Martis Watershed Assessment

Truckee River Watershed Council
Collaborative solutions to protect, enhance and restore the Truckee River Watershed

Balance Hydrologics, Inc.®

INTEGRATED ENVIRONMENTAL RESTORATION SERVICES, INC.

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Martis Watershed Assessment

Placer and Nevada Counties, California

Report prepared for:

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Collaborative solutions to protect, enhance and restore the Truckee River Watershed

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EXECUTIVE SUMMARY

The Truckee River Watershed Council (TRWC) is conducting the Martis Watershed Assessment, a multi-disciplinary effort to provide the science and policy information needed to direct restoration and conservation projects within the watershed, funded by the Martis Fund and the Bella Vista Foundation. The Truckee River Watershed Council has contracted with a team assembled by Balance Hydrologics (Balance) which includes Integrated Environmental Restoration Services (IERS), Dr. Susan Lindström (consulting archaeologist), Digital Mapping Solutions, and Valley Mountain Consulting to develop the assessment in three parts:

1. Watershed Attributes
2. Disturbance Inventory and Existing Conditions, and
3. Restoration Opportunities and Constraints.

The goal of the Watershed Attributes portion of this report is to provide a physiographic analysis of the Martis watershed (Figure 1). This includes identifying particular conditions and sites which are affected by hydrologic and geomorphic processes. Much of our attention has been placed on the conditions and processes which affect opportunities for aquatic habitat restoration in various creek channels within the watershed, as well as groundwater recharge. We follow a customized approach to the watershed assessment process, drawing on methods outlined by the U.S. Environmental Protection Agency and California Department of Water Resources (USEPA, 2008; DWR, 2008). We describe the landscape conditions, including historical and current land uses, watershed soils and geology, watershed hydrogeology, vegetation and habitat types, channel and wetland geomorphology, watershed hydrology, water quality, and sediment transport dynamics.

The Disturbance Inventory and Existing Conditions portion of this assessment is intended to lead planning and implementation of specific restoration and watershed management actions. Through an iterative approach, we have targeted our reconnaissance-based field investigation in areas where projects seem most feasible, or where hydrologic and soil production functions appear to be most impaired. Work was carried out according to a) hydrogeomorphic zones, b) restoration needs identified by stakeholders, and c) the assessment team's understandings of particular disturbed areas. The assessment includes GIS- and field-based analyses to identify watershed disturbances and impacts from prior and current land uses. Together, this literature- and field-based assessment will provide a sound basis for developing approaches and priorities for repairing disturbances, re-establishing watershed processes, and restoring habitat.

To identify Restoration Opportunities and Constraints, we have worked with TRWC and the project stakeholders to identify a number of the more important disturbance areas and impacted stream reaches in the watershed. Our team suggests a range of strategies for addressing these issues and improving water quality and habitat in the watershed. For greater effectiveness, we have grouped these individual disturbance areas/reaches into collective projects which can effect functional re-naturalization at a more meaningful and lasting scale (Section 4, Table 10 and Figures 23 through 40). The attributes assigned to each area or grouping of disturbance areas are intended to provide a framework for ranking and prioritizing projects according to a range of criteria, including key issues affecting future decisions, such as cost, level of complexity, potential constraints, and location (subwatershed).

1. INTRODUCTION

1.1 OBJECTIVES AND CRITICAL QUESTIONS

The primary objective of this assessment is to describe historical and present-day watershed and reach-scale hydrologic and geomorphic conditions in the Martis Creek watershed. This report is intended to be a transitional technical study for use by the project team and other stakeholders as a watershed characterization document that includes direct observations and field documentation of conditions in the watershed. The initial sections of the assessment should provide a clear basis for prioritization of land management needs and restoration priorities, as presented in Section 4. In particular, we seek to address the following questions:

- What are the primary factors and processes affecting habitat?
- What and where are the main historical land uses, and to what degree have land management practices introduced or exacerbated sediment sources?
- What are some of the long-term ecological functions of Native American land use in the watershed?
- What is the range and recurrence of peak flows at a number of locations in the watershed?
- What is the range of late summer baseflow that can be expected in the lower watershed?
- Where do stream-aquifer interactions occur (in terms of 'losing' and 'gaining' reaches)?
- What are the linkages between water, sediment, and channel conditions throughout the watershed?
- Where are the potential and actual problem areas in the watershed, from upland areas to bottomlands supporting channel and riparian areas, and along the flow paths that connect them?
- What current and potential land management practices are effective in protecting and improving water quality?
- What restoration and land management strategies should be implemented to further protect habitat and improve water quality?
- How do various alternatives to address the safety of Martis Dam affect potential habitat restoration strategies?
- Where and to what degree might infiltration offset some of the constraint affecting habitat, and/or provide recharge to the underlying aquifer?

Fundamentally, this report is about caring for the watershed, taking time to understand the natural functions and processes at work and how they have been altered, and taking appropriate actions to continue to protect and enhance the watershed.

1.2 ACKNOWLEDGEMENTS

The work and information presented in this report draws on information and efforts kindly provided by a number of key individuals. Hayes Parzybock of East-West Partners and Matt Setty and Travis Branzell of JBR Environmental Consultants provided a wealth of water quality data that has been collected in the watershed. Marcia Beals and Jay Parker at the Tahoe-Truckee Sanitation Agency provided insight regarding water reclamation operations and prior water quality evaluations that were carried out during design of the facility. John Svahn of the Truckee-Donner Land Trust (TDLT) and Hardy Bullock provided insight regarding recent forest management practices at Waddle Ranch, while Jen Mader and John Loomis granted access to Northstar lands and outlined ski-run and forest management practices being employed by ski area. Mike Stadenmeyer and Joshua Detwiler from the Northstar Community Services District (NCSD) described some details of water operations surrounding Northstar. Ian Fitzgerald and Steve Murphy at the Truckee Donner Public Utility District (TDPUD) quickly and graciously provided high

resolution topographic data for use in re-defining the watershed boundary and assembling the watershed model. John Eaton of the Mountain Area Preservation Foundation (MAPF) provided background and graphics showing areas that have been identified as priority conservation areas. Jacqui Zink assisted in identifying a number of potential restoration projects within U.S. Army Corps of Engineers (USACE) property in the vicinity of Martis Reservoir. Randy Westmoreland (USFS) and Darrel Cruz (Washoe Tribe) participated in the watershed field tour and provided feedback on a number of potential restoration strategies developed in particular areas. Darrel Naruto from CalTrans District 3 has helped develop strategies and provided feedback on potential means of addressing drainage issues at the Highway 267 Middle Martis Creek crossing. Finally, John High at the USACE Sacramento District was extremely helpful in facilitating a Freedom of Information Act Request and providing hydrologic modeling files, reports, and information related to design and evaluation of Martis Dam.

1.3 WORK CONDUCTED

We began this component of the assessment with a review of available background information, drawing on a number of sources. An important challenge in developing the work scope and our analytical approaches has been interpreting existing information and studies in the context of habitat restoration planning — not necessarily the original primary purpose of those studies — so that restoration potential may be meaningfully evaluated. We also attempted to emphasize certain subbasins or general areas of information where new interpretations seemed most needed, or where potential restoration opportunities have already been identified. Development of the watershed attributes report included the following:

1) Reviewing previous local and regional investigations,
2) Reviewing watershed physical characteristics;
3) Evaluating existing hydrologic data;
4) Identifying historical and landscape-altering events; and
5) Reviewing historical aerial photographs to identify patterns of disturbance.

Watershed setting is presented in Section 2.1 of this report, including a review of prior studies, geology and soils mapping, sediment transport estimates, surface-groundwater interactions, and watershed hydrology. Section 2.12 of the report outlines the land use history and inferred or potential effects of various actions that have taken place in the watershed. Hydrologic and geomorphic conditions and particular areas of watershed disturbance observed during the field study are presented in Sections 2 and 3.

1.3.1 HISTORICAL STUDIES

The Martis watershed has a clear signature of complex historical and present-day human uses, differentiating it from most Middle Truckee River tributaries. Legacy impacts associated with logging, grazing, and dairying have been documented in the watershed, and a number of sensitive archaeological sites have been identified. In order to identify particular types and eras of disturbance, Dr. Susan Lindström conducted a literature review of pertinent historical and prehistoric land uses and prior regional archeological investigations. Sources included:

- Placer County land ownership files and archives;
- Historical maps and photographs;
- Early regional field and mining surveys;

- Historical aerial photographs;
- Oral history interviews;
- Native American consultation; and
- General state histories, regional inventories and unpublished manuscripts.

Historical research is ongoing in a sense; current findings are presented as a workbook in progress (Appendix A). Details included in the workbook and trends relating to watershed, hydrologic, and geomorphic changes are also included in the body of this report in Section 2.12.

1.3.2 Hydrologic Assessment

The USACE has carried out a number of investigations prior to and after the construction of Martis Creek Dam. Most recently, updated hydrologic modeling has been conducted to assess the adequacy of the spillway of Martis Creek to convey the 'Probable Maximum Flood' (PMF; USACE, 2002). As part of this evaluation, USACE has developed a hydrologic model of the watershed, and concluded the existing dam configuration (outlet works and spillway) is not adequate to convey. While the study provides a useful basis and establishment of watershed parameters, the main purpose is to evaluate the PMF — a very unlikely scenario and one that bears minimal consideration for restoration planning purposes. In order to adapt the model for restoration planning purposes, Balance's engineering staff reviewed the model, adapted selected parameters, and developed and calibrated a new hydrologic model for prediction and analysis of channel-altering peak flow events, the results of which are described in Section 2.9.2.1.

Channel-altering peak flow estimates were carried out by:

1. Using the USACE Hydrologic Modeling System (HEC-HMS) version 3.1.0 in conjunction with the Geospatial Hydrologic Modeling Extension (HEC-GeoHMS) version 1.1 for use with ArcView Geographic Information System (ArcGIS), and
2. Reviewing flood frequency analyses developed by the USACE for Martis Creek.

1.3.2.1 HEC-HMS Model

Runoff and peak discharge estimates were carried out using the USACE Hydrologic Modeling System (HEC-HMS) version 3.5 in conjunction with the Geospatial Hydrologic Modeling Extension (HEC-GeoHMS). HEC-HMS is a standard industry package for modeling rainfall, hydrologic losses, overland hydrograph routing, and runoff storage in detention basins or reservoirs. HEC-GeoHMS was developed as a geospatial hydrology tool kit for engineers and hydrologists. The program allows users to visualize spatial information, delineate subbasins and streams, construction inputs to hydrologic models, and assist with report preparation. It operates as an extension for ArcGIS that analyzes digital terrain information and transforms the drainage paths and watershed boundaries into a hydrology data structure that represents the watershed response to precipitation. The hydrologic results from HEC-GeoHMS are then imported to HEC-HMS, where meteorological data are added, watershed parameters set, and the rainfall-runoff relation is simulated.

1.3.2.2 Model structure

Three upper basins: Martis, West Martis, and Middle Martis all flow to the uppermost junction of Martis Creek (Martis Creek at Highway 267). Flow is then routed to the next junction downstream (Martis Creek Upstream of Martis Reservoir), where the East Martis Creek and intervening areas are routed in and combined with flows from the upper basin. Streamflow directly into the reservoir is then accounted for by adding intervening areas. Discharge from Martis Reservoir is then routed downstream to the junction for the entire Martis Creek Watershed at the Truckee River (Martis Creek at Mouth), which includes runoff from intervening areas located between Martis Dam and the Truckee River.

1.3.2.3 METEOROLOGICAL MODEL

Hourly streamflow and precipitation data from Martis Creek Reservoir[1] were available for a period between January 1, 1995 and January 1, 2008. Rainfall records from this gage were used to create the meteorological models in the HEC-HMS model calibration. Precipitation data from the storms of March 25-26, 2006 and January 1-3, 1997 were used for model calibration because observed flows were similar to the calculated 2-year streamflow and an extreme rain-on-snow flood event, respectively. For the March 2006 storm event, the total rainfall depth was 1.37 inches; the total for the January 1997 event was 3.89 inches. Storm durations were approximately 12-hours for the 2006 event and 48-hours for the 1997 event.

1.3.2.4 RUNOFF AND FLOW ROUTING

The USACE Martis Creek Spillway Adequacy Study (USACE, 2002) contains a HEC-1 model that provided information and parameterizations on which to base our HEC-HMS model. The HEC-1 model used unit hydrographs to transform the watershed runoff into a flow hydrograph. These unit hydrographs control timing and shape of the outflow hydrograph of the subbasin. Although the watershed boundaries used in our model were slightly different for the lower subbasins, we approximated a relationship for the unit hydrographs in the adequacy study and used them as the transform in our runoff model. This was appropriate because the unit hydrographs in the adequacy study were developed specifically for the Martis Creek watershed, and provided a significantly better correspondence between the simulated and measured discharge going into the reservoir than other common methods of modeling rainfall or rain-on-snow runoff. A stage/storage/discharge relationship and initial conditions for the reservoir were also obtained from the HEC-1 model used by the USACE. The subbasin characteristics and model parameters used in the HEC-HMS model are summarized in Table 1.

Further evaluation of the range of channel-forming flows at various locations in the watershed will be carried out in conjunction with field analyses.

1.3.5 DETECTING GEOMORPHIC CHANGE

Stream channels adjust to changes in climate, hydrology, soil conditions, vegetation and land use, and the natural component of these changes are a vital driver of aquatic ecosystem functioning (Brierley and Fryirs, 2005). The expression of change varies from stream to stream, and the inherent resiliency of creeks to provide habitat and support aquatic species in the face of change also varies. Understanding the variability in these changes, as well as individual channel response and recovery, provides a baseline for evaluating potential and observed effects from water management, forestry, road building, and urbanization on channel structure and function, and provides for a more informed basis for restoration. Since many of these changes occur over time scales that are not readily observed, we have used multiple lines of evidence to define a baseline of variability and resilience including: a) historical accounts of changes in the watershed; b) review of precipitation and streamflow records for assessment

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[1] California Data Exchange Center Station ID: MRT

of significant floods and droughts; c) literature describing channel and response to disturbance in glacial and volcanic derived-systems; and d) aerial photography and historical map interpretation.

We obtained and reviewed the following historical aerial photographs and maps:

- Historical topographic maps (1889, 1895, 1940, 1955, 1969, 1978, 1985, 1992, and 2000) obtained from USGS and UC Berkeley Earth Sciences and Map Library;
- Aerial photography (1939, 1952, 1966, 1987, 1992, 1997, 1998, 2004, and 2009) obtained from USFS, USGS, and Google; and
- False-color infrared aerial photography (1987 and 1992) obtained from USGS and USFS.

Selected historical images were georeferenced to the Universal Transverse Mercator, North American Datum (UTM NAD83) coordinate system using GIS and compared to recent aerial photography to assess and evaluate changes in stream course, riparian areas, and land use. Limited GIS analysis was used to:

- Calculate watershed metrics (e.g., areas, slopes, and channel lengths);
- Establish road densities for subwatersheds or tributaries within the Martis watershed; and
- Identify disturbances or significant changes to areas and channel reaches.

Field observations of meadow and channel conditions, sediment sources, and shallow surface-water groundwater dynamics are scheduled to take place during summer 2011.

1.3.6 Disturbance Inventory and Existing Conditions Field Methodology

Through an iterative approach, we have targeted our reconnaissance-based field investigation in areas where projects seem most feasible, or where hydrologic and soil production functions appear to be most impaired. Work has been carried out according to a) hydrogeomorphic zones b) restoration needs identified by stakeholders, and c) the assessment team's understandings of particular disturbed areas. Field methods have varied according to geomorphic zones and access, and include:

- Road and bike trail drainage mapping in steep upland areas, primarily to describe hydrologic connectivity and sediment delivery from upland areas to streams;
- Partial inventory and preliminary assessment of landings associated with historic and recent logging activities;
- Channel cross-section measurements in alluvial reaches to evaluate the inferred frequency of floodplain inundation;
- Photographs of disturbed reaches;
- Landslide and bank failure mapping;
- Estimation of grain-size distributions on channel beds; and
- Qualitative descriptions of channel types found in various geomorphic zones.

The foundation of this approach is the integration of upland and flow path attributes with channel conditions observed in downstream areas. Accordingly, our discussion in Section 3 is structured according to subwatersheds and hydrogeomorphic zones.

2. WATERSHED ATTRIBUTES

2.1 SETTING

The Martis Creek watershed is located in the Sierra Nevada Geomorphic Province, east of the Sierra Nevada crest and part of the larger Tahoe-Truckee River Basin of California and Nevada. The watershed covers an area of approximately 42.7 square miles and drains to the Truckee River in the Town of Truckee, California (Figure 1). Elevations in the Martis Creek watershed range from 8,617 feet in the headwaters to 5,680 feet at the mouth. The upper watershed is mountainous, underlain by volcanic bedrock. Upper elevations near Mt. Pluto and Northstar have been glaciated, leaving relatively old and well-developed fine-grained soils in most of the upper watershed. Many past and current land uses (such as urbanization, grazing, or road-building) compact or diminish the infiltration capacity and overall function of the soils while increasing runoff and nutrient release to streams. Since these geologic units and fine-grained soils are prone to rapid erosion when disturbed, extensive incision often occurs in channels downstream of disturbed areas. The lower watershed is located in Martis Valley, with well-developed alluvial fans at the mouths of upper drainages that interfinger with a deep sequence of layered glacial outwash, volcanic deposits of the Lousetown Formation, and water-bearing alluvium of the Prosser and Truckee Formations.

The Martis watershed has a clear signature of complex historical and present-day human uses, differentiating it from most Middle Truckee River tributaries. Historically, the watershed has supported a variety of land uses back to the mid-1800s including logging, mining, and grazing, with increasing residential and resort development near the Tahoe-Truckee Airport, Northstar and in the central lower portions of the watershed. Legacy impacts associated with logging, grazing, and dairying have been documented in the watershed, and a number of sensitive archaeological sites have been identified. Most land in the watershed is now privately owned while some lands are managed as open space and/or recreation by special districts or agencies such as the Truckee-Donner Land Trust (Waddle Ranch), Truckee-Tahoe Airport District, USACE, TDPUD, and the NCSD, among others. Forest management practices are carried out by a number of different entities. In Martis Valley, water treatment and infiltration facilities managed by the Truckee-Tahoe Sanitation Agency (T-TSA) are located adjacent to the mouth of Martis Creek near the Truckee River. Groundwater stored in valley sediments provides most of the drinking water to residents of the watershed and the Town of Truckee. Aggregate mining takes place adjacent to the lower-most reaches of the stream, immediately below Martis Dam.

The USACE has identified risks associated with Martis Dam, including inadequate spillway sizing, abutment seepage, and seismic threats. The USACE is planning to remediate these risks within 5 to 7 years, and is evaluating a number of alternatives through ongoing studies of hydrologic, seismic, and geophysical conditions.

Portions of the watershed have been urbanized during conversion from open space to residential housing and golf courses, including the Northstar golf course along West Martis Creek, and the Lahontan and Martis Camp Communities along Martis Creek. Additional areas are under consideration for new ski runs and residential development. A landmark agreement in 2005 established a compromise between open space protection and residential/resort development limiting the footprint of development and initiating and funding a process whereby other areas outside the development zones can be preserved and managed as open space.

Martis Valley represents a unique and fragile habitat, incorporating and at times integrating high desert chaparral, mixed -pine, mountain meadow, and riparian ecosystems. All of these elements clearly indicate the importance of planning and implementing comprehensive and integrated management and restoration projects in the Martis Valley. The opportunities to restore functions and ecosystem services in this watershed and provide high-quality recreation and other economic benefits will need to be considered in the context of a wide range of components.

2.2 HYDROGRAPHY

Martis Creek originates in the southwestern portion of the watershed near Sawtooth Ridge, and is met by four perennial and primary tributaries where it crosses Martis Valley: 1) West Martis Creek, 2) Middle Martis Creek, 3) East Martis Creek, and 4) Dry Lake Creek (see Figure 2). Significant smaller first- and second-order tributary streams are present in each of these subwatersheds and areas along Martis Valley proper. Longitudinal profiles for the mainstem stream, major tributaries, and elevations of mapped springs are illustrated in Figure 3. Representative channel gradients for the five hydrogeomorphic zones described below are provided in Table 2. Stream gradients in the upper watershed range from 6 to 13 percent2; stream channels along the Martis Valley floor and montane-meadows range from 1 to 4 percent; gradients along lower Martis Creek downstream of Martis Dam average approximately 1.5 percent.

2.2.1 MARTIS CREEK DAM

Martis Creek Dam was completed in 1972 in order to provide storage for flood control, recreation, and potentially water supply (USACE, 1985). Shortly following construction, seepage was observed in the dam face, posing significant failure risk. As a result, the reservoir has rarely been filled to capacity, and is now maintained at a minimum pool elevation of 5,780 feet (Figure 4), with outlet works at a near-permanent, maximum capacity condition. If the dam were repaired and used for water supply storage as originally designed, water could be held at a 'normal full pool' elevation of 5,838 feet, resulting in 20,400 acre-feet of stored water (Figure 4).

Under current conditions, the dam is maintained at a minimum pool elevation of 5,780 feet, offering 19,600 acre-feet of flood control storage space (USACE, 2002). The maximum outlet capacity is 580 cubic feet per second (cfs) prior to spilling, so even with outlet gates in a wide-open position for dam safety, the reservoir currently provides some flood control function, such that inflows to the reservoir greater than 580 cfs are detained, and water level in the reservoir begins to rise. If peak flows are high enough and of a significant duration, the reservoir may fill to capacity and spill at an elevation of 5,853 feet, causing relatively widespread upstream inundation, as shown in Figure 4, eventually passing up to 4,640 cfs.

A number of alternative dam operations scenarios are being considered by the USACE. At this time, it is possible that the dam will be repaired and water levels maintained as initially designed. Under this scenario, restoration strategies within the reservoir pool should consider the potential for periodic or permanent inundation. Dam removal is also an alternative considered by the USACE Martis Dam

[2] A channel gradient of 10 percent equals a rise of 528 feet over a longitudinal distance (along the channel) of 5,280 feet (1 mile), as the fish swims.

evaluation team, potentially requiring a great deal of stream channel habitat restoration and management of stored sediment management within the reservoir pool.

2.3 Past Projects and Related Studies

Appendix B is an annotated bibliography of work carried out in the watershed, and describes some of the pertinent findings from those studies, as related to planning for habitat management and restoration.

2.3.1 Hydrology

The USGS maintained a streamflow gaging station on Martis Creek between Martis Dam and the Truckee River from October 1959 through September 2010, and recently transferred the gage to the USACE in October 2010. Since Martis Dam was constructed in 1972, these data have been used by the USACE, along with Martis Reservoir water level data and stage-storage information, to develop a record of inflow to Martis Reservoir. Daily reservoir inflow data are available for water years 1972 to 2008, and hourly data are available from 1995 to 2008. From these data, peak flow frequency analyses were conducted and are presented in Figure 5 (USACE, 2002). The Truckee River Basin Reservoirs Water Control Manual (USACE, 1985) also includes peak-flow frequency curves for the lower Truckee River, and outlines the expected flood control functions of the reservoirs built in the watershed, including Prosser, Boca, and Stampede Dams in addition to Martis Dam.

Baseflow and intermediate peak streamflow data has been collected at a number of locations under various water quality assessments and monitoring programs (Nichols Consulting Engineers, 2008, Appendix C). Table 3 provides a summary of monthly streamflow into Martis Lake.

2.3.2 Hydrogeologic Assessments

A number of aquifer studies and well construction reports are available for the Martis Aquifer, which includes and extends beyond the boundaries of the Martis Watershed. This includes a surface water – groundwater interaction study completed for TDPUD (Interflow Hydrology, 2003), which is used for analysis herein. The Martis Valley Groundwater Management Plan (GMP) is being prepared by the Placer County Water Agency (PCWA), TDPUD, and Northstar Community Services District. The effort will build upon a MODFLOW-based groundwater model being constructed by the Desert Research Institute, which will incorporate climate change and surface-groundwater interactions.

2.3.3 Sediment Transport Evaluations

The Middle Truckee River TMDL for suspended sediment (California Regional Water Quality Control Board, 2008; Amorfini and Holden, 2008) is based on analysis of suspended sediment transport data collected by DRI, the U.S. Geological Survey, and the Lahontan Regional Water Quality Control Board between 1975 and 2000 (McGraw and others, 2001). In this study, flow and load duration curves were developed to establish a numeric target for suspended sediment concentrations, as measured on the Truckee River at Farad, California. Figure 6 shows the data that were used in this initial analysis, suggest that sediment transport rates in Martis Creek were relatively low in 2000 compared to transport rates measured by the USGS from 1975 to 1985. We suggest that suspended sediment transport rates included in this study be used as a baseline to evaluate potential reductions in fine sediment loading as a result of watershed management activities.

2.3.4 WATER QUALITY

Streamflow and water quality data collected by the USGS, the T-TSA, the Town of Truckee, Placer County, and numerous other entities for compliance with stormwater and discharge permit requirements mandated by the Regional Water Quality Control Board provide useful information regarding existing impacts to water quality associated with various land uses.

The Truckee River Water Quality Monitoring Plan (TRWQMP, Nichols Consulting Engineers, 2008) also provides a succinct overview of the various water quality monitoring studies that have recently taken place in the basin and is included as Appendix C to this report. During water year 2010, CDM began implementing the TRWQMP (CDM, 2010), which included rapid assessments in the Martis Watershed and installation of a stream gage on Martis Creek at Highway 267. Water year 2011 streamflow and water quality data is also available (CDM, 2011).

2.3.5 HABITAT

The Northstar Habitat Management Plan is being developed in an effort to maintain and enhance the values of forests, aquatic, riparian, and meadow habitat in the vicinity of Northstar (Northstar-at-Tahoe, 2011), recognizing that these environments provide habitat for a range of sensitive species, including Northern Goshawk, California Spotted Owl, Pileated Woodpecker, American Marten, Mule Deer, Willow Flycatcher, Mountain Yellow-Legged Frog, and Sierra Nevada Mountain Beaver. As part of the HMP development, a number of small (1st and 2nd order) streams with 'altered hydrology' were identified. The habitat management plan calls for enhancement and protection of riparian habitat, restoration of some of these channels, and treatment of roads to reduce their effects on riparian and stream corridors.

Sierra Watch and the Mountain Area Preservation Foundation (MAPF) have established draft priority conservation areas for unspecified species, the majority of which lie in the Martis Creek, East Martis Creek, and Middle Martis Creek subwatersheds.

The Martis Watershed also offers habitat for a variety of fish. Prior to the arrival of European inhabitants and fish species declines, Martis Creek was an important year-round fishery for the Washoe people. Fishery resources included Lahontan Cutthroat Trout (LCT) and a variety of smaller species, such as sucker and chub. LCT is now listed as a threatened species due to two primary factors:

1) Present or threatened destruction, modification, or curtailment of habitat or range, and
2) Natural or manmade factors affecting the species continued existence (Truckee River Basin Recovery Implementation Team, 2003).

Related conditions contributing to the decline and affecting the potential for recovery of the species include:

- Reduction and alteration of streamflow;
- Alteration of stream channels and morphology;
- Degradation of water quality; and
- Introductions of non-native fish species.

The Washoe Tribe has developed a Comprehensive Land Use Plan (Washoe Tribal Council, 1994) which includes goals of reestablishing a tribal presence within the Truckee-Tahoe basins and revitalizing the Washoe heritage and cultural knowledge, including protection of traditional properties within the cultural landscape and the harvest and care of traditional plant resources. Plans include the re-introduction of traditional plant gathering practices by Washoe people and the collection of oral histories relevant to land use, resource use management, diet, social and economic history, organization, and believes. The issues are not simply the presence or absence of traditional plants, but their vigor, their environment, and their physical attributes.

2.3.6 Heritage Resource Sensitivity

Martis Valley is renowned for its large number of prehistoric archaeological sites, some of which exhibit relatively unique characteristics as compared to other sites in the region, and is therefore considered to be at least moderately sensitive to regard to heritage resources, with some areas being highly sensitive. There is a high density of surface remains and some sites contain visible midden (i.e., subsurface cultural deposit). The site inventory for Martis Valley includes a rock shelter, and a somewhat rare form of rock art (known as cupules) is present at several sites. An extensive prehistoric site complex occupies low and gently-sloping, sagebrush/bitterbrush-covered glacial terraces that border lush wet-meadows along Martis Creek and its unnamed tributaries. Artifact assemblages document prehistoric occupation dating from at least the Middle to Late Archaic Period (4,000-500 years ago) and possibly extending into the protohistoric and ethnohistoric period.

Oral histories provided by Washoe Elders and descendants of pioneer families indicate contact-period occupation in Martis Valley by the Washoe Tribe, although this has yet to be confirmed in the ethnographic and archaeological records. Archaeological evidence (albeit meager) provides further support for contact-period occupation in the Valley, as marked by the presence of trade beads, late-period arrow points and miscellaneous tools fashioned from historic glass, etc.

2.4 Climate

2.4.1 Local Climate

The Tahoe-Truckee region experiences warm, dry summers, and cold and snowy/wet winters. Elevation and geography play major roles in temperature and precipitation. Mean annual precipitation ranges from approximately 30 inches3 below 6,500 feet to over 45 inches (snow water equivalent) above 6,500 feet. Precipitation falls mostly as snow between October and April, though streamflow also responds to mid-winter rain-on-snow events. Annual peak flow typically occurs during spring snowmelt in May or June. A small proportion of the total annual precipitation falls during brief thunderstorms in the summer months. Figure 7 provides mean monthly rainfall, as recorded at the USFS Truckee Ranger Station, just north of the watershed. Temperatures can range from well below 0 degrees F in the winter to above 90 degrees F in the summer.

2.4.2 Climate Variability: Wet and Dry Periods

Watershed processes are dependent on a number of factors including climate variability. Variability is marked by periods of greater than average precipitation (‘wet periods’) and periods of below average

[3] Truckee Ranger Station is located just west of the Martis Creek watershed at 5,930 feet above sea level. This station has the longest climate record for the region but may not represent long-term climate conditions for higher elevations in Martis Creek watershed.

precipitation or drought. Droughts are common in the Sierra and recognizing them provides us with an understanding of the limitations of our water resources, especially for consumption, habitat, and the indirect effects on watershed processes. Droughts commonly increase demands on local water resources and cause stress on aquatic habitats. Furthermore, droughts increase risk of wildfire and perpetuate our desire to suppress wildfire. Figure 8 illustrates the annual percent deviation from mean annual precipitation in Truckee (1906-1907, 1913-1914, and 1935-2008). The data show that periods of below average precipitation have longer duration (e.g., 1971-1978, 1987-1994) whereas wet periods are typically short-lived and more extreme (e.g., 1962-1965, 1982-1983).

Dry or wet periods may be punctuated by significant events (i.e. floods, fires). Significant events are the catalyst for measurable changes in the landscape. For example, floods can generate landslides, debris flows, cause bank erosion, channel avulsion or aggradation. Table 4 lists dates of the major flood events in the Tahoe-Truckee Basins.

Identification of prolonged wet and dry periods provides a context for assessing impacts and a basis for developing appropriate restoration approaches. For example, wetland desiccation or conversion to drier conditions may be a relatively temporary phenomenon resulting from successive dry years rather than simply a conversion due to land practices; restoration in such a circumstance must take into account the potential for future wetter or drier conditions. Furthermore, restoration approaches and techniques need to address or account for the site-specific variability in climate such that provisions for ecologic or geomorphic functions deemed important can be planned to support recovery from excessive dry periods or punctuated by wet cycles. Table 5 is a climate summary detailing periods of less than average and greater than average precipitation, identified from climate records (USFS, 2011) and historical accounts documented by Lindström (2011), Kattlemann, 1992, USGS, and Paulson and others (1989). Figure 8 and Table 5 imply that, although current conditions are quite wet, with average or above-average precipitation in water years 2010 and 2011, the prior decade has been a dry one, so recent and current conditions should be reflective of these trends.

Lindström (2011) provides a more detailed review of the paleoclimate and more recent climate and conditions specific to the Martis Watershed (see Appendix A).

2.4.3 Climate Change

This study does not intend to evaluate or predict future conditions in Martis Watershed as the result of climate change. Instead, we cite current literature and the general trends they predict for the regional area.

In the Tahoe Basin, Coats and others (2010) have predicted a future shift from snowfall to rain over the next century as the result of projected increases in both minimum and maximum air temperatures. These predictions also suggest a shift toward earlier snowmelt and runoff, with increased periods of drought as well as a decrease in the annual minimum streamflows for the region. Their predictions also suggest an increase in the magnitude of floods, due possibly to an increased occurrence of rain-on-snow events. Combined, these changes pose significantly different conditions in the watershed than those observed today, including increased threat of wildfire, increased tree mortality due to insects and disease, increased erosion and sediment yields, and losses of aquatic habitat.

Fried (2004) has predicted an increase in the number and severity of fires in the Sierra Nevada, including an accounting for suppression efforts based on hotter, drier summers in the Sierra Nevada resulting from a decreased snowpack and earlier runoff. Effects of fire in the Martis Watershed are discussed further in Section 2.12.2.5.

2.5 HYDROGEOMORPHIC ZONES

The geologic history of this region has given rise to distinct geomorphic settings in the watershed. For the purposes of this study, we consider five zones, herein described as hydrogeomorphic zones. The zones are established on the basis of similar geology, geography, and physical conditions at the watershed scale, and provide a first-cut assessment of the hydrologic processes and channel forms that may be expected in various parts of the watershed. The primary objective of identifying these hydrogeomorphic zones is to highlight influences of slope, geology, soils, and channel types which may require different restoration approaches and expectations. In addition, specific areas in the watershed may be more sensitive to disturbance than others. For example, road density in the deeply weathered older volcanic soils at upper elevations may have a greater effect on sediment delivery than roads in flatter, lower-lying areas, where sediment deposition (rather than sediment generation) is the dominant process.

These zones are listed and briefly described below and shown in Figure 9:

A. Upper watershed

- Mountainous, steep slopes and confined valleys;
- Mostly forested, dominant vegetation includes conifer;
- Underlain by older (Miocene) volcanic bedrock;
- First- and second-order streams;
- Stream channels are expected to have primarily cascade and step-pool forms; and
- Large woody debris is immobile, largely acts to trap sediment and create temporary sediment storage and/or sediment release.

B. Glaciated valleys

- Limited to upper west fork of West Martis Creek;
- U-shaped valley resulting from Tahoe and Tioga glaciations;
- Very steep headwaters, with sandy, coarse and relatively young soils in downstream areas;
- Glacial till and moraine features along valley margins;
- First-and second-order streams;
- Stream morphology is expected to be dominated by cascade and step-pool morphology; and
- Coarse glacial outwash deposits from Tahoe and Tioga glaciations found in downstream areas.

C. Mid-elevation uplands

- Underlain by younger (Quaternary), and in some cases, deeply dissected volcanic bedrock;
- Moderately steep slopes with confined valleys;
- Well-developed soils and rocky exposures;
- Mostly forested, dominant vegetation includes conifer;
- First-, second-, and third-order streams;

- Stream morphology is expected to be step-pool, plane-bed, and pool-riffle; and
- Large woody-debris is immobile, largely acts to trap sediment.

D. Martis Valley floor and meadows

- Buried moraine and weathered glacial outwash from Donner, Tahoe, and (to a limited extent at the lowest elevations) Tioga glaciations;
- Primarily open valleys, meadows, wetlands, floodplains, and alluvial fans, as well as steeper channels where Martis Creek has dissected glacial outwash terraces;
- Alluvial processes are dominant;
- Meadow and rangeland, dominantly scrub and wetland vegetation;
- Third- and fourth-order streams;
- Stream morphology is expected to be predominately pool-riffle, braided, and/or, to some extent, plane-bed;
- Large woody debris forms in-channel structure and habitat;
- Areas historically and presently quarried for gravels and sands;
- Vegetation is scrub or wetland riparian;
- Typically contain modified channels, straightened for historical agricultural activities and/or aggregate mining operations; and
- Some areas periodically or permanently flooded by Martis Reservoir.

2.6 WATERSHED GEOLOGY

This section of the report describes the structural blocks and fault zones, with emphasis placed on those factors affecting (a) groundwater bearing properties and yields, and (b) geomorphology and sediment production. The most detailed available geologic mapping was carried out by Birkeland (1961, 1963, and 1964), with some additional work in the watershed by Latham (1985) and Sylvester and others (2007). A regional compilation was assembled and digitized by Saucedo and others (2005); this compilation coupled with the original geologic descriptors forms the basis of the geologic attributes described herein and shown on Figure 10.

As previously mentioned, the Martis Watershed lies east of the Sierra Nevada crest in the Sierra Nevada Geomorphic Province, but is also part of a transitional zone associated with the adjacent Basin and Range Geomorphic Province. This transitional zone, also known as the Tahoe-Medicine Lake Trough or more locally the Truckee Basin, is largely characterized by early and more recent volcanism (Birkeland, 1963), active Quaternary faulting (Saucedo, 2005; Melody, 2009; Brown, 2010), and Pleistocene glaciation (Birkeland, 1964; Saucedo, 2005; Sylvester and others, 2007), all of which have influenced drainage patterns, landforms, and interactions between surface water and groundwater. Higher elevations in the upper watershed to the south are underlain by Miocene volcanic bedrock. Intermediate elevations in the central portion of the watershed include more recent volcanic flows, whereas the Martis Valley floor comprises the lowermost portion of the watershed. Up to 1,200 feet of water-bearing sedimentary rocks interlayered with less permeable volcanic rocks fill the valley (Nimbus Engineers, 2001). These shallow units all overlie Cretaceous plutonic granitics and metasedimentary rocks, as well as Miocene volcanic units which are found in the upper watershed (Nimbus Engineers, 2001).

In this section we describe the geologic processes that have shaped the landscape in five separate categories. Our discussion is presented through five different categories: a) volcanic bedrock; b) glacial episodes; c) hillslope processes; and d) fluvial processes. All of these components have a direct link to how specific areas of the watershed and channels may respond to both natural (e.g., wildfire, flood) and anthropogenic disturbance (e.g., logging, road building, and urbanization). In Section 3, we describe anthropogenic disturbances that have shaped the watershed over the last 150-200 years.

2.6.1 Bedrock Geology

A number of strike-slip and normal faults have established the structure of the Truckee Basin, in which the Martis valley and portions of the watershed lie. Following the structural formation of the basin, a number of volcanic episodes established the unique physiography of the present-day Martis Valley and watershed. The Pliocene-aged (late Tertiary) Hirschdale flow was the first of these events, and dammed the Truckee River downstream of Martis Creek creating a lake and a period of aggradation upstream into the Martis Valley. Today, these stream and lake deposits, known as the Prosser Creek Alluvium, are characterized by coarse, well-drained fluvial and lacustrine deposits that support a xeric vegetative community in the western end of the Martis Valley along Highway 267. Brown (2010) has divided the Prosser Formation into 3 members: the fluvial member consisting of interbedded fine gravel, sand, silt, and clay, the lacustrine member (also referred to as the 'Blue Silt'), and undifferentiated deposits. The Blue Silt is thickest (15 to 25 feet) to the east, thins to the west, and is thought to serve as an aquitard in the vicinity of Martis Dam, forcing groundwater to flow laterally and creating seeps and wetlands where it outcrops. Wetland conservation and enhancement opportunities may exist in other locations where the Blue Silt or other fine-grained aquitards outcrop in the watershed, probably including along the left (south) bank of Martis Creek below Martis Dam.

The second significant volcanic event to shape Martis Valley was the volcanic flows associated with Bald Mountain (western boundary of Martis Watershed). These flows forced the drainage pattern of the Truckee River Canyon ('Big Chief Corridor') and helped create Martis Valley as we know it today (Birkeland, 1963). Subsequently, there was a period of volcanic flows associated with the eastern side of the watershed also known as the Dry Lake flows, a series of basalt and latite flows where Dry Lake and East Martis Creeks are now located. Weathering and erosion of these volcanics tend to develop relatively young, coarse-textured, and well-drained soils (Hanes, 2002).

These flows are thought to have been numerous and continued over a long period of time because they are deeply dissected by streams in this portion of the watershed (Birkeland, 1963); dissection is likely also driven by continuing uplift associated with local and active faulting. Field-evaluation of streams in certain portions of the watershed should therefore take into consideration channel incision as a natural component of the landscape-forming process, and also recognize that these streams may be more prone to watershed disturbances, as they may already be in a state of dis-equilibrium.

2.6.2 Glaciation

Volcanic flows and resulting sediment accumulation marked an initial phase of sediment aggradation in Martis Valley. A second phase of aggradation ensued as several episodes of glaciation occupied the upper reaches of Middle Martis Creek and the Sierra Nevada Crest to the west. Birkeland (1964) suggested that the Donner Lake glaciation (600,000-400,000 years before present, YBP), traveled down the Truckee River Canyon and reached the confluence with Martis Creek. Evidence for this glacial advance is documented by the moraine terraces and outwash deposits underlying the Truckee-Tahoe Airport and surrounding area. The Tahoe glaciation (118,000 to 56,000 YBP) was not as extensive but

Tahoe-aged outwash terraces are present on left (west) bank of Martis Creek below the older outwash deposits downstream of Martis Dam.

During these glaciations, it is thought that ice dammed the Truckee River and Lake Tahoe at the mouth of Squaw Creek, sometimes breaching releasing extreme and catastrophic floods ('jokulhlaups') down the Truckee River Corridor. As result, glacial outwash deposits include very large (up to 10 feet in diameter) rounded boulders which were transported downstream during the events.

During the Tahoe and Tioga glaciations (30,000 to 10,000 YBP), a small alpine glacier occupied the northeast flank of Mt. Pluto, site of the present-day Northstar ski area, extending as far as 2 miles down the West Fork of West Martis Creek (Birkeland, 1964). As a result, this particular tributary to West Martis Creek is composed of sandy-cobble soils derived from glaciation and outwash.

2.6.3 Channel Processes and Form

Channel processes can be framed in terms of a simple geomorphic construct based on spatial patterns of sediment production, transport, and deposition, as described below in the context of the Martis Watershed. Watershed management strategies are likely to differ where these different processes dominate. It is also important to recognize that these zones are not static, and sediment transport processes may change in a particular location following large floods, fires, or during extreme droughts.

2.6.3.1 Sediment production

Upland areas are characterized by steep slopes and confined valleys where hillslope processes are dominant and channel erosion is constrained to the vertical dimension. In the Martis watershed, we typically find this zone above 6,000 feet with stream gradients in excess of 6 percent in the mountainous upper watershed and, to some extent, at the mid-elevations. Sediment production occurs through landsliding, rilling and road erosion. Streams in this zone typically exhibit cascade or step-pool channel morphology. Cascades consist of tumbling flow over a disorganized bed of large cobbles and boulders or steep bedrock, while step-pools are characterized by longitudinal steps formed by rocks, exposed bedrock, or large woody debris, separated by discrete pools of finer materials (Montgomery and Buffington, 1997). These areas may also serve as temporary sediment storage zones in years following extreme floods, helping modulate the delivery of sediment to lower reaches (Lenzi, 2001).

2.6.3.2 Sediment transport

Mid-elevations in the watershed are dominated by sediment transport and are found in partly-confined to unconfined valleys. These zones are generally characterized by moderate slopes where channel erosion occurs laterally and vertically with fluctuating sediment storage. Stream gradients vary but are generally greater than 1.5 to 2 percent. This zone generally supports step-pool or pool-riffle channel form. Pool-riffle form is characterized by an undulating bed which defines a sequence of bars, pools, and riffles (Leopold and others, 1964). Bed characteristics include sand- to cobble-sized materials, but may include some larger clasts, such as boulders, especially in areas flanked by moraine and glacial outwash deposits.

2.6.3.3 Sediment deposition

The Martis Valley and smaller upland meadows are in zones of deposition or sediment storage. This includes Martis Reservoir, alluvial fans emanating from the stream valleys (Old Joeger Ranch, Northstar-at-Tahoe Resort and Golf Course) as well as upland montane-meadows (Monte Carlo meadow, Klondike meadow). Stream gradients may vary but are generally less than 2 percent. These areas typically support pool-riffle, plane-bed, or braided channel morphologies. Plane-bed channel morphology can assume moderate channel gradients, typically defined by low width to depth ratios and lacking in rhythmic bedforms (Montgomery and Buffington, 1997).

Channels in these zones are generally expected to have meandering planform with connectivity to adjacent floodplains, and are prone to both lateral and vertical adjustment (including channel scouring, incision, and filling). As such, these channels are readily impacted by changes in hydrology, channel form, and/or sediment supply. Meadows formed in these areas have also been used and modified by humans for a number of land uses, including agriculture and grazing, and have been converted from wet meadows to uplands in many parts of the region. With low gradients and a meandering planform, this zone is also particularly important for groundwater recharge.

2.7 Soils

The soils mantling the geologic formations generally reflect the underlying geologic units from which they have developed, and have been influenced by both Pleistocene volcanic activity and glacial outwash and fluvial processes. In the mountainous upper watershed, soils are underlain by potassium-rich andesite and are relatively well-developed. In mid-elevation uplands, soils are underlain by much younger volcanics (i.e., Waddle Ranch), are relatively fine-grained, and therefore more prone to erosion when disturbed (Drake and Hogan, 2011). Lower portions of the watershed including the valley floor and lower West Martis Creek are dominantly sandy-loams derived from glacial outwash and alluvium. Areas adjacent to streams tend to be more clayey fluvial and lacustrine-derived soils.

Figure 11 is a map showing the distribution of soils according to soil hydrologic groups defined by the National Resource Conservation Service (2007). Soil map units assigned to a specific hydrologic soil group have similar physical and runoff characteristics. For instance, soils of group A typically have less than 10 percent clay (more than 90 percent sand or gravels), low runoff potential, and transmit water freely. Alternatively, soils of group D typically have greater than 40 percent clay, high runoff potential, and water movement through these soils is restricted. Some upland areas where rock outcrops are present are classified as group D soils.

Group A soils have not been mapped in the watershed (Figure 11). Group B soils comprise more than 80 percent of the watershed soils. This includes the Umpa (UME) and Jorge very stony sandy loam (UMF) in steep headwater areas where older volcanics are deeply weathered. The Jorge-Tahoma (JTE) and Fugawee-Tahoma (FTE) complexes are typically found in less steep areas overlying the younger volcanics. Group C soils are only present in the Martis Watershed where Cinder land-Sierraville-Kyburz complex soils (CIF) are mapped on cinder cones around Bald Mountain.

Figure 11 also shows areas that have been mapped as wetland soils (Aquolls and Borolls), highlighting zones with historically or present-day shallow groundwater conditions and wet meadows. Aquolls and Borolls are mapped on the valley floor, alluvial fans, and wet meadows. These soils consist of poorly drained soils (group D), developed on broad flats, floodplains or areas that have a high water table during most the year. These soils also support wetland vegetation such as alder, willow, rush and sedge.

Soils in the vicinity of the airport and areas downstream of Martis Dam are formed on terraces of differing glacial origin and age and are mapped as part of the Euer-Martis variant complex (MEB). Since these terraces formed by more active glacial processes, such as glacial outburst flooding, portions of these deposits include very coarse cobble and boulders, and may therefore be more resistive, resilient to disturbance, and slightly more accepting of infiltration and groundwater recharge. In fact, seepage and losses to groundwater have been documented where these soils are present (Interflow Hydrology, 2003; Brown, 2010). These areas, which have a more significant recharge function, merit development and or restoration strategies which promote or retain these functions.

2.8 Hydrogeology

The Martis Groundwater Basin underlies portions of the Martis Watershed and extends to other areas north of the Truckee River (DWR, 2003). It serves as the primary source of water for municipal, industrial, irrigation, and domestic uses. Water purveyors in the area include the TDPUD, PCWA, and NCSD. The basin-fill sedimentary units and inter-layered basin-fill volcanic units constitute a multiple-aquifer system, known as the Martis Valley Groundwater Basin, or Basin No. 6-67 in Bulletin 118 (DWR, 2003). The complex inter-layering and lateral thinning and pinching of sedimentary and volcanic layers, combined with groundwater withdrawals from a range of locations in the basin indicates that groundwater level fluctuations in wells are widely variable across the Valley (Nimbus Engineers, 2001).

A connection between surface water and groundwater is acknowledged, however the Valley geology is complex and the groundwater and surface water interaction is not fully understood. However, understanding groundwater recharge is key to managing the aquifer as a drinking water supply for the local population. Groundwater recharge, infiltration, and shallow groundwater storage are also key ecological functions of floodplains and meadows; groundwater stored in meadows may percolate to the deeper aquifer, and may support downstream and late-season baseflow in the watershed, helping to maintain resiliency and promote recovery following drought periods. Table 6 outlines some of the characteristics of larger meadows in the watershed. These meadows and others identified during future field assessment may provide significant opportunities to restore groundwater conditions and/or promote recharge to the Martis Aquifer. We have used these characteristics to draw some preliminary conclusions regarding the potential for groundwater recharge in these particular areas.

2.8.1 Surface Water - Groundwater Interaction

Springs provide an important perennial source of flow to some Martis Valley tributaries and support in-stream, wet meadow and wetland habitat. Springs tend to be present in the upper watershed near the contacts of different volcanic units and where interbedded volcanic and stream deposits outcrop. Groundwater discharge and a number of artesian wells are also present along faults. This is notable along the Polaris Fault in the vicinity of Middle Martis Creek in the transition area between the mid-elevation uplands and the Martis Valley Floor.

Infiltration may occur along streams in where a net downward hydraulic gradient is present between the channel and deeper groundwater (typically in alluvial reaches and valley floor). Groundwater recharge is an important component of the ecosystem; infiltration along streams can offset intermediate peak flows, recharging the aquifer and supporting baseflow in downstream reaches and during dry periods. Recharge is also necessary for the long-term sustainability of the local drinking water source. Recharge to the aquifer tends to occur in low-gradient areas where soils and geology are conducive to rapid infiltration rates—commonly along alluvial fans and meadows. Excessive aquifer pumping and lowering of the water table may cause water table declines that induce recharge from streams crossing the valley floor, potentially causing declines in streamflow and impairment of aquatic habitat. Historical land uses such as grazing channelization, and/or incision may also create lower water table conditions as deeper channels drain shallow groundwater.

A surface water – groundwater interaction study (Interflow Hydrology, 2003) was completed for the TDPUD. The study provides estimates of the magnitude of stream losses and gains to and from the aquifer across the Martis Valley during summer 2002, in the middle of a multi-year dry period. Observations made during the course of the study showed Martis Creek to be a gaining stream (receiving groundwater discharge) across the Lahontan Golf Club, upstream of Martis Valley. West Martis Creek was found to be a losing stream as it enters Martis Valley, recharging groundwater between the Northstar Golf Course and its confluence with Martis Creek. Middle Martis Creek showed no loss or gain across the valley floor. Groundwater discharge in the form of springs generally support perennial flows in Lower East Martis and Dry Lake Creeks, as well as from the hillside adjacent to Martis Reservoir. Interflow Hydrology (2003) also computed a water balance based on late season low flow measurements in the watershed, and found that in October 2002, total streamflow losses to groundwater across the Martis Valley floor were on the order of 0.65 cfs (approximately 9 percent of the total baseflow), while losses to groundwater at Martis Creek Lake were on the order of 1.55 cfs (approximately 29 percent of the total flow at that point).

Since geologic and soil conditions appear to be conducive to recharge along the West Martis Creek alluvial fan, we recommend that this area be targeted for enhancement of overbank flooding and floodplain detention, so infiltration and recharge can be maximized.

2.9 Hydrology

The purpose of the following discussion is to: 1) provide a summary of the expected range in baseflows that may be expected under current conditions, 2) provide an estimate of the range of peak flows for future restoration design purposes, and 3) describe the role of Martis Dam in flood control efforts for the Lower Truckee River.

2.9.1 Low Flows

Table 3 provides a summary of monthly flows on Martis Creek from 1972 through 2008. The data show the lower watershed to receive fairly persistent baseflow, with combined average summer baseflows to Martis Reservoir on the order of 12 cfs; the median summer baseflow is a little lower at roughly 8 to 10 cfs. Toward the end of multi-year droughts, such as those that occurred in 1976-78 and 1990-92, watershed-wide baseflow may drop as low as 1.5 cfs.

All the named tributaries to Martis Creek are perennial. In October 2002, when the Interflow (2003) study was conducted, watershed baseflow was approximately 6 cfs. Of this 6 cfs, Martis Creek accounted for roughly 30 percent of the total flow entering the valley, West Martis Creek contributed 6 percent of the total baseflow, Middle Martis Creek contributed 3 percent, and East Martis Creek 18 percent. Local springs provided an additional 41 percent (2.46 cfs in October 2003) of the total baseflow to lower Martis Creek, with the Siller Ranch Springs providing the bulk of this remainder (1.04 cfs, 17 percent).

2.9.2 Peak Flows

The significance and importance of floods to watershed functions is well documented. In Martis Valley and the region, flooding is typically an annual event and is driven by the snowmelt-dominated hydrology, where peak flow or flood occurs each year sometime between March and June. Floods are also generated by rain-on-snow events which can occur during the winter or spring. These events are well documented in the hydrologic and historical records; they have had damaging effects on local economies and property, and cause significant changes in riverine systems. The unknown timing and magnitude of rain-on-snow events provides uncertainty and unpredictability in managing watersheds for flood control and public safety.

According to the USACE (2002), the 100-year instantaneous unregulated peak flow on Martis Creek is established to be approximately 5,000 cfs, while the 2-year peak flow is approximately 280 cfs. For context, the 1997 unregulated peak flow was approximately 2,125 cfs, an approximately 20- to 30-year event (USACE, 2002). The maximum discharge capacity of Martis Dam, including the existing spillway, is established to be 4,640 cfs. Based on this information and our review of channel changes following the 1997 event (Section 3.3), it is clear that the 20- to 30-year streamflow is geomorphically significant, and is a decent approximation of a channel-altering event. Restoration elements such as in-stream structures should be designed with this in mind.

The Truckee River Basin Reservoir Water Control Manual (USACE, 1985) describes the flood control operating principals for the Truckee River Basin Reservoirs. The manual indicates that through all flood control measures in the Truckee Basin, the 100-year flow in Reno is reduced from approximately 43,000 cfs to 18,000. In fact, review of annual peak flows in Reno from before and after the dams were constructed indicates little difference in the frequency of significant (20- to 40-year) flood events, with arguably little difference at the predicted 100-year flood event, which is yet to occur. Under unregulated conditions, roughly 8 to 12 percent of a given peak flow on the Truckee River in Reno may be attributed to the Martis Watershed.

