Appendix G

Methodologies

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Methodologies

Introduction

This appendix provides the reader with descriptions of the methodologies used to prepare the impact analyses presented in this environmental impact statement/environmental impact report (EIS/EIR) for Volume 1, Chapter 4, Sections 4.2 through 4.20.

Botanical, Wetlands, and Wildlife Resources

Biological resource surveys were performed in the Battle Creek Salmon and Steelhead Restoration Project (Restoration Project) area in 2000 and 2001. Detailed biological survey results are discussed in Volumes I and II of the *Biological Survey Summary Report for the Battle Creek Salmon and Steelhead Restoration Project* (Summary Report) (Jones & Stokes 2001a, 2001b). The following sections describe the evaluation methodology used for different biological resources.

Botanical and Wetland Study Methods

The areas studied for botanical and wetland resources varied at each Restoration Project site and include a combination of diversion dams, flumes, pipelines, open canals, access roads, and potential staging areas. The study area for each Restoration Project site was based on proposed construction methods, use of existing or new access roads, terrain constraints, private property boundaries, fence lines, and dense vegetation that would not be removed during construction. The study areas for the Restoration Project sites are shown on the maps in Volume II of the Summary Report (Jones & Stokes 2001b). Along existing access roads, the study area consisted of a 20-foot corridor on each side of the road edge (approximately 60 feet total).

Information reviewed to determine the location and types of vegetation that could exist in the Restoration Project area included:

- the California Department of Fish and Game's (DFG) California Natural Diversity Database (CNDDB) (CNDDB 2000);
- the California Native Plant Society's (CNPS) Inventory of Rare and Endangered Vascular Plants of California, sixth edition (CNPS 2000); and
- previously prepared environmental documents (Jones & Stokes Associates file information 1998; Oswald and Ahart 1994).

When appropriate, state and federal resource specialists were asked to provide information on special-status plants, noxious weeds, and local ordinances (e.g., oak tree ordinances or policies).

Botanists conducted a reconnaissance-level field visit on March 24 and 25, 2000, to evaluate existing conditions and to determine the extent of detailed botanical and wetland surveys. Protocol-level botanical surveys and wetland delineations were conducted at various times between April and August 2000 (Table G-1). The purposes of the field surveys were to:

- characterize plant communities and unique plant assemblages,
- identify special-status plant occurrences or suitable habitat for special-status plants,
- delineate waters of the United States (including wetlands) using the *Corps of Engineers Wetlands Delineation Manual* (Corps 1987),
- map noxious weed infestations (see the definition below for species considered as noxious weeds in this analysis), and
- coordinate with state and federal resource agencies to develop measures that avoid or minimize impacts on vegetation and wetland resources.

Special-Status Plant Surveys

Special-status plants are species that are legally protected under the state and federal endangered species acts or other regulations and species that are considered sufficiently rare by the scientific community to qualify for such listing. For the purpose of this document, special-status plants include species in the following categories:

- Species listed or proposed for listing as threatened or endangered under the federal Endangered Species Act (ESA) (50 CFR 17.12 for listed plants and various notices in the *Federal Register* for proposed species).
- Candidates for possible future listing as threatened or endangered under the ESA (64 FR 57534, October 25, 1999).
- Federal species of concern (former C2 candidates).

- Species listed or proposed for listing by the State of California as threatened or endangered under the California Endangered Species Act (CESA) (14 CCR 670.5).
- Plants listed as rare under the California Native Plant Protection Act of 1977 (Fish and Game Code §1900 *et seq.*).
- Plants considered by the CNPS to be "rare, threatened, or endangered in California" (Lists 1B and 2) (Skinner and Pavlik 1994); and
- Plants considered by the CNPS to be plants about which more information is needed or plants of limited distribution (Lists 3 and 4) (Skinner and Pavlik 1994).

Information on occurrences of special-status plants in the Restoration Project area was obtained initially from the CNDDB (CNDDB 2000), the U.S. Fish and Wildlife Service (USFWS), and reconnaissance-level surveys. Additional information on species' habitat requirements, blooming periods, and field identifying characteristics was obtained from state lists of flora (Munz and Keck 1968; Hickman 1993) and the CNPS fifth-edition (Skinner and Pavlik 1994) and sixth-edition inventories. This information was used to develop a list of special-status plants that have the potential to occur in the Battle Creek region (Table G-2). This table was used to identify habitats that have the highest potential to support special-status plants and to develop survey dates.

The floristic survey methods used to locate special-status plants in the Restoration Project area are based on guidelines recommended by the DFG and involve identifying all species to the level necessary to determine whether they qualify as a special-status plant or are plant species with unusual or significant range extensions (Nelson 1987). To account for different special-status plant identification periods biologists conducted several series' of field surveys between April and August 2000 (refer to Table G-1 for survey dates).

Depending on the terrain, various survey patterns were used, including meandering and intuitive controlled transects (i.e., transects that rely on the location and quality of habitat in the study area and focus efforts on those areas) in areas that contained suitable habitat for special-status plants. Survey intensity varied depending on species richness, habitat type and quality, and the probability of special-status species occurring in a particular habitat type.

Plant Community Characterization and Mapping

Plant communities at each Restoration Project site were mapped in the field on aerial photographs (one inch equals approximately 250 feet). Descriptions and names of plant communities were based on field surveys and on descriptions from the list of California terrestrial natural communities recognized by the CNDDB (CNDDB 2000), Holland (1986), and Sawyer and Keeler-Wolf (1995). Although the classification system of Sawyer and Keeler-Wolf represents the most recent treatment and includes greater community detail than the CNDDB

list, it is incomplete for many geographical areas in California. Additionally, some of the plant communities described in this report do not fit well into the communities that were defined by either Holland or Sawyer and Keeler-Wolf. Therefore, some community-type names have been modified based on field observations.

Noxious Weed Surveys

Noxious weeds were documented as part of the special-status plant surveys. For the purpose of this document, a *noxious weed* is defined as a plant that has the potential to displace native plants and natural habitats, affect the quality of forage on range lands, or affect cropland productivity (CNDDB 2000). High-priority noxious weeds include all California Department of Food and Agriculture "A"-rated species. Some "B"- and "C"-rated species were included in this analysis if the county agricultural commissioners identified them as target noxious weeds. Additional weeds were included if they were considered to have great potential for displacing native plants and damaging natural habitats and were not considered too widespread to be effectively controlled.

Noxious weed infestation and dispersal have been identified by federal, state, and county agencies as issues of concern and, therefore, are addressed in this document. Two federal acts and one executive order direct weed control: the Carlson-Foley Act of 1968 (42 USC 1241-1243), the Federal Noxious Weed Act of 1974 (7 USC 2814), and Executive Order 13112, Invasive Species (64 FR 6183, February 8, 1999). Local counties are also concerned about noxious weed infestation and dispersal on private and public lands. To identify noxious weed species of concern in the Restoration Project area, the following sources were consulted:

- a list of species designated as federal noxious weeds by the U.S. Department of Agriculture;
- Shasta and Tehama Counties' agricultural commissioners;
- the California Department of Food and Agriculture's "A," "B," and "C" lists of noxious weeds; and
- the California Exotic Pest Plant Council's list of pest plants of ecological concern.

Wetland Delineation

The term *waters of the United States* is used by the Corps to include areas that would qualify for federal regulation under Section 404 of the Clean Water Act (33 USC 1251-1376). For the purpose of this document, waters of the United States are separated into wetlands and other waters of the United States.

Wetlands are defined as areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that, under normal circumstances, do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (33 CFR 328.3[b]; 40 CFR 230.3). For a wetland to qualify as jurisdictional by the U.S. Army Corps of Engineers and, therefore, subject to regulation under Section 404 of the Clean Water Act (33 USC 1251-1376), the site must support a prevalence of (1) hydrophytic vegetation, (2) hydric soils, and (3) wetland hydrology. Wetlands were identified in the field based on the U.S. Army Corps of Engineers' definition. Wetlands were delineated using the methods outlined in the *Corps of Engineers Wetlands Delineation Manual* (Corps 1987).

Other waters of the United States are sites that typically lack one or more of the three indicators identified above. For the purpose of this document, drainages include all streams, creeks, rivers, and other surface features with defined beds and banks. The jurisdictional boundary for other waters of the United States was determined during the wetland delineation using the estimated ordinary high-water mark (based on an estimated two-year flood event).

Waters of the United States (including wetlands) at each Restoration Project site were mapped in the field on aerial photographs (one inch equals approximately 250 feet). A detailed description of the methods used to delineate waters of the United States is provided in a separate wetland delineation report (Jones & Stokes 2001c).

Wildlife Resource Study Methods

For the purpose of this document, the areas studied for special-status wildlife varied at each Restoration Project site and included a combination of diversion dams, flumes, pipelines, open canals, access roads, and staging areas. The study area for each Restoration Project site was based on the presence of suitable habitat for special-status wildlife, proposed construction methods, use of existing or new access roads, terrain constraints, private property boundaries, fence lines, and dense vegetation that would not be removed during construction. The study areas for each Restoration Project site are shown on the maps presented in Volume II of the Summary Report (Jones & Stokes 2001b). Along existing access roads, the study area for valley elderberry longhorn beetle (VELB) habitat surveys consisted of a 100-foot-wide corridor along both sides of the road (approximately 220 feet total). Raptor nest surveys included a one-half-mile area around all Restoration Project features and access roads. Nighttime calling surveys for the California spotted owl were conducted around diversion dams in suitable foraging, nesting, or roosting habitat. These surveys would detect owls within one-quarter mile.

Existing information was reviewed to determine the location and types of wildlife resources that could exist in the Restoration Project area. The sources of this information included:

- DFG's CNDDB (CNDDB 2000);
- Jones & Stokes file information (1998);
- bird lists for Shasta County Wintu Audubon Society Checklist Committee 2001and Tehama County (Laymon and Deuel 2003);
- Volumes I, II, and III of *California's Wildlife* (Zeiner et al. 1988, 1990a, 1990b); and
- Dr. Hartwell Welsh (pers. comm.).

Wildlife biologists conducted a reconnaissance-level field visit of the entire study area on March 24 and 25, 2000. The goals of this field visit were to evaluate existing conditions and to determine the approximate locations and extent of required future wildlife surveys. Protocol-level wildlife surveys were conducted at various times between April and August in 2000 and 2001 (Table G-3). The overall objectives of the field surveys were to:

- identify and describe wildlife habitat uses associated with plant communities, and
- identify special-status wildlife occurrences and suitable habitats for special-status wildlife.

Special-Status Wildlife Surveys

Special-status wildlife are species that are legally protected under the CESA, the ESA, or other regulations and species that are considered sufficiently rare by the scientific community to qualify for such listing. For the purpose of this report, the term *special-status wildlife* refers to:

- Species that are listed or proposed for listing as threatened or endangered under the ESA (50 CFR 17.11 [listed animals] and various notices in the *Federal Register* [proposed species]).
- Species that are candidates for possible future listing as threatened or endangered under the ESA (61 FR 40:7596–7613, February 28, 1996).
- Species of concern to the USFWS.
- Species that meet the definitions of rare or endangered under the California Environmental Quality Act (CEQA) (State CEQA Guidelines, Section 15380).
- Species that are listed or proposed for listing by the State of California as threatened or endangered under the CESA (14 CCR 670.5).
- Species that are fully protected in California (Fish and Game Code §§3511 [birds], 4700 [mammals], and 5050 [reptiles and amphibians]).
- Nesting raptors protected in California (Fish and Game Code §3503.5).
- Birds considered Species of Special Concern by the DFG (Remsen 1978).

- Migratory birds protected under the Migratory Bird Treaty Act (16 USC 703-712).
- Information on occurrences of special-status wildlife in the Restoration Project area was obtained initially from the CNDDB (CNDDB 2000), USFWS (Appendix H), and the reconnaissance-level surveys. This information was used to develop a list of special-status wildlife that have the potential to occur in the Battle Creek region (Table G-4) and to identify suitable habitats and dates for the special-status wildlife surveys.

