative communities and habitat components that support a large diversity of plant species. To aid in determining potential project effects, a list of potential floral species of concern was developed for the proposed project and was included as part of the terrestrial environment characterization for the pilot study.

For the purposes of this evaluation, floral species of concern are plants that are (1) designated as rare, threatened, or endangered by the state or federal government; or (2) are proposed for rare, threatened, or endangered status; and/or (3) are state or federal candidate species; and/or (4) are listed as species of concern by the U.S. Fish and Wildlife Service; and/or (5) are included on California Native Plant Society (CNPS) List 1A, 1B, 2, 3, or 4; and/or (6) are considered sensitive or endemic by the U.S. Forest Service, Shasta-Trinity National Forest (USFS/STNF); and/or (7) are considered a Survey and Manage species by the USFS/STNF.

Potentially occurring floral species of concern were determined in part by several database searches, a request for and review of a USFWS species list for Shasta County (U.S. Fish and Wildlife Service 2003), discussions with resource agency personnel, and professional experience in ESL area. Additionally, results from the vegetation habitat mapping, botanical surveys, and wildlife surveys conducted within the ESL by NSR during 2002 and 2003 were used in developing the list of species of concern.

Most of the land within the ESL consists of federal lands managed by the USFS/STNF; therefore, USFS Sensitive and Northwest Forest Plan Survey and Manage species are considered species of concern for the purposes of this evaluation. USFS Sensitive and Survey and Manage species potentially occurring within the ESL were determined by reviewing available information from the STNF.

The California Natural Diversity Database (CNDDB) was reviewed for records of special-status floral species within or in the vicinity of the ESL. This search produced a list of sightings of floral species of concern recorded in the CNDDB within the project vicinity. The CNDDB is a database consisting of historical observations of special-status plant species, wildlife species, and special plant communities. The CNDDB is limited to reported sightings and is not a comprehensive list of floral and wildlife species that may occur in a particular area.

Additional floral database searches were conducted using the CNPS Electronic Inventory. The Electronic Inventory allows users to query the *Inventory of Rare and Endangered Vascular Plants of California* (California Native Plant Society 2001) using a set of variable search criteria. The result of the search is a list of special-status plants selected by the particular search criteria. The criteria used for the CNPS query included all CNPS List 1A, 1B, 2, 3, and 4 plants occurring in Shasta County in closed-cone coniferous forest, chaparral, cismontane woodland, lower montane coniferous forest, marshes and swamps, pebble plain, valley and foothill grasslands, riparian forest, riparian woodland, and riparian scrub habitats between elevations of approximately 900 and 2,500 feet.

The most current lists of special-status floral species were reviewed to confirm the present status of these species (California Department of Fish and Game 2003a, 2003b).

Based on the evaluation criteria for potential floral species of concern, the literature review, the database searches, and the vegetation habitat characteristics/attributes within the ESL, 48 floral species that met the criteria were determined to have the highest likelihood to potentially occur within the ESL and are considered the floral species of concern for the purposes of this evaluation. These 48 species are summarized in **Table 4-8**.

Shasta Lake Shoreline

The Shasta Lake shoreline botanical surveys consisted of selected areas within the Big Backbone Creek Arm and Squaw Creek Arm ESL boundaries. These surveys were performed during 2002. Botanical surveys of the main body of the lake and the Sacramento River, McCloud River, and Pit River arms will be performed in spring 2004.

Squaw Creek Arm

The Squaw Creek Arm botanical surveys were conducted on May 16, June 6, July 11 and 12, and August 22 and 23, 2002, within the Squaw Creek Arm portion of the ESL. Approximately 296 acres were surveyed along the Squaw Creek Arm, with 12 person-days of survey effort expended. Representative areas in all vegetation habitats occurring within the ESL were surveyed.

The habitats and areas surveyed along the Squaw Creek Arm are shown in **Figure 4-1**.

No special-status floral species were found during the 2002 botanical surveys along the Squaw Creek Arm. A list of all plant species observed during the surveys is presented in **Appendix E.**

Table 4-8

Potential Floral Species of Concern, Shasta Dam Enlargement Project, Shasta County, California

Scientific Name	Common Name	Current Status	Comments
Ageratina shastensis	Shasta ageratina	CNPS 4, USFS Endemic	Potentially occurring in limestone outcrop habitats.
Amsinckia lunaris	Bent-flowered fiddleneck	FSC, CNPS 1B	Potentially occurring in cismontane woodland and valley and foothill grassland habitats.
Arctostaphylos malloryi	Mallory's manzanita	CNPS 4	Potentially occurring in chaparral and lower montane coniferous forest habitats.
Arnica venosa	Shasta County arnica	CNPS 4	Potentially occurring in cismontane woodland and lower montane coniferous forest habitats.
Astragalus pauperculus	Depauperate milk-vetch	CNPS 4	Potentially occurring in chaparral, cismontane woodland and valley and foothill grassland habitats.
Bondarzewia montana (mesenterica)	*Bondarzewia* fungus	S & M (B)	Potentially occurring in mixed conifer and conifer/woodland habitats.
Botrychium inc. *B. crenulatum*	Moonwort, grape-fern *Botrychium* subgenus	USFS Sensitive	Potentially occurring in mixed conifer and conifer/hardwood habitats.
Botrychium minganese	Moonwort	CNPS 2, S & M (A)	Potentially occurring in mixed conifer and conifer/woodland habitats.
Botrychium montanum	Moonwort	CNPS 2, S & M (A)	Potentially occurring in mixed conifer and conifer/woodland habitats.
Buxbaumia viridis	*Buxbaumia* (bryophyte)	S & M (E)	Potentially occurring in mixed conifer and conifer/woodland habitats.
Calochortus syntrophus	Callahan's mariposa lily	FSC, CNPS 3	Potentially occurring in cismontane woodland and lower montane coniferous forest habitats.
Calystegia atriplicifolia ssp. *buttensis*	Butte County morning-glory	FSC, CNPS 1B	Potentially occurring in chaparral and lower montane coniferous forest habitats.
Campanula shelteri	Castle Crags harebell	CNPS 1B	Potentially occurring in lower montane conifer habitats.
Carex buxbaumii	Buxbaum's sedge	CNPS 4	Potentially occurring in marshes and swamp habitats.
Carex comosa	Bristly sedge	CNPS 2	Potentially occurring marshes and swamps, and valley and foothill grassland habitats.
Carex vulpinoidea	Fox sedge	CNPS 2	Potentially occurring marshes and swamps, and riparian woodland habitats.
Clarkia borealis ssp. *arida*	Shasta clarkia	FSC, 1B	Potentially occurring in cismontane woodland and lower montane coniferous forest habitats.
Clarkia borealis ssp. *borealis*	Northern clarkia	CNPS 1B	Potentially occurring in chaparral, cismontane woodland and lower montane coniferous forest habitats.

Table 4-8 (continued)

Potential Floral Species of Concern, Shasta Dam Enlargement Project, Shasta County, California

Scientific Name	Common Name	Current Status	Comments
Cryptantha crinita	Silky cryptantha	FSC, CNPS 1B	Potentially occurring in cismontane woodland, lower montane coniferous forest, riparian forest, riparian woodland, and valley and foothill grassland habitats (gravelly streambeds).
Cypripedium californicum	California lady's-slipper	CNPS 4	Potentially occurring in lower montane coniferous forest habitats.
Cypripedium fasciculatum	Clustered lady's-slipper	FSC, CNPS 4, S&M (C)	Potentially occurring in lower montane coniferous forest habitats.
Cypripedium montanum	Mountain lady's-slipper	CNPS 4, S&M (C)	Potentially occurring in cismontane woodland and lower montane coniferous forest habitats.
Eleocharis quadrangulata	Four-angled spikerush	CNPS 2	Potentially occurring in marshes and swamp habitats.
Fritillaria eastwoodiae	Butte County fritillary	FSC, CNPS 3	Potentially occurring in chaparral, cismontane woodland and lower montane coniferous forest habitats.
Lathyrus sulphureus var. *argillaceus*	Dubious pea	CNPS 3	Potentially occurring in cismontane woodland and lower montane coniferous forest habitats.
Lewisia cantelovii	Cantelow's lewisia	FSC, CNPS 1B, USFS Sensitive	Potentially occurring in chaparral, cismontane woodland and lower montane coniferous forest habitats. One population found during the 2003 botanical surveys in the Upper Sacramento River ESL.
Lewisia cotyledon var. *howellii*	Howell's lewisia	FSC, CNPS 3	Potentially occurring in chaparral, cismontane woodland and lower montane coniferous forest habitats.
Limnanthes floccosa ssp. *bellingeriana*	Bellinger's meadowfoam	FSC, CNPS 1B	Potentially occurring in cismontane woodland habitats.
Linanthus latisectus	Broad-lobed linanthus	CNPS 4	Potentially occurring in cismontane woodland habitats.
Navarretia subuligera	Awl-leaved navarretia	CNPS 4	Potentially occurring in chaparral, cismontane woodland and lower montane coniferous forest habitats.
Neviusia cliftonii	Shasta snow-wreath	FSC, CNPS 1B, USFS Sensitive	Potentially occurring in cismontane woodland, lower montane coniferous forest and riparian woodland habitats. Several populations found within ESL during 2003 botanical and/or vegetation mapping surveys in the Pit River, McCloud River, and Main Body of Lake ESL.
Otidea leporina	*Otidea* fungus	S & M (D)	Potentially occurring in mixed conifer and conifer/woodland habitats.
Penstemon filiformis	Thread-leaved beardtongue	FSC, CNPS 1B	Potentially occurring in cismontane woodland and lower montane coniferous forest habitats.
Piperia leptopetala	Narrow-petaled rein orchid	CNPS 4	Potentially occurring in cismontane woodland and lower montane coniferous forest habitats.

Table 4-8 (continued)

Potential Floral Species of Concern, Shasta Dam Enlargement Project, Shasta County, California

Scientific Name	Common Name	Current Status	Comments
Polygonum bidwelliae	Bidwell's knotweed	CNPS 4	Potentially occurring in chaparral, cismontane woodland and lower montane coniferous forest habitats.
Polyozellus multiplex	Blue chantrelle	S & M (B)	Potentially occurring in mixed conifer and conifer/woodland habitats.
Potamogeton zosteriformis	Eel-grass pondweed	CNPS 2	Potentially occurring in marshes and swamp habitats.
Ptilidium californicum	Pacific fuzzwort	S & M (A)	Potentially occurring in mixed conifer and conifer/woodland habitats.
Rhynchospora capitellata	Brownish beaked-rush	CNPS 2	Potentially occurring in lower montane coniferous forest and marshes and swamp habitats.
Sagittaria sanfordii	Sanford's arrowhead	FSC, CNPS 1B	Potentially occurring in marshes and swamp habitats.
Schistostega pennata	Bug on a stick	S & M (A)	Potentially occurring in mixed conifer and conifer/woodland habitats.
Scutellaria galericulata	Marsh skullcap	CNPS 2	Potentially occurring in lower montane coniferous forest and marshes and swamp habitats.
Sedum paradisum	Canyon Creek stonecrop	FSC, CNPS 1B	Potentially occurring in chaparral and lower montane coniferous forest habitats.
Smilax jamesii	English Peak greenbriar	CNPS 1B, USFS Sensitive	Potentially occurring in lower montane coniferous forest and marshes and swamp habitats.
(Aleuria) Sowerbyella rhenana	Orange peel fungus	S & M (B)	Potentially occurring in mixed conifer and conifer/woodland habitats.
Stellaria obtusa	Obtuse starwort	CNPS 4	Potentially occurring in lower montane coniferous forest and riparian woodland habitats.
Thermopsis gracilus var. *gracilis*	Slender false lupine	CNPS 4	Potentially occurring in chaparral, cismontane woodland, and lower montane coniferous forest habitats.
Viburnum ellipticum	Oval-leaved viburnum	CNPS 2	Potentially occurring in chaparral, cismontane woodland, and lower montane coniferous forest habitats.

Notes: [1]Status Definitions:
FSC = Federal Species of Concern
CNPS 1B = CNPS List 1B Species
CNPS 2 = CNPS List 2 Species
CNPS 3 = CNPS List 3 Species
CNPS 4 = CNPS List 4 Species
USFS Endemic = U.S. Forest Service Endemic Species
USFS Sensitive = U.S. Forest Service Sensitive Species
S & M (-) = U.S. Forest Service Survey and Manage Species

Big Backbone Creek Arm

The Big Backbone Creek Arm botanical surveys were conducted on May 2, 7, 9, and 14, 2002, within the Big Backbone Creek Arm portion of the ESL. Approximately 92 acres were surveyed along the Big Backbone Creek Arm, with eight person-days of survey effort expended. Representative areas in all vegetation habitats occurring within the ESL were surveyed.

The habitats and areas surveyed along the Big Backbone Creek Arm are shown in **Figure 4-2**.

No special-status floral species were found during the 2002 botancal surveys along the Big Backbone Creek Arm. A list of all plant species observed during the surveys is presented in **Appendix E**.

Selected Riverine Reaches

The 2003 botanical surveys were conducted along 11 selected riverine reaches between June 1 and August 11, 2003, requiring 42 person-days of survey effort. The ESL for the selected riverine reaches consisted of all stream habitats, and20 linear feet on each side of the stream into the adjacent uplands, and upstream to the previously designated end point. The entire ESL boundary for each selected riverine reach was included during the surveys. The 11 riverine reaches are presented in Section 3 of each volume of the Atlas.

Little Backbone Creek

Botanical surveys along the Little Backbone Creek riverine reach were conducted on June 30 and July 31, 2003. Representative areas in all vegetation habitats occurring within the ESL boundary were surveyed. No special-status floral species were found. A list of all plant species observed during the surveys is presented in **Appendix E**.

Sugarloaf Creek

Botanical surveys were conducted along the Sugarloaf Creek riverine reach on July 7 and August 5, 2003. Representative areas in all vegetation habitats occurring within the ESL boundary were surveyed. No special-status floral species were found. A list of all plant species observed during the surveys is presented in **Appendix E**.

Upper Sacramento River

The botanical surveys along the Upper Sacramento River riverine reach were conducted on July 9, July 10, and August 4, 2003. Representative areas in all vegetation habitats occurring within the ESL boundary were surveyed. One special-status floral species, Cantelow's lewisia, was found. This discovery consists of one population found on a rock outcrop on the right bank of the Upper Sacramento River riverine reach near the Shasta Lake/Upper Sacramento River transition zone. The Cantelow's lewisia discovery site is presented in **Figure 4-3**. A list of all plant species observed during the surveys is presented in **Appendix E**.

Middle Salt Creek

The botanical surveys along the Middle Salt Creek riverine reach were conducted on July 15 and August 7, 2003. Representative areas in all vegetation habitats occurring within the ESL boundary were surveyed. No special-status floral species were found. A list of all plant species observed during the surveys is presented in **Appendix E.**

Salt Creek

The botanical surveys along the Salt Creek riverine reach were conducted on July 3, July 5, and August 6, 2003. Representative areas in all vegetation habitats occurring within the ESL boundary were surveyed. No special-status floral species were found. A list of all plant species observed during the surveys is presented in **Appendix E**.

Nosoni Creek

The botanical surveys along the Nosoni Creek riverine reach were conducted on June 25, July 5, and July 29, 2003. Representative areas in all vegetation habitats occurring within the ESL boundary were surveyed. No special-status floral species were found. A list of all plant species observed during the surveys is presented in **Appendix E**.

Dekkas Creek

The botanical surveys along the Dekkas Creek riverine reach were conducted on June 24 and July 28, 2003. Representative areas in all vegetation habitats occurring within the ESL boundary were surveyed. No special-status floral species were found. A list of all plant species observed during the surveys is presented in **Appendix E.**.

Campbell Creek

The botanical surveys along the Campbell Creek riverine reach were conducted on June 1 and June 30, 2003. Representative areas in all vegetation habitats occurring within the ESL boundary surveyed. One special-status floral species, Shasta snow-wreath, was found. This discovery consists of a large, previously known population occurring in riparian habitat along the left bank of Campbell Creek that extends from near the Campbell Creek/Shasta Lake confluence to a point approximately 1/4-mile upstream. The Shasta snow-wreath discovery site is presented in **Figure 4-4**. A list of all plant species observed during the surveys is presented in **Appendix E.**

Flat Creek

The botanical surveys along the Flat Creek riverine reach were conducted on June 23 and July 23, 2003. Representative areas in all vegetation habitats occurring within the ESL boundary were surveyed. No special-status floral species were found. A list of all plant species observed during the surveys is presented in **Appendix E.**

Ripgut Creek

The botanical surveys along the Ripgut Creek riverine reach were conducted on June 23 and July 23, 2003. Representative areas in all vegetation habitats occurring within the ESL boundary were surveyed. One special-status floral species, Shasta snow-wreath, was found. This discovery consists of a population occurring in riparian habitat along the left bank of Ripgut Creek approximately 1/3-mile upstream from the Ripgut Creek/Shasta Lake confluence. The Shasta snow-wreath discovery site is presented in **Figure 4-5**. A list of all plant species observed during the surveys is presented in **Appendix E**.

Potem Creek

The botanical surveys along the Potem Creek riverine reach were conducted on July 8 and August 11, 2003. Representative areas in all vegetation habitats occurring within the ESL boundary were surveyed. No special-status floral species were found. A list of all plant species observed during the surveys is presented in **Appendix E**.

4.1.3 SUMMARY

Two special-status floral species, Shasta snow-wreath and Cantelow's lewisia, were found during the 2003 botany surveys. The Shasta snow-wreath discoveries consist of a single, relatively large population occurring in riparian habitat along the Ripgut Creek riverine reach (Pit River Arm), and another large, previously known population along Campbell Creek (McCloud River Arm). The Cantelow's lewisia discovery consists of one population found on a rock outcrop on the right bank of the Upper Sacramento River riverine reach near the Shasta Lake/Upper Sacramento River transition zone.

In addition to the three sites with special-status plant species found during the botanical surveys, Shasta snow-wreath populations were found at five discovery sites during the vegetation and habitat mapping surveys performed within the entire Shasta Lake ESL during 2003. These discovery sites include a very large population at Stein Creek (Pit River Arm). This population occurs in riparian habitat along both banks of Stein Creek and extends from near the Stein Creek/Shasta Lake confluence to a point at least 1/4-mile upstream. Another small Shasta snow-wreath population was found at an unnamed stream south of Cove Creek (main body of lake). This population occurs in riparian and mixed woodland habitat on the right bank, at the confluence with Shasta Lake. Two Shasta snow-wreath sites, consisting of one moderate and one large population, were found along Blue Ridge on the main body of Shasta Lake. These populations occur in hardwood-conifer and ponderosa pine habitats immediately above the Shasta Lake high water line. The fifth Shasta snow-wreath site consists of a moderate-sized population at Keluche Creek (McCloud River Arm). This population occurs in riparian habitat along both banks of Keluche Creek near the Keluche Creek/Shasta Lake confluence. Figures 4-3 through 4-6 show the discovery sites for special-status floral species.

4.2 Wildlife

This section describes the methods and results of the wildlife habitat characterization and other wildlife technical studies performed for the proposed project during 2002 and 2003. The wildlife technical studies consisted of protocol-level surveys for Survey and Manage terrestrial mollusks, Shasta salamander, and forest carnivores along the Big Backbone Creek and Squaw Creek arms during 2002 and 2003. The 2002/2003 technical studies also included habitat mapping along Big Backbone Creek Arm and Squaw Creek Arm. Studies performed during 2003 included habitat mapping of the remaining portions of the Shasta Lake ESL. Incidental wildlife observations, emphasizing faunal species of concern, were documented throughout the surveys.

4.2.1 METHODS

Wildlife Habitat Mapping

To characterize the plant community portion of the affected environment, NSR conducted an extensive mapping effort to classify and quantify existing vegetation and habitat within the ESL. All vegetation within the ESL was mapped and classified using the Guide to Wildlife Habitats of California (Mayer and Laudenslayer 1988), the classification system developed for use with the California Department of Fish and Game's California Wildlife-Habitat Relationships System (WHR).

The WHR is a predictive database system based on scientific information concerning wildlife species and their habitat relationships. Applications of WHR include characterization of wildlife vegetation habitats and special habitat elements occurring within a particular area by using the WHR vegetation habitat classification system. The WHR model output is a typically a list of wildlife species that potentially occur in the area, based on wildlife habitats, habitat elements, and geographic location. Many other model outputs are also available. Mayer and Laudenslayer (1988) describe the various wildlife habitats that constitute the WHR classification system. The goal of the classification system is to identify and classify vegetation types important to wildlife, and to recognize and logically categorize major vegetative complexes at a scale sufficient to predict wildlife-habitat relationships.

WHR vegetation habitats were classified and mapped using 1:2400-scale color aerial photography provided by Reclamation. All vegetation mapping was performed in the field by ground truthing the ESL from boat or vehicle or by hiking to the site. WHR vegetation habitats were identified within the ESL and then delineated on aerial photographs. The delineated boundaries were then digitized and generated in ArcGIS ArcView 8.2 software for display and data query purposes.

Survey and Manage Terrestrial Mollusk Surveys

NSR conducted surveys for Survey and Manage terrestrial mollusk species within the Big Backbone Creek and Squaw Creek ESL boundaries. Prior to initiating the protocol-level terrestrial mollusk species surveys, NSR defined the survey effort by establishing the survey unit boundaries within each survey area. The survey units encompass the entire area within the ESL boundaries for tBig Backbone Creek Arm and Squaw Creek Arm. The survey unit boundaries were digitized using ArcGIS ArcView 8.2 to create survey unit aerial photo base maps and topographic base maps, to calculate survey unit acreage, and to calculate required survey time. The entire ESL was treated as one contiguous survey unit boundary for each of the Big Backbone Creek Arm and the Squaw Creek Arm study areas. Specifically, protocol-level surveys were conducted on 180 acres along the Big Backbone Creek Arm and 460 acres along the Squaw Creek Arm.

The terrestrial mollusk surveys were conducted following the *Survey Protocol for Terrestrial Mollusk Species from the Northwest Forest Plan, Draft Version 2.0 (October 29, 1997)* (Furnish *et al.* 1997) (mollusk protocol). As described in the mollusk protocol, one hour of survey time is required for every 10 acres of habitat. The survey time is divided into two 20-minute sample areas and one 20-minute opportunistic point search. Each unit must be surveyed during two separate seasons, or on two separate occasions with a minimum of 21 days between visits to a particular site.

During each survey round, NSR conducted a one hour survey for every 10 acres of habitat. Both survey visits at the Big Backbone Creek and Squaw Creek Arms were completed between mid-December 2002 and early February 2003. During the surveys, appropriate microhabitats, such as rocks, woody debris, and leaf litter, were examined for the presence/absence of terrestrial mollusks. For each visit, environmental characteristics of, and survey results of or, individual units were recorded on field data forms. Additional detailed micro-site characterization data were collected upon discovery of each Survey and Manage mollusk species.

Voucher specimens of all terrestrial mollusks found (Survey and Manage and non-Survey and Manage) were retained and reviewed for species verification. Trained NSR personnel verified and maintained quality control/quality assurance for all terrestrial mollusk species identification.

Shasta Salamander Surveys

The Shasta salamander is a terrestrial salamander species endemic to a relatively small portion of Shasta County. It is currently designated as a threatened species under the California Endangered Species Act, a federal species of concern, and a U.S. Forest Service Survey and Manage species. Shasta salamanders have been previously known to occur within, or in the vicinity (within less than 700 feet) of, limestone formations (Olson and Lewendal 1999).

Recently, Shasta salamanders were discovered in non-limestone habitat in an area known as Green Mountain, Shasta Lake, Shasta County, California (Lindstrand 2000). The discovery sites range between 1.5 and 4 miles from the nearest limestone outcrop formation, and show that previous assumptions regarding habitat use by this species are incomplete. Additional non-limestone discovery sites found during 2002 survey efforts include several new sites within the Green Mountain area (North State Resources 2002), and two other new sites; one located southwest of McCloud Reservoir and the other north of Chirpchatter Mountain near Salt Creek (Nauman and Olson, in press).

Recognizing these recent findings and the potential importance to the proposed project, NSR conducted surveys for the Shasta salamander within the Big Backbone Creek and Squaw Creek ESL boundaries and designed the surveys to occur in both limestone and non-limestone habitats. Prior to initiation of the protocol-level surveys, NSR established survey unit boundaries within each survey area. Survey unit boundaries were established in part by using the vegetation habitat mapping previously performed within each survey area. The surveys were designed to provide a 40-acre sample within the Big Backbone Creek study area and an 80-acre sample in the Squaw Creek study area. The survey unit boundaries were digitized using ArcGIS ArcView 8.2 to create survey unit aerial photo base maps and topographic base maps to calculate survey unit acreage and to calculate required survey time per unit.

The Shasta salamander surveys were conducted following the *Survey Protocol for the Shasta Salamander (Hydromantes shastae), Version 3.0, (3/19/99)* (Olson and Lewendal 1999) (salamander protocol). As described in the salamander protocol, eight person-hours of survey time are required for every 10 acres of "rock outcrop habitat", and four person-hours of survey time are required for every 10 acres of habitat in "slope habitat." In both situations, the study area must be surveyed on three separate occasions, with at least one visit occurring during the spring season. Additionally, a minimum of 10 days must elapse between visits.

All Shasta salamander survey results were recorded on field data forms. Additionally, detailed survey and habitat information was recorded on survey and manage discovery site field data forms for each Shasta salamander discovery site. For all Shasta salamander specimens detected, snout-vent length and cover object information was recorded and other pertinent comments were noted.

All Shasta salamander surveys were conducted under California Department of Fish and Game (CDFG) Scientific Collecting Permit #SC-1611, which includes an additional Memorandum of Understanding (MOU) providing authorization to conduct Shasta salamander surveys. As a provision of the CDFG Scientific Collection Permit MOU required to collect Shasta salamanders, California Natural Diversity Database field forms were completed and submitted for the Shasta salamander discovery sites.

Forest Carnivore Surveys

NSR conducted surveys for sensitive forest carnivore species (forest carnivores) within the Big Backbone Creek Arm and Squaw Creek Arm ESL areas. The specific sensitive forest carnivore species (i.e., "target species") for the survey were the Sierra Nevada red fox (Vulpes vulpes necator), American marten (Martes americana), Pacific fisher (Martes pennanti), and wolverine (Gulo gulo).

The forest carnivore surveys were generally conducted following the guidelines described in American Marten, Fisher, Lynx, and Wolverine: Survey Methods for Their Detection, August 1995 (Zielinski and Kucera 1995) (carnivore protocol). The carnivore protocol describes guidelines and techniques routinely approved and used by many various researchers and resource agencies, including the U.S. Forest Service and Bureau of Land Management. Specifically, NSR used the photographic bait station technique to conduct the surveys.

Photographic bait station surveys were conducted using Wildlife Pro cameras (Camtrak South, Inc., Watkinsville, Georgia). The Wildlife Pro camera uses a heat and motion sensor system to activate a Yashica T4 Super D 35mm camera housed in a self-contained weatherproof case. This system allows users to select for day, night, or continuous activity; with photo event settings between 90 seconds and 45 minutes. During the survey, each Wildlife Pro camera was set to run in continuous mode, with a 3-minute delay between photo events.

Camera stations were placed in woodland or forest stands with the most suitable forest carnivore habitat within the sample units encompassing the project area. In determining where to place camera stations, additional consideration was given to the project study area boundary, habitat suitability within the project study area boundary, and access constraints, as well as attempting to place camera stations at least one mile apart. Each camera was secured onto a tree and aligned with the survey station bait to ensure that the unit would be triggered when an individual investigating the bait broke the beam/sensor.

Each photographic survey station was baited with approximately 10 pounds of raw whole chicken (normally two to three whole chickens). Galvanized aviary wire was used to build a “bait basket” to hold the bait. Each bait basket was secured to a “bait tree” and aligned with the camera unit. Additionally, approximately 1/2 ounce of “Gusto” (Caven’s Lures, Minnesota Trapline Products, Pennock, MN) was placed on and around the bait to act as an added attractant.

All baited camera stations were “run” for a minimum of 28 days for two separate survey seasons. At a minimum, each station was checked and monitored every seven days while they were active. During each check, the survey station was first visually examined for activity. Following initial examination, the camera frame number was recorded and test photos were taken to monitor camera alignment and to ensure that the camera unit, batteries, and sensors were properly functioning. Film and/or batteries were changed as appropriate. Following the camera unit check, the bait tree/basket was checked, re-baited, and repaired as necessary.

Surveys were conducted within “sample units” identified by NSR during pre-survey project planning, following the guidelines described in the survey protocol. Generally, a sample unit consists of a 4-square-mile area that is (in most locations) aligned with section boundaries. Sample units are designed and integrated into the carnivore protocol as a standard unit for simplicity, survey effort comparability, and compatibility with existing map coverage. When using the photographic bait station technique to perform forest carnivore surveys, two photographic bait stations generally are located within each sample unit encompassing a project area boundary(s) to provide adequate survey coverage.

A total of three sample units, consisting of six baited camera stations, were surveyed in the Big Backbone Creek Arm portion of the ESL, and six sample units, consisting of 11 baited camera stations, were surveyed in the Squaw Creek Arm portion of the ESL. Three sample units in the Squaw Creek Arm portion were determined to require only one baited camera station each to provide adequate survey coverage because only a small amount of land occurred within both the sample unit and ESL boundaries. The sample unit boundaries and the location of each forest carnivore survey station for the Squaw Creek Arm and Big Backbone Creek Arm portions of the ESL are shown on **Figures 4-7 and 4-8**.

4.2.2 CHARACTERIZATIONS

Wildlife Habitat

The ESL is characterized by a variety of vegetation types typical of transitional mixed woodland and low-elevation forest habitats. Dominant vegetation habitats within the ESL include Sierran mixed conifer, ponderosa pine, closed-cone pine, montane hardwood-conifer, montane hardwood, blue oak woodland, blue oak–digger gray pine, montane riparian, mixed chaparral, annual grassland, fresh emergent wetland, lacustrine, riverine, barren, and urban. Dominant plant species and the composition of vegetation within all these habitats vary, with dramatic changes often occurring in relation to aspect, slope, geologic substrate, or juxtaposition with other habitats. Elevations within the ESL range between approximately 1,070 and 1,200 feet, and the terrain is moderate to steep. WHR vegetation habitat maps are presented in the Atlas, Vols. II through VII. Summaries of the WHR habitats are presented in **Tables 4-9 through 4-15**. Photographs showing examples of the WHR habitats are presented in Appendix D (Plant Series and Wildlife Habitat Photographs). General descriptions of each WHR habitat are presented below.

Table 4-9
Summary of WHR Habitats – Main Body of Lake

WHR Habitat	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
Annual grassland	0.44	0.10	2	0.15	0.28	0.22
Barren	2.30	0.50	4	0.11	1.10	0.57
Blue oak-digger pine	10.36	2.26	15	0.09	2.02	0.69
Closed-cone pine - cypress	32.68	7.12	39	0.03	3.88	0.84
Mixed chaparral	28.68	6.24	106	0.02	2.09	0.27
Montane hardwood - conifer	74.63	16.25	99	0.002	3.61	0.75
Montane hardwood	73.49	16.00	94	0.007	10.74	0.78
Montane riparian	4.12	0.90	76	0.006	0.66	0.05
Ponderosa pine	210.60	45.86	153	0.01	13.97	1.38
Urban	21.96	4.78	6	2.29	7.16	3.66
Total	459.25					

Sierran mixed conifer habitat is uncommon within the ESL, occurring at scattered locations along the Squaw Creek Arm portion of the ESL. This habitat is characterized by a moderate to dense coniferous tree overstory mixed with both overstory and understory hardwoods. Dominant conifer species include Douglas-fir and ponderosa pine, with occasional sugar pine and incense cedar. Dominant hardwoods include California black oak and canyon live oak, with occasional big-leaf maple and Pacific dogwood. Understory vegetation varies and includes sparse to moderate shrub growth, such as whiteleaf manzanita, snowdrop bush, deerbrush, and poison oak, with a variable grass and forb layer. The presence of several conifer tree species and a greater proportion of conifer tree species to hardwood tree species distinguishes this habitat from montane hardwood-conifer habitat.

Table 4-10
Summary of WHR Habitats – Big Backbone Creek

WHR Habitat	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
Mixed chaparral	13.64	14.88	23	0.04	2.02	0.59
Montane hardwood - conifer	0.99	1.08	1	0.99	0.99	0.99
Montane hardwood	36.06	39.34	30	0.05	7.12	1.20
Montane riparian	9.37	10.22	30	0.009	2.69	0.31
Ponderosa pine	30.72	33.52	28	0.02	4.56	1.10
Riverine	0.88	0.96	1	0.88	0.88	0.88
Total	91.67					

Table 4-11
Summary of WHR Habitats – Sacramento River Arm

WHR Habitat	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
Annual grassland	3.10	0.42	8	0.04	1.06	0.39
Barren	10.61	1.43	20	0.11	2.48	0.53
Closed-cone pine - cypress	12.95	1.75	24	0.07	1.43	0.54
Mixed chaparral	165.38	22.37	288	0.01	7.41	0.57
Montane hardwood - conifer	152.50	20.62	189	0.0007	11.88	0.81
Montane hardwood	171.56	23.20	310	0.01	5.33	0.55
Montane riparian	34.30	4.64	114	0.0008	9.33	0.30
Ponderosa pine	181.80	24.59	84	0.002	11.14	2.16
Riverine	5.24	0.71	1	5.24	5.24	5.24
Urban	1.95	0.26	2	0.0002	1.95	0.98
Total	739.41					

Ponderosa pine habitat is fairly common and occurs throughout the ESL. Dominant species include open to moderate stands of ponderosa pine with occasional Douglas-fir, gray pine, and knobcone pine. Dominant hardwoods present include California black oak and canyon live oak. The shrub layer is open to dense and includes whiteleaf manzanita, Brewer oak, snowdrop bush, poison oak, western redbud, and buckbrush. The ground layer is dominated by open to moderate grass and forb cover.

Closed-cone pine habitat consists of open to dense knobcone pine stands. This habitat occurs as delineated stands in all portions of the ESL except along the Big Backbone Creek Arm, where several small inclusions occur within larger habitat types. Closed-cone pine habitat often occurs at locations characterized by disturbances, including historic mining activities and past or recent wildfires. Dominant species include knobcone pine, with occasional ponderosa pine and gray pine. The shrub layer is moderate to dense and is dominated by whiteleaf manzanita, poison oak, and yerba santa. The ground layer varies and is dominated by various grasses and forbs.