2.9.2.1 Modeled peak flows

The USACE developed a watershed hydrology model in order to evaluate the adequacy of the Martis Dam spillway, using a ‘probable maximum flood (PMF) as the basis for the model. As described above, we have adapted the model and calibrated it to intermediate flows so that it is suitable for restoration planning purposes. The model was calibrated to the March 25-26, 2006 and January 1-3, 1997 storm events (Figure 12). For the March 2006 storm we predicted streamflow of 249 cfs and total runoff volume of 236 acre-feet versus the 251 cfs and 330 acre-feet that were measured, a 0.8% difference in flow and a -1.3% difference in volume. The hydrograph shape is also well represented. The runoff timing is off, however, with the predicted peak occurring approximately three and a half hours before the measured peak. For the January 1997 storm the model predicts 2,320 cfs and 5,281 acre-feet versus the 2,125 cfs and 6,052 acre-feet that was measured – a 9.2% difference in flow and a -12.7% difference in volume. The hydrograph shape is also less well represented in this case, with a significant dip between the two rainfall peaks that does not occur in the measured data. The predicted runoff timing corresponds well to the measured data, however (Figure 12).

Modeled peak discharge and runoff volume at various points in the watershed are shown in Table 7 and Figure 13. With this model in place, we now have a tool with which to plan restoration projects at various locations in the watershed, and evaluate potential changes in hydrology associated with those projects.

2.10 Sediment

Watershed modeling indicates watershed-wide suspended sediment generation to be on the order of 600 to 700 tons in an average precipitation year (McGraw and others, 2001). As part of Placer County’s Water Quality Monitoring Program, CDM (2011) estimated that approximately 1,135 tons of suspended sediment was delivered to Martis Reservoir during water year 2011, a year with above average runoff.

McGraw and others (2001) also developed basin-wide estimates of reductions in fine sediment generation and transport that could potentially be achieved through improved watershed management practices, such as road decommissioning and increasing canopy cover. Although increased canopy cover is generally shown to reduce sediment generation in the Middle Truckee and other river basins, models developed for this study showed minimal reductions in the Martis Watershed, presumably due to the existing extensive canopy cover.

Drake and Hogan (2011) note that treatment actions aimed at water quality improvement are often based on untested practices and a poor understanding of site conditions. To fill this gap, they developed a two-tiered, risk-based assessment framework to prioritize treatment of known sediment sources at Waddle Ranch. Tier 1 assesses a site's erosion potential risk and ecological resilience; tier 2 assesses the risk of sediment delivery to nearby water bodies (proximity and connectivity). Site erosion potential assessments at Waddle Ranch included simulations of rainfall and runoff and sediment yield measurements along roads and disturbed areas following logging in the watershed. The simulations measured an order of magnitude (10X) increase in sediment yield from forest roads shortly after logging activities. This dramatic increase in sediment yield is primarily attributed to road grading, which produces a layer of very fine soil that is readily mobilized by water and wind. Sediment yield from a 15 year old abandoned logging road at Waddle Ranch was found to be an order of magnitude higher than a 50 year old abandoned logging road, indicating that unmitigated legacy impacts from logging can continue to impact soil and runoff quality for many years following logging.

CDM (2010) conducted rapid assessments of fine sediment deposition in Martis Watershed channels. Relatively low percentages of fine sediment bed accumulation were observed in steeper streams of the upper watershed. In Martis Valley, 22 percent (average) of the Martis Creek bed was covered with fine sediment (<2 mm); an average of 28 percent of the Middle Martis Creek bed was covered with fine sediment; and 19 percent of the East Martis Creek bed was covered. The investigators also noted a very high percentage of fine sediment covering the bed in the lowermost reach of East Martis Creek, possibly an indicator that deltaic deposits may have formed and may continue to form during high water stands in Martis Reservoir. Restoration strategies within the Martis Reservoir pool should take into account potential future dam operation scenarios, including the mining and sluicing of sediment deposits which may exist at a range of locations in the reservoir pool.

It should also be noted that relatively little work has been conducted to evaluate bedload sediment transport rates in the Martis Watershed—a primary tool in the establishment of channel-altering flows. The USACE (1985) has, however, predicted sedimentation in the Martis Reservoir to be on the order of 0.15 acre-feet per year per square mile of watershed (equivalent to approximately 22,000 tons/yr), implying that roughly 95 percent of sediment (by mass) in the watershed is transported as bedload.

It is important to distinguish between chronic and episodic sediment delivery. Chronic erosion can be characterized as a legacy impact that meters sediment to the stream system over time, resulting in long-term above-average rates of sediment delivery. Separately, episodic events (on a roughly 20- to 30-year recurrence) can be considered ephemeral and infrequent, but the total volume of sediment moved during these episodes is typically higher than the rate and volume of sediment from chronic erosion, often resulting in lasting impacts to in stream aquatic habitat.

2.11 VEGETATION

The lower reaches of the Martis Watershed lie within Storer and Usinger's (l97l) Yellow Pine/Jeffrey Pine Belt (Transition Zone). Dominant tree species include lodgepole pine (Pinus murrayana) Jeffrey pine (P.

jeffreyi) and white fir (Abies concolor). Open areas are covered by sagebrush (Artemesia tridentata) and bitterbrush (Pursia tridentata) and assorted forbs and grasses. The upper reaches encompass the Lodgepole Pine-Red Fir Belt (Canadian Zone), where red fir (A. magnifica) and mountain chaparral species (Quercus vaccinifolia, Castanopsis sempervirens, Arctostaphysus spp., Ceanothus spp., etc.) dominate.

Future revegetation projects initiated by the TRWC in the Martis Watershed should consider the propagation of culturally important plant species whenever appropriate. In former times the area is thought to have supported a luxuriant growth of native bunch grasses which allowed an abundant large game population (deer and antelope) and provided a nutritious source of seeds for use by prehistoric peoples. Oral histories from Native American Elders and descendants of pioneer families in Martis Valley document a variety of valued medicinal and edible plants, including elderberry, willow, and a variety of bulbs, and a comprehensive restoration could include management and use of these plants, consistent with the Washoe Tribe's Comprehensive Land Use Plan (Washoe Tribal Council, 1994). Table 8 lists a number of native plants and their uses by the Washoe, as prepared by Rucks (Rucks, in Lindstrom, 2007).

2.12 Culture, Land Use and Environmental Effects

A detailed historical account of culture and land use was completed by Dr. Susan Lindström. Her account is provided in Appendix A to this report. The following discussion focuses on how historical land use impacts may be exhibited and/or recovering in the watershed today.

2.12.1 History

Human use of the Martis Watershed landscape dates back to the pre-historic period (9,000 YBP) when Native Americans (Washoe Tribe) initially occupied this area. Archeological evidence suggests that their presence and impact on the land was sparse and minimal. It wasn't until the mid-1800s when the first emigrants crossed the Sierra through Martis Valley and built the first transcontinental railroad, beginning a long period of extensive anthropogenic disturbance in the watershed. It was this period between 1863 and 1867 that transformed the Truckee Basin (including Martis Watershed) from a wilderness into a major frontier "urban" center. Over the course of the next 50 years (1860s-1920s), the watershed witnessed episodes of logging, mining, ranching, and residential and recreational land development. Recreational and residential development continues today.

2.12.1.1 Mining

A short-lived flurry of mining activity was staged in Martis Valley in 1863, with a number of small mining towns established along Middle Martis Creek between Martis Valley and Brockway Summit. Elizabethtown (Figure 14) was the hub of this activity with several saloons shops, and makeshift shelters. A number of tunnels and shafts were excavated during this time, but the effort proved unsuccessful and the towns were abandoned within a year. It is possible that many of the springs now present throughout the Middle and East Martis headwaters are the result of mining shaft and tunnel excavation during this period.

Following this initial flurry, mining was carried out on an exploratory basis. Mining pits and tunnels continued to be excavated, and alluvial deposits in Martis Valley were mined hydraulically through ground sluicing or shallow placer mining.

2.12.1.2 Logging

Truckee was a major timber center with over 18 sawmills operating in the Truckee area during the late 19th Century (including Schaeffer's Mills, Richardson Brothers, David Smith Mill, School's Mill, and Davies Mill in the Martis Watershed) with a growing network of railroads, roads, trails, flumes, and chutes to support operations. The logging practices of the late-1800s and early-1900s relied heavily on water to transport timber cut in the upper watershed to mills located downstream. Log chutes—shallow trenches lined by cut and greased logs—were typically cut into hill sides or along creek bottoms to transport logs to the mills from areas where they were logged, and water was sometimes diverted down the chutes to facilitate transport. Figure 14 shows some of the major features associated with logging activities.

2.12.1.3 Grazing

During the period from 1860 to 1930, the rich meadowlands of Martis Valley became a center of dairying operations. Beef cattle were also grazed in higher meadows, however, the quality of grazing lands at upper elevations was limited in some years as meadows dried up toward the end of the summer (Meschery, 1978). Sheepherding began with the Truckee area initially used for transporting banks of sheep to and from California. The most intense grazing occurred during the 1920s and 1930s and declined by the 1960s.

2.12.1.4 Recreation and Residential Development

By the 20th century, the Martis Valley became increasingly developed for seasonal recreation and a year-round residential population. Timber practices continued using modern-day technologies, with additional and extensive road building to support industry. Martis Valley's first airfield was completed in 1929 with improvements in the 1950s and 1960s. Today, the airport is known as the Truckee-Tahoe Airport. In 1963, Highway 267 was improved as a paved corridor connecting Truckee with North Lake Tahoe. Construction of Martis Dam in 1972 required a number of quarries to be established on the Martis Valley floor, with remnants still visible today just north of Highway 267. Aggregate quarrying continues today along Martis Creek downstream of the dam.

In the last several decades, the Martis Watershed has witnessed exponential growth in sub-divisions, second-homes, and resort communities. In the late 1970s, Northstar-at-Tahoe was one of the first major recreation-communities to alter the visual landscape of Martis Valley. Other communities followed including Lahontan, Martis Camp, and Timilick.

In the 1990s, Placer County approved a plan to expand residential and recreational development in the Martis Valley by over 6,000 new homes, effectively doubling the population of Truckee. Significant opposition to this plan delayed implementation and ultimately set into motion lawsuits, new guidelines, and conservation practices moving forward into the 21st century. In 2003, major acreage in the Martis Watershed was protected from further development including significant portions of Martis Creek headwaters, portions of Highway 267 corridor along Middle Martis Creek, and Waddle Ranch.

2.12.2 Effects of Historical and Recent Land Use

2.12.2.1 Effects of Mining

Hydraulic mining in the Martis Valley alluvium and glacial outwash likely mobilized a tremendous amount of sediment, completely and fundamentally altering the mined corridors. Ground sluicing penetrated deeper into the alluvium and glacial outwash than any of the other shallow sluicing techniques used. To carry this out, a water course was diverted to create an artificial channel, which started the operation. The stream of water was directed through a cut in the edge of the terrace toward the channel bank, eroding gravels, cobbles, and boulders from the bank or terrace edge. Removed cobbles were stacked vertically to create a retaining wall, which further aided in controlling the stream of water.

It is likely that many of these remnant features are still present in the watershed, since that the modern-day hydrologic regime is not likely sufficient to transport or further rework the displaced cobbles and boulders. These activities likely took place in the downstream reaches of Martis Creek, below Martis Dam, and perhaps along terrace bluffs north of the airport.

2.12.2.2 Effects of logging

Historic timber harvesting methods resulted in a complete change of the structure and composition of modern forest watershed. Stream channels were heavily modified or diverted to chutes and flumes, where a team of horses was used to transport logs down these paths of least resistance. Similarly, "V" and box flumes were used in the watershed to transport logs using water alone. Figure 14 shows where several flumes were in place in the watershed, including a V-flume which ran along lower Martis Creek across the Valley, and to School's Mill in the vicinity of the Northstar Golf Course. The point of diversion or volume of water used to operate these flumes is unknown. School's Mill was also at the receiving end of a log chute which ran from the uplands around Sawmill Flat down along upper West Martis Creek. Another flume and railroad followed the course of Schaeffer's Creek (tributary to Upper Martis Creek). In the 1870s, Schaeffer operated a mill in the vicinity of Gooseneck Flat (currently Lahontan) and diverted water from Martis Creek using two dams to fill his mill pond. He also operated a V-flume to transport logs from his mill to Truckee.

The miles of historic and modern logging haul roads and skid trails have likely been a significant source of sediment in the watershed. Over the years, these logging features may have become entrenched and served as conduits introducing sediments into Martis Creek and its tributaries (and they may continue to do so). Sediment loading may have been particularly extreme in shallower rocky soils, especially when flood events immediately followed a logging event and before the ground surface had an opportunity to stabilize.

2.12.2.3 Effects of grazing

The lush meadows of Martis Valley supported a livestock business, while the higher meadows were typically used for sheep. With little or no restrictions on grazing, sheepherders in particular grazed their herds at will, sometimes early in the season. Persistent small fires were started by shepherds in order to improve forage for the following season. Sheep were thought to be more destructive than cattle, but both denuded high-elevation alpine areas and lower-elevation wetlands, meadows and forest floors. The Washoe were especially affected by the impacts of livestock grazing in the basin, which altered the composition and vigor of native plants (Elliott-Fisk and others, 1996). Over-grazing in many wetlands, meadows, and on forest floors during the first half of the 20th century has produced lasting changes in communities of grasses, forbs and shrubs (McKelvey and Johnston 1992), converting grass and herb-covered meadows to areas of upland sagebrush (Leiberg, 1902).

Ranchers in the Martis Valley operated a number of in-stream diversions for irrigation. Several irrigation and diversion ditches are noticeable on 1939 and 1952 historical aerial photographs. It appears that when one diversion was washed out by flood (e.g., 1950 flood), another was built to replace it. These dams may have accumulated significant sediment in time and when destroyed by rancher or flood, resulted in downstream sedimentation and/or aggradation.

2.12.2.4 EFFECTS OF ROADS

All of the historical and current land uses in the watershed require roads. Some roads were abandoned, while others were improved. Road networks are a mechanism for potentially significant increases in sediment delivery to streams (Sun and McNulty, 1997) and are considered to be more important in altering sediment transport to streams than the other disturbances listed above (Swanson and Dyrness, 1975). Drake and Hogan (2011) conducted small plot studies at Waddle Ranch (Dry Lake and East Martis Creek subwatersheds) and found that logging roads left unmitigated can contribute increased sediment loads and impact water quality for more than 15 years after active logging. Road maintenance (such as grading) and/or use for hauling were also shown to increase sediment yields by an order of magnitude. With an expanded surface water network, sediment may be more efficiently transported directly to the channel, increasing sediment loadings to downstream areas. Coe (2006) found similar increases in sediment yields from actively maintained and unmaintained roads in El Dorado National Forest.

Figure 15 shows the cumulative road network that has developed over time in the Martis Watershed, beginning in 1889 and continuing through the present. This information suggests that particular watersheds, such as West Martis Creek, with a road density of 6.9 mi/sq. mile, likely produce more road-derived sediment than other subwatersheds, simply due to the history and density of logging roads in the upper watershed. This hypothesis depends largely on the hydrologic connectivity between roads and waterways, which has been evaluated to some extent as part of Northstar’s Habitat Management Plan process and the two-tiered approach developed by IERS. Evaluation of high-density road networks and hydrologic connectivity will be evaluated during fieldwork conducted in future phases of this assessment.

2.12.2.5 EFFECTS OF WILDFIRE

The effects of high-severity fires on watershed processes are well documented in the literature (Carroll and others, 2007, Ice and others, 2004, MacDonald and Larsen, 2008). These studies suggest that erosion resulting from wildfire can generate considerably more erosion and degrade water quality when compared to chronic sources of sediment (e.g., roads). Carroll and others (2007) found that a single rainfall event two weeks after the Gondola Fire (South Lake Tahoe) in 2002 generated an order of magnitude more sediment than the predicted annual erosion rate. Northwest Hydraulic Consultants (2006) examined data collected by McGraw and others (2001), and found suspended sediment transport rates to be an order of magnitude higher in the initial 1-3 years after the wildfire when compared to background levels. The history of logging and ongoing practices in the Martis Valley may exacerbate erosion and subsequent degradation of aquatic habitat and water quality in the event of a severe wildfire. Safford (2009) concluded that the frequency of high-severe wildfires in the Sierra Nevada has increased over the last 25 years. Climate change is likely to further increase the magnitude and extent of wildfire in the region, including in the Martis Watershed.

Studies suggest wildfire was a frequent occurrence in the Martis Valley long before the arrival of Europeans (Leiberg, 1902) and played an important role in forest and meadow composition. There is some evidence that the Washoe Tribe used fire to maintain or control the understory vegetation (Lindström and others, 2000). In the late 1800s Basque shepherds set fire to high-elevation meadows in an attempt to improve range conditions (Leiberg, 1902). Since the early 1900s, wildfire has been actively suppressed as a policy to prevent loss of resources, property, and provide public safety. Wildfire suppression has drastically changed the composition of the forest and steadily increased the threat of wildfire over the past 100+ years. When wildfires do occur in today's mixed conifer forests they can result in high intensity, high severity fire. Figure 16 shows an absence of large-scale wildfire in Martis Valley since before 1880, likely a result of suppression. On-going forest management practices such as thinning (fuel reduction) at Northstar, Waddle Ranch, and in other areas, have helped decrease this threat in parts of the watershed, but the threat of severe wildland fire in the watershed remains high in the eastern part of the watershed.

2.12.3 Stream Channel Changes

Figure 17 illustrates visible changes in the Martis Valley using a sequence of historical aerial photographs between 1939 and 2009. The figure is supplemented with a summary of significant land uses and historical events, or major floods that occurred in the watershed. The suite of historical aerial photographs shown were examined to establish locations where channel conditions may have changed, with specific attention paid to: a) channel planform changes such as meander cut-offs, transition from braided channel to single channel, and human modifications (diversions, straightening, etc.); b) presence, absence or change of riparian or point bar vegetation; c) increased channel widths, and; d) absence or presence of new channels.[4] Examples of typical watershed changes are included in Figures 18, 19, 20, and 21.

2.12.3.1 1952 to 1966

This period includes a transition from a rural ranching and timber economy to more recreational and community development. In the early 1960s, Highway 267 was re-aligned and improved, Martis Creek was straightened to accommodate a new, larger crossing for Highway 267, and a quarry was established to facilitate the improvement of the Truckee-Tahoe Airport. Three significant floods are noted during this period: 1955, 1963, and 1964. The 1955 flood is the largest flood event on record for Martis Creek and it occurred on December 23, 1955.

The land use changes described above had noticeable effects on Martis Creek and its tributaries within the Martis Valley. For example, the quarry disturbed drainage patterns and appears to have impacted wetland areas within the meadow, today these impacts can still be observed. The improvements to Highway 267 required straightening and confinement of Martis Creek in order to accommodate an improved crossing. Diversions north of Highway 267 were dug supposedly to improve grazing pasture in the northern portion of Martis Valley (Lindström, 2011). Finally, grazing and/or hiking impacts are noticeable in the 1966 aerial (red circle, Figure 20b) where a north-south fence line illustrates higher

[4] The areas of channel change are not limited to those identified in this report. Future field reconnaissance is necessary to further evaluate channel conditions, especially in areas obscured by trees.

grazing intensity and trails. Cavitt Ranch (operated from early 1900s through 1960s) constructed many rock-dams in Martis Creek to irrigate the meadow and provide fishing holes for guests.

The sum of these factors has left a measurable impact in the streams of Martis Valley, with a number of channels re-aligned and altered. Martis Creek and the unnamed tributary are now confined in a single-thread channel, where multi-thread meandering channels were present as recently as 1966.

2.12.3.2 1987 TO 1998

This period includes continued subdivision development, on-going road improvements and timber operations, and the 1997 flood. Figures 19 and 20 illustrate the changes observed before and after the 1997 flood at two representative locations where channel changes appear obvious: a) Martis Creek and an unnamed tributary near Joerger Ranch; b) Martis Creek at the Old Schaeffer Mill Site.

In Figure 19, limited channel form is visible in the swale that enters Martis Creek from the northwest. After the 1997 flood, however, a well-defined channel is evident-- likely the result of incision and bank erosion. It is possible that incision was exacerbated by stormwater runoff originating from Highway 267 and/or other ancillary impervious surfaces in the subwatershed. It is also important to note that Gooseneck Flat ('Concert Park') Pond is situated on a very low divide, and may discharge to this unnamed tributary at high flows.

Martis Creek at the Old Schaeffer Mill is a legacy logging site where intense activities and disturbances occurred from the 1870s into the mid-1900s. Conditions before and after the 1997 flood along Martis Creek suggest that stream reaches which were previously disturbed exhibited more significant channel changes than other less-disturbed reaches as the result of the flood (Figure 20). Meanders were cut-off, vegetated point bars were stripped of vegetation, and road crossings appear to have failed, contributing to scour or sedimentation.

2.12.3.4 MARTIS CREEK BELOW MARTIS DAM

The construction of Martis Dam is perhaps the most significant human disturbance that has taken place in the watershed. Figure 21 shows channel conditions prior to and after construction of the dam, which was completed in 1972. The aerial photographs shown in Figure 21 indicate that Martis Creek immediately downstream of Martis Dam has undergone conversion from a meandering system with multiple channels to an entrenched meandering system, with a single-thread channel. Upstream of the dam, much of the riparian meadow system has been inundated.

It is also worth noting that the downstream-most reach of Martis Creek was confined to a relatively straight channel. While it is possible that the channel was re-aligned in this area prior to the 1950s, the channel form through this reach may simply be reflective of the relatively steep gradient and confining banks which became established as the creek eroded through the glacial outwash terrace, roughly 8,000 years ago.

2.13 SUMMARY OF WATERSHED ATTRIBUTES AND IMPLICATIONS FOR RESTORATION PLANNING

The Martis Watershed is a unique and complex landscape. With a diverse land use history and widespread disturbance, a number of restoration needs are likely to be discovered during the next phases of this assessment. With distinct geomorphic zones, a productive aquifer, ski areas, residential housing, large aggregate mining operations, and a 34,600 acre-foot reservoir, a number of restoration challenges are likely to arise when planning for habitat restoration and water quality improvement, and will require consideration of the diverse themes and attributes described in this report.

Based on an initial review of available information at the watershed scale, we draw the following conclusions and related considerations to be kept in mind during future phases of the assessment and restoration planning:

- Historical land uses in the watershed have visibly altered hydrologic processes and vegetation characteristics in the watershed. Most notably, legacy logging impacts have shown to influence watershed drainage patterns and potentially increase sediment yields through extensive road building. Logging has also significantly changed the species composition in both forest and understory vegetation. In turn, these changes, in combination with fire suppression have resulted in the potential for large increases in erosion and sediment yield in the event of a catastrophic wildfire.
- Perennial streamflow emanates from numerous springs throughout the watershed, which may have been unintentionally developed during a flurry of mining activity that occurred in the late 1800's. August low flows have ranged from 1.5 to 97.3 cfs between 1959 and 2007. This is equal to approximately 0.03 to 2.27 cfs per square mile. This wide range of baseflow variability can be attributed to the cycle of wet and dry periods that are recorded through time in this region. Restoration design should take this into account and post-restoration monitoring should be evaluated in the context of climate conditions during the monitoring period.
- Most streams appear to be supported by perennial springs or groundwater inflows at the valley margins and the upper watershed. Of all the tributaries to the valley floor, the main stem of Martis Creek appears to have relatively persistent baseflow and a higher quality of wetlands, perhaps a result of irrigation ditches that crossed the meadow in this area, as well as a large number of springs in this area.
- West Martis Creek was observed to be a losing reach, recharging the aquifer where it crosses its alluvial fan and enters the valley (Interflow Hydrology, 2003). This may be attributed to relatively young soils developed on alluvial outwash from glaciers which occupied upper West Martis Creek. If feasible, restoration, flood control, and groundwater management planning should consider this area as having high recharge potential. Recharge in this area may support late season baseflow in lower Martis Creek, which is predicted to decline over the next 100 years as the climate continues to change.
- Losses to groundwater also appear to be taking place near and downstream of Martis Reservoir. Maintenance or enhancement of ground-water recharge is recommended throughout the watershed, particularly in areas where conditions already appear to be conducive for such, including Monte Carlo Meadows, Monte Carlo Headwater Meadows, Gooseneck Flat, and Meadow. Recharge efforts at strategic locations in upper portions of the watershed are likely to maintain or increase flows from springs and consequentially baseflow in the Truckee River and/or Martis Creek. Groundwater modeling carried out during development of the Martis Groundwater Management Plan can help evaluate the degree to which recharge in these areas may benefit the local aquifer as well.
- Flood frequency analyses and modeling suggest 2-year flows to be on the order of 112 cfs (0.375 cfs/sq. mi.), with 100-year streamflow on the order of 5000 cfs (119 cfs / sq. mi.). These are based solely on accepted statistical analysis, as flows of that magnitude have not been recorded in the watershed. Aerial photograph interpretation and anecdotal evidence suggest that floods significantly smaller than the 100-year flow will induce significant changes to channel conditions. As an example, the 1997 flood (unregulated) peaked at 2,100 cfs, an approximately 20- to 30-year event, and caused observable changes in the channels.
- Peak flows in Reno have likely been moderated to a limited extent by construction of Martis, Prosser, Boca, and Stampede Reservoirs, but the frequency and occurrence of significant flooding in Reno has not changed significantly. Prior to construction of Martis Dam, peak flows on Martis Creek accounted for roughly 8 to 12 percent of the total flow in Reno, based on concurrent annual peak flows. As with Martis Creek, the 100-year flow is based on statistical methods, but has not been recorded on the Truckee River in Reno.

- Martis Dam is not operated for flood control purposes as designed due to compromised dam integrity. If upgraded, Martis Reservoir could be maintained at an elevation that would cover 768 acres of the Martis Valley Floor, with temporary inundation of 1,145 acres during flood events. If removed, sediment stored in the reservoir and tributary channels could be available for transport to and water quality degradation in the Middle Truckee River. Restoration planning within the footprint should take into account these various scenarios, and stay informed of USACE plans as they materialize.
- Sediment and volcanic flows have been deposited in this basin for the past 2 to 3 million years, and the valley floor remains an active depositional zone today. Fine sediment accumulation and delta formation at various reservoir stages likely occurs as well, and may impair habitat in stream reaches that are below the maximum reservoir level. Restoration strategies within this zone should take into careful consideration the range of alternatives for repair, use, or decommissioning of the dam and reservoir.
- With lateral and vertical channel migration common in this area, valley floors are more susceptible and less resilient to effects from watershed disturbances and changes in hydrology and sediment transport dynamics. Sensitive soils, historical grazing, and a location downstream of a wide range of watershed disturbances, leads us to conclude that disturbance and impaired channels may be most prevalent on the Martis Valley floor and in other meadows. For example, Martis Creek on the Martis Valley floor and downstream of Martis Dam appears to have been converted from a highly-sinuous system of multiple channels to an incised single-thread channel. These low-gradient areas also typically support high-quality habitat.
- Treatment of these disturbed reaches should be carried out in conjunction with treatment of upper-watershed disturbances, so that altered hydrology and sediment fluxes will not continue to play a part in meadow degradation.
- The potential for a severe wildfire in portions of Martis Watershed is high; the direct and indirect effects of severe wildfire on water quality and aquatic habitat may be realized after such a fire. Areas in the watershed more prone to wildfire include: 1) uplands of East Martis Creek subwatershed; 2) uplands of Middle Martis Creek subwatershed; 3) eastern portions of West Martis Creek subwatershed; 4) mid-level elevations in Martis Creek; and 5) portions of the Dry Lake subwatershed. Active management of fuels in these areas should continue and expand to areas that are currently unmanaged.
- Treatment of these disturbed reaches should be carried out in conjunction with treatment of upper-watershed disturbances, so that altered hydrology and sediment fluxes will not continue to play a part in meadow degradation. In particular, decommissioning of unused roads and drainage improvements on active roads throughout the watershed would likely result in significant reductions in peak flows and sediment delivery to channels.

3. DISTURBANCE INVENTORY AND EXISTING CONDITIONS

The following discussion and photos of disturbed areas is accompanied by a map of disturbed areas (Figure 22) and a summary of disturbance characteristics (Table 9).

Field reconnaissance investigations took place during Summer 2011. Total precipitation during the winter was above average, with 44.16 inches recorded at the Truckee Ranger Station (California Data Exchange Center Station TKE) compared to the long-term average of 31.5 inches. The unusually deep snowpack lasted through an unusually cold spring, creating one of the latest snowmelt peaks on record in many streams. Peak streamflow on Martis Creek below Martis Dam was measured to be 218 cfs on May 8, 2011, with a nearly equal second peak of 203 cfs on June 6, 2011 (CDEC Station MTK). These are in the range of but lower than the 2-year flow of approximately 280 cfs estimated by the U.S. Army Corps of Engineers. The previous water year (2010) was also somewhat wetter than normal. It was preceded by three drier-than-normal seasons. The most recent regional flooding occurred in later December 2005 and early January, 1997.

3.1 Martis Creek Subwatershed

The Martis Creek subwatershed is 15.7 square miles in area, extending from its headwaters on either side of Sawtooth Ridge among forested areas and ski runs of Northstar-at-Tahoe, through the Martis Camp residential development and Lahontan Golf Club, to the Martis Valley floor. Most of the watershed was logged principally during the Comstock period of the 1860s, with periodic re-entries in some areas continuing through the present. Prominent modern-day land uses include forest management, ski runs, residential, and golf course development.

3.1.1 Martis Creek Subwatershed: Upper Forested Reaches

3.1.1.1 Sawtooth meadow (Site Z, Reach 14)

A number of sediment sources are present along Martis Creek and U.S. Forest Service Fire Road 06, upstream of Northstar and residential development areas. The most significant of these sources is an active right bank landslide complex approximately 1.8 miles upstream of the 700 Road crossing (Site Z). This landslide complex continues to serve as a significant sediment source, delivering an abundance of coarse material to downstream areas. Near the 700 Road crossing, the channel gradient becomes less steep, resulting in active sediment deposition, channel aggradation, and a braided channel system. As a result, multiple shifting channels have formed at the crossing, requiring active maintenance and/or limited seasonal use of the crossing.

Roughly 550 feet downstream of the 700 Road crossing, Martis Creek crosses a meadow we have termed "Sawtooth Meadow." At this meadow, the braided channel system returns to a single, actively incising channel. Channel downcutting is apparently resulting in upland vegetation encroachment into the meadow (shrub-scrub and pines). The impacted portion of the channel (Reach 14) could be addressed through a range of low-tech solutions, such as debris jam construction to promote sedimentation, multiple channels, and/or active channel migration. Similar actions taken at the upstream road crossing to distribute streamflow across the meadow, rather than concentrating it into one channel, are also likely to aid in the natural recovery of the system.

Reach 14 – Artificial confinement of channel at 700 road crossing. (photo credit: Kevin Drake, IERS)

Reach 14 – Depositional material at south end of Sawtooth Meadow. (photo credit: Kevin Drake, IERS)

Reach 14 – Incised channel through Sawtooth Meadow. (photo credit: Kevin Drake, IERS)

3.1.2 Martis Creek Subwatershed - Ski Runs

Ski runs represent a visible component of the Martis Creek watershed. The impact of ski runs is variable and difficult to definitively or consistently identify. A number of conditions exist that affect the environmental 'performance' of ski runs, especially in the realm of erosion. Variables such as steepness, surface irregularities (micro and macro irregularities), soil type, aspect, vegetation, snow accumulation, underlying geology, and management practices, all contribute to the ability of a ski run to control and/or produce erosion. The impacts of erosion on water quality are dependent upon proximity and/or connectivity to watercourses.

Older ski runs were largely developed using old but standard methods used universally throughout the ski industry from at least the 1960s through the current time. Those methods typically included grading and slope reshaping followed by revegetation treatments and drainage infrastructure. Recently, newer, more ecologically -based methods have been developed. One of the more popular methods, which has been pioneered by Northstar, is a process whereby minimal soil disturbance is required, leaving the topsoil and infiltration capacity of the soil essentially intact. Trees are cut and either removed or in some cases ground/chipped on site, stumps are flush cut or mechanically ground, large boulders may be relocated with an excavator or blasted in place. Isolated grading is only conducted where recontouring is necessary for skiing surface or utilities. Revegetation treatments are focused on these isolated grading areas. Runoff characteristics on these types of ski runs are similar or identical to pre-disturbance conditions.

Older, smooth-graded ski run with well-established vegetation and no significant erosion issues. (photo credit: Kevin Drake, IERS)

Ecological techniques: cleared, not graded, and leaving topsoil in place. Shrubs are mowed regularly to maintain skiable surface condition. (photo credit: Kevin)

Between the two extremes of ski run construction exists any number of hybrid run building treatments. With this range of existing and possible treatments, as well as a large range of possible maintenance efforts, it is difficult to ascertain exactly what impacts ski runs have on erosion and habitat. It is clear that ski runs constructed using 'old' methods can moderately to significantly alter local hydrology and create soil erosion. It is more difficult to say what impacts that alteration has on water quality. One of the primary difficulties is that water courses (and the associated water quality measurements) integrate or combine an almost infinite number of variables in a watershed. Thus it is difficult to isolate one practice or one ski run in terms of sediment production. Given that the ski runs are monitored by ski area personnel as well as by Regional Water Board staff, and that most of the runs have been in place long enough to suggest that they are stable, our assessment indicates that ski runs are not major direct contributors to water quality degradation.

3.1.3 Martis Creek Subwatershed: Roads

An extensive network of roads (dirt, rock-surfaced and paved) exists in the Martis subwatershed. Some roads are remnant and infrequently used logging roads (Northstar resort was developed by a timber management company on lands that had been logged at least twice and continue to be logged to this day in a sustainable fashion). Other roads are associated with ski resort operations and others are directly related to housing and commercial development. Thus, a range of road conditions, maintenance procedures and intensities are represented.

Ski area-associated roads in the Martis watershed present a wide range of conditions and erosion potentials. Obviously, and as stated elsewhere, roads can be major sources of erosion. Primarily, roads almost universally result in altered surface and subsurface hydrology. Part of that alteration is in flow capture. That is, roads not only contain compacted surfaces that contribute to accelerated runoff, the road prism itself (and in some cases, utility courses beneath or adjacent to it) is essentially a water diversion structure. This diversion results in concentrated flows, increased volumes and velocities of water and the subsequent erosion potential associated with those variables.

Northstar's road network is being actively managed as a component of the resort's water quality program and Habitat Management Plan. Road maintenance includes the application of asphalt grindings and drainage improvements. In some areas, stream crossings are armored with rock or gravel, covered with trench plates, or conveyed in culverts. Northstar has a road closure policy during wet conditions (fall rain, spring snowmelt) based on water quality threat, and employs 'water chasing' crews to improve and maintenance road drainage features during these times. Rolling dips and water bars are installed at intervals along roads to break up the run length and minimize the catchment areas for particular drainage features.

Spring feeding Kiwi Creek. Note use of trench plates to minimize road impacts. (photo credit: Kevin Drake, IERS)

Road armored with rock at small tributary crossing. (photo credit: Kevin Drake, IERS)

3.1.4 Martis Creek Subwatershed: Residential Development, Roads, and Golf Courses

Residential development in this area has resulted in additional impervious coverage. However, one result of that development is that some of the old dirt roads that were built with relatively minimal water quality protection elements have been replaced with paved roads with extensive water flow and erosion protection elements. Based on our field assessment, it appears that trends in recent years toward better engineered and protected roads and increased efforts toward management practices in the ski resort area are resulting in reduced erosion from roads, especially dirt roads.

Lahontan Golf Club, Martis Creek, and Martis Valley. (photo credit: David Shaw, Balance Hydrologics)

3.1.4.1 HISTORICAL MILLPOND AND DIVERSION DITCH (SITE X)

Along the Martis Creek alluvial corridor, a number of abandoned diversion dams and ditches are present. Of these, perhaps the most notable is the now-abandoned diversion ditch from Martis Creek to Gooseneck Pond (Figure 22, Site X). The diversion dam and pond are located at a former mill site, as indicated on historical maps, and may have been used to transport lumber to Gooseneck Flat, where it could be transported by rail to Truckee. The diversion/mill pond is now filled with sediment, and portions of the ditch have been filled or graded during golf course construction. The pond is now in line with Martis Creek.

3.1.5 MARTIS CREEK SUBWATERSHED: ALLUVIAL FANS AND MARTIS VALLEY FLOOR

3.1.5.1 LOOKOUT MOUNTAIN MEADOW (REACH 4)

A number of tributaries drain lower portions of Northstar and residential areas, and feed lower reaches of Martis Creek, including a tributary we have termed "Lookout Mountain Meadow." This tributary drains an approximately 1.7-square-mile watershed, originating from snowmelt and springs in areas currently and recently developed for residential and resort uses. A number of spring-fed tributary channels flow together as the channel enters USACE lands, with observed baseflow on the order of 4 cfs in September 2011. Fen-like features[5] are present in upper portions of the meadow, and the channel form is steep, and slightly sinuous, with various degrees of channel incision. Incision is most pronounced at the upper end of the meadow and in the vicinity of Jake's Bridge (Figure 22, Reach 4), with bank erosion which appears to be exacerbated by hikers, bikers, and dogs. A number of abandoned diversions of varying integrity have been built in the channel just upstream of the confluence with Martis Creek, and in some cases appear to be promoting a degree of channel stability, forcing higher flows out of the channel, across the meadow surface, before discharging to Martis Creek.

Reach 4 – Upland vegetation encroachment, evidenced by pines growing along channel, increasing in age from downstream to upstream (left to right). (photo credit: David Shaw, Balance Hydrologics)

Reach 4 – Lookout Mountain Meadow is spring-fed and is downstream of recent or ongoing subdivision for residential and recreational use. (photo credit: David Shaw, Balance Hydrologics)

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[5] Fens are peat-forming, groundwater-fed wetlands that have high nutrient and mineral levels and support a more diverse plant and animal community. They are often covered by grasses, sedges, rushes and wildflowers. The fen-like features in Martis Valley exhibit low alkalinity, but exhibit most other characteristics of fens.

3.1.6 MARTIS CREEK IN MARTIS VALLEY RECREATION AREA (USACE LAND)

3.1.6.1 MARTIS CREEK UPSTREAM OF HIGHWAY 267 (REACHES 1 AND 6)

This reach is downstream from a number of historical mill sites and Martis Camp and Lahontan Golf Courses and residential homes. At least 4 old diversions were found in this reach, likely associated with the ranching period of the early to mid-1900s (Cavitt Ranch). Along the valley floor and within the USACE property, the stream exhibits a range of channel incision and equilibration stages, apparently in response to both localized and watershed-wide disturbance (see mining, grazing and logging historical section). In downstream areas (near Highway 267), the channel has incised to approximately 5- to 6-feet below the former meadow surface, and has apparently achieved a state of quasi-equilibrium, widening and forming an inset floodplain. Upstream of this reach, the channel exhibits active incision and bank failures, with several 1- to 2-foot headcuts that are actively progressing upstream.

Reach 1 – Channel incision and bank erosion associated with nearby abandoned diversion structure. (photo credit: Brian Hastings, Balance Hydrologics)

Reach 1 – Abandoned irrigation ditch in meadow. (photo credit: Brian Hastings, Balance Hydrologics)

Incision in this area may be attributed to increased runoff, primarily following the development of roads—first for logging and then for residential development. Installation and operation of the old diversions may have also modified the natural channel system and morphology, disrupting streamflow and hydraulics in some areas, and also distributing water across the meadow surface for grazing purposes in others. As these structures fail or are removed, the channel responds, often unpredictably.

Streambed material through this reach has a median diameter of approximately 24 mm, much of which appears to have been transported during water year 2011. This suggests bedload sediment transport to be fairly active in this reach, so it is possible that restoration approaches to enhance channel aggradation through retention of bedload sediment could be effective. Re-operation of some failed diversion structures may be a viable means of rewatering the floodplain, and would also encourage sediment deposition—suspended load on the floodplain and bedload in the channel.

3.1.6.2 MARTIS CREEK DOWNSTREAM OF HIGHWAY 267 (WITHIN MARTIS DAM FLOOD POOL, REACH 6)

Martis Creek flows through a long straight pool, approximately 300 feet in length, immediately downstream of a double box culvert under Highway 267. Historical aerial photograph investigations indicate that the timing of incision both upstream and downstream of the highway is coincident with several iterations of road and culvert construction. Downstream of the crossing, the channel appears to be incised and actively widening, with a quasi-equilibrated channel bed approximately 4- to 5-feet below an apparently abandoned floodplain surface.

Reach 6 – Martis Creek modified channel at Highway 267. Historical aerial photography indicates that incision episodes correspond with various iterations of highway and channel modification in this location. (photo credit: David Shaw, Balance Hydrologics)

Reach 6 – Relict channel and upland vegetation along Martis Creek Floodplain downstream of Highway 267, a result of channel incision and floodplain abandonment. (photo credit: David Shaw, Balance Hydrologics)

Reach 14 – Borrow pits, modified channels, levees, and floodplain desiccation along Martis Creek downstream of Highway 267. (photo credit: David Shaw, Balance Hydrologics)

In some locations the channel has incised through alluvial gravels and into a more competent (but still erodible) siltstone. Channel widening has led to development of an inset floodplain in a number of locations approximately 2- to 2.5-feet above the channel bottom. Within the inset corridor, a meandering pool-riffle morphology has developed, with active bedload sediment transport as evidenced by recently deposited gravels, roughly 10 to 16 mm in diameter. A number of overhanging banks and willows are well established in many locations along this reach, and many adult fish were observed during the field investigation. As with upstream areas, most of the former floodplain area is occupied by xeric vegetation communities, though a number of remnant channels are readily observed in the field and on aerial photographs within the abandoned floodplain surface.

Several modern and abandoned structures were observed within this reach, including old diversion structures, as well as more modern levees and roadbeds along the channel's left (northwest) bank.

3.1.6.3 Borrow Pits (Reach 7, Site W)

The area between Highway 267 and Martis Dam is within the Martis Dam maximum pool, and has been heavily disturbed. Legacy impacts in this area may be somewhat associated with land use (grazing and logging) in the upper watershed, but the most extensive and extreme disturbance is associated with quarrying and borrow pit excavation during construction of Martis Dam and Highway 267. A number of small channels have been re-routed or destroyed, while other small channels have formed as rills and gullies on artificially steepened slopes with insufficient soils to support vegetation. A small tributary flows into Martis Creek downstream of the Highway 267 crossing. This stream appears to be perennial (flowing in early September 2011), and currently flows in a straightened ditch through a number of borrow pits.

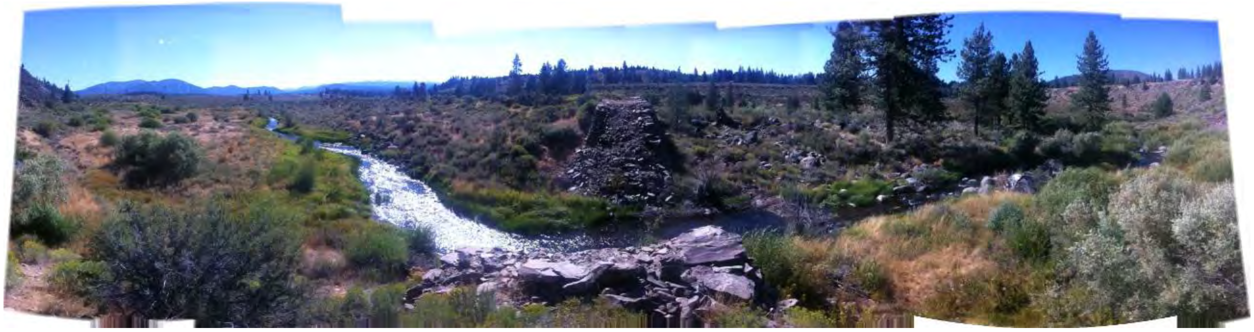
Site W – Depositional "fan" from erosion in former borrow areas. (photo credit: Kevin Drake, IERS)

Reach 7 – Straightened channel within former borrow area adjacent to Highway 267 embankment. (photo credit: David Shaw, Balance Hydrologics)

3.1.7 Martis Creek Downstream of Martis Dam

Martis Creek is heavily modified immediately downstream of Martis Dam, and flows across a meadow, but appears to be minimally incised. Downstream of the meadow, the creek follows the trace of a major regional fault, at the base of a talus slope, which may be serving to control the channel and meadow elevation. The rather straight and steep nature of the channel in this location, along with an abundant supply of large boulders, has given rise to a step-pool channel form through much of the straight reach. While historical ground sluicing or placer mining activities may have taken place in along this reach, the active gravel mining operation on the left (west) bank of the stream does not appear to have significantly altered the stream course in this area.

Immediately upstream of the confluence with the Truckee River, Martis Creek flows into a meadow which appears to have been established in part due to sediment deposition behind an historical dam. The channel has since incised into this meadow, as evidenced by numerous abandoned, or perched secondary channels. Based on aerial photograph interpretation, meadow incision appears to have occurred before 1952. As a result, the meadow vegetation largely consists of upland shrubs.



Reach 10 – Abandoned dam, incised channel, and desiccated meadow near mouth of Martis Creek (photo credit: David Shaw, Balance Hydrologics)

Reach 10 – Entrenched channel in meadow upstream of abandoned dam. (photo credit: David Shaw, Balance Hydrologics)

Reach 11 – Grade-controlled channel and meadow downstream of Martis Dam. Streamflow in this photograph is approximately 180 cfs, slightly lower than the estimated 2-yr flow. (photo credit: Brian Hastings, Balance Hydrologics)

3.2 West Martis Creek Subwatershed

West Martis Creek (Figure 2) drains an approximate 5.6-square-mile subwatershed, including the front side of Northstar California and Sawmill Flat, the site of an historical mill in the creek's headwaters. The confluence of these two branches is located near the Village at Northstar. Downstream from the village, the stream flows adjacent to residential developments, through the Northstar Golf Course, before joining Martis Creek near Highway 267. Historical disturbances in this watershed include intensive logging and mill operations and a sheepherder's camp. Much of the middle watershed has recently or is currently undergoing conversion to residential and recreational land uses.

3.2.1 West Martis Creek Ski Runs

Most ski runs on Northstar's "front side" drain to West Martis Creek, which is culverted under ski runs. Where the creek is not culverted, vegetated buffers have been maintained between ski runs and the creek. Through adaptive management, Northstar has developed revegetation and erosion control treatments to stabilize ski runs, steep slopes, lift terminals, and terrain features (i.e. halfpipes) to protect water quality. Northstar's erosion control techniques typically include soil loosening, organize fertilizer, seeding, and mulch application (hydraulically-applied straw or locally-generated wood shreds, depending on acreage and access). Many of these slopes have now been stable for 3 to 4 years.

For a more in-depth discussion of ski run construction techniques and range of functional conditions, please refer to the ski run discussion in the Martis Subwatershed Ski Runs section, above.

3.2.2 West Martis Roads and Resort Facilities

West Martis Creek runs underneath the mid-mountain lodge in a culvert and daylights just downslope of the lodge. A number of other drainage ways intersect this area, some natural, most anthropogenically altered. As stated previously, strict vehicle access restrictions are implemented around the lodge and lift areas during wet/rainy conditions to protect West Martis Creek. Other water quality improvements include road surfacing, drainage improvements and annual staff water quality trainings.

3.2.3 West Martis Bike Trails

Martis Creek watersheds have been widely used as mountain biking terrain since the mountain bike boom of the 1980s. Commercial mountain biking has grown within the watershed. Northstar is currently one of the top mountain bike resorts in the US.

The original trail system was designed as a single track system that was matched to the riding style and equipment available during the 1990s. Trails ranges from steep, down gradient advanced trails to the more moderate, relatively flat trails along creeks and flood plains. Some of these trails are still in use today and many more have been abandoned. New bicycle technology and riding techniques as well as more comprehensive trail building techniques have resulted in newer trails that incorporate more advanced erosion control and drainage management techniques.

Newer bike park trails and features have been designed and constructed with water flow and watershed protection in mind. Many have energy dissipation and/or infiltration areas at switchbacks, and Northstar has a hand crew assigned to trail maintenance throughout the summer biking season. Northstar is following International Mountain Biking Association (IMBA) guidelines for trail construction (, actively training their bike park staff to identify and address erosion issues on an ongoing basis. Some trails are irrigated to control dust. Northstar is also engaged in adaptively managing trails in order to improve design and function when possible through ongoing monitoring and input from 3rd party experts. Recreation and water quality goals are uniquely aligned in the trail network. Drainage features such as water bars and rolling dips not only limit concentrated surface flow but are valued by riders as terrain features as well.

3.2.4 Sawmill Flat

West Martis Creek originates from perennial spring-fed channels along the northeastern side of Mount Pluto, an area also identified as a montane meadow or ‘Sawmill Flat’ on historical maps. Much of this spring flow is currently captured in Sawmill Flat Reservoir (‘Reservoir A’) and used for irrigation and snowmaking operations on the mountain. This area was historically logged and was an important location for a major sawmill. The meadow shows signs of significant historical logging but maintains a verdant riparian with peat-like soils and overland flow. A more defined channel is identified as flow enters the Sawmill Pond. The channel expresses pool-riffle morphology with sand/gravel bed sediment upstream of the pond.

Sawmill Flat Reservoir is maintained with a 100+ feet high earthen dam and spills to a natural channel via a concrete spillway. The receiving channel was reconstructed in 2007 and exhibits stable, steep, boulder, step-pool morphology in a steep canyon. Historical logging activity in this canyon confined or disturbed the natural width of the former channel.

3.2.5 West Martis Creek at Northstar Golf Course

The West Martis Creek runs through Northstar's 18-hole golf course, much of which is built on wetlands or wet meadow terrain, as is typical of golf course design, where minimal grading is required and the relatively level terrain presents an ideal playing configuration. At the Northstar Golf Course, stream buffers are maintained and Northstar is actively limiting foot traffic near the creek in high priority sensitive areas. Northstar is also converting underutilized sections of turf back into native vegetation communities. Northstar is actively managing and monitoring chemical applications to minimize impacts to water quality. Further, they are actively monitoring West Martis Creek for sediment and nutrients. Northstar has developed action plans, communication systems and staff training programs to respond quickly and effectively to potential issues common in all golf courses such as chemical spills and irrigation system failures.

The golf course also serves as a buffer between the valley floor wetlands-creek complex and the upper mountain. During peak flows of December 2005, the golf course was completely flooded and captured a great deal of sediment. Our observations suggest that recent programs to implement a range of water quality protection efforts has reduced (and should continue to reduce) the impact of golf course operations on West Martis Creek.

3.2.6 West Martis Creek in Martis Valley

Historical maps and field reconnaissance suggests that the West Martis Creek channel, as it drains an alluvial fan and crosses the Martis Valley proper, has either been relocated or adjusted naturally to changes in flow and sediment input. The existing channel may follow the alignment of an abandoned v-flume or ditch. While active channel migration would be expected across this alluvial fan surface, we anticipate that the channel will maintain its current alignment where it exits the Northstar Golf Course, because it is managed to maintain the channel in a constant location for golf activities.

West Martis Creek at Northstar property line. (photo credit: Brian Hastings, Balance Hydrologics)

West Martis Creek in Martis Valley, downstream of Northstar Golf Course (photo credit: Brian Hastings, Balance Hydrologics)

Although this area has undoubtedly been disturbed, the current channel exhibits effective channel-floodplain connectivity with well-vegetated banks dominated by wetland vegetation. As such the channels have relatively low width to depth ratios with little channel incision and/or headcut formation, and are likely suitable references reaches on which to base restoration designs and target criteria for other channels.

3.3 Middle Martis Creek Subwatershed

Middle Martis Creek drains a 5.0 square mile watershed before flowing into Martis Creek on the Martis Valley Floor. The headwaters are north of Brockway Summit and flow along a narrow canyon and Martis Peak Road before crossing underneath Highway 267. From relative high in the watershed, the creek flows parallel to and in most locations, immediately adjacent to Highway 267. A number of tributaries flow into the creek along this reach. Middle Martis Creek is the channel seen by more residents and visitors, and is the potential 'face' of upper-watershed restoration. Most disturbances are attributable to various iterations of road construction, maintenance, and improvement that has taken place over the past 160 years, including roads to support mining, logging, ranching, and recreational activities.

Legacy effects of a short-lived flurry of mining activity in Martis Valley during 1863 has also left their traces on the channel. A number of small mining towns were established along Middle Martis Creek between Martis Valley and Brockway Summit. Elizabethtown was the hub of this activity with several saloons shops, and makeshift shelters. A number of tunnels and shafts were excavated during this time, but the effort proved unsuccessful and the towns were abandoned within a year. It is possible that many of the springs now present in this area may be the result of mining shaft and tunnel excavation during this period; however, a number of active faults intersect in this area and also likely contribute to groundwater discharge in this area.

3.3.1 Middle Martis Headwaters - Upstream of Highway 267 Crossing

3.3.1.1 Martis Estates and Elizabethtown (Sites T, P, and Q)

The Martis Estates parcel is located on the east side of Highway 267 and includes approximately one mile of Middle Martis Creek above the highway undercrossing. This parcel was the site of a proposed subdivision until the Truckee Donner Land Trust (TDLT) purchased the property in 2011. The land is now being managed for conservation and recreation. A single main road runs north to south through the parcel and is oriented roughly on contour (cross-slope). This road has had very little maintenance. Drainage patterns are largely dictated by topography. Despite having a low slope angle, the road is capturing dispersed, seasonal drainages from upslope and releasing it at several concentrated points (Site P). This has created several unstable drainage channels downslope of the road, which converge in a large depositional area where flow concentrates into a single, deeply incised drainage that delivers sediment and concentrated flow directly to Middle Martis Creek. Another steep road that runs uphill in the northeast corner of the parcel has few drainage improvements and high erosion potential (Site T). Given that this parcel is narrow and consistently sloping west toward Middle Martis Creek, most road segments on this property have high connectivity to the creek. Projects aimed at reducing runoff and erosion from roads will offer a good "bang for the buck" in terms of sediment reduction and water quality protection.

An active fault zone dominates the topography and hydrology of this area, and a number of thermal springs are present within and immediately downstream of the parcel. The Elizabethtown Meadow has been disturbed by historical modifications for the mining town. In addition, a high concentration of springs gives rise to fen-like features in the meadow. Several of the smaller spring-supported channels have been ditched or disturbed by tire ruts (Site Q), such that improvement of channel alignments and/or culvert removal could potentially distribute water to support meadows. Debris or mudflow deposits are present in several tributary drainages which cross the parcel. These deposits now serve to store groundwater and support wet meadows or riparian communities. In some cases, material is being eroded from the deposits as the tributary stream or main channel erodes the over-steepened toe of the deposit.

Site P – evidence of erosion and water capture on the main road. (photo credit: Kevin Drake, IERS)

Site P – concentrated flow leaving road, flowing downslope. (photo credit: Kevin Drake, IERS)

Site P –incised channel connecting sediment and concentrated road runoff directly to Middle Martis Creek. (photo credit: Kevin Drake, IERS)

Site Q – spring-fed drainage culverted under road.