Wildlife surveys were used to locate special-status wildlife and to identify sensitive habitats in the Restoration Project area. To account for different seasonal occurrences of special-status wildlife, several series of field surveys were conducted between April and August in 2000 and 2001 (Table G-3). These field surveys included the following elements:

- Two biologists performed two series of field surveys to identify birds that breed either in the early spring or in the late spring or early summer. The surveys consisted of visual and aural detections at all Restoration Project sites and habitats. Suitable breeding habitat was surveyed for evidence of breeding at the appropriate time of year for each species (see Appendix J). All evidence of breeding, such as singing male birds, territorial behavior, and courtship behavior, was recorded. All plant communities were surveyed, and all wildlife species detected were noted.
- With the exception of bats, biologists identified all vertebrates encountered during field surveys to the level necessary to determine whether they qualified as special-status species, unique occurrences, or extensions of species' documented ranges.
- Biologists visually surveyed for bats at dusk at each of the canal tunnel openings, but the species were not identified.
- Using high-powered spotting scopes and binoculars, biologists visually surveyed for raptor nests on all suitable trees and cliff sites within ½ mile of Restoration Project sites and access roads.
- Using USFWS protocols, biologists assessed the Restoration Project area for red-legged frog habitat. Protocol-level surveys were not conducted because of the lack of suitable habitat as established in the reconnaissance-level surveys and site assessments.
- Biologists conducted tailed frog surveys at two Restoration Project sites with the highest potential for occurrence: Soap Creek Feeder and South Diversion Dam. Survey methods followed methods developed by Dr. Hartwell Welsh, Redwood Sciences Laboratory, Pacific Southwest Research Station, U.S. Forest Service (Welsh pers. comm.).
- Biologists conducted area-constrained surveys for other amphibian species following methods proposed by Welsh (1987).
- Elderberry bushes that provide habitat for the listed VELB were plotted on U.S. Geological Survey (USGS) 7.5-minute topographic maps and aerial

photographs of the Restoration Project area and recorded in field notes. The gathering of data for each occurrence followed USFWS protocols. The survey included a search for exit holes on living stems, counts of stems in three size classes, and a physical description of the location.

- In 2000, biologists surveyed for California spotted owls in potential habitats near North Battle Creek Feeder Diversion Dam. Both visual and daytime calling surveys were conducted. In 2001, biologists began a two-year survey at five additional sites, including Eagle Canyon Diversion Dam, Wildcat Diversion Dam, Coleman Diversion Dam/Inskip Powerhouse, Inskip Diversion Dam/South Powerhouse, and South Diversion Dam. California spotted owl survey methods followed the USFWS-endorsed *Protocol for Surveying Proposed Management Activities That May Impact Northern Spotted Owls* (USFWS 1992). According to USFWS representatives, the survey protocol for the California spotted owl will be similar to the survey protocol for the northern spotted owl. A survey protocol will be developed in consultation with USFWS to survey for winter roosting California spotted owls at sites with suitable habitat.
- VELB habitats and other special-status wildlife occurrences were mapped on topographic maps. The topographic maps are provided in Volume II of the Summary Report (Jones & Stokes 2001b).

Hydrology

Hydrologic analyses were required as the basis for the surface water hydrology, fisheries, water quality, and power generation and economics analyses in this EIS/EIR. Data and findings included in the three reports listed below were used as a basis for the impact evaluations in this EIS/EIR.

- The report, *Hydrology of North and South Fork Battle Creek, Battle Creek Salmon and Steelhead Restoration Project* (Reclamation 2001a). This report uses data from the stream gage downstream of the CNFH. Reclamation modeled flows in North Fork and South Fork Battle Creek using the historic flow data from this gage, and augmented that data with more recent information from the gage downstream of Wildcat Diversion Dam. The report, which provides a summary of hydrological conditions, was developed to determine flood flows, scouring, and other parameters fundamental to facility design. Because of its role in guiding dam removal design, this report provided the basis for the identification of several impacts in this analysis and is hereby incorporated by reference because the methods used in its development support the impact assessment in Volume I, Section 4.3.
- The draft report, Sediment Impact Analysis of the Removal of Coleman, South, and Wildcat Diversion Dams on South and North Fork Battle Creek, Battle Creek Salmon and Steelhead Restoration Project (Reclamation 2001b). Reclamation used the same streamflow data as the document discussed in the previous paragraph and quantified the possible impacts resulting from the sediment releases that would occur after the removal of Coleman, South, and

Wildcat Diversion Dams. A numerical model of water surface elevations and sediment transport was used by Reclamation to study the sediment impacts on Battle Creek resulting from the dam removals. The channel geometry described in Reclamation (2001b) provided the necessary input to the model. The output from the model included streambed elevations, sediment size gradations, and water surface elevations as a function of time after dam removal. The model's water routing component solves the steady one-dimensional flow equations. Its sediment routing component solves the sediment routing equation, ignoring changes in suspended concentration or including them, depending upon user input. It also tracks changes in bed elevation and bed sorting in a manner similar to GSTARS2.0. Dam removal sites were modeled independently. The report is hereby incorporated by reference because the methods used in its development support the impact assessment in Volume I, Section 4.4

- *Stream Temperature Model for the Battle Creek Salmon and Steelhead Restoration Project*, a report prepared by PG&E's Land and Water Quality Unit for the PG&E Technical and Ecological Services Department (PG&E 2001). The report uses 20 years of flow data (water years 1980 through 1999) from the U.S. Geological Survey station at the CNFH. It is hereby incorporated by reference because the methods used in its development support the impact assessment in Volume I, Section 4.4

Each of these reports uses slightly different methods to characterize water years as representative of dry, normal, or wet conditions. These differences were reconciled in direct consultation with Reclamation and PG&E. These discussions supported the development of a generalized water year classification system capable of supporting the analyses found in Section 4.1, "Fish," and Section 4.16, "Other Nepa Analyses." The following discussion provides an overview of the development of this classification scheme.

General Hydrology Methodology

Five water year classes (wettest, representative wet, normal, representative dry, and driest) were developed to support the fisheries and power generation and economics analyses in this EIS/EIR. Daily streamflows in cfs for the period from October 1, 1961, through September 30, 1996, were used to classify the water years (Figure G-1). The data originated from the stream gage located downstream of the CNFH.

The average flow in cfs was calculated for each of the 35 water years. Then, the water years were ranked from the largest to the smallest flow and a threshold exceedence probability was calculated for each year. Table G-5 provides the ranking of the water years in quartiles. Quartiles are ranges in which the water years are divided into four groups, each group containing 25% of the data. Because there is an odd number of years of data, the wettest quartile has only eight water years instead of nine.

Next, a variety of methods can be used to calculate threshold exceedence probabilities. The Weibull relationship was chosen for the purpose of this classification scheme because it has been shown to provide estimates that are more consistent with experience (Hann 1977). The Weibull relationship is calculated from the equation m/(n+1), where m is the rank of the water year and n is the total number of years.

From these data, the initial identification of the five water year classes was based on their ranking position, using the threshold exceedence probabilities or extreme positions as shown in Table G-5. Next, the year closest to the exceedence probability of interest was compared to the other members of its respective quartile to ensure that its hydrograph had a shape typical of the other members in the quartile. The actual threshold exceedence probabilities for the representative wet, average, and representative dry years are 1982, 13.89%; 1989, 52.78%; and 1994, 86.11%. Water year 1983 was the overall wettest year and water year 1977 was the overall driest year for the 35-year period. Figures G-2 through G-5 illustrate the key relationships in this classification methodology.

Power Generation Analysis

The Battle Creek Hydrology and Hydroelectric Power Model (Appendix K) was used as a basis for the power generation and economics analysis because it provides the most accurate, consistent, and expeditious hydrologic data for use in power generation impact analyses. This model provides streamflow estimates at each current diversion point within the defined Restoration Project area, including unimpaired instream flows, inflows between diversion points, diversions to the Hydroelectric Project conveyance facilities, and instream flows after diversions. Hydrologic data from the model is presented as an average daily flow (in cfs) by month for a defined water year (October 1 through September 30). A more thorough discussion of the assumptions underlying the model and the consideration of other methods of estimating the hydrology of the Battle Creek watershed can be found in the report *Development and Assumptions of the Battle Creek Hydrology and Hydroelectric Model* (Appendix K).

Power generation estimates under the various operating conditions specified within each alternative are directly related to the hydrology of the watershed and hydroelectric system constraints (as defined by instream flow requirements and facility capacities). To most closely simulate a reasonable range of expected generation impacts, the power generation analysis modeled hydrology and generation for each alternative using a set of representative water years that correlate to wet, dry, and normal hydrologic conditions. Determination of these representative wet, representative dry, and normal water years is consistent with the classification scheme developed above. The representative water years were used for modeling power generation.

Median flow values for the representative water years were used in the power generation analysis. The median of a data set is the middle number when the number is ranked in either ascending or descending order and is one of several

measures of central tendency (median, average, and mode). For nearly all of the 35 water years, the median value is slightly less than the calculated average value.

Actual representative water years are used rather than the synthetic water years used in the fisheries analysis, which is discussed below. In addition to being standard practice for power generation impact analyses, this approach is used because it more closely approximates a likely range of expected generation within a single year. The approach is also consistent with preliminary analyses developed within the Battle Creek watershed that were performed as a part of negotiations between the Resource Agencies[1] and PG&E, the Hydroelectric Project owner.

Despite this difference, power generation analyses using synthetic water years are not expected to differ greatly from generation estimates developed using actual representative water years. This is primarily true because the method by which the actual representative years were chosen considered the shape of the annual hydrograph in order to limit strong spikes or dips in observed streamflows. In addition, most observed spikes in instream flows within an actual water year would not greatly alter generation because the limiting factor is likely to be facility capacity rather than available instream water.

Fish Analysis

Because fish habitat requirements change continuously throughout the calendar year, depending on what life-history stage is present in the stream in any given month, it is important to consider seasonal variations in streamflow when modeling hydrology for an evaluation of fish habitat. Therefore, the approach of identifying "representative" water years based on a single annual flow statistic (e.g., annual average flow) does not generate the best starting hydrograph for fish habitat modeling. For instance, a representative dry water year might be typified by some relatively low annual average flow. However, flows during June, for example, may have been quite high if the weather had been stormy in the spring. In this specific case, the seasonal variation would invalidate the dry water year modeling of habitat for winter-run chinook salmon that spawn in spring.

A better method, often used to generate hydrographs for season-specific modeling of fish habitat (e.g., Zedonis 1997, PG&E 2001), is to generate "hypothetical-year types" based, in the Battle Creek analysis, on exceedence probabilities of monthly average flows independently generated for each month over the 35-year period of record. For determining hydrographs for fish habitat modeling in Battle Creek, the monthly average flows were calculated, ranked, and assigned exceedence probabilities (representative wet, 13.9%; normal, 52.8%; and representative dry, 86.1% exceedence), using the same methods used

[1] References to *Resource Agencies* refer to the Bureau of Reclamation, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the California Department of Fish and Game, as appropriate.

to determine exceedence probabilities for representative water years. Then the hypothetical year was generated by combining the January monthly average flow matching that year-type's exceedence probability with the corresponding flow for February, March, and the other months. In this way, "representative wet-year," "normal-year," and "representative dry-year" hydrographs were created. Thus, these water year types are not used to evaluate a year as a whole (i.e., one would not expect to observe consecutive months of these conditions over a long period of time). Instead, they are used to show the sensitivity of combinations of variables (e.g., flow, month, fish life history, or fish habitat requirements) on fish habitat (PG&E 2001; Zedonis 1997).