Table 4-12
Summary of WHR Habitats – McCloud River Arm

WHR Habitat	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
Annual grassland	0.70	0.17	3	0.03	0.56	0.23
Barren	3.38	0.84	12	0.04	1.11	0.28
Closed-cone pine - cypress	20.79	5.16	33	0.002	3.12	0.63
Mixed chaparral	12.60	3.13	60	0.01	1.79	0.21
Montane hardwood - conifer	130.40	32.37	125	0.0002	7.65	1.04
Montane hardwood	62.05	15.40	101	0.00001	3.94	0.61
Montane riparian	3.53	0.88	62	0.00001	0.42	0.06
Ponderosa pine	157.80	39.17	91	0.0007	12.48	1.73
Sierran mixed conifer	3.62	0.90	1	3.62	3.62	3.62
Urban	7.96	1.98	9	0.00001	1.63	0.88
Total	402.82					

Table 4-13
Summary of WHR Habitats – Squaw Creek Arm

WHR Habitat	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
Blue oak-gray pine	5.46	1.85	4	0.20	2.40	1.36
Closed-cone pine - cypress	53.38	18.06	27	0.01	9.97	1.98
Mixed chaparral	10.49	3.55	31	0.009	2.41	0.34
Montane hardwood - conifer	144.16	48.78	59	0.005	15.12	2.44
Montane hardwood	23.03	7.79	37	0.0004	3.76	0.62
Montane riparian	1.55	0.53	35	0.00001	0.40	0.04
Ponderosa pine	53.75	18.19	14	0.14	19.74	3.84
Riverine	1.41	0.48	1	1.41	1.41	1.41
Sierran mixed conifer	2.28	0.77	1	2.28	2.28	2.28
Total	295.51					

The montane hardwood-conifer habitat (MHC) is the most abundant vegetation habitat in the ESL, occurring throughout the ESL. This habitat includes a variable mixture of conifer and hardwood overstory trees with an open to dense understory. Dominant conifer species include Douglas-fir, ponderosa pine, gray pine, and knobcone pine. Hardwood composition varies and includes California black oak, canyon live oak, blue oak, and occasional interior live oak. Shrub species and composition vary and include whiteleaf manzanita, western redbud, buckbrush, poison oak, birch-leaf mountain

Table 4-14
Summary of WHR Habitats – Pit River Arm

WHR Habitat	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
Annual grassland	0.38	0.07	1	0.38	0.38	0.38
Barren	1.20	0.23	4	0.04	0.70	0.30
Blue oak-gray pine	34.69	6.67	31	0.01	6.52	1.12
Blue oak woodland	3.29	0.63	8	0.11	0.96	0.41
Closed-cone pine - cypress	69.84	13.43	37	0.02	6.73	1.89
Mixed chaparral	12.01	2.31	46	0.009	1.54	0.26
Montane hardwood - conifer	178.56	34.34	135	0.02	7.69	1.32
Montane hardwood	78.84	15.16	82	0.07	6.10	0.96
Montane riparian	5.03	0.97	58	0.006	0.60	0.09
Ponderosa pine	123.57	23.76	67	0.0004	19.06	1.84
Sierran mixed conifer	11.16	2.15	12	0.10	4.24	0.93
Urban	1.42	0.27	2	0.15	1.27	0.71
Total	520.00					

mahogany, brewer oak, and California buckeye. The ground layer varies and is dominated by various grasses and forbs.

Montane hardwood habitat includes nearly pure to mixed stands dominated by various hardwood tree species with a variable understory. Dominant tree species include hardwoods, such as California black oak and canyon live oak, with occasional Douglas-fir and ponderosa pine. Shrub species and composition vary and are similar to species occurring in the montane hardwood-conifer habitat.

Blue oak woodland habitat occurs mainly as small inclusions or moderate stands in scattered locations within the Pit River Arm portion of the ESL. This habitat is characterized as open to moderate woodlands dominated by blue oak with occasional interior live oak and gray pine. The shrub layer is open or absent, and a moderate to dense forb layer dominates the understory.

Blue oak–gray pine habitat also occurs as small inclusions and/or moderate stands and is found in the main body of Shasta Lake, Squaw Creek Arm and the Pit River Arm portions of the ESL. Species composition is similar to the blue oak woodland habitat; however, gray pine and a shrub component are more common. Shrub species include whiteleaf manzanita, poison oak, buckbrush, and western redbud.

Montane riparian habitat occurs throughout the ESL along the many streams and drainages tributary to Shasta Lake. Montane riparian habitat also occurs in isolated spring/seep features scattered throughout the ESL. Vegetation within this habitat is sparse to dense, mainly occurring in thin to moderate stringers or small patches. In many locations, the adjacent upland habitats often extend into the riparian areas. Dominant species include white alder, black willow, red willow, shining willow, arroyo willow, sandbar willow, Oregon ash, big-leaf maple, buttonwillow (*Cephalanthus occidentalis*), ninebark, mock orange, spicebush, California blackberry, sedges, and various other grasses and forbs.

Table 4-15
Summary of WHR Habitats – Entire Lake

WHR Habitat	Area (ac)	Percent Total Area	Number of Polygons	Size of Polygons		
				Min.	Max.	Mean
Annual grassland	4.62	0.18	14	0.03	1.06	0.33
Barren	17.86	0.71	40	0.04	2.48	0.45
Blue oak-gray pine	50.51	2.02	50	0.01	6.52	1.01
Blue oak woodland	3.29	0.13	8	0.11	0.96	0.41
Closed-cone pine - cypress	189.64	7.57	160	0.002	9.97	1.19
Mixed chaparral	239.41	9.56	554	0.00001	6.43	0.43
Montane hardwood - conifer	681.23	27.20	608	0.0002	15.12	1.12
Montane hardwood	444.24	17.74	654	0.00001	10.74	0.68
Montane riparian	57.90	2.31	375	0.00001	9.33	0.15
Ponderosa pine	758.25	30.27	437	0.0004	19.74	1.74
Riverine	7.53	0.30	3	0.88	5.24	2.51
Sierran mixed conifer	17.05	0.68	14	0.10	4.24	1.22
Urban	33.29	1.33	19	0.00001	7.16	1.75
Total	2504.32					

Mixed chaparral occurs as variable stands of moderate to dense shrubs, or as small inclusions within other woodland or forest habitats. Dominant species include whiteleaf manzanita, common manzanita, western redbud, buckbrush, deerbrush, poison oak, birch-leaf mountain mahogany, interior live oak (shrub form), silktassel, bush poppy, yerba santa, and brewer oak.

Annual grassland habitat is uncommon within the ESL, and occurs as small inclusions within other woodland, hardwood, or hardwood-conifer habitats. Dominant species include wild oat, cheatgrass, ripgut, yellow starthistle, squirreltail, and European hairgrass.

Fresh emergent wetland habitat is uncommon within the ESL, occurring only at the confluence of Salt Creek (Sacramento Arm) and Shasta Lake. Dominant species include narrow-leaved cattail, parrots feather (*Myriophyllum aquaticum*), knotweed (*Polygonum* sp.), sedges (*Carex* spp.), iris (*Iris pseudacorus*), and horsetail (*Equisetum arvense*).

Lacustrine habitat consists of the area regularly inundated by Shasta Lake (i.e., areas up to and below the 1,070-foot elevation). Most of this area is barren of vegetation and is characterized as exposed soil and/or rock. Portions of the lacustrine habitat do support vegetation during draw-down periods, including woody riparian species such as black willow, buttonwillow, Fremont cottonwood, and various grasses and forbs.

Riverine habitat includes the free-flowing portions of the larger Shasta Lake tributaries occurring within the ESL. The riverine habitat is highly variable, and ranges from moderate, low-gradient to steep, well-confined stream reaches.

Barren habitat consists mainly of non-vegetated man-made features scattered throughout the ESL, including boat ramps, parking lots, and roads. Other barren habitats include a large gravel plain feature at the confluence of Butcher Creek (main body of lake) and Shasta Lake, and a sealed rip-rap feature adjacent to Interstate 5 near the Upper Sacramento Arm and Shasta Lake confluence.

Urban habitat consists of various man-made features scattered throughout the ESL, including resorts and a portion of the visitor center complex at Shasta Dam. These features are typically a combination of various buildings, pavement areas with landscaping, and/or lawns.

Potential Faunal Species of Concern

The ESL includes of a wide variety of vegetative communities and habitat components that support a large diversity of wildlife species. To aid in determining potential project effects, a list of potential faunal species of concern was developed for the proposed project and included as part of the terrestrial environment characterization for the pilot study.

For the purposes of this evaluation, wildlife species of concern include taxa that are (1) designated as threatened or endangered by the state or federal governments; or (2) are proposed or petitioned for federal listing as threatened or endangered; and/or (3) are state or federal candidates for listing as threatened or endangered; and/or (4) are identified by the USFWS as species of concern; and/or (5) are identified by the California Department of Fish and Game as species of special concern; and/or (6) are considered sensitive or endemic by the USFS/STNF; and/or (7) are considered a Survey and Manage species by the USFS/STNF.

Most of the land within the ESL consists of federal lands managed by the USFS/STNF; therefore, USFS Sensitive and Northwest Forest Plan Survey and Manage species are considered species of concern for the purposes of this evaluation. USFS Sensitive and Survey and Manage species potentially occurring within the ESL were determined by reviewing available information from the STNF.

Potentially occurring wildlife species of concern were determined in part using several database searches, a request for and review of a USFWS species list for Shasta County (USFWS 2003), discussions with resource agency personnel, and professional experience in the vicinity of the ESL. Additionally, results from the vegetation habitat mapping, botanical surveys, and wildlife surveys conducted within the ESL by NSR during 2002 and 2003 were used to develop the list of species of concern.

The CNDDB was reviewed for records of special-status wildlife species within or in the vicinity of the ESL. This search produced a listing of sightings of wildlife species of concern recorded in the CNDDB within the project vicinity.

CDFG's WHR system (version 8.0) was used to help determine wildlife species that potentially occur in the vegetation habitats within the ESL. WHR is a predictive system based on scientific information of wildlife species and their habitat relationships. Fish fauna and invertebrates are not included in the WHR system. The application of WHR is based on characterization of wildlife habitats and special habitat elements occurring within a particular study area. Vegetation within the ESL was classified using the system developed for use with WHR (Mayer and Laudenslayer 1988). The model output is a list of wildlife species that potentially occur within the study area, based on wildlife habitats, habitat elements, and geographic location. Based on the vegetation habitat mapping performed by NSR during 2002 and 2003, Sierra mixed conifer, ponderosa pine, closed-cone pine, montane hardwood-conifer, montane hardwood, blue oak woodland, blue oak-gray pine, montane riparian, mixed chaparral, annual grassland, fresh emergent wetland, lacustrine, riverine, barren, and urban WHR habitats occur within the ESL. The criteria used for the WHR query included all species potentially occurring in Shasta County in the previously described habitats. All habitat stages were included, and no habitat elements were excluded for the purposes of the WHR query.

The most current lists of special-status wildlife species were reviewed to confirm the present status of these species (California Department of Fish and Game 2003c, 2003d).

Based on the evaluation criteria for potential wildlife species of concern, the literature review, the database searches, and the vegetation habitat characteristics and attributes within the ESL, 51 wildlife species that met the criteria were determined have the highest likelihood to potentially occur within the ESL and are considered the wildlife species of concern for the purposes of this evaluation. These 51 species are summarized in **Table 4-16**.

Wildlife Surveys

Big Backbone Creek and Squaw Creek Arms – Survey and Manage Terrestrial Mollusk Surveys

Two rounds of surveys were conducted in both the Big Backbone Creek Arm and Squaw Creek Arm portions of the ESL between December 2002 and February 2003. The first round of surveys along the Big Backbone Creek Arm was initiated on December 17, 2002, and completed on January 13, 2003. The second round of surveys along the Big Backbone Creek Arm was initiated on January 29, 2003, and completed on January 30, 2003. The first round of surveys along the Squaw Creek Arm was initiated on January 23, 2003, and completed on January 28, 2003. The second round of surveys was initiated on February 5, 2003, and completed on February 27, 2003. Appropriate survey weather

Table 4-16
Potential Faunal Species of Concern. Shasta Dam Enlargement Project, Shasta County, California

Common Name	Scientific Name	Current Status	Comments
Shasta salamander	*Hydromantes shastae*	CT, FSC, USFS, S & M (A)	Potentially occurring in mixed conifer, woodland, and chaparral habitats, especially in the vicinity of limestone. Known occurrences within and in the vicinity of the ESL. Found within the Big Backbone Creek Arm ESL during 2003 terrestrial mollusk and Shasta salamander surveys.
Tailed frog	*Ascaphus truei*	FSC, CSC	Potentially occurring in stream habitats. Known occurrences in McCloud and Upper Sacramento Arm tributaries.
Foothill yellow-legged frog	*Rana boylii*	FSC, CSC, USFS	Potentially occurring in stream habitats. Known occurrences scattered throughout the ESL and vicinity.
Northwestern pond turtle	*Clemmys marmorata marmorata*	FSC, CSC, USFS	Potentially occurring in stream or other wetland habitats. Adjacent upland habitats are potential nesting areas. Known occurrences scattered throughout the ESL and vicinity.
Double-crested cormorant	*Phalacrocorax auritus*	CSC (Rookery site)	Potentially occurring in riverine and lacustrine habitats. Mainly a fall/winter migrant, however, also a resident species locally. No known rookery sites within the ESL.
Osprey	*Pandion haliaetus*	CSC	Potentially occurring in riverine and lacustrine habitats. Common at Shasta Lake and many known nests occur within the ESL and vicinity.
Bald eagle	*Haliaeetus leucocephalus*	CE, FT (FPD), CP	Potentially occurring in riverine and lacustrine habitats. Common at Shasta Lake and several known nests occur within the ESL and vicinity.
Sharp-shinned hawk	*Acciptier striatus*	CSC	Potentially occurring in mixed conifer and conifer/woodland habitats.
Cooper's hawk	*Accipiter cooperi*	CSC	Potentially occurring in mixed conifer and conifer/woodland habitats.
Northern goshawk	*Accipiter gentilis*	CSC, FSC, USFS	Potentially occurring in mixed conifer habitats.
Peregrine falcon	*Falco peregrinus*	CE, FSC, USFS, CP	Potentially occurring in mixed conifer and conifer/woodland habitats. Nesting sites in the ESL unlikely due to lack of suitable eyrie sites, however, potential eyrie sites occur adjacent to the ESL. Known historical eyrie in McCloud River Arm, and "new" eyrie found at the Gooseneck (Sacramento River Arm).
Northern spotted owl	*Strix occidentalis caurina*	FT	Potentially occurring in coniferous forest habitats.
Flammulated owl	*Otus flammeolus*	FSC	Potentially occurring in coniferous forest habitats.
Long-eared owl	*Asio otus*	CSC	Potentially occurring in coniferous forest habitats.
Black swift	*Cypseloides niger*	FSC, CSC	Potentially occurring in coniferous forest, conifer/woodland, and riparian habitats with waterfall or other mist-zone features.
Vaux's swift	*Chaetura vauxi*	FSC, CSC	Potentially occurring in coniferous forest and conifer/woodland habitats.
Lewis' woodpecker	*Melanerpes lewis*	FSC	Potentially occurring in coniferous forest and conifer/woodland habitats.
Red-breasted sapsucker	*Sphyapicus ruber*	FSC	Potentially occurring in coniferous forest and conifer/woodland habitats.
Olive-sided flycatcher	*Contopus cooperi*	FSC	Potentially occurring in coniferous forest and conifer/woodland habitats. Generally breeds at higher elevations than the ESL.
Willow flycatcher	*Empidonax traillii brewsteri*	CE, FSC	Potentially occurring in riparian habitats.

Table 4-16 (Continued)
Potential Faunal Species of Concern. Shasta Dam Enlargement Project, Shasta County, California

Common Name	Scientific Name	Current Status	Comments
Purple martin	*Progne subis*	CSC	Potentially occurring in conifer, woodland, and riparian habitats. Foraging habitat throughout ESL. Shasta Lake is one of the few known breeding sites in Shasta County.
Bank swallow	*Riparia riparia*	CT, FSC	Potentially occurring in riparian habitats, foraging habitat throughout ESL.
California thrasher	*Toxostoma redivivum*	FSC	Potentially occurring in chaparral and mixed woodland habitats.
Yellow warbler	*Dendroica petechia*	CSC	Potentially occurring in riparian habitats.
Yellow-breasted chat	*Icteria virens*	CSC	Potentially occurring in riparian habitats.
Lawrence's goldfinch	*Carduelis lawrencei*	FSC	Potentially occurring in chaparral, mixed woodland, and riparian habitats. Uncommon breeder in Shasta County.
Western red bat	*Lasiurus blossevillii*	USFS	Potentially occurring in mixed conifer and conifer/woodland habitats, foraging habitat throughout the ESL.
Spotted bat	*Euderma maculatum*	CSC, FSC	Potentially occurring in mixed conifer and conifer/woodland habitats, foraging habitat throughout the ESL.
Townsend's big-eared bat	*Plecotus townsendii*	CSC, FSC, USFS	Potentially occurring in mixed conifer and conifer/woodland habitats, foraging habitat throughout the ESL.
Pallid bat	*Antrozous pallidus*	CSC, USFS	Potentially occurring in mixed conifer and conifer/woodland habitats, foraging habitat throughout the ESL.
Western mastiff bat	*Eumops perotis*	CSC, FSC	Potentially occurring in mixed conifer and conifer/woodland habitats, foraging habitat throughout the ESL.
Small-footed myotis	*Myotis ciliolabrum*	FSC	Potentially occurring in mixed conifer and conifer/woodland habitats, foraging habitat throughout the ESL.
Long-eared myotis	*Myotis evotis*	FSC	Potentially occurring in mixed conifer and conifer/woodland habitats, foraging habitat throughout the ESL.
Fringed myotis	*Myotis thysanodes*	FSC	Potentially occurring in mixed conifer and conifer/woodland habitats, foraging habitat throughout the ESL.
Long-legged myotis	*Myotis volans*	FSC	Potentially occurring in mixed conifer and conifer/woodland habitats, foraging habitat throughout the ESL.
Yuma myotis	Myotis yumanensis	FSC	Potentially occurring in mixed conifer and conifer/woodland habitats, foraging habitat throughout the ESL.
Ringtail	*Bassariscus astutus*	CP	Potentially occurring in mixed conifer and conifer/woodland habitats. Detected at numerous sites during 2003 forest carnivore surveys in Big Backbone and Squaw Creek Arms.
Fisher	*Martes pennanti*	CSC, FSC, USFS	Potentially occurring in mixed conifer and conifer/woodland habitats. Detected at one site each during 2003 forest carnivore surveys in Big Backbone and Squaw Creek Arms.
Shasta sideband	*Monadenia troglodytes troglodytes*	FSC, USFS, S & M (A)	Terrestrial mollusk. Potentially occurring in mixed conifer and woodland habitats, especially in the vicinity of limestone.
Wintu sideband	*Monadenia troglodytes wintu*	USFS, S & M (A)	Terrestrial mollusk. Potentially occurring in mixed conifer and woodland habitats, especially in the vicinity of limestone.
Shasta chaparral	*Trilobopsis roperi*	USFS, S & M (A)	Terrestrial mollusk. Potentially occurring in mixed conifer and conifer/woodland habitats. Found within the Big Backbone Creek and Squaw Creek Arm ESL during 2003 terrestrial mollusk surveys.

Table 4-16 (Continued)
Potential Faunal Species of Concern. Shasta Dam Enlargement Project, Shasta County, California

Common Name	Scientific Name	Current Status	Comments
Shasta Hesperian	*Vespericola shasta*	USFS, S & M (A)	Terrestrial mollusk. Potentially occurring in mixed conifer and conifer/woodland habitats (riparian and/or riverine habitats). Found within Squaw Creek ESL during 2003 terrestrial mollusk surveys, also several incidental detections during 2003 in the Pit and McCloud River Arms.
Nugget pebblesnail	*Fluminicola* seminalis	USFS, S & M (A[2])	Aquatic mollusk. Potentially occurring in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).
Potem pebblesnail	*Fluminicola* sp. 14	USFS, S & M (A)	Aquatic mollusk. Potentially occurring in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).
Flat-top pebblesnail	*Fluminicola* sp. 15	USFS, S & M (A)	Aquatic mollusk. Potentially occurring in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).
Shasta pebblesnail	*Fluminicola* sp. 16	USFS, S & M (A)	Aquatic mollusk. Potentially occurring in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).
Disjunct pebblesnail	*Fluminicola* sp. 17	USFS, S & M (A)	Aquatic mollusk. Potentially occurring in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).
Globular pebblesnail	*Fluminicola* sp. 18	USFS, S & M (A)	Aquatic mollusk. Potentially occurring in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).
Cinnamon juga	*Juga* (*Orebasis*) sp.3	USFS, S & M (A)	Aquatic mollusk. Potentially occurring in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).
Canary duskysnail	*Lyogyrus* sp. 3	USFS, S & M (A)	Aquatic mollusk. Potentially occurring in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).
Knobby rams-horn	*Vorticifex* sp. 1	USFS, S & M (E)	Aquatic mollusk. Potentially occurring in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).

Notes:
[1]Status Definitions:
CSC = California Species of Special Concern
FSC = Federal Species of Concern
FT = Federally Threatened
FPD = Proposed for Federal Delisting
CE = California Endangered
CT = California Threatened
CP = California Fully Protected Species
USFS = U.S. Forest Service Sensitive
S & M (-) = U.S. Forest Service Survey and Manage Species

conditions, as defined in the mollusk protocol, were met during all terrestrial mollusk surveys. Two Survey and Manage terrestrial mollusk species, Shasta chaparral (*Trilobopsis roperi*) and Shasta hesperian (*Vespericola shasta*), were found during the surveys. Shasta chaparral was detected at four discovery sites in the Big Backbone Creek Arm portion of the ESL and at five discovery sites in the

Squaw Creek Arm portion of the ESL. Shasta hesperian was detected at three discovery sites in the Squaw Creek Arm portion. A summary of the Survey and Manage terrestrial mollusks found within each survey area is presented in **Table 4-17**. The locations of each Survey and Manage terrestrial mollusk species discovery site in the Squaw Creek Arm and Big Backbone Creek Arm portions of the ESL are presented in **Figures 4-9** and **4-10**.

Table 4-17
Summary of Survey and Manage Terrestrial Mollusk Species Detections, Big Backbone Creek and Squaw Creek Arms, Shasta Dam Enlargement Project, Shasta County, California

	Trilobopsis roperi		*Vespericola shasta*	
Survey Area	Total Discovery Sites	Total Individuals	Total Discovery Sites	Total Individuals
Big Backbone Creek Arm	4	28	0	0
Squaw Creek Arm	5	9	3	16
Total	9	37	3	16

Shasta chaparral and Shasta hesperian are currently designated as Category A species under the Northwest Forest Plan *2002 Survey and Manage Standards and Guidelines Category Assignment* (Bureau of Land Management 2003) (2002 Category Assignment). Taxa in this category are considered rare, and preservation of all known sites or population areas is likely to be necessary to provide reasonable assurance of species persistence.

Other terrestrial mollusk species (non-Survey and Manage) found during the surveys include Church's sideband (*Monadenia churchi*), shoulderband (*Helminthogypta cypreophylla* [hertleini][*]), harpoon snail (*Haplotrema keepi*), and California megomphix (*Megomphix californicus*).

Although recently designated as a Category B species, as of the 2002 Category Assignment, *H. hertleini* is no longer designated as a Survey and Manage species. Therefore, even if the recent taxonomic changes to *H. cypreophylla/H. hertleini* were incorporated into the Northwest Forest Plan, *H. hertleini* would not be considered a Survey and Manage species. Also, although previously designated as a Category F species, Church's sideband is no longer designated a Survey and Manage species as of the 2002 Category Assignment.

Incidental observations of other wildlife species were also noted during the surveys, particularly herpetofauna, as these species often occupy similar microhabitat features as terrestrial mollusks and are often detected during survey efforts. Other herpetofauna species found include rough-skinned newt

[*]Due to recent taxonomic changes, Helminthogypta cypreophylla in the vicinity of Shasta Lake are now recognized as H. hertleini (Roth 2002). This recent taxonomic change, however, has not been formalized, nor is it currently incorporated into the Survey and Manage Species Program of the Northwest Forest Plan.

(*Taricha granulosa*), black salamander (*Aneides flavipunctatus*), ensantina (*Ensantina eschscholtzii*), western skink (*Eumeces skiltonianus*), and northern alligator lizard (*Gerrhonotus multicarinatus*).

Additionally, one special-status herpetofauna species was detected at two discovery sites in the Big Backbone Creek Arm portion of the ESL; Shasta salamander (*Hydromantes shastae*). Details regarding these discovery sites are included in the Shasta salamander section of this report.

Several incidental Survey and Manage terrestrial mollusk discoveries also occurred during the 2003 vegetation and habitat mapping and/or botanic surveys of the riverine reaches. These include five Shasta hesperian discovery sites at Potem, Ripgut, Flat, Stein (Pit River Arm), and Campbell Creeks (McCloud River Arm). **Figures 4-11** and **4-12** show the discovery sites for Survey and Manage faunal species.

Big Backbone Creek and Squaw Creek Arms – Shasta Salamander Surveys

The Big Backbone Creek Arm survey area consisted of five survey units, four of which were slope habitat and one of which was rock habitat. A small portion of one slope habitat unit (#3) consists of scattered limestone rock. The Squaw Creek Arm survey area consisted of six survey units, all of which were slope habitat. Based on the habitat characteristics of the two survey areas and the requirements of the salamander protocol, a total of 51 person-hours of search time were expended within the Big Backbone Creek Arm survey area and 96 person-hours within the Squaw Creek Arm survey area. The Shasta salamander survey unit boundaries for the Squaw Creek Arm and Big Backbone Creek Arm are shown on **Figures 4-13** and **4-14**.

Shasta salamander surveys were initiated on January 27, 2003, and completed on March 25, 2003. Overall, appropriate weather conditions, as defined in the salamander protocol, were met during the surveys.

Shasta salamanders were detected at five sites within three of the survey units in the Big Backbone Creek Arm survey area. No Shasta salamander discovery occurred in the Squaw Creek Arm survey areas. A summary of Shasta salamander discovery sites by survey unit for the Big Backbone Creek Arm survey area is presented in **Table 4-18**.

Table 4-18
Shasta Salamander Detections by Survey Unit, Big Backbone Creek Arm, Shasta Dam Enlargement Environmental Studies, Shasta County, California

Survey Unit	Shasta Salamander Detections, Big Backbone Creek Arm.		
	Total Discovery Sites	Total Individuals	Habitat Type[1]
1	0	0	Slope
2	0	0	Slope
3	1	1	Slope
4	1	1	Rock
5	3	4	Slope
N/A[2]	1	1	Slope
3[2]	1	2	Slope

Notes:[1] Slope = Non-limestone, Rock = Limestone. [2] Discovery Site From Terrestrial Mollusk Surveys.

In addition to the five discovery sites found during the Shasta salamander surveys, Shasta salamanders were found at two discovery sites during the terrestrial mollusk surveys performed within the Big Backbone Creek Arm portion of the ESL. One discovery site occurs in non-limestone habitat located approximately 1/4 mile south of Shoemaker Creek. The other discovery site occurs in scattered limestone rock habitat within Shasta salamander survey unit #3. These sites are also included in **Table 4-18**.

Figure 4-14 shows the locations of all Shasta salamander discovery sites.

Other herpetofauna found during the Shasta salamander surveys include rough-skinned newt, ensatina, black salamander, western toad *(Bufo boreas),* foothill yellow-legged frog *(Rana boylei),* western fence lizard *(Sceloporus occidentalis),* western skink, northern alligator lizard, sharp-tailed snake *(Contia tenuis),* garter snake *(Thamnophis elegans),* and ringneck snake *(Contia tenuis).*

Big Backbone Creek and Squaw Creek Arms – Forest Carnivore Surveys

Two complete forest carnivore surveys were conducted, one winter survey during January and February 2003, and one spring survey during March and April 2003. The initial survey round along the Big Backbone Creek Arm was conducted between January 13 and February 11, 2003, and the second round was conducted between March 5 and April 3, 2003. The initial survey round along the Squaw Creek Arm was conducted between January 13 and February 12, 2003, and the second round was conducted between March 6 and April 7, 2003.

One target forest carnivore species was detected during the survey, Pacific fisher (*Martes pennati*). This species was detected at one survey station in each of the two survey areas. The Pacific fisher discovery sites are shown on **Figure 4-15**.

Six additional mammal species were detected during the surveys in the Big Backbone Creek Arm portion of the ESL: gray fox (*Urocyon cinereoargenteus*), black bear (*Ursus americanus*), ringtail (*Bassariscus astutus*), cougar (*Felis concolor*), black-tailed mule deer (*Odocoileus hemionus columbianus*), and wild boar (*Sus scrofa*). A summary of all mammal species detected during the surveys by photographic bait station is presented in **Table 4-19**. Other wildlife species detected during the surveys include turkey vulture (*Cathartes aura*), stellar’s jay (*Cyanocitta stelleri*), and raven (*Corvus corax*).

Six mammal species were also detected during the surveys in the Squaw Creek Arm portion of the ESL: gray fox, black bear, ringtail, cougar, spotted skunk (*Spilogale gracilis*), and black-tailed mule deer. A summary of all mammal species detected during the surveys by photographic bait station is presented in **Table 4-20**. Other wildlife species detected during the surveys include common raven.

As shown in **Table 4-19**, black bear and ringtail were the most commonly detected species during the Big Backbone Creek Arm survey effort; these species were each detected at five of the six survey stations. All other species found were detected at two or more survey stations. Survey station 4 detected the most species (five), while all survey stations had at least two species detections.

Table 4-19 Mammal Species Detected by Photographic Bait Station, Big Backbone Creek Arm, Shasta Dam Enlargement Environmental Studies, Shasta County, California						
Species Detected (listed by common name)						
Gray Fox	Black Bear	Ringtail	Cougar	Pacific Fisher	Black-tailed Mule Deer	Wild Boar
	✓	✓				
	✓	✓				
	✓	✓				
✓	✓	✓	✓	✓		
					✓	✓
✓	✓	✓				

Notes: "✓" Indicates species was detected

As shown in **Table 4-20**, gray fox and black bear were the most commonly detected species during the Squaw Creek Arm surveys; these species were each detected at eight of the 11 survey stations. Ringtail were detected at seven of the 11 survey stations. All other species found were detected at one survey station each. Survey stations 1 and 3 detected the most species (four), while survey stations 10 and 11 each had one species detection.

Table 4-20 Mammal Species Detected by Photographic Bait Station, Squaw Creek Arm, Shasta Dam Enlargement Environmental Studies, Shasta County, California							
Survey Station Number	Species Detected (listed by common name)						
	Gray Fox	Black Bear	Ringtail	Cougar	Spotted Skunk	Pacific Fisher	Black-tailed Mule Deer
1	✓	✓	✓			✓	
2	✓	✓	✓				
3	✓	✓	✓		✓		
4	✓	✓					
5	✓	✓					
6	✓		✓				
7	✓	✓	✓				
8	✓	✓	✓				
9		✓	✓				
10							✓
11				✓			

Notes: "✓" Indicates species was detected

To aid in determining the effectiveness of the forest carnivore surveys, NSR calculated the number of “lost trap nights” that occurred during the survey effort. A lost trap night is defined as the time when no additional photos were taken at a survey station during a particular week (i.e., between weekly camera survey station checks). This situation normally occurs due to running out of film exposures, which is usually due to repeated visits by a particular mammal species.

The Big Backbone Creek Arm forest carnivore surveys consisted of six camera stations working for 28 days each survey season, for a total of 168 possible trap nights each survey season. During the winter surveys, 84 lost trap nights occurred at five survey stations, or 50 percent of the survey effort. During the spring surveys, 78 lost trap nights occurred at all six survey stations, or 46 percent of the survey effort. Overall, the entire survey effort consisted of 336 possible trap nights, with a total of 162 lost trap nights, or 48 percent of the entire survey effort.

The Squaw Creek Arm forest carnivore surveys consisted of 11 camera stations working for 28 days each survey season, for a total of 308 possible trap nights each survey season. During the winter surveys, 69 lost trap nights occurred at eight survey stations, or 22 percent of the survey effort. During the spring surveys, 92 lost trap nights occurred at eight survey stations, or 29 percent of the survey effort. Overall, the entire survey effort consisted of 616 possible trap nights, with a total of 161 lost trap nights, or 26 percent of the entire survey effort.

Generally, these results constitute a moderate number of lost trap nights for the Big Backbone Creek Arm survey and a low number of lost trap nights for the Squaw Creek Arm survey. Most lost trap nights were caused from film exposures being used due to repeated visits by black bear, although many were also caused by ringtail and gray fox. To eliminate, or minimize, lost trap nights due to black bear activity, most of these types of surveys are conducted during the winter. Recognizing this, NSR performed the surveys during the winter and early spring. Though black bear activity wanes during this time of year, the Big Backbone Creek Arm and Squaw Creek Arm survey areas lie within a geographic region where this species is active year-round due to the low elevation, relatively mild winters, and available food sources. Given the presence of black bear, and the detection of several other wildlife species, the overall number of lost trap nights is considered low to moderate. Additionally, considering that at one of the six survey stations in the Big Backbone Creek Arm portion of the ESL and at one of the nine survey stations in the Squaw Creek Arm portion of the ESL where lost trap nights occurred, fisher were detected (*i.e.*, a target species was found anyway), the overall survey effort should be considered effective.

Incidental Observations

During all vegetation and habitat mapping and the other biological studies performed during 2002 and 2003, NSR maintained a list of incidental wildlife observations for inclusion in the biological characterization. The incidental observations included all species observed and emphasized faunal species of concern. These observations occurred during the previously described technical studies and were made with the unaided eye, binoculars, or spotting scope, and by identification of wildlife vocalizations.

Incidental faunal species of concern observed during the surveys include foothill yellow-legged frog, northwestern pond turtle (*Clemmys marmorata marmorata*), bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), purple martin (*Progne subis*), yellow warbler (*Dendroica petechia*), and yellow-breasted chat (*Icteria virens*). Locations of these detections are shown on **Figures 4-16** through **4-22**. A summary of all species observed during the various surveys and/or as incidental observations during other studies is presented in **Appendix F**.

4.2.3 SUMMARY

Four special-status faunal species were found during the protocol-level wildlife survey efforts: two Survey and Manage terrestrial mollusks (Shasta chaparral, Shasta Hesperian), one Survey and Manage and state-listed salamander (Shasta salamander), and one mammal (Pacific fisher).