3.3.1.2 Highway 267 Operations and Maintenance (Reach 12)

As a result of construction of Highway 267, Middle Martis Creek was rerouted and confined to a narrow corridor alongside the highway impoundment. The presence and maintenance of Highway 267 is far and away the most significant historical and ongoing impact to Middle Martis Creek. Runoff from the highway is generally routed to down-drains and/or sand traps before being discharged directly to the creek. With these impacts, the stream channel appears to have responded by eroding and downcutting. Channel incision is exacerbated where the stream is confined on both sides by road beds, fill slopes, and/or bedrock, with up to 5 feet of incision measured in places.

Traction sand is applied heavily and regularly during the winter months due to the steep grade of the highway. Caltrans conducts sweeping to recover as much road sand as possible; however, despite sweeping and sand traps, heavy accumulations of road sand are evident in many reaches of Middle

Martis Creek. As with most high-use roadways, highway runoff is likely to contain fine sediment, hydrocarbons and heavy metals, which receive little to no treatment before entering the creek.

Caltrans initiated slope stabilization and road drainage improvements along Highway 267 in the upper reaches of Middle Martis Creek in 2011. The improvements are focused on stabilizing eroding slopes and improving down-drains, with the addition of sand traps at selected drainage areas. These improvements are likely to reduce sediment/sand transport to the creek from portions of the highway but are unlikely to attenuate runoff volumes or reduce concentrations of other pollutants.

3.3.2 Middle Martis Creek at Highway 267 (Reach 2)

Soil outcrops in eroded banks along Martis Creek suggest debris flow or episodic sediment delivery events occur in this subwatershed, and that this would historically have been a zone of sediment aggradation and alluvial fan development. Historical maps and field reconnaissance also suggest that Middle Martis Creek historically migrated across an alluvial fan as it entered Martis Valley. When Brockway Road and subsequently Highway 267 were constructed up the axis of the fan, however, a more permanent channel location was established such that channel crosses under Highway 267 and is confined to the south side of the highway before it passes through the northernmost extent of the Northstar Golf Course. This permanent alignment in an otherwise transient environment presents a number of problems and maintenance challenges, including:

- Moderate flows (seasonal peaks) overflow the channel immediately downstream of the Highway 267 crossing, and flow onto the highway.
- High flows overtop and erode the Golf Course maintenance road when culvert capacity is exceeded.
- Flows overtop channel banks and are directed toward the highway, where a large berm has been constructed to keep water off the road. This drainage configuration focuses some portion of the streamflow into a roadside ditch which conveys flow directly to Martis Creek.
- Flow concentration and confinement in a single channel has led to channel instability, erosion, and headcut development in a number of locations, most notably near Frank’s Fish Bridge and the Martis Wildlife Viewing Area Trail.

Reach 2 – Overflow from Middle Martis Creek is confined to the south side of Highway 267, rather than following the topography and flowing through the meadow on the north side of the highway. (photo credit: Brian Hastings, Balance Hydrologics)

Reach 2 – Near confluence of Middle Martis Creek and Martis Creek. Lowered base level on Martis Creek, increased runoff, and focusing of drainage have led to headcut development and propagation. (photo credit: Brian Hastings, Balance Hydrologics)

Overflow from Middle Martis Creek floods over golf course access road during large runoff events. (Photo credit: Kevin Drake, IERS)

While it may be possible to address each of these issues independently (i.e. replacing culverts and maintaining drainage ditches), we recommend that the causes of the problem be addressed, so that some portion of the total flow be maintained on the north side of the highway, where remnant channels remain.

3.3.2.1 Waddle Ranch Access Road (Sites I, H and G)

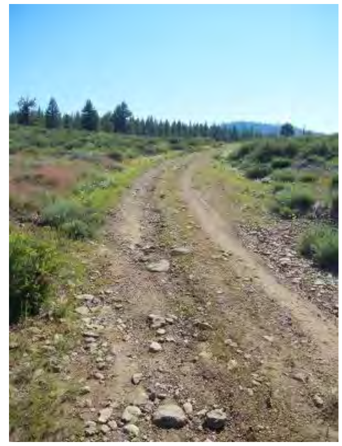
The Waddle Ranch property spans the East Martis Creek and Dry Lake/Creek watersheds. East Martis Creek drains roughly the southern third of the property and is the only perennial stream passing through Waddle Ranch. Since the majority of the property is in the Dry Lake/Creek watershed, a more complete description of historical disturbances and overarching management issues is included in the Dry Lake/Creek watershed section of this report. This section focuses on a few key disturbance areas within the East Martis Creek watershed.

The primary access road for the Waddle Ranch property is a key feature that has affected watershed processes in several ways. Near Highway 267 and the Middle Martis Creek alluvial fan, the road impoundment bisects a historically wet meadow and has fragmented flooding patterns and meadow hydrology (Site I). Culverts installed underneath the roadway in this location are undersized and most are partly or completely blocked by sediment and other debris. Water is now retained upstream of the road and confined to a channel downstream of the road, causing the historically wet meadow to dry out, causing the vegetation community to shift toward predominately upland species. On the same access road, just north of the crossing over East Martis Creek, an ephemeral branch of the creek flows across the road surface and has washed out the road (requiring repair) several times (Site H). Additionally, several gullies have developed along a steeper section of the access road that has high connectivity to the lower reach of East Martis Creek (Site G).

Site I – road impoundment interrupts meadow flooding patterns, causing intermittent road damage and vehicle access issues. (photo credit: Kevin Drake, IERS)

Site I – undersized culverts under road are clogged and insufficient to convey surface water to west side of road impoundment.(photo credit: Kevin Drake, IERS)

Site H – ephemeral branch of creek crossing road in unplanned/unstable location. (photo credit: Kevin Drake, IERS)



Site G – accelerated erosion/gullying on road with direct sediment transport to lower reach of East Martis Creek. (photo credit: Kevin Drake, IERS)

3.4 East Martis Creek Subwatershed

East Martis Creek drains an approximate 7.3 square mile watershed. The majority of land is owned by Sierra Pacific Industries (SPI) and managed for timber and forest health. The upper watershed includes two headwater meadows: Klondike Meadow and Monte Carlo Meadow. It is also worth noting that use of this portion of the watershed for mountain biking is growing. A fairly extensive network of downhill-oriented mountain bike trails; jumps and other features have been created by the local mountain bike community over the past decade. The condition of these trails ranges from well-maintained to abandon and eroding, including many unimproved stream crossings.

One of many downhill mountain biking trails and jump features in the East Martis subwatershed. (photo credit: Kevin Drake)

3.4.1 EAST MARTIS CREEK HEADWATERS

3.4.1.1 EAST MARTIS CREEK ROAD NETWORK (SITE N, REACHES 5, 8, 13, 15, 17)

This area has been actively logged and managed for timber supply since the late 19th century. Historic timber harvesting methods resulted in a complete change in forest structure. The network of roads, skid trails and log landings created over the past 150 years are still largely visible today. Most stream channels have been impacted and some were diverted to flumes and chutes. Many of the tributary drainages in the East Martis Creek watershed still exhibit signs of realignment and straightening from past logging activities.

SPI maintains an extensive road network in this watershed, nearly all of which is unpaved. According to current and historical maps, road density in this watershed is moderate compared to other watersheds (roughly 3 miles/square mile). However, many roads were encountered (and inventoried) during field activities which did not appear on the any available USGS maps and USFS road GIS layers, indicating that actual road density may be higher than the available data suggests. Most primary roads are being maintained and are in fairly good condition. However, capture of surface flow and evidence of erosion was observed in a number of areas (Reaches 5, 8, 13, 15, and 17) where water bars, rolling dips and other drainage features have become degraded and ineffective. Most road-stream crossings observed were stable and did not introduce significant grade changes. A few surface crossings could benefit from minor rock armoring (Site S). Some crossings had hand-placed rock upslope and downslope of the road for energy dissipation, which appeared to be effective at trapping sediment and even supporting establishment of mesic vegetation (Site S). This is a good example of a low-cost treatment technique that could be employed at road-stream crossings throughout the Martis Watershed.

Site S – crossing is fairly stable but could benefit from broadening and armoring sideslopes. (photo credit: Kevin Drake, IERS)

Site S – hand-placed rock above road for energy dissipation and sediment capture in ephemeral drainage. (photo credit: Kevin Drake, IERS)

Older secondary logging roads run downslope parallel to several tributaries to East Martis Creek, contributing surface runoff and sediment from the road surface directly to the channels (Reaches 5 and 15). Streams connected to these road segments exhibit varying levels of incision with head cuts and large depositional areas, which is likely a result of flashy peak flows due to road runoff. Large, compacted landings are also present at or near some of these segments, which contribute additional surface runoff and sediment to stream channels. Water bars are installed at landing 36 near Site N that route runoff directly to the stream channel. These areas of high connectivity between roads, landings and stream channels are a key restoration opportunity in the East Martis subwatershed.

Landing 36 – runoff from this heavily compacted landing drains directly to stream channel (Reach 15). (photo credit: Kevin Drake, IERS)

Reach 15 – substantial headcut roughly 50 feet downstream of road crossing. (photo credit: Kevin Drake, IERS)

3.4.1.2 East Martis Creek Landings

A high density of landings were observed and mapped in this watershed. In one afternoon of assessment, 27 landings were visually identified along 8.6 miles of road. That equates to 3.1 landings per road mile assessed. Many of these landings appeared to have been created and/or actively used over the past 10-20 years. Landings are generally flat with bare cut slopes on the uphill side, moderate to high levels of soil compaction and supporting limited vegetation (mostly trees, minimal herbaceous plants). With limited infiltration and waters storage capacity and high runoff connectivity to the road network, the cumulative impact of landings on the timing and volume of watershed-wide runoff is worth considering. For example, using only the 27 landings identified, at an average size of 10,000 square feet, they account for a total area of 270,000 square feet (6.2 acres). Assuming the compacted soil in these landings can currently store approximately 8% water by volume and that water storage in an undisturbed forest soil is approximately 40% (which can be achieved at disturbed sites though low-cost soil loosening treatments), water storage capacity in the top 24 inches of soil of these landings could be increased by nearly 400%, from 43,200 cubic feet to 216,000 cubic feet (roughly 5 acre-feet). Treatment of landings to reduce runoff and increase water storage and groundwater recharge is a key restoration opportunity in this watershed.

3.4.2 East Martis Subwatershed: Alluvial Corridors

3.4.2.1 Klondike Meadow (Reach 5)

Klondike Meadow drains a 1.1 square mile area with a high density of roads, historical logging infrastructure, and historical grazing operations. The primary drainage is a branch of upper East Martis Creek, and appears to have been re-routed or captured by a railroad grade such that it now flows down the margin of the valley, rather down the topographic low along the axis of the valley. The re-located channel is heavily disturbed, and is serving as a sediment source to downstream areas. Disturbance is likely due to a combination of factors; including increased runoff and sediment delivery from upstream road surfaces, flow concentration along historical railroad or logging road grades, and flow concentration associated with user-created mountain bike and OHV trails. Minor headcuts have developed at meadow outlet, but appear to be stable and largely controlled by bedrock.

Site O, Reach 5 – Drainage capture along historical grades near the head of Klondike Meadow has eroded marginal areas at the edge of the valley. Stream capture also keeps excess runoff from the meadow surface, and has likely helped limit the extent of channel erosion in the meadow. (photo credit: Brian Hastings, Balance Hydrologics)

Reach 5 – Stream capture continues due to OHV and mountain bike use under current conditions. (photo credit: Brian Hastings, Balance Hydrologics)

Conditions in the meadow are largely intact, with fairly persistent and, in some cases, perennial conditions maintained by a number of springs in hillsides immediately adjacent to the meadow as well as in the meadow itself. Springs in the meadow have helped to form groundwater mounds with fen-like habitat. Since disturbance in this area is primarily confined to the meadow margins and contributing watershed area, we recommend that drainage and sediment delivery from contributing areas be addressed before surface flows are re-introduced to the meadow itself.

Numerous spring-fed perennial tributaries and groundwater mounds, or fens are present at and near Klondike Meadow. (photo credit: Brian Hastings, Balance Hydrologics)

Monte Carlo Meadow (photo credit: Brian Hastings, Balance Hydrologics)

3.4.2.2 Monte Carlo Meadow (Reach 8)

Monte Carlo Meadow drains a 1.8 square mile area with a high density of roads, historical logging infrastructure, and historical grazing operations. The primary drainage is Monte Carlo Creek, a seasonal creek with fewer springs and groundwater discharge features than other nearby areas. Monte Carlo Creek meanders down the center of the valley with a relatively high degree of connectivity with the meadow surface, creating wet meadow conditions during the early part of the summer. Historical road or railroad alignments along the western margin of the meadow have captured some streamflow, perhaps metering the flow across the meadow and helping to preserve the hydrologic connectivity between the channel and meadow surface.

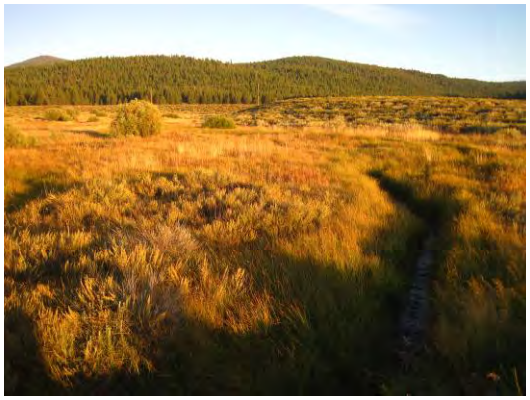
Conditions in the meadow are largely intact, with some limited disturbance to the channel at the head of the meadow (Reach 8). This is likely a result of numerous roads and trails which contribute excess runoff and sediment in this area.

3.4.2.3 Lower East Martis Creek (Reach 17)

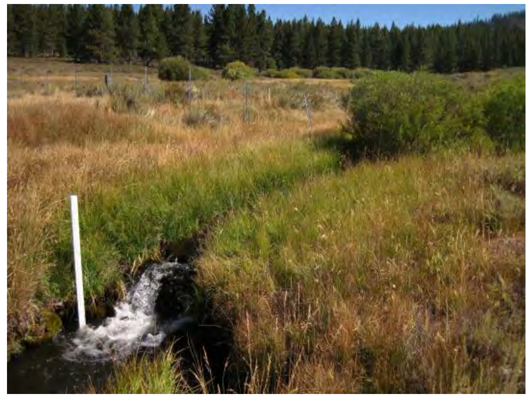
Below Monte Carlo Meadow, East Martis Creek flows through a confined, forested valley toward lower Martis Valley. While the riparian woodland along the creek channel is largely intact and functional, the corridor is heavily disturbed, with evidence of logging infrastructure capturing flow, eroding the hillside or streambanks, and generating sediment for delivery to downstream areas. Evidence of debris or mudflows is also apparent in this reach. These deposits, located in the bottom of the corridor, provide a readily-mobilized source of fine sediment for transport to downstream areas.

Lower East Martis Creek flows across an alluvial fan and active faults as it enters Martis Valley. Holocene (modern) movement along the Polaris Fault has offset the channel and fan surface in this area (Hunter and others, 2011), requiring a nuanced interpretation of channel form. It appears that historical and pre-historical incision has occurred, such that the modern-day channel and floodplain are set below the alluvial fan surface elevation, with relatively high connectivity between the channel and active floodplain. Several knickpoints are present along the channel the vicinity of the fault, and may be influenced by vertical movement along the fault. These minor headcuts may also be influenced by elevated sediment delivery from the upper watershed and alluvial fan development. In summary, we interpret this reach to be functional, and in a process of recovery from anthropogenic and tectonic stresses.

Oblique aerial view of Lower East Martis Creek, Waddle Ranch Access Road, and Highway 267. (photo credit: David Shaw, Balance Hydrologics)



East Martis Creek near the Waddle Ranch Access Road crossing (photo credit: Brian Hastings, Balance Hydrologics)



Headcut development in the vicinity of the Polaris Fault (photo credit: Brian Hastings, Balance Hydrologics)

3.4.2.3 Waddle Ranch Recreational Trail (Site M)

A moderately-used hiking/biking trail runs generally on-contour along the north side of East Martis Creek. Due to a combination of the trail's alignment and bowled surface configuration, the trail captures and directs concentrated runoff directly to East Martis Creek in one known location (Site M). It should be noted that most of this trail is low-angle with limited erosion potential and low to moderate stream connectivity.

Site M – evidence of water capture on hiking trail near creek. (photo credit: Kevin Drake, IERS)

Site M – flow path through well-vegetated area connects trail runoff to creek.(photo credit: Kevin Drake, IERS)

3.5 Dry Lake / Dry Creek Subwatershed

The Dry Lake/Creek subwatershed includes several primary ephemeral drainages and one lake (Dry Lake). Nearly all drainages terminate at Martis Creek Lake, just west of the property, with the exception of several small ephemeral channels that drain to Dry Lake. Two primary ephemeral drainages collect water from the majority of the property. One of these drainages runs between Dry Lake and Martis Creek Lake and flow is controlled by an earthen dam.

Nearly all of the persistent impacts on watershed function identified in the East Martis Creek watershed are rooted in logging activities at Waddle Ranch. The Waddle Ranch property was likely cleared for timber resources in the early part of the 20th century. Logging is believed to have occurred again in the 1950s. More recently, targeted logging operations have been conducted on the property in 1994-95 and again in 2009. SPI also owns a small portion of the land in the East Martis watershed, which has been used for logging both historically and through present-day operations.

3.5.1 Waddle Ranch and SPI Lands – Legacy and Ongoing Forest Management

3.5.1.1 Road Grading and Erosion (Site E)

Of all the human-created features at Waddle Ranch, roads have had by far the greatest impact on watershed hydrologic function. Like many watersheds, the existing road system at Waddle Ranch has been created on a project-by-project basis over a long period of time, not in a deliberate manner. Roads at Waddle Ranch are highly compacted and nearly impermeable to water, resulting in accelerated runoff, scouring of road surface sediment and the need for regular maintenance of the road surface condition and drainage patterns. By capturing and routing surface runoff, many roads at Waddle Ranch function as default ephemeral drainages. Accelerated erosion (gullying) has been observed on several road segments along the main haul road, especially Site E. This section of road is not particularly steep, but it does have a long run without flow breaks and runoff is likely contributed by a legacy skid trail that intersects with the road. Smooth grading was conducted to enable recent forestry operations, which temporarily “erased” the gullies but did not address the underlying drainage issues. Signs of erosion were observed on the same section of road within one year.

Site E – large gully present before smooth grading.(photo credit: Kevin Drake, IERS)

Site E – one season after smooth grading, rilling was observed in the exact same location as the gully. (photo credit: Kevin Drake, IERS)

Rainfall simulation monitoring conducted at Waddle Ranch by IERS indicates that the common practice of grading forest roads increased sediment yield by nearly an order of magnitude (9 times) compared to actively used road conditions immediately before grading and more than 200 times compared to reference conditions (intact forest with minimal disturbance)6. This monitoring confirms that roads are

[6] Waddle Ranch Watershed Assessment Phase II Summary Report. Integrated Environmental Restoration Services. July 2011

indeed a relatively high erosion risk and that grading can substantially increase the water quality liability associated with actively managed forest roads.

3.5.1.2 Haul Road and Ephemeral Drainages above Dry Lake (Sites A & B, Reach 16)

Of particular concern is an area of high road-drainage connectivity on the main haul road from Waddle Ranch onto SPI land above Dry Lake. An ephemeral drainage (Reach 16) runs parallel to the main road in a narrow, deeply incised channel (most of which is on SPI-owned land). This drainage appears to have been used as a skid trail during past logging, resulting in a straightened, incised channel. This drainage has been realigned in an effort to avoid washing out the haul road. However, the haul road intercepts this drainage in several locations, which has caused accelerated erosion (gullying) on the road surface and sediment transport directly to Dry Lake (Site B). Just downslope from Site B, runoff is diverted from the road via a water bar into a braided network of channels/gullies, which cross a rarely used road enroute to its terminus at Dry Lake. A small headcut has formed just downstream of where the channel crosses the old haul road due to the change in gradient (Site A).

Reach 16 – deeply incised ephemeral drainage, likely used as a skid trail for logging.(photo credit: Kevin Drake, IERS)

Reach 16 at haul road crossing shortly following road grading. (photo credit: Kevin Drake, IERS)

Site B – accelerated erosion on haul road above Dry Lake. (photo credit: Kevin Drake, IERS)

Site A - ephemeral drainage crossing old road above Dry Lake. Headcut has developed just downslope of road. (photo credit: Kevin Drake, IERS)

3.5.1.3 WADDLE RANCH ROAD-DRAINAGE CROSSINGS (SITES C & F)

Haul roads cross directly through and/or contribute significant runoff to ephemeral drainages in several locations at Waddle Ranch. At Site C, a rolling dip shunts road runoff directly to an ephemeral drainage. Minor scouring and sediment deposition was observed. This road segment is effectively the "headwaters" for this drainage. At Site F, a haul road crosses a large ephemeral drainage from the road surface directly into the At all of these locations, the road surfaces create grade breaks that would likely result in head-cutting and large amounts of sediment being mobilized in large runoff events.

Site C – road runoff connects directly to ephemeral drainage. (photo credit: Kevin Drake, IERS)

Site F – haul road with unimproved crossing at ephemeral drainage to Martis Creek Lake. Straw was spread after logging in 2009 as a best management practice. (photo credit: Kevin Drake, IERS)

3.5.1.4 WADDLE RANCH SKID TRAILS (SITE D)

Historic skid trails are widespread at Waddle Ranch, continuing to alter drainage patterns by concentrating runoff into a semi-hidden network of erosion-prone gullies. Skid trails are created by dragging felled trees over the ground to a central point. The primary land disturbances associated with skidding are displacement of duff and topsoil, soil compaction, and reshaping of the forest floor into linear swale-like features. Most skid trails run to historic landing areas, which are typically located along historic or active roads, increasing the hydrologic connection between these legacy areas and their potential impacts on water courses during episodic runoff events. Even after decades of no human use, many of these historic skid trails still have heavily compacted soils and exhibit evidence of long-term water capture.

Site D – skid trail likely created during 90's-era logging. (photo credit: Kevin Drake, IERS)

3.5.1.5 Waddle Ranch Landings

18 landings have been visually identified and inventoried along 6.3 miles of road at Waddle Ranch to date, and there are believed to be many more. This equates to 2.8 landings per road mile assessed, which is comparable to the actively managed SPI-owned land in the East Martis Creek watershed, where landing density was 3.1 landings per road mile assessed. Most landings identified to date are historic landings and some were re-used and further impacted during 2009 logging operations. The size and physical condition of landings varies widely. For instance, landing 11 was covered in wood chips following use in 2009. However, soils are still quite compacted and no vegetation has re-established. Landing 1, in contrast, has large, eroding cut and fill slopes and more than 10,000 square feet of nearly bare, heavily compacted soil. Many of the other historic landings at Waddle Ranch have been colonized by vegetation (primarily trees and shrubs) but are still very compacted.

Landing 11 (L11) – compacted landing covered in 1-2 inches of wood chips. (photo credit: Kevin Drake, IERS)

Landing 1 (L1) – large landing with eroding cut and fill slopes. (photo credit: Kevin Drake, IERS)

Results of monitoring by IERS in 2009 indicate that historic landings and other legacy impacts (e.g. old logging roads and skid trails) continue to remain relatively compacted despite the increasing vegetation on those sites7. Soils that are compacted tend to remain in that state for a long period of time with some reduction in soil density occurring but not enough in most cases to return the site to original levels of infiltration or productivity. Most landings at Waddle Ranch are low in slope angle and therefore, may not be perceived as a high erosion risk. However, the cumulative impacts of these large compacted areas on watershed hydrology and sediment transport should not be underestimated, especially since landings are typically connected to roads and skid trails, which are very efficient at conveying the increased runoff from these areas and exacerbating erosion and drainage issues downslope.

3.5.2 Dry Lake and other Ephemeral Drainages

Dry Lake discharges to Dry Creek only during short periods of time during large episodic events and wet years. No evidence of recent surface flow was observed in this channel during the assessment. Dry Creek's channel is fairly steep and exhibits step-pool morphology. The lower channel reach sustains some perennial flow from springs associated with Holocene faulting. The other primary ephemeral drainage in the middle of the property exhibited no signs of recent flow. However, it has a well-defined channel and has the potential to route surface runoff directly to Martis Creek Lake in a large runoff event during periods of saturated soils, such as a rain-on-snow event.

[7] Waddle Ranch Watershed Assessment Phase II Summary Report. Integrated Environmental Restoration Services. July 2011

4. RESTORATION OPPORTUNITIES

The Martis Watershed includes many restoration opportunities which are (a) important locally to residents and wildlife, (b) keystone in restoration at the Middle Truckee Basin scale, and (c) uniquely well-suited to returning landscapes with major cultural importance to both the Washoe Tribe and to residents with historical roots in the region. Restoration is particularly achievable in this portion of the Truckee watershed because it has sufficient rainfall, was not glaciated – with deep soils and aquifers distributed through the various subwatersheds -- , with a mosaic of parcels owned by engaged private, public, and semi-public entities of sufficient scale upon which to base meaningful restoration of natural functions. Restoration of these functions will mean additional recharge to the Truckee watershed's largest aquifers—aquifers which will become even more important to water supply if climate follows the expected trajectory over the next century. Important cultural and historical sites abound, at locations which can be easily integrated into re-naturalization of entire systems, along locations accessible to many visitors and residents. Restoration of the Martis watershed is ecologically important, essential for the long-term human settlement of the region, achievable, and a potential template for the entire region.

We have worked with TRWC and the community to identify a number of the more important disturbance areas and impacted stream reaches in the Martis Watershed. The assessment team is suggesting a range of strategies for addressing these issues and improving water quality and habitat in the watershed. For greater effectiveness, we have grouped these individual disturbance areas/reaches into collective projects which can effect functional re-naturalization at a more meaningful and lasting scale (Table 10 and Figures 23 through 40). The attributes assigned to each area or grouping of disturbance areas are intended to provide a framework for ranking and prioritizing projects according to a range of criteria, including key issues affecting future decisions, such as cost, level of complexity, potential constraints, subwatershed, etc. The section below provides an overview of the information contained in the summary table, including our rationale for grouping and defining projects, project planning elements, goals, approaches, and relative cost ratings.

4.1 PROJECT GROUPING RATIONALE

We are proposing potential projects with a range of scales and geographic distributions. In order to establish a reasonable approach to addressing restoration needs and lay out an efficient construction effort, we grouped projects which, in combination, would provide more durable, lasting, and diverse functions. Whereas single small projects mean proportionately more disturbance and higher mobilization and monitoring costs, groupings allow for a more reasonable cost:benefit ratio. Suggested projects can be further grouped if funding, permitting, or implementation logistics require.

- Hydrologic connectivity
  - Hydrologic connectivity is a key element in grouping project. Where hydrologic connectivity exists -- for instance, where a drainage ran to a road or landing -- those sites have been combined. Upslope/upstream sites would be treated first and as part of an integrated project so that source areas would be stabilized, restored or managed in such a way that they would no longer impact a downslope/downstream restoration site. Thus, the downslope/downstream site work could be completed more easily and with greater probability of lasting success. One example of this is at Klondike Meadow (Reach 5), where road building and poor drainage upstream of the meadow, along with channelization along the margin of the valley has resulted in sediment deposition and erosion along the edge of the valley. Returning flow toward the center of the valley is a logical restoration

approach for the meadow, but could result in excess water, erosion, sediment deposition, or other adverse effects to the meadow if upstream drainage is not treated first.

- Where a stream restoration or realignment project is proposed, we attempted to link it sequentially with upslope restoration so that when the stream work is done, is will equilibrate to the actual flow regime within a restoration context rather than to unrestored, higher runoff upland conditions.

- Proximity
  - Physical proximity of sites minimizes 'collateral construction disturbance' and allows for restoration to be completed much more cost effectively. It also reduces monitoring costs while concurrently providing more useful information about long-term trends. Proximity was a primary grouping element.
- Similar/same disturbance types and/or treatment approaches
  - Where projects were proximal, similar projects were grouped and thus allow for a common goal and treatment approach. This simplifies the overall project approach.
- Same catchment/subwatershed
  - Where projects were in near proximity but were in a different drainage basins or catchment, they were grouped within one drainage basin. This approach following the logic of hydrologic connectivity.
- Same ownership
  - Ownership was a grouping factor since planning and implementation is always done in consultation and coordination with landowners.

A number of restoration projects may be most efficiently carried out without specifically grouping them with other sites, especially in isolated areas. However, it is still necessary to account for potential changes in upstream and adjacent areas when planning and designing these projects.

4.2 Project Planning Elements

Each project includes the following information needed for project planning, implementation and monitoring.

- Project Goal(s)
  - Overall restoration goal(s) of the project
- Restoration Approach(es)
  - A brief overview of how restoration might best be conducted. Full project specifications would tier from this section. In some cases a range of alternative restoration strategies are described.
- Success Criteria/Parameters
  - Success criteria are, as much as possible, explicit in terms of indicators of project performance success. More specific success criteria will be developed at the full project planning stage. Success criteria are linked to project goals and in fact, are used to help evaluate how well project goals have been met.
- Performance Monitoring Elements
  - Performance monitoring elements are the tools used to assess project performance and are used in support of success criteria. These tools and approaches are used to assess the degree to which success criteria have been met.

- Implementation Constraints
    - All projects come with specific project constraints. In this category, we consider constraints specific to land ownership, phasing with other projects, or other considerations that would inform project planning.
- Complexity
    - Low complexity projects include recommendations for specific land management practices.
    - Moderately complex projects may require additional field analysis or investigations, cooperation with landowners, on-the-ground work. These projects will likely need additional design work, ranging from informal planning to comprehensive plans, specifications, and cost estimates
    - Highly complex projects involve multiple landowners, public agencies, of local municipalities. These projects will require extensive additional studies, are likely to be dependent on one or more additional planning efforts, and are achievable over the long term.

4.3 Cost and Benefit Ratings

Projects and project groupings carry an associated rating for construction costs and sediment-related impacts in order to provide an approximation of each project's costs and expected benefits. Ratings are based on best professional judgment, experience and research results from similar projects.

- Current Sediment Yield (H,M,L)
    - Sediment yield potential was based on a number of parameters and each project was assigned a high/medium/low rating. While these ratings are not numerical, they are based on more than 10 years of field trials, research findings and direct experience from project areas of similar disturbance, soil type, channel type, climate, and geographical setting. Sediment yield potential refers to the site itself and not the whole watershed. Sediment yield is a measure of erosion in that it refers to the potential of sediment to be moved from a particular source. It is also a more meaningful measure of downstream impacts than just 'erosion'.
- Potential Sediment Yield Reduction (%)
    - Sediment load reduction potential refers to the potential to reduce the total sediment load from the project area. Recent research and modeling work (Grismer, Hogan, and Drake, in prep) has suggested that the most effective method of assessing the impact of a project on a watershed is to first determine the impact of the project work at the project site. Thus, we used an estimated percentage reduction of the estimated sediment yield potential. For instance, a project may have low yield potential but where treatment is highly effective, may receive a very high reduction rating. The reduction percentage is not an actual volume or mass of sediment. That level of assessment would require a costly and time consuming effort beyond the scope of this project. Estimated sediment load reduction provides a useful metric for evaluating the expected benefits of a particular project.
- Estimated Construction Cost

The following listing shows how costs were estimated and rated. Costs are for planning, construction, and design, and do not include permitting or follow-up monitoring costs. Additional project grouping may reduce overall project costs through gaining economies of scale where planning, permitting and monitoring costs can be spread over a greater number of individual project sites.

- $ 0-10k
- $$ 10-50k
- $$$ 50-100k
- $$$$ 100-500k
- $$$$$ >500k

5. LIMITATIONS

As stated in the introduction to the report, the objectives of this study are to provide the Truckee River Watershed Council with a characterization of the hydrologic and geomorphic processes that support habitat in the Martis Watershed. The disturbance inventory is a reconnaissance-based evaluation, and restoration opportunities have been carried out according to geomorphic zones, historical land use trends, and heavily altered sites identified in the Watershed Attributes Report and our experience in the watershed. This is a reconnaissance report, intended to bracket likely future conditions, to identify certain hydrologic or geomorphic factors which must be better known, and to help guide initial planning. This report should not be used to assess, site or design individual facilities and wells without further site-specific investigations. Similarly, it is not intended to serve as basis for flood management or detailed floodplain planning, both of which are conducted by well-defined and separate procedures, and which frequently require multiple lines of evidence. Use of these results for purposes other than those identified above can lead to significant environmental, public-safety or property losses. Balance Hydrologics should be contacted for consultation prior to considering use of this analysis for any purposes other than the reconnaissance, watershed-scale analysis specified above in this paragraph.

The application of geomorphic history to inferring future channel and corridor change has a long and respected record in the earth sciences. As with all historical or archival analysis, the better the record is known and understood, the more relevant and predictive the analysis can be. We do encourage those who have knowledge of other events or processes which may have affected the site or channel system to let us know at the first available opportunity.

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TABLES

Table 1. Hydrologic characteristics used in the HEC-HMS model of the Martis watershed, Placer and Nevada Counties, California

Point of Concentration	Martis Cr Watershed	Martis Creek Lake	Martis Cr US Lake	East Martis Cr	Middle Martis Cr	West Martis Cr	Martis Cr	Totals
Sub-Basin Characteristics:								
Area (ac)	1,891	2,913	1,243	4,903	3,031	3,270	10,060	27,311
Area (mi^2)	2.95	4.55	1.94	7.66	4.74	5.11	15.72	42.7
Maximum elevation (ft)	6,644	7,300	6,980	8,746	7,684	8,621	8,621	
Minimum elevation (ft)	5,648	5,782	5,782	5,782	5,812	5,814	5,812	
Centroid elevation (ft)	5,758	6,285	5,806	6,844	6,924	6,784	6,166	
Longest flow path (ft)	13,755	19,571	16,268	32,337	30,884	25,080	44,018	
Average slope	7.2%	7.8%	7.4%	9.2%	6.1%	11.2%	6.4%	
Hydrologic Modeling Parameters:								
Transform - Unit Hydrographs developed for each storm based on curves presented in the Corps report								
March 2006 Storm (represents 2-year event)								
Losses (using initial loss and constant infiltration method)								
Initial abstraction (in)	0	0	0	0	0	0	0	
Infiltration rate (in/hr)	0.13	0.13	0.13	0.135	0.135	0.135	0.13	
% Impervious	0	0	0	0	0	0	0	
Baseflow (using recession method)								
Baseflow (cfs)	6	8	4	14	9	9	28	78
Recession constant	1	1	1	1	1	1	1	
Reset threshold	10	10	10	10	10	10	10	70
January 1997 Storm (represents channel-altering event)								
Losses (using initial loss and constant infiltration method)								
Initial abstraction (in)	0	0	0	0	0	0	0	
Infiltration rate (in/hr)	0.05	0.05	0.05	0.07	0.07	0.07	0.05	
% Impervious	0	0	0	0	0	0	0	
Baseflow (using recession method)								
Baseflow (cfs)	45	69	29	116	72	77	237	645
Recession constant	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
Reset threshold	10	10	10	10	10	10	10	70
Resevoir								
Initial Storage = Minimum pool bottom = 800 ac-ft								
Modeled with Elevation-Storage-Discharge curves for the all-gates-open condition (curves obtained from Corps HEC 1 model)								

Table 2. Channel gradient along streams in differing hydrogeomorphic zones, Martis Watershed, Placer and Nevada Counties, California

	Hydrogeomorphic Zones				
	Mountainous Upper Watershed	Mid-elevation Uplands (younger volcanics	Glaciated Areas	Valley Floor	Upland Meadows
Martis Creek (mainstem)	6.2			0.7	2.3
Gooseneck Flat (tributary)					1.9
West Martis Creek	7.8			2.8	
Unnamed tributary-Northstar			12.8		
Middle Martis Creek	5.8			2.4	
East Martis Creek		6.5		2.5	4.2
Monte Carlo Creek (tributary)	9.4				4.1
Dry Lake Creek (ephemeral)		7.9			

Notes:

1. See Figure 8 for location of hydrogeomorphic zones and Section 2.0 for descriptions
2. Slopes calculated from beginning and ending elevations between zones using 40-ft contour intervals and GIS
3. Calculations do not imply accuracy greater than one significant figure

Table 3. Monthly unregulated flows in Martis Creek from 1959 to 2007, Placer and Nevada Counties, California

Water Year	Year Type	Oct (cfs)	Nov (cfs)	Dec (cfs)	Jan (cfs)	Feb (cfs)	Mar (cfs)	Apr (cfs)	May (cfs)	Jun (cfs)	Jul (cfs)	Aug (cfs)	Sep (cfs)
1959	DRY	9.3	10.4	9.3	19.6	21.1	29.3	27.7	13.5	4.1	2.2	2.2	4.7
1960	DRY	5.6	6.3	7.3	9.1	24.7	53.4	32.4	10.0	3.2	1.9	1.8	2.4
1961	DRY	4.3	6.5	7.8	7.0	11.0	11.1	15.4	9.8	3.8	1.8	1.9	2.5
1962	AVERAGE	3.7	4.8	5.4	4.3	28.7	19.1	91.3	33.8	7.5	3.1	2.1	2.4
1963	WET	16.4	16.0	13.2	44.9	83.4	26.4	74.6	80.6	24.8	5.8	4.3	6.3
1964	WET	7.5	17.7	9.9	11.6	9.6	13.8	46.2	32.9	10.8	2.3	1.8	2.8
1965	AVERAGE	4.6	7.9	86.5	39.3	26.8	42.8	92.3	65.0	22.3	8.2	8.5	7.9
1966	DRY	7.1	15.5	10.8	12.1	10.5	38.2	36.4	10.4	4.9	2.5	2.2	3.5
1967	WET	4.8	14.6	22.4	17.5	28.1	78.8	41.6	201.6	96.6	18.0	10.8	10.1
1968	AVERAGE	11.0	11.6	12.3	14.1	36.9	40.2	42.4	20.7	7.7	3.0	4.1	3.8
1969	WET	6.7	11.9	11.2	85.2	25.5	34.6	147.9	156.6	53.3	13.5	9.6	9.3
1970	WET	13.9	14.3	29.2	116.1	41.1	36.8	34.0	34.7	17.3	7.0	5.1	6.5
1971	AVERAGE	MARTIS DAM CONSTRUCTION											
1972	DRY												
1973	AVERAGE	7.4	7.5	11.6	18.4	11.1	25.7	95.5	95.9	96.4	96.9	97.3	97.0
1974	DRY	97.1	55.1	21.8	32.0	96.9	58.5	85.2	99.5	99.3	99.9	23.0	8.5
1975	AVERAGE	2.5	3.0	3.0	2.9	3.0	3.2	2.3	69.3	73.6	15.0	22.5	23.2
1976	DRY	22.5	22.8	22.9	23.0	23.5	23.1	22.9	22.7	22.8	23.2	22.9	17.3
1977	DRY	7.9	4.8	6.6	6.2	9.1	8.1	10.5	9.5	8.3	4.9	4.0	4.1
1978	AVERAGE	4.9	8.2	15.5	23.4	27.4	72.2	64.6	32.1	3.9	4.5	1.6	2.6
1979		2.2	3.3	2.7	15.5	19.1	29.9	45.6	43.4	9.7	6.7	5.1	5.5
1980		7.8	8.7	9.7	61.5	47.1	35.1	78.5	57.1	25.3	13.5	7.0	7.2
1981	WET	6.5	6.4	7.5	7.7	12.1	14.0	18.2	8.5	5.6	4.3	4.1	4.8
1982	WET	8.0	54.8	73.7	34.2	87.9	60.0	116.7	88.9	36.7	18.9	10.8	12.9
1983	WET	15.1	32.2	70.4	49.1	64.7	108.9	78.1	179.7	127.3	36.6	25.3	22.9
1984	DRY	22.1	65.4	89.3	48.7	36.2	55.5	54.7	49.5	27.5	18.4	15.2	15.3
1985	DRY	18.1	23.9	19.1	16.6	18.0	28.5	64.3	27.8	14.3	12.2	10.4	14.3
1986	AVERAGE	15.5	17.3	17.9	30.8	213.8	160.5	72.3	41.0	24.7	24.5	15.9	17.2
1987		16.2	15.9	16.2	18.1	21.3	25.0	21.9	15.5	12.1	9.9	9.7	11.8
1988	DRY	12.4	14.0	16.0	16.9	18.3	18.0	15.4	12.5	7.0	4.7	6.3	6.7
1989	AVERAGE	6.5	10.0	5.9	5.2	14.6	72.1	37.4	11.5	9.1	5.0	4.9	5.8
1990	DRY	8.0	9.1	8.3	9.7	7.9	30.5	27.3	10.5	7.1	5.1	4.5	5.4
1991	AVERAGE	4.2	4.9	5.2	5.9	7.1	16.2	24.5	15.8	6.2	5.7	2.3	6.3
1992	AVERAGE	6.2	5.5	5.0	5.4	11.8	13.6	13.5	6.7	3.0	2.2	1.5	5.5
1993	AVERAGE	5.5	5.4	6.9	24.7	23.3	96.4	106.8	93.0	21.8	8.7	6.5	6.0
1994	DRY	6.0	6.1	6.5	6.2	7.5	14.5	11.4	9.1	5.3	3.7	3.1	4.2
1995	WET	5.6	7.4	7.1	50.7	28.1	133.2	83.3	143.5	91.9	26.1	19.0	17.6
1996	WET	9.1	7.5	13.2	16.9	90.7	81.2	115.1	97.3	23.8	14.7	10.3	9.6
1997	AVERAGE	10.0	13.7	71.0	211.9	47.1	88.5	68.7	36.3	21.3	14.5	11.2	10.2
1998	WET	10.3	11.6	10.5	21.6	26.1	93.0	89.6	102.9	66.1	22.1	14.3	14.0
1999	AVERAGE	12.2	14.2	13.6	28.8	56.2	78.0	91.0	113.7	34.1	13.8	13.3	12.6
2000	AVERAGE	13.0	13.6	12.0	24.6	48.6	39.0	61.2	31.6	11.7	8.3	8.2	7.5
2001	DRY	9.8	11.0	10.9	9.1	10.1	21.0	17.3	10.2	4.5	4.5	4.0	4.4
2002	DRY	5.5	9.2	12.0	14.7	19.2	33.7	44.2	18.4	8.1	6.2	6.5	6.6
2003	DRY	7.5	13.2	15.9	27.2	23.2	40.5	43.8	38.6	13.7	9.8	8.2	7.9
2004	DRY	8.4	10.8	17.0	14.5	30.2	66.3	43.0	17.9	10.3	8.9	8.1	7.9
2005	WET	8.8	8.6	9.4	10.3	12.5	52.0	74.1	84.1	22.1	8.9	5.2	4.3
2006	AVERAGE	5.7	7.2	88.9	72.0	62.4	70.1	158.8	95.4	15.3	7.6	8.4	32.4
2007	DRY	12.3	10.4	11.5	9.1	11.9	18.2	16.9	4.9	13.1	12.0	4.6	4.3
average		11.0	14.1	20.4	28.8	33.9	47.0	56.5	52.4	26.4	13.9	10.2	10.8
min		2.2	3.0	2.7	2.9	3.0	3.2	2.3	4.9	3.0	1.8	1.5	2.4
max		97.1	65.4	89.3	211.9	213.8	160.5	158.8	201.6	127.3	99.9	97.3	97.0
median		7.9	10.4	11.6	17.5	23.5	36.8	45.6	33.8	13.7	8.3	6.5	6.7
std dev		13.7	13.0	23.8	35.5	35.7	34.0	37.1	49.1	30.8	19.5	14.4	14.3

Notes:

Data provided by the US Army Corps of Engineers. Values are calculated by adding the outflow from Martis Creek Lake to the change in reservoir storage, and therefore represent the sum of all inflows to the lake.

Year types are based on percent deviation from the long-term mean annual precipitation in Truckee. Years are classified as "Dry" if total precipitation was more than 20 percent less than the average, and "Wet" if annual precipitation was more than 20 percent greater than the average.

Table 4. Summary of Significant Floods, Truckee River and Martis Creek

Date	Truckee River at Reno Peak Streamflow[1]	Truckee River at Farad Peak Streamflow[2]	Date	Martis Creek at Martis Reservoir Outflow[3] (regulated)	Martis Creek below Martis Dam (unregulated)
		(cfs)		*(cfs)*	
December 11, 1937	--	15,500	*uncertain*	--	*2,181* [4]
November 21, 1950	19,900	17,500	*uncertain*	--	*2,591* [4]
December 23, 1955	20,800	14,400	*uncertain*	--	*1,969* [4]
February 1, 1963	18,400	11,900	February 1, 1963	--	1,880[3]
December 23, 1964	11,300	12,000	December 23, 1964	--	1,040[3]
Predicted 100-year flood (unregulated)	43,000	36,000	--	--	5000[6]
January 14, 1980	8,630	8,150	*uncertain*	633	*950* [4]
March 8, 1986	--	9,550	*uncertain*	663	*1,150* [4]
January 2, 1997	18,200	14,900	*uncertain*	372	*2,125* [5]
December 31, 2005	16,400	10,100	December 31, 2005	<675	*2,838* [5]
Predicted 100-year flow (regulated)[7]	18,000	14,000	--	540	--
Predicted 50-year flow (regulated)[7]	12,000	9,200	--	540	--

Notes:

1. Instantaneous peak streamflow, USGS #10348000: Truckee River at Reno
2. Instantaneous peak streamflow, USGS #10346000: Truckee River at Farad (downstream of Martis Creek, Truckee River confluence)
3. Instantaneous peak streamflow, USGS #10339400, Martis Creek nr Truckee (approximately 0.5 miles upstream from confluence with Truckee River)
4. Peak flows for Martis Creek were calculated using a correlation between pre-dam annual peak flows (USGS #103349400 Martis Creek nr Truckee, 1959-1970) with annual peak flows for Truckee River at Farad for the same time period. These values represent unregulated peaks (absent of dam opearations). These values have not been verified against other data and may represent an under- or over-estimate of the actual peak flow. Due to the limitations of this correlation, we cannot verify the date the annual peak flow may have occurred.
5. Martis Reservoir inflow data provided by USACE.
6. Data provided by USACE, 2002, Spillway Adequecy Study.
7. Date provided by USACE, 1985, Truckee River Water Control Manual.

Table 5. Summary of historical wet and dry periods, Lake Tahoe and Truckee Basins, 1875 to 2011.

Date	Annual precipitation characteristics	Conditions documented	Source
Dry Periods (drought)			
1928-1935	Tahoe City registered annual precipitation below long-term mean annual precipitation for each year within this period.	Lake Tahoe ceased to spill to the Truckee River Canyon	Western Regional Climate Center, station #048758; National Weather Service station ID: TAC; Lindstrom, 2011
1976-1977	Precipitation deviated -49 percent below long-term, mean annual precipitation		
1987-1994	Precipitation deviated -40 percent below long-term, mean annual precipitation	Lake Tahoe lake levels reached lowest recorded elevation in 1992; massive timber mortality due to insect investations	USFS, 2009; Lindstrom, 2011
2000-2004	Precipitation deviated -37 percent below long-term, mean annual precipitation	Martis wildfire, 2001; other significant wildfires in the greater Tahoe area	USFS, 2011
Wet Periods			
1875-1915	unavailable	Longest period (documented record) in which Truckee River flows were above average; era of historic logging and fluming activies; water rights first evaluated.	Lindstrom, 2011
1950-1952, 1955	Precipitation deviated +56 percent above long-term, mean annual precipitation in 1950	Most significant flooding on record for the Tahoe-Reno area (1955)	Kattleman, 1992, USFS, 2009
1962-1964	Precipitation deviated +26 percent above long-term, mean annual precipitation in 1963	Significant floods on record for 1963 and 1964	
1969-1970	Precipitation deviated +54 percent above long-term, mean annual precipitation in 1969		USFS, 2011
1981-1982, 1986	Average annual snowpack of up to 200 percent; 1983 became the standard "High Water Year" for comparison to all other years	Significant flooding along the Truckee River (March 1983)	Lindstrom, 2011; Kattleman, 1992
1995-1997	Precipitation deviated +73 percent above long-term, mean annual precipitation in 1996	New Years flood, 1997 recurrence: ~50-year flood, Truckee River at Farad	USGS, USFS, 2009
2010-2011	Greatest total seasonal snowfall depth since 1971; 5th highest snowfall depth on record	April 1, 2011: 178% of normal snowpack	Central Sierra Snow Laboratory, Soda Springs, CA

Table 6. Large meadows and preliminary analysis of potential for infiltration and recharge in the Martis watershed, Placer and Nevada Counties, California

Meadow	Subwatershed	Slope (%)	Soil Type	Soil Hydrologic Group	Underlying geology	Inferred infiltration potential	Inferred aquifer recharge potential	Remarks
Martis Valley floor, downstream Hwy 267		2 to 3	Inville-Riverwash-Aquolls Complex	B	alluvial fan, Prosser Fm	high	high	Within Martis Reservoir maximum pool, exposure to water-bearing Prosser Formation
		0 to 1	Aquolls and Borolls	D	alluvium	limited	limited	
Martis Valley floor, upstream Hwy 267		0 to 1	Aquolls and Borolls	D	undifferentiated alluvium	limited	limited	
Dry Lake	Dry Lake	--	Jorge-Cryumbrepts, Wet-Tahoma Complex	B	undifferentiated alluvium	?	?	currently dammed and flooded, soil type and infiltration largely unknown
Klondike Meadow	East Martis	3-10	Aquolls and Borolls	D	undifferentiated alluvium	limited	limited	limited by slope and high water table (?)
Monte Carlo Meadows	East Martis	3-10	Jorge-Tahoma Complex	B	undifferentiated alluvium	medium	high	proximity to volcanics and potential connection to the deeper aquifer
Monte Carlo Creek Headwaters	East Martis	0 to 2	Jorge-Tahoma Complex	B	Miocene volcanics	high	high	low gradient, high permeability
Middle Martis alluvial fan	Middle Martis	5 to 10	Aquolls and Borolls	D	alluvial fan, undifferentiated alluvium	limited	limited	inferred groundwater discharge zone
Middle Martis corridor	Middle Martis	2 to 3	Jorge-Cryumbrepts, Wet-Tahoma Complex	B	alluvial fan, Miocene volcanics	limited	limited	potential groundwater discharge zone
West Martis Creek above Martis Valley	West Martis	3 to 5	Jorge-Cryumbrepts, Wet-Tahoma Complex	B	undifferentiated alluvium	medium	medium	vicinity of Northstar golf course; inferred high permeability and limited groundwater discharge
			Kyburz-Trojan-Sierraville Complex	B				
Gooseneck flat	West Martis	0-2	Kyburz-Trojan-Sierraville Complex	B	Quaternary alluvium and volcanics	high	high	low gradient, high permeability, proximity to deeper geologic units
Schaffer Mill	Martis Creek	5 to 10	Aquolls and Borolls	D	Miocene volcanics	limited	limited	inferred groundwater discharge
'Sawtooth Meadow'	Martis Creek	2 to 5	Aquolls and Borolls	D	Quaternary alluvium and volcanics	limited	high	related to deeper geologic formations
Martis Creek riparian corridor	Martis Creek	3 to 5	Aquolls and Borolls	D	Miocene volcanics	limited	limited	

Notes
1) Locations have been identified through review of aerial photos and maps and are approximate. Additional meadows are likely to be documented during future field work activities
2) Soil type based on Hanes (2002). Soils are classified into hydrologic soil groups on the basis of infiltration rates. Group A soils have very rapid infiltration, while Group D soils have very slow infiltration.
3) Underlying geology based on Saucedo and others (2005)
4) Infiltration potential basd solely on meadow gradient and mapped soils. Local channel and hydrologic conditions have not yet been field-evaluated.
5) Aquifer recharge potential is based on geology, and relationships to identified water bearing strata within the Martis Aquifer.

Table 7. Native plants and historical uses by the Washoe Tribe in the Martis Valley region (reproduced from Rucks, 2007)

Scientific Name	Common Name	Washoe Name	Seasonal consumption or medicine	Collected, processed, and stored for food	Used for construction
Achillea millefolium	yarrow	*Wémši*	X		
Allium companulatum	dusky onion	*Bošdi*	X		
A. validum	swamp onion	*Búye* or P*uyeli*		X	
Amelanchier ainifloia var. *pumlia*	western service berry	*Śu-wet-k*	X		X
Arctostaphylos patula	greenleaf manzanita	*eyéye-e*	X		
Balsamorhiza sagittata	arrow-leaf balsam root	*Śú'gilá-ci'*	X		
Camassia quamash	small camas	*Sésmi*		X	
Fragaria virginiana	mountain strawberry	*Ma alanji*	X		
Heracleum lanatum	cow parsnip	*K'ómho*	X		
Lilium parvum	Sierra tiger lily	*Silá'twhu*	X		
Lupinus polyphyllus	bigleaf lupine	*Wadasa or Wa*		X	
Mentzelia dispersa	bushy blazing star	*Dáhal*		X	
Peonia brownii	mountain peony	*Tuyá'g-mhu*	X		
Perideridia spp.	Yampah	*Déguš*		X	
Pteridim aquilinum var. *pubescens*	bracken fern	*Megé-eš*			X
Ribes rozelii	Sierra gooseberry	*Séw-t yá'g-l*	X		
Rorippa nasturtium-aquaticum	water cress	*Ulipántza*	X		
Rosa woodsii var. *ultramontane*	interior rose	*Pećumeli*	X		X
Triteleia hyacinthine	white brodiaea	*Ma-hal*	X		
Typha latifolia	broadleaf cattail	*Mahatálal*	X		X
Verattrum californicum var. *californicum*	California corn lily	*Badópo*	X		
Wyethia mollis	mules ear	*Śú'gil*		X	

Table 8. Summary of the HEC-HMS watershed modeling results for the Martis watershed

HEC-HMS Description	Type[1]	Drainage Area (mi^2)	2-year (March, 2006) event: Peak Flow (cfs)	2-year (March, 2006) event: Runoff Volume (ac-ft)	Rain-on-snow (January 1997) event: Peak Flow (cfs)	Rain-on-snow (January 1997) event: Runoff Volume (ac-ft)
Martis Cr	**Subbasin**	**15.7**	**66**	**113**	**834**	**2303**
West Martis Cr	**Subbasin**	**5.1**	**24**	**33**	**336**	**590**
Middle Martis Cr	**Subbasin**	**4.7**	**19**	**30**	**290**	**548**
Martis Cr at Highway 267	**Junction**	**25.6**	**103**	**176**	**1367**	**3441**
East Martis Cr	**Subbasin**	**7.7**	**32**	**50**	**473**	**885**
Intervening areas between Hwy 267 and E. Martis Cr	Subbasin	1.9	54	43	167	286
Martis Cr upstream of reservoir	**Junction**	**35.2**	**180**	**268**	**1963**	**4609**
Intervening area contributing directly to reservoir	Subbasin	4.6	77	58	379	672
Total inflow to reservoir	**Junction**	**39.7**	**249**	**326**	**2320**	**5281**
Martis Cr Reservoir outflow[2]	**Reservoir**	**39.72**	**102**	**184**	**603**	**1893**
Change in flow and volume through reservoir[2]		----	*-147*	*-142*	*-1717*	*-3388*
Intervening areas below reservoir	Subbasin	3.0	36	34	247	687
Martis Cr at mouth	**Junction**	**42.7**	**112**	**215**	**813**	**2317**

Notes:

1 Subbasins are areas for which unique runoff parameters are established. Runoff rates, volumes, and timing from various subbasins are combined at junctions, or confluences.