Power Generation and Economics

The analyses performed in this section required the development of annual estimates of generation and revenue from the Hydroelectric Project under various alternative configurations and operating conditions (described within each of the Restoration Project alternatives). These estimates were developed using the Battle Creek Hydrologic/Economic Model, which is described in greater detail in Appendix K, "Development and Assumptions of the Battle Creek Hydrology and Hydroelectric Model." Output from the modeled generation results is provided in Appendix L, "Results from Monthly Flow and Power Generation Model."

Water Quality

Water Temperature

An assessment of potential water temperatures for the various Battle Creek system alternatives was made using information presented in PG&E (2001). In 1988–1989, Thomas R. Payne and Associates (1996a, 1996b) developed a predictive water temperature model for the Battle Creek watershed, using the USGS Biological Resources Division's and Midcontinent Ecological Science Center's Stream Network Temperature Model (SNTEMP). In 1999–2000, PG&E updated, modified, further refined, and validated this model. PG&E (2001) summarizes the modeling conducted by Thomas R. Payne and Associates and documents the results of PG&E's additional modeling efforts.

The SNTEMP model, as modified by Thomas R. Payne and Associates and as applied to the Battle Creek system, was developed to predict daily average water temperatures for a network of natural channels and canals (PG&E 2001). The model used hydrology, meteorology, and stream geometry data from the Restoration Project area. It conceptualized the Battle Creek watershed as 10 separate segments, consisting of the following six natural channels and four canals:

- Al Smith Reach – North Fork Battle Creek from Al Smith Diversion Dam to North Fork Battle Creek Feeder Diversion Dam (6.5 miles).
- North Fork Battle Creek Feeder Reach – North Fork Battle Creek from North Fork Battle Creek Feeder Diversion Dam to the confluence of Digger Creek (4 miles).
- Eagle Canyon Reach – North Fork Battle Creek from Eagle Canyon Diversion Dam to Wildcat Diversion Dam (2.7 miles).
- South Reach – South Fork Battle Creek from South Diversion Dam to South Powerhouse (5.8 miles).
- Inskip Reach – South Fork Battle Creek from Inskip Diversion Dam to Inskip Powerhouse (5.2 miles).
- Lower Battle Creek Reach – Combination of North Fork from Wildcat Diversion Dam to confluence (2.5 miles), South Fork from Coleman Diversion Dam to confluence (2.5 miles), and mainstem from confluence to above Coleman Powerhouse (9.4 miles).
- AAA system – Al Smith system (Al Smith Canal, Lower Mill Creek Canal, Baldwin Creek, Lake Grace Canal, Lake Grace, and Millseat Creek Flume [13.5 miles]) and Keswick system (Keswick Canal and Lake Nora [5.8 miles]).
- XXX system – Cross Country Canal (4.2 miles), South Canal (5.7 miles), and Union Canal (1 mile).
- III system – Inskip Canal (5 miles) and Eagle Canyon Canal (2.6 miles).
- CCC system – Coleman Canal (10.5 miles) and Wildcat Canal (1.8 miles).

The model was used to predict daily average temperatures for June through September for each alternative. For the model simulations, three conditions were chosen that bracketed all possible variations—normal-normal, dry-warm, and wet-cold. The normal-normal condition represented normal hydrology and normal meteorology. The dry-warm and wet-cold conditions represented the extreme case in which dry (or wet) hydrology occurred concurrently with a warm (or cold) climate.

Surface Water Quality Data

A field survey of the Restoration Project area was conducted on August 17 and 18, 2000. The survey included on-site inspections and photo-documentation of existing conditions. In addition, a meeting with DFG representatives was held on November 9, 2000, in Redding, California, to review available information.

Historic and recent water quality data collected by the USGS, USEPA, DWR, and State Board and stored in the USEPA's Storage and Retrieval database were used to analyze the surface water quality impacts. A summary of these data can

be found in Appendix N. Recent water quality and sediment data collected by Reclamation are also summarized in Appendix N.

Groundwater

Historic and recent groundwater quality data from the USEPA's Storage and Retrieval database were analyzed for groundwater quality impacts. In addition, USGS and DWR technical documents were also consulted.

Land Use

Methods used to determine potential land use impacts consisted of consulting readily available information, including applicable federal, state, and local planning documents. The Shasta and Tehama County General Plans (Shasta County 1998; Tehama County Community Development Group 1983) were also reviewed to assess the Restoration Project's conformance with county planning frameworks. Additional land use information was also obtained from the BLM, other agency representatives, and PG&E staff. The Restoration Project sites were also visited. The proposed Restoration Project activities, described in Chapter 3, "Project Alternatives," were analyzed for their potential impacts on existing land uses.

Socioeconomics

Regional Sales and Jobs

Tehama and Shasta Counties comprise the potentially affected area for regional socioeconomic impact assessments. They provide the baseline data from which analyses of short-term and long-term impacts on the region were conducted. It was determined to look at the two counties combined because Battle Creek runs through both counties, and in many cases, impacts will be shared, often indivisibly, between them. Quantified impacts are measured, therefore, on a regional basis. A direct measurement of a particular impact was applied to the regional data on a macro basis.

For the purposes of this EIS/EIR, the impacts on sales and jobs analyzed are those associated with each alternative's demolition, construction, and operation and maintenance of structures and access roads, and the abandonment of canals. The short-term demolition and construction costs and the annual operation and maintenance (O&M) costs were directly measured against regional sales data and jobs to determine if a significant impact was observed.

Typically, a multiplier such as RIMS 11 or the IMPLAN model is used in socioeconomic analyses. This approach imparts not only direct impacts, but also measures indirect and induced impacts for each analyzed action alternative. Because of the inherent size and scope of the various levels of effort associated with the construction, demolition, annual O&M, and canal reconfigurations, this analysis does not use a multiplier approach. This is because the socioeconomic impacts are intuitively small when measured directly against the regional data and the addition of indirect and induced factors would have little consequence to the outcome. Those impacts that cannot be quantified, nonetheless, have a narrative description of the qualified nature of those impacts and possible mitigation measures.

For each of the alternatives, the short-term and recurring costs and jobs created or lost were analyzed against regional data (Shasta and Tehama Counties). This was a direct measurement. The associated cost estimates and job implications for each alternative were applied against the regional baseline data, and a resulting estimated percentage of that direct measurement against existing conditions was determined.

Trout Farming

The descriptions of the conditions prevailing at potentially affected trout farming operations were based on field observations and interviews with trout farmers and fishery biologists with expertise on Battle Creek stocks.[2] Potential impacts from Restoration Project implementation are predicated on a risk analysis that accounts for the amount of risk that trout farmers currently accept, the level of anticipated increase in risk associated with long-term Restoration Project implementation, and appropriate mitigation. No determination to date has been made as to the marginal value of production of the Mount Lassen Trout Farms, Inc. (MLTF) and its income elasticity.

Typically, socioeconomic analyses address the impacts of a given project on the local economy and social structure of the affected environment. This could be a county or a target region where the impacts are expected to occur. This macro-perspective helps planners determine if the magnitude of a project is enough to cause a significant impact, whether beneficial or negative, on the financial and social infrastructure of a targeted environment, both in the short term and the long term.

Occasionally, socioeconomic analyses are adjusted to the micro level to examine the impacts of a project to a targeted enterprise. This is consistent with NEPA regulations (40 CFR Part 1500-1508) addressing the "context" of an action. This means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected

[2] Studies of disease transmission cited herein, especially surveys of disease in naturally produced fish, may be viewed as "snapshots." The incidence of disease in naturally produced fish may fluctuate over time.

interests, and the locality. Potential socioeconomic impacts may not qualify as significant when compared to society as a whole or at a national level or, more relevantly, when this loss is measured against county or regional revenues or against a sector's revenues.

The rationale used in this analysis of trout farming, however, is that the local enterprise may be impacted to the level of financial demise. This potential demise is significant to that enterprise and to the affected region and interests. Further, the demise of an enterprise may have indirect and induced impacts that could significantly affect dependent economies.

For the purpose of this EIS/EIR, potential socioeconomic impacts on the MLTF are examined at the enterprise and stakeholder level in the Restoration Project vicinity. The analysis is limited to the MLTF and potential implications to lessees associated with the MLTF.

In response to MLTF concerns, Reclamation consultants toured the MLTF's Battle Creek and Paynes Creek facilities on December 14, 2000, with MLTF owner, Phil Mackey, and interviewed Mr. Mackey and Mr. Dan Brown of the MLTF's technical staff. The tour included seven of the nine facilities in the area that could be affected by the Restoration Project and an eighth was viewed from a distance. Table O-3 in Appendix O is a synopsis of what was observed on the tour.

Reclamation consultants also reviewed MLTF's CALFED proposal for measures to reduce disease risks associated with Restoration Project implementation; interviewed state, federal, and industry fish pathologists; and reviewed published literature relevant to the critical issues discussed in this section.

Applicable Laws and Regulations

Title 14, Section 245 of the California Code of Regulations and the California Fish and Game Code govern the movement and disease certification of aquacultural products. Generally, Section 245 states that disease certification and stocking permits are not required if products are shipped between registered aquaculturalists or if the product is stocked in certain bodies of water (possibly including the fee-fishing lakes stocked by the MLTF). It is possible, therefore, that the MLTF could still sell its product even if it were infected with infectious hematopoietic necrosis (IHN). However, if IHN were detected at MLTF and DFG notified, the Aquaculture Disease Committee, a non-state regulatory board, would assess the case and submit recommendations to the DFG. Depending on the severity of the case, the recommended action could range from monitoring the stock to destroying the stock and disinfecting the facility. However, it is rare that stock destruction is ordered. This action has not been taken within the last 11 years (Cox pers. comm.). Further, if the stock were destroyed, the MLTF would be compensated in an amount equal to 75 percent of the market value of the destroyed fish. Even if IHN were to infect the MLTF, therefore, the

reimbursement policy and allowances within relevant regulations would likely forestall any catastrophic financial loss by the MLTF.

Geology and Soils

A geologic field survey of the Restoration Project vicinity was conducted on August 17 and 18, 2000. The visits included on-site inspections and photo-documentation of existing conditions.

The Restoration Project area geology was also researched, using reference material that included Reclamation's technical reconnaissance reports, region specific geologic reports, conceptual design reports, a value engineering report, a sediment management report, and related web sites. The USGS and the California Department of Conservation, Division of Mines and Geology were also contacted to verify and substantiate the information.

Geologic impacts were evaluated by "overlaying" Restoration Project construction activities on geologic features within or adjacent to the Restoration Project vicinity and including such considerations as blasting noise and vibrations, road construction, toe-slope stability, and other impacts that could result from changes in slope and rock formation stability.

The *Soil Survey of Tehama County, California* (Soil Conservation Service 1967) and *Soil Survey of Shasta County Area, California* (Soil Conservation Service 1974) were used to identify potentially affected soil resources. Applicable soil survey maps, map unit descriptions, and supporting tabular information were summarized, based on the extent of physical environmental impact that would result from the construction and removal activities planned for the Restoration Project. Geology and soils impacts were assessed from current Restoration Project plans as overlain on soil survey map units.

Proposed Restoration Project features were then compared to the same locations on the soil survey maps prepared for *Soil Survey of Tehama County California* (Soil Conservation Service 1967) and *Soil Survey of Shasta County Area, California* (Soil Conservation Service 1974). Soil map units and the corresponding soils were then identified as potentially affected by the development of the particular Restoration Project elements identified under the scenario.

Aesthetics and Visual Resources

Methods used to determine potential visual impacts included completing a field reconnaissance to evaluate visibility of Restoration Project facilities from adjacent areas as well as reviewing and applying the U.S. Forest Service's National Forest Landscape Management System to assess impacts on visual

resources. In addition, BLM staff completed a photosimulation of proposed facilities at one site, because of the visual sensitivity of the adjacent area.