In addition to the four special-status faunal species sites found during the wildlife surveys, seven faunal species of concern were observed incidentally during other project-related surveys and activities: foothill yellow-legged frog, northwestern pond turtle, bald eagle, peregrine falcon, purple martin, yellow warbler, and yellow-breasted chat.

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Figure 4-1
Squaw Creek Arm Botanical Survey Areas and WHR Habitat Types

F:Projects\10022 - Biological Surveys and Impact Analyses for Potential Shasta Dam Enlargement\GIS\Figure_4-2.mxd   June, 2004 Source: NSR, Inc.; USGS

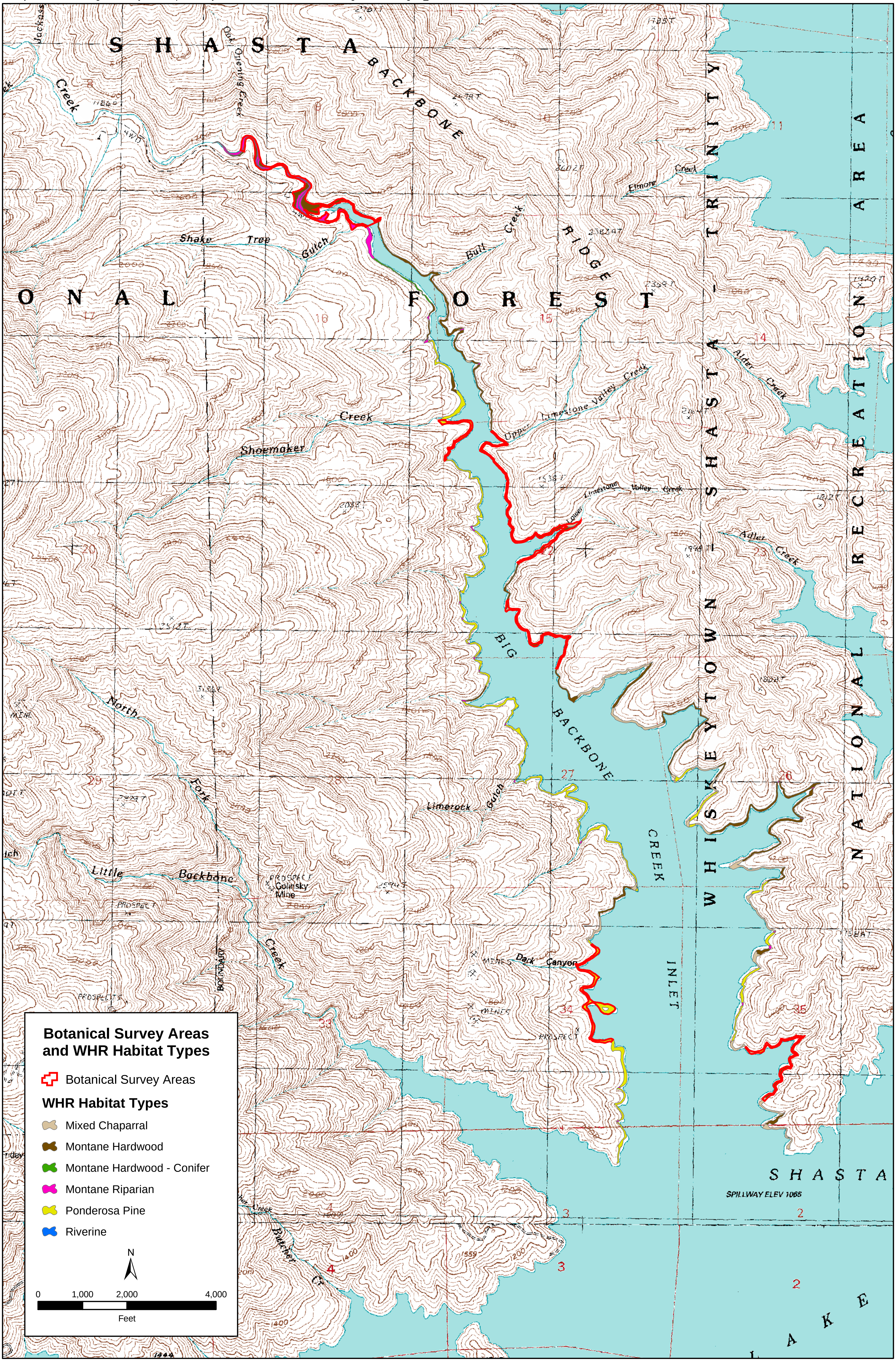

Figure 4-2
Big Backbone Arm Botanical Survey Areas and WHR Habitat Types

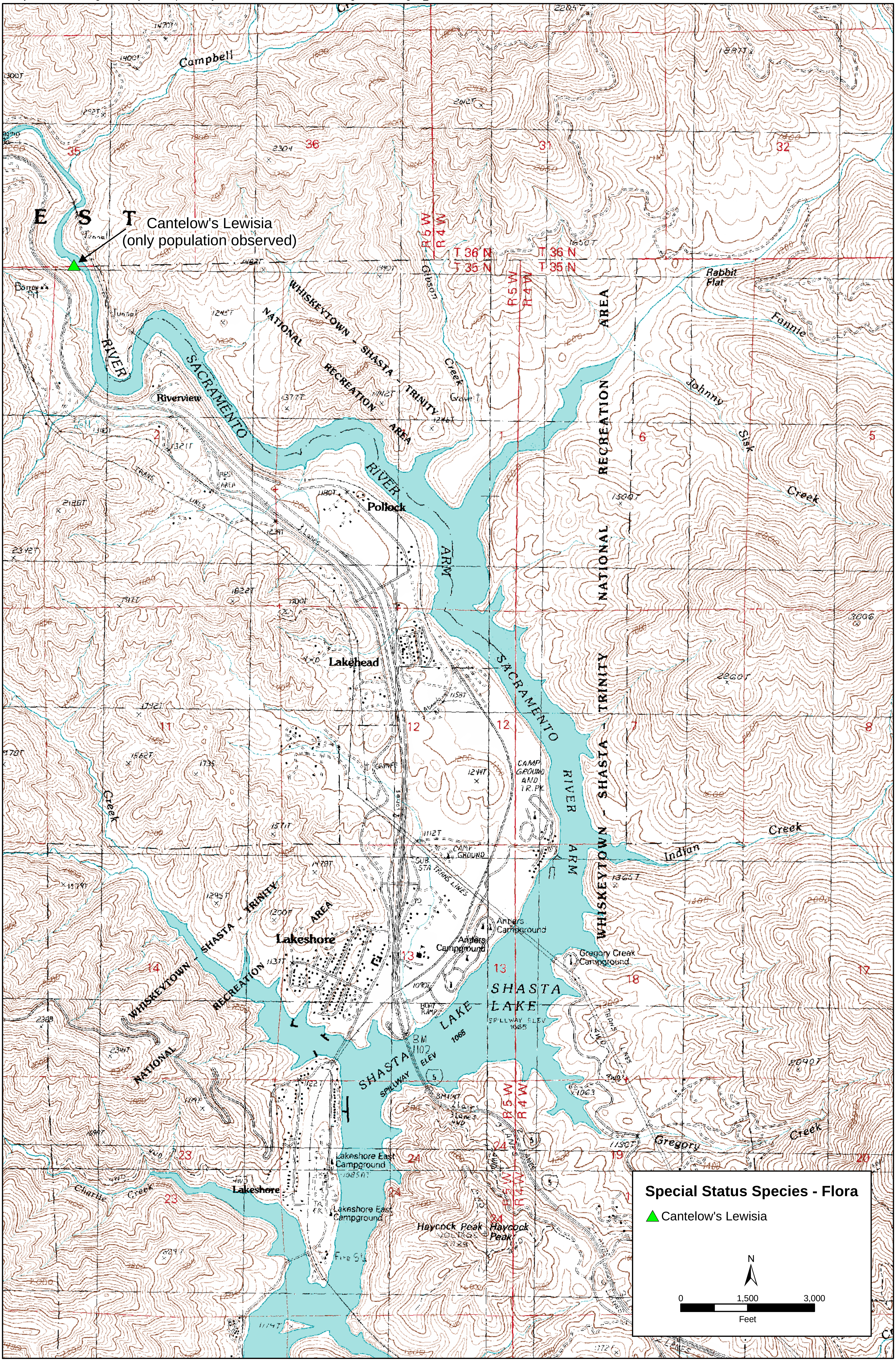

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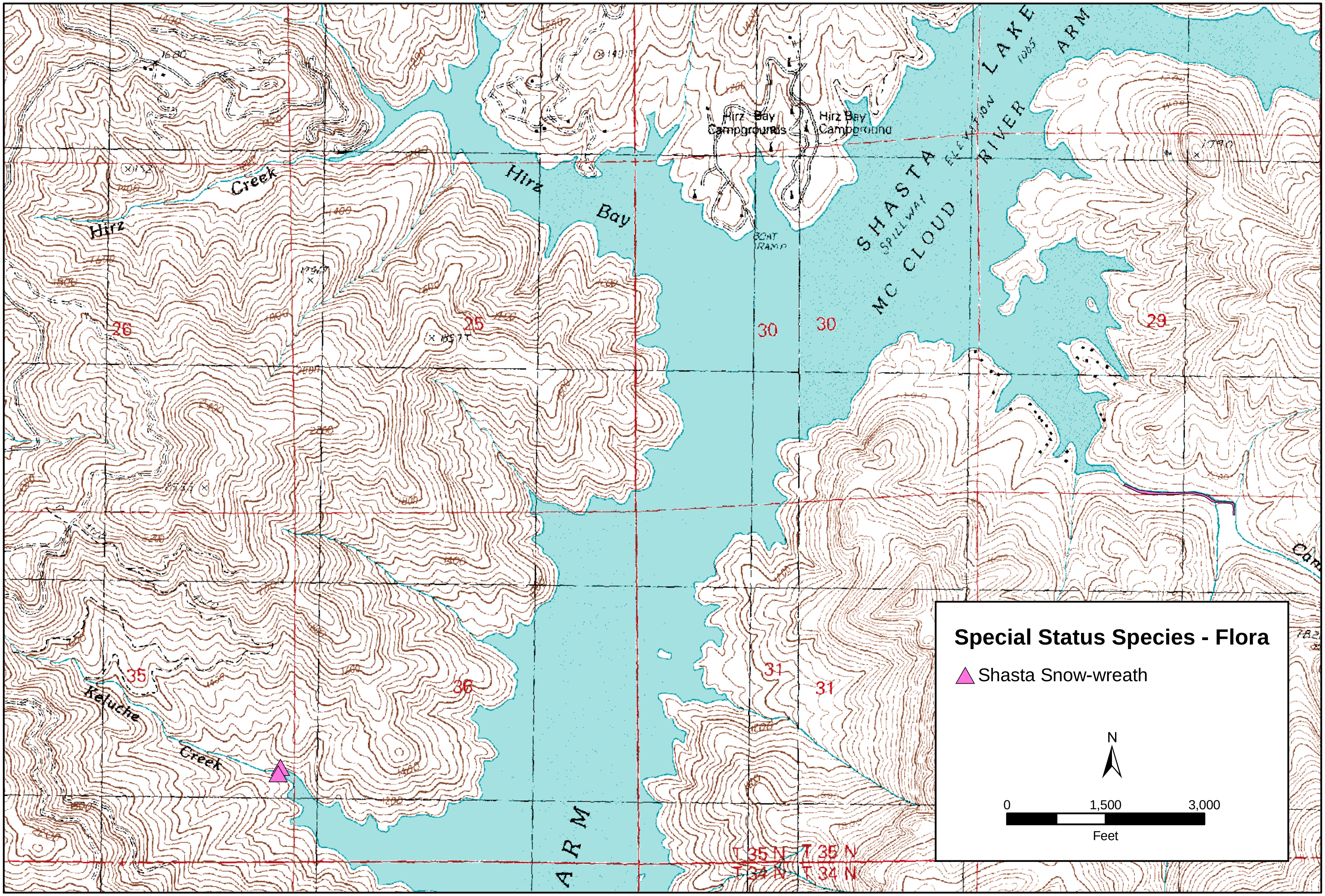
Figure 4-3
Special Status Species
Incidental Observations - Flora



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Shasta Lake Water Resources Investigation Technical Report

Figure 4-4
Special Status Species
Incidental Observations - Flora

F:Projects\10022 - Biological Surveys and Impact Analyses for Potential Shasta Dam Enlargement\GIS\Figure_4-5.mxd June, 2004 Source: NSR, Inc.; USGS

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Figure 4-5
Special Status Species
Incidental Observations - Flora

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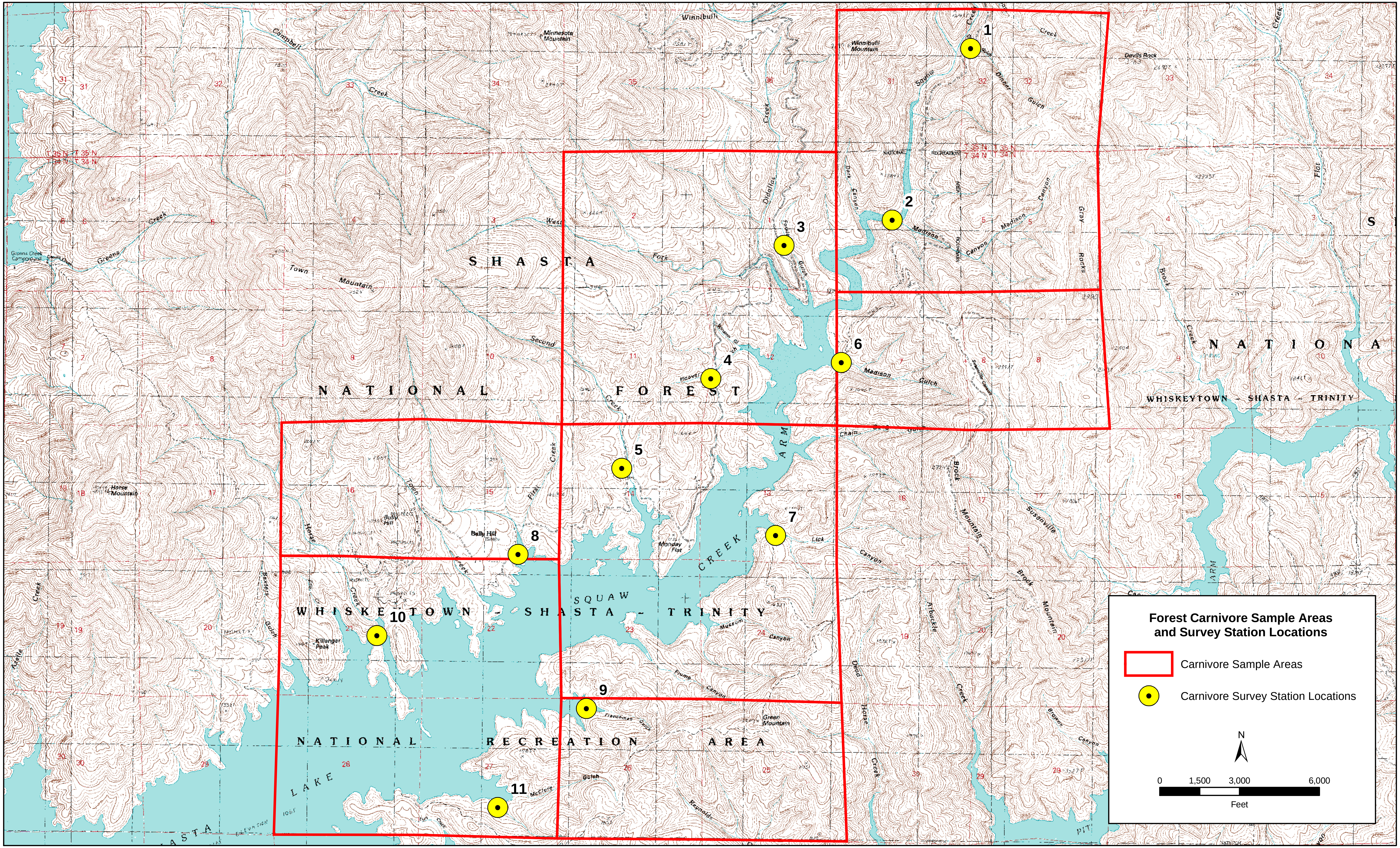
Figure 4-6
Special Status Species
Incidental Observations - Flora



F:Projects\10022 - Biological Surveys and Impact Analyses for Potential Shasta Dam Enlargement\GIS\Figure_4-7.mxd June, 2004 Source: NSR, Inc.; USGS

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Figure 4-7
Squaw Creek Arm 2002/2003
Forest Carnivore Sample Areas and Survey Station Locations

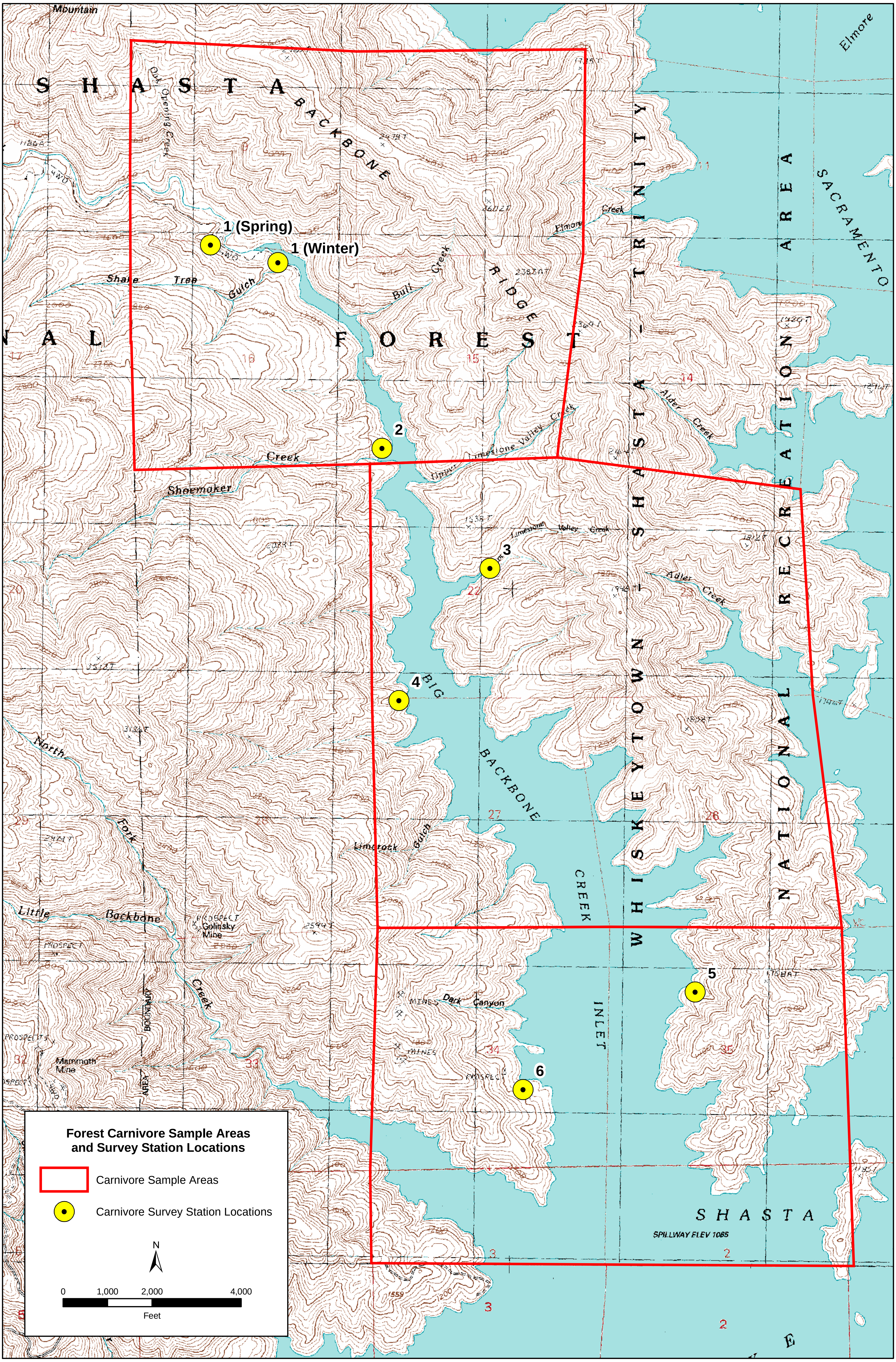

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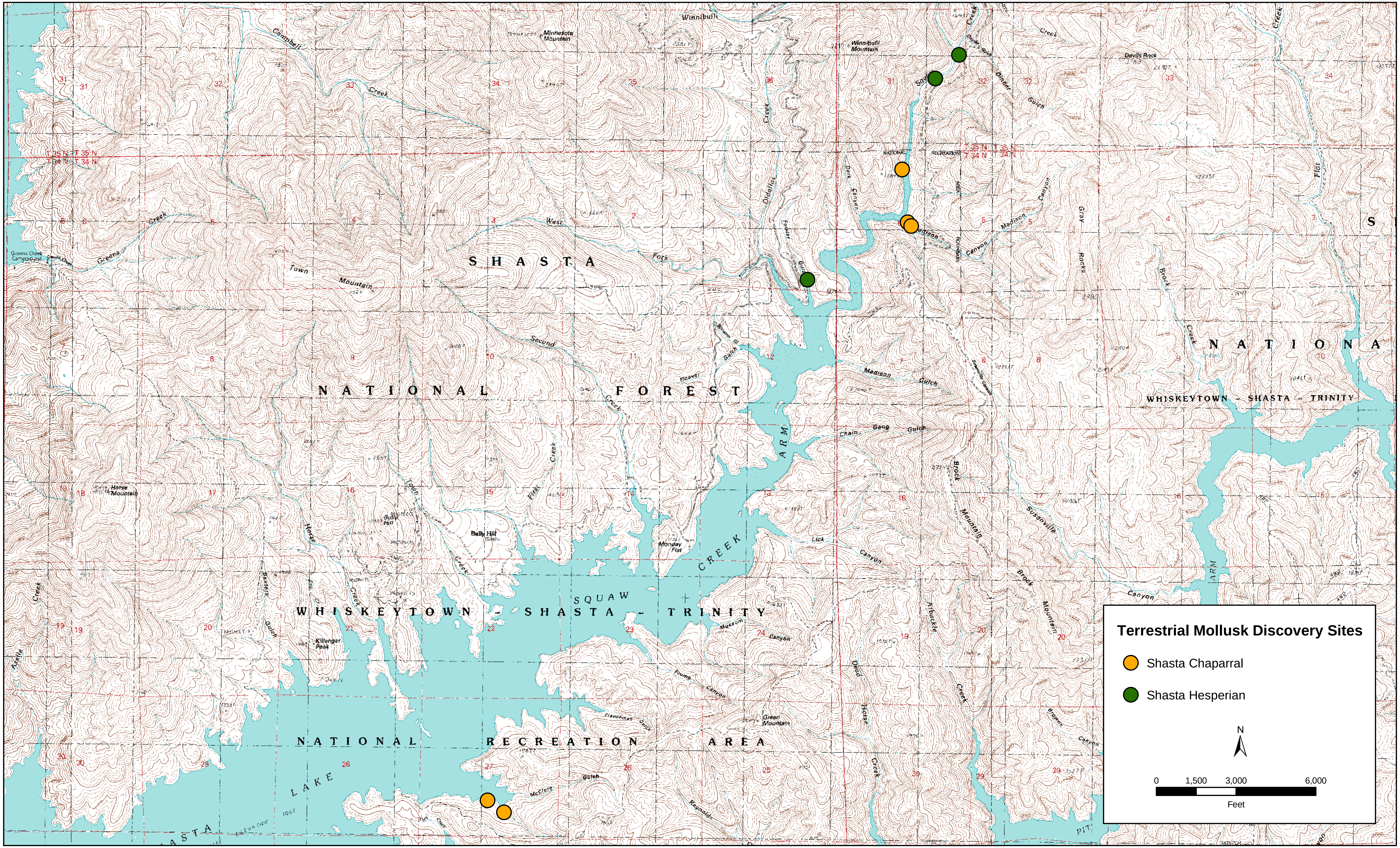
Figure 4-8
Big Backbone Arm 2002/2003
Forest Carnivore Sample Areas and Survey Station Locations



F:Projects\10022 - Biological Surveys and Impact Analyses for Potential Shasta Dam Enlargement\GIS\Figure_4-9.mxd June, 2004 Source: NSR, Inc.; USGS

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Figure 4-9
Squaw Creek Arm 2002/2003
Terrestrial Mollusk Discoveries

Figure 4-10
Big Backbone Arm
2002/2003 Terrestrial Mollusk Discoveries

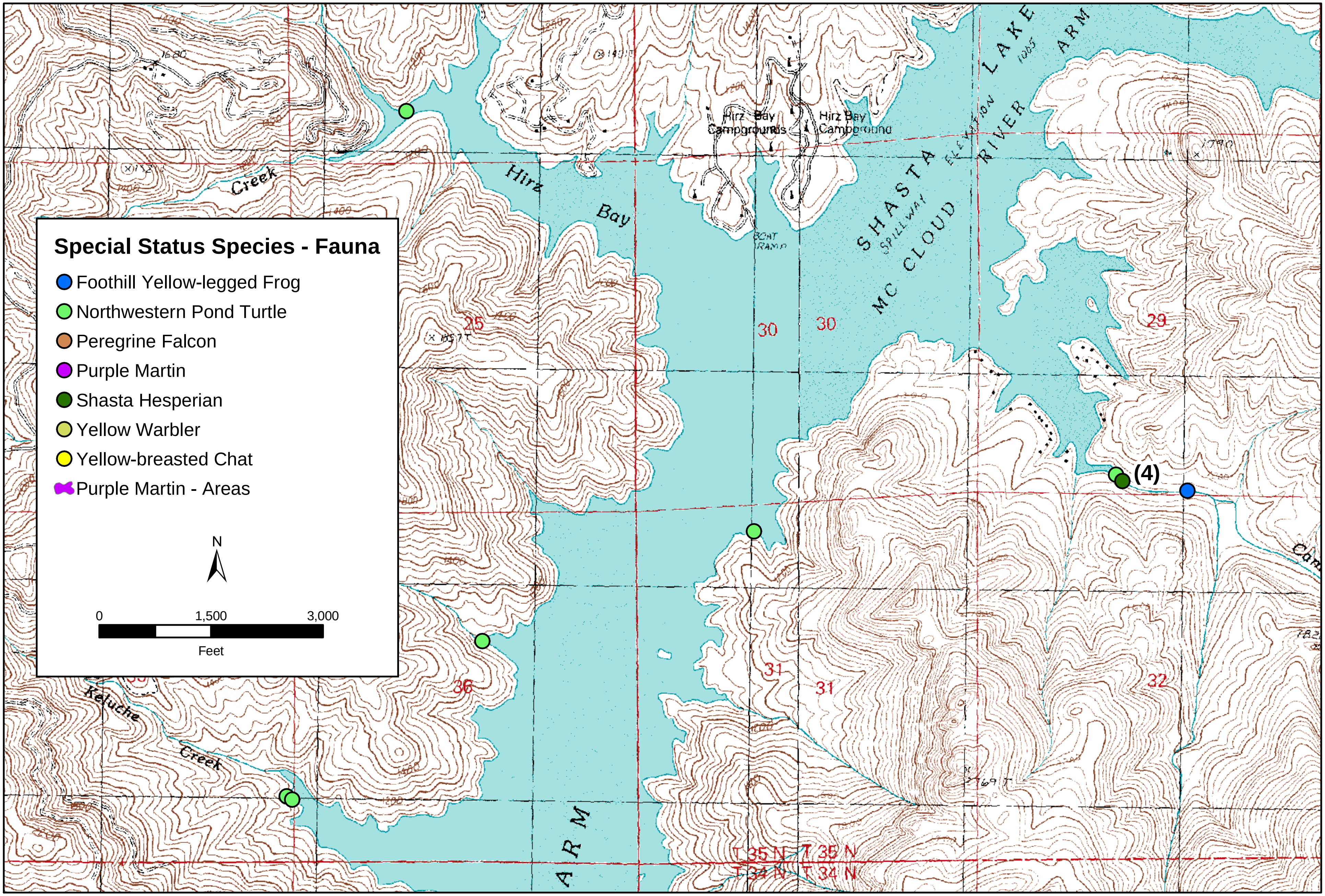

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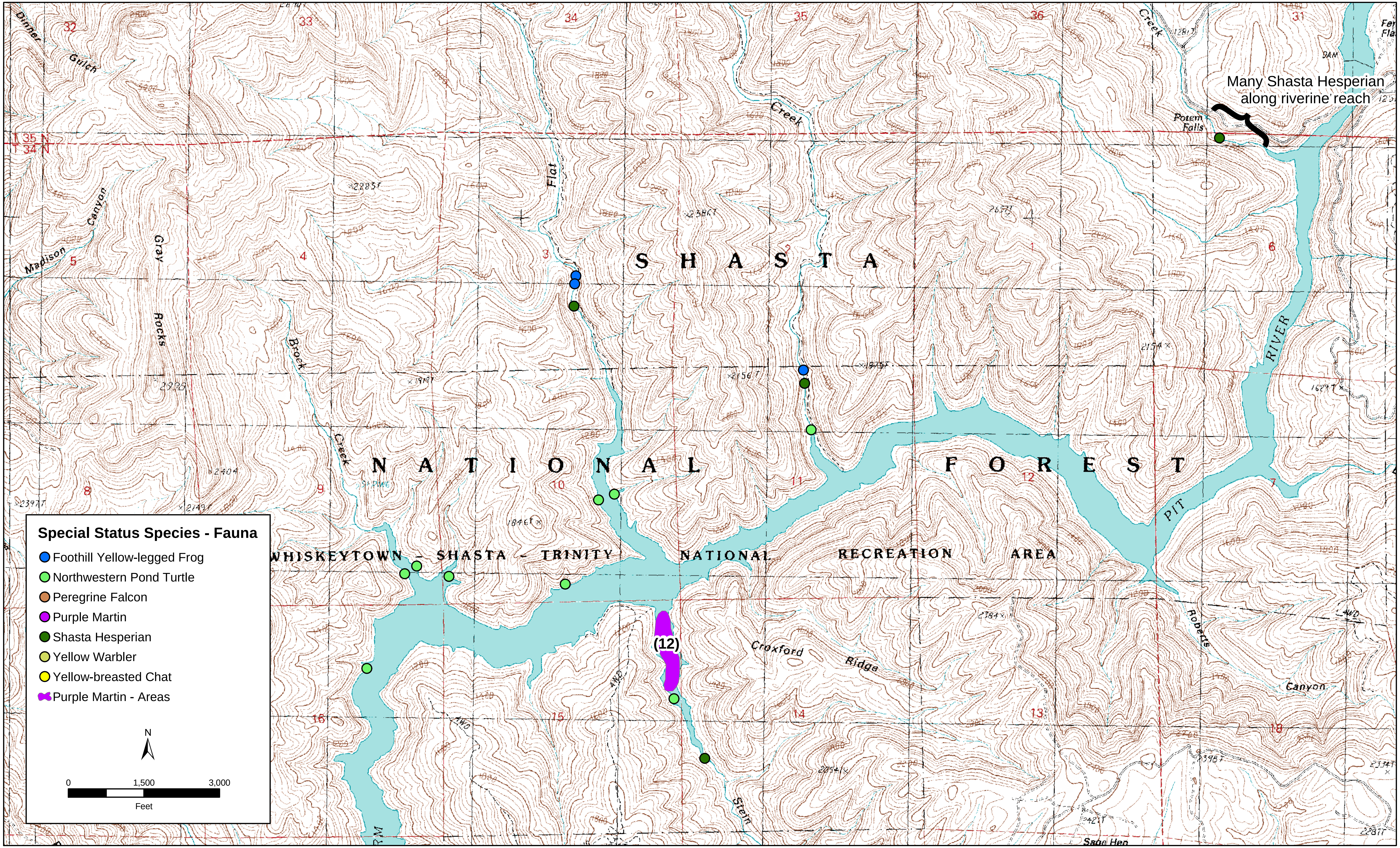
Figure 4-11
Special Status Species
Incidental Observations - Fauna



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North State Resources, Inc.