2. Martis Cr Reservoir reduces peak flow and runoff volume. Runoff volume does not include entire inflow volume due to run time ending before reservoir drains. Extending the run time, however, invalidates flow volumes from the subbasins and inflow to the reservoir because baseflows continue to occur.

3 Total outflow volume at downstream end of Entire Martis Cr watershed does not represent entire outflow of the storm because the run time ends before the reservoir drains.

4 The ouflow from the reservoir was measured as 372 cfs at the XX gage located .....

Table 9. Summary of Disturbance Areas, Martis Creek Watershed, Nevada and Placer Counties, California

Disturbance ID	Subwatershed	Tributary / Reach	Land Use Type	Hydrogeomorphic Zone	Feature	Nature of Disturbance	Current Issues	Extent of Disturbance *(stream length, area)*
1	**Martis Creek**	Mainstem / Upstream of Hwy 267	Recreation/Wildlife Area	Alluvial Corridor/Meadow	Channel/Meadow	Historical diversions, legacy logging, grazing, bank trammeling	Incised channel is disconnected from floodplain; wet meadow conversion to upland; erosion and fine sediment production; downstream sedimentation	~1.6 miles
2	**Middle Martis Creek**	Mainstem / Martis Valley	Recreation/Wildlife	Alluvial Corridor/Meadow	Channel/ Meadow	Road runoff	Erosion, headcutting	~0.5 mile
4	**Martis Creek**	Lookout Mountain Tributary	Recreation/Wildlife Area	Alluvial Corridor/Meadow	Channel/Meadow	Historical diversions, legacy logging, grazing, bank trammeling; possible hydromodification	Erosion, channel incision	~300 feet
5	**East Martis Creek**	Klondike Tributary	Forestry/Wildlife/ Recreation	Alluvial Corridor/Meadow	Channel/ Meadow	Legacy logging, road building, railroad, ranching/grazing, channel re-alignment	Road/trail-stream connectivity; erosion, sedimentation, altered meadow hydrology	3,000+ feet
6	**Martis Creek**	Mainstem / Downstream Hwy 267	Recreation/Wildlife	Alluvial Corridor/Meadow	Channel/Meadow	Historical watershed disturbances (logging, road building, ranching, quarrying); channelization, diversions, reservoir operations	Channel confiment, floodplain disturbance and fill, channel incision, bank erosion, sedimentation	~1.0 mile
7	**Martis Creek**	Airport Tributary	Commercial/Wildlife	Alluvial Corridor/Meadow	Channel/Meadow	Urbanization and hydromodification, quarrying, channel re-alignment	Channelization and incision	~1.0 mile
8	**East Martis Creek**	Monte Carlo Tributary	Forestry/Wildlife/ Recreation	Alluvial Corridor/Meadow	Channel/ Meadow	Legacy logging, road building, railroad, ranching/grazing	Road-stream connectivity; erosion, sedimentation, altered meadow hydrology-channel incision	~1,000 feet
9	**Martis Creek**	Schaffer Road Trib	Recreation/Wildlife Area	Alluvial Corridor/Meadow	Channel/Meadow	Undersized culvert	Erosion around culvert	25 feet
10	**Martis Creek**	Mainstem / Downstream Gravel Pits	Commercial/Wildlife	Alluvial Corridor/Meadow	Channel/Meadow	Historical diversions, dam operations, historical placer mining, historical ice harvesting	Regulated hydrology, Channel incision, erosion and sedimentation	~1,500 feet
11	**Martis Creek**	Mainstem / Below Martis Dam	Recreation / Wildlife / Open Space / Industrial	Alluvial Corridor/Meadow	Channel/Meadow	Dam construction and infrastructure,	Fish barrier, channel incision/obsruction	~2,500 feet
12	**Middle Martis Creek**	Mainstem	Forestry/Wildlife/ Recreation	Upper Watershed	Channel	Historical mining and settlement (Elizabethtown); legacy logging; Road sand application and highway maintenance drainage	Hydromodification, channel incision, bank erosion, sedimentation	~1,500 feet
13	**East Martis Creek**	Ephemeral tributary	Forestry/Wildlife/ Recreation	Forested, lower elevation uplands	Ephemeral channel	Road runoff, logging (landings), channel rerouting into old skid trail(?)	Road-drainage connectivity; channel incision; sediment generation	~1500 ft
14	**Martis Creek**	Mainstem	Forestry/Wildlife/Recre ation	Alluvial Corridor/Meadow	Meadow and road-drainage crossing	Upstream landslides; channelization/rerouting at road crossing	Channel incision; occasional washout of 700 Rd; meadow conversion to upland; increased sediment transport through meadow	~2000 ft
15	**East Martis Creek**	SPI tributary	Forestry/Wildlife/ Recreation	Alluvial Corridor	Road-stream interaction	Channel realigned for logging road access	Channel incision; increased runoff directly to channel from adjacent roads, big landing and water bars	4000-5000 ft
16	**Dry Creek/Lake**	Ephemeral drainage to Dry Lake	Forestry/Wildlife/ Recreation	Alluvial Corridor	Ephemeral channel	Legacy logging, road building, channel rerouting	Channel incision; high road-stream connectivity; erosion and sediment transport directly to Dry Lake	~3500 ft
17	**East Martis Creek**	Mainstem	Forestry/Wildlife/ Recreation	Alluvial Corridor	Channel	Road runoff, historic flumes/logging railroad/roads, channel capture and rerouting	Channel incision, bank erosion, sedimentation	~2,000 feet
18	**Martis Creek**	Mainstem (Lahontan)	Recreation / Golf	Alluvial Corridor	Channel	Historical logging road, possible channel re-alignment	Apparent channel incision and wet meadow conversion	1,200 ft
19	**Martis Creek**	Tributary (Martis Camp)	Residential Development	Alluvial Corridor	Possible historical flume / chute / Skid Trail	Legacy hillside channelization and sediment production	Sediment delivery to Martis Creek	2,500 ft
A	**Dry Creek/Lake**	Ephemeral drainage to Dry Lake	Forestry/Wildlife/ Recreation	Forested, lower elevation uplands	Channel-road crossing	Legacy logging, road building	Road-stream connectivity; channel incision/headcutting due to grade change at road crossing	200 feet
B	**Dry Creek/Lake**	Ephemeral drainage to Dry Lake	Forestry/Wildlife/ Recreation	Forested, lower elevation uplands	Road	Legacy logging, road building, channel rerouting	High road-stream connectivity; erosion and sediment transport directly to Dry Lake; poor vehicle access due to degraded road conditions	~1000 feet
C	**Dry Creek/Lake**	Ephemeral drainage to Martis Lake	Forestry/Wildlife/ Recreation	Forested, lower elevation uplands	Active road	logging (legacy and recent); road drainage mgmt	Water bar shunts road runoff directly to ephemeral drainage; erosion and scouring in channel downslope of road	500 feet
D	**Dry Creek/Lake**	Ephemeral drainage to Martis Lake	Forestry/Wildlife/ Recreation	Forested, lower elevation uplands	Skid trail	Skid trail on steep slope, likely from 90s-era logging	Soil compaction; erosion; evidence of concentrated flow	2000 feet

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Disturbance ID	Subwatershed	Tributary / Reach	Land Use Type	Hydrogeomorphic Zone	Feature	Nature of Disturbance	Current Issues	Extent of Disturbance *(stream length, area)*
E	**Dry Creek/Lake**	Ephemeral drainage to Martis Lake	Forestry/Wildlife/ Recreation	Forested, lower elevation uplands	Active road and skid trail	Logging, road construction	Actively used road capturing runoff (partly from skid trail upslope), resulting in accelerated erosion/gullying	1000 feet
F	**Dry Creek/Lake**	Ephemeral drainage to Martis Lake	Forestry/Wildlife/ Recreation	Forested, lower elevation uplands	Road-stream crossing	Logging, road construction	Haul road crossing ephemeral drainage. Steep road drains to this crossing. Evidence of high energy flows in drainage, large material deposited, scouring, etc.	500 ft
G	**East Martis Creek**	Mainstem	Forestry/Wildlife/ Recreation	Forested, lower elevation uplands	Road	Road construction, lack of maintenance	Accelerated erosion of road surface	500 ft
H	**East Martis Creek**	Mainstem	Forestry/Wildlife/ Recreation	Alluvial Corridor/Meadow	road-meadow/stream crossing	Access road constructed without effective drainage features or accomodation of stream-meadow hydrology	Unstable crossing; altered meadow hydrology; seasonal vehicle access issues; erosion/gullying steep section of road upslope of crossing	300 ft
I	**East Martis Creek**	Mainstem	Forestry/Wildlife/ Recreation	Alluvial Corridor/Meadow	Road-meadow/stream crossing	Access road constructed without effective drainage features or accomodation of stream-meadow hydrology	Altered meadow hydrology due to road impoundment; erosion from road surface; weed establishment along road	1000 ft
J	**Dry Creek/Lake**	Mainstem	Forestry/Wildlife/ Recreation	Forested, lower elevation uplands	Landing	Recent logging activity (past 2-3 years)	Soil compaction; high runoff potential	10,000 SF
K	**Dry Creek/Lake**	Mainstem	Forestry/Wildlife/ Recreation	Forested, lower elevation uplands	Landing	Recent logging activity (past 2-3 years)	Soil compaction; high runoff potential; drainage connectivity via access road	10,000 SF
L	**Dry Creek/Lake**	Mainstem	Forestry/Wildlife/ Recreation	Forested, lower elevation uplands	Landing	Recent logging activity (90's?)	Soil compaction; significant cut/fill; heavily eroded cut slope; source of concentrated runoff	~20,000 SF
M	**East Martis Creek**	Mainstem	Forestry/Wildlife/ Recreation	Forested, lower elevation uplands	Recreational trail	Trail construction for recreation (hiking, biking)	Trail directs concentrated runoff directly to creek; erosion/sediment transport	300 ft
N	**East Martis Creek**	SPI tributary	Forestry/Wildlife/ Recreation	Forested, higher elevation uplands	Road-stream interaction; landing	Landing and logging road created during recent logging (likely in past 5 years)	1) Channel incision and significant sediment transport due to drainage from road parallel to channel; 2) Large headcut 50 ft downstream of road crossing; 3) Compacted landing shunts runoff to road running parallel to channel downslope	~1500 ft (road/stream); ~10,000 SF for landing
P	**Middle Martis Creek**	Mainstem	Forestry/Wildlife/ Recreation	Forested, lower elevation uplands	Road	Road construction and vehicle traffic	On-contour road captures dispersed surface flows and shunts concentrated water off in at least 3 locations, resulting in deep gullying downslope and erosion direct to creek	~500 ft
Q	**Middle Martis Creek**	Ephemeral tributary	Forestry/Wildlife/ Recreation	Forested, lower elevation uplands	Road	Road runs through wet meadow. Deep ruts from vehicle traffic during muddy conditions. General degredation of road surface from erosion and vehicle traffic.	Deep rutting, soil compaction and vegetation disturbance; road erosion into channel at crossing; culvert is degraded	~300 ft
S	**East Martis Creek**	SPI tributary	Forestry/Wildlife/ Recreation	Forested, higher elevation uplands	Road-stream crossing	Road construction and ongoing use	Crossing appears fairly stable, no downcutting. Sideslopes of drainage are not armored and are a potential source of sediment.	50 ft
T	**Middle Martis Creek**	Road	Forestry/Wildlife/ Recreation	Forested, higher elevation uplands	Road	Logging, road construction	Steep road with minimal drainage improvements; evidence of erosion/concentrated flow	~1000-2000 ft
W	**Martis Creek**	Mainstem (Northstar)	Recreation/Wildlife	Forested, lower elevation uplands	Borrow material placement	Borrow material from dam and Hwy 267 construction	Erosion, gullying, sediment transport to reservoir	~ 20 acres
X	**Martis Creek**	Mainstem (Martis Camp)	Recreation / Wildlife / Open Space	Alluvial Corridor	Historical Impoundment and Diversion Dam	Diversion structure and pond	Sediment-filled pond, possible fish barrier. Possible sediment source if breached	0.8 acres
Y	**Martis Creek**	Mainstem (Martis Camp)	Golf; Residential Development	Alluvial Corridor	Road crossing	New culverts appear to be potential fish barrier, should be evaluated	Potential fish barrier	50 ft
Z	**Middle Martis Creek**	Elizabethtown Meadow	Legacy Mining	Alluvial Corridor	Channel	Historical road capture	Perennial flow is channeled away and potentially dewatering former wet meadow areas	0.5 to 1 acre

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Project #	Grouping Justification	Disturbance ID (sites, reaches, landings)	Subwatershed	Ownership	Feature	Current Issues	Extent of Disturbance (stream length, area)	Project Goal(s)	Restoration Approach(s)	Success Criteria/ Parameters	Performance Monitoring Elements	Potential Implementation Constraints	Complexity (H, M, L)	Current Sediment Yield (H,M,L)	Potential Sediment Yield Reduction (%)	Est. Construction Cost
1	Hydrologically connected	A, B, 16	Dry Creek/Lake	TTAD (Waddle Ranch) and SPI	Ephemeral channel criss-crossing active and inactive roads	Road alignment captures ephemeral drainage and creates sediment source	~4000 ft channel; ~1200 ft road	1) Minimize sediment transport to Dry Lake; 2) Re-establish natural hydrologic condictions in drainage; 3) create stable, low-maintenance road prism	**1) Drainage:** define drainage alignment and construct channel to preferentially accomodate peak flows all the way to lake; **2) Road-drainage crossings:** reconstruct armored road-drainage crossings to accommodate peak water flow and large trucks; **3) Road:** design road to preclude capture of stream flows	1) Reduced sedimentation in lower reaches of drainage; 2) Stable drainage not captured by road; 3) Minimal erosion of road surface	Seasonal observations of road and channel conditions	1) Multiple landowners - majority of channel is on SPI land, road issues on Waddle Ranch; 2) Road needs to accommodate large forestry equipment	M	H	75	$$ - $$$
		A	Dry Creek/Lake	TTAD (Waddle Ranch)	Channel-road crossing	Road-stream connectivity; channel incision/headcutting due to grade change at road crossing	200 feet		Recontour crossing and minimize grade change and stabilize channel; targeted road decommisioning near stream crossing							
		B	Dry Creek/Lake	TTAD (Waddle Ranch)	Road	High road-stream connectivity; erosion and sediment transport directly to Dry Lake; poor vehicle access due to degraded road conditions	~1000 feet		Realign ephemeral drainage channel to minimize road connectivity; road drainage improvements; road surfacing							
		16	Dry Creek/Lake	SPI	Ephemeral channel	Channel incision; high road-stream connectivity; erosion and sediment transport directly to Dry Lake	~4000 feet		Realign ephemeral drainage channel to minimize road connectivity; road drainage improvements; road surfacing							
2	Similar treatment approaches	L, L2-9	Dry Creek/Lake	TTAD (Waddle Ranch)	Landings	Soil compaction; High runoff potential; Large-scale cut/fill interupts hillslope hydrology	~100,000 SF	1) Increase groundwater recharge; 2) Disconnect concentrated flow paths;	Recontour cut/fill slopes where applicable; loosen compacted soil in landings + seed and mulch; create high surface roughness; create slight surface depression (to contain runoff during saturated soil conditions)	1) Soil density – cone penetrometer depth-to-refusal 18 inches at 350 psi; 2) Surface roughness 4" relief over 24" distance; 3) Total surface (mulch) cover – 90% or greater in year 1; 4) 5% veg cover (from seed) in year 1; 5) no signs of erosion or concentrated runoff.	Cone penetrometer; ocular cover estimates; visual erosion assessment		L-M	L-M	90+	$$
3	Proximity	C, D, E, L10	Dry Creek/Lake	TTAD (Waddle Ranch)	Road drainage/ erosion with connected skid trails and landing	Skid trails and landing contributing runoff to roads; road flow capture and drainage directly to ephemeral channel	1500 LF active road treatments; ~30,000 SF landing/skid trail treatments	1) Increase groundwater recharge; 2) Disconnect concentrated flow paths; 3) minimize road erosion	**1) Skid trails:** targeted soil loosening and surface roughening of skid trails; **2) Landings:** loosen compacted soil + seed and mulch, create high surface roughness and slight depression (to contain runoff during saturated soil conditions); **3) Roads:** install additional rolling dips with infiltration/spreading areas; surface road w/ rock or asphalt grindings	**Landings/skid trails:** 1) soil density – cone penetrometer depth-to-refusal 18 inches at 350 psi; 2) surface roughness 4" relief over 24" distance; 3) total surface (mulch) cover – 90% or greater in year 1; 4) 5% veg cover (from seed) in year 1; 5) no signs of erosion or concentrated runoff. **Roads:** no concentrated flow overtopping rolling dips; no scouring at rolling dip outlets	**Landings/skid trails:** Cone penetrometer; Ocular cover estimates; visual erosion assessment; **Roads:** Visual erosion assessment.	Road needs to accommodate large forestry equipment	M	M	90+	$$
		C	Dry Creek/Lake		Active road	water bar shunts road runoff directly to ephemeral drainage; erosion and scouring in channel downslope of road	500 feet		Road drainage improvements upslope (water bars and infiltration areas, road surfacing, etc).							
		D	Dry Creek/Lake		Skid trail	soil compaction; erosion; evidence of concentrated flow	2000 feet		Targeted loosening; add infiltration/sediment capture areas at water bars							
		E	Dry Creek/Lake		Active road and skid trail	Actively used road capturing runoff (partly from skid trail upslope), resulting in accelerated erosion/gullying	1000 feet		Road surfacing; road drainage management (water bars, infiltration areas). Treat skid trail adjacent to roadway.							
		L10	Dry Creek/Lake		Landing	soil compaction; high runoff potential	~10,000 SF		Mulching; "chip 'n' rip"; soil loosening/surface roughening							
4	Similar treatment approaches; proximity	K, F, J, L12, L17, L18		TTAD (Waddle Ranch)	Landings and road-stream crossing	Compacted soil and high runoff potential from landings; unstable stream crossing; road erosion direct to ephemeral channel	landings: ~50,000 SF; road: 500 ft; stream crossing: 50 ft	1) Maximize groundwater recharge; 2) Disconnect point sources of runoff/erosion; 3) Minimize sediment transport to Martis Creek Lake; 4) Create stable, low-maintenance road prism	**1) Landings:** loosen compacted soil + seed and mulch, create high surface roughness and slight depression (to contain runoff during saturated soil conditions). **2) Road drainage:** install additional rolling dips with infiltration/spreading areas; surface road w/ rock or asphalt grindings. **3) Stream crossing:** rock-armor crossing, minimize grade break.	**Landings:** 1) soil density – cone penetrometer depth-to-refusal 18 inches at 350 psi; 2) surface roughness 4" relief over 24" distance; 3) total surface (mulch) cover – 90% or greater in year 1; 4) 5% veg cover (from seed) in year 1; 5) no signs of erosion or concentrated runoff. **Road drainage:** 1) no concentrated flow overtopping rolling dips; 2) no scouring at rolling dip outlets. **Stream crossing:** 1) no scouring or deposition at road crossing; 2) passable by large forestry equipment.	**Landings:** Cone penetrometer; ocular cover estimates; visual erosion assessment. **Road drainage and stream crossing:** Visual erosion assessment.		M	M	90+	$$
		J	Dry Creek/Lake		Landing	Soil compaction; high runoff potential	~10,000 SF		Mulching; "chip 'n' rip"; soil loosening/surface roughening							
		K	Dry Creek/Lake		Landing	Soil compaction; high runoff potential; drainage connectivity via access road	~10,000 SF		Mulching; "chip 'n' rip"; soil loosening/surface roughening							
		F	Dry Creek/Lake		Road-stream crossing	Haul road crossing ephemeral drainage. Steep road drains to this crossing. Evidence of high energy flows in drainage, large material deposited, scouring, etc.	road: 500 ft; stream crossing: 50 ft		Manage road drainage upslope of crossing (add infiltration areas at water bars, road surfacing, etc). Stabilize/broaden channel at crossing.							
		L12, L17, L18	Dry Creek/Lake		Landing	Soil compaction; high runoff potential; some have drainage connectivity via roads	~ 30,000 SF		Mulching; "chip 'n' rip"; soil loosening/surface roughening							

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5	Similar treatment approaches; proximity	M, L13-15		TTAD (Waddle Ranch)	Landings and recreational trail	Trail directs concentrated runoff to EM creek; upslope landings are compacted sources of runoff in close proximity to EM creek	Landings: ~30,000 SF; trail: ~300 ft	1) Increase groundwater recharge; 2) Disconnect point sources of runoff/erosion; 3) Minimize sediment transport to East Martis Creek; 4) Create stable, low-maintenance recreational trail	**1) Landings:** loosen compacted soil + seed and mulch; create high surface roughness and slight depression (to contain runoff during saturated soil conditions). **2) Trail:** redesign/rebuild problem section of trail to minimize water capture and direct runoff to infiltration/spreading areas (disconnect drainage from EM creek).	**Landings:** 1) soil density – cone penetrometer depth-to-refusal 18 inches at 350 psi; 2) surface roughness 4" relief over 24" distance; 3) total surface (mulch) cover – 90% or greater in year 1; 4) 5% veg cover (from seed) in year 1; 5) no signs of erosion or concentrated runoff. **Trail:** 1) no evidence of water capture or erosion.	**Landings:** cone penetrometer; ocular cover estimates; visual erosion assessment. **Trail:** visual erosion assessment.	Vehicle/trail access to trail is limited. Treatments can be implemented by hand crew or some off-road travel would be required.	M	M	90+	$$
		M	East Martis Creek		Recreational trail	Trail directs concentrated runoff directly to creek; erosion/sediment transport	300 ft		Recontour trail to prevent drainage to creek; trail surfacing; infiltration areas							
		L13-15			Landing	Soil compaction; high runoff potential; some have drainage connectivity to EM Creek	~30,000 SF		Mulching; "chip 'n' rip"; soil loosening/surface roughening							
6	Similar treatment approaches; proximity	G, H		ACOE	Road and stream crossings	Road has altered stream alignments and flooding patterns road surface is erosion/runoff source direct to creek; seasonal vehicle access issues	~3000 ft of road needs improvement	1) Recreate functional hydrologic flow regimes in and around roads; 2) Minimize road hydrologic and sediment impacts to streams; 3) Create stable and low-maintainance road prism	Develop integrated flow paths that deliver water through road area into lower meadow. G: define and stablize flow above and below road and develop a stabilized flow crossing; H : route water directly from contributing area either across road in a robust Arizona crossing or bridge, stabilize flow paths; reshape and surface all roads to minimize erosion, raise road bed where needed.	Water flow paths accepting and retaining all water during spring runoff events; road surfaces not eroding into meadow or stream areas; Arizona crossing stable and not blocking flows	Visual erosion assessment		M	H	90+	$$-$$$
		G	East Martis Creek		Road	accelerated erosion of road surface	500 ft		road surfacing; road drainage management (water bars, infiltration areas, stable flow paths).							
		H	East Martis Creek		Road-meadow/stream crossing	unstable crossing; altered meadow hydrology; seasonal vehicle access issues; erosion/gullying steep section of road upslope of crossing	300 ft		stabilize/formalize crossing; road drainage improvements upslope (water bars and infiltration areas, road surfacing, etc).							
7		P, Q, T	Middle Martis Creek	TDLT	Road, trail, stream crossings	Road water capture has caused erosion/gullying directly to Middle Martis Creek; meadow vegetation disturbance by vehicles; culverted crossings limit floodplain connectivity of ephemeral drainages	~7000 ft of road (approx. 70,000-100,000 SF)	1) Increase groundwater recharge; 2) Minimize sediment transport to Middle Martis Creek; 3) Maintain non-motorized recreational access	**1) Road removal:** complete or partial recontouring (utilizing spoils piles onsite); soil loosening, fertilizer, seed, mulch. **2) Ephemeral stream crossings:** remove culverts and reconstruct disturbed reaches; construct debris jams and/or other channel biostabilization approaches. **3) Trail construction:** create singletrack trail for hiking/biking with appropriate drainage improvements (e.g. dips with infiltration/spreading areas).	**1) Road removal:** 1) soil density – cone penetrometer depth-to-refusal 18 inches at 350 psi; 2) surface roughness 4" relief over 24" distance; 3) total surface (mulch) cover – 90% or greater in year 1; 4) 5% veg cover (from seed) in year 1; 5) no signs of erosion or concentrated runoff. **2) Ephemeral stream crossings:** Stable channels; **3) Trail:** no evidence of water capture or erosion.	**Road Removal:** cone penetrometer; ocular cover estimates; visual erosion assessment. **Stream crossings and trail:** visual assessment; channel topo surveys	Projects would need to be done in sequence to maintain equipment access Q then P then T.	M	H	90+	$$$
		P	Middle Martis Creek		Road	On-contour road captures dispursed surface flows and shunts concentrated water off in at least 3 locations, resulting in deep scouring downslope and erosion direct to creek	~500 ft		Remove/recontour problem section of road using original spoils (still onsite), chipping slash, etc. Create singletrack trail for hiking/biking.							
		Q	Middle Martis Creek		Road	Deep rutting, soil compaction and vegetation disturbance by vehicles; road erosion into channel at crossing; culvert is degraded	~300 ft		Remove/recontour road; create singletrack trail for recreation access; improve/stabilize road-stream crossing; consider culvert removal							
		T	Middle Martis Creek		road	Steep road with minimal drainage improvements; evidence of erosion/concentrated flow	~1000-2000 ft		Remove/recontour road using original spoils (still onsite), slash, logs, large boulders, etc. Create singletrack trail for hiking/biking.							
		Z	Middle Martis Creek		road / trail	Abandoned road and ditch has captured perennial springflow, diverting water from former wet meadow areas	0.5 to 1 acre		Remove/recontour road; allow for dispersal of spring flow across meadow							
8		Reach 5, O, L19		SPI	Roads, Trails, Channels	Road water capture has caused erosion, sediment deposition, and channel incision adjacent to Klondike Meadow. Road drainage infrastructure has marginally dewatered portions of meadow.	see below	Re-establish hydrology to meadow areas to attenuate peak flows and reestablish meadow hydrology; reduce sediment generation from roads and incising channels.	see below	see below	see below		M	M	75	$$$
		5	East Martis Creek / Klondike Meadow		Channel/ Meadow	Road/trail-stream connectivity; erosion, sedimentation, altered meadow hydrology	3,000+ feet		Restore channel alignment and meadow connectivity (Note: must be prececeded by correction of road drainage issues)	Longer periods of saturation in meadow, stable or no channel form	Groundwater monitoring, channel cross-sectional or topographic surveys					
		O	East Martis Creek		Road	Road/trail-stream connectivity; erosion, sedimentation, altered meadow hydrology	3,000+ feet		Modify road drainage and connectivity to downstream channels (Must precede restoration of Reach 5-- Klondike Meadow hydrology)	Stable roads and trails	Visual inspections					

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		L19	East Martis Creek		Landing	Soil compaction; high runoff potential	~10,000 SF		Mulching; "chip 'n' rip"; recontouring	1) Soil density – cone penetrometer depth-to-refusal 18 inches at 350 psi; 2) Surface roughness 4" relief over 24" distance; 3) Total surface (mulch) cover – 90% or greater in year 1; 4) 5% veg cover (from seed) in year 1; 5) No signs of erosion or concentrated runoff.	Cone penetrometer; ocular cover estimates; visual erosion assessment					
9	Hydrologic connectivity, proximity	15, N, L37	East Martis Creek	SPI	Road, drainage, landing	Road is capturing ephemeral but high energy drainage, old drainage is also old road capture; landing disrupts this and other surface flows and subsequently causes downcutting below crossing	up to 50,000 SF	Re-establish stable, lower energy flow paths not available for road capture; to open up and reshape downslope landing to not disrupt but to capture, infiltrate and route some flows; to reduce velocities and resore head cut area below landing/road crossing; Peak flow attenuation	Remove road above landing creating a stable, step pool type of drainage regime; reshape landing to open up road crossing area and to also receive, infiltrate and distribute some high flow water in order to reduce velocies and then restore and stabilize large head cut below road and landing	Stable, equilibrated flow path above landing, minimal sediment deposition downslope; high infiltration reconfigured landing area, stable road crossing; no additional head cutting	Visual erosion assessment	Landowner cooperation required	M	H	75	$$$
		15	East Martis Creek		Road-stream interaction	Channel incision; increased runoff directly to channel from adjacent roads, big landing and water bars	4000-5000 ft		Realign and/or stabilize existing stream channel; improve road-stream crossing (regrade to minimze grade change);							
		N, L37	East Martis Creek		Road-stream interaction; landing	1) Channel incision and significant sediment transport due to drainage from road parallel to channel; 2) large headcut 50 ft downstream of road crossing; 3) compacted landing shunts runoff to road running parallel to channel downslope	~1500 ft (road/stream); ~10,000 SF for landing		Remove/recontour road along stream; roughen/seed/mulch landing area and potentially route stream through to allow spreading/infiltration							
10	similar treatment approaches	S, L20-35, L38-46	East Martis Creek	SPI	Landings; road-stream crossing	Soil compaction; high runoff potential; large-scale cut/fill interupts hillslope hydrology	~250,000 SF	Increase groundwater recharge; Disconnect point sources of runoff/erosion; reduce sediment generation from roads	see below	see below	see below		L	L-M	90+	$$$
		S	East Martis Creek		Road-stream crossing	Crossing appears fairly stable, no downcutting. Sideslopes of drainage are not armored and are a potential source of sediment.	50 ft		Armor sideslope of drainage crossing. Highlight hand-placed rock above/below road as effective, low-cost practice for energy dissipation and extending the life of road-stream crossings.	stable crossing, no downcutting or sediment deposition	visual erosion assessment					
		L20-35, L37-46	East Martis Creek		Landing	Soil compaction; high runoff potential; some have drainage connectivity via roads	~250,000 SF		Recontour cut/fill slopes where applicable; loosen compacted soil in landings + seed and mulch; create high surface roughness; create slight surface depression (to contain runoff during saturated soil conditions)	1) Soil density – cone penetrometer depth-to-refusal 18 inches at 350 psi; 2) Surface roughness 4" relief over 24" distance; 3) Total surface (mulch) cover – 90% or greater in year 1; 4) 5% veg cover (from seed) in year 1; 5) no signs of erosion or concentrated runoff.	Cone penetrometer; ocular cover estimates; Visual erosion assessment					
		Reach 1	Martis Creek	ACOE	Channel/ Meadow	Incised channel is disconnected from floodplain; wet meadow conversion to upland; erosion and fine sediment production; downstream sedimentation	~1.6 miles	Re-establishment of wet meadow conditions, channel-floodplain connectivity, and opportunities for sediment storage	A) Bank layback and planting; promote evolution of new inset floodplain; B) Actively encourage channel aggradation to restore channel/meadow connectivity through construction of debris/sediment jams;	More frequent (1- to 3-year) meadow / floodplain inundation; upland vegetation converted to wetland vegetation	Streamflow and groundwater measurements, annual high water surveys, vegetation transects		M	M	75	$$$$
11	Hydrologic connectivity	12, I, 2	Middle Martis Creek	ACOE, Northstar, CalTrans, TDLT	Channel / Meadow	see below	see below	Re-establish hydrology to alluvial fan distrubitary channels, alleviate erosion, sediment input to channels, and drainage issues on golf course and highway; peak flow attenuation;	see below	see below	see below	see below	H	M	95	$$$$$
		Reach 12	Middle Martis Creek	CalTrans; Northstar; SPI; USFS	Channel	Hydromodification, channel incision, bank erosion, sedimentation	~1,500 feet		Establish highway stormwater and sediment management infrastructure; establish incision controls	Reductions in fine sediment loadings to channel	Channel reconnaissance, V-star pool surveys, Channel cross-section surveys, Turbidity, Suspended sediment, and streamflow monitoring	Confiment of channel in narrow corridor between highway and hillside;				
		Reach 2	Middle Martis Creek	ACOE, Northstar, CalTrans, TDLT	Channel/ Meadow	Erosion, headcutting, historical realignment, road drainage issues	~0.5 mile		A) Relocate channel alignment to north side of HWY 267; B) Permit some high flows to occupy former channel north of HWY 267; C) Re-construct channel and its ability to convey increased flow from road runoff; NOTE: Need to account for potential future restoration strategies and baselevel elevations in Martis Creek.	Water does not flow onto highway; stable and dynamic distributary channels on Alluvial fan surface, absence of headcut propagation	Visual inspections, annual high water surveys	Multiple landowners/stakeholders; Conformance with CalTrans standards; Accommodation of a range of future baselevel conditions;				

Table 10. Summary of Restoration Opportunities, Martis Creek Watershed, Nevada and Placer Counties, California

Project #	Grouping Justification	Disturbance ID (sites, reaches, landings)	Subwatershed	Ownership	Feature	Current Issues	Extent of Disturbance (stream length, area)	Project Goal(s)	Restoration Approach(s)	Success Criteria/ Parameters	Performance Monitoring Elements	Potential Implementation Constraints	Complexity (H, M, L)	Current Sediment Yield (H,M,L)	Potential Sediment Yield Reduction (%)	Est. Construction Cost
		Site I	East Martis Creek	TTAD (Waddle Ranch), ACOE	Road-meadow/stream crossing	Altered meadow hydrology due to road impoundment; erosion from road surface; weed establishment along road	1000 ft	1) Recreate functional hydrologic flow regimes in and around roads; 2) Minimize road hydrologic and sediment impacts to stream/meadow; 3) Create stable and low-maintainance road prism	Stabilize/formalize crossing and/or add appropriately sized/located culverts under road impoundment; road surfacing and drainage improvements; weed mgmt and native vegetation re-establishment	Designated water flow paths accepting and retaining all water during spring runoff events; road surfaces not eroding into meadow or stream areas; crossing stable and not blocking flows; road surface passable by vehicles	Visual inspections, annual high water surveys					
12	Hydrologic connectivity	Site W, Reaches 6,7,11	Martis Reservoir	ACOE	Channel / Meadow / Borrow Pit	Channel confiment, floodplain disturbance and fill, channel incision, bank erosion, sedimentation		Re-establisment of wet meadow conditions, remove fill associated with abandoned road beds, improve water quality and reduce sediment loads; peak flow attenuation; restore historical channel alignments				Portions of this area may be sensitive cultural resources; Need to accommodate potential future pool extents in Martis Reservoir	L	M	50	$$$
		W	Martis Creek	ACOE	borrow material placement	erosion, gullying, sediment transport to reservoir	~ 20 acres		Use sediment deposited in downstream areas and in reservoir to fill/reclaim borrow areas; use large woody debris to encourage deposition	Stable slopes, vegetation recruitment, soil development on hillsides	Visual inspections, sediment production/transport measurements, soil carbon measurements	Future Martis Reservoir operations;	H	H	80	$$$$
		Reach 6	Martis Creek	ACOE	Channel/ Meadow	Channel confiment, floodplain disturbance and fill, channel incision, bank erosion, sedimentation	~1.0 mile		A) Bank excavation, layback and planting; promote evolution of new inset floodplain; Excavated material could potentially be used for borrow-pit reclamation as aggregate for other purposes. B) Actively encourage channel aggradation to restore channel/meadow connectivity through construction of debris/sediment jams;	Channel-floodplain connectivity, improved water quality	Streamflow and sediment sampling					
		Reach 7	Martis Creek	ACOE	Channel/ Meadow	Channelization and incision	~1.0 mile		Channel reconstruction, riparian corridor widening, borrow pit reclamation and planting	Vegetation development; soil density – cone penetrometer depth-to-refusal 18 inches at 350 psi; 2) surface roughness 4" relief over 24" distance; 3) total surface (mulch) cover – 90% or greater in year 1; 4) 5% veg cover (from seed) in year 1; 5) no signs of erosion or concentrated runoff.	Cone penetrometer, surface and groundwater monitoring, vegetation transects					
		Reach 11	Martis Creek (Martis Dam)	ACOE	Channel/ Meadow	Fish barrier, channel incision/obsruction	~2,500 feet		Floodplain restoration, bank stabilization, fish passage development	Reintroduction or enhancement of native fish populations	Fish surveys	Downstream flood control requirements; potential increases in sediment yield associated with dam removal; potential impacts to Martis Reservoir fringe wetlands	H	L	0	$$$$$
		Reach 4	Martis Creek	ACOE	Channel/ Meadow	Erosion, channel incision	~300 feet	Improve channel-floodplain connectivity; reduce sediment loads	Temporary exclusion; bank layback; revegetation,	Alleviation of bank erosion: vegetated banks, and channel-floodplain connectivity	Channel cross-section and high-water-mark surveys	Access		L	50	$
		Reach 8	East Martis Creek		Channel/ Meadow	Road-stream connectivity; erosion, sedimentation, altered meadow hydrology-channel incision	~1,000 feet		A) Address upstream road drainage and connectivity; B) restore channel alignment and meadow connectivity (Note: A must precede B)							
		Reach 9	Martis Creek	ACOE	Channel/ Meadow	Erosion around culvert	25 feet	Reduce sediment loads	Replace culvert with free-span bridge or wooden walkway; recontour channel morphology at crossing; revegetation.	Re-establisment of wet meadow conditions and vegetation	Visual inspections	Potential need to maintain vehicular access	L-M	L	100	$$
		Reach 10	Martis Creek	USFS (?)	Channel/ Meadow	Regulated hydrology, Channel incision, erosion and sedimentation	~1,500 feet	Re-establish wet meadow and channel/floodplain connectivity; encourage sediment deposition upstream of Truckee River; peak flow attenuation	Bank stabilization, construction of debris/sediment jams to trap sediment and aggrade channel	Re-establisment of wet meadow conditions and vegetation; sediment deposition and channel aggradation	Groundwater monitoring, vegetation transects; Channel topographic surveys,	Access through T-TSA	M	L	5-10	$$$$
		Reach 13	East Martis Creek	SPI	Ephemeral channel	road-drainage connectivity; channel incision; sediment generation	~1500 ft	Reduce runoff to and reconstruct ephemeral step-pool channels; retain sediment in alluvial corridor	redirect or infiltrate road runoff; restore compacted landing upslope; remove/decommission one of two channels; establish grade control / sediment traps in channels	Sediment aggradation in channel; stable channel form with minimal erosion	Visual inspections; topographic surveys	Steep, unstable channel with very limited productive soil	M	H	75	$$
		Reach 14	Martis Creek	Northstar	meadow and road-drainage crossing	channel incision; occasional washout of 700 Rd; eadow conversion to upland; increased sediment transport through meadow	~2000 ft	Restore channel-floodplain connectivity and capacity to store sediment delivery from upstream areas; peak flow attenuation	Grading of multiple channels and crossings at 700 Rd; Placement of large woody debris and/or plug-and-pond methods in meadow	More frequent flooding of meadow; channel aggradation; sediment load reductions	Streamflow and sediment sampling; channel geomorphic mapping; vegetation conversion to wet meadow conditions	Access	M	L	100	$$$

Table 10. Summary of Restoration Opportunities, Martis Creek Watershed, Nevada and Placer Counties, California

Project #	Grouping Justification	Disturbance ID (sites, reaches, landings)	Subwatershed	Ownership	Feature	Current Issues	Extent of Disturbance (stream length, area)	Project Goal(s)	Restoration Approach(s)	Success Criteria/ Parameters	Performance Monitoring Elements	Potential Implementation Constraints	Complexity (H, M, L)	Current Sediment Yield (H,M,L)	Potential Sediment Yield Reduction (%)	Est. Construction Cost
		Reach 17	East Martis Creek	SPI	Channel	channel incision, bank erosion, sedimentation	~2,000 feet	Reduce runoff to and reconstruct stable channel; retain sediment in alluvial corridor	Redirect or infiltrate drainage captured in historical railroad beds, roadbeds, and trails; construct sediment traps and grade control structures in a restored and stablized channel.	Sediment aggradation in channel; stable channel form with minimal erosion	Visual inspections; topographic surveys	Access	M	H	75	$$$
		Reach 18	Martis Creek	Lahontan Golf Club	Channel	Apparent channel incision and wet meadow conversion	1,200 ft	Restore channel-floodplain connectivity and flood storage capacity; peak flow attenuation	Needs futher field evaluation; Potentially through strategic debris jam placement and grade control structures	Sediment aggradation in channel; stable channel form with minimal erosion;	Cross-section surveys, high-water mark surveys	Existing infrastructure; flood control requirements; Landowner cooperation required	H	Needs evaluation	Needs evaluation	Needs evaluation
		Reach 19	Martis Creek	Martis Camp	Inferred historical flume / chute / Skid Trail	Sediment delivery to Martis Creek	2,500 ft	Reduce runoff to and reconstruct ephemeral step-pool channels; retain sediment in alluvial corridor	Needs futher field evaluation	Stable channel form with minimal erosion	Visual inspections; topographic surveys	Equipment Access, steep slops	M	Needs evaluation	Needs evaluation	Needs evaluation
		X	Martis Creek	Martis Camp	Historical Impoundment and Diversion Dam	Sediment-filled pond, possible fish barrier. Possible sediment source if breached	0.8 acres	Evaluate fish passage and hydrologic connectivity	Establish aquatic organism passage, if appropriate	Hydraulic conditions which permit fish passage	Criteria to be determined by fisheries biologist or criteria put forth in USFS AOP guidance documents	Needs evaluation; Landowner cooperation required	M	Needs evaluation	Needs evaluation	Needs evaluation
		Y	Martis Creek	Martis Camp	Road crossing	Potential Fish Barrier	50 ft	Establish aquatic organism passage at crossing	Needs futher field evaluation	Hydraulic conditions which permit fish passage	Criteria to be determined by fisheries biologist or criteria put forth in USFS AOP guidance documents	Needs evaluation; Landowner cooperation required	M	Needs evaluation	Needs evaluation	Needs evaluation

Notes:
TTAD = Truckee Tahoe Airport District; SPI = Sierra Pacific Industries; TDLT = Truckee Donner Land Trust
Chip 'n' rip refers to application of wood chips/shreds and incorporation into soil via ripping or targeted loosening with bucket-mounted tines. Intent is to improve soil hydrologic function while minimizing disturbance to the soil profile and established vegetation
Estimated construction costs are approximate and preliminary estimates for planning purposes only, as follows:

- $: $1 to $10,000
- $$: $10,000 to $50,000
- $$$: $50,000 to $100,000
- $$$$: $100,000 to $500,000
- $$$$$: >$500,000

Relative costs include additional analysis and design, and assume that construction will be contracted. Permitting costs are not included

Figures

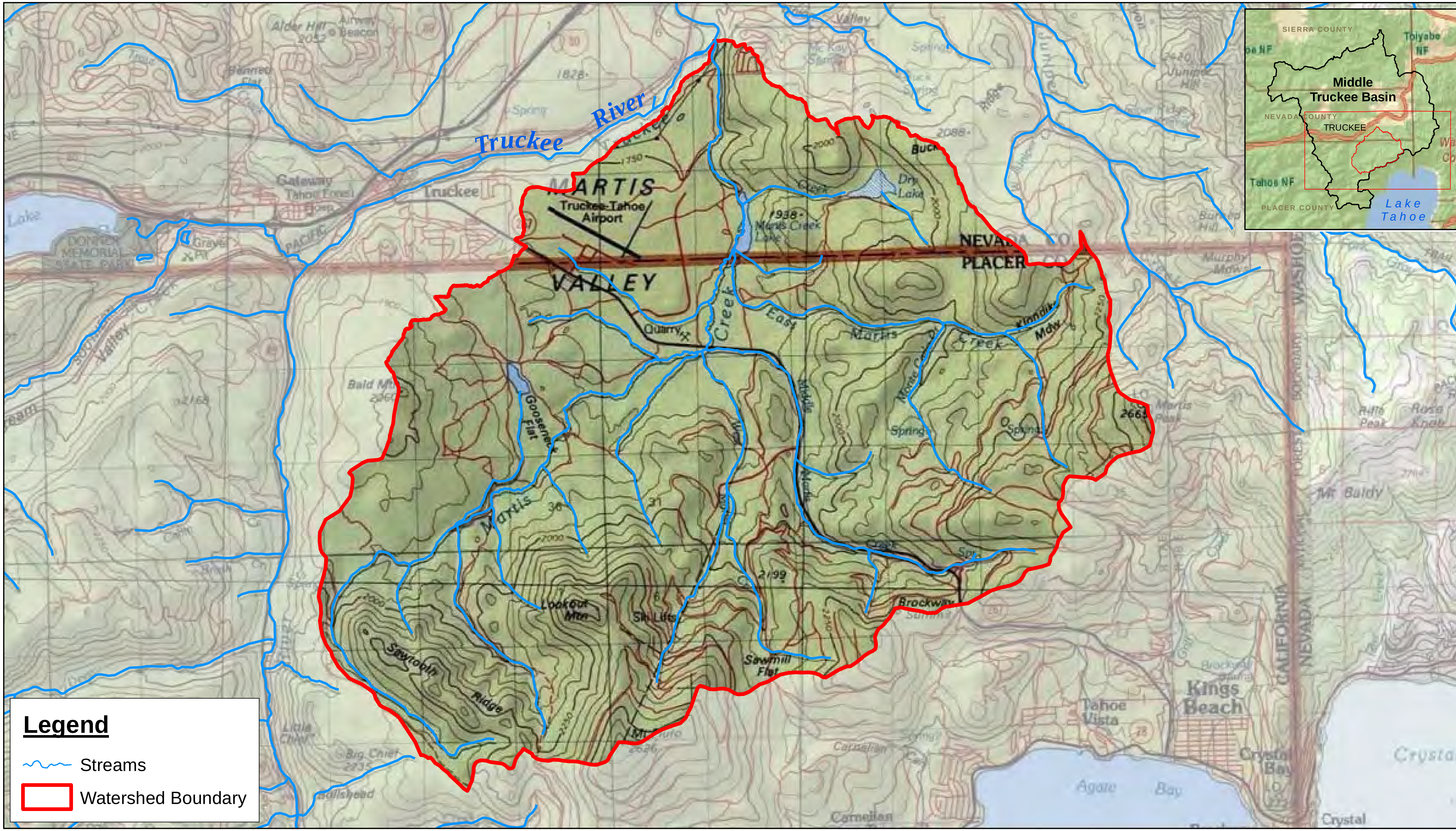

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Figure 1. Martis Watershed Location and Map, Placer and Nevada Counties, California

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Miles

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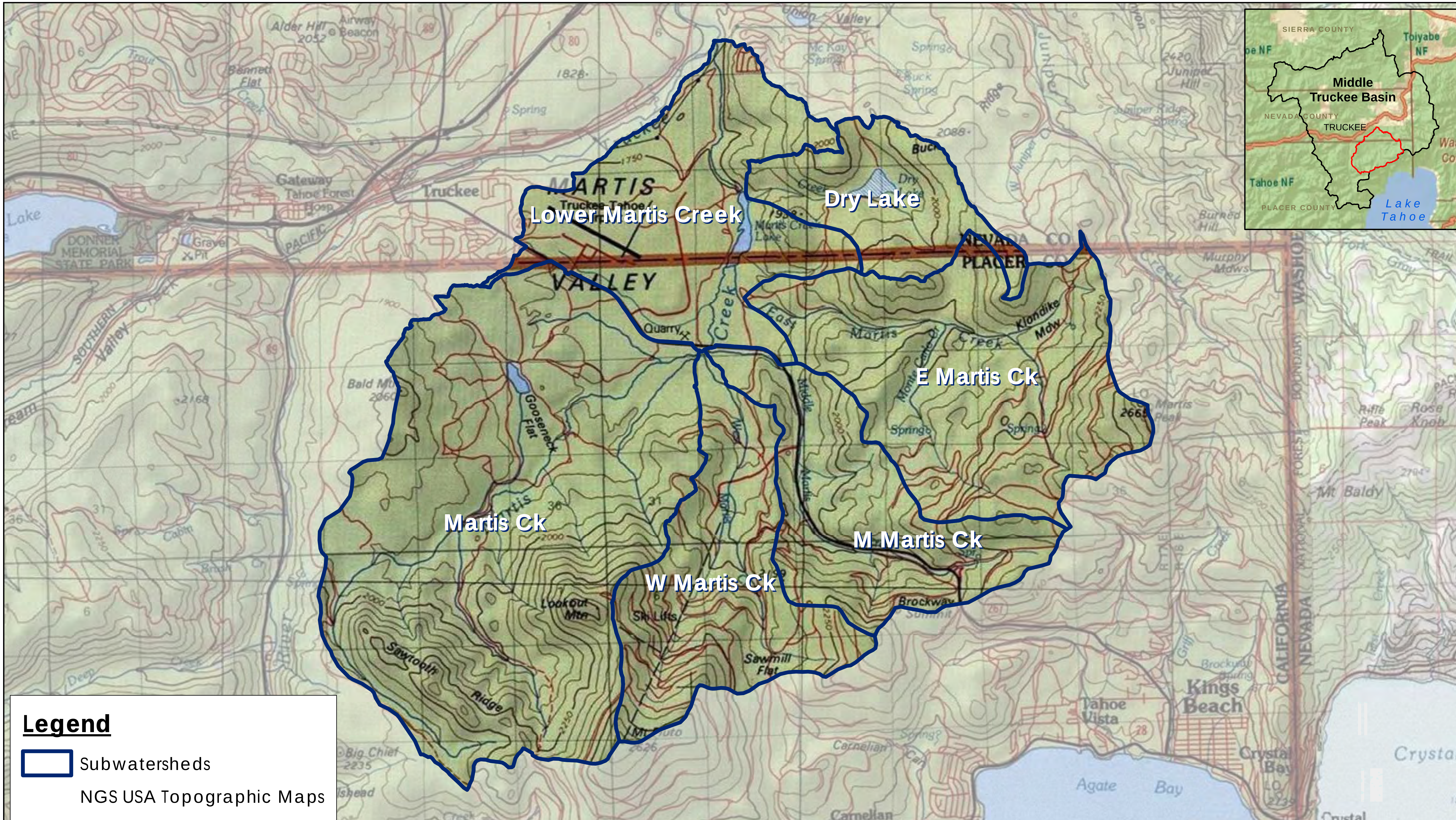

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Figure 2. Martis subwatersheds and stream location map, Placer and Nevada Counties, California

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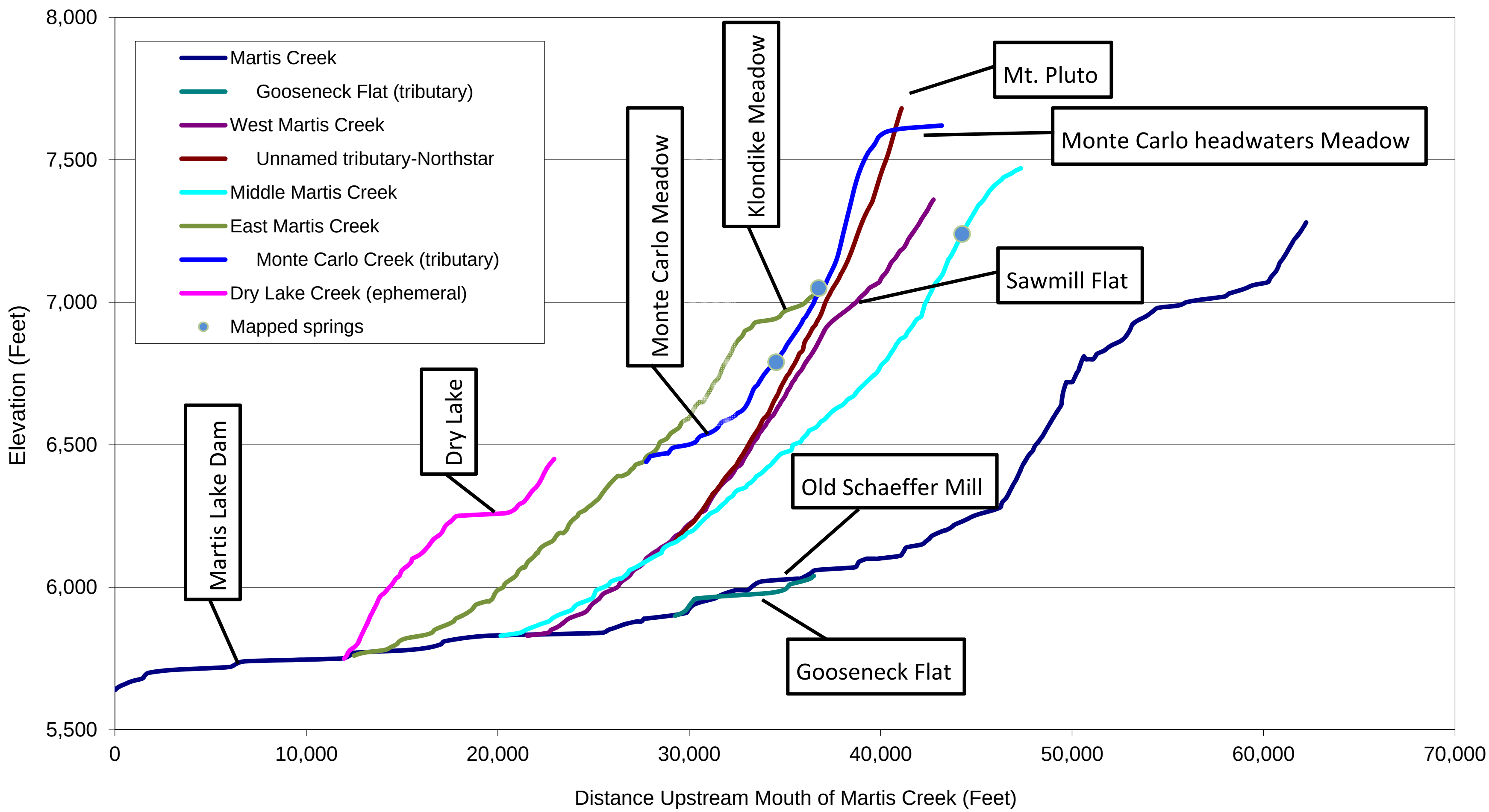

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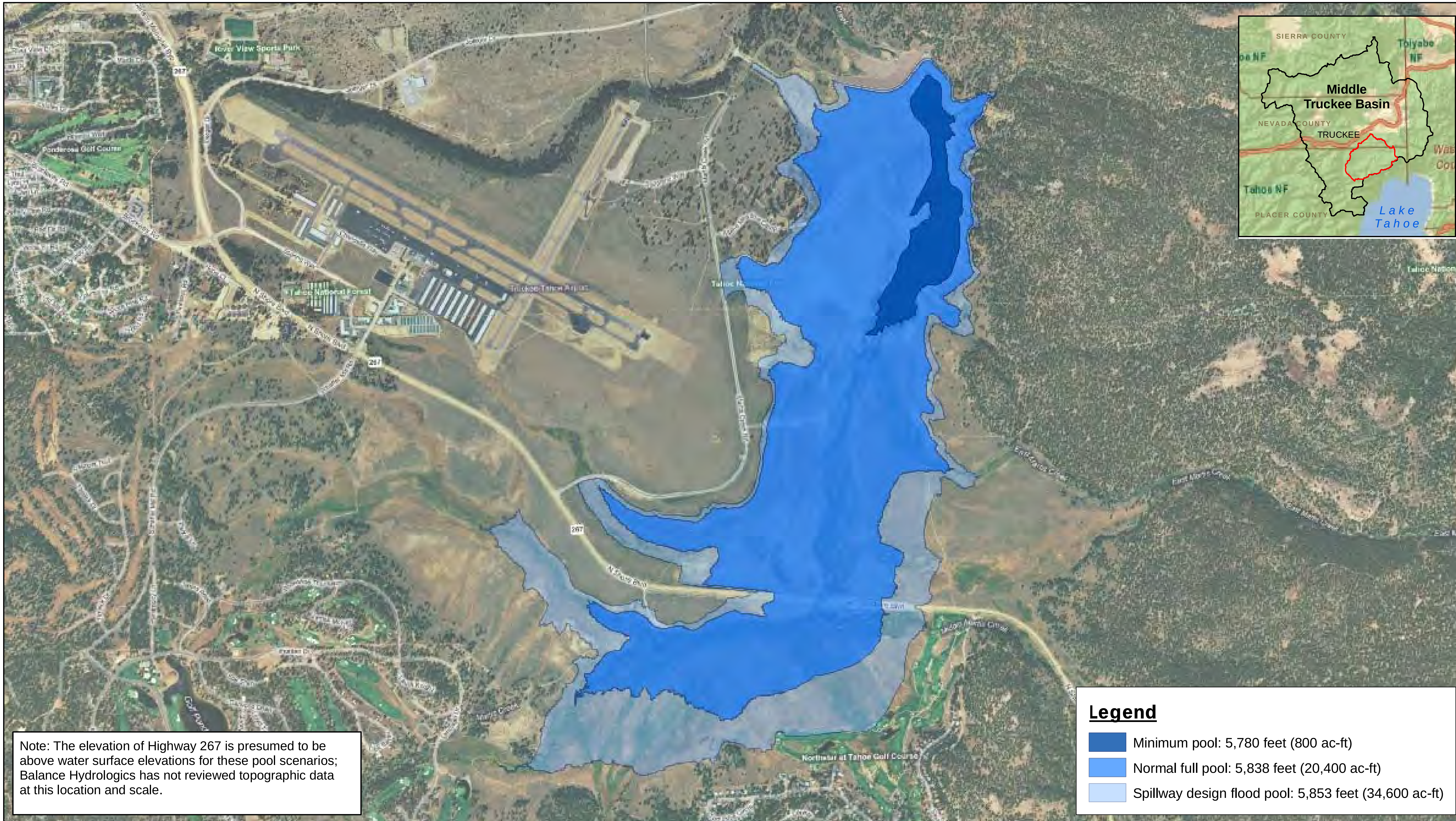
Figure 3. Longitudinal profiles for streams and major tributaries, Martis Watershed, Placer and Nevada Counties, CA.
Prominent watershed meadows and other similar physiographic features are labeled.