Although scenic quality is high in the vicinity of all Restoration Project facilities, the visual sensitivity of each facility must be determined to assess impacts on visual resources. The visual sensitivity of each facility was evaluated by determining visibility of each facility from the following receptors (U.S. Department of Agriculture, Forest Service 1974):

- Primary and secondary roads and trails including scenic highways or roads leading directly to major areas of interest (national parks, national recreation areas, wilderness, dedicated wild areas, major recreation composites, historic sites and areas, and botanical sites).
- Fishing, swimming, and boating areas and other active/passive recreational areas located adjacent to water bodies such as creeks or lakes.
- Recreation areas such as vista points, campgrounds, picnic grounds, visitor centers, and trail camps.
- Resorts and winter sports areas.
- Geological and botanical areas.
- Historical sites.
- Areas of primary importance for observation of wildlife.
- Tracts of primarily summer homes.
- Highly sensitive communities such as one where a large portion of the population is not directly related to performing land management activities.

Transportation

Data collection and analysis focused on the best available information. Available reports and planning and agency documents were used to describe the existing transportation network and those roadways that could potentially be affected by the implementation of the Restoration Project. Information on county roadways was obtained from local transportation planning agencies. Information on private access routes was obtained from local agency representatives and field surveys. Information on access routes to the Restoration Project sites were derived from the project design and construction plans discussed in Chapter 3, "Project Alternatives."

The analysis of impacts on transportation in the Restoration Project vicinity focused on additional increased traffic associated with construction activities, including the use of heavy equipment, and included effects on local traffic circulation and potential impacts on existing roadways. Traffic related to construction and facility removals was evaluated for the impacts that both worker-commute traffic and material- and equipment-haul trucks could have on

potentially affected roadways. To evaluate potentially significant impacts associated with the implementation of the Restoration Project, the estimated construction-related traffic, provided by facility, was compared to the existing levels of service for the roadways used during construction. Additionally, the types of construction activities that may occur along roadways in the Restoration Project vicinity and their potential effects were estimated.

Noise

The existence and severity of noise impacts are largely subjective, primarily because of variations in individual tolerances. A common way to determine the potential for noise impacts is to compare anticipated project-related noise levels to existing noise levels at or near sensitive receptors. Generally, as noise levels increase at sensitive receptor locations, the potential for noise impacts to occur at those locations also increases. Noise impacts were assessed by first estimating the noise levels that could be generated during construction, modification, and/or facility removal activities at the Restoration Project sites. The noise levels produced during construction were compared to acceptable noise levels for adjacent areas based on federal, state and local standards to determine the potential noise level increases at locations of the closest sensitive receptors. In addition to the effects on increased noise levels, the effects of increased noise levels on construction workers were also evaluated. Available information on noise emissions from construction equipment was also obtained and used in this analysis.

Air Quality

Air quality impacts were evaluated based on professional experience and criteria identified in Appendix G of the CEQA Guidelines and the California Air Resources Board's air quality standards and area designation maps.

Public Health and Safety

Potential impacts on public health and safety are identified by how the implementation of the Proposed Restoration Project or action alternatives could change or alter existing public health and safety in the Restoration Project vicinity. For the evaluation of public health and safety, typical hazards associated the construction of new facilities or the removal and/or modification of existing facilities proposed to occur at the Restoration Project sites were identified and evaluated. Data collection and analysis focused on the best available information.

Public Services and Utilities

Data collection and analysis focused on the best available information. Existing reports, planning and agency documents, public records of service levels, and facility locations were used to describe the public services and utilities that would be potentially affected by the implementation of the Proposed Action or action alternatives and to determine the impacts on potential end users and distribution systems. Information was also collected though interviews with local agency representatives and was gathered during field visits. Physical impacts, service level requirements, and utility demands were based on the information on project construction and design plans discussed or referenced in Chapter 3, "Project Alternatives."

Recreation

Data collection and analysis focused on the best available information. Information on recreational use in the area was obtained through a review of existing reports and documentation. Information was also obtained from PG&E, discussions with agency representatives, a review of project files at the DFG office in Redding, and phone interviews. All of the Restoration Project sites were visited.

Information on recreational use in the Restoration Project vicinity was primarily qualitative in nature. Specific information quantifying use for recreational activities such as fishing, rafting, kayaking, and others, as discussed later in this section, was not readily available. Because of limited public access to the Restoration Project vicinity and predominantly private lands, studies indicating recreational use in the area in terms of the number of recreational user-days were not available and were not conducted as part of this analysis. Therefore, the potential impacts on recreational resources associated with the Restoration Project were not calculated in terms of the specific increases or decreases in the number of recreational user-days. All impacts in this section are discussed in terms of the potential for the general decrease or increase in recreational activities.

Cultural Resources

The proposed area of potential effect was discussed with staff of the State Historic Preservation Officer in 1999. Reclamation determined that the area of potential effect consists of the specific locations of each diversion dam, affected canals, flumes, and tunnels, construction zones, adjacent staging areas, new or modified access routes, and a swath of land that parallels the existing Inskip Penstock. These areas were examined for the proposed project. Standard survey techniques included pedestrian transects for areal coverage and specific examination of the dams and canals. A widespread examination of the upland

area in the vicinity of the Inskip Junction Box was conducted since the route for the bypass penstock was not known at the time of fieldwork. Portions of flumes and canals that might be affected were examined. The entrances and exits of a number of tunnels were examined but none was entered.

Prior to fieldwork, a records search was completed at the Northeast Center of the California Historical Resources Information System at Chico State University. Reclamation staff met with representatives of Manton Historical Society and a grant was let to collect oral history information about the hydroelectric system from retired workers and long-time residents. Maintenance records and drawings held by PG&E were examined. The Historic American Engineering Record: The Battle Creek Hydroelectric System (Reynolds and Scott 1980) provided a wealth of information. Library searches were conducted via the Internet and, finally, records at the California Department of Parks and Recreation facility in West Sacramento were consulted.

Environmental Justice

The Environmental Justice section was written using the best information available. To identify and evaluate potential environmental justice issues and the consequences of Restoration Project implementation, analysts obtained and cited the most recent relevant federal regulations and used professional judgment, based on socioeconomic, land use, and other impacts analyses in this EIS/EIR and their knowledge of environmental justice issues in the area potentially affected.

Other NEPA/CEQA Analyses

The other NEPA/CEQA analysis was conducted using the best available scientific and commercial information. The discussions of areas of potential controversy, growth-inducing impacts, and irreversible and/or irretrievable commitments of resources were based on an in-depth review of several related projects, growth trends in Shasta and Tehama Counties, and the effects that the Restoration Project could have on the existing resource base.

Table G-1. Botanical Survey and Wetland Delineation Dates

Restoration Project Area	Survey Dates	Survey Purpose
North Fork Battle Creek		
North Battle Creek Feeder Diversion Dam	April 13, 2000 August 4, 2000	Botanical surveys and wetland delineation
Eagle Canyon Diversion Dam	April 20, 2000 May 26, 2000	Botanical surveys and wetland delineation
	March 19, 2001	Butte County fritillary surveys
Wildcat Diversion Dam	April 25, 2000 August 4 and 11, 2000	Botanical surveys and wetland delineation
	March 19, 2001	Butte County fritillary surveys
South Fork Battle Creek		
Coleman Diversion Dam/Inskip Powerhouse	April 4 and 5, 2000 June 15, 2000 August 11, 2000	Botanical surveys and wetland delineation
	March 20, 2001	Butte County fritillary surveys
Penstock Junction Box	April 4 and 5, 2000 August 11, 2000	Botanical surveys and wetland delineation
	March 20, 2001	Butte County fritillary surveys
Lower Ripley Creek Feeder	April 12, 2000 August 8, 2000	Botanical surveys and wetland delineation
Inskip Diversion Dam/South Powerhouse	April 6, 2000 June 13 and 14, 2000	Botanical surveys and wetland delineation
	March 20, 2001	Butte County fritillary surveys
Soap Creek Feeder	April 12, 2000 August 8, 2000	Botanical surveys and wetland delineation
South Diversion Dam	April 7 and 25, 2000 August 11, 2000	Botanical surveys and wetland delineation
	March 20, 2001	Butte County fritillary surveys
Access Roads		
Eagle Canyon Access Road	April 20, 2000	Botanical surveys and wetland delineation
	March 19, 2001	Butte County fritillary surveys
Wildcat Dam Access Road	April 13 and 25, 2000 August 4 and 11, 2000	Botanical surveys and wetland delineation
	March 19, 2001	Butte County fritillary surveys
Lower Ripley Creek Feeder Access Road	April 12 and 24, 2000 August 8, 2000	Botanical surveys and wetland delineation
	March 20, 2001	Butte County fritillary surveys
South Powerhouse Road to Inskip Diversion Dam/South Powerhouse Access Road	April 6 and 21, 2000 August 8, 2000	Botanical surveys and wetland delineation

Restoration Project Area	Survey Dates	Survey Purpose
	March 20, 2001	Butte County fritillary surveys
East of Bar Ranch and South Powerhouse Access Road	April 20, 2000	Botanical surveys and wetland delineation
	March 20, 2001	Butte County fritillary surveys
Bluff Springs to South Powerhouse Access Road	April 19, 2000 August 13 and 14, 2000	Botanical surveys and wetland delineation
	March 20, 2001	Butte County fritillary surveys
Soap Creek Feeder Access Road	April 12, 2000 August 8, 2000	Botanical surveys and wetland delineation
South Diversion Dam Access Road	April 7, 14, and 25, 2000 August 11, 2000	Botanical surveys and wetland delineation
	March 20, 2001	Butte County fritillary surveys

Table G-2. Special-Status Plants Documented or Identified as Potentially Occurring in the Restoration Project Area

Common Name/ Scientific Name	Legal Status[1]			Distribution	Habitat Association	Occurrence in Restoration Project Area	Period of Identification2
	Federal	State	CNPS				
State- and Federally Listed Plants							
Boggs Lake hedge-hyssop *Gratiola heterosepala*	–	E	1B	Fresno, Lake, Lassen, Madera, Modoc, Placer, Sacramento, Shasta, San Joaquin, Solano, and Tehama Counties; also in Oregon	Shallow water, vernal pools, marshes, and lake margins (below 3,940 feet elevation)	None	April–June
Slender orcutt grass *Orcuttia tenuis*	T	E	1B	Lake, Lassen, Plumas, Sacramento, Shasta, Siskiyou, and Tehama Counties	Vernal pools (660 to 5,760 feet elevation)	None	May–July
CNPS List 1B and 2 Plants							
Adobe-lily *Fritillaria puriflora*	SC	–	1B	Butte, Colusa, Glenn, Lake, Napa, Plumas, Solano, and Tehama Counties	Chaparral, cismontane woodland, and clayey foothill valley grasslands (below 1,640 feet elevation)	None	February–April
Ahart's paronychia[3] *Paronychia ahartii*	SC	–	1B	Butte, Shasta, and Tehama Counties	Well-drained rocky outcrops, often vernal pool edges, volcanic uplands (below 1,650 feet elevation)	None	April–June
Big-scale balsamroot *Balsamorhiza macrolepis* var. *macrolepis*	–	–	1B	Alameda, Butte, Mariposa, Napa, Placer, Santa Clara, and Tehama Counties	Cismontane woodland, valley and foothill grassland, and sometimes serpentine (below 4,600 feet elevation)	None	March–June
Brandegee's eriastrum *Eriastrum brandegeae*	SC	–	1B	Colusa, Glenn, Lake, Santa Clara, Tehama, and Trinity Counties	Chaparral, and cismontane woodland on volcanic soil (2,600 to 3,300 feet elevation)	None	May–August
Canyon Creek stonecrop *Sedum paradisum*	SC	–	1B	Shasta and Trinity Counties	Broad-leaved upland forest, chaparral, lower montane conifer forest, and subalpine conifer forest on granitic outcrops (980 to 4,600 feet elevation)	None	May–June
Dimorphic snapdragon *Antirrhinum subcordatum*	–	–	1B	Colusa, Glenn, Lake, and Tehama Counties	Chaparral, lower conifer forest, and sometimes on serpentine (980 to 2,600 feet elevation)	None	April–July