Figure 4-12
Special Status Species
Incidental Observations - Fauna

F:Projects\10022 - Biological Surveys and Impact Analyses for Potential Shasta Dam Enlargement\GIS\Figure_4-13.mxd June, 2004 Source: NSR, Inc.; USGS

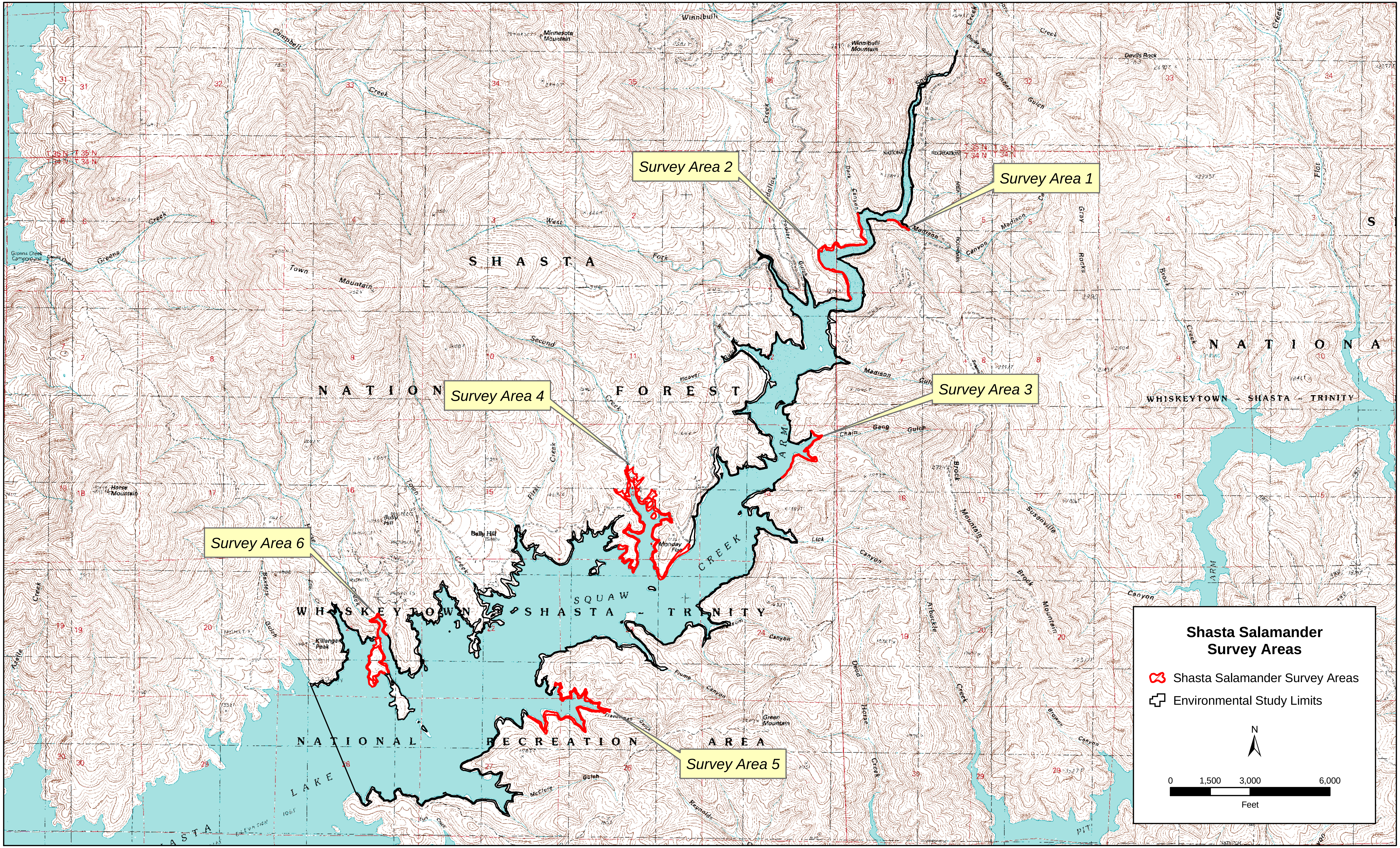

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Figure 4-13
Squaw Creek Arm
2002 Shasta Salamander Survey Areas

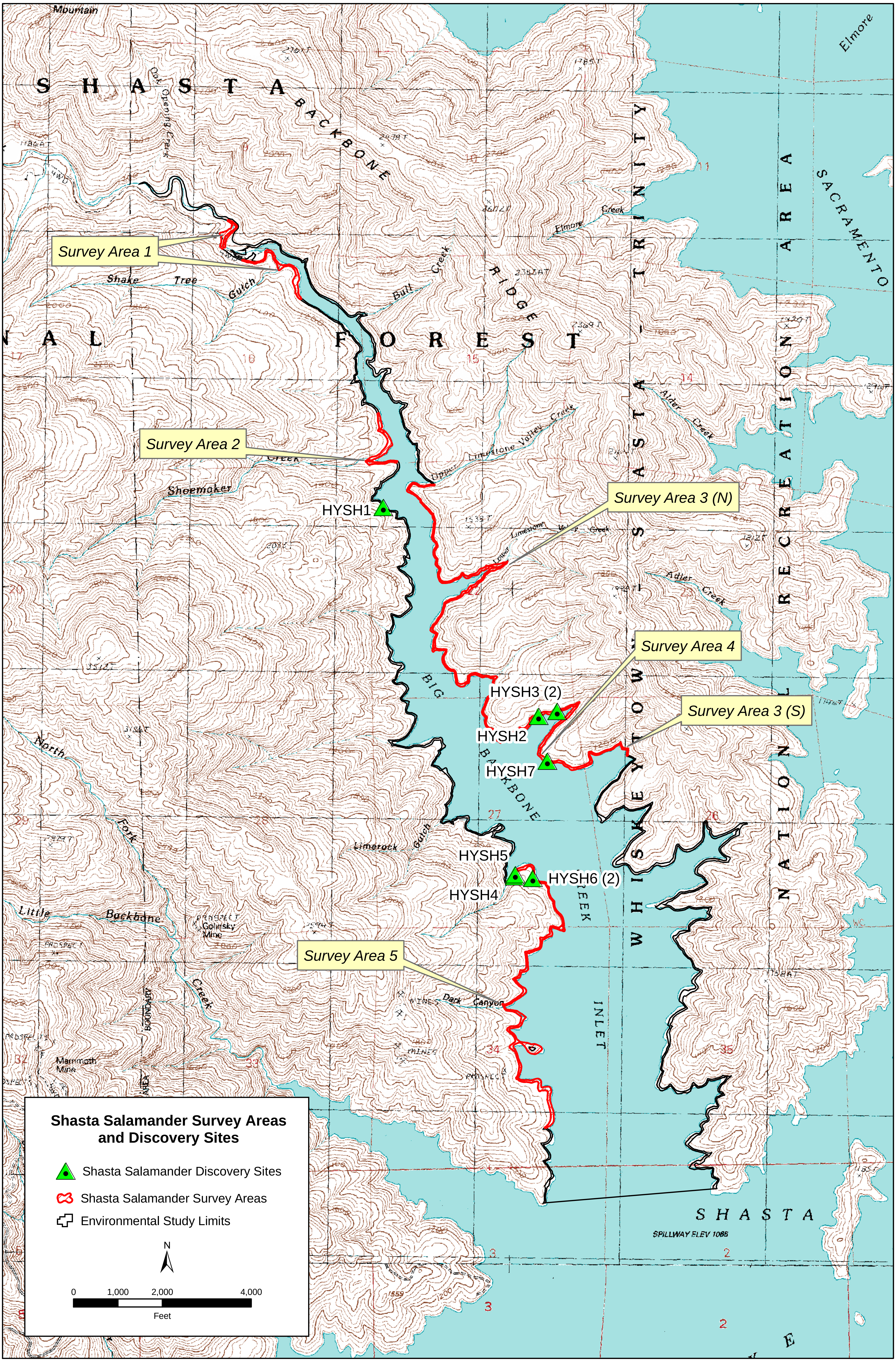
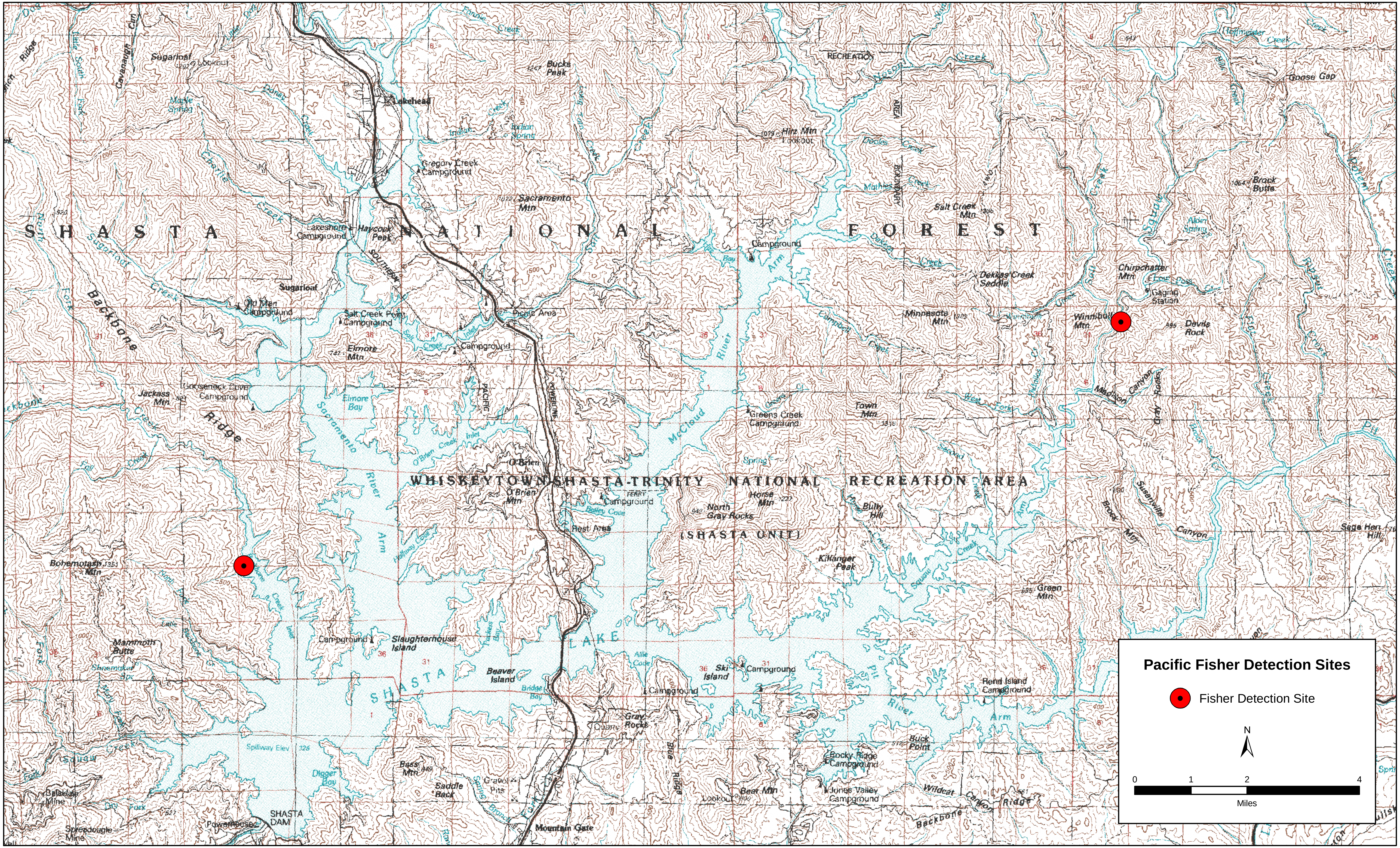


Figure 4-14
Big Backbone Arm
2002 Shasta Salamander Survey Areas and Discovery Sites



F:Projects\10022 - Biological Surveys and Impact Analyses for Potential Shasta Dam Enlargement\GIS\Figure_4-15.mxd June, 2004 Source: NSR, Inc.; USGS

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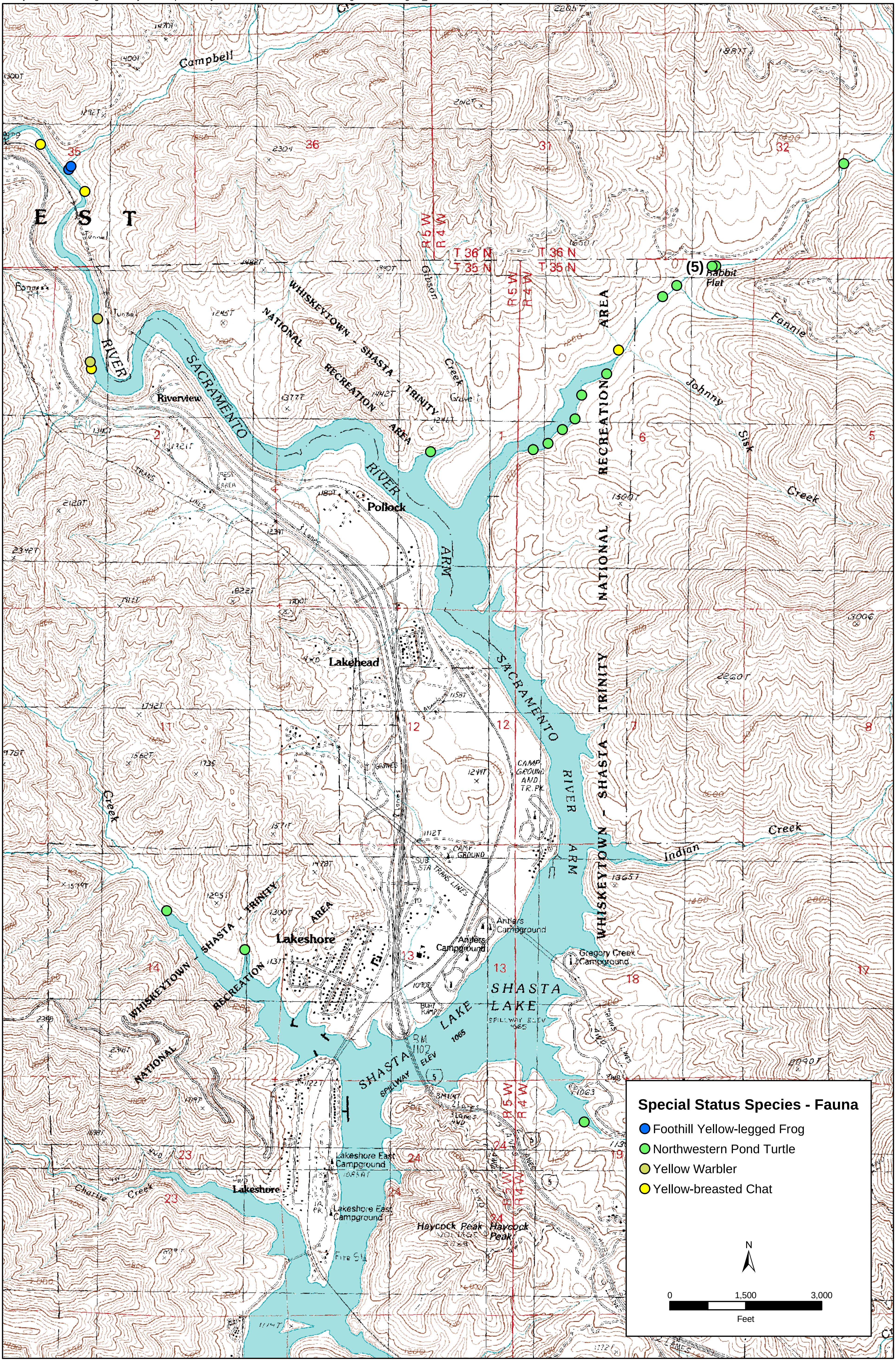
Figure 4-15
Big Backbone and Squaw Creek Arms
2002/2003 Pacific Fisher Detection Sites

F:Projects\10022 - Biological Surveys and Impact Analyses for Potential Shasta Dam Enlargement\GIS\Figure_4-16.mxd June, 2004 Source: NSR, Inc.; USGS



North State Resources, Inc.

Figure 4-16
Special Status Species
Incidental Observations - Fauna

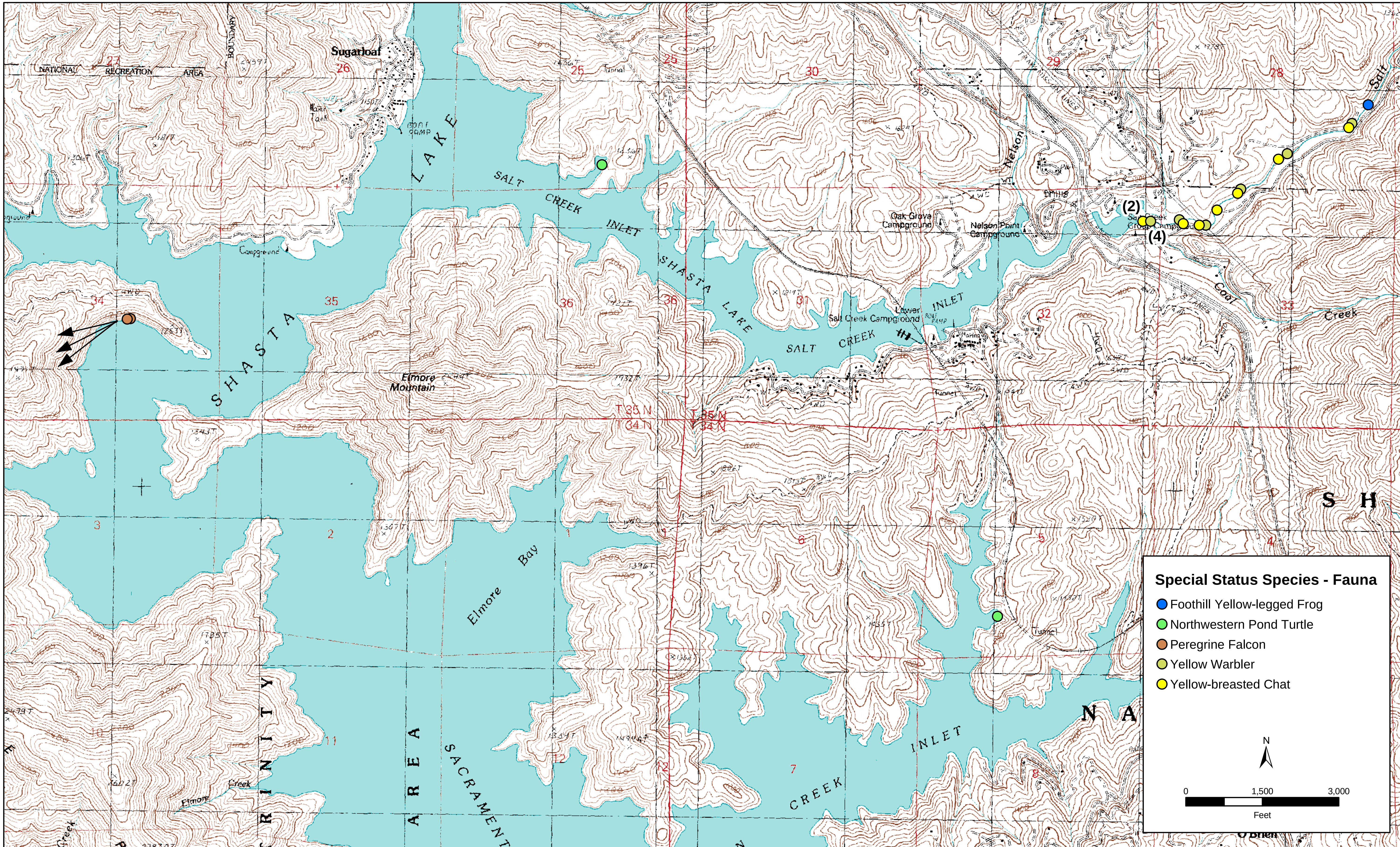


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Figure 4-17
Special Status Species
Incidental Observations - Fauna

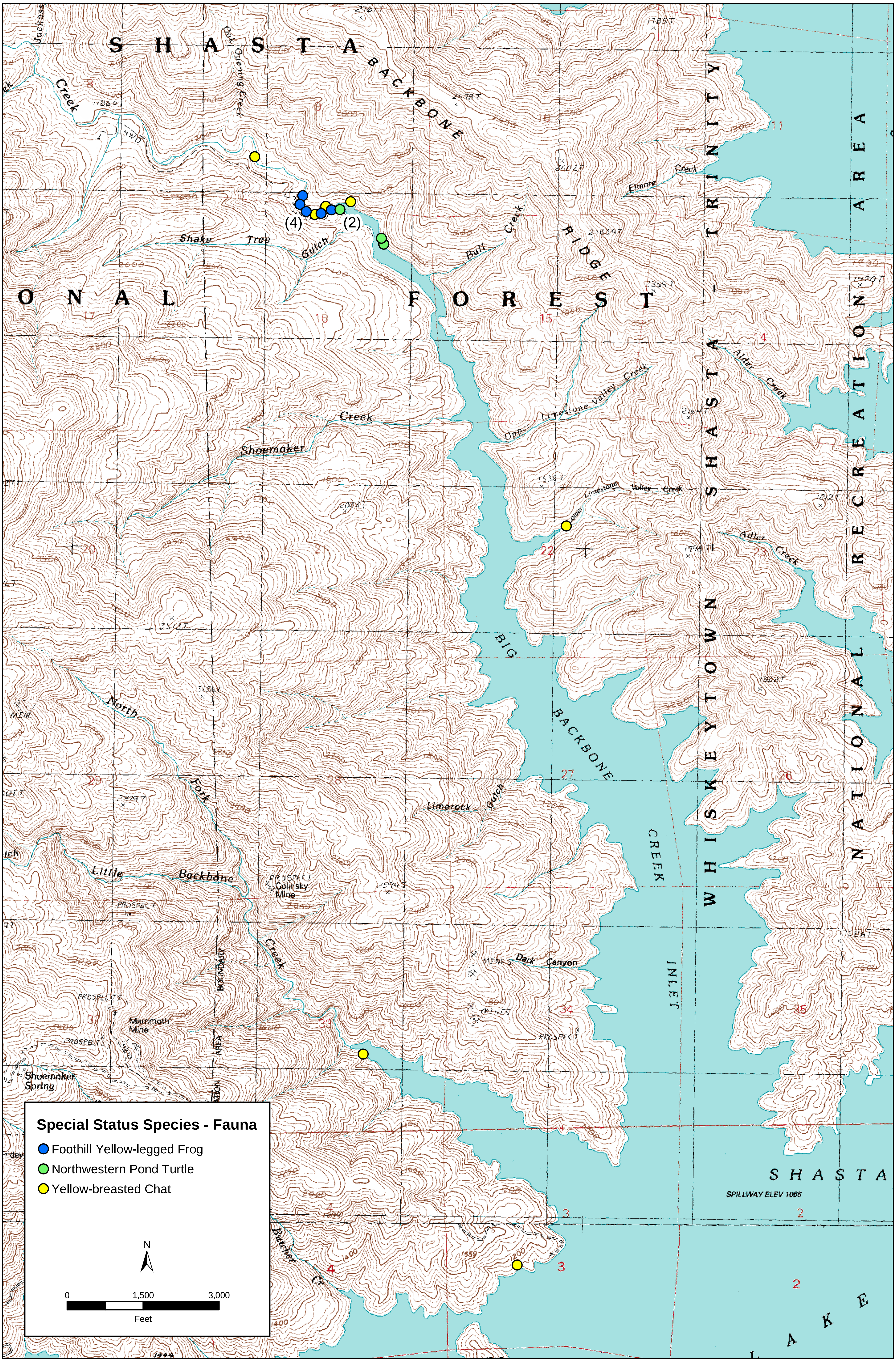

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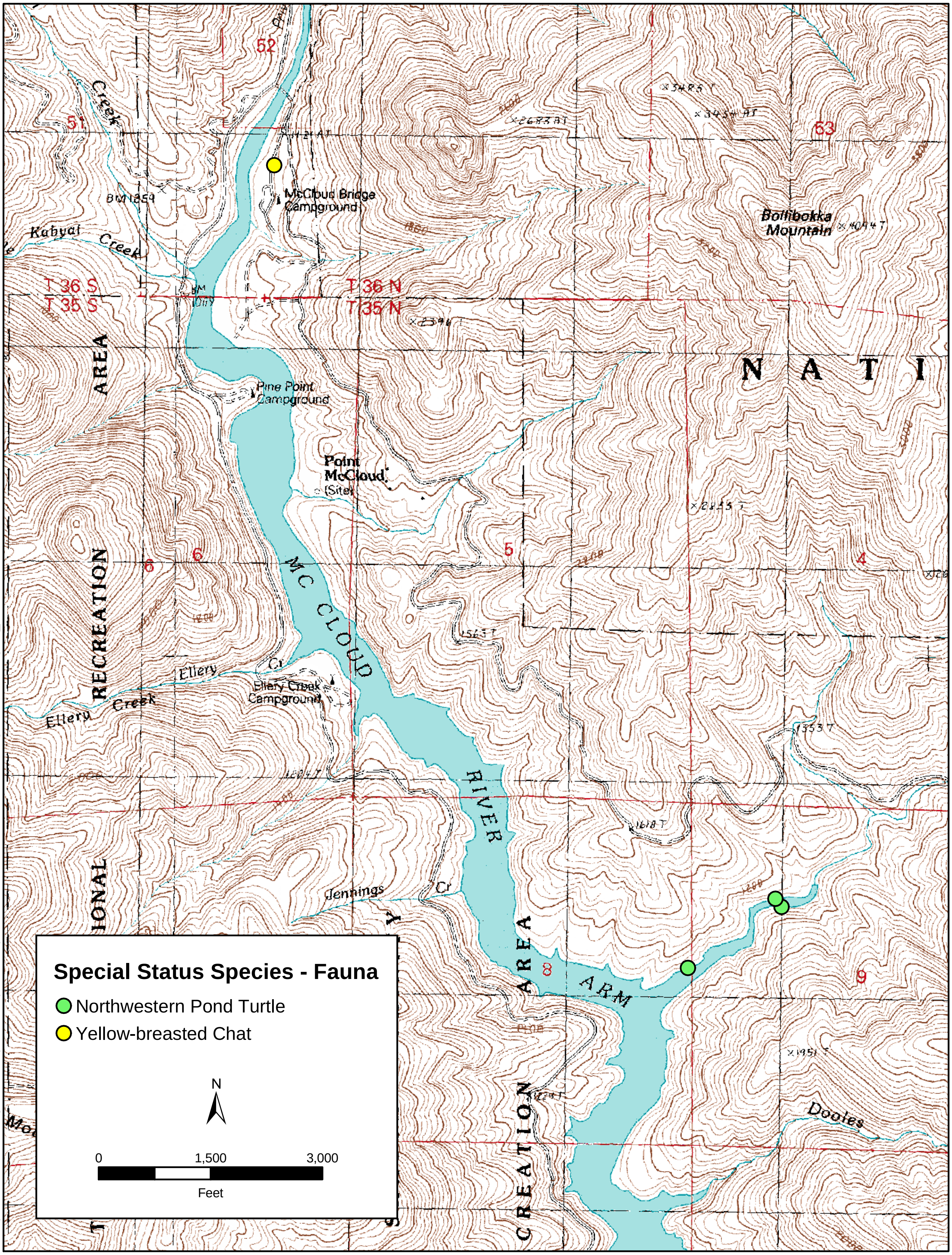
Figure 4-18
Special Status Species
Incidental Observations - Fauna

F:Projects\10022 - Biological Surveys and Impact Analyses for Potential Shasta Dam Enlargement\GIS\Figure_4-19.mxd June, 2004 Source: NSR, Inc.; USGS

North State Resources, Inc.

Figure 4-19
Special Status Species
Incidental Observations - Fauna



F:Projects\10022 - Biological Surveys and Impact Analyses for Potential Shasta Dam Enlargement\GIS\Figure_4-20.mxd June, 2004 Source: NSR, Inc.; USGS

North State Resources, Inc.

Figure 4-20
Special Status Species
Incidental Observations - Fauna

F:Projects\10022 - Biological Surveys and Impact Analyses for Potential Shasta Dam Enlargement\GIS\Figure_4-21.mxd June, 2004 Source: NSR, Inc.; USGS

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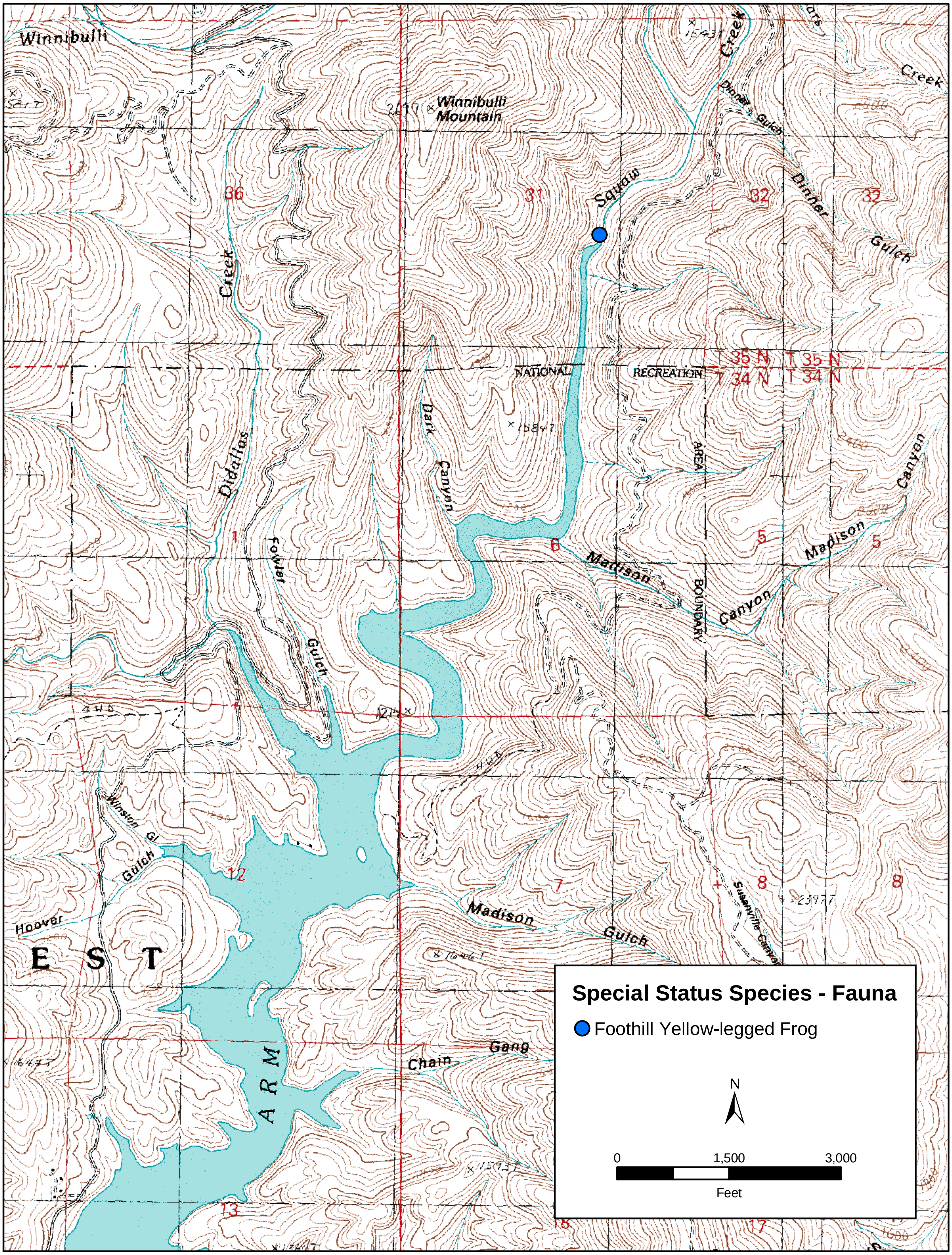
Figure 4-21
Special Status Species
Incidental Observations - Fauna



F:Projects\10022 - Biological Surveys and Impact Analyses for Potential Shasta Dam Enlargement\GIS\Figure_4-22.mxd June, 2004 Source: NSR, Inc.; USGS

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Figure 4-22
Special Status Species
Incidental Observations - Fauna

Section 5 Impacts Analysis

Section 5

IMPACTS ANALYSIS

This section is intentionally left blank. Impacts analysis will be conducted in conjunction with Reclamation and other participants, and will be presented in subsequent revisions to this document.

Section 6 References

Section 6.0

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Section 7 Acronyms and Abbreviations

Section 7

ACRONYMS AND ABBREVIATIONS

CALFED	CALFED Bay-Delta Program/ California Bay Delta Authority
CDFG	California Department of Fish and Game
cfs	cubic feet per second
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
ESL	environmental study limits
F.	Fahrenheit
ft	feet
GIS	geographic information system
I-5	Interstate 5
in.	inches
MCV	Manual of California Vegetation
mm	millimeter
MOU	memorandum of understanding
mph	miles per hour
msl	mean sea level
NSR	North State Resources, Inc.
Reclamation	U.S. Bureau of Reclamation
ROD	record of decision
RWQCB	Regional Water Quality Control Board
SOW	scope of work
STNF	Shasta-Trinity National Forest
SWRCB	State Water Resources Control Board
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WHR	Wildlife-Habitat Relationships System

Appendix A GIS Methods

APPENDIX A, GIS METHODS

This appendix was prepared to describe the development of certain elements of the project GIS prepared by NSR. These elements are Environmental Study Limits, Shoreline Erosion Potential, Plant Series, and WHR Habitat Types. Additional information on the GIS aspects will be forthcoming in conjunction with metadata requirements.

Development of the Environmental Study Limits

Reclamation provided NSR with 2-ft-interval elevation contour data for the Shasta Lake area.. The elevation contours were derived photogrammetrically from the orthophotography that was flown and processed by Pacific Western Technologies, Ltd, for Reclamation's Mid-Pacific Region photogrammetry division. The contours cover approximately 14,400 acres, between the lake water surface elevation of 1,012.5 ft msl at the time of the aerial surveys and an elevation of 1,200 ft msl. The contour data encompass the entire lake shoreline, and were provided in AutoCAD DWG format. The DWG files were imported to the ESRI ArcMap GIS environment, and the 1,070-ft, 1,080-ft, and 1,090-ft elevation lines were queried and extracted as separate ESRI shapefiles from the existing CAD contour data. The three elevation lines were edited to produce continuous contours, and then converted to polygon features for each area or arm of the lake. These polygon features were then cleaned and built to define topology in ESRI's ArcInfo Workstation environment. The resulting features were converted back to shapefiles, from which NSR produced polygon shapefiles representing areas of the ESL defined by the 1,070-ft and 1,090-ft elevations as lower and upper bounds, as well as polygon shapefiles representing alternate ESL areas defined by 1,070-ft and 1,080-ft elevations. These ESL layers were produced separately for the main body of the lake and for each arm, as were composite layers representing the entire lake. The polygon type is defined within these ESL layers by four separate elevation classes:

1. Lake areas lower than the current maximum pool elevation of 1,070 ft

2. Island polygons internal to the contour defining the current highest shoreline, which would be completely inundated at raised maximum pool elevations (above 1,070 ft but lower than either 1,080 or 1,090 ft);

3. Shoreline polygons that encompass the elevation range between 1,070 ft and either 1,080 ft or 1,090 ft;

4. Hilltop polygons above 1,090 ft elevation that are within the geographic limits defined by the outer 1,090-ft ESL contour.

Classes 2 and 3 are within the ESL; classes 1 and 4 are not. Complete metadata for each ESL layer have been generated and are associated with each ESL GIS file.

Development of the Shoreline Erosion Layers

Projected shoreline erosion polygon GIS layers have been developed for the main body and each arm of Shasta lake. A copy of the 1,070-ft to 1,090-ft ESL layer for each arm was used as a base layer to begin digitizing the shoreline erosion layer for that arm. Geo-referenced digital orthophotographic images were used to provide back images for digitizing. Shoreline erosion polygon information was digitized on-screen, in a "heads-up" manner, employing ESRI ArcView and ArcInfo software in either the ArcMap or Workstation environments. Digitizing was performed by reproducing lines that had been drawn on Mylar overlays on 9-inch by 9-inch color aerial photographs. The aerial photos have a scale of 1:7,200 and digitizing was performed at this scale or larger. No ESL boundaries were delineated on the field photos; rather, the projected erosion areas had been indicated with a line drawn along the shoreline on the photograph, with hatch-marks drafted to divide areas of differing erosion characteristics. Each different erosion area was designated as an erosion site, with a unique alphanumeric code. Also, unlike the WHR and MCV maps, shoreline erosion was not mapped continuously along the shoreline. Therefore, once lines were digitized to define the limits of all erosion polygons, these polygons were exported as a new shapefile, representing only the areas of projected shoreline erosion.