Aerial image from Microsoft Virtual Earth via ESRI.

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Figure 4. **Martis Reservoir maximum pool extents, Martis Watershed, Placer and Nevada Counties, California.** Martis Reservoir is currently operated in a safety mode, with the outlet open and at a minimum pool elevation of 5,780 feet. If maintained for flood control and water supply, the reservoir may be maintained at the normal full pool elevation (5,838 feet), occassionally spilling at 5,853 feet during high flows.

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Feet

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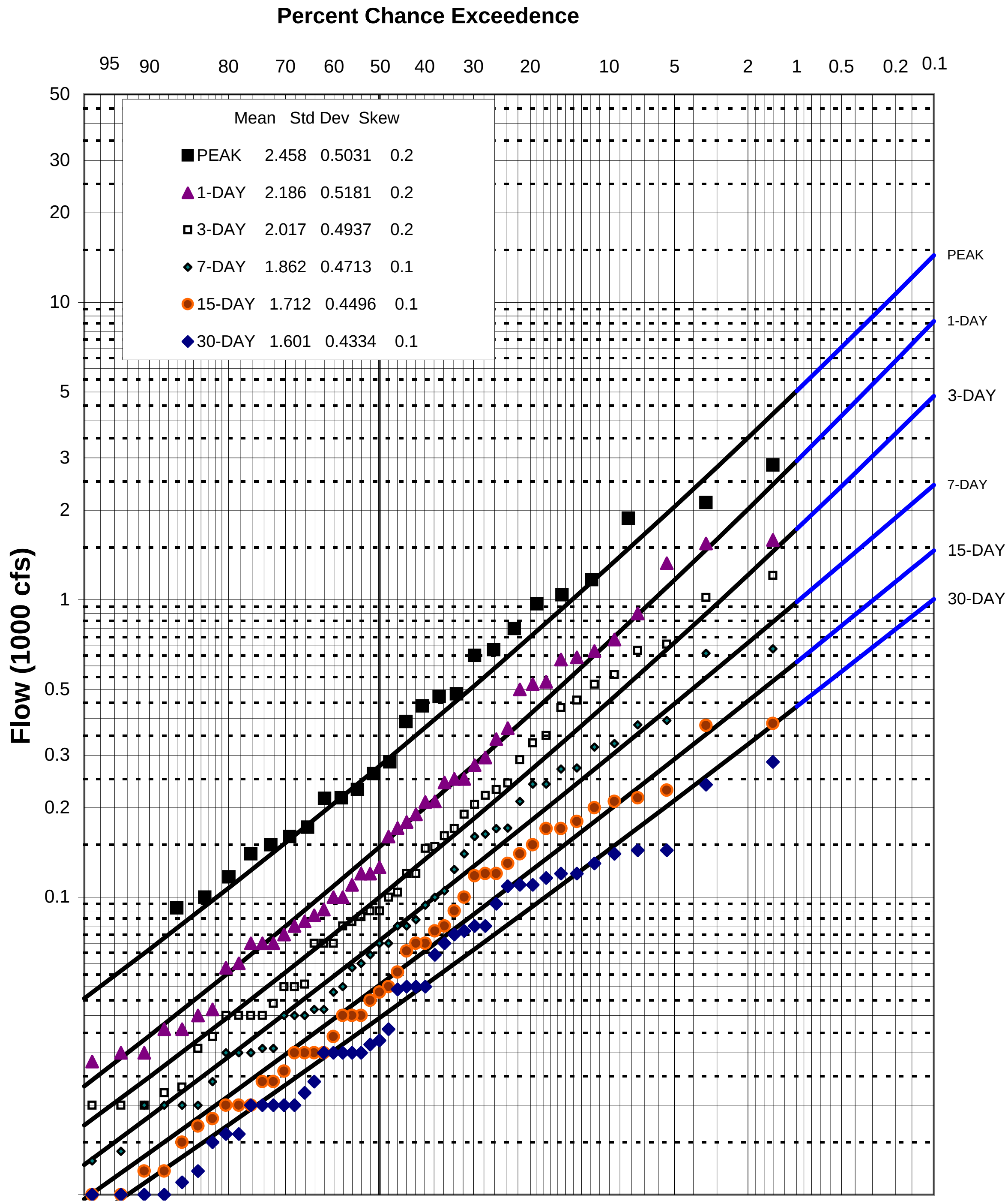

NOTES:
1. Median plotting positions
2. Period of record: 1959 - 2007
3. Drainage area 39 sq mi

Prepared by WC

Martis Creek Dam Break Analysis
Hydrology

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Figure 5. Rain flood frequency curves for Martis Creek under unregulated conditions, Martis Creek at Martis Dam, Placer and Nevada Counties,

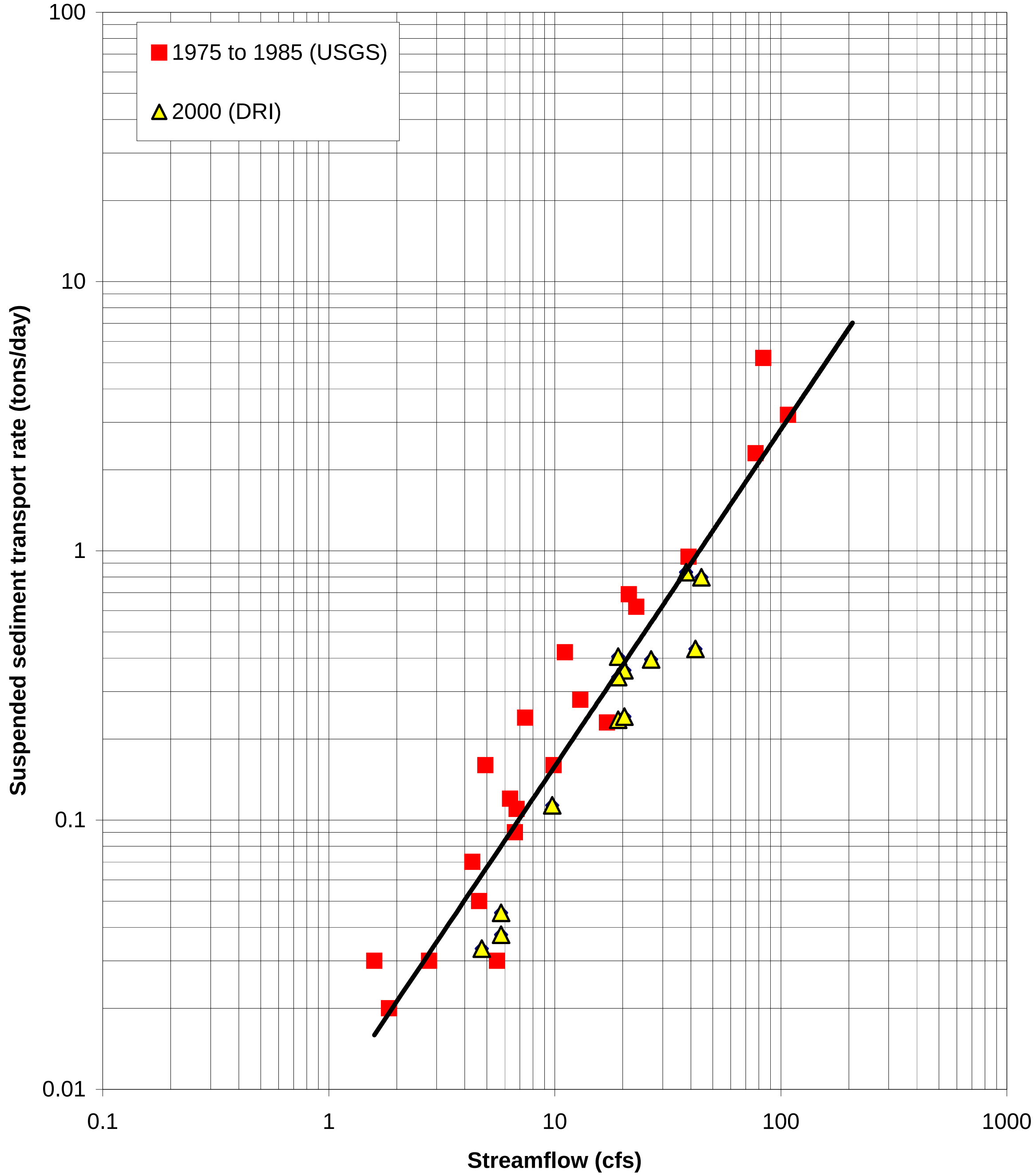

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Figure 6. Suspended sediment rating curve for Martis Creek, Placer and Nevada County, California

Data collected by the Desert Research Institute (DRI) and USGS. The DRI data, collected during water year 2000 and 15 to 25 years after the USGS data, reflect lower suspended sediment transport rates.

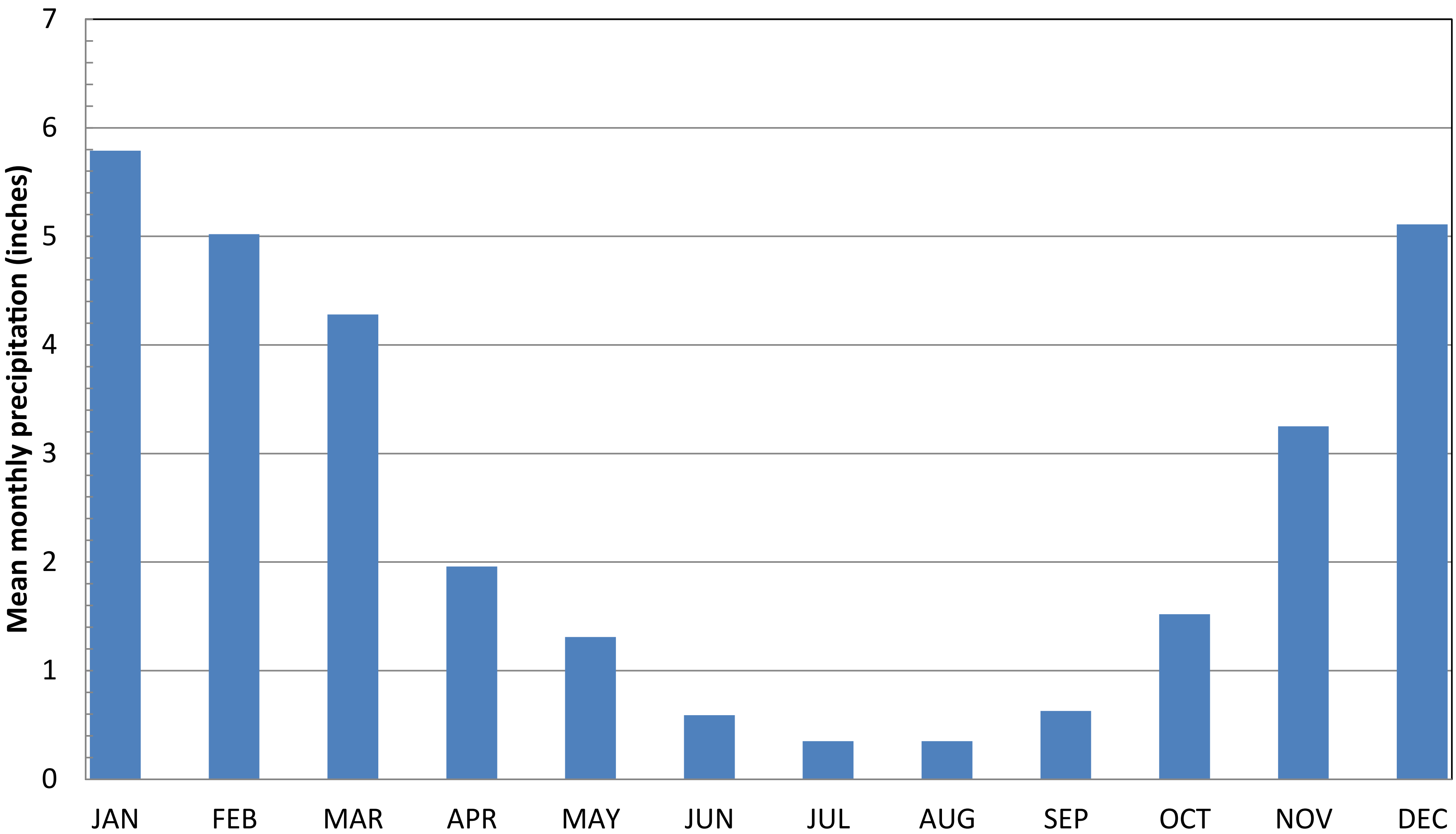

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Figure 7. **Mean monthly precipitation, 1904-2008**
Truckee District Ranger Station, Tahoe National Forest, USFS
Truckee, California

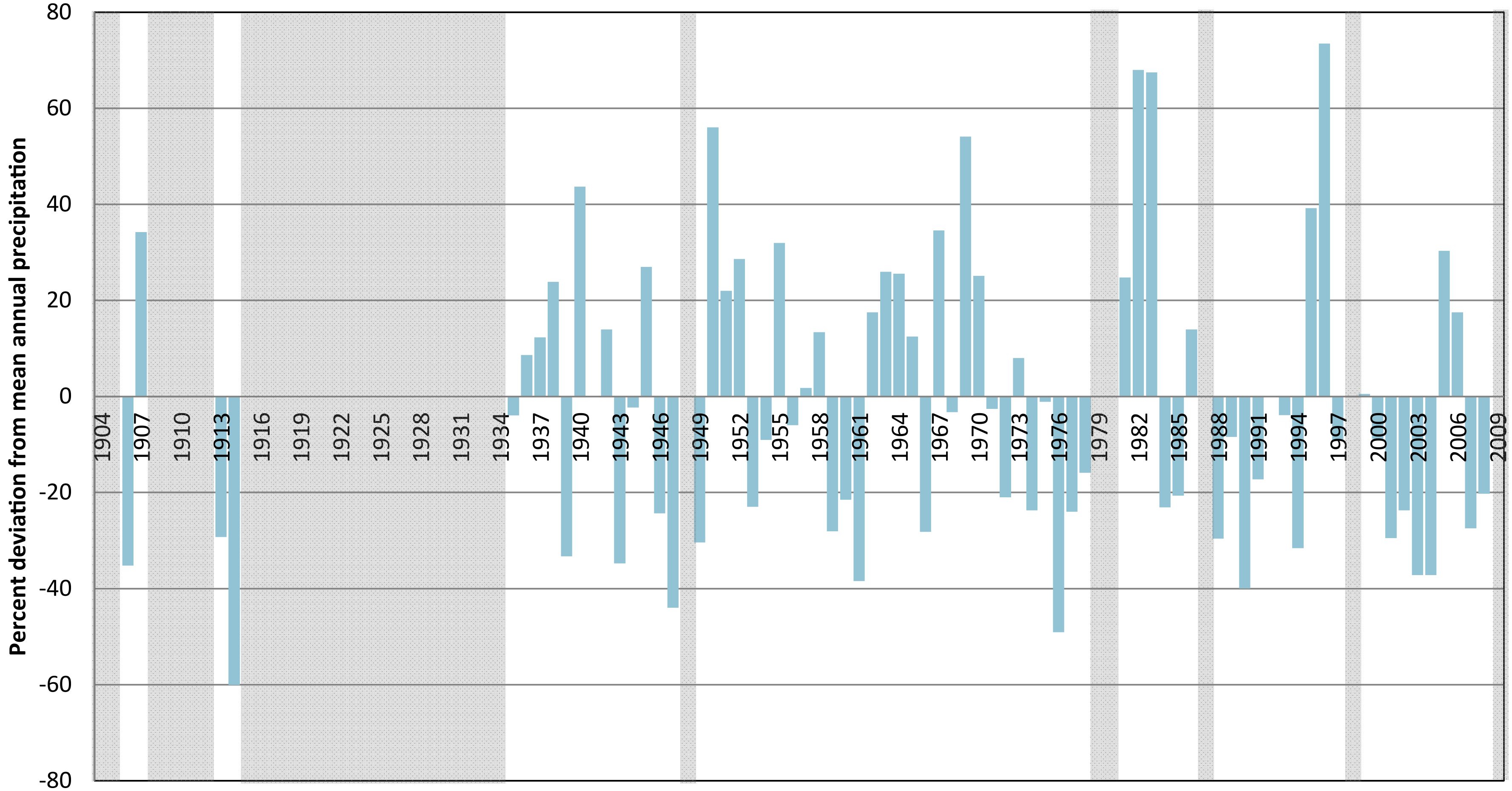

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Figure 8. **Percent Deviation from mean annual precipitation, Truckee District Ranger Station, Tahoe National Forest, USFS Truckee, California.**
Shaded areas represent gaps in record

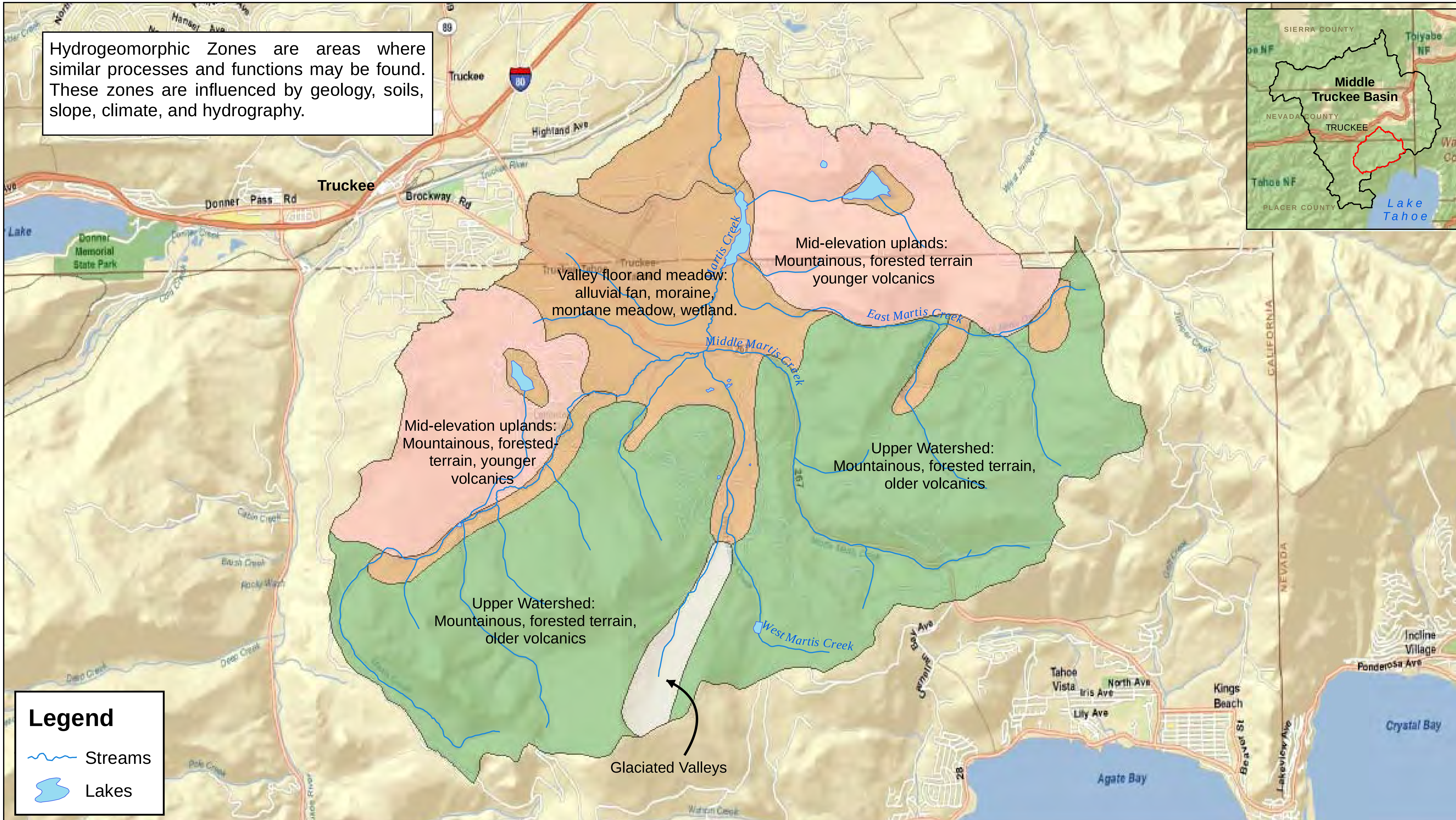

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Figure 9. **Hydrogeomorphic Zones, Martis Watershed, Placer and Nevada Counties, California**

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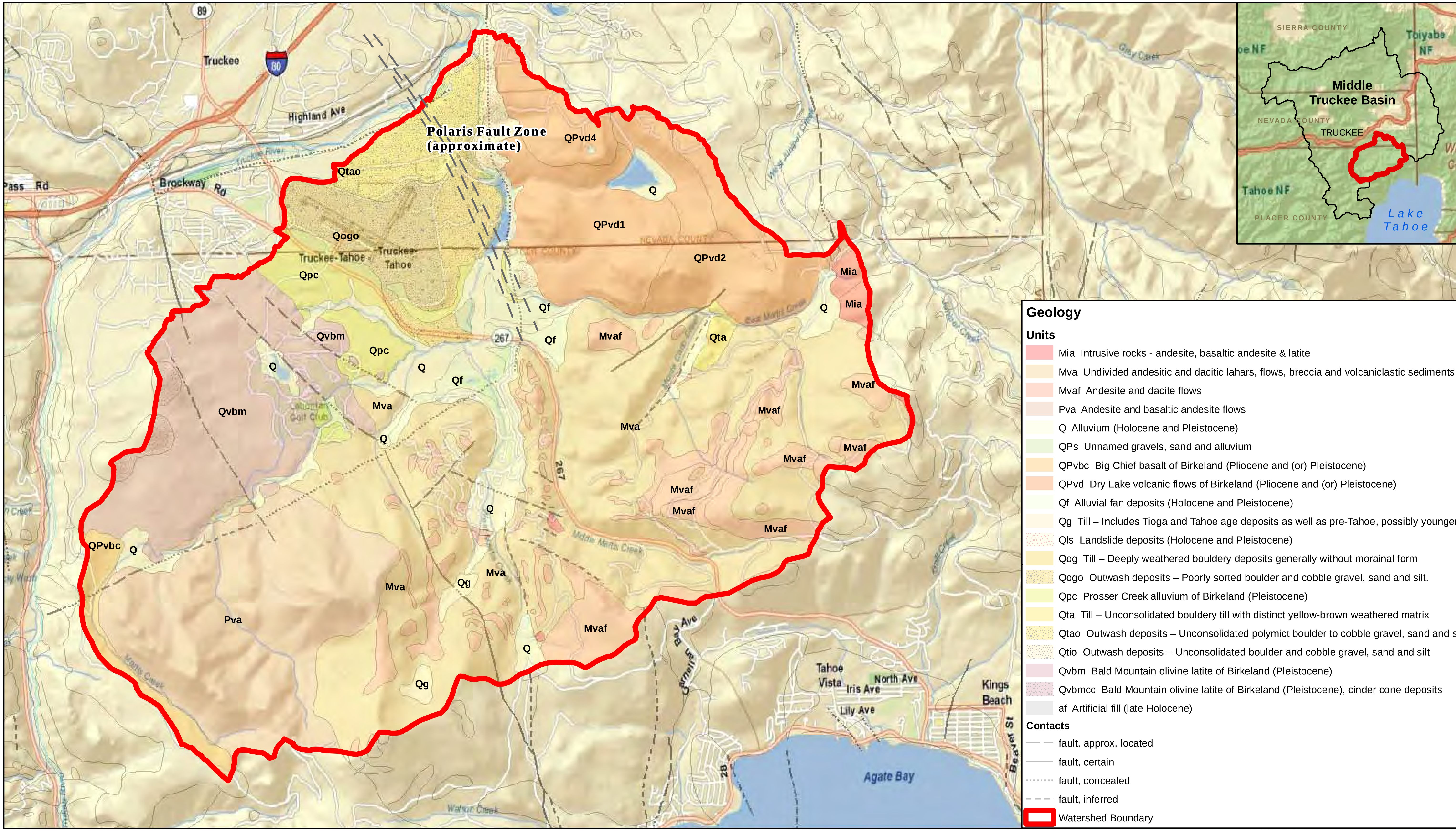

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Figure 10. Geologic Map of the Martis Watershed, Placer and Nevada Counties, California
Source: Saucedo and others, 2005.

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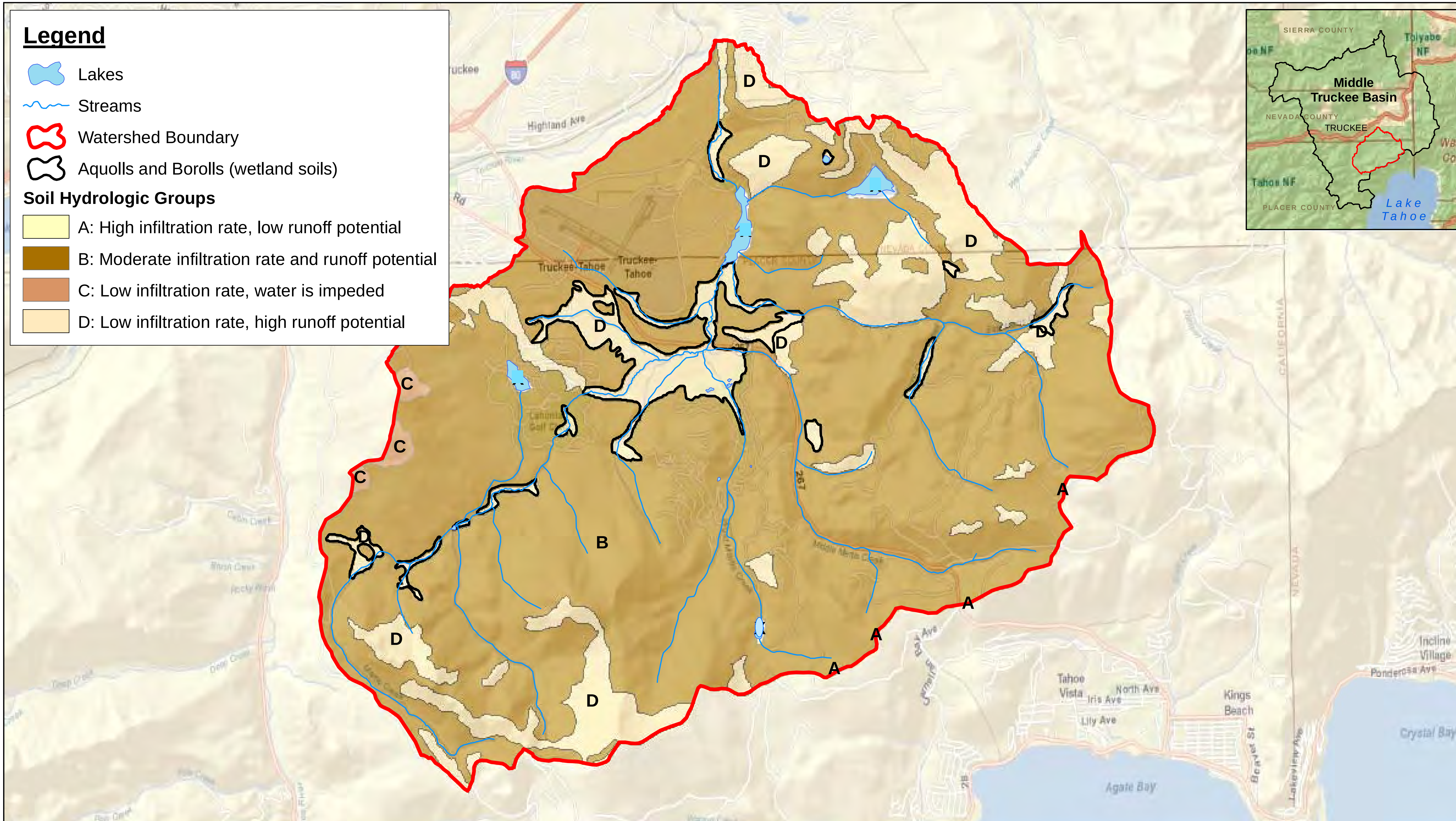

Figure 11. **Wetland soils and soil hydrologic groups, Martis Watershed, Placer and Nevada Counties, California**
Soil hydrologic groups are based on Hanes, USFS Tahoe National Forest soil survey (2002)

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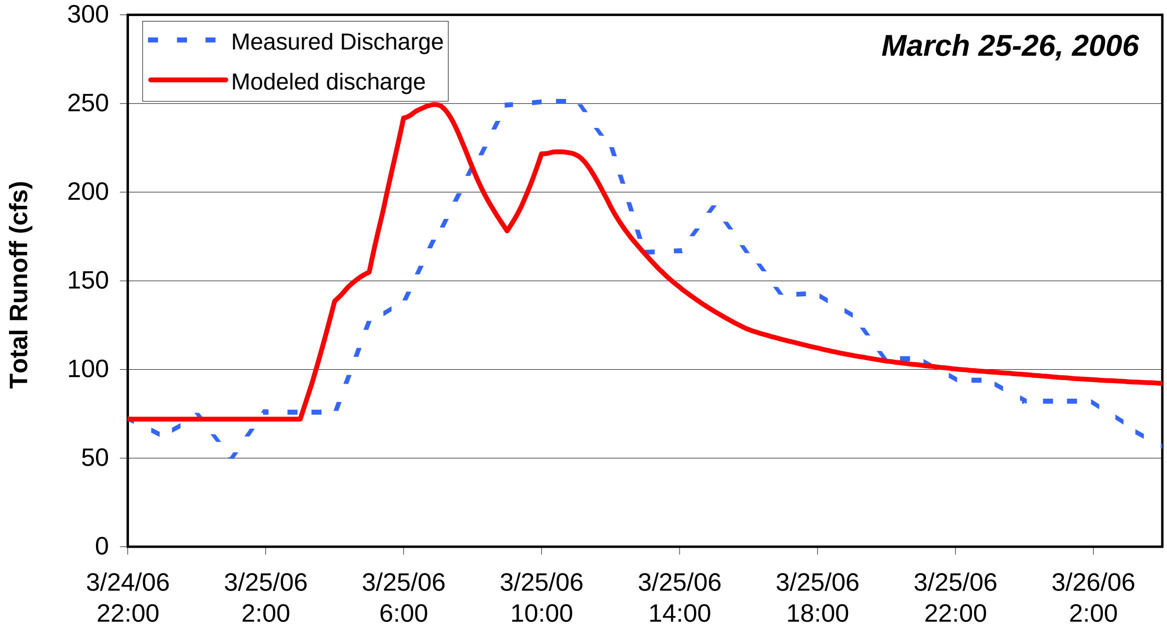

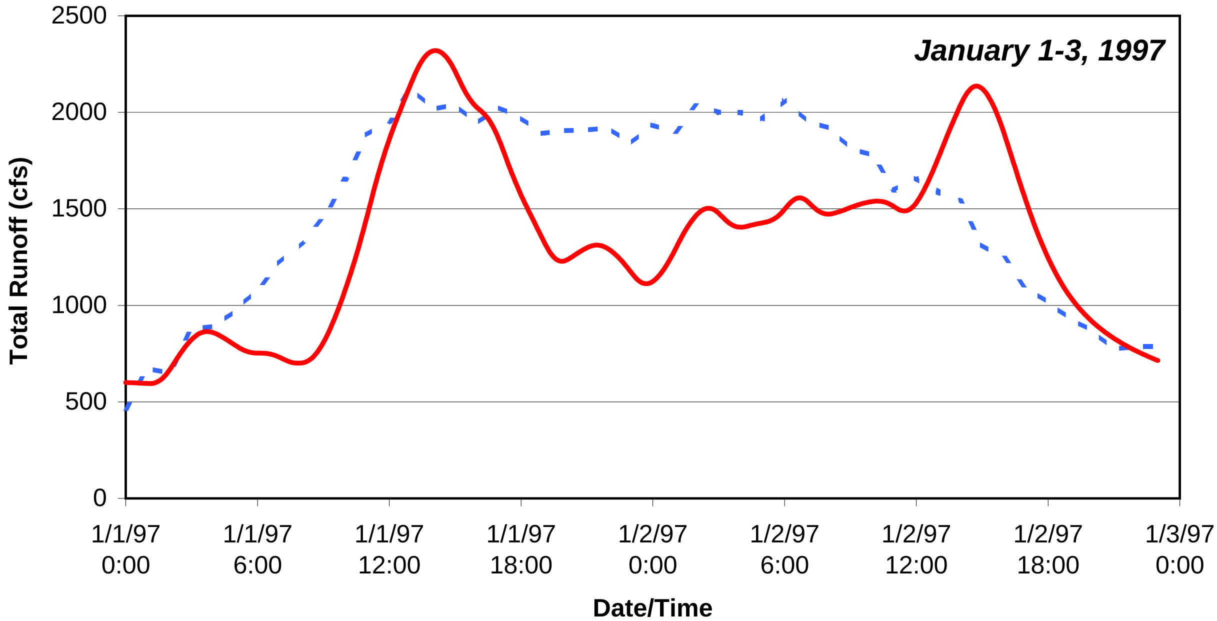

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Figure 12. Measured and modeled runoff, Martis Watershed, Placer and Nevada Counties, California

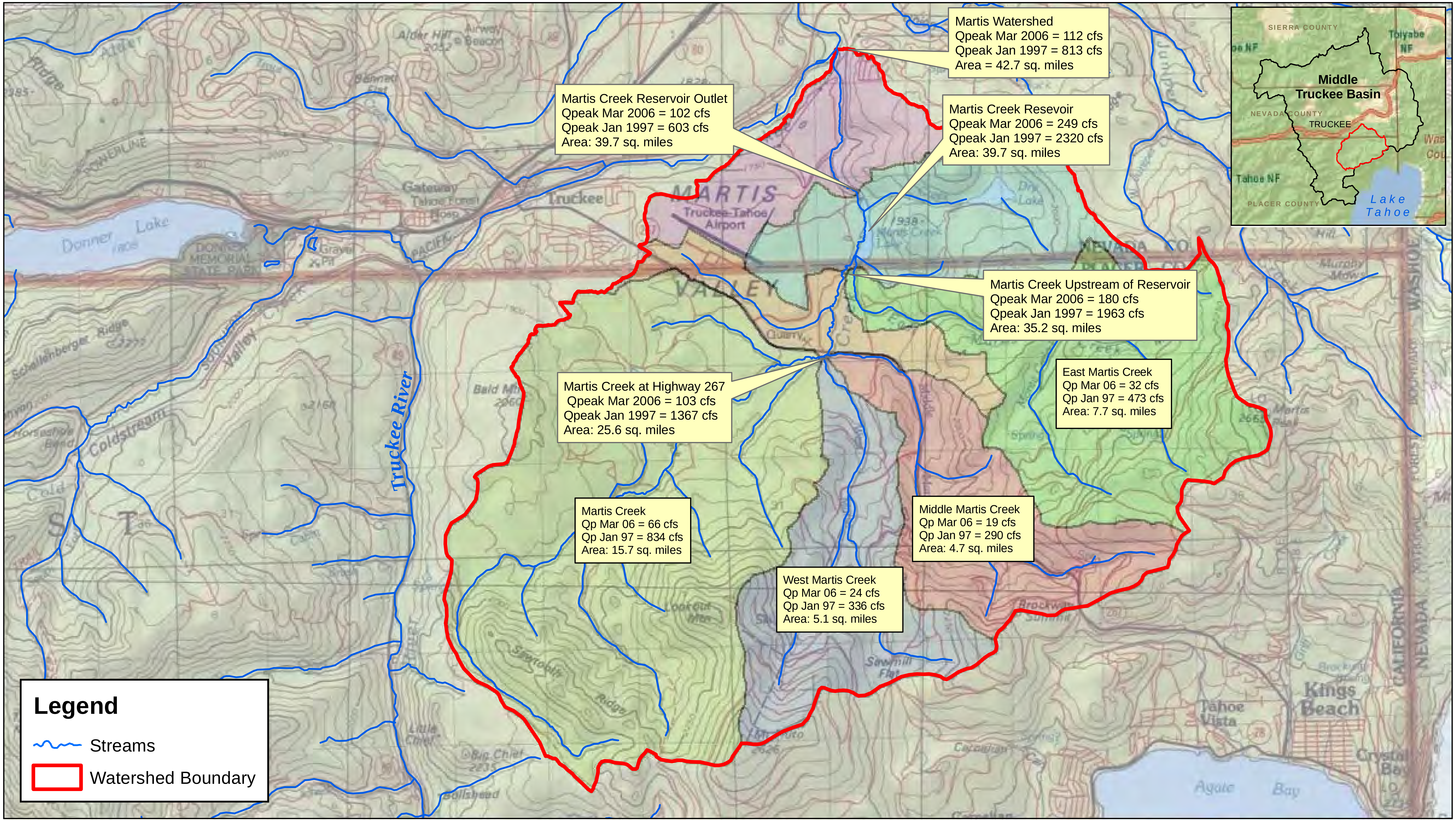

Figure 13. Subwatersheds and modeling results for the Martis Watershed, Placer and Nevada Counties, California

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Figure 14. **Historical Features, Martis Watershed, Placer and Nevada Counties, California**

Locations of features are approximate, as based on historical resources (Lindström, 2011)

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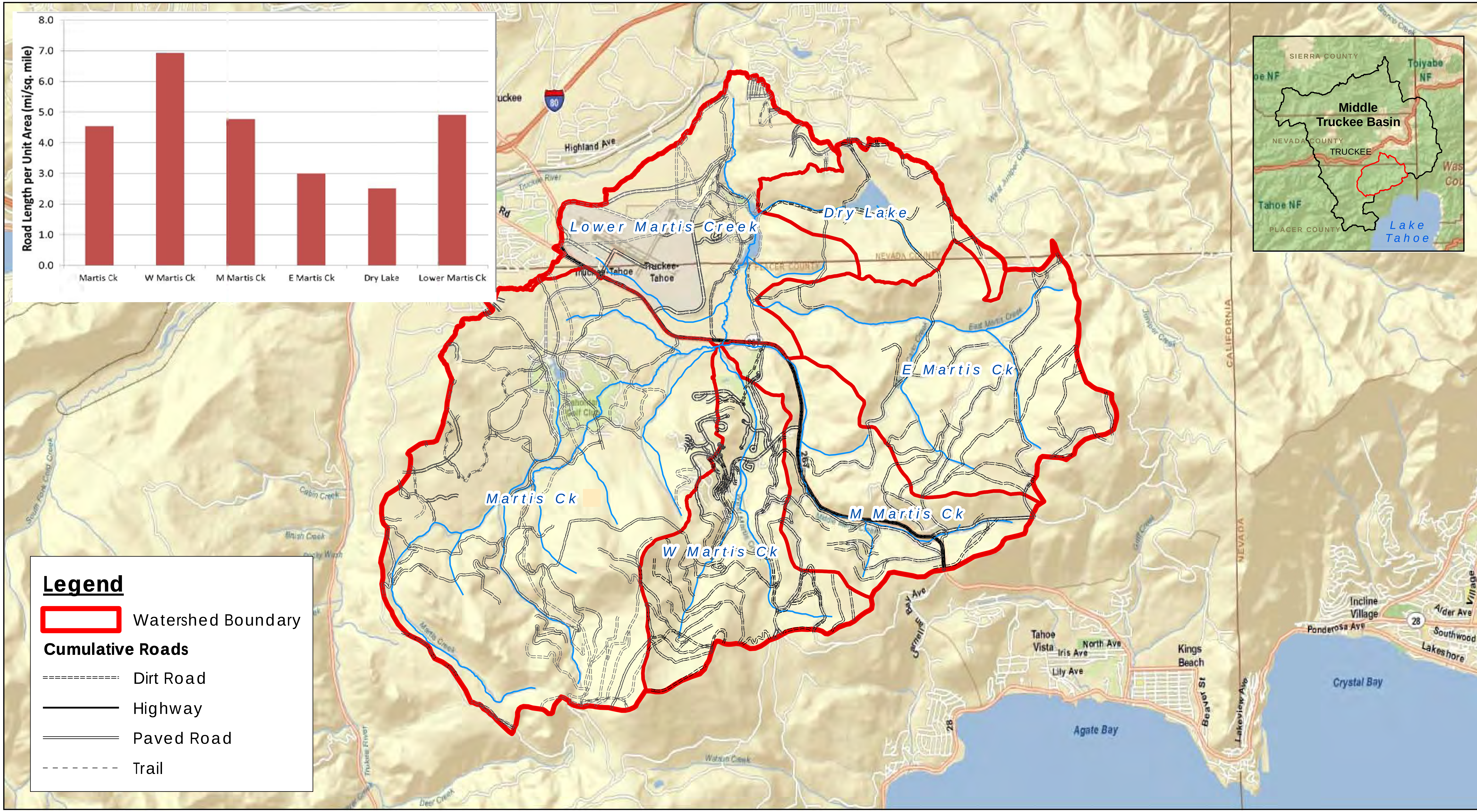

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Figure 15. **Cumulative Roads Network, 1889 to present, Martis Watershed**
Placer and Nevada Counties, California

This map shows most roads constructed between 1889 and today.
Some roads may no longer be active, while other existing roads may not be mapped.

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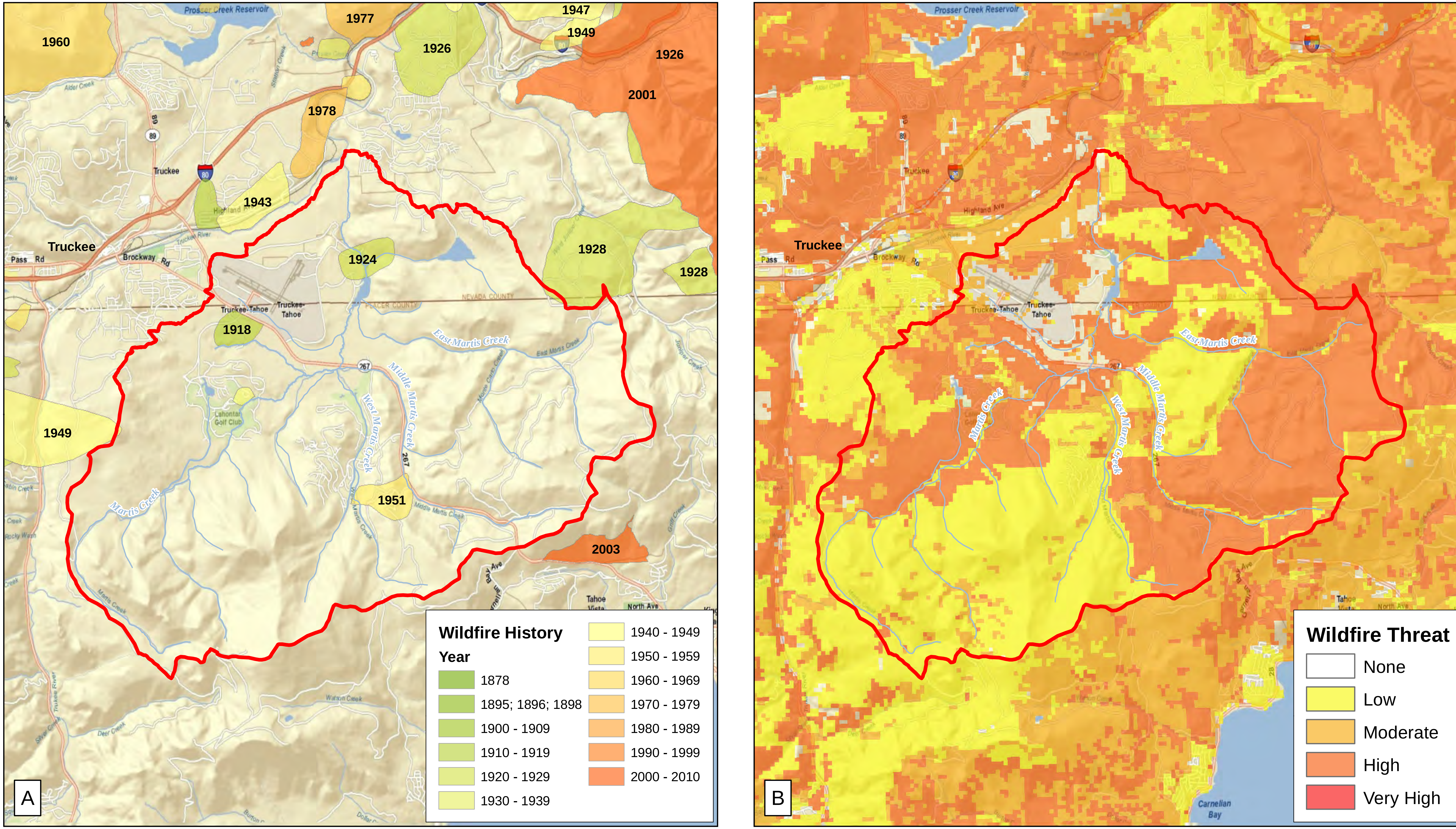

Source: Sierra Coordinated Resources Management Council, 2008

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Figure 16. Wildfire history (A) and threat of wildfire (B), in the Martis Watershed, Placer and Nevada Counties, California.

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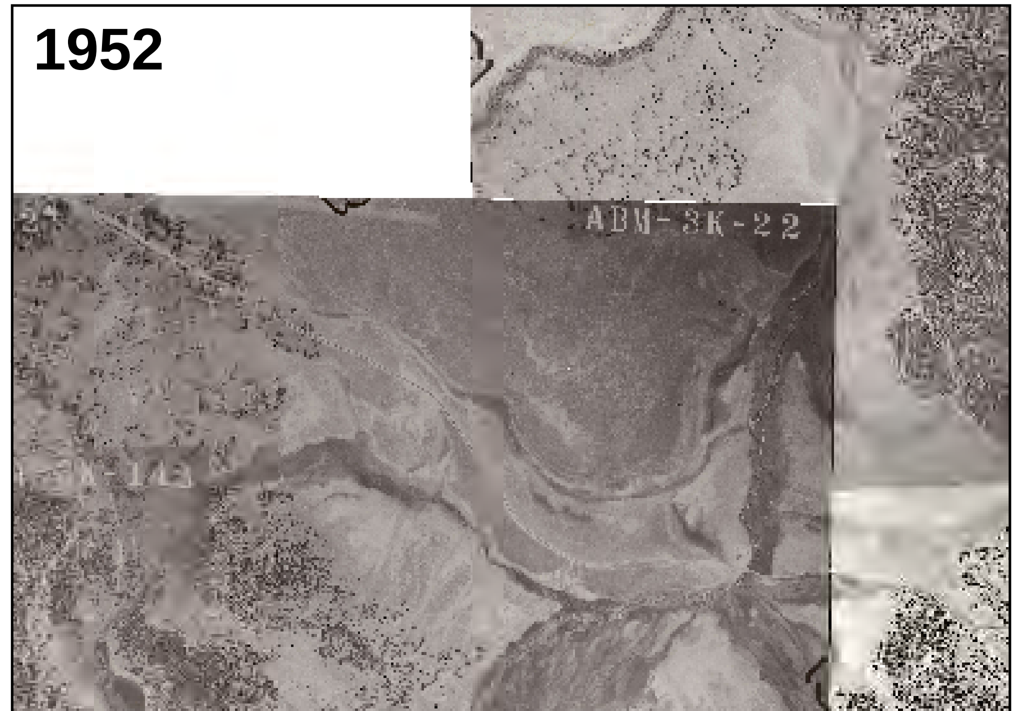
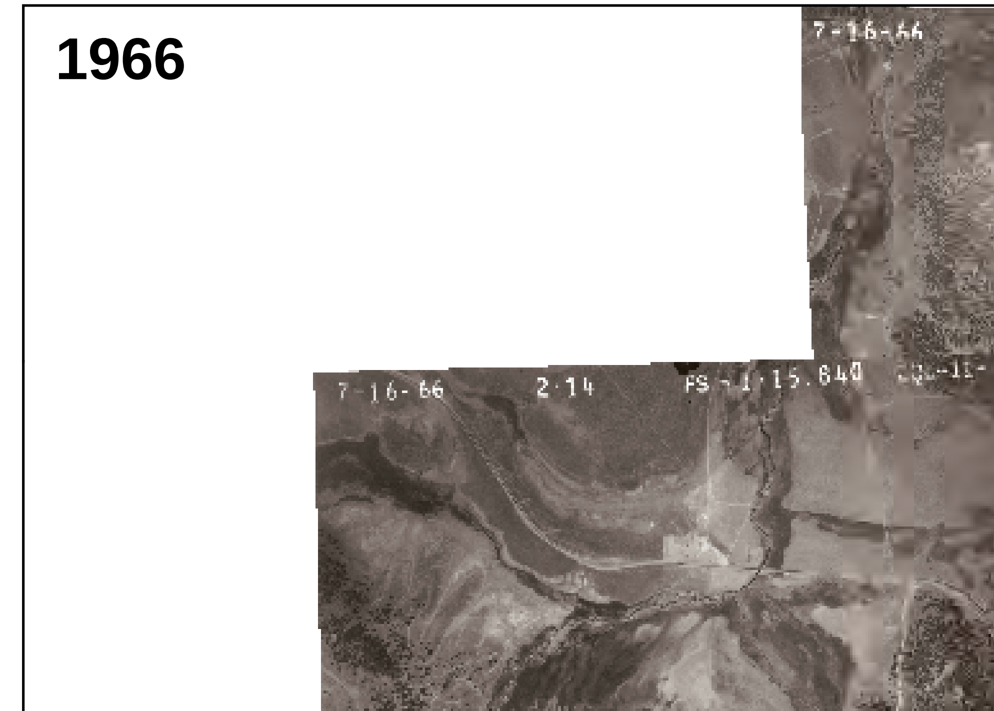
2011 Balance Hydrologics





Early 1900s intensive logging, 1930s increased road traffic, 1941 Joeger Ranch | 1940s-1970s stand re-entry/modern-era logging, 1960s sheep herding, quarrying
1950s airfield enlargement, 1960 Olympics, Highway 267 improvements, 1964 airport improvements | 1970 Martis Dam, 1972 Northstar

MAJOR FLOODS | Nov 20, 1950 | Dec 23, 1955 | Feb 1, 1963

1980s modern logging continued | 1993 Town of Truckee incorporated | 1990s Martis Camp, Lahontan and Big Springs Estates | 2000s Northstar expansion | 2005 Martis Valley Agreement | 2007 Waddle Ranch protected open space

MAJOR FLOODS | January 3, 1997 | Dec 31, 2005

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Figure 17. Visual timeline 1939 to 2011, Martis Valley, Martis Watershed, Placer and Nevada Counties, California

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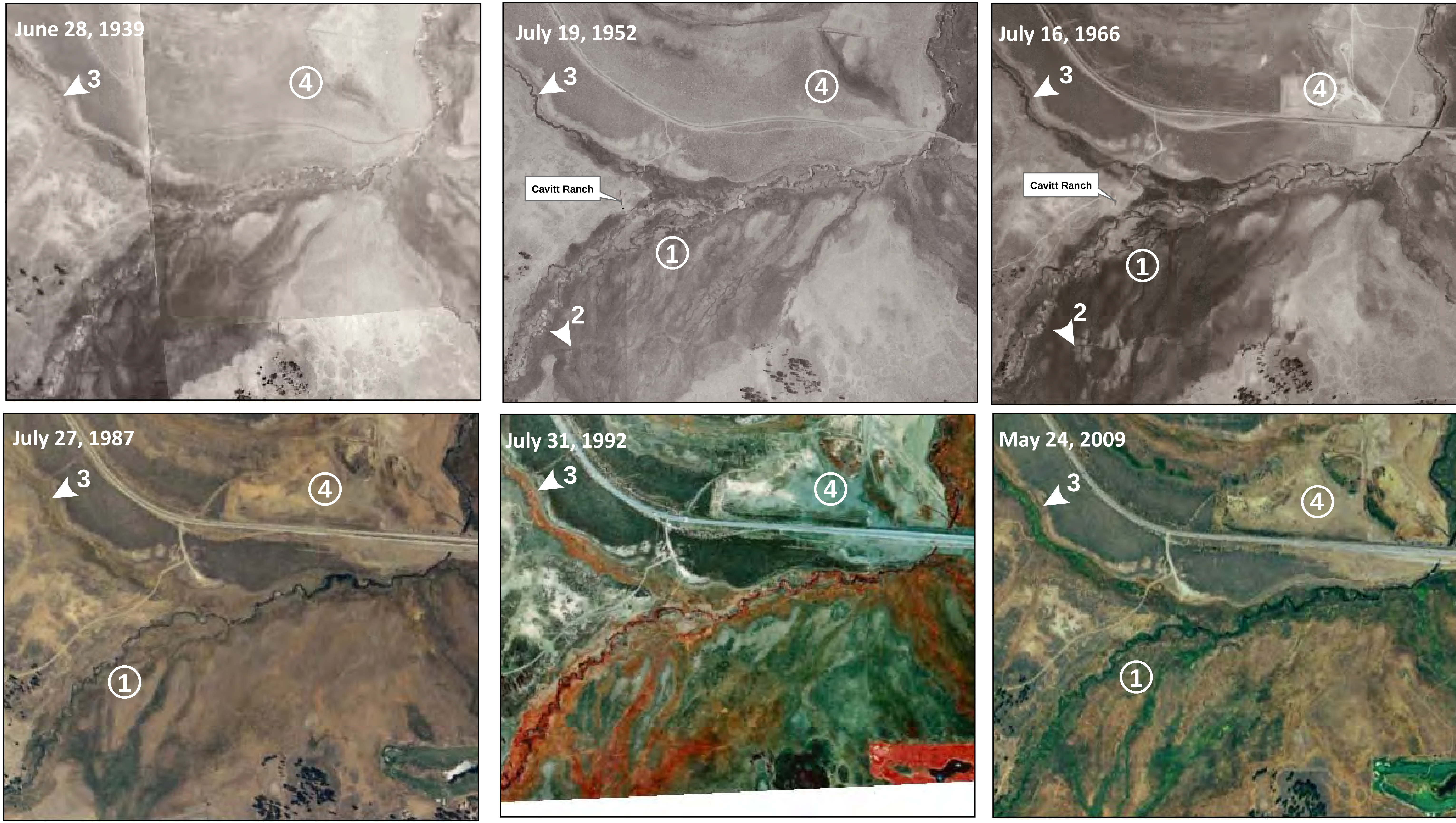

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Figure 18. **Selected channel changes, 1939 to 2009, Martis Valley, Placer and Nevada Counties, California**
1) Martis Creek exhibited multiple channels historically, whereas today, only a single channel exists; 2) Irrigation ditches watered the meadow; 3) tributaries incised and widened; 4) quarry expansion supported airport, road improvements (1963) and Martis Dam construction (1970).