Common Name/ Scientific Name	Legal Status[1]			Distribution	Habitat Association	Occurrence in Restoration Project Area	Period of Identification2
	Federal	State	CNPS				
Dwarf downingia *Downingia pusilla*	–	–	2	Merced, Mariposa, Napa, Placer, Sacramento, Solano, Sonora, Stanislaus, and Tehama Counties	Vernal pools and other seasonally wet places in valley and foothill annual grasslands (490 feet elevation)	None	March–May
Eel-grass pondweed *Potamogeton zosteriformis*	–	–	2	Contra Costa, Lake, Lassen, Modoc, and Shasta Counties; also in Washington and Oregon	Marshes and swamps (below 4,300 feet elevation)	None	June–July
Four-angled spikerush *Eleocharis quadrangularis*	–	–	2	Butte, Merced, and Tehama Counties	Marshes and swamps with seasonally or permanently saturated soils (below 1,600 feet elevation)	None	July–September
Legenere *Legenere limosa*	SC	–	1B	Lake, Napa, Placer, Sacramento, San Mateo, Solano, Sonoma, Stanislaus, and Tehama Counties	Vernal pools (below 490 feet elevation)	None	May–June
Marsh skullcap *Scutellaria galericulata*	–	–	2	Plumas, Placer, Nevada, El Dorado, and Shasta Counties	Wet meadows, marshes, and stream banks in montane conifer forest (3,275 to 6,895 feet elevation)	None	June–September
Obtuse starwort[3] *Stellaria obtusa*	–	–	2	Butte, Glenn, Humboldt, and Tuolumne Counties; also in Idaho, Oregon, and Washington	Mesic areas in upper montane conifer forest (5,250 to 6,500 feet elevation)	None	July
Red Bluff dwarf rush[3] *Juncus leiospermus* var. *leiospermus*	–	–	1B	Butte, Shasta, and Tehama Counties	Vernal pools and other seasonally wet sites in chaparral, oak woodland, and annual grassland (900 to 1,620 feet elevation)	None	March–May
Red-flowered lotus *Lotus rubriflorus*	SC	–	1B	Colusa, Stanislaus, and Tehama Counties	Cismontane woodland and foothill valley grassland (±660 feet elevation)	None	April–June

Common Name/ Scientific Name	Legal Status[1]			Distribution	Habitat Association	Occurrence in Restoration Project Area	Period of Identification2
	Federal	State	CNPS				
Sanford's arrowhead *Sagittaria sanfordii*	SC	–	1B	Butte, Del Norte, Fresno, Kern, Merced, Marin, Orange, Sacramento, Shasta, San Joaquin, Tehama, and Ventura Counties	Slow-moving water often within saltwater and freshwater marshes (above 990 feet elevation)	None	May–August
Silky cryptantha[3] *Cryptantha crinita*	SC	–	1B	Shasta and Tehama Counties	Cismontane woodland, lower conifer forest, riparian forests, riparian woodland, and gravelly areas with valley foothill grasslands (490 to 990 feet elevation)	Known from several occurrences along the edge of Battle Creek; no populations documented during 2000 field surveys	April–May
Water bulrush *Scirpus subterminalis*	–	–	2	Butte, Plumas, Tehama, El Dorado, Del Norte, and Humboldt Counties; also in Oregon	Lake margins, ponds, and marshes (2,460 to 7,385 feet elevation)	None	July–August
Western compion *Silene occidentalis* ssp. *longistipitata*	–	–	1B	Butte, Plumas, Shasta, and Tehama Counties	Chaparral and lower montane conifer forest (3,280 to 6,565 feet elevation)	None	July–August
White-stemmed pondweed [3] *Potamogeton praelongus*	–	–	2	Lassen, Plumas, Shasta, and Sierra Counties; also in Washington and Oregon	Marshes and swamps with deep water (lakes) (5,900 to 9,800 feet elevation)	None	July–August
CNPS List 3 and 4 Plants							
Bidwell's knotweed[4] *Polygonum bidwelliae*	–	–	4	Butte, Shasta, and Tehama Counties	Thin volcanic soils of openings in chaparral, oak woodland, and valley and foothill grasslands (195 to 3,940 feet elevation)	One occurrence documented in the Restoration Project area	April–June
Butte County fritillary[3] *Fritillaria eastwoodiae*	–	–	3[5]	Butte, Shasta, Tehama, and Yuba Counties	Chaparral, cismontane woodland, and lower montane conifer forest (1,640 to 4,900 feet elevation)	None	March–May
Depauperate milk-vetch[4] *Astragalus pauperculus*	–	–	4	Butte, Placer, Shasta, Tehama, and Yuba Counties	Open, vernally moist, volcanic clay soils in oak woodland and annual grassland (490 to 1,970 feet elevation)	27 occurrences documented in the Restoration Project area	March–May

Common Name/ Scientific Name	Legal Status[1]			Distribution	Habitat Association	Occurrence in Restoration Project Area	Period of Identification2
	Federal	State	CNPS				
Henderson's bent grass[3] *Agrostis hendersonii*	–	–	3	Butte, Calaveras, Merced, and Shasta Counties; also in Oregon	Valley and foothill grasslands and vernal pools (3,000 to 3,500 feet elevation)	None	April–May
Hot rock daisy *Erigeron inornatus* var. *calidipetris*	–	–	4	Butte, Modoc, Plumas, Shasta, and Tehama Counties	Sandy, volcanic soils in lower montane conifer forest (3,600 to 4,600 feet elevation)	None	June–September
Marsh claytonia *Claytonia palustris*	–	–	4	Butte, Fresno, Plumas, Siskiyou, Tehama, and Tulare Counties	Montane marshes, meadows, springs, and stream banks (3,280 to 8,205 feet elevation)	None	June–August
Pale yellow stonecrop *Sedum laxum* ssp. *flavidum*	–	–	4	Glenn, Humboldt, Shasta, Siskiyou, Tehama, and Trinity Counties	Serpentine or volcanic outcrops in broad-leaved upland forest, chaparral, cismontane woodland, and lower montane conifer forest (2,600 to 6,500 feet elevation)	None	May–July
Sanborn's onion *Allium sanbornii* var. *sanbornii*	–	–	4	Butte, Calaveras, El Dorado, Nevada, Placer, Tehama, and Yuba Counties; also in Oregon	Gravelly areas on serpentinite substrates in chaparral, oak woodland, and lower montane coniferous forest (980 to 4,495 feet elevation)	None	May–September
Shield-bracted monkeyflower[4] *Mimulus glaucescens*	–	–	4	Butte, Colusa, Lake, and Tehama Counties	Seeps and other wet places in foothill woodland and foothill annual grassland (below 1,970 feet elevation)	15 occurrences documented in the Restoration Project area	March–May
Woolly meadowfoam[4] *Limnanthes floccosa* ssp. *floccosa*	–	–	4	Butte, Lake, Shasta, Tehama, and Trinity Counties; also in Oregon	Vernal pools, moist meadows, and other seasonally wet habitats in oak woodland and valley and foothill annual grassland (33 to 1,320 feet elevation)	15 occurrences documented in the Restoration Project area	March–June

Common Name/ Scientific Name	Legal Status[1] Federal	State	CNPS	Distribution	Habitat Association	Occurrence in Restoration Project Area	Period of Identification2

[1] Status explanation:

Federal

T = Listed as threatened under the federal Endangered Species Act.

SC = Species of concern; species for which existing information indicates it may warrant listing but for which substantial biological information to support a proposed rule is lacking.

– = No listing.

State

E = Listed as endangered under the California Endangered Species Act.

– = No listing.

CNPS

1B = List 1B species: rare, threatened, or endangered in California and elsewhere.

2 = List 2 species: rare, threatened, or endangered in California but more common elsewhere.

3 = List 3 species: plants about which more information is needed to determine their status.

4 = List 4 species: plants of limited distribution.

[2] Refers to the expected flowering period for the species. This period is considered a guide for the best time to survey for the species.

[3] Species identified in the CNDDB search (California Department of Fish and Game 2000d).

[4] Species was located during spring and summer 2000 field surveys.

[5] *Fritillaria eastwoodiae* was recently listed as a CNPS List 3 species because of taxonomic problems; however, it could possibly be relisted as a CNPS List 1B species.

Table G-3. Wildlife Survey Dates

Restoration Project Site	Survey Dates	Survey Purpose
North Fork Battle Creek		
North Battle Creek Feeder Diversion Dam	April 20, 2000 June 16, 2000	Raptor nests; special-status birds; breeding birds; California spotted owl
	April 13, 2000 May 28, 2001 August 26, 2001	Raptor nests; California spotted owl
Eagle Canyon Diversion Dam	April 20, 2000 June 15 and 16, 2000 July 24, 2000	Raptor nests; special-status birds; breeding birds; bats; VELB habitat
	May 29, 2001 June 25, 2001 August 25, 2001	Raptor nests; California spotted owl
Wildcat Diversion Dam	April 20, 2000 June 16, 2000	Raptor nests; special-status birds; breeding birds
	April 12, 2001 May 28, 2001 August 25, 2001	Raptor nests; California spotted owl
South Fork Battle Creek		
Coleman Diversion Dam/ Inskip Powerhouse	April 17, 2000 June 13, 2000 July 25, 2000	Raptor nests; special-status birds; breeding birds; bats; VELB habitat
	April 12, 2001 May 28, 2001 August 26, 2001	Raptor nests; California spotted owl
Penstock Junction Box	April 17, 2000 June 13, 2000	Raptor nests; special-status birds; breeding birds
Lower Ripley Creek Feeder	April 17, 2000 June 16, 2000 July 7 and 25, 2000	Raptor nests; special-status birds; breeding birds; willow flycatcher; VELB habitat
Inskip Diversion Dam/ South Powerhouse	April 17, 2000 June 13 and 14, 2000 July 24, 2000	Raptor nests; special-status birds; breeding birds; bats; VELB habitat
	May 29, 2001 June 25, 2001 August 25, 2001	Raptor nests; California spotted owl
Soap Creek Feeder	April 17, 2000 June 14, 2000 July 24, 2000	Raptor nests; special-status birds; breeding birds; tailed frogs and general amphibians
South Diversion Dam	April 17, 2000 June 12 and 14, 2000 July 24, 2000	Raptor nests; special-status birds; breeding birds; bats; tailed frogs and general amphibians

Table G-4. Threatened, Endangered, Candidate, and Other Special-Status Wildlife Documented or Identified as Potentially Occurring in the Restoration Project Area

Common Name/ Scientific Name	Legal Status[1]		Distribution	Habitat Association	Occurrence in the Restoration Project Area
	Federal	State			
Insects					
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	FT, FS	–	Streamside habitats below 3,000 feet throughout the Central Valley	Riparian and oak savanna habitats with elderberry shrubs; elderberries (the host plant)	No records from CDFG's CNDDB
Amphibians					
California red-legged frog *Rana aurora draytoni*	FT	SSC	Along the coast and coastal mountain ranges of California from Marin County to San Diego County and in the Sierra Nevada from Tehama County to Fresno County	Permanent and semipermanent aquatic habitats, such as creeks and coldwater ponds, with emergent and submergent vegetation; may estivate in rodent burrows or cracks during dry periods	No records from CDFG's CNDDB
Cascades frog *Rana cascadae*	SC, FS	SSC	In the Shasta-Trinity region, east to the Modoc Plateau and south to the Lassen area and the upper Feather River system	Seasonal and permanent ponds and streams; oviposition habitat is open, shallow water in unshaded areas	No records from CDFG's CNDDB
Foothill yellow-legged frog *Rana boylii*	SC, FS	SSC	In the Klamath, Cascade, north Coast, south Coast, Transverse, and Sierra Nevada Ranges up to approximately 6,000 feet elevation	Creeks or rivers in woodlands or forests with rock and gravel substrate and low overhanging vegetation along the edge; usually found near riffles with rocks and sunny banks nearby	No records from CDFG's CNDDB
Southern torrent (seep) salamander *Rhyacotriton variegatus* (*olympicus*)	SC	SSC	Northwestern California forests in Del Norte, Humboldt, western Siskiyou, Trinity, and Mendocino Counties; disjunct population on Pit River watershed in Shasta County	Seeps, springs, and high-gradient reaches of small forested streams; usually found in or adjacent to cool, shallow water beneath rocks or organic debris	No records from CDFG's CNDDB
Tailed frog *Ascaphus truei*	SC	SSC, FP	Northwestern California from Del Norte County south to central Sonoma County and east as far as southwest Shasta County	Cool, perennial, swiftly flowing streams in redwood, Douglas fir, and yellow pine forests; altered microclimate conditions from timber harvesting in riparian areas	No records from CDFG's CNDDB