Attribute fields were generated within the GIS database corresponding to the shoreline erosion site number, and populated as digitizing proceeded. Additionally, a field representing acres for each polygon was generated, and calculated once the layer was complete. The bulk of the field data collected to characterize each projected erosion site was entered in a separate database, represented in 14 separate fields, and keyed to site number. Once the digitizing was complete, and the external database had been populated, the GIS database and the external database were joined, and exported as a single layer incorporating all of the site data. The layers representing the 1,070-ft to 1,080-ft ESL as well as the 1,070-ft to 1,090-ft layer have been completed for the shoreline erosion portion of the project. Only the data from 1,070 ft to 1,090 ft are reported in this draft, however.

The erosion polygon features were cleaned and built to define topology in ESRI's ArcInfo Workstation environment. The resulting features were converted back to shapefiles. Only areas within the ESL are represented in the projected shoreline erosion layers. Complete metadata for each ESL layer have been generated and are associated with each ESL GIS file.

Development of the MCV Layers

MCV (Manual of California Vegetation) polygon GIS layers have been developed for the main body and each arm of Shasta lake. A copy of the 1,070-ft to 1,090-ft ESL layer for each arm was used as a base layer to begin digitizing the MCV layer for that arm. Geo-referenced digital orthophotographic images were used to provide back images for digitizing. MCV polygon information was digitized on-screen in a "heads-up" manner, employing ESRI ArcView and ArcInfo software in either the ArcMap or Workstation environments. Digitizing was performed by reproducing lines that had been drawn on field plots of the orthophotographs. The field maps had been enlarged to a scale of 1:2,400, and digitizing was performed at this scale or larger. The field maps were generated with only the upper ESL bound of 1,090 ft plotted. Field divisions between MCV polygons consisted of lines drawn from the 1,090-ft contour to the edge of the vegetated slope. As noted above, these lines sometimes extended down slope beyond the position of the 1,070- ft contour. In these instances, the digitized line was truncated at the 1,070' contour to close the polygon.

Attribute fields were generated within the GIS database corresponding to the three-letter MCV abbreviation and the full text definition of the MCV map units. Additionally, a field representing acres for each polygon was generated. The MCV fields were populated as digitizing proceeded, and the acreage was calculated once each layer was complete. At this time, only layers representing the study area between 1,070' and 1,090 were completed. The 1,070-ft to 1,080-ft layers will be produced for subsequent drafts, by clipping the wider study area to 1,080' elevation.

These polygon features were then cleaned and built to define topology in ESRI's ArcInfo Workstation environment. The resulting features were converted back to shapefiles. Unlike the ESL layers, only areas within the ESL are represented in the MCV layers. Complete metadata for each MCV layer have been generated and are associated with each MCV GIS file. MCV types used in layer generation are defined in "A Manual of California Vegetation" (Sawyer and Keeler-Wolf, 1995).

Development of the WHR Layers

Wildlife Habitat Relationship (WHR) polygon GIS layers have been developed for each arm of the lake. A copy of the 1,070-ft to 1,090-ft ESL layer for each arm was used as a base layer to begin digitizing the WHR layer for that arm. Geo-referenced digital orthophotographic images were used to provide back images for digitizing. WHR polygon information was digitized on-screen in a "heads-up" manner, employing ESRI ArcView and ArcInfo software in either the ArcMap or Workstation environments. Digitizing was performed by reproducing lines that had been drawn on field plots of the orthophotographs. The field maps had been enlarged to a scale of 1:2,400, and digitizing was performed at this scale or larger. The field maps were generated with only the upper ESL bound of 1,090 ft plotted. Field divisions between WHR polygons consisted of lines drawn from the 1,090-ft contour to the edge of the vegetated slope. As noted above, these lines sometimes extended down slope beyond the position of the 1,070- ft contour. In these instances, the digitized line was truncated at the 1,070' contour to close the polygon.

Attribute fields were generated within the GIS database corresponding to the three-letter WHR abbreviation and the full text definition of the WHR map units. Additionally, an field representing acres for each polygon was generated. The WHR fields were populated as digitizing proceeded, and the acreage was calculated once each layer was complete. At this time, only layers representing the study area between 1,070' and 1,090 were completed. The 1,070-ft to 1,080-ft layers will be produced for subsequent drafts, by clipping the wider study area to 1,080' elevation.

These polygon features were then cleaned and built to define topology within ESRI's ArcInfo Workstation environment. The resulting features were converted back to shapefiles. Unlike the ESL layers, only areas within the ESL are represented in the WHR layers. Complete metadata for each WHR layer have been generated and are associated with each WHR GIS file. The WHR habitat types used in layer generation are defined in "*A Guide to Wildlife Habitats of California*" (Mayer and Laudenslayer, 1988).

Appendix B Discussion of ESL Contour Anomalies

APPENDIX B, DISCUSSION OF ESL CONTOUR ANOMALIES

Some examples of seemingly anomalous contour-to-shoreline congruence may be found for the main body and arms of Shasta Lake. Predictably, they seem to be most common where relief is low and the amount of horizontal positional change for a given deviation in elevation would be greatest. Anomalies are most common for low-relief areas of the shoreline of the Sacramento River Arm and the main body of the lake. They are less common for the McCloud River Arm and the Pit River Arm, which have higher proportions of high-slope-gradient shoreline and adjacent hillslope. Numerous anomalies were noted and visually corrected for the Squaw Creek Arm, which has a high proportion of low-relief shoreline. Very few visible anomalies were noted for the Big Backbone Arm, where the shoreline is generally very steep. **Table B-1** shows the location of some of the more obvious and serious anomalies, organized by the three described anomaly categories, and refers to Atlas sheet number and general location on the sheet. A complete list of anomalies has not been compiled at this time.

TABLE Appendix B-1
ESL Contour Anomaly Examples by Map Sheet

Atlas Volume	Truncated Contour	Anomalous Island	Poor Contour-Shoreline Congruence
Sacramento River Arm	2 - NE	7 - EC	10 - E
McCloud River Arm	13 - EC, 16 - SC	11 - SC	11 - SC
Pit River Arm		1 - EC	16 - NE, 17 - C
Main Body of Shasta Lake	10 - NW, 13 - EC	7 - C, 8 - NE	12 - WC, 13 - NC, 13 - C

Notes: NE = northeast, EC = east-central, SC = south-central, NW = northwest, C = central, E = east, WC = west-central, NC = north-central

Appendix C Erosion Inventory Survey Form

APPENDIX C, EROSION INVENTORY SURVEY FORM

Shasta Lake Enlargement Study
Shoreline Erosion Reconnaissance Inventory NSR 10022

Project Location: location	**File Name:**
Investigators:	**Date:**
Site Number: number	**Air Photo Number:** photo
Site Length: (feet) length	**Erosion Activity:** activity ‘ Chronic (C) ‘ Episodic (E) ‘ Historic (H)
Dominant Erosion Type: domtype ‘ Mass Wasting (mw) ‘ Rill (rl) ‘ Gully (gu) ‘ Other (ot) ‘ Surface (su) ‘ Ravel (rv) ‘ Sapping (sp) ‘ Wave (wv)	
Erosion Severity severity ‘ Low (l) ‘ Moderate (m) ‘ High (h)	**Wind Exposure** exposure ‘ Yes (y) ‘ No (n)
Slope Angle (% slope upslope) angle ‘ 0 – 30% (0) ‘ 31 – 60% (30) ‘ 61+% (60)	**Slope Break Type (oversteepened, undercut)** break ‘ oversteepened (os) ‘ undercut (uc) ‘ both (osuc)
Material Type (Un-eroded Slope) mattype ‘ Bedrock (br) ‘ Cobble-Boulder (sb) ‘ Soil (so)	**Slope Armor (Un-eroded Slope)** armor ‘ 0 - 30% (0) ‘ 31 – 70% (30) ‘ 71+% (70)
Slope Height (eroded) height ‘ 0-3’ (0) ‘ 3-6’ (3) ‘ 6+’ (6)	**Vegetative Cover (% vegetation)** vegcover ‘ Dense (d) ‘ Moderate (m) ‘ Sparse (s)
Comments:	

Appendix D Photographs of Plant Series and WHR Types

Photo 1 Black Oak Series – Sacramento River Arm

Photo 2 Blue Oak Series – Pit River Arm

Photo 3 Brewer Oak Series – Sacramento River Arm

Photo 4 California Annual Grassland Series – Pit River Arm

Photo 5 California Buckeye Series – Sacramento River Arm

Photo 6 Canyon Live Oak Series – Pit River Arm

Photo 7 Deerbrush Series – Main Body of Lake (Little Backbone Creek Inlet)

Photo 8 Douglas Fir – Ponderosa Pine Series – Pit River Arm

Photo 9 Foothill Pine Series – Pit River Arm

Photo 10 Fremont Cottonwood Series (right portion of photo) – Sacramento River Arm (Dog Creek Confluence)

Photo 11 Interior Live Oak Series – Pit River Arm

Photo 12 Interior Live Oak Shrub Series – Sacramento River Arm

Photo 13 Knobcone Pine Series - Pit River Arm

Photo 14 Mixed Willow Series – Main Body of Lake
(Little Backbone Creek Inlet)

Photo 15 Oregon White Oak Series – Pit River Arm

Photo 16 Ponderosa Pine Series - Pit River Arm

Photo 17 Sandbar Willow Series – Squaw Creek Arm

Photo 18 Wedgeleaf Ceanothus Series – Sacramento River Arm

Photo 19 White Alder Series – Sacramento River Arm

Photo 20 Whiteleaf Manzanita Series – Sacramento River Creek Arm

Photo 1 Annual Grassland – Pit River Arm

Photo 2 Barren – Main Body of Lake (Butcher Creek Confluence)

Photo 3 Blue Oak – Gray Pine – Pit River Arm

Photo 4 Blue Oak Woodland – Pit River Arm

Photo 5 Closed-Cone Pine-Cypress – Main Body of Lake

Photo 6 Mixed Chaparral– Pit River Arm

Photo 7 Montane Hardwood Conifer – Pit River Arm

Photo 8 Montane Hardwood – McCloud River Arm

Photo 9 Montane Riparian– McCloud River Arm

Photo 10 Ponderosa Pine – Sacramento River Arm

Photo 11 Riverine – Big Backbone Creek Arm

Photo 12 Sierran Mixed Conifer– Squaw Creek Arm

Appendix E Plant Species, Selected ESL Areas

APPENDIX E, PLANT SPECIES, SELECTED ESL AREAS

The following tables describe the plant species observed on the Big Backbone and Squaw Creek arms of Shasta Lake, and the 13 riverine reaches described in Section 2 of this report.

Table 1 Plant Species Observed on Little Backbone Creek of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
RIPARIAN PLANTS		
Acer macrophyllum	Big leaf maple	Aceraceae
Aesculus californica	California buckeye	Hippocastanaceae
Alnus rhombifolia	White alder	Betulaceae
Antirrhinum spp.	Snapdragon	Scrophulariaceae
Aruncus dioicus var. pubescens	Goat's beard	Rosaceae
Athyrium filix-femina	Lady fern	Dryopteridaceae
Calycanthus occidentalis	Spice bush	Calycanthaceae
Carex nudata	Torrent sedge	Cyperaceae
Cheilanthes gracillima	Cheilanthes	Pteridaceae
Cyperus esculentus	Yellow nut sedge	Cyperaceae
Eriodictyon californicum	Yerba santa	Hydrophyllaceae
Hastingsia alba	Hastingsia	Liliaceae
Hypericum perforatum	Klamathweed	Hypericaceae
Juncus xiphioides	Rush	Juncaceae
Ledum glandulosum	Labrador tea	Ericaceae
Lithocarpus densiflora	Tan oak	Fagaceae
Mimulus cardinalis	Scarlet monkey flower	Scrophulariaceae
Mimulus guttatus	Seep-spring monkey flower	Scrophulariaceae
Panicum acuminatum	Panicgrass	Poaceae
Rhododendron occidentale	Western azalea	Ericaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Salix lucida	Shining willow	Salicaceae
Sedum spathulifolium	Pacific sedum	Crassulaceae
Streptanthus tortuosus	Mountain jewelflower	Brassicaceae
Umbellularia californica	California bay	Lauraceae
Vaccinium parvifolium	Red huckleberry	Ericaceae
Woodwardia fimbriata	Giant chain fern	Blechnaceae

Table 1 Plant Species Observed on Little Backbone Creek of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
UPLAND PLANTS		
Arctostaphylos viscida	Whiteleaf manzanita	Ericaceae
Bromus inermis	Smooth brome	Poaceae
Calocedrus decurrens	Incense cedar	Cupressaceae
Digitalis pupurea	Foxglove	S crophulariaceae
Elymus elymoides	Squirreltail	Poaceae
Eriophyllum lanatum	Wooly sunflower	Asteraceae
Heteromeles arbutifolia	Toyon	Rosaceae
Pentagramma triangularis	Goldenback fern	Pteridaceae
Pinus attenuata	Knobcone pine	Pinaceae
Pinus ponderosa	Ponderosa pine	Pinaceae
Polystichum munitum	Swordfern	Dryopteridaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Rhamnus rubra	Sierran coffeeberry	Rhamnaceae
Styrax officianalis	Snowdrop bush	Styraceae

Table 2 Plant Species Observed at the Big Backbone Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
MONTANE RIPARIAN		
Acer circinatum	Vine maple	Aceraceae
Acer macrophyllum	Bigleaf maple	Aceraceae
Adiantum capillus-veneris	Southern maiden-hair	Pteridaceae
Aira caryophyllea	European hairgrass	Poaceae
Alnus rhombifolia	White alder	Betulaceae
Andropogon virginicus var. virginicus	Broomsedge bluestem	Poaceae
Anthoxanthum odoratum	Sweet vernal grass	Poaceae
Arctostaphylos viscida var. viscida	Whiteleaf manzanita	Ericaceae
Aristolochia californica	Pipevine	Aristolochiaceae
Artemisia douglasiana	Mugwort	Asteraceae
Asarum hartwegii	Wild-ginger	Aristolochiaceae
Asclepias cordifolia	Purple milkweed	Asclepiadaceae
Briza minor	Lesser quaking grass	Poaceae
Bromus carinatus var. carinatus	California brome	Poaceae

Table 2 Plant Species Observed at the Big Backbone Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Bromus diandrus	Ripgut grass	Poaceae
Bromus hordeaceus	Soft chess	Poaceae
Bromus madritensis ssp. rubens	Red brome	Poaceae
Calochortus tolmiei	Pussy ears	Liliaceae
Calycanthus occidentalis	Spicebush	Calycanthaceae
Carex deweyana var. leptopoda	Short-scaled sedge	Cyperaceae
Carex feta	Greensheath sedge	Cyperaceae
Carex nudata	Torrent sedge	Cyperaceae
Ceanothus integerrimus	Deer brush	Rhamnaceae
Centaurea solstitialis	Yellow star-thistle	Asteraceae
Cercis occidentalis	Redbud	Fabaceae
Chlorogalum pomeridianum var. pomeridianum	Soap plant	Liliaceae
Claytonia rubra ssp. rubra	Red-stemmed miner's lettuce	Portulacaceae
Collomia heterophylla	Variableleaf collomia	Polemoniaceae
Cornus sessilis	Miner's dogwood	Cornaceae
Corylus cornuta var. californica	Hazelnut	Betulaceae
Cyperus eragrostis	Tall flatsedge	Cyperaceae
Cyperus squarrosus	Umbrella sedge	Cyperaceae
Darmera peltata	Indian rhubarb	Saxifragaceae
Daucus carota	Queen Anne's lace	Apiaceae
Deschampsia cespitosa	Tufted hairgrass	Poaceae
Dichelostemma capitatum ssp. capitatum	Blue dicks	Liliaceae
Elymus glaucus	Blue wild rye	Poaceae
Epilobium angustifolium ssp. circumvagum	Fireweed	Onagraceae
Epilobium torreyi	Boisduvalia	Onagraceae
Eriodictyon californicum	Yerba Santa	Hydrophyllaceae
Eriogonum nudum	Naked buckwheat	Polygonaceae
Eriophyllum lanatum var. grandiflorum	Woolly sunflower	Asteraceae
Erodium botrys	Broadleaf filaree	Geraniaceae
Ficus carica	Edible fig	Moraceae
Fraxinus latifolia	Oregon ash	Oleaceae
Galium bolanderi	Bolander's bedstraw	Rubiaceae
Hypericum perforatum	Klamathweed	Hypericaceae
Hypochaeris radicata	Rough cat's-ear	Asteraceae
Iris tenuissima	Iris	Iridaceae

Table 2 Plant Species Observed at the Big Backbone Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Juncus effusus	Common rush	Juncaceae
Juncus sp.	Rush	Juncaceae
Lathyrus sulphureus	Snub pea	Fabaceae
Lilium pardalinum ssp. pardalinum	Leopard lily	Liliaceae
Lonicera hispidula var. vacillans	Hairy honeysuckle	Caprifoliaceae
Lotus oblongifolius var. oblongifolius	Streambank bird's-foot trefoil	Fabaceae
Lupinus albifrons	Silver bush lupine	Fabaceae
Lupinus bicolor	Miniature lupine	Fabaceae
Marah watsonii	Watson's wild-cucumber	Cucurbitaceae
Melica californica	California melic	Poaceae
Mimulus guttatus	Common monkeyflower	Scrophulariaceae
Montia parvifolia	Showy rock-montia	Portulacaceae
Nemophila heterophylla	Variable-leaved nemophila	Hydrophyllaceae
Panicum acuminatum var. acuminatum	Panicgrass	Poaceae
Pentagramma triangularis ssp. triangularis	Goldback fern	Pteridaceae
Petrorhagia dubia	Windmill pink	Caryophyllaceae
Philadelphus lewisii	Wild mock orange	Philadelphaceae
Pinus ponderosa	Ponderosa pine	Pinaceae
Plagiobothrys tener	Slender popcornflower	Boraginaceae
Plantago lanceolata	English plantain	Plantaginaceae
Polygonum lapathifolium	Willow weed	Polygonaceae
Polypogon monspeliensis	Annual beard grass	Poaceae
Polystichum imbricans	Narrowleaf sword fern	Dryopteridaceae
Populus fremontii ssp. fremontii	Fremont cottonwood	Salicaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Pteridium aquilinum var. pubescens	Western bracken fern	Dennstaedtiaceae
Pycnanthemum californicum	Mountain mint	Lamiaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Quercus kelloggii	Black oak	Fagaceae
Ranunculus californicus	California buttercup	Ranunculaceae
Rhus trilobata	Skunkbrush	Anacardiaceae
Ribes divaricatum	Gooseberry	Grossulariaceae
Rosa gymnocarpa	Wood rose	Rosaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Rubus leucodermis	Western raspberry	Rosaceae

Table 2 Plant Species Observed at the Big Backbone Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Rubus ursinus	California blackberry	Rosaceae
Salix exigua	Narrow-leaved willow	Salicaceae
Salix laevigata	Red willow	Salicaceae
Salix lasiolepis	Arroyo willow	Salicaceae
Sedum spathulifolium	Pacific stonecrop	Crassulaceae
Smilax californica	Greenbriar	Liliaceae
Solanum parishii	Parish's nightshade	Solanaceae
Stachys ajugoides	Hedge nettle	Lamiaceae
Streptanthus tortuosus var. tortuosus	Mountain jewelflower	Brassicaceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Tellima grandiflora	Fringe cups	Saxifragaceae
Torilis arvensis	False hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trientalis latifolia	Starflower	Primulaceae
Trifolium hirtum	Rose clover	Fabaceae
Trifolium variegatum	White-tipped clover	Fabaceae
Triteleia hyacinthina	White brodiaea	Liliaceae
Umbellularia californica	California bay	Lauraceae
Verbascum thapsus	Woolly mullein	Scrophulariaceae
Verbena lasiostachys	Common verbena	Verbenaceae
Viola glabella	Stream violet	Violaceae
Vitis californica	Wild grape	Vitaceae
Vulpia myuros	Rattail fescue	Poaceae
MIXED CHAPARRAL		
Aesculus californica	California buckeye	Hippocastanaceae
Ailanthus altissima	Tree of heaven	Simaroubaceae
Aira caryophyllea	Silver European hairgrass	Poaceae
Anaphalis margaritacea	Pearly everlasting	Asteraceae
Andropogon virginicus var. virginicus	Broomsedge bluestem	Poaceae
Anthoxanthum odoratum	Sweet vernal grass	Poaceae
Arctostaphylos viscida	Whiteleaf manzanita	Ericaceae
Avena fatua	Wild oat	Poaceae
Bromus diandrus	Ripgut grass	Poaceae
Bromus madritensis ssp. rubens	Red brome	Poaceae
Calycadenia truncata	Rosin weed	Asteraceae

Table 2
Plant Species Observed at the Big Backbone Arm of Shasta Lake

Scientific Name	Common Name	Family Name
Calystegia occidentalis	Western morning glory	Convolvulaceae
Capsella bursa-pastoris	Shepherd’s purse	Brassicaceae
Ceanothus cuneatus	Buck brush	Rhamnaceae
Ceanothus integerrimus	Deer brush	Rhamnaceae
Centaurea solstitialis	Yellow star thistle	Asteraceae
Cercis occidentalis	Redbud	Fabaceae
Chlorogalum pomeridianum var. pomeridianum	Soap plant	Liliaceae
Clarkia purpurea	Purple clarkia	Onagraceae
Claytonia rubra ssp. rubra	Red-stemmed miner’s lettuce	Portulacaceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Dendromecon rigida	Bush poppy	Papaveraceae
Dichelostemma capitatum ssp. capitatum	Blue dicks	Liliaceae
Dichelostemma ida-mae	Firecracker flower	Liliaceae
Eriodictyon californicum	Yerba Santa	Hydrophyllaceae
Eriogonum nudum	Naked buckwheat	Polygonaceae
Eriophyllum lanatum	Woolly sunflower	Asteraceae
Eschscholzia caespitosa	Foothill poppy	Papaveraceae
Galium bolanderi	Bolander’s bedstraw	Rubiaceae
Galium porrigens	Climbing bedstraw	Rubiaceae
Gastridium ventricosum	Nit grass	Poaceae
Gilia capitata	Globe gilia	Polemoniaceae
Heteromeles arbutifolia	Toyon	Rosaceae
Hieracium albiflorum	White-flowered hawkweed	Asteraceae
Hypericum perforatum	Klamathweed	Hypericaceae
Lonicera interrupta	Chaparral honeysuckle	Caprifoliaceae
Lotus denticulatus	Toothed lotus	Fabaceae
Lotus purshianus var. purshianus	Spanish lotus	Fabaceae
Lupinus albifrons	Silver bush lupine	Fabaceae
Lupinus bicolor	Bi-colored lupine	Fabaceae
Marah watsonii	Watson’s wild-cucumber	Cucurbitaceae
Medicago polymorpha	California burclover	Fabaceae
Melica californica	California melic	Poaceae
Phacelia hastata	Silverleaf phacelia	Hydrophyllaceae
Pinus sabiniana	Gray pine	Pinaceae
Plagiobothrys tenellus	Pacific popcornflower	Boraginaceae

Table 2 Plant Species Observed at the Big Backbone Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Quercus berberidifolia	Scrub oak	Fagaceae
Rhamnus rubra	Sierra coffeeberry	Rhamnaceae
Rhamnus tomentella ssp. tomentella	Hoary coffeeberry	Rhamnaceae
Rhus trilobata	Skunkbrush	Anacardiaceae
Sanicula bipinnatifida	Purple sanicle	Apiaceae
Scutellaria siphocampyloides	Skullcap	Lamiaceae
Silene gallica	Common catchfly	Caryophyllaceae
Solanum parishii	Parish’s nightshade	Solanaceae
Streptanthus tortuosus	Mountain jewelflower	Brassicaceae
Styrax officinalis var. redivivus	Snowdrop bush	Styracaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trifolium hirtum	Rose clover	Fabaceae
Verbascum thapsus	Woolly mullein	Scrophulariaceae
MONTANE HARDWOOD - CONIFER		
Achillea millefolium	Yarrow	Asteraceae
Agoseris glauca	Mountain dandelion	Asteraceae
Arbutus menziesii	Pacific madrone	Ericaceae
Avena fatua	Wild oat	Poaceae
Berberis aquifolium var. aquifolium	Oregon grape	Berberidaceae
Claytonia rubra ssp. rubra	Red-stemmed miner’s lettuce	Portulacaceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Disporum hookeri	Hooker’s fairybells	Liliaceae
Elymus glaucus	Blue wild rye	Poaceae
Galium bolanderi	Bolander’s bedstraw	Rubiaceae
Lathyrus sulphureus	Sulfur pea	Fabaceae
Nemophila heterophylla	Variable-leaved nemophila	Hydrophyllaceae
Osmorhiza occidentalis	Sierran sweet-cicely	Apiaceae
Philadelphus lewisii	Wild mock orange	Philadelphaceae
Pinus ponderosa	Ponderosa pine	Pinaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Pteridium aquilinum var. pubescens	Western bracken fern	Dennstaedtiaceae
Quercus kelloggii	Black oak	Fagaceae
Ribes divaricatum	Gooseberry	Grossulariaceae
Rosa gymnocarpa	Wood rose	Rosaceae

Table 2 Plant Species Observed at the Big Backbone Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Rubus discolor	Himalayan blackberry	Rosaceae
Rubus parviflorus	Thimbleberry	Rosaceae
Smilax californica	Greenbriar	Liliaceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Verbascum thapsus	Woolly mullein	Scrophulariaceae
MONTANE HARDWOOD		
Aesculus californica	California buckeye	Hippocastanaceae
Aira caryophyllea	Silver European hairgrass	Poaceae
Anthoxanthum odoratum	Sweet vernal grass	Poaceae
Anthriscus caucalis	Bur-chervil	Apiaceae
Arabis glabra var. glabra	Smooth rock cress	Brassicaceae
Arctostaphylos manzanita	Common manzanita	Ericaceae
Arctostaphylos viscida	Whiteleaf manzanita	Ericaceae
Aristolochia californica	Pipevine	Aristolochiaceae
Artemisia douglasiana	Mugwort	Asteraceae
Asclepias cordifolia	Purple milkweed	Asclepiadaceae
Avena fatua	Wild oat	Poaceae
Brassica nigra	Black mustard	Brassicaceae
Brodiaea coronaria ssp. coronaria	Harvest brodiaea	Liliaceae
Bromus diandrus	Ripgut grass	Poaceae
Bromus hordeaceus	Softchess	Poaceae
Bromus madritensis ssp. rubens	Red brome	Poaceae
Calycadenia truncata	Rosin weed	Asteraceae
Calystegia occidentalis	Western morning glory	Convolvulaceae
Capsella bursa-pastoris	Shepherd’s purse	Brassicaceae
Ceanothus cuneatus	Buck brush	Rhamnaceae
Ceanothus integerrimus	Deer brush	Rhamnaceae
Cercis occidentalis	Redbud	Fabaceae
Chlorogalum pomeridianum var. pomeridianum	Soap plant	Liliaceae
Cirsium occidentalis	Snowy thistle	Asteraceae
Clarkia purpurea	Purple clarkia	Onagraceae
Claytonia rubra ssp. rubra	Red-stemmed miner’s lettuce	Portulacaceae
Collomia heterophylla	Variableleaf collomia	Polemoniaceae

Table 2
Plant Species Observed at the Big Backbone Arm of Shasta Lake

Scientific Name	Common Name	Family Name
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Daucus pusillus	Rattlesnake weed	Apiaceae
Dichelostemma capitatum ssp. capitatum	Blue dicks	Liliaceae
Dichelostemma ida-mae	Firecracker flower	Liliaceae
Elymus glaucus	Blue wild rye	Poaceae
Epilobium sp.	Willow herb	Onagraceae
Eremocarpus setigerus	Dove weed	Euphorbiaceae
Eriodictyon californicum	Yerba Santa	Hydrophyllaceae
Eriophyllum lanatum	Woolly sunflower	Asteraceae
Erodium botrys	Filaree	Geraniaceae
Eschscholzia caespitosa	Foothill poppy	Papaveraceae
Galium bolanderi	Bolander’s bedstraw	Rubiaceae
Gastridium ventricosum	Nit grass	Poaceae
Gilia capitata	Globe gilia	Polemoniaceae
Heteromeles arbutifolia	Toyon	Rosaceae
Hieracium albiflorum	White-flowered hawkweed	Asteraceae
Hypericum perforatum	Klamathweed	Hypericaceae
Hypochaeris radicata	Rough cat’s ears	Asteraceae
Iris tenuissima	Slender iris	Iridaceae
Lathyrus sulphureus	Sulfur pea	Fabaceae
Lomatium utriculatum	Common lomatium	Apiaceae
Lotus humistratus	Foothill lotus	Fabaceae
Lupinus albifrons	Silver bush lupine	Fabaceae
Lupinus bicolor	Bi-colored lupine	Fabaceae
Luzula comosa	Common wood rush	Juncaceae
Marah watsonii	Watson’s wild-cucumber	Cucurbitaceae
Medicago polymorpha	California burclover	Fabaceae
Melica californica	California melic	Poaceae
Minuartia californica	California sandwort	Caryophyllaceae
Osmorhiza occidentalis	Sierran sweet-cicely	Apiaceae
Panicum acuminatum var. acuminatum	Panicgrass	Poaceae
Pellaea mucronata var. mucronata	Bird’s-foot fern	Pteridaceae
Penstemon heterophyllus var. purdyi	Foothill beardtongue	Scrophulariaceae
Pentagramma triangularis ssp. triangularis	Goldback fern	Pteridaceae
Petrorhagia dubia	Windmill pink	Caryophyllaceae

Table 2 Plant Species Observed at the Big Backbone Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Phacelia hastata	Silverleaf phacelia	Hydrophyllaceae
Philadelphus lewisii	Wild mock orange	Philadelphaceae
Phoradendron villosum	Oak mistletoe	Viscaceae
Pinus attenuata	Knobcone pine	Pinaceae
Pinus ponderosa	Ponderosa pine	Pinaceae
Plagiobothrys tenellus	Pacific popcornflower	Boraginaceae
Polystichum imbricans	Narrow-leaved sword fern	Dryopteridaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Quercus berberidifolia	Scrub oak	Fagaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Quercus garryana var. garryana	Oregon oak	Fagaceae
Quercus kelloggii	Black oak	Fagaceae
Quercus wislizenii	Interior live oak	Fagaceae
Quercus x morehus	Oracle oak	Fagaceae
Rhamnus rubra	Sierra coffeeberry	Rhamnaceae
Rhus trilobata	Skunkbrush	Anacardiaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Sanicula bipinnatifida	Purple sanicle	Apiaceae
Scutellaria siphocampyloides	Skullcap	Lamiaceae
Streptanthus tortuosus	Mountain jewelflower	Brassicaceae
Styrax officinalis var. redivivus	Snowdrop bush	Styracaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trifolium hirtum	Rose clover	Fabaceae
Umbellularia californica	California bay	Lauraceae
Verbascum blattaria	Moth mullein	Scrophulariaceae
Verbascum thapsus	Woolly mullein	Scrophulariaceae
Vitis californica	Wild grape	Vitaceae
PONDEROSA PINE		
Acer macrophyllum	Bigleaf maple	Aceraceae
Achillea millefolium	Yarrow	Asteraceae
Adenocaulon bicolor	Trail plant	Asteraceae
Adiantum capillus-veneris	Southern maiden-hair	Pteridaceae
Aesculus californica	California buckeye	Hippocastanaceae
Agoseris glauca	Mountain dandelion	Asteraceae

Table 2
Plant Species Observed at the Big Backbone Arm of Shasta Lake

Scientific Name	Common Name	Family Name
Andropogon virginicus var. virginicus	Broomsedge bluestem	Poaceae
Anthriscus caucalis	Bur-chervil	Apiaceae
Arctostaphylos viscida	Whiteleaf manzanita	Ericaceae
Artemisia douglasiana	Mugwort	Asteraceae
Asclepias cordifolia	Purple milkweed	Asclepiadaceae
Avena fatua	Wild oat	Poaceae
Berberis aquifolium var. aquifolium	Oregon grape	Berberidaceae
Bromus madritensis ssp. rubens	Red brome	Poaceae
Calystegia occidentalis	Western morning glory	Convolvulaceae
Ceanothus integerrimus	Deer brush	Rhamnaceae
Cercis occidentalis	Redbud	Fabaceae
Chlorogalum pomeridianum var. pomeridianum	Soap plant	Liliaceae
Claytonia rubra ssp. rubra	Red-stemmed miner's lettuce	Portulacaceae
Collomia heterophylla	Variable-leaved collomia	Polemoniaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Cornus sericea	American dogwood	Cornaceae
Corylus cornuta var. californica	Hazelnut	Betulaceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Elymus glaucus	Blue wild rye	Poaceae
Epilobium pallidum	Large-flower spike-primrose	Onagraceae
Eriophyllum lanatum	Woolly sunflower	Asteraceae
Eschscholzia caespitosa	Foothill poppy	Papaveraceae
Galium bolanderi	Bolander's bedstraw	Rubiaceae
Galium sp.	Bedstraw	Rubiaceae
Hieracium albiflorum	White-flowered hawkweed	Asteraceae
Hypericum perforatum	Klamathweed	Hypericaceae
Hypochaeris radicata	Rough cat's ears	Asteraceae
Iris tenuissima	Slender iris	Iridaceae
Lathyrus sulphureus	Sulfur pea	Fabaceae
Lonicera hispidula var. vacillans	Hairy honeysuckle	Caprifoliaceae
Lotus denticulatus	Toothed lotus	Fabaceae
Lotus purshianus var. purshianus	Spanish lotus	Fabaceae
Luzula comosa	Common wood rush	Juncaceae
Melica californica	California melic	Poaceae
Nemophila heterophylla	Variable-leaved nemophila	Hydrophyllaceae