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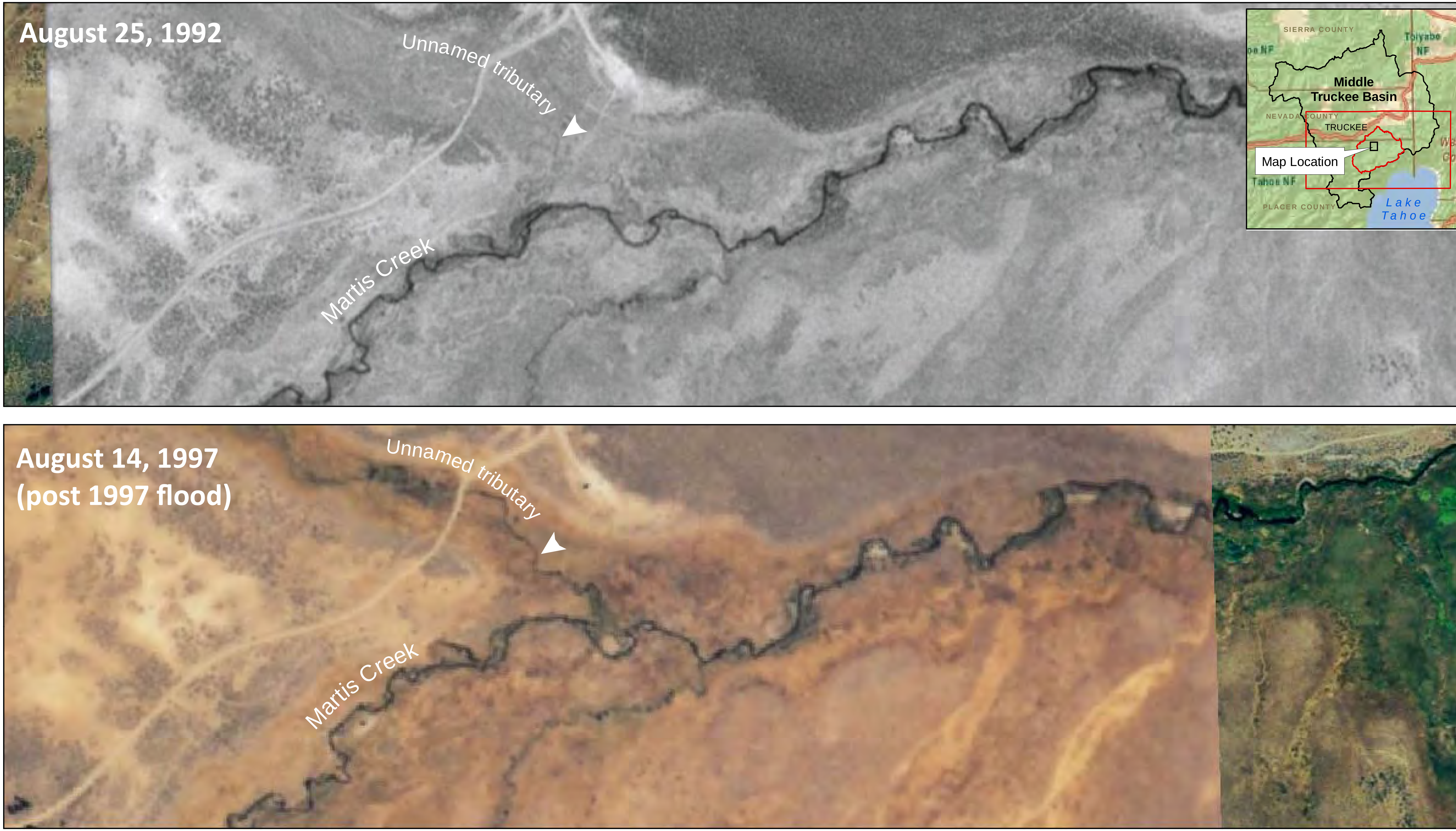

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Figure 19. **Selected changes in channel morphology: Martis Creek with confluence of unnamed tributary, Martis Valley; a) 1992; b) 1997**
Note the evolution of a defined tributary channel--likely the result of the January 1, 1997 flood.

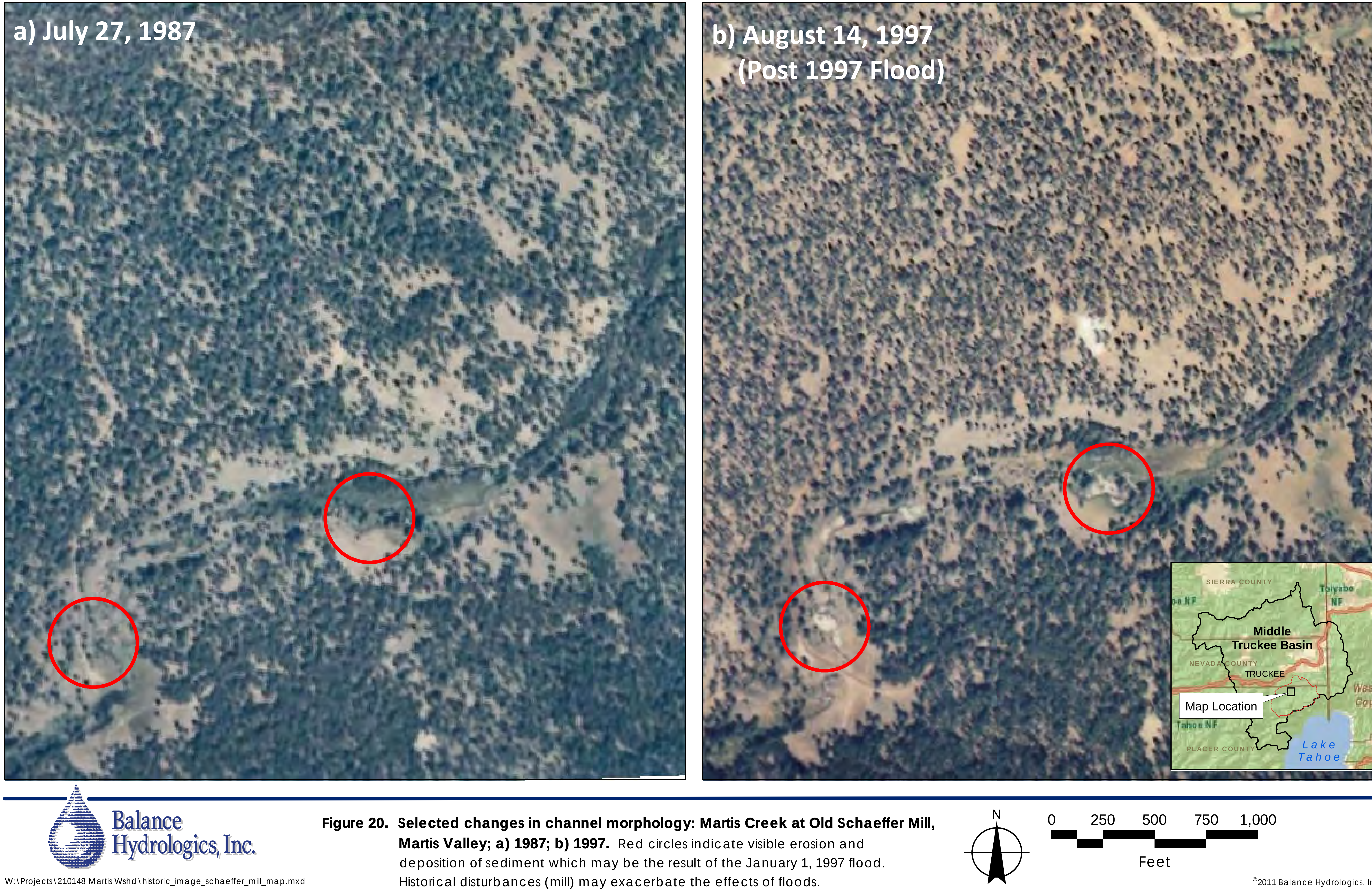

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Figure 20. Selected changes in channel morphology: Martis Creek at Old Schaeffer Mill, Martis Valley; a) 1987; b) 1997. Red circles indicate visible erosion and deposition of sediment which may be the result of the January 1, 1997 flood. Historical disturbances (mill) may exacerbate the effects of floods.

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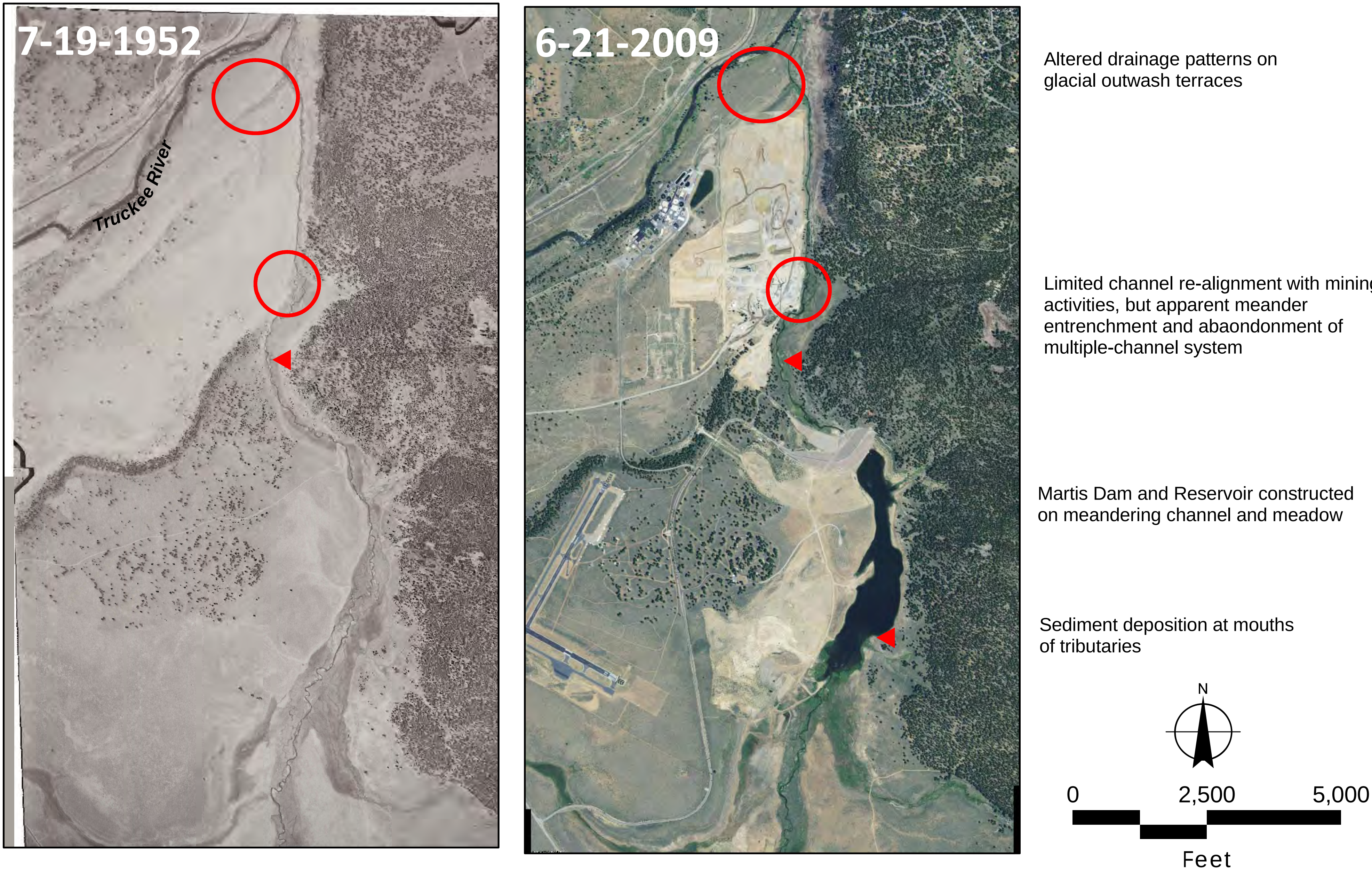

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Figure 21. Selected changes in channel morphology: Lower Martis Creek at Martis Dam

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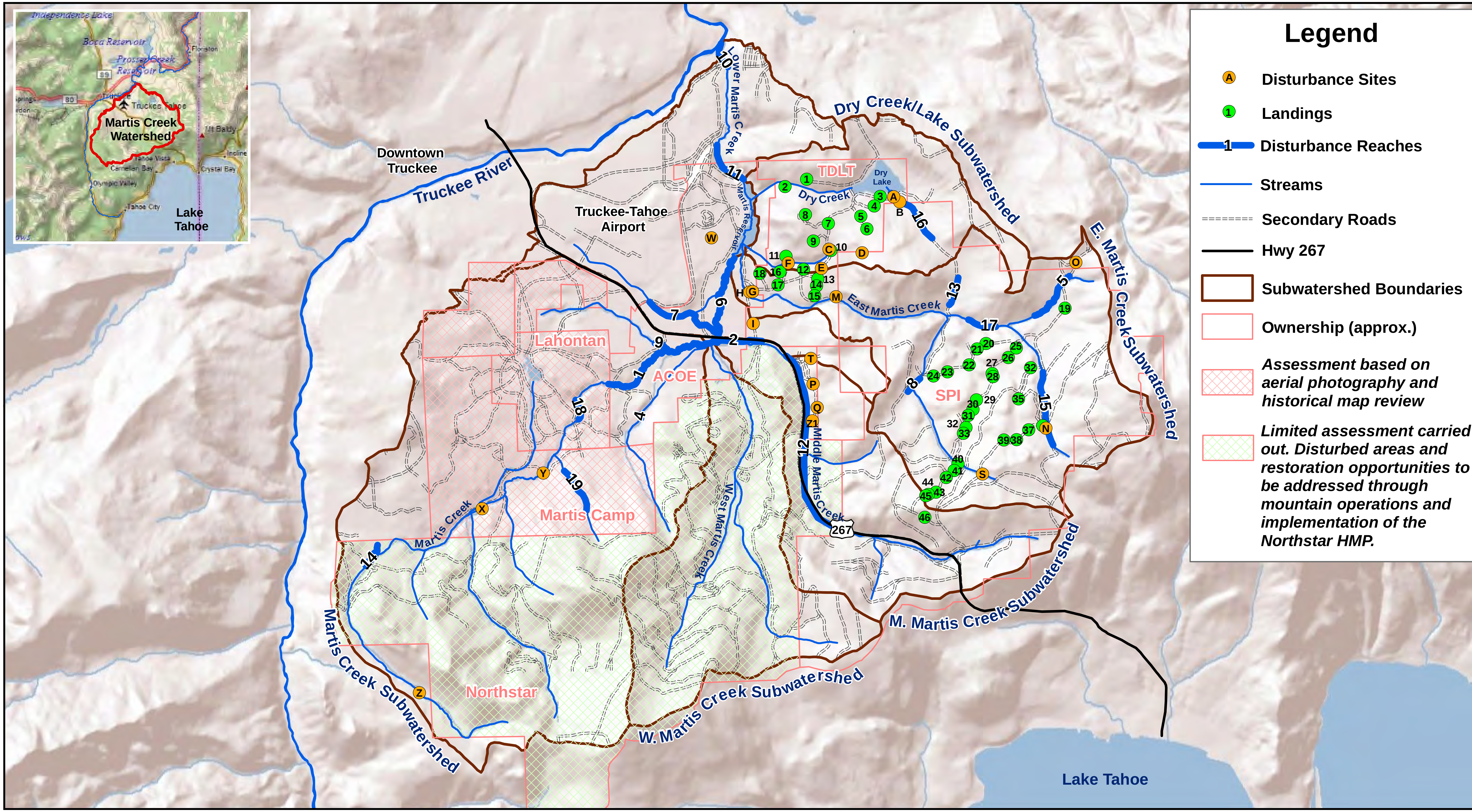

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INTEGRATED ENVIRONMENTAL RESTORATION SERVICES, INC.

TruckeeRiverWatershedCouncil

Figure 22. Martis Watershed Assessment Disturbance Inventory Map

Note: For the purposes of this assessment, disturbance sites are discrete locations whereas disturbance "reaches" are segments of stream channels or drainages. Some disturbance sites may be within a stream channel, such as an unstable road crossing.

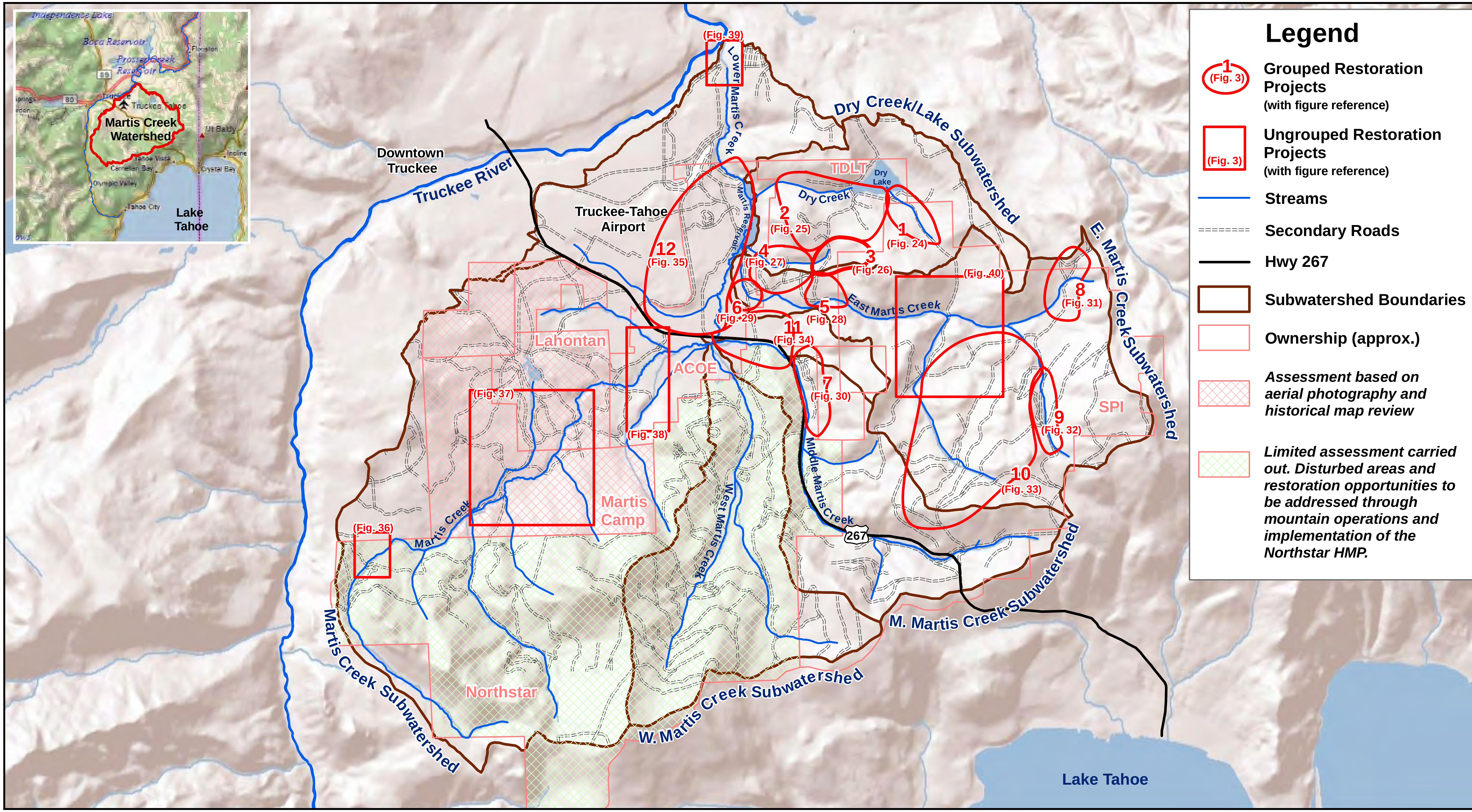

Figure 23. Martis Watershed Assessment Restoration Opportunities Overview Map

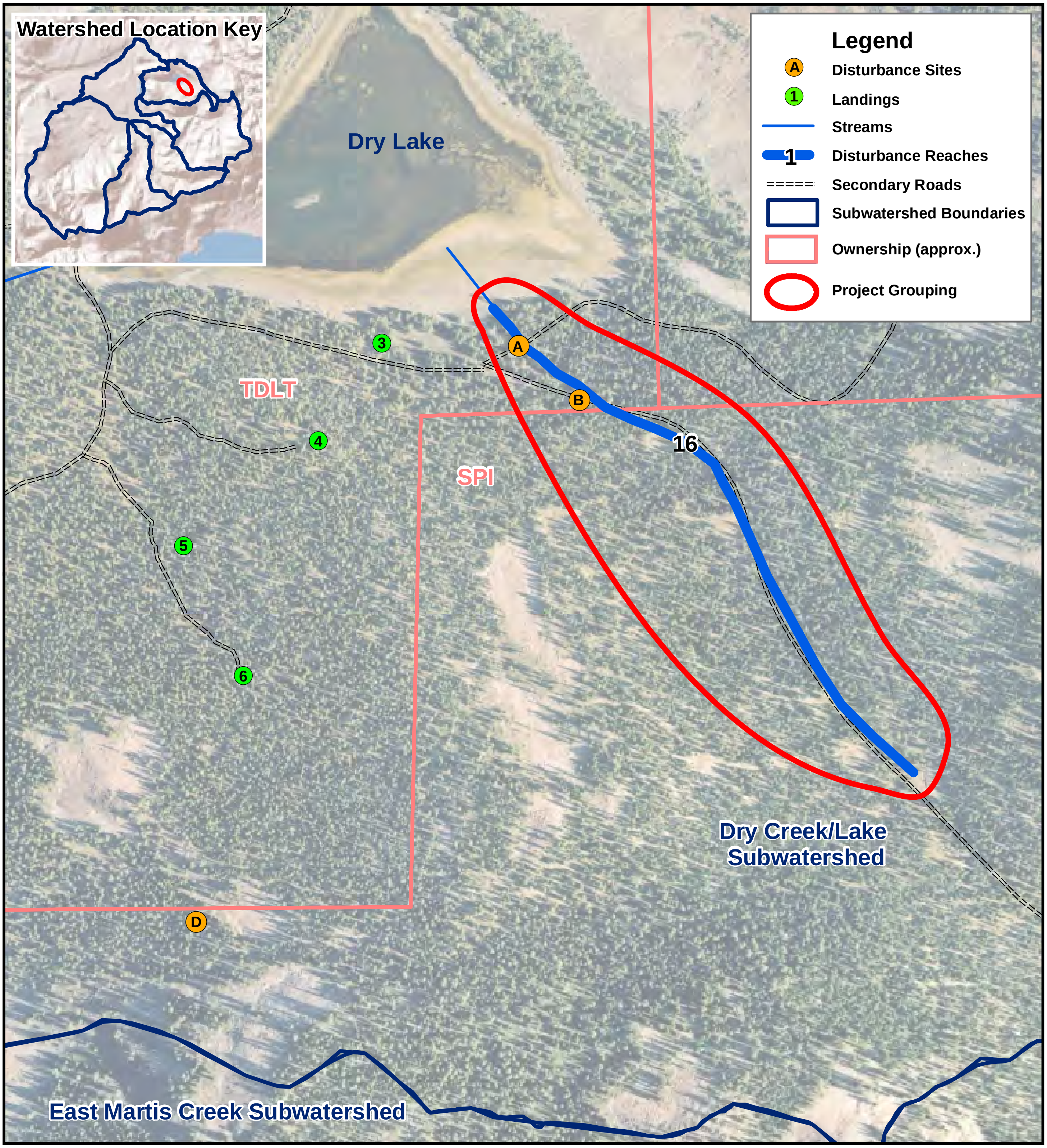

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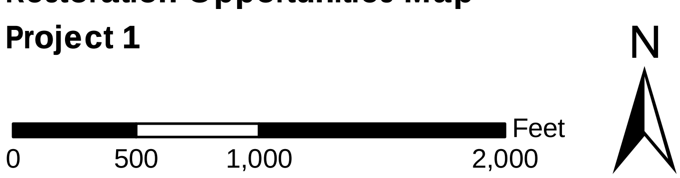
Figure 24. Martis Watershed Assessment Restoration Opportunities Map Project 1



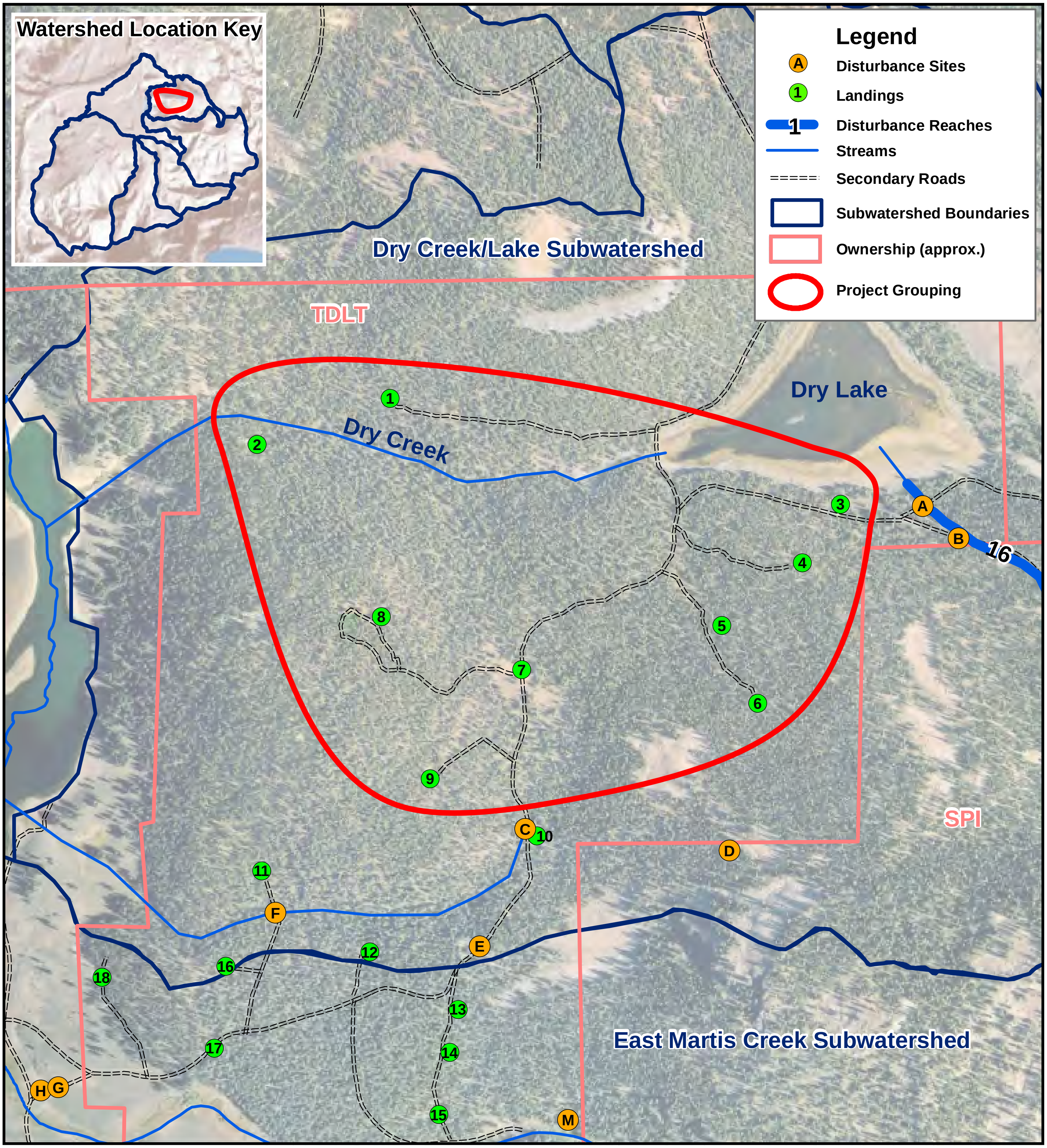


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Figure 25. Martis Watershed Assessment Restoration Opportunities Map Project 2

0 750 1,500 3,000 Feet

N

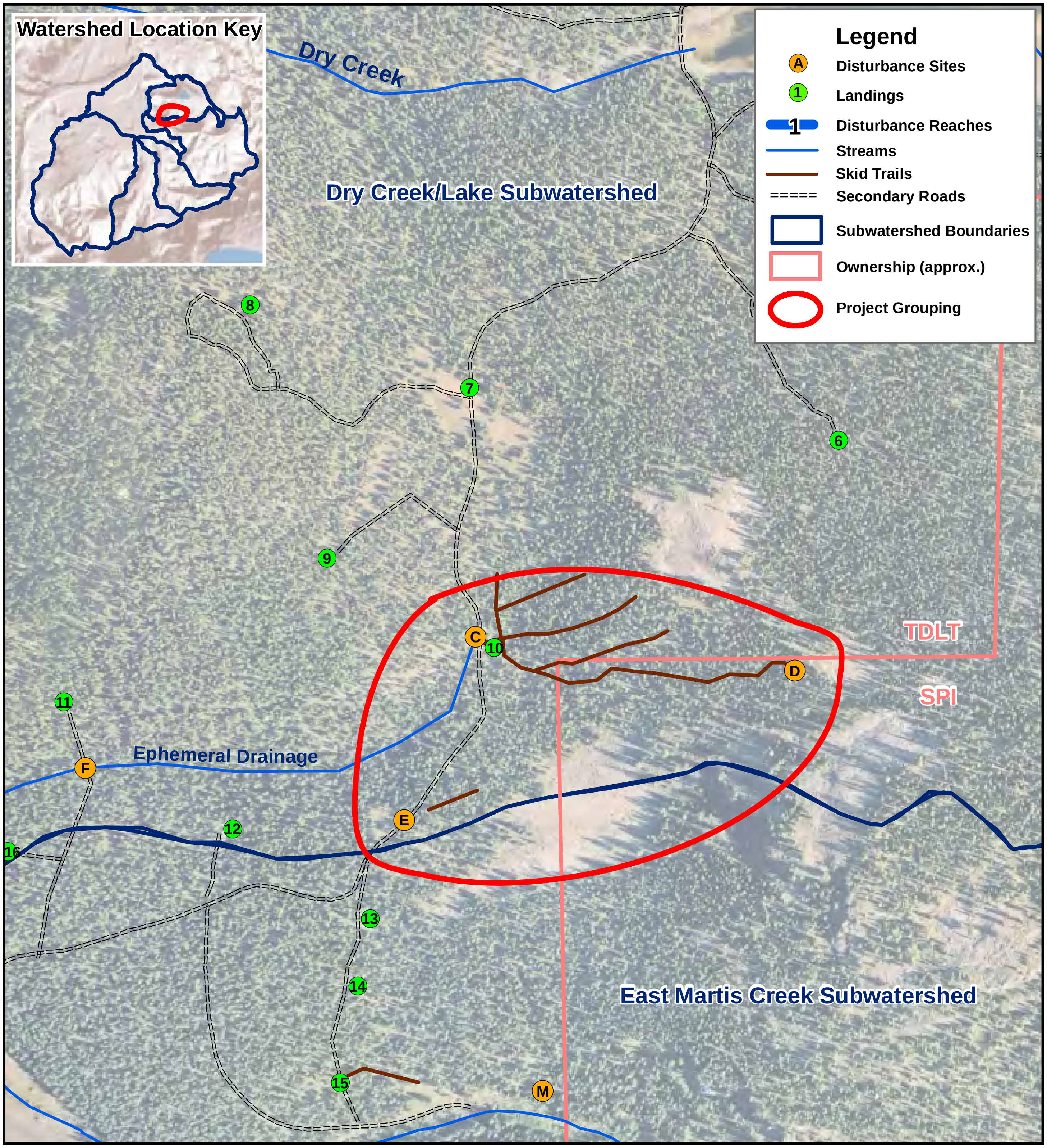

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Figure 26. Martis Watershed Assessment Restoration Opportunities Map Project 3

0 500 1,000 2,000 Feet

N

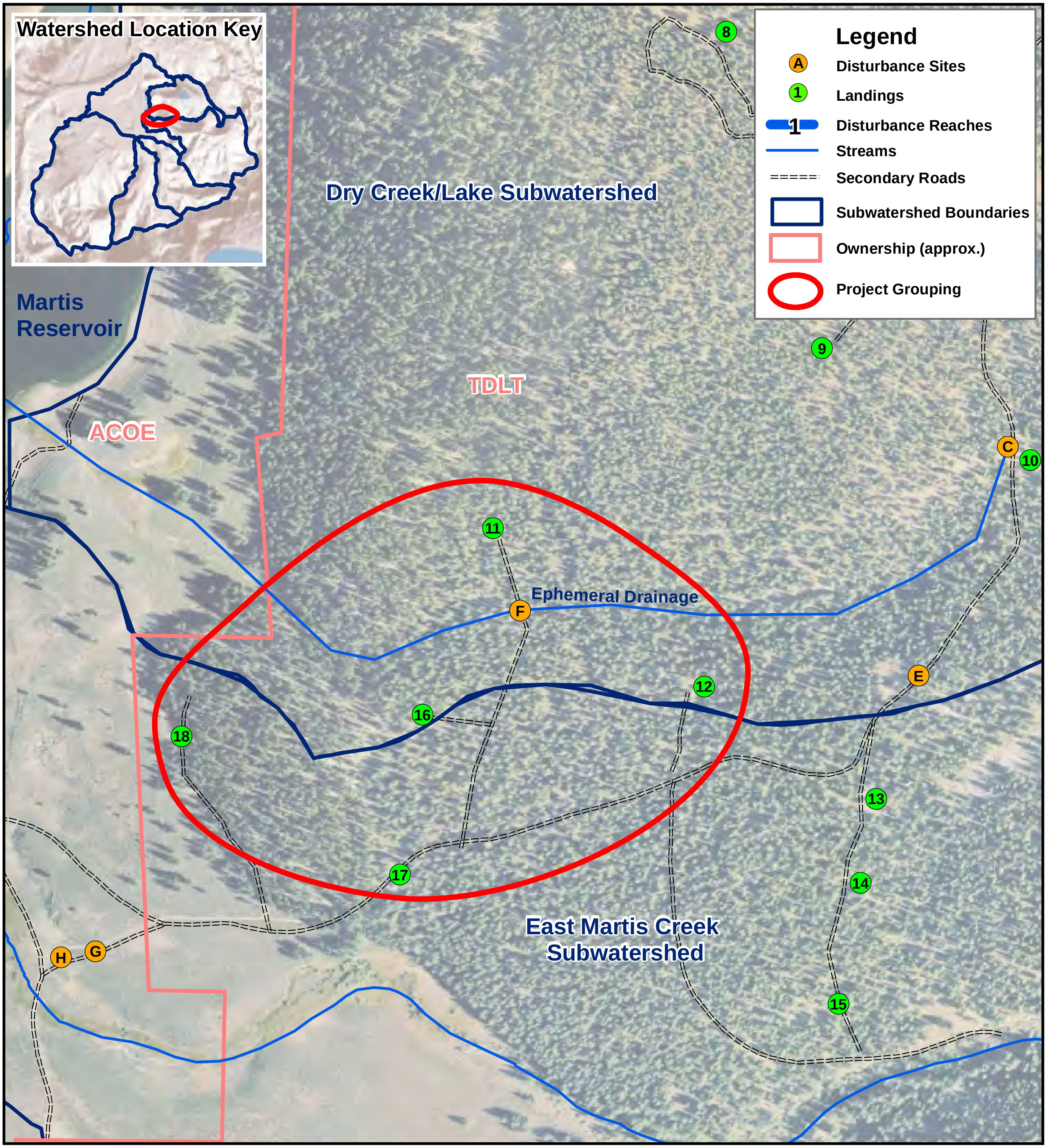

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Figure 27. Martis Watershed Assessment Restoration Opportunities Map Project 4

0 385 770 1,540 Feet

N

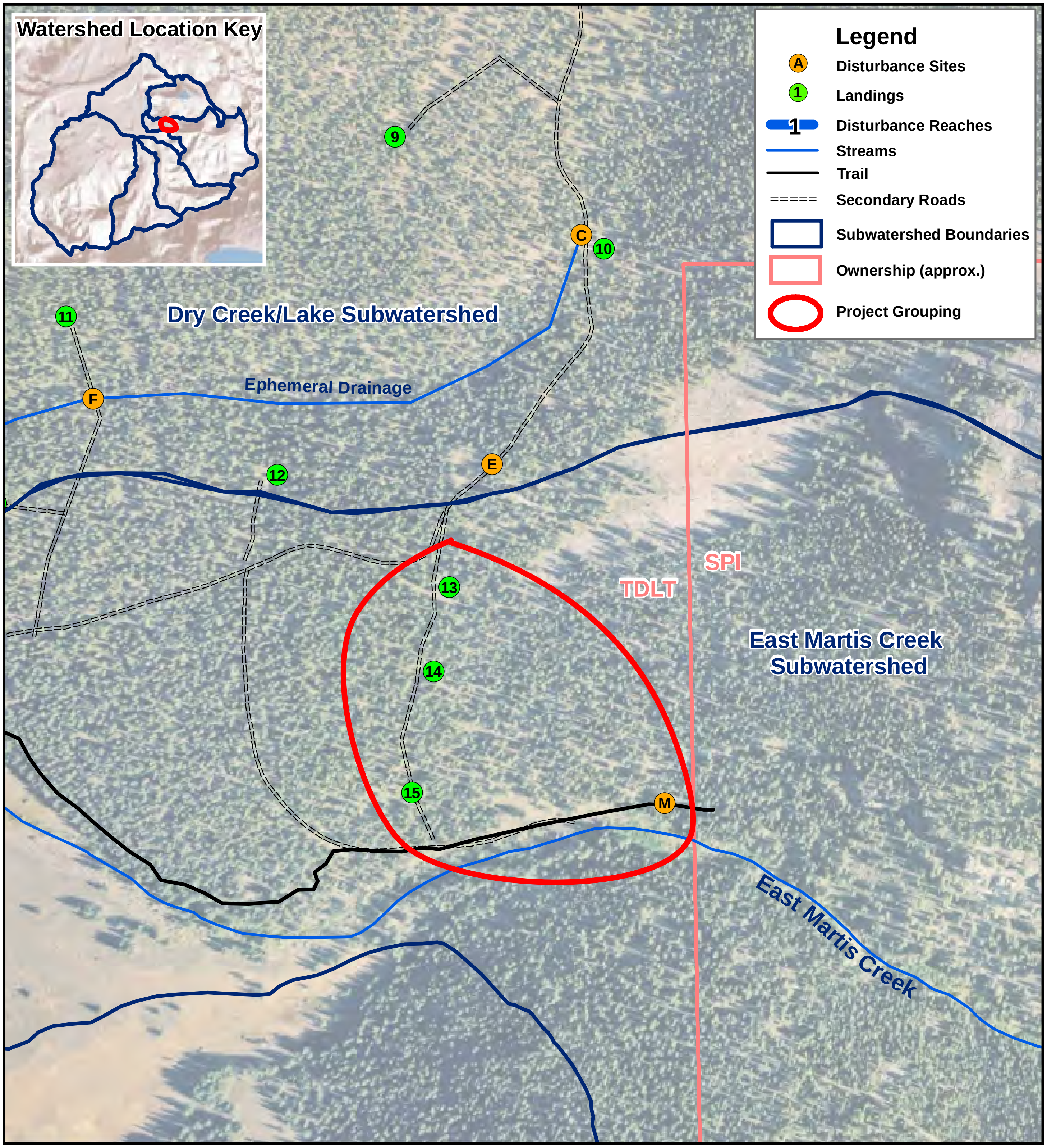

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Figure 28. Martis Watershed Assessment Restoration Opportunities Map Project 5

Feet
0 380 760 1,520

N

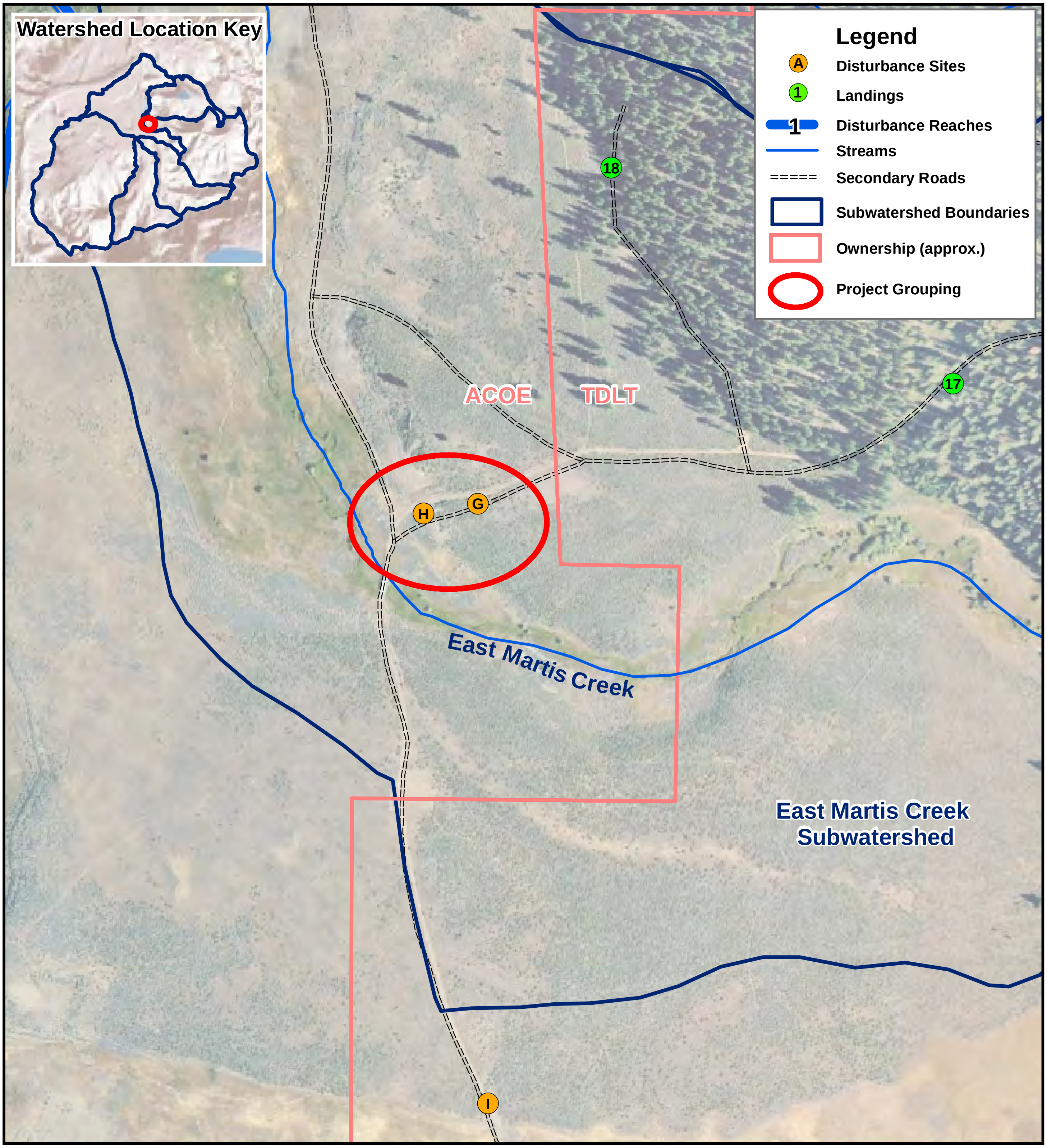

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Figure 29. Martis Watershed Assessment Restoration Opportunities Map Project 6

0 255 510 1,020 Feet

N

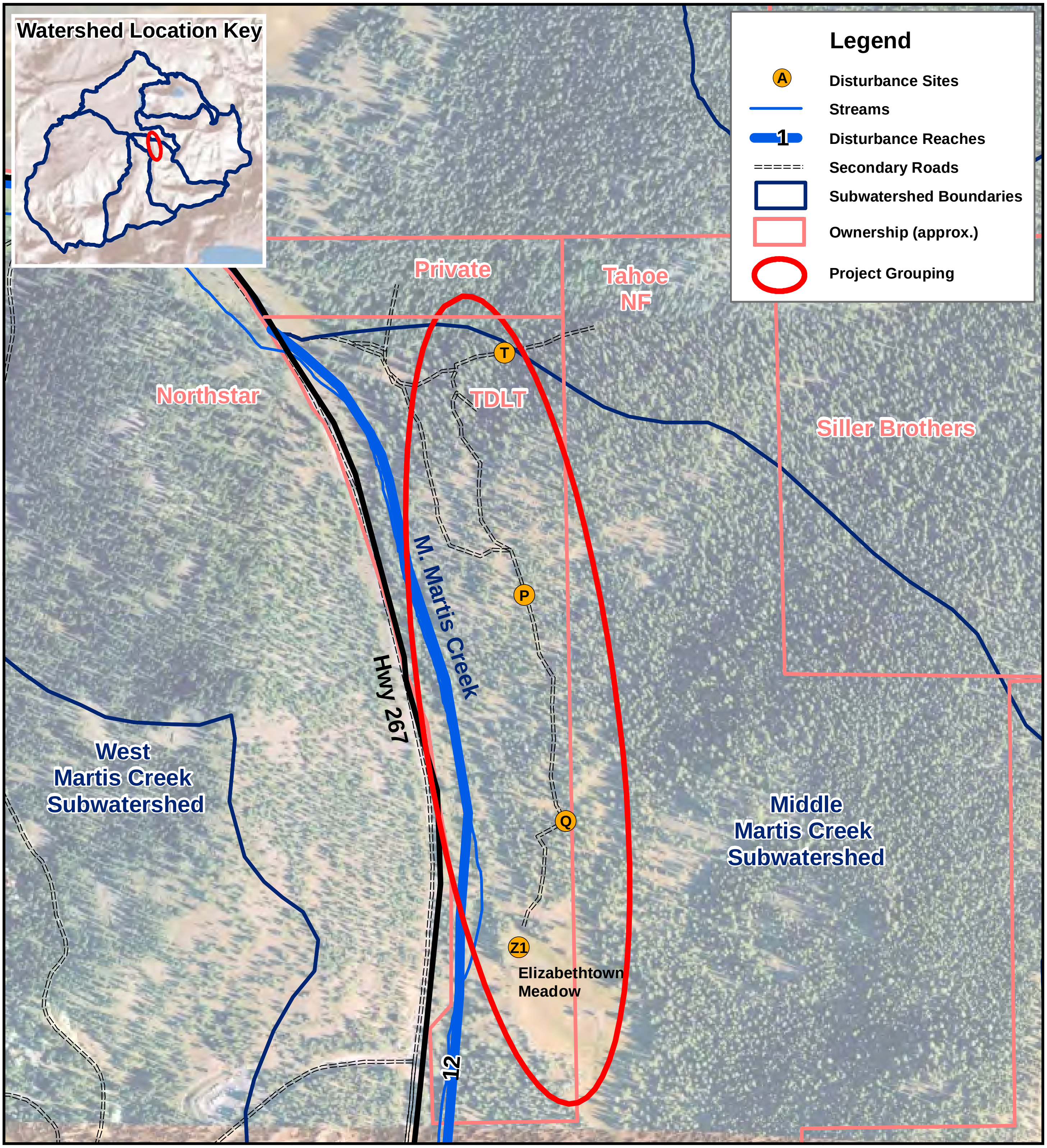

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Figure 30. Martis Watershed Assessment Restoration Opportunities Map Project 7

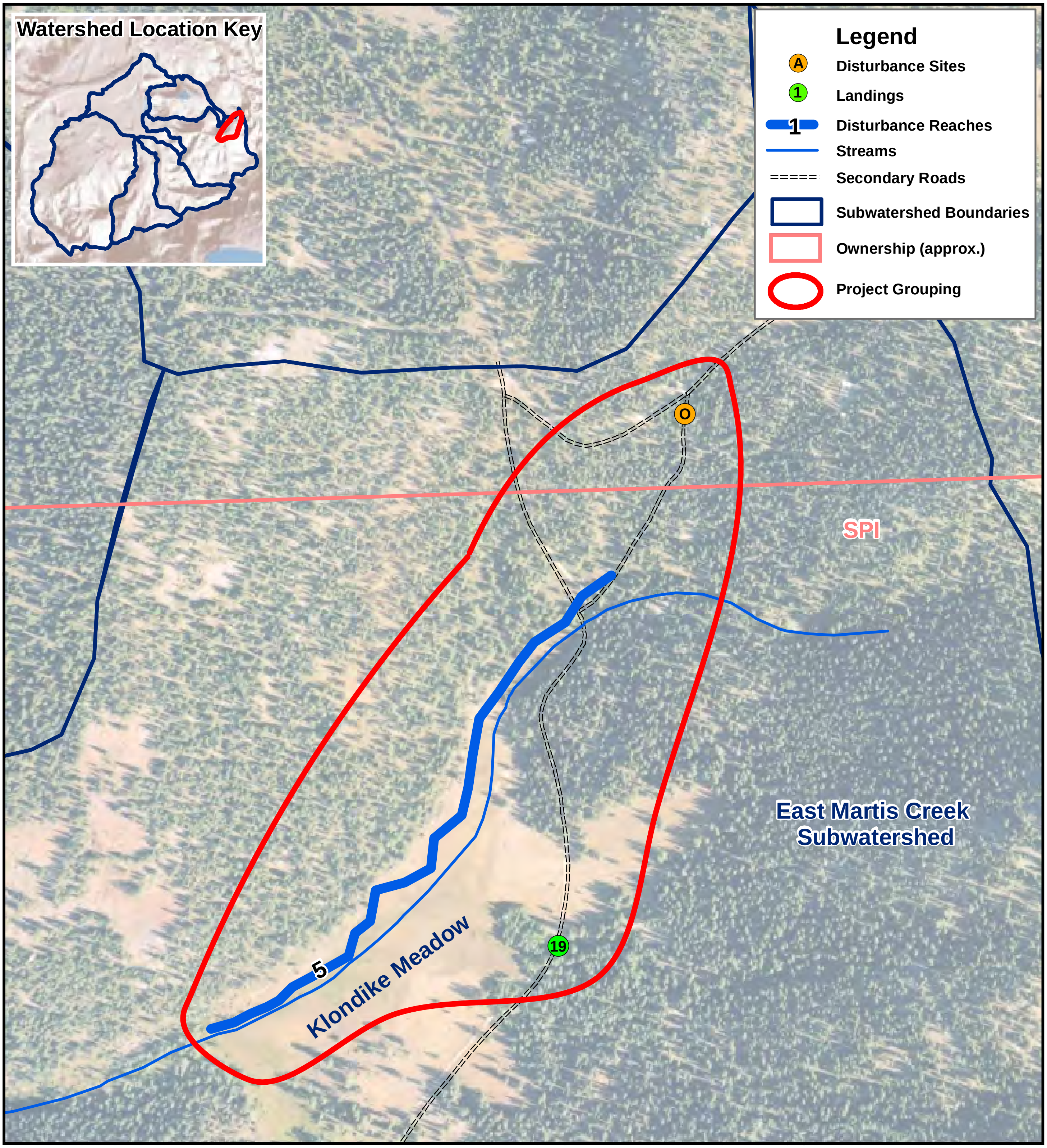

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Figure 31. Martis Watershed Assessment Restoration Opportunities Map Project 8