Common Name/ Scientific Name	Legal Status[1]		Distribution	Habitat Association	Occurrence in the Restoration Project Area
	Federal	State			
Reptiles					
Northwestern pond turtle *Clemmys marmorata marmorata*	SC, FS	SSC	From the Oregon border of Del Norte and Siskiyou Counties, south along the coast to San Francisco Bay, inland through the Sacramento Valley, and on the western slope of the Sierra Nevada	Ponds, marshes, rivers, streams, and irrigation canals with muddy or rocky bottoms and with watercress, cattails, water lilies, or other aquatic vegetation in woodlands, grasslands, and open forests	No records from CDFG's CNDDB
Birds					
American peregrine falcon *Falco peregrinus anatum*	FS	SE, FP	Permanent resident along the north and south Coast Ranges; may summer in the Cascade and Klamath Ranges and through the Sierra Nevada to Madera County; winters in the Central Valley south through the Transverse and Peninsular Ranges and the plains east of the Cascade Range	Nests and roosts on protected ledges of high cliffs, usually adjacent to lakes, rivers, or marshes that support large prey populations	No records from CDFG's CNDDB
Bald eagle *Haliaeetus leucocephalus*	FT	SE, FP	Nests in Siskiyou, Modoc, Trinity, Shasta, Lassen, Plumas, Butte, Tehama, Lake, and Mendocino Counties and in the Lake Tahoe Basin; reintroduced into central coast; winter range includes the rest of California, except the southeastern deserts, very high altitudes in the Sierra Nevada, and east of the Sierra Nevada south of Mono County	In western North America, nests and roosts in coniferous forests within one mile of a lake, reservoir, stream, or the ocean	One record from CDFG's CNDDB
Black swift *Cypseloides niger*	–	SSC	Breeds locally in the Sierra Nevada and Cascade Ranges and the San Gabriel, San Bernardino, and San Jacinto Mountains; and in coastal bluffs from San Mateo County south to near San Luis Obispo County	Nests in moist crevices or caves on sea cliffs above the surf, or on cliffs behind or adjacent to waterfalls in deep canyons	No records from CDFG's CNDDB
California spotted owl *Strix occidentalis occidentalis*	SC, FS	SSC	Sierra Nevada from Lassen County south to northern Kern County, and in the Transverse, Peninsular, and southern coastal mountains	Mature forest with suitable nesting trees; in southern California, in oak and oak-conifer habitats and in mature conifer forest	No records from CDFG's CNDDB

Common Name/ Scientific Name	Legal Status[1]		Distribution	Habitat Association	Occurrence in the Restoration Project Area
	Federal	State			
California yellow warbler *Dendroica petechia brewsteri*	–	SSC	Nests in all of California except the Central Valley, the Mojave Desert region, and high altitudes in the Sierra Nevada; winters along the Colorado River and in parts of Imperial and Riverside Counties	Nests in riparian areas dominated by willows, cottonwoods, sycamores, or alders or in mature chaparral; may also use oaks, conifers, and urban areas near streamcourses	No records from CDFG's CNDDB
Cooper's hawk[2] *Accipiter cooperii*	–	SSC	Throughout California except high altitudes in the Sierra Nevada; winters in the Central Valley, southeastern desert regions, and plains east of the Cascade Range	Nests in a wide variety of habitat types, from riparian woodlands and digger pine-oak woodlands through mixed conifer forests	No records from CDFG's CNDDB
Golden eagle *Aquila chrysaetos*	–	SSC, FP	Foothills and mountains throughout California; uncommon nonbreeding visitor to lowlands such as the Central Valley	Nests on cliffs and escarpments or in tall trees overlooking open country; forages in annual grasslands, chaparral, and oak woodlands with plentiful medium- and large-sized mammals	No records from CDFG's CNDDB
Little willow flycatcher *Empidonax traillii brewsteri*	SC, FS	SE	Summers along the western Sierra Nevada from El Dorado to Madera County, in the Cascade and northern Sierra Nevada in Trinity, Shasta, Tehama, Butte, and Plumas Counties, and along the eastern Sierra Nevada from Lassen to Inyo County	Riparian areas and large wet meadows with abundant willows; usually found in riparian habitats during migration	No records from CDFG's CNDDB
Loggerhead shrike *Lanius ludovicianus*	SC	SSC	Resident and winter visitor in lowlands and foothills throughout California; rare on coastal slope north of Mendocino County, occurring only in winter	Prefers open habitats with scattered shrubs, trees, posts, fences, utility lines, or other perches	No records from CDFG's CNDDB
Long-eared owl *Asio otus*	–	SSC	Permanent resident east of the Cascade Range from Placer County north to the Oregon border, east of the Sierra Nevada from Alpine County to Inyo County; scattered breeding populations along the coast and in southeastern California; winters throughout the Central Valley and southeastern California	Nests in abandoned crow, hawk, or magpie nests, usually in dense riparian stands of willows, cottonwoods, live oaks, or conifers	No records from CDFG's CNDDB

Common Name/ Scientific Name	Legal Status[1]		Distribution	Habitat Association	Occurrence in the Restoration Project Area
	Federal	State			
Northern goshawk *Accipiter gentilis*	SC, FS	SSC	Permanent resident in the Klamath and Cascade Ranges, in the north Coast Ranges from Del Norte County to Mendocino County, and in the Sierra Nevada south to Kern County; winters in Modoc, Lassen, Mono, and northern Inyo Counties	Nests and roosts in older stands of red fir, Jeffrey pine, ponderosa pine, lodgepole pine, Douglas fir, and mixed conifer forests	One record from CDFG's CNDDB
Osprey[2] *Pandion haliaetus*	–	SSC	Nests along the north coast from Marin County to Del Norte County, east through the Klamath and Cascade Ranges, and in the upper Sacramento Valley; important inland breeding populations at Shasta Lake, Eagle Lake, and Lake Almanor and small numbers elsewhere south through the Sierra Nevada; winters along the coast from San Mateo County to San Diego County	Nests in snags, trees, or utility poles near the ocean, large lakes, or rivers with abundant fish populations	One record from CDFG's CNDDB
Prairie falcon *Falco mexicanus*	–	SSC	Permanent resident in the south Coast, Transverse, Peninsular, and northern Cascade Ranges, the southeastern deserts, Inyo-White Mountains, foothills surrounding the Central Valley, and in the Sierra Nevada in Modoc, Lassen, and Plumas Counties; winters in the Central Valley, along the coast from Santa Barbara County to San Diego County, and in Marin, Sonoma, Humboldt, Del Norte, and Inyo Counties	Nests on cliffs or escarpments, usually overlooking dry, open terrain or uplands	No records from CDFG's CNDDB
Purple martin *Progne subis*	–	SSC	Coastal mountains south to San Luis Obispo County, west slope of the Sierra Nevada, and northern Sierra and Cascade ranges; absent from the Central Valley except in Sacramento; isolated, local populations in southern California	Nests in abandoned woodpecker holes in oaks, cottonwoods, and other deciduous trees in a variety of wooded and riparian habitats; also nests in vertical drainage holes under elevated freeways and highway bridges	No records from CDFG's CNDDB
Sharp-shinned hawk [2] *Accipiter striatus*	–	SSC	Permanent resident in the Sierra Nevada, Cascade, Klamath, and north Coast Ranges at mid-elevations and along the coast in Marin, San Francisco, San Mateo, Santa Cruz, and Monterey Counties; winters over the rest of the state except at very high elevations	Dense-canopy ponderosa pine or mixed conifer forest and riparian habitats	No records from CDFG's CNDDB

Common Name/ Scientific Name	Legal Status[1]		Distribution	Habitat Association	Occurrence in the Restoration Project Area
	Federal	State			
Swainson's hawk *Buteo swainsoni*	–	ST	Lower Sacramento and San Joaquin Valleys, the Klamath Basin, and Butte Valley; highest nesting densities occur near Davis and Woodland in Yolo County	Nests in oaks or cottonwoods in or near riparian habitats; forages in grasslands, irrigated pastures, and grain fields	No records from CDFG's CNDDB
Vaux's swift *Chaetura vauxi*	–	SSC	Coastal belt from Del Norte County south to Santa Cruz County and in mid-elevation forests of the Sierra Nevada and Cascade Range	Nests in hollow, burned-out tree trunks in large conifers	No records from CDFG's CNDDB
Western burrowing owl *Athene cunicularia hypugea*	SC	SSC	Lowlands throughout California, including the Central Valley, northeastern plateau, southeastern deserts, and coastal areas; rare along south coast	Level, open, dry, heavily grazed or low-stature grassland or desert vegetation with available burrows	No records from CDFG's CNDDB
White-tailed kite *Elanus leucurus*	–	FP	Lowland areas west of the Sierra Nevada from the head of the Sacramento Valley south, including coastal valleys and foothills, to western San Diego County	Low foothills or valley areas with valley or live oaks, riparian areas, and marshes near open grasslands	No records from CDFG's CNDDB
Yellow-breasted chat *Icteria virens*	–	SSC	Nests locally in coastal mountains and Sierra Nevada foothills, east of the Cascades in northern California, along the Colorado River, and very locally inland in southern California	Nests in dense riparian habitats dominated by willows, alders, Oregon ash, tall weeds, blackberry vines, and grapevines	No records from CDFG's CNDDB
Mammals					
American badger *Taxidae taxus*	–	–	Statewide except for the northwestern corner in Del Norte County and parts of Humboldt and Siskiyou Counties	Typically found in open areas with scattered shrubs and trees; also found in open forests, particularly ponderosa pine	No records from CDFG's NDDB
Fringed myotis *Myotis thysanodes*	SC	–	Throughout California except the southeastern deserts and the Central Valley	Found in a wide variety of habitats from low desert scrub to high-elevation coniferous forests; day and night roosts in caves, mines, trees, buildings, and rock crevices	No records from CDFG's CNDDB
Long-eared myotis *Myotis evotis*	SC	–	Throughout California except the southeastern deserts and the Central Valley	Occurs primarily in high-elevation coniferous forests, but also found in mixed hardwood/conifer, high desert, and humid coastal conifer habitats	No records from CDFG's CNDDB