Table 2 Plant Species Observed at the Big Backbone Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Osmorhiza occidentalis	Sierran sweet-cicely	Apiaceae
Panicum acuminatum var. acuminatum	Panicgrass	Poaceae
Pentagramma triangularis ssp. triangularis	Goldback fern	Pteridaceae
Petrorhagia dubia	Windmill pink	Caryophyllaceae
Philadelphus lewisii	Wild mock orange	Philadelphaceae
Pinus ponderosa	Ponderosa pine	Pinaceae
Polystichum imbricans	Narrow-leaved sword fern	Dryopteridaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Pteridium aquilinum var. pubescens	Western bracken fern	Dennstaedtiaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Quercus berberidifolia	Scrub oak	Fagaceae
Quercus kelloggii	Black oak	Fagaceae
Rhamnus purshiana	Cascara	Rhamnaceae
Rhamnus rubra	Sierra coffeeberry	Rhamnaceae
Rosa gymnocarpa	Wood rose	Rosaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Sanicula bipinnatifida	Purple sanicle	Apiaceae
Smilax californica	Greenbriar	Liliaceae
Solanum parishii	Parish's nightshade	Solanaceae
Styrax officinalis var. redivivus	Snowdrop bush	Styracaceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Umbellularia californica	California bay	Lauraceae
Verbascum thapsus	Woolly mullein	Scrophulariaceae
Vulpia myuros	Rattail fescue	Poaceae

Table 3 Plant Species Observed on Sugarloaf Creek at the Sacramento Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
RIPARIAN PLANTS		
Acer circinatum	Vine maple	Aceraceae
Acer macrophyllum	Big leaf maple	Aceraceae
Adiantum jordanii	California maiden-hair	Pteridaceae
Aesculus californica	California buckeye	Hippocastanaceae
Agrostis exarata	Spike bentgrass	Poaceae
Alnus rhombifolia	White alder	Betulaceae
Amelanchier utahensis	Utah serviceberry	Rosaceae
Aralia californica	California spikenard	Araliaceae
Aruncus dioicus var. pubescens	Goat's beard	Rosaceae
Brickellia californica	Brickellbush	Asteraceae
Calycanthus occidentalis	Spice bush	Calycanthaceae
Cephalanthus occidentalis var. californicus	California button willow	Rubiaceae
Cercis occidentalis	Redbud	Fabaceae
Cirsium vulgare	Bull thistle	Asteraceae
Clematis ligusticifolia	Virgin's bower	Ranunculaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Cornus sericea	Red twig	Cornaceae
Cornus sessilis	Miner's dogwood	Cornaceae
Corylus cornuta	Hazelnut	Betulaceae
Crataegus douglasii	Black Hawthorn	Rosaceae
Cyperus eriogrostus	Nutsedge	Cyperaceae
Darmera peltata	Umbrella plant	Saxifragaceae
Elymus glaucus	Blue wild rye	Poaceae
Epilobium ciliatum	Fireweed	Onagraceae
Eriophyllum lanatum	Wooly sunflower	Asteraceae
Fraxinus latifolia	Oregon ash	Oleaceae
Galium spp.	Bedstraw	Rubiaceae
Heuchera micrantha	Crevice heuchera	Saxifragaceae
Juncus effusis	Common rush	Juncaceae
Lilium pardalinum ssp. pardalinum	Leopard lily	Liliaceae
Lonicera hispidula var. vascillans	Hairy honeysuckle	Caprifoliaceae
Madia spp.	Tarweed	Asteraceae
Mimulus guttatus	Seep-spring monkey flower	Scrophulariaceae

Table 3 **Plant Species Observed on Sugarloaf Creek at the Sacramento Arm of Shasta Lake**		
Scientific Name	**Common Name**	**Family Name**
Montia parviflora	Little-leaf montia	Portulaceae
Panicum acuminatum	Panicgrass	Poaceae
Philadelphis lewisii	Wild mock orange	Philadelphaceae
Populus fremontii	Fremont cottonwood	Salicaceae
Prunella vulgaris	Self-heal	Lamiaceae
Prunus virginiana	Western choke-cherry	Rosaceae
Pteridium aquilinum var. pubescens	Bracken fern	Dennstaedtiaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Rhododendron occidentale	Western azalea	Ericaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Rubus ursinus	California blackberry	Rosaceae
Salix gooddingii	Black willow	Salicaceae
Salix laevigata	Red willow	Salicaceae
Salix lasiolepis	Arroyo willow	Salicaceae
Salix lucida	Shining willow	Salicaceae
Smilax californica	Greenbriar	Liliaceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Taxus brevifolia	Pacific yew	Taxaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Vitis californica	California grape	Vitaceae
Woodwardia fimbriata	Giant chain fern	Blechnaceae
UPLAND PLANTS		
Aesculus californica	California buckeye	Hippocastanaceae
Amelanchier utahensis	Utah serviceberry	Rosaceae
Ceanothus intergerrimus	Deer brush	Rhamnaceae
Cercis occidentalis	Redbud	Fabaceae
Corylus cornuta	Hazelnut	Betulaceae
Elymus glaucus	Blue wild rye	Poaceae
Hieracium albiflorum	Hawkweed	Asteraceae
Hypericum perforatum	Klamathweed	Hypericaceae
Keckiella lemmonii	Lemmon's keckiella	Scrophulariaceae
Lathyrus polyphyllus	Wild pea	Fabaceae
Lonicera hispidula var. vascillans	Hairy honeysuckle	Caprifoliaceae
Osmorhiza chilensis	Sierran sweet-cicely	Apiaceae
Petrorhagia dubia	Windmill pink	Caryophyllaceae

Table 3
Plant Species Observed on Sugarloaf Creek at the Sacramento Arm of Shasta Lake

Scientific Name	Common Name	Family Name
Pinus ponderosa	Ponderosa pine	Pinaceae
Polystichum munitum	Swordfern	Dryopteridaceae
Potentilla spp.	Cinquefoil	Rosaceae
Potentilla spp.	Cinquefoil	Rosaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Quercus garryana var. breweri	Brewer's oak	Fagaceae
Quercus kelloggii	Black oak	Fagaceae
Rhododendron occidentale	Western azalea	Ericaceae
Rhus trilobata	Skunkbrush	Anacardiaceae
Rosa gymnocarpa	Wood rose	Rosaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Rubus ursinus	California blackberry	Rosaceae
Styrax officianalis	Snowdrop bush	Styraceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Tellima grandiflora	Fringe cups	Saxifragaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trientalis latifolia	Starflower	Primulaceae
Triteleia hyacinthina	White brodiaea	Liliaceae
Umbellularia californica	California bay	Lauraceae
Viola lobata	Pine violet	Violaceae
Vitis californica	California grape	Vitaceae

Table 4 Plant Species Observed on the Upper Sacramento River of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
RIPARIAN PLANTS		
Acer macrophyllum	Big leaf maple	Aceraceae
Achillea millifolium	Yarrow	Asteraceae
Agrostis exarata	Spike bentgrass	Poaceae
Allium amplectens	White lily	Liliaceae
Alnus rhombifolia	White alder	Betulaceae
Amelanchier utahensis	Utah serviceberry	Rosaceae
Apocynum cannibinum	Indian hemp	Apocynaceae
Aralia californica	California spikenard	Araliaceae
Artemesia douglasiana	Mugwort	Asteraceae
Aruncus dioicus var. pubescens	Goat's beard	Rosaceae
Asclepias speciosa	Showy milkweed	Asclepiadaceae
Brickellia californica	Brickellbush	Asteraceae
Calycanthus occidentalis	Spice bush	Calycanthaceae
Carex nudata	Torrent sedge	Cyperaceae
Catalpa speciosa	Catalpa	Bignoniaceae
Centaurium venustum	Canchalagua	Gentianaceae
Cephalanthus occidentalis var. californicus	California button willow	Rubiaceae
Cercis occidentalis	Redbud	Fabaceae
Chenopodium botrys	Jerusalum oak	Chenopodiaceae
Clematis ligusticifolia	Virgin's bower	Ranunculaceae
Conium maculatum	Poisen hemlock	Apiaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Crataegus douglasii	Black Hawthorn	Rosaceae
Cynodon dactylon	Bermudagrass	Poaceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Cyperus eriogrostus	Nutsedge	Cyperaceae
Cytisus scoparius	Scotch broom	Fabaceae
Darmera peltata	Umbrella plant	Saxifragaceae
Deschampsia danthonioides	Annual hairgrass	Poaceae
Dichelostemma capitatum	Blue dicks	Liliaceae
Eleocharis spp.	Spike rush	Cyperaceae
Elymus elymoides	Squirreltail	Poaceae
Elymus glaucus	Blue wild rye	Poaceae

Table 4 Plant Species Observed on the Upper Sacramento River of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Epilobium canum	California fuchsia	Onagraceae
Epipactus gigantea	Stream orchid	Orchidaceae
Equisetum arvense	Field horsetail	Equisetaceae
Equisetum laevigatum	Smooth scouring rush	Equisetaceae
Eriogonum nudum	Naked buckwheat	Polygonaceae
Eriogonum umbellatum	Sulfur flower	Polygonaceae
Eriophyllum lanatum	Wooly sunflower	Asteraceae
Eyrngium articulatum	Eryngium	Apiaceae
Fraxinus latifolia	Oregon ash	Oleaceae
Gnaphalium spp.	Cudweed	Asteraceae
Hastingsia alba	Hastingsia	Liliaceae
Heuchera micrantha	Crevice heuchera	Saxifragaceae
Hieracium albiflorum	Hawkweed	Asteraceae
Hoita orbicularis	Hoita	Fabaceae
Hypericum perforatum	Klamathweed	Hypericaceae
Juncus effusis	Common rush	Juncaceae
Juncus mexicanus	Mexican rush	Juncaceae
Juncus xiphioides	Rush	Juncaceae
Lathyrus latifolius	Everlasting peavine	Fabaceae
Lewisia cantelovii	Cantelow's lewisia	Portulacaceae
Lotus oblongifolius	Bird's-foot trefoil	Fabaceae
Lotus purshianus var. purshianus	Spanish lotus	Fabaceae
Lupinus albifrons	Silver bush lupine	Fabaceae
Melilotus alba	White sweet clover	Fabaceae
Mimulus cardinalis	Scarlet monkey flower	Scrophulariaceae
Montia parviflora	Little-leaf montia	Portulaceae
Muhlenbergia minutissima	Muhly	Poaceae
Panicum acuminatum	Panicgrass	Poaceae
Pellaea mucronata var. californica	Bird's foot fern	Pteridaceae
Penstemon azureus	Azure beardtongue	Scrophulariaceae
Pentagramma triangularis	Goldenback fern	Pteridaceae
Perideridia oregana	Yampah	Apiaceae
Petrorhagia dubia	Windmill pink	Caryophyllaceae
Philadelphis lewisii	Wild mock orange	Philadelphaceae
Physocarpus capitatus	Pacific ninebark	Rosaceae

Table 4 Plant Species Observed on the Upper Sacramento River of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Plantago lanceolata	English plantain	Plantaganaceae
Polypogon interruptus	Rabbitfoot grass	Poaceae
Populus balsamifera ssp. trichocarpa	Black cottonwood	Salicaceae
Populus fremontii	Fremont cottonwood	Salicaceae
Potentilla spp.	Cinquefoil	Rosaceae
Prunella vulgaris	Self-heal	Lamiaceae
Pteridium aquilinum var. pubescens	Bracken fern	Dennstaedtiaceae
Rhododendron occidentale	Western azalea	Ericaceae
Robinia pseudoacacia	Black locust	Fabaceae
Rosa californica	California rose	Rosaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Rubus laciniatus	Cut-leaved blackberry	Rosaceae
Salix gooddingii	Black willow	Salicaceae
Salix laevigata	Red willow	Salicaceae
Salix lasiolepis	Arroyo willow	Salicaceae
Salix lucida	Shining willow	Salicaceae
Saponaria officinalis	Bouncing bet	Caryophyllaceae
Sedum spathulifolium	Pacific sedum	Crassulaceae
Smilax californica	Greenbriar	Liliaceae
Spiraea douglasii	Spiraea	Rosaceae
Spiranthes romanzoffiana	Ladies tresses	Orchidaceae
Stachys ajugoides	Stachys mint	Lamiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Triteleia hyacinthina	White brodiaea	Liliaceae
Verbascum blattaria	Moth mullein	Scrophulariaceae
Vitis californica	California grape	Vitaceae
Woodwardia fimbriata	Giant chain fern	Blechnaceae
UPLAND PLANTS		
Aesculus californica	California buckeye	Hippocastanaceae
Ailanthus altissima	Tree of heaven	Simaroubaceae
Aira caryophylla	European hairgrass	Poaceae
Arctostaphylos manzanita	Common manzanita	Ericaceae
Arctostaphylos viscida	Whiteleaf manzanita	Ericaceae
Avena fatua	Wild oat	Poaceae
Brassica nigra	Black mustard	Brassicaceae

Table 4 Plant Species Observed on the Upper Sacramento River of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Bromus diandrus	Ripgut	Poaceae
Bromus hordeaceous	Softchess	Poaceae
Calocedrus decurrens	Incense cedar	Cupressaceae
Calystegia occidentalis	Western morning-glory	Convolvulaceae
Centaurea solstitialis	Yellow star thistle	Asteraceae
Cercis occidentalis	Redbud	Fabaceae
Cercocarpus betuloides	Birchleaf mountain mahogany	Rosaceae
Cytisus scoparius	Scotch broom	Fabaceae
Datisca glomerata	Durango root	Datiscaceae
Daucas carota	Wild carrot	Apiaceae
Elymus glaucus	Blue wild rye	Poaceae
Equisetum arvense	Field horsetail	Equisetaceae
Eriodictyon californicum	Yerba santa	Hydrophyllaceae
Eriophyllum lanatum	Wooly sunflower	Asteraceae
Galium spp.	Bedstraw	Rubiaceae
Lomatium macrocarpum	Lomatium	Apiaceae
Lonicera hispidula var. vascillans	Hairy honeysuckle	Caprifoliaceae
Madia spp.	Tarweed	Asteraceae
Mimulus guttatus	Seep-spring monkey flower	Scrophulariaceae
Philadelphis lewisii	Wild mock orange	Philadelphaceae
Pinus ponderosa	Ponderosa pine	Pinaceae
Pinus sabiniana	Grey pine	Pinaceae
Plantago lanceolata	English plantain	Plantaganaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Quercus garryana var. breweri	Brewer's oak	Fagaceae
Quercus kelloggii	Black oak	Fagaceae
Ribes roezlii	Sierra gooseberry	Grossulariaceae
Rubus laciniatus	Cut-leaved blackberry	Rosaceae
Rumex crispus	Curly dock	Polygonaceae
Silene californica	California Indian pink	Caryophyllaceae
Smilax californica	Greenbriar	Liliaceae
Styrax officianalis	Snowdrop bush	Styraceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae

Table 4
Plant Species Observed on the Upper Sacramento River of Shasta Lake

Scientific Name	Common Name	Family Name
Trifolium hirtum	Rose clover	Fabaceae
Verbascum blattaria	Moth mullein	Scrophulariaceae
Vitis californica	California grape	Vitaceae

Table 5 Plant Species Observed on Middle Salt Creek at the Sacramento River Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
RIPARIAN PLANTS		
Acer circinatum	Vine maple	Aceraceae
Acer macrophyllum	Big leaf maple	Aceraceae
Alnus rhombifolia	White alder	Betulaceae
Aquilegia formosa	Columbine	Ranunculaceae
Aruncus dioicus var. pubescens	Goat's beard	Rosaceae
Calycanthus occidentalis	Spice bush	Calycanthaceae
Carex bolanderi	Toad rush	Cyperaceae
Carex nudata	Torrent sedge	Cyperaceae
Cephalanthus occidentalis var. californicus	California button willow	Rubiaceae
Chenopodium botrys	Jerusalum oak	Chenopodiaceae
Clematis ligusticifolia	Virgin's bower	Ranunculaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Cornus sericea	Red twig	Cornaceae
Cornus sessilis	Miner's dogwood	Cornaceae
Corylus cornuta	Hazelnut	Betulaceae
Crataegus douglasii	Black Hawthorn	Rosaceae
Darmera peltata	Umbrella plant	Saxifragaceae
Datisca glomerata	Durango root	Datiscaceae
Elymus glaucus	Blue wild rye	Poaceae
Epilobium ciliatum	Fireweed	Onagraceae
Epipactus gigantea	Stream orchid	Orchidaceae
Fraxinus latifolia	Oregon ash	Oleaceae
Lilium pardalinum ssp. pardalinum	Leopard lily	Liliaceae
Lonicera hispidula var. vascillans	Hairy honeysuckle	Caprifoliaceae
Melissa officinalis	Melissa	Lamiaceae
Mimulus cardinalis	Scarlet monkey flower	Scrophulariaceae
Mimulus guttatus	Seep-spring monkey flower	Scrophulariaceae
Philadelphis lewisii	Wild mock orange	Philadelphaceae
Physocarpus capitatus	Pacific ninebark	Rosaceae
Populus fremontii	Fremont cottonwood	Salicaceae
Prunella vulgaris	Self-heal	Lamiaceae
Prunus subcordata	Klamath plum	Rosaceae
Pteridium aquilinum var. pubescens	Bracken fern	Dennstaedtiaceae

Table 5 Plant Species Observed on Middle Salt Creek at the Sacramento River Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Rhododendron occidentale	Western azalea	Ericaceae
Rosa californica	California rose	Rosaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Rubus ursinus	California blackberry	Rosaceae
Salix exigua	Narrowleaf willow	Salicaceae
Salix gooddingii	Black willow	Salicaceae
Salix laevigata	Red willow	Salicaceae
Salix lucida	Shining willow	Salicaceae
Saponaria officinalis	Bouncing bet	Caryophyllaceae
Smilax californica	Greenbriar	Liliaceae
Stachys ajugoides	Stachys mint	Lamiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Vitis californica	California grape	Vitaceae
Xanthium strumarium	Cocklebur	Asteraceae
UPLAND PLANTS		
Achillea millifolium	Yarrow	Asteraceae
Adiantum jordanii	California maiden-hair	Pteridaceae
Allium amplectens	Allium	Liliaceae
Amelanchier utahensis	Utah serviceberry	Rosaceae
Aquilegia formosa	Columbine	Ranunculaceae
Arctostaphylos manzanita	Common manzanita	Ericaceae
Arctostaphylos viscida	Whiteleaf manzanita	Ericaceae
Artemesia douglasiana	Mugwort	Asteraceae
Asarum hartwegii	Wild ginger	Aristolochiaceae
Avena fatua	Wild oat	Poaceae
Berberis aquifolium	Oregon grape	Berberidaceae
Brickellia californica	Brickellbush	Asteraceae
Bromus diandrus	Ripgut	Poaceae
Bromus hordeaceous	Softchess	Poaceae
Bromus tectorum	Cheatgrass	Poaceae
Calocedrus decurrens	Incense cedar	Cupressaceae
Calystegia occidentalis	Western morning-glory	Convolvulaceae
Ceanothus cuneatus	Buck brush	Rhamnaceae
Ceanothus intergerrimus	Deer brush	Rhamnaceae
Centaurea solstitialis	Yellow star thistle	Asteraceae

Table 5 Plant Species Observed on Middle Salt Creek at the Sacramento River Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Cercis occidentalis	Redbud	Fabaceae
Cercocarpus betuloides	Birchleaf mountain mahogany	Rosaceae
Clematis ligusticifolia	Virgin's bower	Ranunculaceae
Cornus sericea	Red twig	Cornaceae
Corylus cornuta	Hazelnut	Betulaceae
Crataegus douglasii	Black Hawthorn	Rosaceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Dichelostemma capitatum	Blue dicks	Liliaceae
Elymus elymoides	Squirreltail	Poaceae
Eriodictyon californicum	Yerba santa	Hydrophyllaceae
Fraxinus dipetala	California ash	Oleaceae
Galium spp.	Bedstraw	Rubiaceae
Heuchera micrantha	Crevice heuchera	Saxifragaceae
Hieracium albiflorum	Hawkweed	Asteraceae
Hypericum perforatum	Klamathweed	Hypericaceae
Juncus spp.	Rush	Juncaceae
Lathyrus latifolius	Everlasting peavine	Fabaceae
Lathyrus polyphyllus	Wild pea	Fabaceae
Lonicera hispidula var. vascillans	Hairy honeysuckle	Caprifoliaceae
Malus sylvestris	Apple	Rosaceae
Montia parviflora	Little-leaf montia	Portulaceae
Osmorhiza chilensis	Sierran sweet-cicely	Apiaceae
Panicum acuminatum	Panicgrass	Poaceae
Pentagramma triangularis	Goldenback fern	Pteridaceae
Petrorhagia dubia	Windmill pink	Caryophyllaceae
Philadelphis lewisii	Wild mock orange	Philadelphaceae
Pinus ponderosa	Ponderosa pine	Pinaceae
Pinus sabiniana	Grey pine	Pinaceae
Plantago lanceolata	English plantain	Plantaganaceae
Polypogon interruptus	Rabbitfoot grass	Poaceae
Polystichum munitum	Swordfern	Dryopteridaceae
Potentilla spp.	Cinquefoil	Rosaceae
Prunus subcordata	Klamath plum	Rosaceae
Prunus virginiana	Western choke-cherry	Rosaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae

Table 5
Plant Species Observed on Middle Salt Creek at the Sacramento River Arm of Shasta Lake

Scientific Name	Common Name	Family Name
Quercus chrysolepis	Canyon live oak	Fagaceae
Quercus garryana var. breweri	Brewer's oak	Fagaceae
Quercus kelloggii	Black oak	Fagaceae
Quercus lobata	Valley oak	Fagaceae
Rhus trilobata	Skunkbrush	Anacardiaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Rumex acetosella	Red sorrel	Polygonaceae
Salvia sonomensis	Sonoma sage	Lamiaceae
Sedum spathulifolium	Pacific sedum	Crassulaceae
Smilax californica	Greenbriar	Liliaceae
Spiranthes romanzoffiana	Ladies tresses	Orchidaceae
Styrax officianalis	Snowdrop bush	Styraceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trientalis latifolia	Starflower	Primulaceae
Triteleia hyacinthina	White brodiaea	Liliaceae
Verbascum blattaria	Moth mullein	Scrophulariaceae
Vitis californica	California grape	Vitaceae

Table 6 Plant Species Observed on Salt Creek at the Sacramento River Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
EMERGENT WETLAND PLANTS		
Agrostis exarata	Spike bentgrass	Poaceae
Artemesia douglasiana	Mugwort	Asteraceae
Aruncus dioicus var. pubescens	Goat's beard	Rosaceae
Carex nudata	Torrent sedge	Cyperaceae
Chenopodium botrys	Jerusalum oak	Chenopodiaceae
Cyperus eriogrostus	Nutsedge	Cyperaceae
Darmera peltata	Umbrella plant	Saxifragaceae
Datisca glomerata	Durango root	Datiscaceae
Digitaria sanguinalis	Large crabgrass	Poaceae
Equisetum arvense	Field horsetail	Equisetaceae
Fraxinus latifolia	Oregon ash	Oleaceae
Iris pseudacorus	Iris	Iridaceae
Lathyrus latifolius	Everlasting peavine	Fabaceae
Mentha pulegium	Pennyroyal	Lamiaceae
Myriophyllum aquaticum	Parrot's feather	Haloragaceae
Panicum acuminatum	Panicgrass	Poaceae
Phalaris spp.	Canarygrass	Poaceae
Phytolacca americana	Pokeweed	Phytolaccaceae
Plantago major	Common plantain	Plantaganaceae
Polygonum spp.	Knotweed	Polygonaceae
Populus fremontii	Fremont cottonwood	Salicaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Rumex crispus	Curly dock	Polygonaceae
Salix exigua	Narrowleaf willow	Salicaceae
Salix gooddingii	Black willow	Salicaceae
Salix laevigata	Red willow	Salicaceae
Salix lucida	Shining willow	Salicaceae
Typha angustifolia	Narrow-leaved cattail	Typhaceae
Vitis californica	California grape	Vitaceae
Xanthium strumarium	Cocklebur	Asteraceae
RIPARIAN PLANTS		
Acer circinatum	Vine maple	Aceraceae
Acer macrophyllum	Big leaf maple	Aceraceae

Table 6 Plant Species Observed on Salt Creek at the Sacramento River Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Aesculus californica	California buckeye	Hippocastanaceae
Agrostis exarata	Spike bentgrass	Poaceae
Alnus rhombifolia	White alder	Betulaceae
Amelanchier utahensis	Utah serviceberry	Rosaceae
Apocynum cannibinum	Indian hemp	Apocynaceae
Aquilegia formosa	Columbine	Ranunculaceae
Aralia californica	California spikenard	Araliaceae
Aruncus dioicus var. pubescens	Goat's beard	Rosaceae
Brickellia californica	Brickellbush	Asteraceae
Brodiaea elegans	Harvest brodiaea	Liliaceae
Calycanthus occidentalis	Spice bush	Calycanthaceae
Carex bolanderi	Sedge	Cyperaceae
Carex nudata	Torrent sedge	Cyperaceae
Centaurea solstitialis	Yellow star thistle	Asteraceae
Cercis occidentalis	Redbud	Fabaceae
Clematis ligusticifolia	Virgin's bower	Ranunculaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Cornus sericea	Red twig	Cornaceae
Cornus sessilis	Miner's dogwood	Cornaceae
Dactylis glomerata	Orchard grass	Poaceae
Darmera peltata	Umbrella plant	Saxifragaceae
Datisca glomerata	Durango root	Datiscaceae
Elymus glaucus	Blue wild rye	Poaceae
Equisetum arvense	Field horsetail	Equisetaceae
Fraxinus latifolia	Oregon ash	Oleaceae
Galium spp.	Bedstraw	Rubiaceae
Heuchera micrantha	Crevice heuchera	Saxifragaceae
Hypochaeris radicata	Rough cat's ears	Asteraceae
Lathyrus latifolius	Everlasting peavine	Fabaceae
Lilium pardalinum ssp. pardalinum	Leopard lily	Liliaceae
Lotus crassifolius	Lotus	Fabaceae
Lotus oblongifolius	Bird's-foot trefoil	Fabaceae
Melissa officinalis	Melissa	Lamiaceae
Mimulus cardinalis	Scarlet monkey flower	Scrophulariaceae
Mimulus guttatus	Seep-spring monkey flower	Scrophulariaceae

Table 6 Plant Species Observed on Salt Creek at the Sacramento River Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Muhlenbergia minutissima	Muhly	Poaceae
Panicum acuminatum	Panicgrass	Poaceae
Pentagramma triangularis	Goldenback fern	Pteridaceae
Petrorhagia dubia	Windmill pink	Caryophyllaceae
Phacelia hastata	Silverleaf phacelia	Hydrophyllaceae
Phalaris arundinacea	Reed canary grass	Poaceae
Physocarpus capitatus	Pacific ninebark	Rosaceae
Phytolacca americana	Pokeweed	Phytolaccaceae
Pinus attenuata	Knobcone pine	Pinaceae
Pinus ponderosa	Ponderosa pine	Pinaceae
Plantago lanceolata	English plantain	Plantaganaceae
Polypogon interruptus	Rabbitfoot grass	Poaceae
Populus fremontii	Fremont cottonwood	Salicaceae
Prunella vulgaris	Self-heal	Lamiaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Quercus kelloggii	Black oak	Fagaceae
Quercus lobata	Valley oak	Fagaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Rubus ursinus	California blackberry	Rosaceae
Rumex crispus	Curly dock	Polygonaceae
Salix laevigata	Red willow	Salicaceae
Salix lasiolepis	Arroyo willow	Salicaceae
Salix lucida	Shining willow	Salicaceae
Saponaria officinalis	Bouncing bet	Caryophyllaceae
Sedum spathulifolium	Pacific sedum	Crassulaceae
Smilax californica	Greenbriar	Liliaceae
Spiraea douglasii	Spiraea	Rosaceae
Spiranthes romanzoffiana	Ladies tresses	Orchidaceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trifolium willdenovii	Clover	Fabaceae
Triteleia hyacinthina	White brodiaea	Liliaceae
Urtica dioica	Stinging nettle	Urticaceae
Verbascum blattaria	Moth mullein	Scrophulariaceae

Table 6 Plant Species Observed on Salt Creek at the Sacramento River Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Verbascum thapsis	Wooly mullein	Scrophulareaceae
Vitis californica	California grape	Vitaceae
UPLAND PLANTS		
Acer circinatum	Vine maple	Aceraceae
Acer macrophyllum	Big leaf maple	Aceraceae
Aira caryophylla	European hairgrass	Poaceae
Apocynum cannibinum	Indian hemp	Apocynaceae
Arctostaphylos manzanita	Common manzanita	Ericaceae
Arctostaphylos viscida	Whiteleaf manzanita	Ericaceae
Artemesia douglasiana	Mugwort	Asteraceae
Aruncus dioicus var. pubescens	Goat's beard	Rosaceae
Asarum hartwegii	Wild ginger	Aristolochiaceae
Asclepias fascicularis	Narrow-leaved milkweed	Asclepiadaceae
Asclepias speciosa	Showy milkweed	Asclepiadaceae
Avena fatua	Wild oat	Poaceae
Berberis aquifolium	Oregon grape	Berberidaceae
Brodiaea coronaria	Brodiaea	Liliaceae
Bromus diandrus	Ripgut	Poaceae
Bromus hordeaceous	Softchess	Poaceae
Bromus tectorum	Cheatgrass	Poaceae
Calocedrus decurrens	Incense cedar	Cupressaceae
Calystegia occidentalis	Western morning-glory	Convolvulaceae
Campanula prenanthoides	California bluebell	Campanulaceae
Ceanothus cuneatus	Buck brush	Rhamnaceae
Ceanothus intergerrimus	Deer brush	Rhamnaceae
Centaurea solstitialis	Yellow star thistle	Asteraceae
Cercis occidentalis	Redbud	Fabaceae
Cercocarpus betuloides	Birchleaf mountain mahogany	Rosaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Cornus sericea	Red twig	Cornaceae
Corylus cornuta	Hazelnut	Betulaceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Cytisus scoparius	Scotch broom	Fabaceae
Elymus caput-medusae	Medusahead	Poaceae
Elymus elymoides	Squirreltail	Poaceae

Table 6
Plant Species Observed on Salt Creek at the Sacramento River Arm of Shasta Lake

Scientific Name	Common Name	Family Name
Elymus glaucus	Blue wild rye	Poaceae
Eriogonum nudum	Naked buckwheat	Polygonaceae
Eriophyllum lanatum	Wooly sunflower	Asteraceae
Eschscholzia californica	California poppy	Papaveraceae
Fraxinus dipetala	California ash	Oleaceae
Fraxinus latifolia	Oregon ash	Oleaceae
Hypericum perforatum	Klamathweed	Hypericaceae
Juniperus spp.	Ornamental juniper	Cupressaceae
Lactuca serriola	Prickly lettuce	Asteraceae
Lathyrus latifolius	Everlasting peavine	Fabaceae
Lathyrus polyphyllus	Wild pea	Fabaceae
Lolium spp.	Ryegrass	Poaceae
Lonicera hispidula var. vascillans	Hairy honeysuckle	Caprifoliaceae
Lonicera spp.	Ornamental honeysuckle	Caprifoliaceae
Mentha pulegium	Pennyroyal	Lamiaceae
Montia parviflora	Little-leaf montia	Portulaceae
Oemlaria cerasiformis	Oso berry	Rosaceae
Osmorhiza chilensis	Sierran sweet-cicely	Apiaceae
Panicum acuminatum	Panicgrass	Poaceae
Petrorhagia dubia	Windmill pink	Caryophyllaceae
Phacelia hastata	Silverleaf phacelia	Hydrophyllaceae
Philadelphis lewisii	Wild mock orange	Philadelphaceae
Physocarpus capitatus	Pacific ninebark	Rosaceae
Pinus ponderosa	Ponderosa pine	Pinaceae
Pinus sabiniana	Grey pine	Pinaceae
Plantago lanceolata	English plantain	Plantaganaceae
Polystichum munitum	Swordfern	Dryopteridaceae
Potentilla spp.	Cinquefoil	Rosaceae
Prunus cerasifera	Cherry plum	Rosaceae
Prunus subcordata	Klamath plum	Rosaceae
Prunus virginiana	Western choke-cherry	Rosaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Pteridium aquilinum var. pubescens	Bracken fern	Dennstaedtiaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Quercus garryana	Oregon white oak	Fagaceae

Table 6 Plant Species Observed on Salt Creek at the Sacramento River Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Quercus garryana var. breweri	Brewer's oak	Fagaceae
Quercus kelloggii	Black oak	Fagaceae
Quercus lobata	Valley oak	Fagaceae
Rhamnus rubra	Sierran coffeeberry	Rhamnaceae
Rhododendron occidentale	Western azalea	Ericaceae
Rhus trilobata	Skunkbrush	Anacardiaceae
Ribes roezlii	Sierra gooseberry	Grossulariaceae
Rosmarinus spp.	Rosemary	Lamiaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Rubus leucodermis	Black cap rasperry	Rosaceae
Rubus parviflorus	Thimbleberry	Rosaceae
Rumex acetosella	Red sorrel	Polygonaceae
Rumex crispus	Curly dock	Polygonaceae
Salix lucida	Shining willow	Salicaceae
Sedum spathulifolium	Pacific sedum	Crassulaceae
Styrax officianalis	Snowdrop bush	Styraceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trifolium hirtum	Rose clover	Fabaceae
Verbena lasiostachys	Common verbena	Verbenaceae
Vitis californica	California grape	Vitaceae
Woodwardia fimbriata	Giant chain fern	Blechnaceae
Xanthium strumarium	Cocklebur	Asteraceae

Table 7 Plant Species Observed on Nosoni Creek at the Mccloud Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
RIPARIAN PLANTS		
Acer circinatum	Vine maple	Aceraceae
Acer macrophyllum	Big leaf maple	Aceraceae
Adiantum jordanii	California maiden-hair	Pteridaceae
Aesculus californica	California buckeye	Hippocastanaceae
Alnus rhombifolia	White alder	Betulaceae
Amelanchier utahensis	Utah serviceberry	Rosaceae
Apium graveolens	Celery	Apiaceae
Apocynum cannibinum	Indian hemp	Apocynaceae
Aquilegia formosa	Columbine	Ranunculaceae
Aralia californica	California spikenard	Araliaceae
Arbutus menziesii	Pacific madrone	Ericaceae
Aristolochia californica	Dutchman's pipe	Aristolochiaceae
Aruncus dioicus var. pubescens	Goat's beard	Rosaceae
Brickellia californica	Brickellbush	Asteraceae
Calycanthus occidentalis	Spice bush	Calycanthaceae
Calystegia occidentalis	Western morning-glory	Convolvulaceae
Carex nudata	Torrent sedge	Cyperaceae
Cercis occidentalis	Redbud	Fabaceae
Clematis ligusticifolia	Virgin's bower	Ranunculaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Cornus sericea	Red twig	Cornaceae
Cornus sessilis	Miner's dogwood	Cornaceae
Crataegus douglasii	Black Hawthorn	Rosaceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Cyperus eriogrostus	Nutsedge	Cyperaceae
Darmera peltata	Umbrella plant	Saxifragaceae
Datisca glomerata	Durango root	Datiscaceae
Elymus glaucus	Blue wild rye	Poaceae
Epilobium ciliatum	Fireweed	Onagraceae
Epipactus gigantea	Stream orchid	Orchidaceae
Equisetum arvense	Field horsetail	Equisetaceae
Fraxinus dipetala	California ash	Oleaceae
Fraxinus latifolia	Oregon ash	Oleaceae