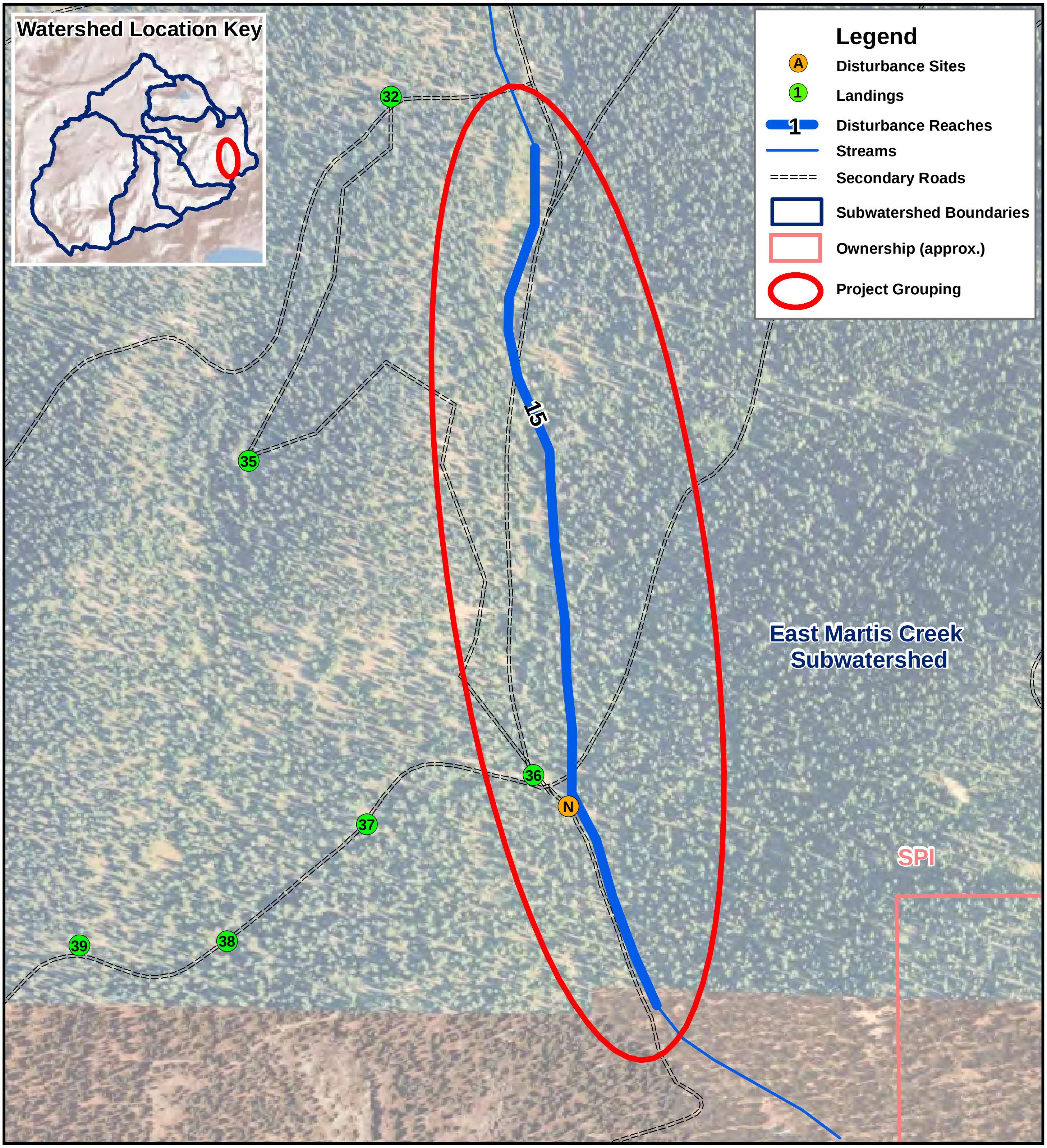

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Figure 32. Martis Watershed Assessment
Restoration Opportunities Map
Project 9

Feet
0 375 750 1,500

N

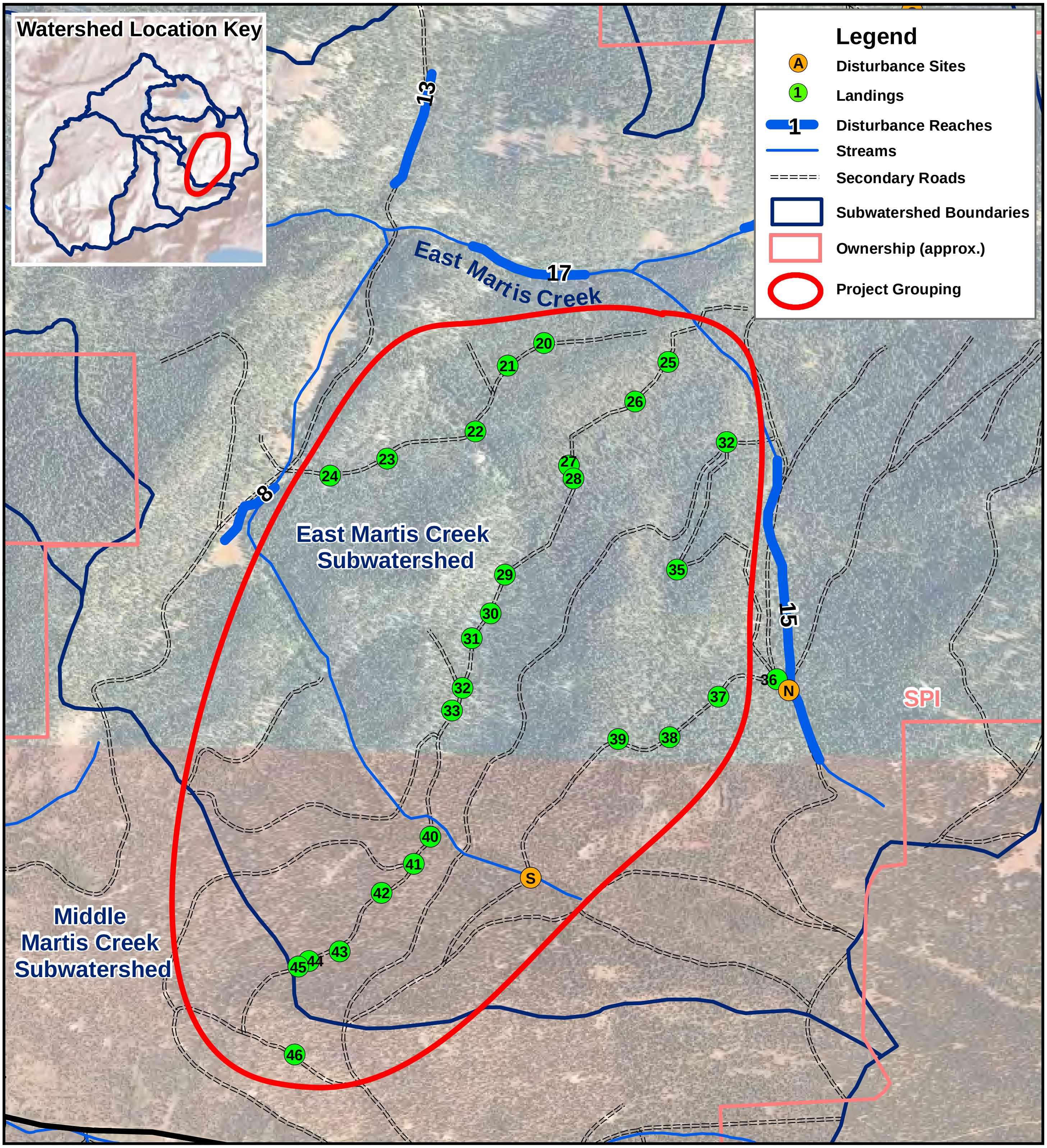

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Figure 33. Martis Watershed Assessment
Restoration Opportunities Map
Project 10

0 1,250 2,500 5,000 Feet

N

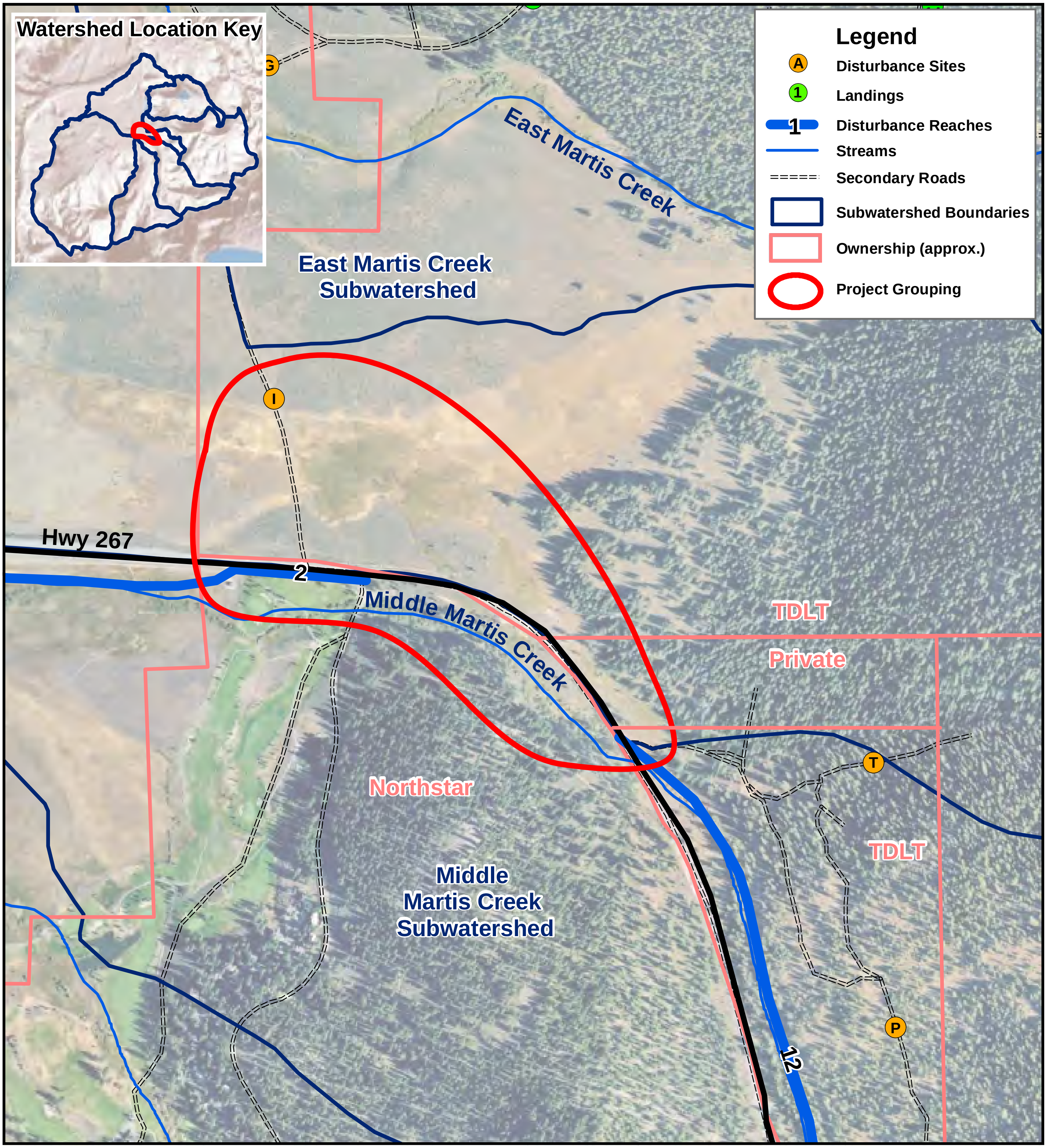

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Figure 34. Martis Watershed Assessment Restoration Opportunities Map Project 11

0 500 1,000 2,000 Feet

N

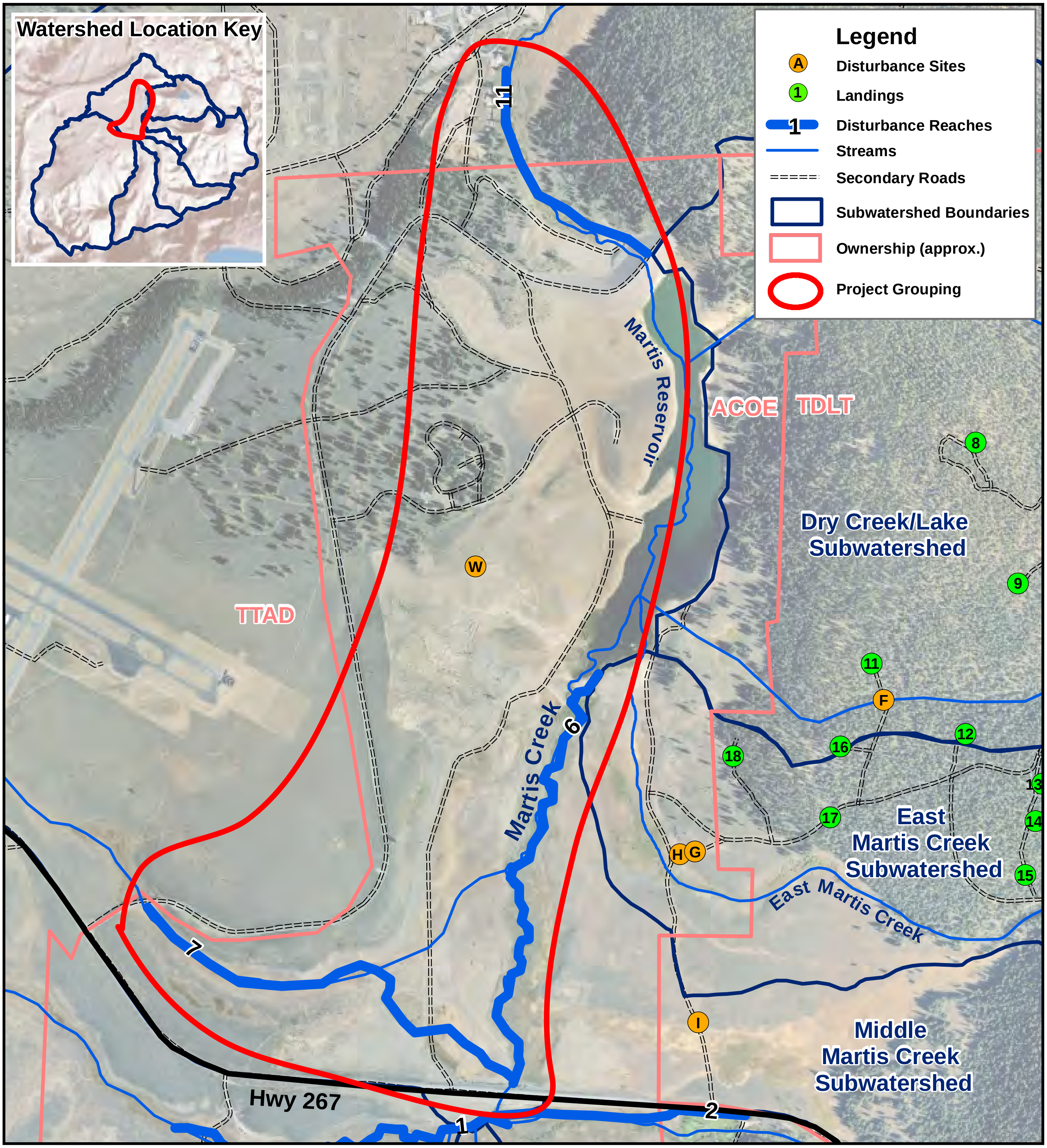

Figure 35. Martis Watershed Assessment
Restoration Opportunities Map
Project 12

0 1,000 2,000 4,000 Feet

N

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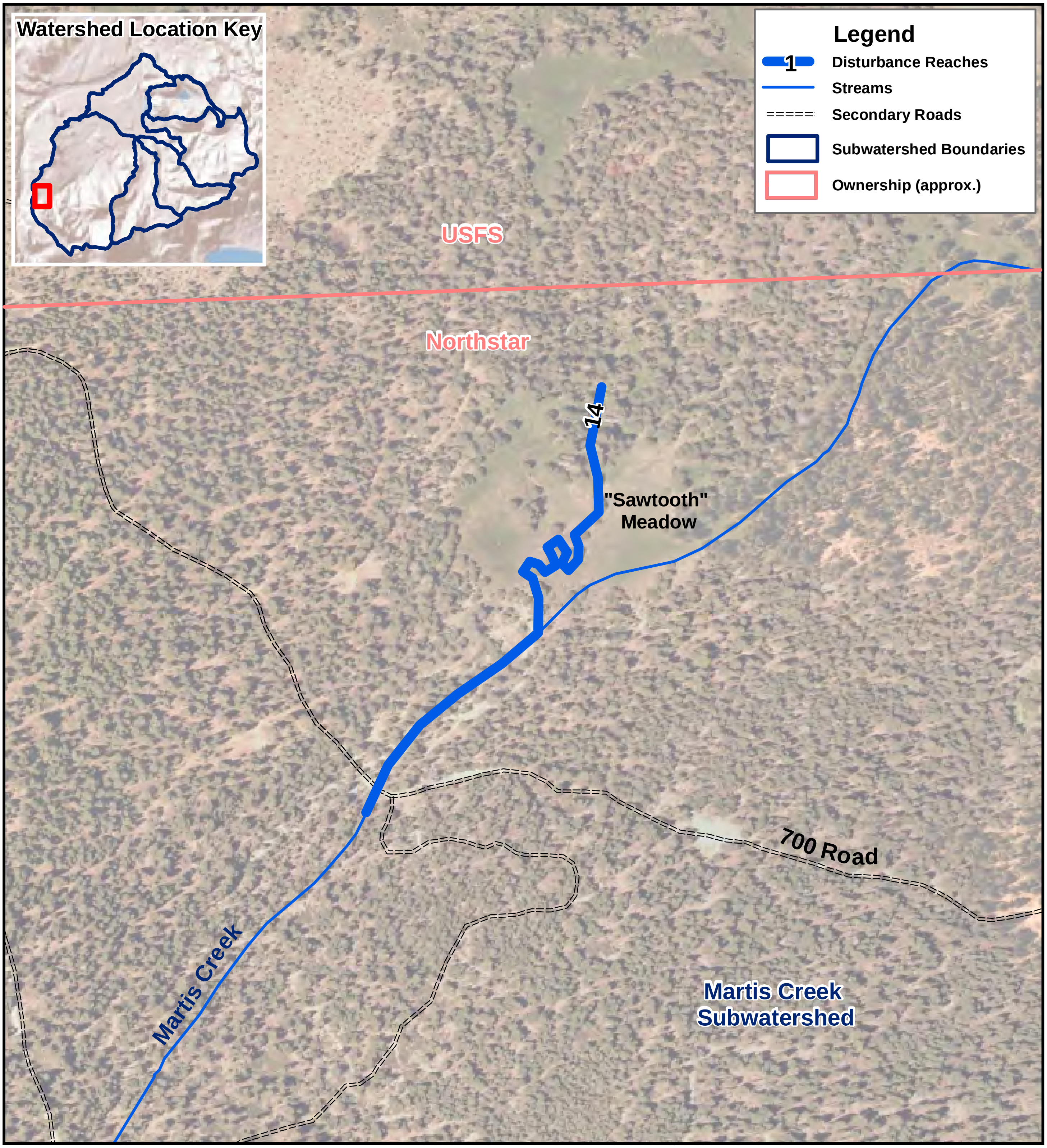

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Figure 36. Martis Watershed Assessment Restoration Opportunities Map Reach 14

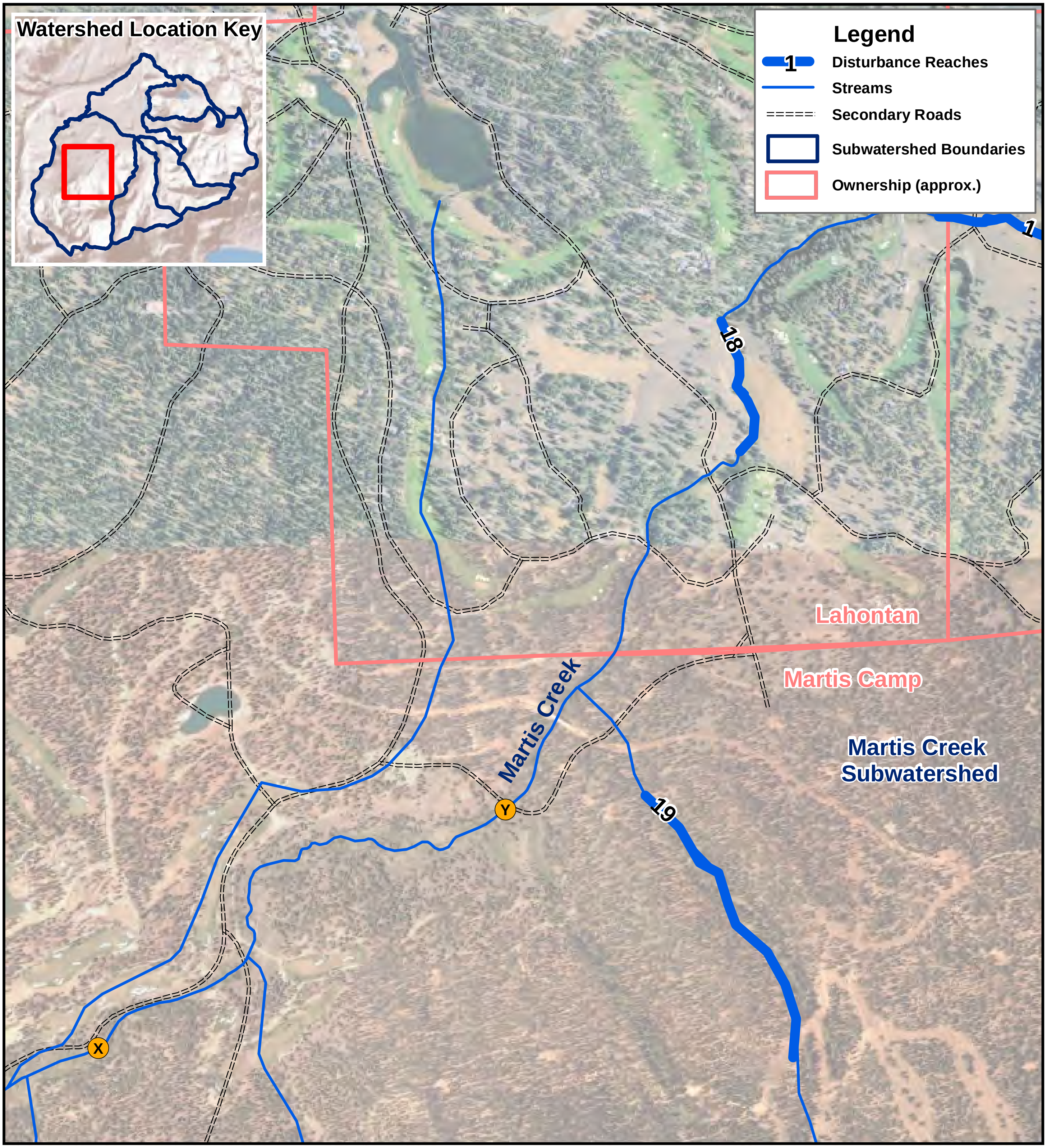

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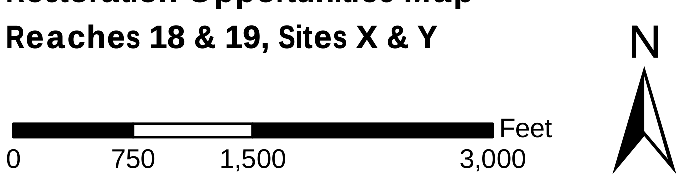
Figure 37. Martis Watershed Assessment
Restoration Opportunities Map
Reaches 18 & 19, Sites X & Y



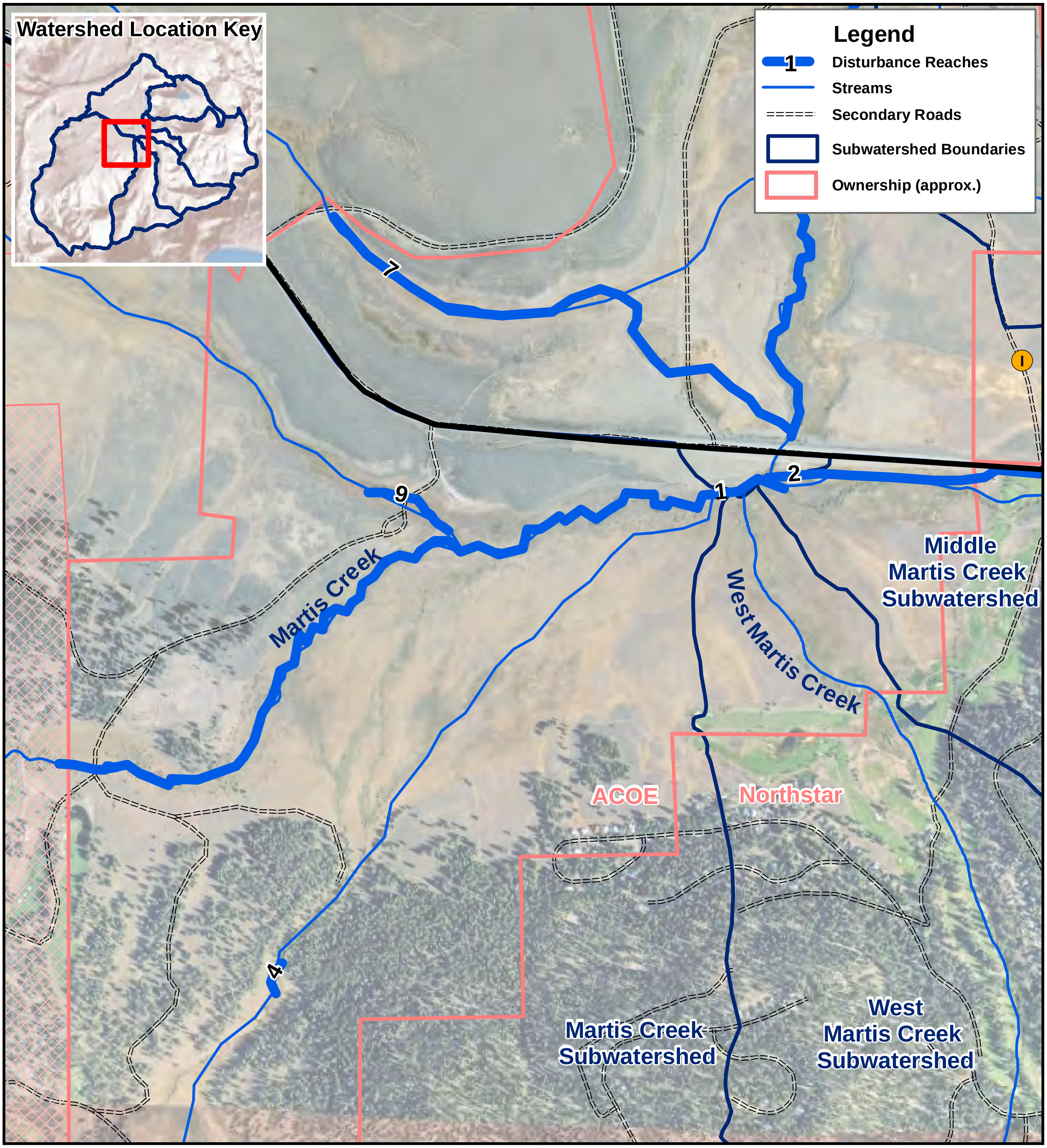


Figure 38. Martis Watershed Assessment Restoration Opportunities Map Reaches 1, 4 & 9

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Figure 39. Martis Watershed Assessment Restoration Opportunities Map Reach 10

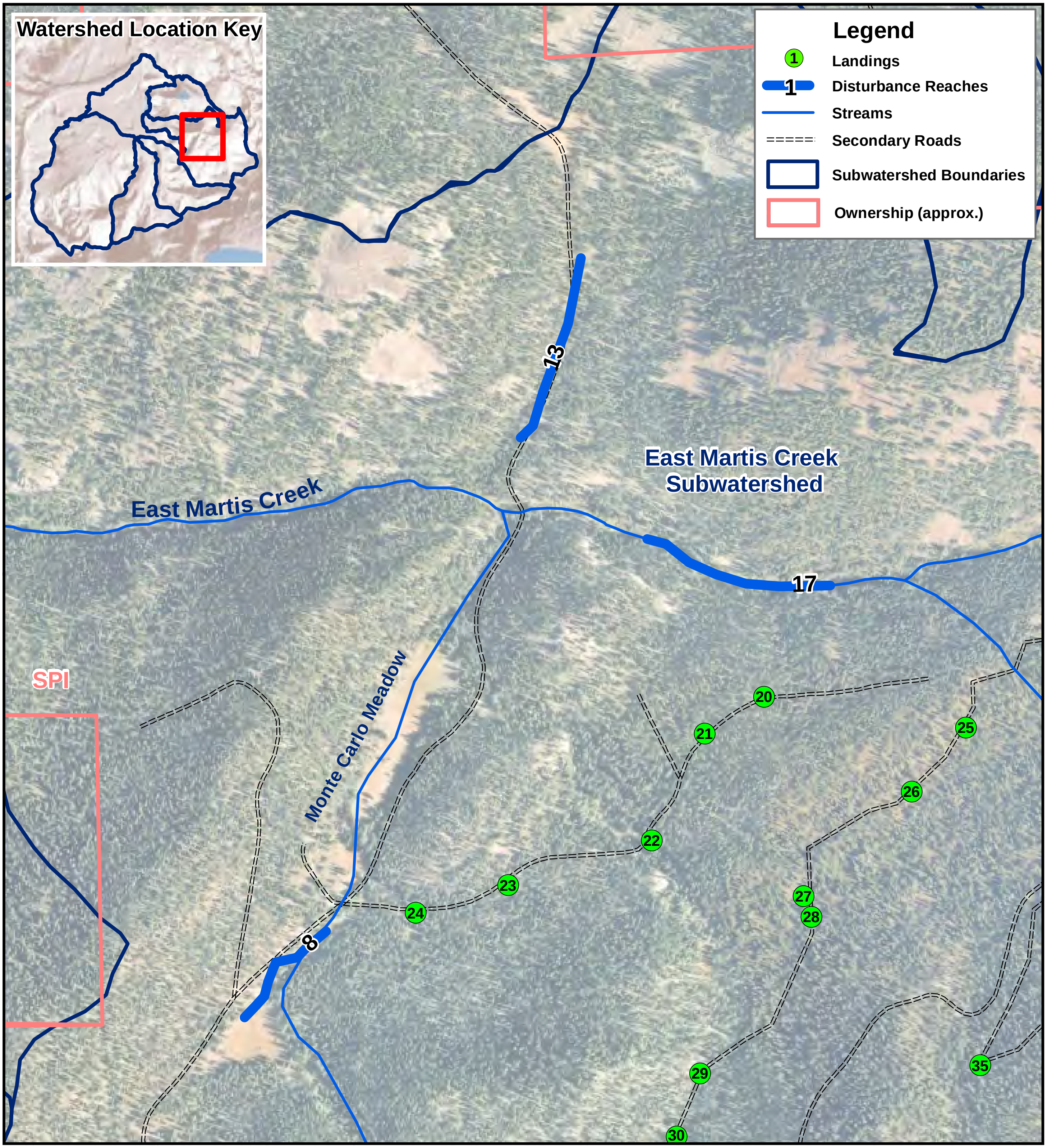

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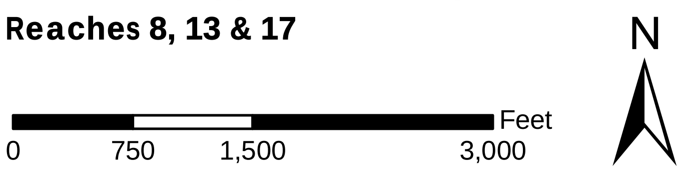
Figure 40. Martis Watershed Assessment
Restoration Opportunities Map
Reaches 8, 13 & 17



APPENDIX A

MARTIS VALLEY WORK BOOK

A CONTEXTUAL OVERVIEW OF HUMAN LAND USE AND ENVIRONMENTAL CONDITIONS

prepared by

SUSAN LINDSTRöM, PH.D.
CONSULTING ARCHAEOLOGIST
TRUCKEE, CALIFORNIA

prepared for

BALANCE HYDROLOGICS, INC.
BERKELEY, CALIFONRIA

on behalf of

TRUCKEE RIVER WATERSHED COUNCIL
TRUCKEE, CALIFORNIA

APRIL 2011

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MARTIS VALLEY WORK BOOK
A CONTEXTUAL OVERVIEW OF HUMAN LAND USE AND ENVIRONMENTAL CONDITIONS

INTRODUCTION

The Martis Creek watershed covers 26,204 acres, comprising four branches of Martis Creek: West, East, Middle, and the main branch. The goal of the Martis Watershed Assessment Project is to provide the science and policy information needed to establish a baseline to direct restoration and protection projects within the watershed.

Watershed restoration efforts can benefit from an understanding of the long-term ecological role of aboriginal peoples and historical Euroamerican populations in the dynamics of wild plant and animal populations and alterations of the physical environment. Paleoenvironmental, archaeological, ethnographic, and historic documentation offer great time depth and can be used as independent and corroborative tools with which to link historic conditions and contemporary environmental restoration and protection. With this premise in mind, available background data was gathered to assist project planners in assessing potential restoration opportunities and constraints. The past is part of the living present and the Martis Creek watershed has had a long period of human occupation. Human land disturbances were initiated by millennia of low-intensity land management by the Washoe Indians and their prehistoric predecessors. Within a century's time, indigenous practices were replaced by profound resource exploitation by in-coming Euroamerican populations. These past land management practices engendered environmental impacts that varied in space, time, scale, intensity, and consequence. In Martis Valley, for example, human disturbances ranged widely from pruning a patch of native shrubs to clear-cutting thousands of acres of timberland. Some resources were targeted in a single brief event, while others were affected for decades or generations.

Study results have been organized into this “work book” format. A fairly extensive contextual history of pre-modern conditions within the Martis Creek watershed is presented in order to document human disturbances and set a baseline of reference conditions from which to assess the contemporary environment of the Martis Creek watershed. All of this information has been analyzed in order to better identify the location, nature and intensity of environmental/cultural changes that have occurred within the Martis Watershed. These events are summarized in the time line that accompanies this report. In addition, findings have been directed towards the feasibility and compatibility of heritage resource protection and enhancement concerns in conjunction with habitat, wildlife and landscape restoration, and contemporary development interests within the Martis Creek watershed by identifying the relative cultural resource sensitivity of lands potentially targeted for watershed restoration improvements.

DATA SOURCES AND CONTACTS

Research for the Martis Watershed Assessment was conducted by Susan Lindström, Ph.D. Lindström meets the Secretary of Interior's Professional Qualifications Standards. She has 38 years of professional experience in regional prehistory and history, holds a doctoral degree in anthropology/archaeology and has maintained certification by the Register of Professional Archaeologists since 1982.

This contextual discussion draws upon the existing literature, supplemented by personal notes and experience. The overview is far from exhaustive and data are uneven. Assembled at an earlier time and for a different purpose, information has been adapted to fit into the Martis Valley watershed assessment context.

PUBLISHED AND UNPUBLISHED SOURCES

Research involved a literature review of pertinent historical and prehistoric themes and an assessment of prior regional archaeological investigations. A number of sources were consulted to include Placer County files (Archives, Recorders, Assessors offices), as well as historic photographs and maps on file in Lindström's personal library. Referenced maps included early surveys (General Land Office 1865, Von Leicht and Hoffman 1874, Wheeler 1876-1877), county maps (Nevada County 1880 and 1913, Placer County 1887), USGS quadrangles (1889/1897, Truckee 1940/1951, 1955, 1969, 1978, 1985, 1986), U.S. Forest Service maps (1915, 1921, 1926, 1930, 1962, 1976, grazing maps from 1911 and 1944-1945 and various Tahoe National Forest cut plats dating from 1915 to 1970), Metsker's Map of Nevada County (ca. 1938), Placer County township and range maps (ca. 1938), and miscellaneous maps showing historic saw mills by Knowles (1942), Spohr (1990) and Wilson (1992). Aerial photographs examined include those on file with the U. S. Forest Service (1939, 1952 and 1966) and the Air National Guard (1952). In addition, general local and state histories, regional inventories, miscellaneous unpublished manuscripts, newspaper articles, and oral history interviews with descendants of Martis Valley pioneers were examined. Original field notes from the 1957 California State College (University) Martis Valley Archaeological Field School (provided courtesy of U.S. Army Corps of Engineers, USACE) were also reviewed. Other resources are listed in the references cited section at the end of this report.

ORAL HISTORY INTERVIEWS

A series of oral history interviews involving descendents of pioneer families in Martis Valley are on file with the Placer County Archives in Auburn. Oral histories are referenced in the bibliography of this report and include the recollections of Cavitt, Joerger and Waddle family members. Personal recollections have also been gleaned from various newspaper interviews. Over the years, Lindström has initiated more informal communications with the following individuals and pertinent information has been included in this report:

- Dave and Linda Brown -- Northstar residents with historic photos of the Sagadi Basque camp; interviewed November 2009

- Heidi Euer Martin -- daughter of Bernal Euer, who was a son of Sophery Euer, pioneer dairyman in Truckee and her husband Tom Martin; interviewed July 2010

- Ellie Huggins – close friend of the Tong family; interviewed June 2010

- Frank Titus -- Truckee native and long-term resident (born ca. 1920); interviewed July 2010

- Cindy Tong -- great granddaughter of Joseph Joerger, Sr., pioneer Martis Valley dairyman and rancher and grand niece of Bertha Joerger Wolverton; Ms. Tong resided at Joerger Ranch; personal communications continued with her from the 1990s until Ms. Tong's death in 2006

- Art Tong -- husband of the late Cindy Tong; currently resides at Joerger Ranch; Mr. Tong grazes stock at the summer range in Sierra Valley; he came to Martis Valley ca. 1960s and leased land from the Waddle family near the Old Joerger Ranch; the Tong family is a prominent ranching family in El Dorado county history; interviewed July 2010

- Norman Wilson -- field school co-director with B.A. Arnold during 1957-1958 excavations by Sacramento State College; career archaeologist and historian; personal communications continued from 1989 until his death in 2002

NATIVE AMERICAN CONSULTATION

Washoes have maintained ties to Martis Valley, both during the pioneer and modern periods and prior ethnographic studies indicate that the Washoe Tribe is the applicable tribal authority for lands encompassing the project area. In order to incorporate the Tribe's opinions, knowledge and sentiments regarding any potential concerns specific to the project, Darrel Cruz, Washoe Tribal Historic Preservation Office (THPO), was contacted A project description and project maps were emailed and mailed to Mr. Cruz in early April 2011. The tribe is considered to be an important stakeholder within the Martis Creek watershed and a number of important Native American sites are known to exist. To supplement any new information, research also drew upon prior interviews with Washoe elders and with descendants of local pioneer families in order to provide further historical perspective on traditional land management practices within Martis Valley. Lindström has maintained more informal contact with members of the Washoe Tribe regarding Martis Valley since the early 1970s. For example, in 2003 at the request of former Washoe Tribal Chairperson (Brian Wallace) and members of his extended family, she conducted a tour of selected sites in Martis Valley.

PALEOCLIMATE

From a knowledge of past climate patterns and ecosystem response, we gain some sense of future sustainable conditions. Paleoenvironmental data (including issues related to landscape evolution, drought, floods, and changing fire regimes) enhance our understanding of the frequencies, durations, magnitudes and rates of climatic change and the environmental responses to these changes. In particular, these data indicate the norm (Lindström et al. 2000:88). The findings may be used to derive predictions regarding the possible paths that the ecosystem may take in the future, under given scenarios of future climate and the impacts of anthropogenic activities. Although we may not be able to control the direction of future climate conditions, we can affect other parts of the ecosystem through the type and scale of our management activities so that we may achieve some measure of environmental sustainability (Lindstrom et al 2000:24-34).

A three-part model of climatic change for the 10,000-year Holocene period (Antevs 1925; Davis 1982) subdivides the period into the cool-moist Early Holocene, the hot-dry Middle Holocene and the cool-moist Late Holocene. Changing aspects of the natural environment, which were of special importance to human populations inhabiting the Tahoe Sierra during the last 9000 years, are summarized below (after Lindström et al. 2000:24-34).

EARLY HOLOCENE (10,000-7000 BP)

During the Late Pleistocene, more than 13,000 years before present (BP), glaciers occupied much of the Sierra Nevada and Carson Range, and a vast pluvial lake (known as Lake Lahontan) flooded much of the western Great Basin. By the Early Holocene, 10,000-7000 years BP, warming and drying caused glaciers to melt and Lake Lahontan to shrink. Although climates were relatively cool and moist, compared to those of today, they were considerably warmer than those of the Late Pleistocene. Winter dominance of precipitation, which had characterized the Late Pleistocene, continued during the Early Holocene. With the final arrival of montane woodland at higher elevations, sparse human populations entered the region and engaged in a highly mobile foraging economy based on large game hunting

MIDDLE HOLOCENE (7000-4000 BP)

The Early Holocene was followed by a much warmer and dryer Middle Holocene period from about 7000-4000 BP, which caused the final desiccation of many lakes in the western Great Basin and the retreat of montane and semi-arid woodlands to elevations higher than those at which they are currently found. Locally, the water level of Lakes Tahoe and Pyramid declined, but were among the few that did not dry up completely. Middle Holocene aridity in the Tahoe Sierra is further documented by the remains of submerged tree stumps, which stand rooted on the floor of Lake Tahoe, as deep as 20 feet below its present surface. These ancient drowned forests date from between 6300-4800 BP (Lindström 1990, 1997). Shallowly submerged prehistoric milling features (bedrock mortars) occur lake-wide and may date from this and/or subsequent droughts. About 5500 BP the harshest period of Middle Holocene drought came to an abrupt end, as manifest by the drowned shore-side forests at Lake Tahoe. During this period, prehistoric populations increasingly exerted their influence in altering the landscape and affecting fauna and flora. Archaeological evidence indicates a gradual decrease in overall residential mobility, greater land-use diversity, a broadened diet, and intensified use of plant resources.

LATE HOLOCENE (4000 BP to present)

The Late Holocene record appears to be punctuated by alternating intervals of cool-moist and warm-dry periods. More intensive human use of the Tahoe Sierra occurred during this period, as increasing populations of mixed-mode foragers-collectors ventured into the highlands on seasonal gathering, fishing, and hunting forays.

Neoglacial Period (4000-2000 BP)

Climates became cooler and moister initiating the Neoglacial (or Neopluvial) period that lasted for the next 2000 years. Climates reached their Late Holocene cool-moist climax by 4000 BP causing the rebirth of many Great Basin lakes, the growth of marshes, and, apparently, minor glacial advances in the Sierra.

Drought Intervals

A dry interval seems to have persisted from 2200-l600 BP. Relatively dry conditions continued, with summer-shifted rainfall and less severe winters between 1600 and 1200 BP. This time is characterized by strong swings between very wet periods and very dry periods. Wet cycles allowed significant expansion of single-leaf pine into the semi-arid woodlands east of Lake Tahoe, with forests becoming more densely packed. Dry times appear to have coincided with a rise in fire frequency in the montane woodlands in the Carson Range, an event linked with increased slope erosion and channel filling in the central Great Basin.

After 1200 BP increasingly drier conditions caused the retreat of both semi-arid and montane woodlands. There is evidence of gradual drying from 1345-1145 BP, as trees grew on Ralston Ridge Bog south of Lake Tahoe due to low water tables. Analysis of a number of ancient woodrat nests (middens), recovered from the upper walls and ceiling of the cave at Cave Rock along Tahoe's southeastern shore, dated at about 1360 BP, reveal the increasingly warm dry conditions that represented the beginning of the much drier period than has characterized the last millennium (Lindström et al. 1998). However, the occurrence of a brief wet interval around 1100 years ago is suggested by the presence of buried A-horizon soils in association with a sand lens near Taylor Creek, indicating a rise in the level of Lake Tahoe and deposition of lake deposits as sand

A period of intense drought occurred from 1100-900 BP (AD 900-1100). Relict Jeffrey pine stumps, rooted in the Walker River stream bed, date to 920 BP (AD 1030) and 660 BP (AD 1290). Submerged stumps along the Walker Lake shorelands also yielded carbon-14 ages of 980 BP.

Intense drought returned again around 700-500 BP (AD 1300-1500). The relationship between tree growth and stream flow in the upper Truckee River watershed indicates that intermittent drought conditions prevailed around 675 BP (AD 1275; Hardman and Reil 1936). Relict Jeffrey pine stumps, rooted in the Walker River stream bed, date to 660 BP (AD 1290) (Stine 1992, 1994). Evidence of a dry period around 669 BP (AD 1281) is provided by a series of deeply submerged tree stumps in Independence Lake north of Truckee (Lindström 1997). In addition, dozens of submerged tree stumps are located up to 30 feet below the present day level of Donner Lake near Truckee; carbon-14 samples from one stump date from 517 BP (AD 1433) and 460 BP (AD 1490) (Lindström 1997).

Another warm period, documented by reduced Truckee River run-off and the relatively narrow tree rings of pines growing in proximity to the river, is dated between 371-365 BP (AD 1579-1585), and again around 320 BP (AD 1630) (Hardman and Reil 1936). A dated woodrat midden stratum from Cave Rock indicates that as late as 360 BP (AD 1590), climates were still very warm and dry in the Tahoe Basin (Lindström et al. 1998).

Little Ice Age and Formation of Truckee-Tahoe's Old Growth Forest (350-175 BP/AD-1600-1775)

Between 350 and 175 years ago (AD 1600-1775) a cool-wet climate, comparable to the Little Ice Age event of Western Europe, dominated the region. Lake levels again rose and cirque glaciers reformed in the Sierra, reaching their greatest extent since the latest Pleistocene. The Little Ice Age is marked by the expansion of both semi-arid and montane woodlands. Many of the old growth forests remaining in the Sierra and the Cascades today began to develop during this period.

At the end of the Little Ice Age, about AD 1825, drier conditions caused retreat of forests to higher elevations. Fire frequency increased, as the lower-elevation and water-stressed portions of these forests dried.

Beginning about the mid 1700s through the mid 1800s, the level of Lake Tahoe (which supplies about 75 percent of the flow of the Truckee River in normal years) may have contributed relatively little water to the Truckee River. The decline of Little Ice Age climates is documented by radiocarbon dates of currently submerged tree stumps in the Tahoe Sierra (Lindström 1990, 1997). These include a stump in Lake Tahoe near the mouth of Upper Truckee River dating from about AD 1720 (230±50 BP uncalibrated), one in Emerald Bay dating to AD 1840 (110±60 BP uncalibrated), one from Moon Dune Beach at Tahoe Vista dating from AD 1802 (148.5±mod uncalibrated), and one from Cave Rock with a calibrated date of AD 1695-1725 and 1815-1920. In addition, two submerged stumps from Independence Lake date from AD 1780 (170±50 BP uncalibrated) and AD 1850 (100±mod uncalibrated), respectively. Another stump from Donner Lake dates from AD 1800 (150±50 BP uncalibrated). (Given the problems of radiocarbon-dating materials less than 250 years old, these dates may also include the Little ice Age event.)

Later 19th Century and Beyond (AD 1875 to present)

The 40 years between AD 1875-1915 were the longest period (during the historical record) in which the flow of the Truckee River was above average. Tahoe reached its recorded high, with a lake surface level of 6231.26 feet recorded on July 14-18, 1907; this is 8.26 feet above its natural rim, measured at 6223 feet. This wet interval encompasses all of historic-era logging and fluming activities and includes the first few decades of forest regeneration. Relying on "above-average" precipitation, water reclamation projects were planned and initiated in the Truckee-Tahoe basins. Intensive livestock grazing began during the latter part of this wet period.

During the severe drought of AD 1928-1935, Lake Tahoe ceased to flow from its outlet for six consecutive years. The water crisis prompted several unsuccessful attempts by downstream water users to cut down or blast Tahoe's rim and dredge the Truckee River channel; all were blocked by Tahoe lakeshore property owners. Eventually a compromise was reached and millions of gallons of water were pumped out of the lake and into the Truckee River.

Wet years during the period 1982-1986 contributed to an average annual snow water content of up to 200 percent of normal. The year 1983 became the standard "High Water Year" for virtually all water ways within the Truckee River drainage basin.

Between 1987 and 1994 there was a period of drought in the Truckee River drainage basin. Although of the same duration as the 1928-1935 drought, the 1987-1994 drought was far worse. In the Lake Tahoe Basin, the average annual snowpack water content was recorded at 29 percent of normal. On November 30, 1992 the surface of Lake Tahoe reached its record low at 6220.27 feet, 2.72 feet below its natural rim of 6223 feet. Sustained drought increased the vulnerability of forests to severe insect attacks. By 1991 an estimated 300 million board feet of timber were dead or dying.

In 1995 a near-record year of precipitation in the Lake Tahoe and Truckee River basins recharged groundwater and replenished near-empty reservoirs. Although a trend of normal to above-normal precipitation continues to the present, drought will inevitably revisit the region. Investigations as part of the 1996 *Sierra Nevada Ecosystem Project*, a study commissioned by Congress to aid policy makers planning for the future of the Sierra Nevada, revealed that Sierran climate influences the source of much of California's and western Nevada's water, may be getting drier. Century-long droughts that have occurred within the last 1200 years may recur in the near future.

The rapidity of hydrologic response to changes in climate is highlighted by the impact of the El Niño cycles of the last 20 years. Even slight increases in precipitation can have an amplified effect on runoff, where strong streamflow enhances erosion and delivery of sediments and nutrients to water bodies in the Truckee-Tahoe basins. Increased moisture has also promoted plant growth and added to the accumulation of forest fuels and, with subsequent droughts forests may be ravaged by fire. These short-term observations are supported by sediment cores, which hold a record of long-term fire frequency in the charcoal that they contain. Data indicate that greatest fire severity occurred during the droughts which punctuated the wetter episodes of the Holocene. The typical density of trees in the montane forest at middle and upper elevations assures the continued presence of abundant fuel and, when coupled with increased susceptibility during drier climate, both fire severity and frequency will increase.

PHYSICAL ENVIRONMENT

Martis Valley is situated in the Truckee Basin, an alluviated structural basin west of the Carson Range and east of the main crest of the Sierra Nevada. Low hills and ridges are Tertiary and Pleistocene volcanic rocks (Birkeland l963) and valley floors are covered with relatively flat laying alluvial, glacial and glaciofluviatile deposits (Birkeland l964). In 1882 William Morris Davis described Martis Valley (Davis 1882:218).

> A well defined but extinct lake…in Truckee Valley is now, according to Lindgren [1897], represented by Martis Valley, a plain of fine sediments 4 miles across at an altitude of 5900 feet…The lake rose to an altitude of 6000 feet in consequence of a lava barrier that blocked

Truckee River not far to the east. The river has now not only washed a quantity of sediment into the basin but has drained away the lake by cutting down a gorge through the barrier; since then it has trenched a shallow valley along the northern border of the lake-basin plain.

Leiberg (1902:174) also observed the “gravelly flat of Martis Valley” and glacial activity in the vicinity of Mount Pluto: “Mount Pluto ridge as well as those inclosing the basin on the east likewise show evidence of glacial action, but in much less degree.” Areas along Martis Creek and its tributaries and comprising the valley floor are primarily glacial outwash, with pockets of glacial moraines marked by granite boulders surrounding the valley. These boulders were used by Native American peoples as bedrock mills. Glacial gravels were mined for aggregate in historic and modern times.

As noted above, landforms in Martis Valley have also been influenced greatly by Pleistocene volcanic activity, which occurred between 2.3 and l.2 million years ago. These flows are correlated with the Lousetown Formation, a series of early Quaternary basaltic rocks extruded from several local vents which underlie much of the Truckee Basin and its flanks (Birkeland l963). Residual soils are a tan sandy-loam of volcanic and glacial origin. Truckee Basin basalts were used by prehistoric residents to fashion stone tools and the presence of a basalt source of suitable toolstone quality influenced the prehistoric occupation of the general project area. Multiple high-quality basalt sources are present within Martis Valley, but they are small and dispersed.

Elevations within the Martis Watershed elevations range from around 5,800 feet (1,770 meters) on the valley floor up to over 8,000 feet (2,440 meters) on the surrounding peaks. Summer climate in Martis Valley is fair; winters are generally cold with some snow in the valley and considerable accumulations in the uplands.

The watershed is well-watered, being drained by four perennial branches of Martis Creek (West, East, Middle, and the main branch) and their unnamed tributaries. Discharge measurements of Martis Creek into the Truckee River taken June 1, 1889 indicate a flow of 19 second feet (Taylor 1902:17). Oral histories by descendents of pioneer families who resided in Martis Valley contain accounts of a prolific supply of fish (W. Cavit 1989). The creek also sustained a healthy population of fresh water mussel. The 1950s field logs by archaeologists working in the valley report harvesting mussels (3 inches by 1 ½ inches in size) from Martis Creek (Arnold Field Notes 1957). Martis Creek was undoubtedly an important tributary of the rich Truckee River fishery (Lindström 1992, 1996). The Truckee River retained an extraordinarily productive and stable native fishery for thousands of years (Lindström et al. 2000:69). Since the 1860s excessive commercial fishing, dam construction, disturbance of spawning grounds, obstruction of spawning runs, pollution of the watershed, and competition from introduced species combined to cause the demise of the native fishery by the 1920s. With the demise of native fish populations, programs intended to restore the sport fishery were based on unrecorded stockings of exotic aquatic species; the subsequent hybridization, competition, predation, disease, and taking of spawn completely decimated the native population of cutthroat trout.

The lower reaches of the Martis Watershed lie within Storer and Usinger's (l97l) Yellow

Pine/Jeffrey Pine Belt (Transition Zone). Dominant tree species include lodgepole pine (*Pinus murrayana*) Jeffrey pine (*P. jeffreyi*) and white fir (*Abies concolor*). Open areas are covered by sagebrush (*Artemesia tridentata*) and bitterbrush (*Pursia tridentata*) and assorted forbs and grasses. The upper reaches encompass the Lodgepole Pine-Red Fir Belt (Canadian Zone), where red fir (*A. magnifica*) and mountain chaparral species (*Quercus vaccinifolia*, *Castanopsis sempervirens*, *Arctostaphysus* spp., *Ceanothus* spp., etc.) dominate.