Common Name/ Scientific Name	Legal Status[1]		Distribution	Habitat Association	Occurrence in the Restoration Project Area
	Federal	State			
Long-legged myotis *Myotis volans*	SC	–	Mountains throughout California, including ranges in the Mojave Desert	Most common in woodlands and forests above 4,000 feet, but occurs from sea level to 11,000 feet	No records from CDFG's CNDDB
Pacific fisher *Martes pennanti pacifica*	SC, FS	SSC	Coastal mountains from Del Norte County to Sonoma County, east through the Cascades to Lassen County, and south in the Sierra Nevada to Kern County	Late-successional coniferous forests and montane riparian habitats	No records from CDFG's CNDDB
Pallid bat *Antrozous pallidus*	–	SSC	Throughout California, primarily at lower elevations and mid-elevations	Occurs in a variety of habitats from desert to coniferous forest; most closely associated with oak, yellow pine, redwood, and giant sequoia habitats in northern California; relies heavily on trees for roosts	No records from CDFG's CNDDB
Ringtail *Basariscus astutas*	–	FP	Little information on distribution and abundance; apparently occurs throughout the state except for the southern Central Valley and the Modoc Plateau	Occurs primarily in riparian habitats, but also known to occur in most forest and shrub habitats from lower elevations to mid-elevations	No records from CDFG's CNDDB
Sierra Nevada Mountain beaver *Aplodontia rufa*	–	SSC	Throughout the Klamath, Cascade, and Sierra Nevada mountains and the north Coast Ranges in Del Norte and Humboldt Counties; Sierra Nevada populations scattered and local	Slopes of ridges or gullies where there is abundant moisture, thick undergrowth, and soft soil for burrowing	No records from CDFG's CNDDB
Small-footed myotis *Myotis ciliolabrum*	SC	–	South Coast, Transverse, and Peninsular Ranges; Sierra Nevada; and the Great Basin	Open stands in forests and woodlands, as well as shrublands and desert scrub; uses caves, crevices, trees, and abandoned buildings	No records from CDFG's CNDDB
Townsend's big-eared bat *Plecotus townsendii*	SC	SSC	Throughout California, from low desert to mid-elevation montane habitats	Roosts in caves, tunnels, mines, and dark attics of abandoned buildings; buildings must offer cavelike spaces to be suitable; highly sensitive to disturbance at roost sites	No records from CDFG's CNDDB

Common Name/ Scientific Name	Legal Status[1] Federal	State	Distribution	Habitat Association	Occurrence in the Restoration Project Area
Yuma myotis *Myotis yumanensis*	SC	–	Common and widespread throughout most of California except the Colorado and Mojave Deserts	Found in a wide variety of habitats from sea level to 11,000 feet, but uncommon above 8,000 feet; optimal habitat is open forests and woodlands near water bodies	No records from CDFG's CNDDB

[1] Status Explanations:

Federal:

FE = Federally listed as endangered.
FS = U.S. Forest Service sensitive species.
FT = Federally listed as threatened.
SC = Species of concern.
– = No listing.

State:

FP = State fully protected.
SE = State listed as endangered.
SSC = Species of special concern.
ST = State-listed as threatened.
– = No listing.

[2] This species is not considered to be a state species of special concern in the Draft List of California Bird Species of Special Concern (California Department of Fish and Game and Point Reyes 2001). This list is currently under review by the CDFG and the Point Reyes Bird Observatory Advisory Committee.

Table G-5. Quartile Analysis for Selected Representative Water Years

	Rank	Year	Exceedence	Average Flow (cfs)
Wettest Quartile	1	1983 [1]	2.78%	869.2
	2	1974	5.56%	838.2
	3	1995	8.33%	827.7
	4	1970	11.11%	719.9
	5	1982 [2]	13.89%	713.7
	6	1969	16.67%	708.9
	7	1984	19.44%	664.8
	8	1986	22.22%	642.8
Middle Quartiles	9	1971	25.00%	609.9
	10	1965	27.78%	600.0
	11	1996	30.56%	581.4
	12	1975	33.33%	573.2
	13	1978	36.11%	570.2
	14	1980	38.89%	562.3
	15	1973	41.67%	561.2
	16	1993	44.44%	558.3
	17	1967	47.22%	556.5
	18	1963	50.00%	525.5
	19	1989 [3]	52.78%	449.5
	20	1968	55.56%	421.5
	21	1972	58.33%	404.5
	22	1985	61.11%	397.2
	23	1979	63.89%	379.9
	24	1962	66.67%	377.9
	25	1987	69.44%	377.6
	26	1981	72.22%	362.2

	Rank	Year	Exceedence	Average Flow (cfs)
Driest Quartile	27	1976	75.00%	357.5
	28	1966	77.78%	349.4
	29	1988	80.56%	330.0
	30	1964	83.33%	319.0
	31	1994 [4]	86.11%	312.5
	32	1990	88.89%	307.6
	33	1991	91.67%	281.7
	34	1992	94.44%	256.3
	35	1977 [5]	97.22%	238.3

[1] Wettest water year

[2] Representative wet water year

[3] Normal or average water year

[4] Representative dry water year

[5] Driest water year

Source: U.S. Bureau of Reclamation 2001a

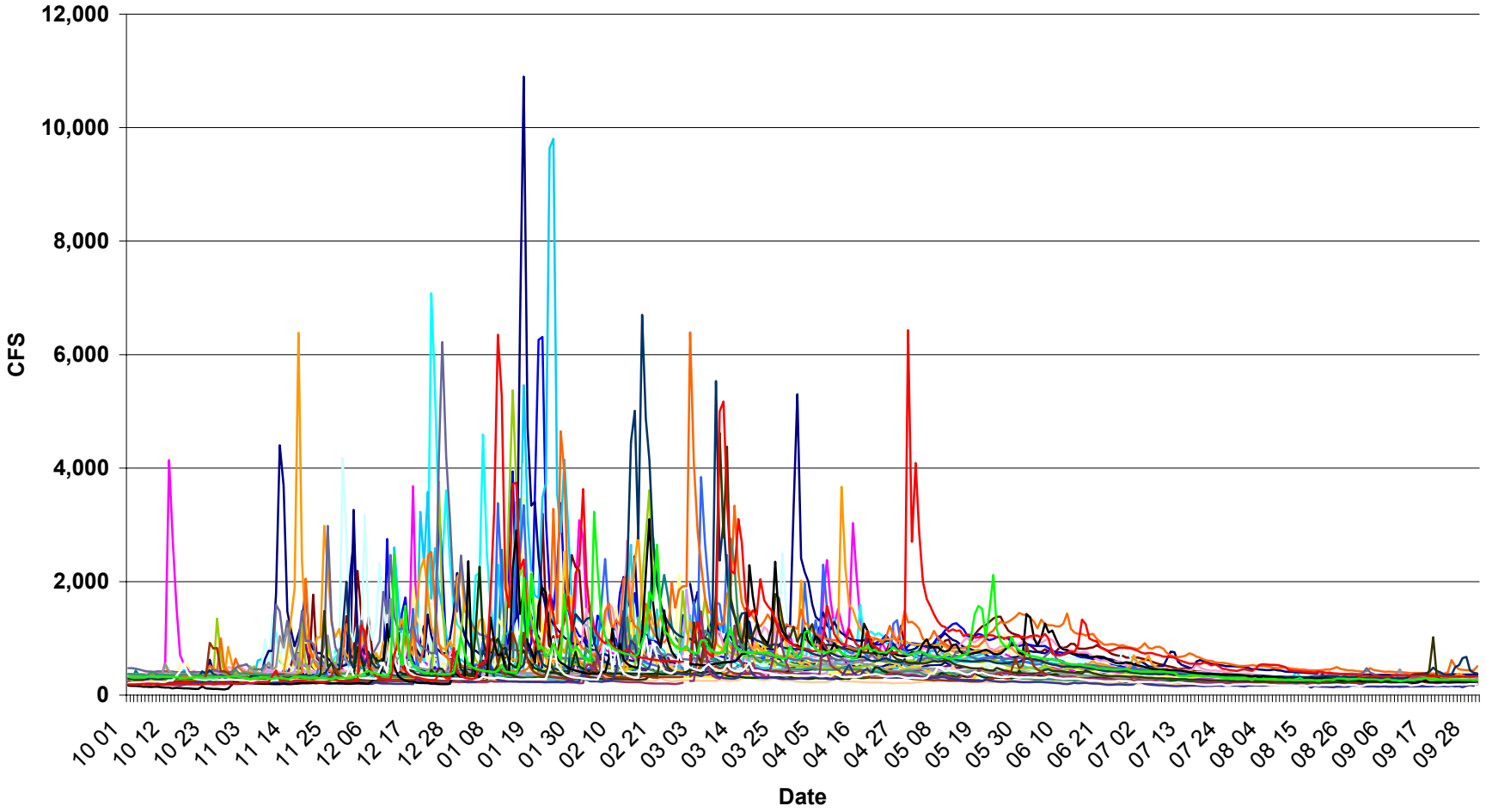

Figure G-1. Battle Creek Period of Record: 35 Water Years (1962–1996).

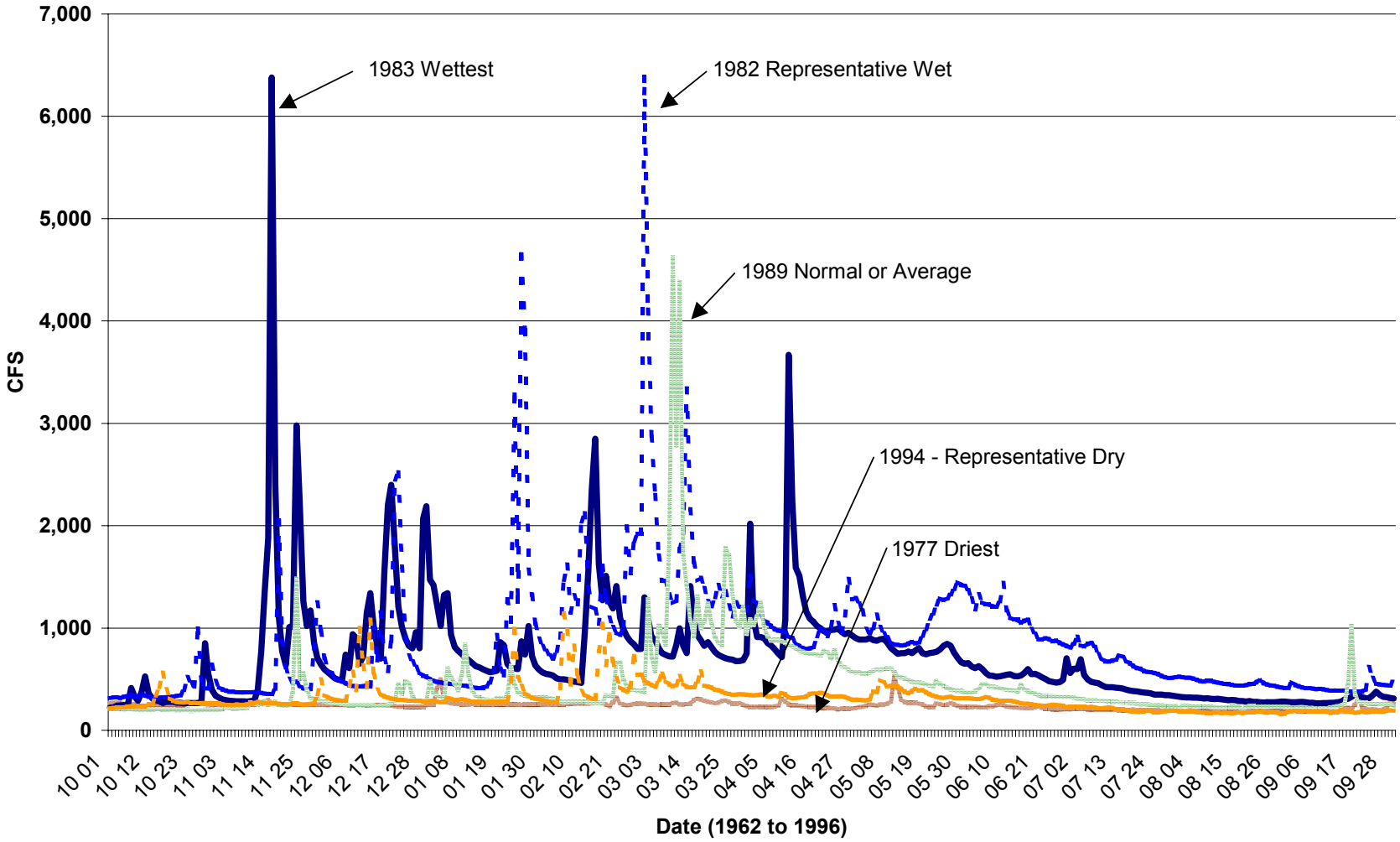

Figure G-2. Battle Creek Representative Water Years.