Table 7 Plant Species Observed on Nosoni Creek at the Mccloud Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Heuchera micrantha	Crevice heuchera	Saxifragaceae
Hieracium albiflorum	Hawkweed	Asteraceae
Hypericum perforatum	Klamathweed	Hypericaceae
Lilium pardalinum ssp. pardalinum	Leopard lily	Liliaceae
Lonicera hispidula var. vascillans	Hairy honeysuckle	Caprifoliaceae
Lotus crassifolius	Lotus	Fabaceae
Melilotus alba	White sweet clover	Fabaceae
Melissa officinalis	Melissa	Lamiaceae
Mimulus guttatus	Seep-spring monkey flower	Scrophulariaceae
Montia parviflora	Little-leaf montia	Portulaceae
Panicum acuminatum	Panicgrass	Poaceae
Philadelphis lewisii	Wild mock orange	Philadelphaceae
Physocarpus capitatus	Pacific ninebark	Rosaceae
Phytolacca americana	Pokeweed	Phytolaccaceae
Polystichum munitum	Swordfern	Dryopteridaceae
Potentilla spp.	Cinquefoil	Rosaceae
Prunella vulgaris	Self-heal	Lamiaceae
Prunus subcordata	Klamath plum	Rosaceae
Ribes aureum	Golden currant	Grossulariaceae
Rosa californica	California rose	Rosaceae
Rubus leucodermis	Black cap rasperry	Rosaceae
Rubus ursinus	California blackberry	Rosaceae
Rumex acetosella	Red sorrel	Polygonaceae
Salix exigua	Narrowleaf willow	Salicaceae
Salix gooddingii	Black willow	Salicaceae
Salix laevigata	Red willow	Salicaceae
Salix lasiolepis	Arroyo willow	Salicaceae
Salix lucida	Shining willow	Salicaceae
Scutellaria siphocampyloides	Narrowleaf skullcap	Lamiaceae
Sedum spathulifolium	Pacific sedum	Crassulaceae
Silene californica	California Indian pink	Caryophyllaceae
Smilax californica	Greenbriar	Liliaceae
Solanum dulcamara	Bittersweet nightshade	Solanaceae
Solanum sarrachoides	White nightshade	Solanaceae
Styrax officianalis	Snowdrop bush	Styraceae

Table 7 Plant Species Observed on Nosoni Creek at the Mccloud Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Taxus brevifolia	Pacific yew	Taxaceae
Tellima grandiflora	Fringe cups	Saxifragaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trientalis latifolia	Starflower	Primulaceae
Triteleia hyacinthina	White brodiaea	Liliaceae
Vitis californica	California grape	Vitaceae
Woodwardia fimbriata	Giant chain fern	Blechnaceae
Philadelphis lewisii	Wild mock orange	Philadelphaceae
Physocarpus capitatus	Pacific ninebark	Rosaceae
Phytolacca americana	Pokeweed	Phytolaccaceae
Polystichum munitum	Swordfern	Dryopteridaceae
Potentilla spp.	Cinquefoil	Rosaceae
Prunella vulgaris	Self-heal	Lamiaceae
Prunus subcordata	Klamath plum	Rosaceae
Ribes aureum	Golden currant	Grossulariaceae
Rosa californica	California rose	Rosaceae
Rubus leucodermis	Black cap rasperry	Rosaceae
Rubus ursinus	California blackberry	Rosaceae
Rumex acetosella	Red sorrel	Polygonaceae
Salix exigua	Narrowleaf willow	Salicaceae
Salix gooddingii	Black willow	Salicaceae
Salix laevigata	Red willow	Salicaceae
Salix lasiolepis	Arroyo willow	Salicaceae
Salix lucida	Shining willow	Salicaceae
Scutellaria siphocampyloides	Narrowleaf skullcap	Lamiaceae
Sedum spathulifolium	Pacific sedum	Crassulaceae
Silene californica	California Indian pink	Caryophyllaceae
Smilax californica	Greenbriar	Liliaceae
Solanum dulcamara	Bittersweet nightshade	Solanaceae
Solanum sarrachoides	White nightshade	Solanaceae
Styrax officianalis	Snowdrop bush	Styraceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Taxus brevifolia	Pacific yew	Taxaceae

Table 7 Plant Species Observed on Nosoni Creek at the Mccloud Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Tellima grandiflora	Fringe cups	Saxifragaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trientalis latifolia	Starflower	Primulaceae
Triteleia hyacinthina	White brodiaea	Liliaceae
Vitis californica	California grape	Vitaceae
Woodwardia fimbriata	Giant chain fern	Blechnaceae
Philadelphis lewisii	Wild mock orange	Philadelphaceae
Physocarpus capitatus	Pacific ninebark	Rosaceae
Phytolacca americana	Pokeweed	Phytolaccaceae
Polystichum munitum	Swordfern	Dryopteridaceae
Potentilla spp.	Cinquefoil	Rosaceae
Prunella vulgaris	Self-heal	Lamiaceae
Prunus subcordata	Klamath plum	Rosaceae
Ribes aureum	Golden currant	Grossulariaceae
Rosa californica	California rose	Rosaceae
Rubus leucodermis	Black cap rasperry	Rosaceae
Rubus ursinus	California blackberry	Rosaceae
Rumex acetosella	Red sorrel	Polygonaceae
Salix exigua	Narrowleaf willow	Salicaceae
Salix gooddingii	Black willow	Salicaceae
Salix laevigata	Red willow	Salicaceae
Salix lasiolepis	Arroyo willow	Salicaceae
Salix lucida	Shining willow	Salicaceae
Scutellaria siphocampyloides	Narrowleaf skullcap	Lamiaceae
Sedum spathulifolium	Pacific sedum	Crassulaceae
Silene californica	California Indian pink	Caryophyllaceae
Smilax californica	Greenbriar	Liliaceae
Solanum dulcamara	Bittersweet nightshade	Solanaceae
Solanum sarrachoides	White nightshade	Solanaceae
Styrax officianalis	Snowdrop bush	Styraceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Taxus brevifolia	Pacific yew	Taxaceae
Tellima grandiflora	Fringe cups	Saxifragaceae
Torilis arvensis	Hedge-parsley	Apiaceae

Table 7 Plant Species Observed on Nosoni Creek at the Mccloud Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trientalis latifolia	Starflower	Primulaceae
Triteleia hyacinthina	White brodiaea	Liliaceae
Vitis californica	California grape	Vitaceae
Woodwardia fimbriata	Giant chain fern	Blechnaceae
UPLAND PLANTS		
Adiantum jordanii	California maiden-hair	Pteridaceae
Aesculus californica	California buckeye	Hippocastanaceae
Aquilegia formosa	Columbine	Ranunculaceae
Arbutus menziesii	Pacific madrone	Ericaceae
Arctostaphylos viscida	Whiteleaf manzanita	Ericaceae
Asarum hartwegii	Wild ginger	Aristolochiaceae
Calocedrus decurrens	Incense cedar	Cupressaceae
Rhamnus purshiana	Cascara	Rhamnaceae
Ceanothus intergerrimus	Deer brush	Rhamnaceae
Cercis occidentalis	Redbud	Fabaceae
Cirsium vulgare	Bull thistle	Asteraceae
Claytonia perfoliata	Miner's lettuce	Portulaceae
Collomia heterophylla	Vari-leaf collomia	Polemoniaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Corylus cornuta	Hazelnut	Betulaceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Cyperus eriogrostus	Nutsedge	Cyperaceae
Dicentra formosa	Bleeding heart	Papaveraceae
Elymus glaucus	Blue wild rye	Poaceae
Galium spp.	Bedstraw	Rubiaceae
Heuchera micrantha	Crevice heuchera	Saxifragaceae
Hieracium albiflorum	Hawkweed	Asteraceae
Hypericum perforatum	Klamathweed	Hypericaceae
Keckiella lemmonii	Lemmon's keckiella	Scrophulariaceae
Lonicera hispidula var. vascillans	Hairy honeysuckle	Caprifoliaceae
Madia spp.	Tarweed	Asteraceae
Osmorhiza chilensis	Sierran sweet-cicely	Apiaceae
Pentagramma triangularis	Goldenback fern	Pteridaceae
Philadelphis lewisii	Wild mock orange	Philadelphaceae

Table 7 Plant Species Observed on Nosoni Creek at the Mccloud Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Pinus ponderosa	Ponderosa pine	Pinaceae
Plantago lanceolata	English plantain	Plantaganaceae
Polypodium calirhiza	Polypody	Polypodiaceae
Polystichum munitum	Swordfern	Dryopteridaceae
Potentilla spp.	Cinquefoil	Rosaceae
Prunella vulgaris	Self-heal	Lamiaceae
Prunus virginiana	Western choke-cherry	Rosaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Pteridium aquilinum var. pubescens	Bracken fern	Dennstaedtiaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Quercus garryana var. breweri	Brewer's oak	Fagaceae
Quercus kelloggii	Black oak	Fagaceae
Rhamnus rubra	Sierran coffeeberry	Rhamnaceae
Rhododendron occidentale	Western azalea	Ericaceae
Rhus trilobata	Skunkbrush	Anacardiaceae
Rosa gymnocarpa	Wood rose	Rosaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Rubus leucodermis	Black cap rasperry	Rosaceae
Rubus parviflorus	Thimbleberry	Rosaceae
Rubus ursinus	California blackberry	Rosaceae
Rumex crispus	Curly dock	Polygonaceae
Smilax californica	Greenbriar	Liliaceae
Styrax officianalis	Snowdrop bush	Styraceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trientalis latifolia	Starflower	Primulaceae
Viola lobata	Pine violet	Violaceae

Table 8 Plant Species Observed on Dekkas Creek at the McCloud Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
RIPARIAN PLANTS		
Acer macrophyllum	Big leaf maple	Aceraceae
Adenocaulon bicolor	Trailplant	Asteraceae
Adiantum jordanii	California maiden-hair	Pteridaceae
Alnus rhombifolia	White alder	Betulaceae
Aquilegia formosa	Columbine	Ranunculaceae
Aralia californica	California spikenard	Araliaceae
Artemesia douglasiana	Mugwort	Asteraceae
Aruncus dioicus var. pubescens	Goat's beard	Rosaceae
Calystegia occidentalis	Western morning-glory	Convolvulaceae
Carex bolanderi	Sedge	Cyperaceae
Carex nudata	Torrent sedge	Cyperaceae
Claytonia perfoliata	Miner's lettuce	Portulaceae
Collomia heterophylla	Vari-leaf collomia	Polemoniaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Darmera peltata	Umbrella plant	Saxifragaceae
Elymus glaucus	Blue wild rye	Poaceae
Epilobium ciliatum	Fireweed	Onagraceae
Erigeron philadelphicus	Fleabane daisy	Asteraceae
Fraxinus latifolia	Oregon ash	Oleaceae
Heuchera micrantha	Crevice heuchera	Saxifragaceae
Hypericum perforatum	Klamathweed	Hypericaceae
Lathyrus polyphyllus	Wild pea	Fabaceae
Lilium pardalinum ssp. pardalinum	Leopard lily	Liliaceae
Madia spp.	Tarweed	Asteraceae
Mimulus cardinalis	Scarlet monkey flower	Scrophulariaceae
Montia parviflora	Little-leaf montia	Portulaceae
Perideridia gairdneri	Yampah	Apiaceae
Phytolacca americana	Pokeweed	Phytolaccaceae
Populus balsamifera ssp. trichocarpa	Black cottonwood	Salicaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Rubus ursinus	California blackberry	Rosaceae

Table 8 Plant Species Observed on Dekkas Creek at the McCloud Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Salix exigua	Narrowleaf willow	Salicaceae
Salix gooddingii	Black willow	Salicaceae
Sedum spathulifolium	Pacific sedum	Crassulaceae
Silene californica	California Indian pink	Caryophyllaceae
Smilacina racemosa	False solomon's seal	Liliaceae
Tellima grandiflora	Fringe cups	Saxifragaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Vitis californica	California grape	Vitaceae
UPLAND PLANTS		
Acer macrophyllum	Big leaf maple	Aceraceae
Adenocaulon bicolor	Trailplant	Asteraceae
Adiantum jordanii	California maiden-hair	Pteridaceae
Aesculus californica	California buckeye	Hippocastanaceae
Aristolochia californica	Dutchman's pipe	Aristolochiaceae
Bromus diandrus	Ripgut	Poaceae
Bromus hordeaceous	Softchess	Poaceae
Cercis occidentalis	Redbud	Fabaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Corylus cornuta	Hazelnut	Betulaceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Dicentra formosa	Bleeding heart	Papaveraceae
Dichelostemma capitatum	Blue dicks	Liliaceae
Elymus glaucus	Blue wild rye	Poaceae
Fraxinus dipetala	California ash	Oleaceae
Fraxinus latifolia	Oregon ash	Oleaceae
Galium spp.	Bedstraw	Rubiaceae
Lonicera hispidula var. vascillans	Hairy honeysuckle	Caprifoliaceae
Osmorhiza chilensis	Sierran sweet-cicely	Apiaceae
Philadelphis lewisii	Wild mock orange	Philadelphaceae
Pinus ponderosa	Ponderosa pine	Pinaceae
Polystichum munitum	Swordfern	Dryopteridaceae
Prunus subcordata	Klamath plum	Rosaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Quercus chrysolepis	Canyon live oak	Fagaceae

Table 8
Plant Species Observed on Dekkas Creek at the McCloud Arm of Shasta Lake

Scientific Name	Common Name	Family Name
Rhamnus rubra	Sierran coffeeberry	Rhamnaceae
Rhus trilobata	Skunkbrush	Anacardiaceae
Ribes roezlii	Sierra gooseberry	Grossulariaceae
Rosa gymnocarpa	Wood rose	Rosaceae
Rubus leucodermis	Black cap rasperry	Rosaceae
Rubus ursinus	California blackberry	Rosaceae
Smilax californica	Greenbriar	Liliaceae
Styrax officianalis	Snowdrop bush	Styraceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trientalis latifolia	Starflower	Primulaceae
Vitis californica	California grape	Vitaceae

Table 9 Plant Species Observed on Campbell Creek at the McCloud Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
RIPARIAN PLANTS		
Acer circinatum	Vine maple	Aceraceae
Acer macrophyllum	Big leaf maple	Aceraceae
Adenocaulon bicolor	Trailplant	Asteraceae
Adiantum jordanii	California maiden-hair	Pteridaceae
Alnus rhombifolia	White alder	Betulaceae
Aralia californica	California spikenard	Araliaceae
Aruncus dioicus var. pubescens	Goat's beard	Rosaceae
Berberis aquifolium	Oregon grape	Berberidaceae
Brickellia californica	Brickellbush	Asteraceae
Calycanthus occidentalis	Spice bush	Calycanthaceae
Carex nudata	Torrent sedge	Cyperaceae
Ceanothus intergerrimus	Deer brush	Rhamnaceae
Cercis occidentalis	Redbud	Fabaceae
Cercocarpus betuloides	Birchleaf mountain mahogany	Rosaceae
Cirsium vulgare	Bull thistle	Asteraceae
Clematis ligusticifolia	Virgin's bower	Ranunculaceae
Collomia heterophylla	Vari-leaf collomia	Polemoniaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Cornus sericea	Red twig	Cornaceae
Cornus sessilis	Miner's dogwood	Cornaceae
Corylus cornuta	Hazelnut	Betulaceae
Darmera peltata	Umbrella plant	Saxifragaceae
Dicentra formosa	Bleeding heart	Papaveraceae
Elymus glaucus	Blue wild rye	Poaceae
Epilobium canum	California fuchsia	Onagraceae
Epilobium ciliatum	Fireweed	Onagraceae
Erigeron philadelphicus	Fleabane daisy	Asteraceae
Fraxinus latifolia	Oregon ash	Oleaceae
Galium spp.	Bedstraw	Rubiaceae
Hieracium albiflorum	Hawkweed	Asteraceae
Hypericum perforatum	Klamathweed	Hypericaceae
Lathyrus latifolius	Everlasting peavine	Fabaceae
Lonicera hispidula var. vascillans	Hairy honeysuckle	Caprifoliaceae

Table 9 Plant Species Observed on Campbell Creek at the McCloud Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Madia spp.	Tarweed	Asteraceae
Mimulus guttatus	Seep-spring monkey flower	Scrophulariaceae
Neviusia cliftonii	Shasta snow-wreath	Rosaceae
Philadelphis lewisii	Wild mock orange	Philadelphaceae
Physocarpus capitatus	Pacific ninebark	Rosaceae
Polypogon interruptus	Rabbitfoot grass	Poaceae
Populus fremontii	Fremont cottonwood	Salicaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Rhus trilobata	Skunkbrush	Anacardiaceae
Rubus leucodermis	Black cap rasperry	Rosaceae
Rubus parviflorus	Thimbleberry	Rosaceae
Rubus ursinus	California blackberry	Rosaceae
Rumex acetosella	Red sorrel	Polygonaceae
Salix exigua	Narrowleaf willow	Salicaceae
Salix gooddingii	Black willow	Salicaceae
Salix laevigata	Red willow	Salicaceae
Salix lucida	Shining willow	Salicaceae
Sedum spathulifolium	Pacific sedum	Crassulaceae
Smilacina racemosa	False solomon's seal	Liliaceae
Smilax californica	Greenbriar	Liliaceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Tellima grandiflora	Fringe cups	Saxifragaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Urtica dioica	Stinging nettle	Urticaceae
Verbena lasiostachys	Common verbena	Verbenaceae
Viola glabella	Stream violet	Violaceae
Vitis californica	California grape	Vitaceae
Woodwardia fimbriata	Giant chain fern	Blechnaceae
UPLAND PLANTS		
Acer circinatum	Vine maple	Aceraceae
Acer macrophyllum	Big leaf maple	Aceraceae
Adiantum jordanii	California maiden-hair	Pteridaceae
Aesculus californica	California buckeye	Hippocastanaceae
Amelanchier utahensis	Utah serviceberry	Rosaceae
Aristolochia californica	Dutchman's pipe	Aristolochiaceae

Table 9
Plant Species Observed on Campbell Creek at the McCloud Arm of Shasta Lake

Scientific Name	Common Name	Family Name
Asarum hartwegii	Wild ginger	Aristolochiaceae
Berberis aquifolium	Oregon grape	Berberidaceae
Ceanothus intergerrimus	Deer brush	Rhamnaceae
Cercis occidentalis	Redbud	Fabaceae
Cercocarpus betuloides	Birchleaf mountain mahogany	Rosaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Corylus cornuta	Hazelnut	Betulaceae
Cynoglosssum grande	Hound's tongue	Boraginaceae
Dicentra formosa	Bleeding heart	Papaveraceae
Eriophyllum lanatum	Wooly sunflower	Asteraceae
Galium spp.	Bedstraw	Rubiaceae
Hypericum perforatum	Klamathweed	Hypericaceae
Keckiella lemmonii	Lemmon's keckiella	Scrophulariaceae
Lathyrus polyphyllus	Wild pea	Fabaceae
Neviusia cliftonii	Shasta snow-wreath	Rosaceae
Oemlaria cerasiformis	Oso berry	Rosaceae
Physocarpus capitatus	Pacific ninebark	Rosaceae
Pinus attenuata	Knobcone pine	Pinaceae
Pinus ponderosa	Ponderosa pine	Pinaceae
Polystichum munitum	Swordfern	Dryopteridaceae
Potentilla spp.	Cinquefoil	Rosaceae
Prunus subcordata	Klamath plum	Rosaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Pteridium aquilinum var. pubescens	Bracken fern	Dennstaedtiaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Quercus kelloggii	Black oak	Fagaceae
Rhamnus rubra	Sierran coffeeberry	Rhamnaceae
Rhus trilobata	Skunkbrush	Anacardiaceae
Rubus ursinus	California blackberry	Rosaceae
Silene californica	California Indian pink	Caryophyllaceae
Smilax californica	Greenbriar	Liliaceae
Styrax officianalis	Snowdrop bush	Styraceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae

Table 9 Plant Species Observed on Campbell Creek at the McCloud Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Trientalis latifolia	Starflower	Primulaceae
Trillium albidum	Trillium	Liliaceae
Viola lobata	Pine violet	Violaceae
Vitis californica	California grape	Vitaceae

Table 10
Plant Species Observed at the Squaw Creek Arm of Shasta Lake

Scientific Name	Common Name	Family Name
MIXED CHAPARRAL		
Aesculus californica	California buckeye	Hippocastanaceae
Aira caryophyllea	Silver European hairgrass	Poaceae
Anaphalis margaritacea	Pearly everlasting	Asteraceae
Andropogon virginicus var. virginicus	Broomsedge bluestem	Poaceae
Anthoxanthum odoratum	Sweet vernal grass	Poaceae
Antirrhinum vexillo-calyculatum ssp. breweri	Brewer's sail-flower snapdragon	Scrophulariaceae
Arctostaphylos viscida	Whiteleaf manzanita	Ericaceae
Avena fatua	Wild oat	Poaceae
Bromus diandrus	Ripgut grass	Poaceae
Bromus madritensis ssp. rubens	Red brome	Poaceae
Calycadenia truncata	Rosin weed	Asteraceae
Calystegia occidentalis	Western morning glory	Convolvulaceae
Ceanothus cuneatus	Buck brush	Rhamnaceae
Ceanothus integerrimus	Deer brush	Rhamnaceae
Centaurea solstitialis	Yellow star thistle	Asteraceae
Cercis occidentalis	Redbud	Fabaceae
Chlorogalum pomeridianum var. pomeridianum	Soap plant	Liliaceae
Clarkia purpurea	Purple clarkia	Onagraceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Dendromecon rigida	Bush poppy	Papaveraceae
Dichelostemma capitatum ssp. capitatum	Blue dicks	Liliaceae
Dichelostemma ida-mae	Firecracker flower	Liliaceae
Eriodictyon californicum	Yerba Santa	Hydrophyllaceae
Eriogonum nudum	Naked buckwheat	Polygonaceae
Eriophyllum lanatum	Woolly sunflower	Asteraceae
Eschscholzia caespitosa	Foothill poppy	Papaveraceae
Galium porrigens	Climbing bedstraw	Rubiaceae
Gastridium ventricosum	Nit grass	Poaceae
Gilia capitata	Globe gilia	Polemoniaceae
Heteromeles arbutifolia	Toyon	Rosaceae
Hieracium albiflorum	White-flowered hawkweed	Asteraceae
Hypericum perforatum	Klamathweed	Hypericaceae
Keckiella lemmonii	Lemmon's keckiella	Scrophulariaceae

Table 10 Plant Species Observed at the Squaw Creek Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Lamium amplexicaule	Giraffehead	Lamiaceae
Lonicera interrupta	Chaparral honeysuckle	Caprifoliaceae
Lotus denticulatus	Toothed lotus	Fabaceae
Lotus purshianus var. purshianus	Spanish lotus	Fabaceae
Lupinus albifrons	Silver bush lupine	Fabaceae
Lupinus bicolor	Bi-colored lupine	Fabaceae
Marah watsonii	Watson's wild-cucumber	Cucurbitaceae
Pellaea mucronata var. mucronata	Bird's-foot fern	Pteridaceae
Phacelia hastata	Silverleaf phacelia	Hydrophyllaceae
Pinus sabiniana	Gray pine	Pinaceae
Quercus berberidifolia	Scrub oak	Fagaceae
Rhamnus rubra	Sierra coffeeberry	Rhamnaceae
Rhamnus tomentella ssp. tomentella	Hoary coffeeberry	Rhamnaceae
Rhus trilobata	Skunkbrush	Anacardiaceae
Sanicula bipinnatifida	Purple sanicle	Apiaceae
Scutellaria siphocampyloides	Skullcap	Lamiaceae
Solanum parishii	Parish's nightshade	Solanaceae
Streptanthus tortuosus	Mountain jewelflower	Brassicaceae
Styrax officinalis var. redivivus	Snowdrop bush	Styracaceae
Swertia albicaulis var. nitida	White-stemmed swertia	Gentianaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trifolium hirtum	Rose clover	Fabaceae
Verbascum thapsus	Woolly mullein	Scrophulariaceae
MONTANE HARDWOOD - CONIFER and SIERRAN MIXED CONIFER		
Acer macrophyllum	Bigleaf maple	Aceraceae
Achillea millefolium	Yarrow	Asteraceae
Achnatherum occidentale	Needle grass	Poaceae
Adiantum capillus-veneris	Southern maiden-hair	Pteridaceae
Aesculus californica	California buckeye	Hippocastanaceae
Agoseris glauca	Mountain dandelion	Asteraceae
Aira caryophyllea	Silver European hairgrass	Poaceae
Alnus rhombifolia	White alder	Betulaceae
Anaphalis margaritacea	Pearly everlasting	Asteraceae
Antirrhinum vexillo-calyculatum ssp. breweri	Brewer's sail-flower snapdragon	Scrophulariaceae
Aquilegia formosa	Crimson columbine	Ranunculaceae

Table 10 **Plant Species Observed at the Squaw Creek Arm of Shasta Lake**		
Scientific Name	**Common Name**	**Family Name**
Arbutus menziesii	Pacific madrone	Ericaceae
Arctostaphylos viscida	Whiteleaf manzanita	Ericaceae
Aristolochia californica	Pipevine	Aristolochiaceae
Artemisia douglasiana	Mugwort	Asteraceae
Asarum hartwegii	Wild-ginger	Aristolochiaceae
Avena fatua	Wild oat	Poaceae
Berberis aquifolium var. aquifolium	Oregon grape	Berberidaceae
Bromus carinatus	California brome	Poaceae
Bromus diandrus	Ripgut grass	Poaceae
Bromus laevipes	Woodland brome	Poaceae
Calocedrus decurrens	Incense cedar	Cupressaceae
Calycadenia truncata	Rosin weed	Asteraceae
Calycanthus occidentalis	Spicebush	Calycanthaceae
Calystegia occidentalis ssp. occidentalis	Western morning glory	Convolvulaceae
Carex deweyana var. leptopoda	Short-scaled sedge	Cyperaceae
Castilleja applegatei	Wavy-leaved Indian paintbrush	Scrophulariaceae
Ceanothus integerrimus	Deer brush	Rhamnaceae
Centaurea solstitialis	Yellow star thistle	Asteraceae
Centaurium venustum	Canchalagua	Gentianaceae
Cercis occidentalis	Redbud	Fabaceae
Cirsium sp.	Thistle	Asteraceae
Claytonia rubra ssp. rubra	Red-stemmed miner’s lettuce	Portulacaceae
Clematis ligusticifolia	Virgin’s bower	Ranunculaceae
Conyza canadensis	Horseweed	Asteraceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Cornus sericea	American dogwood	Cornaceae
Corylus cornuta var. californica	Hazelnut	Betulaceae
Cynoglossum grande	Hound’s tongue	Boraginaceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Cyperus squarrosus	Umbrella sedge	Cyperaceae
Delphinium nudicaule	Red larkspur	Ranunculaceae
Dichelostemma capitatum ssp. capitatum	Blue dicks	Liliaceae
Disporum hookeri	Hooker’s fairybells	Liliaceae
Elymus glaucus	Blue wild rye	Poaceae
Equisetum arvense	Common horsetail	Equisetaceae

Table 10 Plant Species Observed at the Squaw Creek Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Eremocarpus setigerus	Dove weed	Euphorbiaceae
Eriophyllum lanatum	Woolly sunflower	Asteraceae
Fraxinus dipetala	California ash	Oleaceae
Fraxinus latifolia	Oregon ash	Oleaceae
Galium bolanderi	Bolander's bedstraw	Rubiaceae
Galium triflorum	Sweet-scented bedstraw	Rubiaceae
Gastridium ventricosum	Nit grass	Poaceae
Gnaphalium sp.	Cudweed	Asteraceae
Hieracium albiflorum	White-flowered hawkweed	Asteraceae
Hypericum perforatum	Klamathweed	Hypericaceae
Hypochaeris radicata	Rough cat's ears	Asteraceae
Iris tenuissima	Slender iris	Iridaceae
Lactuca serriola	Prickly lettuce	Asteraceae
Lathyrus sulphureus	Sulfur pea	Fabaceae
Lepidium densiflorum var. pubicarpum	Hairy peppergrass	Brassicaceae
Lonicera hispidula var. vacillans	Hairy honeysuckle	Caprifoliaceae
Lotus humistratus	Foothill lotus	Fabaceae
Lotus purshianus var. purshianus	Spanish lotus	Fabaceae
Lupinus albifrons	Silver bush lupine	Fabaceae
Lupinus bicolor	Bicolored lupine	Fabaceae
Luzula comosa	Common wood rush	Juncaceae
Melica californica	California melic	Poaceae
Mimulus kelloggii	Kellogg's monkeyflower	Scrophulariaceae
Monardella odoratissima	Mountain monardella	Lamiaceae
Nemophila heterophylla	Variable-leaved nemophila	Hydrophyllaceae
Osmorhiza occidentalis	Sierran sweet-cicely	Apiaceae
Panicum acuminatum var. acuminatum	Panicgrass	Poaceae
Pentagramma triangularis ssp. triangularis	Goldback fern	Pteridaceae
Phacelia heterophylla	Phacelia	Hydrophyllaceae
Philadelphus lewisii	Wild mock orange	Philadelphaceae
Pinus lambertiana	Sugar pine	Pinaceae
Pinus ponderosa	Ponderosa pine	Pinaceae
Pinus sabiniana	Gray pine	Pinaceae
Piperia elongata	Dense-flowered rein orchid	Orchidaceae
Poa annua	Annual bluegrass	Poaceae

Table 10 Plant Species Observed at the Squaw Creek Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Polemonium micranthum	Annual sky pilot	Polemoniaceae
Polypogon maritimus	Mediterranean beard grass	Poaceae
Polystichum imbricans	Narrow-leaved sword fern	Dryopteridaceae
Prunella vulgaris	Self-heal	Lamiaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Pteridium aquilinum var. pubescens	Western bracken fern	Dennstaedtiaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Quercus garryana var. garryana	Oregon oak	Fagaceae
Quercus kelloggii	Black oak	Fagaceae
Quercus wislizenii	Interior live oak	Fagaceae
Rhus trilobata	Skunkbrush	Anacardiaceae
Ribes roezlii	Sierra gooseberry	Grossulariaceae
Rosa gymnocarpa	Wood rose	Rosaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Rubus parviflorus	Thimbleberry	Rosaceae
Sanicula bipinnatifida	Purple sanicle	Apiaceae
Scutellaria antirrhinoides	Snapdragon skullcap	Lamiaceae
Sedum spathulifolium	Pacific stonecrop	Crassulaceae
Silene californica	Indian pink	Caryophyllaceae
Smilax californica	Greenbriar	Liliaceae
Styrax officinalis var. redivivus	Snowdrop bush	Styracaceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Tellima grandiflora	Fringe cups	Saxifragaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trientalis latifolia	Starflower	Primulaceae
Trifolium hirtum	Rose clover	Fabaceae
Trifolium microcephalum	Small-headed clover	Fabaceae
Verbascum blattaria	Moth mullein	Scrophulariaceae
Verbascum thapsus	Woolly mullein	Scrophulariaceae
Viola glabella	Stream violet	Violaceae
Vitis californica	Wild grape	Vitaceae
Woodwardia fimbriata	Giant chain fern	Blechnaceae
MONTANE HARDWOOD		
Acer macrophyllum	Bigleaf maple	Aceraceae

Table 10 Plant Species Observed at the Squaw Creek Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Achillea millefolium	Yarrow	Asteraceae
Adiantum capillus-veneris	Southern maiden-hair	Pteridaceae
Aesculus californica	California buckeye	Hippocastanaceae
Aira caryophyllea	Silver European hairgrass	Poaceae
Amelanchier utahensis	Utah service-berry	Rosaceae
Anaphalis margaritacea	Pearly everlasting	Asteraceae
Anthoxanthum odoratum	Sweet vernal grass	Poaceae
Antirrhinum vexillo-calyculatum ssp. breweri	Brewer’s sail-flower snapdragon	Scrophulariaceae
Arbutus menziesii	Pacific madrone	Ericaceae
Aristolochia californica	Pipevine	Aristolochiaceae
Artemisia douglasiana	Mugwort	Asteraceae
Avena fatua	Wild oat	Poaceae
Bromus diandrus	Ripgut grass	Poaceae
Bromus hordeaceus	Softchess	Poaceae
Calycanthus occidentalis	Spicebush	Calycanthaceae
Ceanothus integerrimus	Deer brush	Rhamnaceae
Cercis occidentalis	Redbud	Fabaceae
Cercocarpus betuloides var. betuloides	Birch-leaf mountain-mahogany	Rosaceae
Claytonia rubra ssp. rubra	Red-stemmed miner’s lettuce	Portulacaceae
Cornus sericea	American dogwood	Cornaceae
Corylus cornuta var. californica	Hazelnut	Betulaceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Datura stramonium	Jimson weed	Solanaceae
Dichelostemma capitatum ssp. capitatum	Blue dicks	Liliaceae
Echinochloa crus-galli	Barnyard grass	Poaceae
Elymus glaucus	Blue wild rye	Poaceae
Eremocarpus setigerus	Dove weed	Euphorbiaceae
Fraxinus latifolia	Oregon ash	Oleaceae
Galium bolanderi	Bolander’s bedstraw	Rubiaceae
Helianthella californica	California helianthella	Asteraceae
Hieracium albiflorum	White-flowered hawkweed	Asteraceae
Hypericum perforatum	Klamathweed	Hypericaceae
Iris tenuissima	Slender iris	Iridaceae
Keckiella lemmonii	Lemmon’s keckiella	Scrophulariaceae
Lamium amplexicaule	Giraffehead	Lamiaceae

Table 10
Plant Species Observed at the Squaw Creek Arm of Shasta Lake

Scientific Name	Common Name	Family Name
Lathyrus sulphureus	Sulfur pea	Fabaceae
Lomatium utriculatum	Common lomatium	Apiaceae
Lonicera hispidula var. vacillans	Hairy honeysuckle	Caprifoliaceae
Lotus humistratus	Foothill lotus	Fabaceae
Lupinus albifrons	Silver bush lupine	Fabaceae
Lupinus bicolor	Bicolored lupine	Fabaceae
Luzula comosa	Common wood rush	Juncaceae
Melica californica	California melic	Poaceae
Pellaea mucronata var. mucronata	Bird's-foot fern	Pteridaceae
Pentagramma triangularis ssp. triangularis	Goldback fern	Pteridaceae
Philadelphus lewisii	Wild mock orange	Philadelphaceae
Phoradendron villosum	Oak mistletoe	Viscaceae
Physocarpus capitatus	Ninebark	Rosaceae
Pinus lambertiana	Sugar pine	Pinaceae
Pinus ponderosa	Ponderosa pine	Pinaceae
Pinus sabiniana	Gray pine	Pinaceae
Polystichum imbricans	Narrow-leaved sword fern	Dryopteridaceae
Potentilla glandulosa	Common cinquefoil	Rosaceae
Prunus virginiana var. demissa	Western choke-cherry	Rosaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Quercus garryana var. garryana	Oregon oak	Fagaceae
Quercus kelloggii	Black oak	Fagaceae
Quercus wislizenii	Interior live oak	Fagaceae
Rhamnus rubra	Sierra coffeeberry	Rhamnaceae
Rhododendron occidentale	Western azalea	Ericaceae
Rhus trilobata	Skunkbrush	Anacardiaceae
Ribes roezlii	Sierra gooseberry	Grossulariaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Rubus ursinus	California blackberry	Rosaceae
Salix laevigata	Red willow	Salicaceae
Salvia sonomensis	Creeping sage	Lamiaceae
Sanicula bipinnatifida	Purple sanicle	Apiaceae
Scutellaria antirrhinoides	Snapdragon skullcap	Lamiaceae
Styrax officinalis var. redivivus	Snowdrop bush	Styracaceae

Table 10 Plant Species Observed at the Squaw Creek Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Swertia albicaulis var. nitida	White-stemmed swertia	Gentianaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trientalis latifolia	Starflower	Primulaceae
Trifolium hirtum	Rose clover	Fabaceae
Verbascum thapsus	Woolly mullein	Scrophulariaceae
Vitis californica	Wild grape	Vitaceae
Vulpia myuros	Rattail fescue	Poaceae
Woodwardia fimbriata	Giant chain fern	Blechnaceae
MONTANE RIPARIAN		
Acer macrophyllum	Bigleaf maple	Aceraceae
Adiantum capillus-veneris	Southern maiden-hair	Pteridaceae
Alnus rhombifolia	White alder	Betulaceae
Andropogon virginicus var. virginicus	Broomsedge bluestem	Poaceae
Arabis glabra var. glabra	Smooth rock cress	Brassicaceae
Aristolochia californica	Pipevine	Aristolochiaceae
Artemisia douglasiana	Mugwort	Asteraceae
Aruncus dioicus var. pubescens	Goat's beard	Rosaceae
Asclepias fascicularis	Narrow-leaved milkweed	Asclepiadaceae
Avena fatua	Wild oat	Poaceae
Bromus carinatus	California brome	Poaceae
Calycanthus occidentalis	Spicebush	Calycanthaceae
Carex barbarae	Santa Barbara sedge	Cyperaceae
Carex deweyana var. leptopoda	Short-scaled sedge	Cyperaceae
Carex feta	Greensheath sedge	Cyperaceae
Carex nudata	Torrent sedge	Cyperaceae
Centaurium venustum	Canchalagua	Gentianaceae
Cephalanthus occidentalis var. californicus	California button willow	Rubiaceae
Claytonia rubra ssp. rubra	Red-stemmed miner's lettuce	Portulacaceae
Clematis ligusticifolia	Virgin's bower	Ranunculaceae
Collomia heterophylla	Variableleaf collomia	Polemoniaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Corylus cornuta var. californica	Hazelnut	Betulaceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Cyperus squarrosus	Umbrella sedge	Cyperaceae

Table 10 Plant Species Observed at the Squaw Creek Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Darmera peltata	Indian rhubarb	Saxifragaceae
Datisca glomerata	Durango root	Datiscaceae
Delphinium nudicaule	Red larkspur	Ranunculaceae
Deschampsia cespitosa	Tufted hairgrass	Poaceae
Elymus glaucus	Blue wild rye	Poaceae
Equisetum arvense	Common horsetail	Equisetaceae
Erigeron philadelphicus	Philadelphia fleabane	Asteraceae
Ficus carica	Edible fig	Moraceae
Fraxinus latifolia	Oregon ash	Oleaceae
Heuchera micrantha	Crevice alumroot	Saxifragaceae
Holcus lanatus	Velvet grass	Poaceae
Hypericum perforatum	Klamathweed	Hypericaceae
Juncus effusus	Common rush	Juncaceae
Juncus ensifolius	Sword-leaved rush	Juncaceae
Juncus tenuis	Slender rush	Juncaceae
Juncus sp.	Rush	Juncaceae
Lactuca serriola	Prickly lettuce	Asteraceae
Mimulus guttatus	Common monkeyflower	Scrophulariaceae
Nemophila heterophylla	Variable-leaved nemophila	Hydrophyllaceae
Panicum acuminatum var. acuminatum	Panicgrass	Poaceae
Pellaea mucronata var. mucronata	Bird’s-foot fern	Pteridaceae
Penstemon azureus var. azureus	Azure beardtongue	Scrophulariaceae
Petrorhagia dubia	Windmill pink	Caryophyllaceae
Plantago lanceolata	English plantain	Plantaginaceae
Polygonum lapathifolium	Willow weed	Polygonaceae
Polystichum imbricans	Narrowleaf sword fern	Dryopteridaceae
Populus fremontii ssp. fremontii	Fremont cottonwood	Salicaceae
Pycnanthemum californicum	Mountain mint	Lamiaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Rhus trilobata	Skunkbrush	Anacardiaceae
Ribes divaricatum	Gooseberry	Grossulariaceae
Rosa californica	California rose	Rosaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Rubus leucodermis	Western raspberry	Rosaceae
Rubus ursinus	California blackberry	Rosaceae

Table 10 Plant Species Observed at the Squaw Creek Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Rumex crispus	Curly dock	Polygonaceae
Salix exigua	Narrow-leaved willow	Salicaceae
Salix laevigata	Red willow	Salicaceae
Salix lucida	Shining willow	Salicaceae
Sedum spathulifolium	Pacific stonecrop	Crassulaceae
Smilax californica	Greenbriar	Liliaceae
Stachys ajugoides	Hedge nettle	Lamiaceae
Tellima grandiflora	Fringe cups	Saxifragaceae
Torilis arvensis	False hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trifolium hirtum	Rose clover	Fabaceae
Trifolium variegatum	White-tipped clover	Fabaceae
Triteleia hyacinthina	White brodiaea	Liliaceae
Typha latifolia	Broad-leaved cattail	Typhaceae
Umbellularia californica	California bay	Lauraceae
Verbascum thapsus	Woolly mullein	Scrophulariaceae
Verbena lasiostachys	Common verbena	Verbenaceae
Viola glabella	Stream violet	Violaceae
Vitis californica	Wild grape	Vitaceae
Vulpia myuros	Rattail fescue	Poaceae
Woodwardia fimbriata	Giant chain fern	Blechnaceae
Xanthium strumarium	Cocklebur	Asteraceae
Zigadenus venenosus var. venenosus	Death camas	Liliaceae
PONDEROSA PINE		
Achillea millefolium	Yarrow	Asteraceae
Adenocaulon bicolor	Trail plant	Asteraceae
Adiantum capillus-veneris	Southern maiden-hair	Pteridaceae
Aira caryophyllea	Silver European hairgrass	Poaceae
Anaphalis margaritacea	Pearly everlasting	Asteraceae
Arbutus menziesii	Pacific madrone	Ericaceae
Arctostaphylos viscida	Whiteleaf manzanita	Ericaceae
Aristolochia californica	Pipevine	Aristolochiaceae
Artemisia douglasiana	Mugwort	Asteraceae
Avena fatua	Wild oat	Poaceae
Bromus carinatus	California brome	Poaceae

Table 10 Plant Species Observed at the Squaw Creek Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Bromus diandrus	Ripgut brome	Poaceae
Bromus madritensis ssp. rubens	Red brome	Poaceae
Bromus tectorum	Cheatgrass	Poaceae
Calocedrus decurrens	Incense cedar	Cupressaceae
Ceanothus integerrimus	Deer brush	Rhamnaceae
Chlorogalum pomeridianum var. pomeridianum	Soap plant	Liliaceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Dichelostemma capitatum ssp. capitatum	Blue dicks	Liliaceae
Elymus elymoides	Squirreltail	Poaceae
Elymus glaucus	Blue wild rye	Poaceae
Eriophyllum lanatum	Woolly sunflower	Asteraceae
Fraxinus latifolia	Oregon ash	Oleaceae
Galium bolanderi	Bolander’s bedstraw	Rubiaceae
Gastridium ventricosum	Nit grass	Poaceae
Gnaphalium sp.	Cudweed	Asteraceae
Hieracium albiflorum	White-flowered hawkweed	Asteraceae
Hypericum perforatum	Klamathweed	Hypericaceae
Hypochaeris radicata	Rough cat’s ears	Asteraceae
Iris tenuissima	Slender iris	Iridaceae
Keckiella lemmonii	Lemmon’s keckiella	Scrophulariaceae
Lathyrus sulphureus	Sulfur pea	Fabaceae
Lonicera hispidula var. vacillans	Hairy honeysuckle	Caprifoliaceae
Lotus purshianus var. purshianus	Spanish lotus	Fabaceae
Luzula comosa	Common wood rush	Juncaceae
Osmorhiza occidentalis	Sierran sweet-cicely	Apiaceae
Petrorhagia dubia	Windmill pink	Caryophyllaceae
Pinus ponderosa	Ponderosa pine	Pinaceae
Pinus sabiniana	Gray pine	Pinaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Pteridium aquilinum var. pubescens	Western bracken fern	Dennstaedtiaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Quercus kelloggii	Black oak	Fagaceae
Quercus wislizenii	Interior live oak	Fagaceae
Rhus trilobata	Skunkbrush	Anacardiaceae
Rosa californica	California rose	Rosaceae

Table 10 Plant Species Observed at the Squaw Creek Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Rosa gymnocarpa	Wood rose	Rosaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Salvia sonomensis	Creepng sage	Lamiaceae
Sanicula bipinnatifida	Purple sanicle	Apiaceae
Scutellaria tuberosa	Common skullcap	Lamiaceae
Styrax officinalis var. redivivus	Snowdrop bush	Styracaceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trientalis latifolia	Starflower	Primulaceae
Verbascum thapsus	Woolly mullein	Scrophulariaceae
Vitis californica	Wild grape	Vitaceae
BLUE OAK - GRAY PINE		
Achillea millefolium	Yarrow	Asteraceae
Aira caryophyllea	Silver European hairgrass	Poaceae
Allium amplectens	Narrow-leaved onion	Liliaceae
Anaphalis margaritacea	Pearly everlasting	Asteraceae
Anthoxanthum odoratum	Sweet vernal grass	Poaceae
Arctostaphylos viscida	Whiteleaf manzanita	Ericaceae
Avena fatua	Wild oat	Poaceae
Bromus hordeaceus	Softchess	Poaceae
Calycadenia truncata	Rosin weed	Asteraceae
Cercocarpus betuloides var. betuloides	Birch-leaf mountain-mahogany	Rosaceae
Chlorogalum pomeridianum var. pomeridianum	Soap plant	Liliaceae
Conyza canadensis	Horseweed	Asteraceae
Daucus pusillus	Rattlesnake weed	Apiaceae
Dichelostemma capitatum ssp. capitatum	Blue dicks	Liliaceae
Elymus elymoides	Squirreltail	Poaceae
Eremocarpus setigerus	Dove weed	Euphorbiaceae
Eriodictyon californicum	Yerba Santa	Hydrophyllaceae
Eriophyllum lanatum	Woolly sunflower	Asteraceae
Eschscholzia caespitosa	Foothill poppy	Papaveraceae
Gastridium ventricosum	Nit grass	Poaceae
Gilia tricolor	Bird's eyes	Polemoniaceae
Grindelia nana	Idaho gumweed	Asteraceae

Table 10 Plant Species Observed at the Squaw Creek Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Helianthella californica	California helianthella	Asteraceae
Hypochaeris radicata	Rough cat's ears	Asteraceae
Lactuca serriola	Prickly lettuce	Asteraceae
Lotus humistratus	Foothill lotus	Fabaceae
Lupinus bicolor	Bi-colored lupine	Fabaceae
Micropus californicus	Slender cottonweed	Asteraceae
Petrorhagia dubia	Windmill pink	Caryophyllaceae
Pinus sabiniana	Gray pine	Pinaceae
Quercus berberidifolia	Scrub oak	Fagaceae
Quercus douglasii	Blue oak	Fagaceae
Quercus wislizenii	Interior live oak	Fagaceae
Streptanthus tortuosus	Mountain jewelflower	Brassicaceae
Swertia albicaulis var. nitida	White-stemmed swertia	Gentianaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
CLOSED-CONE PINE-CYPRESS		
Aira caryophyllea	Silver European hairgrass	Poaceae
Anaphalis margaritacea	Pearly everlasting	Asteraceae
Anthoxanthum odoratum	Sweet vernal grass	Poaceae
Antirrhinum vexillo-calyculatum ssp. breweri	Brewer's sail-flower snapdragon	Scrophulariaceae
Arbutus menziesii	Pacific madrone	Ericaceae
Arctostaphylos viscida	Whiteleaf manzanita	Ericaceae
Avena fatua	Wild oat	Poaceae
Bromus diandrus	Ripgut grass	Poaceae
Bromus hordeaceus	Softchess	Poaceae
Bromus madritensis ssp. rubens	Red brome	Poaceae
Bromus tectorum	Cheatgrass	Poaceae
Calycadenia fremontii	Fremont's calycadenia	Asteraceae
Calycadenia truncata	Rosin weed	Asteraceae
Castilleja applegatei	Wavy-leaved Indian paintbrush	Scrophulariaceae
Ceanothus cuneatus	Buck brush	Rhamnaceae
Ceanothus integerrimus	Deer brush	Rhamnaceae
Ceanothus lemmonii	Lemmon's ceanothus	Rhamnaceae
Centaurea solstitialis	Yellow star thistle	Asteraceae
Cercis occidentalis	Redbud	Fabaceae

Table 10 Plant Species Observed at the Squaw Creek Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Cercocarpus betuloides var. betuloides	Birch-leaf mountain-mahogany	Rosaceae
Chlorogalum pomeridianum var. pomeridianum	Soap plant	Liliaceae
Collomia heterophylla	Variableleaf collomia	Polemoniaceae
Conyza canadensis	Horseweed	Asteraceae
Datura stramonium	Jimson weed	Solanaceae
Daucus pusillus	Rattlesnake weed	Apiaceae
Dendromecon rigida	Bush poppy	Papaveraceae
Dichelostemma capitatum ssp. capitatum	Blue dicks	Liliaceae
Elymus elymoides	Squirreltail	Poaceae
Elymus glaucus	Blue wild rye	Poaceae
Eremocarpus setigerus	Dove weed	Euphorbiaceae
Eriodictyon californicum	Yerba Santa	Hydrophyllaceae
Eriophyllum lanatum	Woolly sunflower	Asteraceae
Galium porrigens	Climbing bedstraw	Rubiaceae
Gastridium ventricosum	Nit grass	Poaceae
Gnaphalium sp.	Cudweed	Asteraceae
Hieracium albiflorum	White-flowered hawkweed	Asteraceae
Hypericum perforatum	Klamathweed	Hypericaceae
Hypochaeris radicata	Rough cat's ears	Asteraceae
Iris tenuissima	Slender iris	Iridaceae
Keckiella lemmonii	Lemmon's keckiella	Scrophulariaceae
Lamium amplexicaule	Giraffehead	Lamiaceae
Lonicera interrupta	Chaparral honeysuckle	Caprifoliaceae
Lotus purshianus var. purshianus	Spanish lotus	Fabaceae
Luzula comosa	Common wood rush	Juncaceae
Mimulus kelloggii	Kellogg's monkeyflower	Scrophulariaceae
Panicum acuminatum var. acuminatum	Panicgrass	Poaceae
Pellaea mucronata var. mucronata	Bird's-foot fern	Pteridaceae
Petrorhagia dubia	Windmill pink	Caryophyllaceae
Phalaris arundinacea	Reed canary grass	Poaceae
Pinus attenuata	Knobcone pine	Pinaceae
Pinus ponderosa	Ponderosa pine	Pinaceae
Pinus sabiniana	Gray pine	Pinaceae
Plantago lanceolata	English plantain	Plantaginaceae
Quercus berberidifolia	Scrub oak	Fagaceae

Table 10 Plant Species Observed at the Squaw Creek Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Quercus kelloggii	Black oak	Fagaceae
Quercus wislizenii	Interior live oak	Fagaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Salix laevigata	Red willow	Salicaceae
Salvia sonomensis	Creepng sage	Lamiaceae
Scutellaria tuberosa	Common skullcap	Lamiaceae
Streptanthus tortuosus	Mountain jewelflower	Brassicaceae
Styrax officinalis var. redivivus	Snowdrop bush	Styracaceae
Swertia albicaulis var. nitida	White-stemmed swertia	Gentianaceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Tragopogon dubius	Western salsify	Asteraceae
Trifolium hirtum	Rose clover	Fabaceae
Verbascum thapsus	Woolly mullein	Scrophulariaceae
Vulpia myuros	Rattail fescue	Poaceae
Xanthium strumarium	Cocklebur	Asteraceae

Table 11 Plant Species Observed on Flat Creek at the Pit River Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
RIPARIAN PLANTS		
Acer circinatum	Vine maple	Aceraceae
Acer macrophyllum	Big leaf maple	Aceraceae
Adenocaulon bicolor	Trailplant	Asteraceae
Alnus rhombifolia	White alder	Betulaceae
Amelanchier utahensis	Utah serviceberry	Rosaceae
Aquilegia formosa	Columbine	Ranunculaceae
Aralia californica	California spikenard	Araliaceae
Artemesia douglasiana	Mugwort	Asteraceae
Brickellia californica	Brickellbush	Asteraceae
Bromus diandrus	Ripgut	Poaceae
Calycanthus occidentalis	Spice bush	Calycanthaceae
Collinsia tinctoria	Sticky chinese houses	Scrophulariaceae
Collomia heterophylla	Vari-leaf collomia	Polemoniaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Corylus cornuta	Hazelnut	Betulaceae
Crataegus douglasii	Black Hawthorn	Rosaceae
Darmera peltata	Umbrella plant	Saxifragaceae
Erigeron philadelphicus	Fleabane daisy	Asteraceae
Fraxinus latifolia	Oregon ash	Oleaceae
Galium spp.	Bedstraw	Rubiaceae
Heuchera micrantha	Crevice heuchera	Saxifragaceae
Hypericum perforatum	Klamathweed	Hypericaceae
Lilium pardalinum ssp. pardalinum	Leopard lily	Liliaceae
Lonicera hispidula var. vacillans	Honeysuckle	Caprifoliaceae
Madia spp.	Tarweed	Asteraceae
Melissa officinalis	Melissa	Lamiaceae
Mimulus cardinalis	Scarlet monkey flower	Scrophulariaceae
Mimulus guttatus	Seep-spring monkey flower	Scrophulariaceae
Osmorhiza chilensis	Mountain sweet-cicely	Apiaceae
Philadelphis lewisii	Wild mock orange	Rosaceae
Physocarpus capitatus	Pacific ninebark	Rosaceae
Potentilla spp.	Cinquefoil	Rosaceae
Prunella vulgaris	Self-heal	Lamiaceae

Table 11 Plant Species Observed on Flat Creek at the Pit River Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Rhamnus purshiana	Cascara	Rhamnaceae
Rosa gymnocarpa	Wood rose	Rosaceae
Rubus ursinus	California blackberry	Rosaceae
Salix laevigata	Red willow	Salicaceae
Sedum spathulifolium	Pacific sedum	Crassulaceae
Smilax californica	Greenbriar	Liliaceae
Styrax officianalis	Snowdrop bush	Styraceae
Symphoricarpus albus var. laevigatus	Snowberry	Caprifoliaceae
Taxus brevifolia	Pacific yew	Taxaceae
Tellima grandiflora	Fringe cups	Saxifragaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Verbena lasiostachys	Common verbena	Verbenaceae
Vitis californica	California grape	Vitaceae
Woodwardia fimbriata	Giant chain fern	Blechnaceae
UPLAND PLANTS		
Acer macrophyllum	Big leaf maple	Aceraceae
Adiantum jordanii	California maiden-hair	Pteridaceae
Aesculus californica	California buckeye	Hippocastanaceae
Amelanchier utahensis	Utah serviceberry	Rosaceae
Aristolochia californica	Dutchman's pipe	Aristolochiaceae
Athyrium filix-femina	Lady fern	Dryopteridaceae
Ceanothus integerrimus	Deer brush	Rhamnaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Lonicera hispidula var. vacillans	Honeysuckle	Caprifoliaceae
Osmorhiza chilensis	Mountain sweet-cicely	Apiaceae
Polystichum munitum	Sword fern	Dryopteridaceae
Prunus subcordata	Klamath plum	Rosaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Quercus kelloggii	Black oak	Fagaceae
Ribes roezlii	Sierra gooseberry	Grossulariaceae
Rubus parviflorus	Thimbleberry	Rosaceae

Table 11 Plant Species Observed on Flat Creek at the Pit River Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Rubus ursinus	California blackberry	Rosaceae
Smilax californica	Greenbriar	Liliaceae
Styrax officianalis	Snowdrop bush	Styraceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Viola lobata	Pine violet	Violaceae
Vitis californica	California grape	Vitaceae

Table 12
Plant Species Observed on Ripgut Creek at the Pit River Arm of Shasta Lake

Scientific Name	Common Name	Family Name
RIPARIAN PLANTS		
Acer circinatum	Vine maple	Aceraceae
Acer macrophyllum	Big leaf maple	Aceraceae
Alnus rhombifolia	White alder	Betulaceae
Aquilegia formosa	Columbine	Ranunculaceae
Aralia californica	California spikenard	Araliaceae
Aristolochia californica	Dutchman's pipe	Aristolochiaceae
Artemesia douglasiana	Mugwort	Asteraceae
Aruncus dioicus var. pubescens	Goat's beard	Rosaceae
Bromus diandrus	Ripgut	Poaceae
Calycanthus occidentalis	Spice bush	Calycanthaceae
Carex nudata	Torrent sedge	Cyperaceae
Collinsia tinctoria	Sticky chinese houses	Scrophulariaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Corylus cornuta	Hazelnut	Betulaceae
Crataegus douglasii	Black Hawthorn	Rosaceae
Darmera peltata	Umbrella plant	Saxifragaceae
Datisca glomerata	Durango root	Datiscaceae
Epilobium ciliatum	Fireweed	Onagraceae
Erigeron philadelphicus	Fleabane daisy	Asteraceae
Erodium cicutarium	Storksbill	Geraniaceae
Fraxinus latifolia	Oregon ash	Oleaceae
Heuchera micrantha	Crevice heuchera	Saxifragaceae
Hypericum perforatum	Klamathweed	Hypericaceae
Lilium pardalinum ssp. pardalinum	Leopard lily	Liliaceae
Madia spp.	Tarweed	Asteraceae
Melissa officinalis	Melissa	Lamiaceae
Mimulus guttatus	Seep-spring monkey flower	Scrophulariaceae
Montia parviflora	Little-leaf montia	Portulaceae
Perideridia gairdneri	Yampah	Apiaceae
Philadelphis lewisii	Wild mock orange	Philadelphaceae
Physocarpus capitatus	Pacific ninebark	Rosaceae
Potentilla spp.	Cinquefoil	Rosaceae
Prunella vulgaris	Self-heal	Lamiaceae

Table 12 Plant Species Observed on Ripgut Creek at the Pit River Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Ribes roezlii	Sierra gooseberry	Grossulariaceae
Rubus parviflorus	Thimbleberry	Rosaceae
Rubus ursinus	California blackberry	Rosaceae
Salix laevigata	Red willow	Salicaceae
Sedum spathulifolium	Pacific sedum	Crassulaceae
Smilax californica	Greenbriar	Liliaceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Tellima grandiflora	Fringe cups	Saxifragaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Triteleia hyacinthina	White brodiaea	Liliaceae
UPLAND PLANTS		
Adiantum jordanii	California maiden-hair	Pteridaceae
Aesculus californica	California buckeye	Hippocastanaceae
Aristolochia californica	Dutchman's pipe	Aristolochiaceae
Asarum hartwegii	Wild ginger	Aristolochiaceae
Athyrium filix-femina	Lady fern	Dryopteridaceae
Calocedrus decurrens	Incense cedar	Cupressaceae
Cercis occidentalis	Redbud	Fabaceae
Corylus cornuta	Hazelnut	Betulaceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Elymus glaucus	Blue wild rye	Poaceae
Galium spp.	Bedstraw	Rubiaceae
Lonicera hispidula var. vascillans	Hairy honeysuckle	Caprifoliaceae
Neviusia cliftonii	Shasta snow-wreath	Rosaceae
Osmorhiza chilensis	Sierran sweet-cicely	Apiaceae
Philadelphis lewisii	Wild mock orange	Philadelphaceae
Physocarpus capitatus	Pacific ninebark	Rosaceae
Polystichum munitum	Swordfern	Dryopteridaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Pteridium aquilinum var. pubescens	Bracken fern	Dennstaedtiaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Rhus trilobata	Skunkbrush	Anacardiaceae
Rosa gymnocarpa	Wood rose	Rosaceae
Silene californica	California Indian pink	Caryophyllaceae
Smilax californica	Greenbriar	Liliaceae

Table 12 Plant Species Observed on Ripgut Creek at the Pit River Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Styrax officianalis	Snowdrop bush	Styraceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Tellima grandiflora	Fringe cups	Saxifragaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trientalis latifolia	Starflower	Primulaceae
Trillium albidum	Trillium	Liliaceae
Viola lobata	Pine violet	Violaceae
Vitis californica	California grape	Vitaceae

Table 13 Plant Species Observed on Potem Creek at the Pit River Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
RIPARIAN PLANTS		
Acer circinatum	Vine maple	Aceraceae
Acer macrophyllum	Big leaf maple	Aceraceae
Adiantum jordanii	California maiden-hair	Pteridaceae
Agrostis exarata	Spike bentgrass	Poaceae
Alnus rhombifolia	White alder	Betulaceae
Amelanchier utahensis	Utah serviceberry	Rosaceae
Aralia californica	California spikenard	Araliaceae
Aruncus dioicus var. pubescens	Goat's beard	Rosaceae
Avena fatua	Wild oat	Poaceae
Brickellia californica	Brickellbush	Asteraceae
Bromus diandrus	Ripgut	Poaceae
Calycanthus occidentalis	Spice bush	Calycanthaceae
Carex nudata	Torrent sedge	Cyperaceae
Clematis ligusticifolia	Virgin's bower	Ranunculaceae
Collomia heterophylla	Vari-leaf collomia	Polemoniaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Cynosurus echinatus	Hedgehog dogtail	Poaceae
Cyperus eriogrostus	Nutsedge	Cyperaceae
Cyperus esculentus	Yellow nut sedge	Cyperaceae
Darmera peltata	Umbrella plant	Saxifragaceae
Elymus glaucus	Blue wild rye	Poaceae
Equisetum arvense	Field horsetail	Equisetaceae
Erigeron philadelphicus	Fleabane daisy	Asteraceae
Fraxinus latifolia	Oregon ash	Oleaceae
Galium spp.	Bedstraw	Rubiaceae
Hypericum perforatum	Klamathweed	Hypericaceae
Lathyrus polyphyllus	Wild pea	Fabaceae
Lilium pardalinum ssp. pardalinum	Leopard lily	Liliaceae
Lonicera hispidula var. vascillans	Hairy honeysuckle	Caprifoliaceae
Madia spp.	Tarweed	Asteraceae
Melissa officinalis	Melissa	Lamiaceae
Mentha pulegium	Pennyroyal	Lamiaceae
Mimulus cardinalis	Scarlet monkey flower	Scrophulariaceae

Table 13 Plant Species Observed on Potem Creek at the Pit River Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Mimulus guttatus	Seep-spring monkey flower	Scrophulariaceae
Montia parviflora	Little-leaf montia	Portulaceae
Muhlenbergia minutissima	Muhly	Poaceae
Osmorhiza chilensis	Sierran sweet-cicely	Apiaceae
Philadelphis lewisii	Wild mock orange	Philadelphaceae
Physocarpus capitatus	Pacific ninebark	Rosaceae
Prunella vulgaris	Self-heal	Lamiaceae
Pteridium aquilinum var. pubescens	Bracken fern	Dennstaedtiaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Rhamnus purshiana	Cascara	Rhamnaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Rubus parviflorus	Thimbleberry	Rosaceae
Rubus ursinus	California blackberry	Rosaceae
Rumex crispus	Curly dock	Polygonaceae
Salix exigua	Narrowleaf willow	Salicaceae
Salix gooddingii	Black willow	Salicaceae
Salix laevigata	Red willow	Salicaceae
Salix lasiolepis	Arroyo willow	Salicaceae
Stachys ajugoides	Stachys mint	Lamiaceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Taxus brevifolia	Pacific yew	Taxaceae
Tellima grandiflora	Fringe cups	Saxifragaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Urtica dioica	Stinging nettle	Urticaceae
Woodwardia fimbriata	Giant chain fern	Blechnaceae
UPLAND PLANTS		
Acer macrophyllum	Big leaf maple	Aceraceae
Adenocaulon bicolor	Trailplant	Asteraceae
Adiantum jordanii	California maiden-hair	Pteridaceae
Aesculus californica	California buckeye	Hippocastanaceae
Aquilegia formosa	Columbine	Ranunculaceae
Aristolochia californica	Dutchman's pipe	Aristolochiaceae
Asarum hartwegii	Wild ginger	Aristolochiaceae
Athyrium filix-femina	Lady fern	Dryopteridaceae
Berberis aquifolium	Oregon grape	Berberidaceae

Table 13 Plant Species Observed on Potem Creek at the Pit River Arm of Shasta Lake		
Scientific Name	**Common Name**	**Family Name**
Calocedrus decurrens	Incense cedar	Cupressaceae
Ceanothus intergerrimus	Deer brush	Rhamnaceae
Cornus nuttallii	Mountain dogwood	Cornaceae
Corylus cornuta	Hazelnut	Betulaceae
Fraxinus latifolia	Oregon ash	Oleaceae
Galium spp.	Bedstraw	Rubiaceae
Goodyera oblongifolia	Rattlesnake plantain	Orchidaceae
Lonicera hispidula var. vascillans	Hairy honeysuckle	Caprifoliaceae
Osmorhiza chilensis	Sierran sweet-cicely	Apiaceae
Polystichum munitum	Swordfern	Dryopteridaceae
Prunus subcordata	Klamath plum	Rosaceae
Pseudotsuga menziesii var. menziesii	Douglas-fir	Pinaceae
Pteridium aquilinum var. pubescens	Bracken fern	Dennstaedtiaceae
Quercus chrysolepis	Canyon live oak	Fagaceae
Quercus kelloggii	Black oak	Fagaceae
Rhamnus rubra	Sierra coffeeberry	Rhamnaceae
Rubus discolor	Himalayan blackberry	Rosaceae
Rubus ursinus	California blackberry	Rosaceae
Smilax californica	Greenbriar	Liliaceae
Streptopus amplexifolius var. americanus	Twisted stalk	Liliaceae
Styrax officianalis	Snowdrop bush	Styraceae
Symphoricarpos albus var. laevigatus	Snowberry	Caprifoliaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Trientalis latifolia	Starflower	Primulaceae
Viola lobata	Pine violet	Violaceae
Vitis californica	California grape	Vitaceae

Appendix F Wildlife Species List (Interim)

APPENDIX F, WILDLIFE SPECIES LIST (INTERIM)

Appendix F provides a interim list of the wildlife species observed, or known to occur in the immediate vicinity of Shasta Lake. A more comprehensive species list will be incorporated into subsequent revisions of this report.

List of Wildlife Species Observed. Shasta Dam Enlargement Project. Shasta County, California. North State Resources, Inc. April 2002 through October 2003. Listed by Common Name.
HERPETOFAUNA
Pacific giant salamander
Rough-skinned newt
Black salamander
Ensantina
Shasta salamander
Western toad
Foothill yellow-legged frog
Bullfrog
Northwestern pond turtle
Western fence lizard
Western skink
Northern alligator lizard
Ringneck snake
Sharp-tailed snake
Racer
Gopher snake
Common garter snake
Aquatic garter snake
Western rattlesnake
BIRDS
Western grebe
Great blue heron
Green-backed heron
Canada goose
Wood duck
Mallard
Common merganser
Turkey vulture
Osprey
Bald eagle
Accipiter sp.
Red-shouldered hawk
Red-tailed hawk
Peregrine falcon
California quail
Mountain quail
American coot
Killdeer
Spotted sandpiper
“peep” sp.
Ring-billed gull
Caspian tern

List of Wildlife Species Observed. Shasta Dam Enlargement Project. Shasta County, California. North State Resources, Inc. April 2002 through October 2003. Listed by Common Name.
Band-tailed pigeon
Mourning dove
Common nighthawk
Anna's hummingbird
Belted kingfisher
Acorn woodpecker
Nuttall's woodpecker
Northern flicker
Pileated woodpecker
Pacific-slope flycatcher
Black phoebe
Ash-throated flycatcher
Purple martin
Tree swallow
Violet-green swallow
Northern rough-winged swallow
Cliff swallow
Barn swallow
Steller's jay
Scrub jay
Common raven
Oak titmouse
Bushtit
Red-breasted nuthatch
White-breasted nuthatch
Rock wren
Canyon wren
Bewick's wren
Winter wren
American dipper
American robin
Wrentit
European starling
Cassin's (Solitary) vireo
Hutton's vireo
Orange-crowned warbler
Yellow warbler
Black-throated gray warbler
MacGillivrays warbler
Yellow-breasted chat
Western tanager
Black-headed grosbeak
Spotted towhee
California towhee
Song sparrow
Golden-crowned sparrow
White-crowned sparrow
Red-winged blackbird
Brown-headed cowbird
Purple finch
House finch
Lesser goldfinch

List of Wildlife Species Observed. Shasta Dam Enlargement Project. Shasta County, California. North State Resources, Inc. April 2002 through October 2003. Listed by Common Name.

MAMMALS
Chipmunk
California ground squirrel
Gray squirrel
Gray fox
Cougar
Wild boar
Black-tailed mule deer