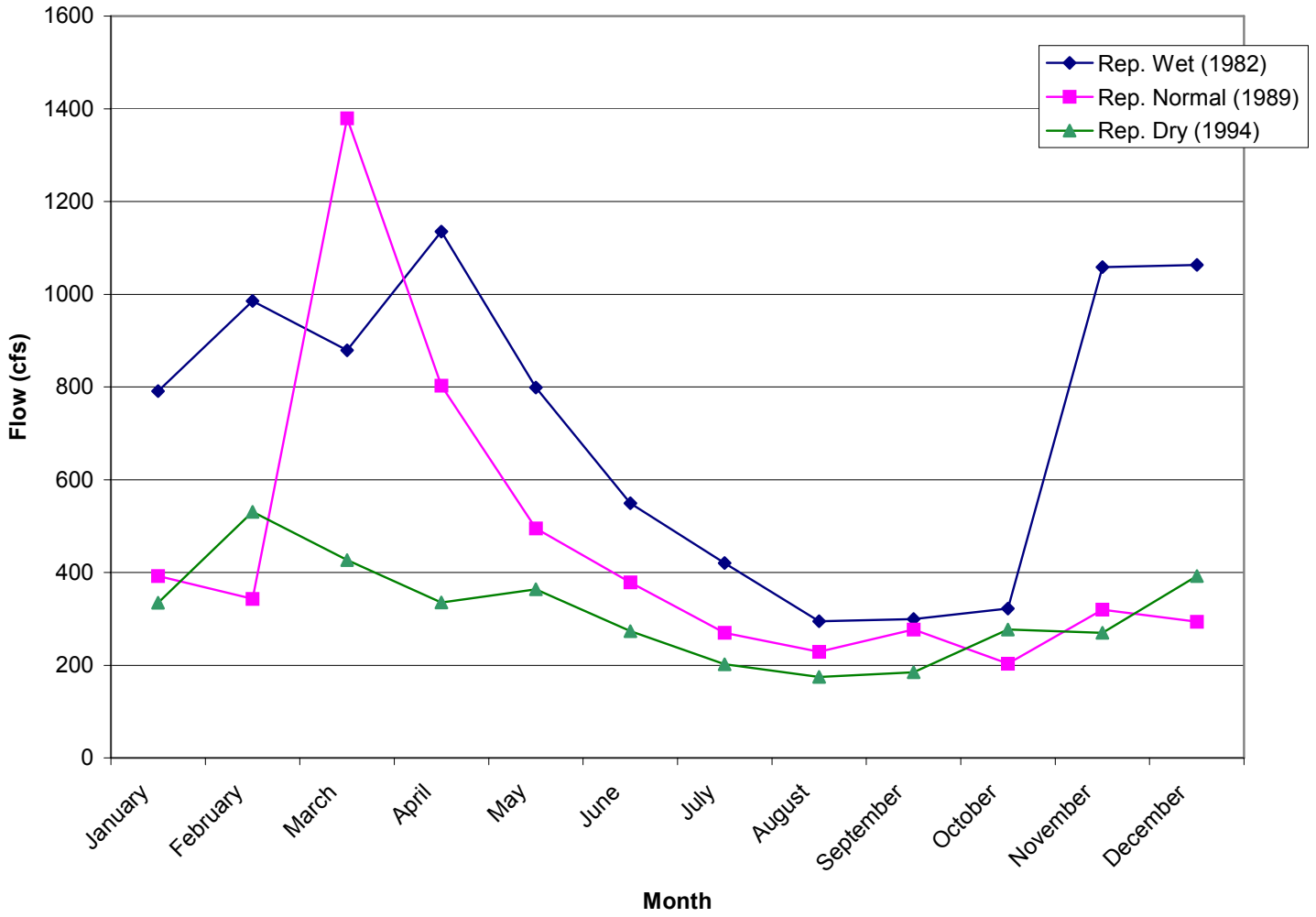

Figure G-3. Representative Water Years Selected by Ranking Yearly Average Flow

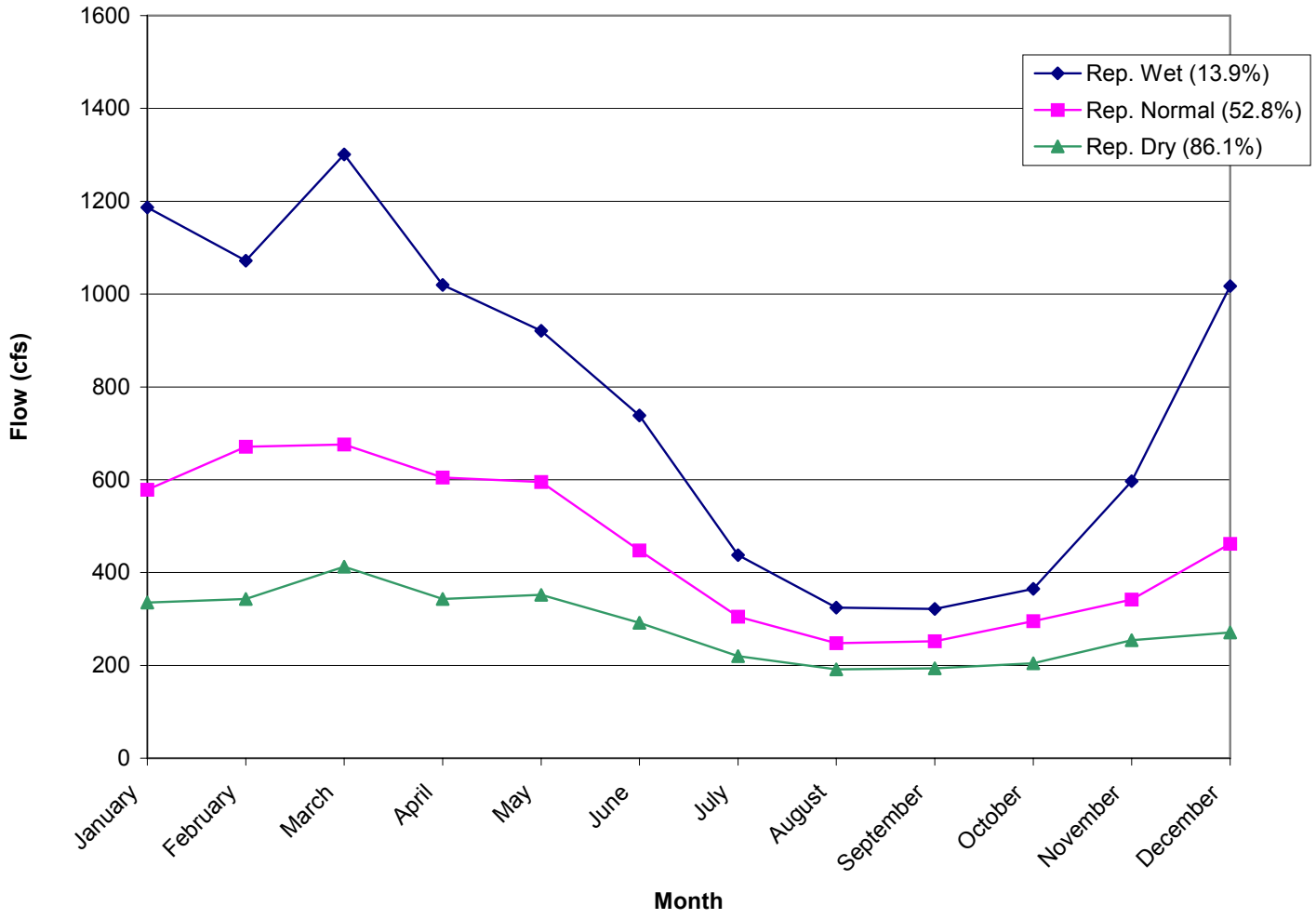

Figure G-4. Representative Water Year Composite Constructed by Ranking Monthly Average Flow.

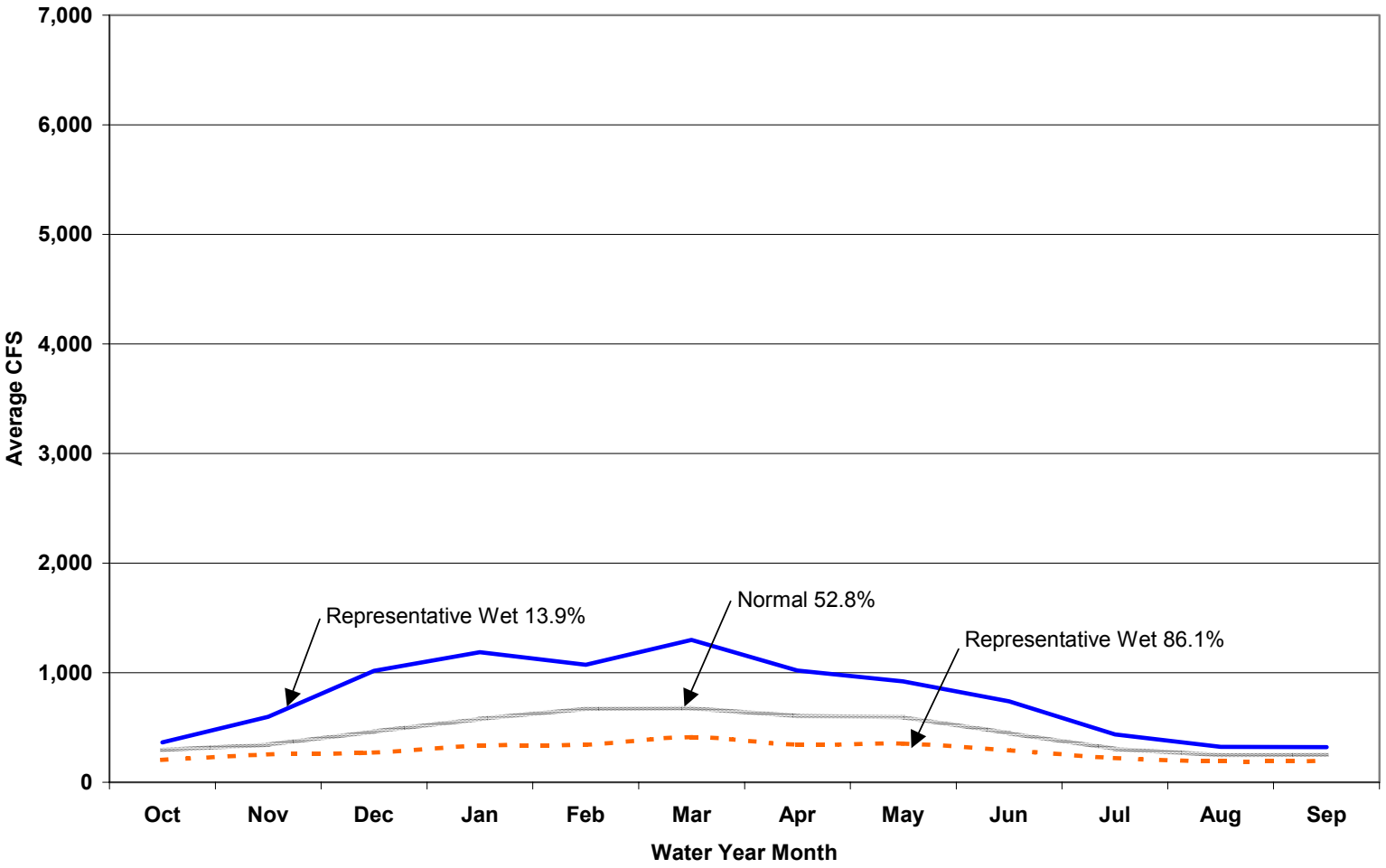

Figure G-5. Representative Synthetic Water Years.