Potential human modifications to these habitat types and plant-animal associations began with the aboriginal management of plants and animals, followed by historic and modern gold and silver mining, aggregate mining, logging, stock grazing and dairying activities, water reclamation, recreation, and residential development. Mixed conifer forests were harvested with the most intensive cutting occurring ca. 1870s-1906. Stands were re-entered during the 1950s-1970s. It is doubtful that modern plant and animal communities closely resemble their pristine composition due to past disturbance. In former times the area is thought to have supported a luxuriant growth of native bunch grasses which allowed an abundant large game population (deer and antelope) and provided a nutritious source of seeds for use by prehistoric peoples. James (1915:303) commented: "Indeed it used to be a common thing for hunters, in the early days, to come from Truckee, through Martis Valley…and shoot sage-hens all along the way." Oral histories from Native American Elders and with descendents of pioneer families in Martis Valley document a variety of valued medicinal and edible plants. For example, there once was a prolific growth of elderberry, willow (used for basket-making) and a variety of bulbs such as *Allium* spp. (see Appendix A).

PREHISTORY

A large view divides the prehistory of the Sierra Nevada and adjoining regions into intervals marked by changes in adaptive strategies that represent major stages of cultural evolution (Elston 1982, 1986). In broadest terms, the archaeological signature of the Truckee Basin marks a trend from hunting-based societies in earlier times to populations that were increasingly reliant upon diverse resources by the time of historic contact (Elston 1982; Elston *et al*. 1977, 1994, 1995). The shift in lifeways may be attributed partially to factors involving paleoclimate, a shifting subsistence base, and demographic change.

Martis Valley is considered to be the "heartland" for an important archaeological prehistoric complex identified by archaeologists over a half-century ago. The archaeology of the region was first outlined by Heizer and Elsasser (l953) in their study of sites located in the valley. They identified two distinct prehistoric lifeways which are believed to have once characterized the area's early occupants. Subsequent studies have further refined the culture history of the region (Elston 1971; Elston *et al* 1977) and the "Martis" concept, first put forth by Heizer and Elsasser, has since been expanded by some archaeologists to include a larger cultural sphere that has been identified throughout the central Sierra. Its time period extends from at least 1,300 to 4,500 years ago.

Some of the oldest archaeological remains reported for the Truckee-Tahoe Region have been found in the Truckee River Canyon near Squaw Valley. These Pre-Archaic remains suggest occupation by about 9,000 years ago (Tahoe Reach Phase). Other Pre-Archaic to Early Archaic occupation dating from about 7,000 years ago was documented at Spooner Lake (Spooner Phase) near Spooner Summit overlooking Lake Tahoe. The most intensive period of occupation in the region may have occurred at varying intervals between 4,000 and 500 years ago (Martis Phases during the Early and Middle Archaic, and Early Kings Beach Phase during the Late Archaic). The protohistoric ancestors of the Washoe (Late Kings Beach Phase), also of Late Archaic times, may date roughly from 500 years ago to historic contact. Martis Valley falls within the traditional territory of the Washoe Indians, who regard all "prehistoric" remains and sites within the Martis Valley/Truckee Basin as associated with their own ancestry. In support of this contention, they point to the traditions of their neighbors (the Northern Paiute, Maidu, Northern Miwok, etc.), which include stories about migrations and movement, whereas theirs do not (Rucks 1996:6).

WASHOE HISTORY

LAND TENURE AND SUBSISTENCE

At the time of “contact” (ca. 1840s with the onset of incoming Euroamericans), the Washoe homeland encompassed Lake Tahoe and the upper reaches of the Truckee, Carson and Walker rivers; it extended south from Honey Lake, down through Antelope Valley and the West Fork of the Walker River; and it reached eastward to the Pine Nut Mountains in the Great Basin (d’Azevedo 1986; Downs 1966; Nevers 1976; Price 1980; Stewart 1966). Martis Valley was frequented by the northern Washoe or *Welmelti*. These northerners occupied the northern Lake Tahoe Basin, Donner-Truckee basins, Sierra Valley, and the eastern Sierra front north of Carson Valley through Washoe Valley and north to Truckee Meadows (Reno). Ethnographic accounts of northern Washoe in the Truckee Basin are relatively obscure, as compared to their Washoe counterparts at Lake Tahoe and in the Carson Valley. While Washoe settlements are believed to have existed in Martis Valley, no specific place names have been identified. Yet, ethnographic settlements and resource areas are documented in the Truckee vicinity (d’Azevedo 1956; 1984). The historic period press (dating from 1869) reports on a population of Washoe Indians with surprising frequency. Washoe consultants working with anthropologist Warren d’Azevedo (1956 in Rucks in Lindström et al. 2007) identified a relatively unusual concentration of named settlement areas along the Truckee River between Donner Creek and the Little Truckee River, suggesting that there were permanent habitations here. Over-wintering at higher altitudes is reported as a short-term strategy during milder winters.

> [They] Lived there [Donner Creek] all year round—even in deep snow when just the roofs of the *galis dangal* [winter homes] were showing. This was possible because there was plenty of wood there, and also they could gather an abundance of food for winter. [d’Azevedo 1956:54)]

> A number of small Washoe groups in the north maintained their winter settlements in southern Honey Lake Valley, Long Valley, and Truckee Valley. Washoe respondents insisted that such habitation also occurred in eastern Sierra valley and up the Truckee River to Donner Lake in all but the most severe winters, a view supported by James Clyman’s encounter with Washoe in Martis and Dog Valleys in the still severe winter conditions of May, 1848. [d’Azevedo 1984:33]

At least one archaeological site in Martis Valley contains remnant house depressions and archaeological excavations there (Arnold 1957-1958) suggest winter occupation in this cold but relatively snow-free zone (Wilson and Wilson 1966).

As referenced above, the Washoe once embodied a blend of Great Basin and California in their geographical position and so it also goes for cultural attributes. While they were an informal and flexible political collectivity, Washoe ethnography hints at a level of technological specialization and social complexity for Washoe groups, non-characteristic of their surrounding neighbors in the Great Basin. Semi-sedentism and higher population densities, concepts of private property, and communal labor and ownership are reported and may have developed in conjunction with their residential and subsistence resource stability (Lindström 1992).

The Washoe have a tradition of making long treks across the Sierran passes for the purpose of hunting, trading and gathering acorns. These aboriginal trek routes were patterned after game trails and are often the precursors of our historic and modern road systems. The ethnographic record suggests that small groups traveled through high mountain valleys during mild seasons to collect edible and medicinal roots, seeds, and marsh plants. In the higher elevations men hunted large game (mountain sheep, deer) and trapped smaller mammals. As noted above, suitable toolstone (such as basalt) was quarried at various locales in Martis Valley and elsewhere. The Truckee River and tributaries such as Martis Creek were important fisheries year-round and anthropologists describe a pattern of dispersal from winter settlements that was tethered to key fisheries throughout Washoe territory. For millennia native cutthroat trout and a variety of sucker, chub, and “minnow” species were important and dependable staples of the aboriginal diet, especially during annual spawning runs and return migrations in the fall (Lindström et. al 2000). Feeder streams (such as Martis Creek) were the favored fishing locations because “the water was too rough and there were too many bears along the Truckee River” (d’Azevedo 1956 field notes; Rucks in Lindström et al. 2007). Washoe fishing techniques reported along the middle stretch of the Truckee River drainage included fish blinds, where larger fish were speared from platforms, and temporary fish dams, where stranded fish were scooped out of the shallows and tossed onto the bank. Archaeological evidence of these ancient subsistence activities (fishing, hunting, plant collecting, and the acquisition of toolstone) are found along the mountain flanks as small and temporary camps containing flakes of stone and broken tools. In the high valleys (such as Martis Valley) more permanent base camps along water courses are represented by stone flakes, tools, grinding implements, and house depressions.

While there was a tendency for groups to move from lower to higher elevations during the mild seasons, and to return to lower elevations the remainder of the year (Downs l966), a fixed seasonal round was not rigidly adhered to by all Washoe and, as previously mentioned, when conditions were favorable, some groups may even have wintered in Martis Valley (d'Azevedo l986:472-473). While some Washoe trekked to distant places for desired resources, most groups circulated in the vicinity of their traditional habitation sites and appear to have been less compelled in their subsistence pursuit to cover large expanses of land, as was the case for some other groups in the Great Basin. This was due to the large variety of predictable resources close at hand (d'Azevedo l986:472).

Their relatively rich environment afforded the Washoe a degree of isolation and independence from neighboring peoples and may account for their long tenure in their known area of historic occupation (d'Azevedo 1986:466, 471; Price 1962). The Washoe are part of an ancient Hokan-speaking population, which has been subsequently surrounded by Numic-speaking incomers, such as the Northern Paiute (Jacobsen 1966). Later, with increasing encroachment by Euroamericans during the 1860s-1870s, further loss of traditional Washoe camping and resource areas ensued (Rucks in Lindström et al. 2007). Washoes responded with a strategy of accommodation and negotiation voiced through a steady stream of protests and petitions to government officials. Although the Tribe was not federally recognized until 1936, in 1917 Washoes were awarded small tracts of land in Nevada on which to establish residential "colonies." The Tribe filed a case with the Indian Land Claims Commission (Docket 288) in 1951, which was not settled until 1970 when they were awarded five million dollars as compensation for their loss of resources and real estate within a traditional territory that may have covered over 10,000 square miles.

CONTACT PERIOD

Throughout this initial contact period, Washoes survived by trading goods and services to the dominant Euroamerican population (selling baskets, catching fish and game, and working as domestic laborers, wood cutters, ice harvesters, caretakers, game guides, etc.). In exchange Washoes arranged for camping privileges on traditional lands with access to what resources remained (Rucks in Lindström et al. 2007). Traditional plant management continued on the fringe of "white" settlements, but on a very reduced scale. Many established patronage relationships on ranches in the Carson Valley, Truckee Meadows and even Martis Valley. Oral histories with descendents of pioneer families who settled Martis Valley indicate that Washoes maintained contact with their ancestral lands here, at least for awhile. For example, genealogical research conducted by Washoe Tribal Historian, Jo Ann Nevers, documents her extended family ties to Martis Valley. However, there appears to be a "disconnect" in a continuous chain of Washoe occupation here, perhaps due to early mining events (ca. 1863) and logging activities (1860s-1910s), which may have been very disruptive to the maintenance of traditional camps. Cattle ranching and dairying was practiced in Martis Valley from the late 1850s well into the 20th century. Yet, aspects of these ranching enterprises may have been more accommodating to Washoe Indians and oral history accounts seem to suggest that a kind of symbiotic relationship prevailed in terms of mutual resource management and trade relations.

For example, according to Art Tong (in-law relation to Joseph Joerger, Sr.), Washoes caught fish and traded them for milk products "and such" down at the "old house" (Old Joerger Ranch), which was closer to where the Indians lived (Tong, personal communication 2010). Stories of Washoe trading fish for milk are also told by Bertha Joerger Wolverton (granddaughter of Joseph Joerger, Sr.; Cindy Tong, personal communication 1990s-2006). Washoe targeted the prolific patches of onion/garlic that grew in the valley. Native onion and garlic (*Allium* spp.) were roasted in rock ovens, prepared in cakes, dried, and saved for winter food (Rucks, personal communication 2010). Art Tong also recalls that "…there was lots of onion in Martis Valley and that was a reason for Indians to be there…Dairymen had no problem with Indians digging onion…dairymen didn't want cows eating onion because it made the milk taste bad." (Onion-tainted milk was also confirmed in other interviews with descendents of Truckee pioneers including Heidi Euer Martin and Frank Titus, personal communication 2010). Art Tong's great uncle (Harv Tong), who was born in the house at the Old Joerger Ranch, was employed by the Joergers just to ride horseback with the herds and keep the cows out of the onions. Dry Lake was also a favored place to harvest wild onion. In her oral history, Gladys Joerger Gray (great-granddaughter of Joseph Joerger, Sr. and daughter of Joseph E. Joerger, Jr.) states that there were "no" Washoe Indians in Martis Valley, but those who traveled there did so to harvest wild onions.

> Dad has told us that during his time, Indian women used to ride the logging train out to the area near what is now the Airport to dig wild onions, and take them back to town. Even then, I think there were not many Indians in Truckee. There were more at Lake Tahoe, who came for the tourists… Martis Valley had no Indians. [Gladys Joerger n.d.:1]

Another constant problem to ranchers was the invasion of grasshoppers that ate all of the grass, such as occurred to Joseph Joerger in 1879-1880:

> Joseph Joerger…has milked 84 cows this summer, but has made only 6,500 pounds of butter. The grasshoppers destroyed the grass on his ranch so effectually that he drove his stock to Schaffer's place. [*Truckee Republican* 10/23/1880]

While periodic infestations by grasshoppers could be devastating to Martis Valley ranchers, Native Americans viewed the event with good fortune and as the windfall of a valued food source. "Dairymen also liked the Indians to get rid of grasshoppers, because they ate the cow pastures. Indians would beat the ground with willows and drive the grasshoppers into small holes (like a post hole) and then get them out, toast them and eat them" (Art Tong, personal communication 2010).

Field notes of recording archaeologists (Arnold 1957; Norm Wilson, personal communication 1989-2002) indicate that Washoe moved freely through the valley, even into the 1950s. During archaeological excavations in Martis Valley in 1957-1958, archaeologists were visited by a practicing Washoe "doctor" (and his assistant) dressed in the traditional rabbit skin robe (Norm Wilson, personal communication 1989-2002).

HORTICULTURE AND VEGETATION CHANGE

It is simply not known how Washoe horticultural practices influenced the structure and composition of various habitats in Martis Valley. Studies to measure these effects have not been conducted and throughout the historic period, the Washoe have felt restricted from harvesting plants on any but the most sporadic and opportunistic basis. Many hundreds of montane plants were regarded as significant by prehistoric populations (Lindström et al. 2000:38). Women systematically shook mature seeds from the flower heads as they gathered whole plants. Species in which the whole plant could be harvested for food, such as, *Allium spp.*, *Perideridia spp.*, *Lewisia spp.*, *Lilium spp.*, *Calochortus spp.*, and *Brodiaea*, were likely to have been affected by aboriginal horticulture. The distribution and relative density and vigor of this category of plants, especially those which were also harvested for winter storage, may most accurately reflect the effects of harvesting and horticulture for sustained yields. Certain targeted species, especially bulbs, were planted. Stands of plants were pruned, culled and weeded, and the ground surface was cleaned and restored after digging to encourage new growth and maintain beds. The same logic applied to fisheries and wildlife (Lindström et al. 2000:38).

California vegetation evolved with fire, not only to tolerate it but some species even require it. This relationship may have, in part, been influenced by millennia of micro-burning by Native Americans. The efficiency and scale of this practice would have varied with the climate and the fuel loads. There is some evidence that Washoe people deliberately set fires in the forest or valley (Lindström et al. 2000:40). Intentionally set fires were strategically timed and placed, such that native burning extended the range, increased the frequency and altered the timing of the natural fire regime. Fire setting practices concentrated around camps and inside prime meadow resource catchments. Systematic and localized micro-burning by Native Americans would have kept down fuel loads, resulting in low intensity fires that may not have left telltale fire scarring on trees. The data are unclear at this point, but they raise questions regarding Native American influence on historic fire regimes (Lindström et al. 2000:41).

The Washoe Tribe has developed a Comprehensive Land Use Plan (Washoe Tribal Council 1994) that includes goals of reestablishing a presence within the Truckee-Tahoe basins and re-vitalizing Washoe heritage and cultural knowledge, including the protection of traditional properties within the cultural landscape and the harvest and care of traditional plant resources. Plans include the re-introduction of traditional plant gathering practices by Washoe people and the collection of oral histories relevant to land use, resource use and management, diet, social and economic history, organization, and beliefs (Rucks 1996:3). The issues are not simply the presence or absence of traditional plants, but their vigor, their environment, and their physical attributes. (Ethnobotanically important plants of the north-central Sierra Nevada are listed in a number of sources; see Table 1 for a compilation). Revegetation projects initiated by the Truckee River Water Council in the Martis Watershed should consider the propagation of culturally important plant species whenever appropriate.

EUROAMERICAN HISTORY

Several themes dominate historic period events within Martis Valley (or “Murtis Valley” as shown on the 1865 General Land Office survey plat): transportation, mining, logging, ranching and early settlement, ice production, and recreation and residential development. The mouth of Martis Creek (also known as “Martys Creek”) at its confluence with the Truckee River was witness to the first emigrant trans-sierra crossings in the 1840s and 1850s, the first transcontinental railroad in the 1860s, and the first transcontinental auto road in the 1910s. This locale (historically known as Martis Creek Station) was strategically positioned along this historic transcontinental and trans-sierra transportation and communications corridor, especially with regard to wood, water, and recreational resources, which were to become the essential economic bases of Truckee.

After the passage of emigrant wagons during the mid 1840s and 1850s, little is known about actual settlement of the Truckee Basin until the early 1860s. Between 1863 and 1867, the Truckee Basin went from a wilderness to a major frontier “urban” center. Events in Martis Valley are tied to the history of the community of Truckee. The town's beginnings are marked by the arrival of Joseph Gray, who built a stage station near the present-day downtown in l863. This tiny way station (known in 1864 as Coburn’s Station) grew from two structures into a thriving town that accommodated emigrants, stagecoach travelers and freight wagons in route westward to

California's gold fields and eastward to the Comstock Lode in Nevada. In 1868 Coburn's Station burned and the name was changed to Truckee. The completion of the transcontinental railroad through Truckee in l868 (and across the nation in 1869) gave rise to continued developments in the transportation, lumbering, ice, agriculture, and dairying industries. By the 1920s the old industrial economy had largely disappeared, due in major part to the relocation of the train switching yard to Roseville, the depletion of local timber supplies, and the development of mechanical refrigeration. In its place, the community began to develop a recreation-based economy.

MINING

A brief flurry of mining was staged out of Martis Valley. In the summer of 1863 a number of quartz ledges were discovered in Martis Valley. In May of 1863 General J. F. Houghton and Butler Ives (Commissioner of the Nevada Territory) began their survey of the California-Nevada state line, which took them due east of the Truckee Basin and through Martis Valley. Two members of the survey party found the promising ledges in May 1863; they deserted the survey party and started mining operations (Richards 2004:A4). A reporter accompanying the J. F. Houghton and Butler Ives survey of the California-Nevada state line was the first to report news of the mining excitement.

> On inquiry we found that the mineral region thereabouts was already quite extensively developed. Shafts and tunnels were under way in the vicinity of our old camp ground, then a romantic mountain plat, not the site of a surveyed, though by no means finished, town to be called Modiosho – which is Washoe for quartz. There are two districts organized – the Red, White, and Blue, and Squaw Valley – together containing more than a hundred ledges of very uniform looking quartz, the assays of which are from $6 to $98 a ton. Neptune City, near the Neptune ledge, five miles northwest from Agate Bay, appears to be the most promising neighborhood, having already opened several drinking shops, and eating house [sic], barber's shop, butcher shop, etc., for the accommodation of a population of from forty to fifty persons. The Truckee has been bridged. A third new town, the name of which I have not learned, has been surveyed. A quartz mill is to be put up immediately; water privileges, and timber ranch claims have been located. Many El Dorado and Sacramento people are largely interested at Squaw valley [sic] and Neptune City, but the Tahoers and Washoers are in the majority at Modiosho. These discoveries are on the line of the Dutch Flat wagon road, and are not far from the route of the Pacific Railroad. [*Sacramento Daily Union* August 26, 1863]

The diggings in Martis Valley, known as the Red, White, and Blue Mining District, were named in symbolic support of the North in the Civil War (Schegg 1993:3). The initial focus of mining was along Middle Martis Creek where miners dug "coyote holes" and started shafts and tunnels. The "Lost Dutchman's Mine" was located on the north side of Mt. Pluto and a 364-long tunnel was dug near the headwaters of Juniper Creek (Richards 2004:A4). Original assays of Martis Valley rock were reportedly worth between $500 and $7,000 per ton.

Within a few days of the discovery, "hundreds" of miners descended on the diggings (Scott 1973:150) and by July 1863, 700 miners had populated the district (Richards 2004:A4). The settlements of Knoxville and Claraville were established on the Truckee River near its confluence with Squaw Creek. Modiosho, located near Brockway Summit on the trail that would become today's State Route 267 (SR 267), was later referred to as Centerville (Richards 2004:A4). Neptune City, located three miles down the trail from Modiosho and near the Middle Fork of Martis Creek and the entrance to today's Northstar-at-Tahoe, was later known as Elizabethtown. These early mining camps are shown on the 1865 General Land Office survey plat (Township 17 North, Range 17 East, Sections 28 and 33), where Elizabethtown is marked by at least 13 buildings in north-south alignment along the west side of the road, to include a "Blacksmith Shop" and "Store." With a population of 50 people, Elizabethtown became the hub of the district. By July 1863 it boasted several saloons, an eating house, barber shop and butcher shop, along with makeshift shelters of small logs and canvas-covered brush shelters. As a member of the Josiah Dwight Whitney's government geological survey (1860-1864), William H. Brewer wrote of the boom and bust towns he visited in Martis Valley in August of 1863:

> We struck over a ridge…crossing a high volcanic ridge and sinking into a new mining district which is just starting…people are pouring in. As we went down a canyon we passed numerous prospecting holes, where more or less search has been made for silver ore. Since the immense wealth of the Washoe mines has been demonstrated, people are crazy on the subject of silver. We passed through the town of Centerville, its streets all staked off among the trees, notices of claims of town lots on trees and stumps and stakes, but as yet the town was not built…Three miles below is Elizabethtown, a town of equal pretentions [sic] and more actual houses, boasting of two or three…The miners have camps – generally some brush to keep off the sun and dew; but as often nothing. Some blankets lying beside the brook, a tin kettle, a tin cup, and a bag of provisions tell of the home of some adventurous wandering man…The crowd – only men (neither women nor children are here yet)…
>
> …Six weeks ago…there were but two miners here; now there are six hundred in this district…There is great excitement here – and many think it a second Washoe. Some money will be sunk here before it can be known what the value will be. I have but little faith in it myself. I surely would not invest money in any mine I have seen today, and I have visited eight or nine of the best. [Brewer 1974:444-446]

The strike was over by September 1863 (Scott 1973:147-150) and by the end of the year mining towns were deserted. On the 1874 Von Leicht and Hoffmann map "Elizabethtown" is depicted as four buildings located on both sides of the road and it is described as "deserted." "Elizabethtown" is captioned on the 1876 Wheeler map as "abandoned." The 1897 map of Placer County depicts at least 10 buildings covering both sides of the road. Saloons, eating houses, bakeries, butcher and blacksmith shops, and log houses were abandoned along the Truckee River along East Martis Creek, and in Monte Carlo and Klondike Meadows.

> About five miles from Truckee, on the Hot Springs road to Tahoe, may still be seen the ruins of abandoned log houses, many of them apparently, having been built of hewn logs, and put up in good style. These houses once constituted the bustling and

> flourishing city of Elizabethtown, in the Red, White and Blue Mining District. [Edwards 1883:100-101]

In January 1873 (and for decades after) there was talk of reopening the mines but no real investment was ever made (Richards 2004:A4). The mining fiasco brought, in its aftermath, a significant influx of people into the area. It ushered in the settlement of Tahoe's north and west shores, as the disenchanted miners shifted their attentions to the other resources of the Truckee-Tahoe basins.

In terms of mining geology, the area north of Lake Tahoe and in the Truckee Basin is characterized by volcanic activity with massive andesite flows with andesitic tuffs and breccias. In some places zones of bleaching and silicification are impregnated with pyrite that contains traces of gold and silver (Clark 1970:125). Mining was carried out on an exploratory basis and no ore bodies of any economic importance were found (U.S. Geological Survey: Geological Atlas, Truckee Folio 1897). Even though the event was so brief, it still left little lasting mark on the landscape. Mine exploration pits, adits and tunnels (representative of hard rock mining during this early era) have been recorded in the hills surrounding Martis Valley. While the focus of mining was on hard rock mining and silver ore, it is probable that some industrious miners in a search for free gold washed down from these ore deposits also engaged in limited placer mining along Martis Creek and the Truckee River where stream gravels were disturbed and displaced. Placer mining features are present near the mouth of Martis Creek. The deposits along Martis Creek were shallow bench gravels. Bench placers were usually remnants of deposits formed during an earlier stage of stream development; these upper benches became elevated (even if only slightly) as the stream cuts downward. Many of the larger bench deposits were worked by hydraulicking, and smaller ones (such as those present in Martis Valley) were worked by ground sluicing or shallow placer mining (e.g., pans, rockers, long toms, and sluice boxes).

> In the Martis mining district the board-sluice, comparable to a long shallow-sided wooden trough was in common use due to the plentiful supply of water found in ravine and canyon. [Scott 1973:148]

Ground sluice mining penetrated deeper into the bench gravels than any of the other shallow sluicing techniques. The intent was to reach bedrock, since gold deposits typically are richest in the contact zone between the overlying gravels and bedrock. A natural or artificial water channel was used to start the operation. While a stream of water was directed through the channel or cut, the adjacent gravel banks were brought down by picking at the base of the bank and by directing the water flow so as to undercut the bank, aiding in its caving. A substantial water flow and adequate bedrock grade are necessary. Forks and shovels were used along the sluices to loosen and throw out larger cobbles and pebbles that were not moved along by the water. Cobbles removed from the ground sluice trench were stacked vertically on ground along the edge that has been worked. In time a low cobble wall was formed, which served both as a retaining wall (impounding other cobbles tossed behind it) and as a water diverting device (directing the flowing water to the base of the cut bank to facilitate erosion). The gold was collected from the rock layers or block riffles in the bottom of the ground sluices. Wooden sluice boxes were sometimes attached to the bottom end of a ground sluice to enhance gold retrieval. Otherwise, the gold was allowed to accumulate on the bedrock awaiting subsequent cleanup.

TRANSPORTATION

In 1863 surveys for a trans-sierran wagon road commenced, not only in support of the railroad, but as a road connector between the Mother Lode and the Comstock. One alternative route was charted through Martis Valley and along the later routes of the Old Brockway Road and modern State Route (SR) 267 (*Sacramento Daily Union* 8/26/1863; Schegg 1993:3). In August of 1869 Truckee stage owner William "Billy" Campbell and sawmill owner George Schaffer privately began construction of this new wagon road between Truckee and Lake Tahoe (Scott 1957:319) along the same route of the proposed 1863 wagon road. The turnpike (also known as the Truckee-Hot Springs Road) commenced from Truckee's transcontinental railroad stop and went eastward across the river into Martis Valley, over Brockway Summit, and on to Brockway Hot Springs. With a crew of laborers and mule and horse-drawn graders and wagons, the job was done in a month. Schaffer was motivated by the need for a timber haul road to access stands along the Tahoe Divide in the vicinity of his mill on Martis Creek (Edwards 1883:94). The logging interests of the Richardson Brothers' were also served as the historic road junctioned with their sawmill spur near Middle Martis Creek. The Old Brockway Road is first shown on a General Land Office Survey Plat from 1865. It appears on historic maps thereafter, being listed as an "improved [dirt] road" on Metskers ca. 1938 map. Improvements along this transportation corridor opened the door for the development of the Truckee and Tahoe basins. By 1883 Edwards (1883:94) in his *Tourist Guide to the Truckee Basin*, described planned improvements on portions of the Truckee-Hot Springs Road to put the road in "first-class turn-pike order." These upgrades within the SR 267 corridor were undertaken simultaneously with upgrades along present SR 28 (along Tahoe's north shore) and on SR 27/431 (over Mt. Rose). The paving of Highway 267 between Truckee and Kings Beach in 1963 really opened the North Tahoe area. Previously, the road was a rough gravel surface (Lindström and Waechter 1996).

A number of secondary and tertiary roads traverse the Martis Watershed. The roads accessing Sawmill Flat and the Old Shaffer Mill Site are shown on a 1897 USGS Truckee Sheet topographic map. These roads accessed some of the earliest logging within the project area. A U.S. Forest Service map dating from 1921 shows the road to the Old Shaffer Mill site being extended southward and over Sawtooth Ridge and down Deer Creek to the Truckee River. The 1926 versions of the U.S. Forest Service map depict a road following along the divide between Brockway Summit, Sawmill Flat, and Mt. Pluto, and traveling down Deer Creek to the Truckee River. By 1940 a road connecting Sawmill Flat and Tahoe City appears on a USGS Truckee Quadrangle. This connection allowed the Floriston Pulp and Paper Company to transport wood down to their siding along the Lake Tahoe Rail and Transportation Company railroad, and ultimately to the main rail line at Truckee and to their mill on the Truckee River. The 1955 USGS quadrangle covering the area shows a road along the headwaters of the West Branch of Martis Creek, southwest of Sawtooth Ridge. A 1962 U.S. Forest Service Map shows the beginnings of modern logging road development around Sawmill Flat and Mt. Pluto. The 1969 photo revised versions of the 1955 USGS quadrangles depict a dramatic increase in the number of logging roads along the flanks of Mt. Pluto and Lookout Mountain. These roads were probably constructed by the Fibreboard Corporation during later period logging in Martis Valley.

Additional logging roads appear on the 1978 U.S. Forest Service topographic maps of the area. Northstar Ski Area facilities are depicted on the 1985 U.S. Forest Service topographic maps.

Evolution in the development of these road systems can also be traced on early aerial photographs. Ranching roads appear on aerial photographs dating from 1939, with progressively more roads, along with a network of stock trails, showing on the 1952 and 1966 aerials. A sharp increase in logging roads and landings appear in forested areas on the 1966 aerial photographs.

LOGGING

Logging was first initiated in the Truckee area after the discovery of the Comstock Lode in l859. When production began to fall in the mines in l867, the lumbering business also began to suffer. A new market for lumber was found in the Central Pacific Railroad (CPRR, later Southern Pacific and now Union Pacific Railroad). As the rails reached Donner Summit in l866-1867, a number of mills established operations in the Truckee Basin to supply the railroad with cordwood for fuel, lumber for construction and ties for the roadbed. Truckee (then known as Coburn's Station) soon became one of the major lumbering centers. Over 18 sawmills were operating in the Truckee area during the late l9th century. Until around the turn of the century, demands for large saw logs and cordwood targeted pine species for the production of timbers for the mines and the railroad. As timber markets were gradually expanded with the completion of the railroad, a growing emphasis was placed on the production of other wood products. The expansion beyond saw milling targeted such facilities as planing mills, box factories, sash and door establishments, a chair factory and furniture factory, shingle mills, and charcoal earthen and brick kilns.

Logging Technology

There was a smooth, logical flow of material from the woods to the mills to the consumers. The potentially great distance between the wood resource and its point of consumption prompted the innovation of a variety of transport techniques. A labyrinth of railroads, roads, trails, and flumes formed a tiered network along mountain slopes. This system was marked by a series of wood camps and mills that served as strategic staging points to facilitate the progressive movement of wood. As logging extended farther into the mountains, the transport of timber presented significant problems for the lumbermen and Sierran loggers were forced to devise ingenious methods of employing water, animal, and steam power to move bulky and heavy products through steep terrain from the harvest site to the mill. The suite of logging techniques brought by loggers from Canada and the northeastern United States was adapted and amplified to an unprecedented scale. The accelerating demands for wood products and the awesome size of the western conifers called for logging methods on an equally heroic scale.

The few small sawmills established in Martis Valley during the late 1860s prefaced the large-scale logging to come. Clear-cut logging commenced in the Martis Watershed in the early 1870s with the arrival of larger lumber and fluming companies stoked with capital to finance and establish a network of logging railroads, wagon roads, V-shaped flumes, water storage reservoirs, and associated wood camps and mills. Lumber company records, supplemented by the archaeological remains of logging activities, reveal where and when anthropogenic disturbances occurred. History and archaeology delineate the sub-watersheds where logging disturbances were relatively short-lived (lasting perhaps a single season) as well as locales that endured intense impacts for decades and the areas that escaped impacts altogether. The scale and intensity of historic logging, as well as the timing of harvest, was not uniform. The progression of harvest was tied to the proximity and accessibility of timber stands and harvesting strategies were tailored to suit varying wood markets. Logging techniques of the day relied heavily on cross-country skidding, which would have had damaging effects on existing young growth and thus on future stand regeneration. Environmental degradation was compounded by the erosion of soils. The compaction of soil and the destruction of humus resulting from historic activities in and around wood camps may have created artificial openings that have survived for over a century. Clear-cutting on hillsides accelerated erosion, releasing sediment loads into the streams. Intensive logging probably left forests fragmented and contributed to the decline and/or extinction of birds and mammals requiring structurally complex forest habitat (Elliott-Fisk *et al.* 1996). In light of the above, a summary description of some of the technological aspects of historic timber harvest, transport and processing, and water supply engineering are presented. The discussion draws heavily from sources that document logging techniques from other times and places (Berry 1917; Brown 1934, Bryant 1913, Edwards 1883; Goodwin 1971; Simmons 1951) and from more recent syntheses on historic lumbering technology (Lindström and Hall 1993, 1997; Lindström in Waechter *et al*. 1995; Waechter, Costello, Lindström, and Bloomer 1995). Three major eras in logging technology are represented within the Truckee-Tahoe basins:

(1) animal logging - animal power is the dominant mode but water and steam power in wood processing and steam in wood transport are also employed (1860s-1890s)

(2) steam logging - steam power is the dominant mode but animal power is also employed in wood transport (1890s-1930s); and

(3) diesel logging - diesel (and electrical) power is the dominant mode but steam is also employed (1930s to present).

Wood Harvest

Timber was harvested selectively with specific markets in mind. Clear cutting was not necessarily practiced. While large pines were economically superior for general purposes, specialized and selective timber cutting was carried out for cordwood, pulp/paper wood, charcoal, shingles, lath, boxes, sashes/doors, etc. (Knowles 1942:45). Felling was done entirely by hand, with an ax for the undercut and a two-man-cross-cut saw for the back cut. Directional falling allowed logs to be removed most easily. After it was felled, the tree was limbed by ax and buckers then sawed it into log-lengths. Logs were bucked into lengths according to cutting specifications for marketing the various wood products (Simmons 1951:47-63). Defective or "cull" wood was left in the woods. Likewise, crooked logs and forked logs were usually abandoned, as they were more expensive to handle both in the forest and the mill (Bryant 1913:101).

It was fatiguing and inefficient for fallers to lean over to cut stumps near ground level (Brown 1934:91; Bryant 1913:95). Spring-boards served as platforms on which notchers and fallers could comfortably stand and get above the root swelling or defective and pitchy butts and debris and deadfall (Brown 1934:124; Bryant 1913:83,92). Spring boards were 2 by 8 and 3 by 8 inch boards with a sharp tongue. The metal tongue was thrust into a notch cut into the tree. Standing on the outer end of the board forced the tongue into the wood to prevent the board from slipping. Early loggers cut very high stumps, typically over three feet tall. Excessive amounts of timber were wasted in this manner. Remnant stumps from mid-20th century logging mark the archaeological landscape within the project area and typically range between 18 and 24 inches high, with modern cut stumps measuring less than 12 inches (Parsons, personal communication 1995 in Lindström and Waechter 1995).

Cold-weather wood cutting practices are amply documented for the Truckee Basin. George Schaffer continued logging through the winter (Coates 1995). The varying height of historic high-cut stumps in the area is one indication of cutting over the snow. Here, logging activities were at their height in midwinter (*Truckee Republican* 1/25/1879, 2/26/1879). Occasionally, unseasonable winter rains interfered with winter logging operations, and severe snowstorms temporarily halted winter logging and cutting at the wood camps (*Truckee Republican* 1/10/1880, 2/25/1880, 3/27/1880, 3/31/1888). Under most conditions, winter logging offered several advantages to the lumberman. Haul roads were more easily and cheaply constructed for winter use. Certain timbered areas became more easily accessible during winter. The snow facilitated the transport of logs, as snow was compacted to solid ice under their weight. Equal loads could be pulled with less energy in winter, either hauled directly over the snow or on wood sleds (*Truckee Republican* 1/7/1880, 1/24/1880). In the case of railroad logging, logs were banked along their narrow gauge track for immediate transport to the mill as soon as the railroad opened in the spring (*Truckee Republican* 3/8/1879, 4/2/1879, 4//9/1879, 1/21/1880, 1/31/1880, 3/13/1880, 5/8/80). Other logging outfits hauled logs over the snow and deposited them on ice-covered mill ponds, ultimately to fall in the water with the spring thaw (*Truckee Republican* 2/8/1879). The lumberman gained further advantage by winter logging, as trees felled on the snow fractured less than when felled on bare ground (*Truckee Republican* 2/15/1879). Logs check least when cut in the autumn or winter, as the water content evaporates more slowly (Bryant 1913:85, 88). The likelihood of sap stain and insect attack is also the least when timber is cut during the dormant season (Bryant 1913:85, 87). Winter felled timber is less subject to serious damage by insects and fungus (Bryant 1913:88). Pinesap is down in the winter and it is less likely to clog-up crosscut saws during cold-weather cutting. In the case of cordwood harvest, bark is retained best on winter-cut wood and cold weather cutting facilitated fuel wood handling (Edwards 1883:74-75): "Most of the new contracts let by the [Central Pacific] railroad company specify that the trees must be cut in January, February and March when the sap is down, to prevent the loss of bark, which makes quite an item in a year's supply" (*Truckee Republican* 1/21/1880).

Wood Transport

Logs cut in the woods were hauled by railroads, wagons or sleds, or dragged in skid trails or dual log chutes down to centralized collection areas. Cordwood was packed out by mules or rafted down from the backwoods in flumes.

<u>Haul Road</u>. The logs were hauled on heavy wagons built on the site. Wheels were made of solid sections of logs, 50 inches or so in diameter, with hand-forged iron rims and axle fittings and a maximum capacity of nearly six tons (Galloway 1947:78). Oftentimes, hauling teams were mixed, with two or four oxen stabilizing the tongue of the wagon and

from 10 to 12 horses or mules hitched ahead of the oxen (Galloway 1947:93). Logs were commonly loaded by means of the "cross haul." Loading was accomplished up inclined log ramps, located on the opposite side of the wagon from the animal power. The most economical roads were built directly in the bottom of a drainage (Simmons 1951:131). The disadvantages of side-hill roads lay in balancing the amount of cutting and filling required to maintain road grade, the rock work needed to stabilize the grade, and problems with drainage and slides. In road layout, bogs or flats, springs, and non-established stream crossings were avoided if possible (Bryant 1913:190). Haul roads were engineered for maximum uphill grades of 10% to 12% (vertical rise of 10 to 12 feet in 100 feet of road) and downhill grades of 15 percent, with a minimum width of 10 to 12 feet.

Skidding. Longer distances were covered more economically by skidding on the ground, where the soil was free from rocks and debris that would hinder the movement of logs. Bryant (1913:230) refers to skid trails as earth or ground slides. A good lay-out for gentle slopes involved straight trails with moderate curves. Steeper slopes required zig-zag trails to reduce grade and prevent logs from sliding into the heels of the team. Rocky ground and dense timber or brush was avoided when possible and minor improvements in the trail were often necessary. Special skidding equipment consisted of a 10- or 12-foot chain with a slip hook in one end and a stout whiffletree with clevis and swivel grab hook. Many devices have been developed to reduce friction and make logs easier to skid. One of the simplest ways was to round off the front end of the log with an ax or slightly lift the leading end. A variety of wood sleds were developed to carry the front ends of logs in skidding over dry ground or over snow. Log skidding was also assisted by a "high wheeler log drag" (Scott 173:151). This device allowed saw logs to be chained to and slung under an axle that connected two giant spoke wheels. The log, lifted only slightly above the ground surface, was then wheeled to the mill or centralized collection point.

Log Chute. Log chutes were used chiefly for transporting logs, although pulpwood, crossties, firewood, etc., were also moved in this manner (Bryant 1913:320). Log chutes and adjacent horse towpaths were usually built along side hills or creek bottoms and below the area to be logged. Orr (1918:3, 6, 7, 9) describes aspects of their construction in his "Logging Chute Study on the Plumas National Forest." A shallow trench was excavated and the dual logs (or "chute poles") were rolled inside and anchored to the ground when necessary. Once the chute poles were put into position, they were ballasted by shoveling dirt and rocks along the outside. When the chute was in place, the inside of each pole was hewn so that the logs rode smoothly and stayed on the poles. Spool posts (20 to 30 inches in diameter and five to seven feet high) were used on curves to hold the main line close enough to the chute so that the logs were not pulled out. Trestles and cribbing was sometimes necessary over ravines, on steep hillsides, around rocky points, and across low swales or boggy ground. To reduce friction during the summer season the trailing stretches were watered or greased. During the cold season such stretches were iced by throwing water on them at night (Bryant 1913:239). The “chute greaser” placed grease on the chute. He usually rode on the first log in the trail and dabbed on the grease while the logs were in motion. The spools were oiled periodically. The up grades and level portions of the chute required the most grease. Many barrels of grease were required.

Logs were loaded into chutes with a peavey, or spiked pole. It was possible for two men with broad axes to hew 276 feet of chute in one day. If pine was used in chute construction, it was generally taken up upon completion of the chute and utilized for saw logs (Brown 1934:21). Edwards (1883:24-25) provides a description of early log chutes ("logways" or "horse railways").

> An ordinary chute is composed of two logs, lying side by side, imbedded slightly in the ground...Four men and four oxen can lay a quarter of a mile in a day. Timbers for saw logs are cut from trees 18 inches in diameter and upward. Timbers for chutes are cut from trees averaging from 13 to 14 inches in diameter, and are about 40 feet long. At the small end they are frequently not over 10 inches. Laid parallel, about six inches apart, the small ends notched into the butts of the next sticks, the inside faces being hewn smooth and greased with tallow, the horse-chute is complete. A boy with a pail of warm tallow and a swab, greases them twice a day...The chute is so cheap that branches can be extended in any direction into the forests...The teams bring the logs into the chute, and four horses hitched tandem, draw them...The driver rides the last or wheel horse. A hook is struck into the hind end of a log which [sic] has three or four other logs in front of it, and the horses are hitched to the hook. No strain is required. The saw logs are peeled of their bark, the chute is greased, the grade is descending, and the horses driven by a check-line, have to go at a lively trot to keep up.

> Down these tracks or troughs are slid huge logs. When the troughs are steep, the logs rush down at more than railroad speed, leaving behind them a trail of fire and smoke. Such log ways are generally to be seen about the lakes, and are so contrived that the logs leap from them into water of great depth, as otherwise they would be shivered to pieces and spoiled for use in the manufacture of lumber (DeQuille 1877:240; 1974:175).

At various points along the Truckee River, logs were dragged for miles through the forest east of the divide and dropped down from the bluffs along Sawtooth Ridge into the river in long "dry chutes." In 1877 the Truckee Lumber Company operated eight chutes (Knowles 1942:20). Later, the *Reno Evening Gazette* (in Scott 1957:14) reported that a total of 30 chutes, the longest one three miles, were in use on the river, and loggers were constantly on the watch for fire from the whistling logs smoking down the terminal chute. In these dry chutes, logs moving up to 70 mph and traveling 100-200 feet per second plummeted into the river for the downriver drive. Company operations along the bluffs above the Truckee River were reported in the *Truckee Republican* during July of 1873 (Scott 1957:14):

> Up river from the Truckee River Lumber Company's double mill, bluffs run back above the gorge a full half mile into the heavy stands of timber. Here high line logging camps are established, each camp consisting of the gang boss, a forty-odd man crew of fallers, trimmers, teamsters, swampers, a blacksmith, cook, tallow boy, and draft animals. French-Canadian lumberjacks are dropping the mammoth six- and seven-foot-through sugar pine, averaging one down every three minutes, and the great forest kings are crashing in every direction. Before the dust even settles around a fallen monarch, a swarm of trimmers are cleaning off the limbs. The air resounds to the monotonous rasp of two-man hand saws, the sharp ring of double-edged axes, and the long-drawn-out `wheehoes' of the bullwhackers and

> skinners. Through the din may be heard the steady grinding rasp of the heavy log sections as they are dragged onto the feeder ramps preparatory to starting their run down the mountainside. When three to four logs have been positioned in the upper logway, a team of six, hitched in tandem by a `chain gearing,' moves in with a `breaker' riding the wheel animal. A large iron hook is faced into the butt of the last log in the chute, secured by trace-chains to the horses or mules.
>
> With the sharp crack of the buckskin lash's `popper' the team is off at a trot toward the edge of the steep bluff, pulling eight tons of logs easily down the greased chute. The tallow boy is running up and down the sides of the trough, slopping brushfulls of animal fat onto the running surfaces. At the top of the precipitous fall to the river, the hook is thrown and the logs plunge over the rim of the canyon wall and down the chute. This is accomplished without stopping the team or breaking their gait.

Archaeological evidence of such a dry chute (or gravity flume) remains on the steep talus slope along the east bank of Martis Creek, about ½-mile south of its confluence with the Truckee River. This gravity flume dumped wood (probably shingle bundles) from Juniper Flat and into Martis Creek in much the same manner as described above for Sawtooth Ridge and the Truckee River. Gravity flumes operated on steep slopes much like a chute or slide, without the aid of water to transport wood.

<u>Animal Draft Power</u>. Loggers operating in remote areas found the ox more desirable than the horse or mule, because it could live on coarser feed, draw heavier loads, and stand rougher treatment (Bryant 1913:129). Oxen were not as fast as horses and mules but they were strong and dependable; horses were best for fast loads and hauling that required more intelligence (Simmons 1951:73-75). Eight or 10 oxen could be handled by one teamster, while only four or five horses or mules could be worked by one man. Oxen could be used in cold weather without danger, but suffered in warmer weather; mules and horses could stand more heat. For summer use shoes with low, flat calks gave a firm footing under most conditions. In the winter longer, sharper calks were needed. A draft animal at hard work required a certain amount of concentrated food containing protein, carbohydrates, and fats (grains) along with rough material (hay) to give bulk to the ration. Horses and mules have smaller stomachs and less power to digest foods and had to be fed smaller amounts at more frequent intervals and could not return to work immediately after eating. Oxen were fed only once a day; they are ruminants and can regurgitate their food and chew it at will (Bryant 1913:133). A horse weighing about 1500 pounds needed about 24 pounds of hay and 18 pounds of oats per day.

<u>Railroad Transport</u>. Horse-drawn tramways were precursors of the narrow-gauged logging railways; these were quickly replaced by steam engines and more durable rolling stock. Logging railroads were not built with the same care or precision as were standard gauge passenger and freight lines that were meant to be permanent. Rod locomotives were used for the longer hauls on main-line roads. The maximum grades ordinarily employed for rod locomotives were 5% empty and 2% loaded. The maximum curves used were 30-40% for narrow gauge. The usual maximum curve for narrow gauge spurs was 50-60%. Early locomotives were powered by steam and used slab wood or white fir cordwood as fuel. Grade construction involved survey, clearing, stump/rock

blasting, and grading with pick and shovel. Cedar ties lasted considerably longer than fir ties.

Steam Donkey. Between the 1890s and the 1930s, most large-scale companies in the Truckee Basin logged with steam donkey engines (Ayres 1958:35-37). These steam powered skidding machines were equipped with wire ropes and drums for low lead hauling, pulling logs by cable fastened to the stationary donkey engine. Oxen and horses continued to play crucial roles, shifting the line and hauling fuel wood, water and supplies that were not available onsite. The engine was mounted on skids so that it could move itself around with its drum winch and cable. Subsequent improvements on the design and power of the steam logging engine and improvements in the quality of the steel rope made it possible to skid larger loads at longer distances.

Ayres (1958:38) describes a typical donkey logging layout as it existed around 1907. Three different types of steam donkeys might be used. A bull donkey was the main haul engine, pulling logs from a distance of 1000 to 4000 feet along a main log chute to the mill or railroad. At appropriate places along the main chute, smaller yarding donkeys were placed to haul logs from the stump to the main chute, a distance of 200 to 1800 feet. Felled trees were yarded to the logways in tree lengths and then sawed into log lengths by steam saw, which was powered by steam from the yarding donkey. When enough logs were collected in the chute at a yarder to make a trail, the last two logs were dogged together and the outer end of the main line was attached to the next to the last log. Swing donkeys were positioned close to the yarding donkeys to take logs from the yarder and place them into trains along the main chute. The trail of logs was then pulled through the log chute by a large bull donkey into the landing.

Steam Tractors. Where terrain was level, huge steam tractors were employed to pull heavy wagons loaded with logs or cut lumber. These were large (up to 29 tons) three-wheeled steam tractors that pulled loaded wagons (Jackson 1982:105). Water tanks to replenish the tenders of the steam wagons were erected all along the haul routes (Goodwin 1960:35C).

V-flume. There are basically two kinds of flumes, the box flume and the V-flume. The conventional box flume and its variation the U-flume are covered and uncovered wooden boxes, respectively, used to transport water by gentle gravity flow from one location to another. The V-flume was developed out of a simple modification of the traditional box flume. To form the V-flume, rough planks were joined at an angle of 90 degrees, and the trough thus made was lengthened by the junction of similar abutting sections (Galloway 1947:87). The flume was laid on the ground with simple wooden props and supported by trestle-work when ravines were crossed. V-flumes could be built of any length. They could be constructed piecemeal, up or down a canyon as cutting advanced. Similarly, flumes were dismantled and the wood was salvaged and recycled into the construction of each successive flume. V-flumes were generally constructed at steeper angles than box flumes and the falling water generated great speed and power, carrying wood and lumber right along with it. V-flumes were engineered to operate on a regular grade, usually about 20% or 20 feet to the hundred (Galloway 1947:87). The grade was maintained by following a meandering course, building trestle-work and excavating cuts. Curves were of large radius. Flumes could transport lumber up to 16 inches square and 40 feet long. Lumber, shingles, and cordwood were transported via V-flume along Martis Creek to processing facilities at Martis Creek Station.

Wood Processing

Industrial Towns and Sawmills. Processing of timber products was accomplished at a few large water and steam-powered mills, like those operated by George Schaffer and the Richardson Brothers in Martis Valley. Mills were strategically located at converging points of key wood and water conveyance features. Their tactical placement within timber catchment zones afforded the maximum lumber output with minimum transportation costs. In this regard, the costs of hauling mill machinery were weighed against the costs of transporting saw logs or finished wood products. Large lumber companies operated boarding houses and general stores in connection with their logging and milling work. Since it was to their advantage to have the trade of their employees, cash was paid only on specified pay days and employees obtained credit at the company store or for lodging. This tended to keep trade within the company (Bryant 1913:49).

Wood Camps. Mill sites were directly served by a series of wood camps, which were key locales for initial and final wood processing and transport. Factors governing base camp location included: (1) a central location to timber (it was not considered profitable to walk more than 1½ miles from camp to work), (2) level and well-drained soil, and (3) proximity to a pure water source (for drinking, cooking, laundry, stock watering, but away from insects; Brown 1934:63; Bryant 1913:56). Large base camps comprised an office/store, cookhouse, and bunk house. Spartan furnishings consisted of benches, drinking water barrel, a tin washbasin, heating stove, grindstone, and wires for drying clothing and harnesses, which were suspended over the cast iron stove. Bedding consisted of straw or hay mattresses incorporating cedar to deter insects. Tools were stored indoors at night to prevent rodents from gnawing on wooden handles, salty with sweat (State Historical Society of Wisconsin 1975:11-12). Outbuildings included a stable, storehouse, and blacksmith shop (Brown 1934: 60-61; Bryant 1913:58).

Satellite wood camps were much scaled-down versions of base wood camps. Buildings were of rough crude construction and characterized by few comforts (Brown 1934:60-61). Log structures had sloping roofs that came close to the ground with walls only three feet high. Shake roofs were covered with clay and then branches; cracks in walls chinked with twigs and moss. Some building elements may have been portable and fashioned of canvas (Bryant 1913:61, 64). Remote and inaccessible locations and the necessity for low costs were responsible for these conditions. Satellite work camps are often comprised of a single domestic structure. Their locations are not necessarily tied to major haul roads or skids. Single-structure remote camps are often associated with cordwood cutting or are located along flume lines and were occupied by flume tenders. Men often worked daily from twelve to fourteen hours or more (Brown 1934:61).

Cordwood

Cordwood formed a principal adjunct to the lumber business. A number of wood contractors concentrated solely on cutting cordwood to meet the fuel demands of railroads and ore mills in particular for fuel. Many large trees, 50 to 80 feet high, were cut down, from which only one good saw log, perhaps 20 feet long or less could be obtained. The remaining pine scrap, along with fir wood, was usually salvaged for cordwood and not left to rot on the ground. Efficient procedures were developed to glean cutovers after a timber harvest and convert residues into cordwood (Wilson 1992:7). Pack mules proved to be ideal carriers of this secondary harvest to collection points along railroads, haul roads, and flumes. The flume system rendered the cordwood business especially profitable, as wood could be floated, not hauled, to market. As a result, cordwood was cheap and plentiful (Edwards 1883:74; Galloway 1947:79). Slab wood trimmings (waste derived from squaring the saw log for board wood) was usually not marketable like cordwood but was used similarly for domestic firewood and as a localized source to fuel steam-powered mills.

Sisson and Company, the principal employer of Chinese labor in the Truckee Basin, had substantial land holdings in Martis Valley. The company operated wood camps in the forest surrounding the valley and cordwood was floated down their flume to Martis Creek Station. In 1882 Sisson had railroad contracts for 25 to 30 thousand cords and to fulfill the contract they had 200 men and up to 30 teams working from Kneelands (Coldstream Canyon) to Martis Creek (*Truckee Republican* 8/12/1882).

Charcoal

Like cordwood, charcoal production also formed an important aspect of the logging industry in the Truckee Basin. The organization of Sisson and Company was created in l866 at Truckee exclusively for the purpose of importing Chinese labor for railroad construction. With completion of the railroad, many Chinese immigrants were channeled into the lumber industry. This forced immigrant Chinese into direct competition with Euro-Americans, and the subsequent anti-Chinese sentiment resulted in the initial expulsion of Chinese from Truckee town in l878 and the ultimate demise of Truckee's Chinese community in 1886. An economic boycott on Sisson and

Company forced them out of the Truckee Basin in 1887 due to their practice of hiring Chinese.

Prior to this time, Sisson and Company employed large numbers of Chinese in the production of charcoal to supply the railroad, smelting works in Nevada and Utah, and a local smelting works in Truckee (Lindström 2004; Lindström and Waechter 2006). It was an opportunistic enterprise, whereby Chinese employed as woodcutters were able to mobilize into an efficient force of colliers who met fluctuating market demands for charcoal. During the late 1860s through mid 1870s, charcoal was produced in earthen kilns. These were generally constructed in cut over areas within a few mile radius of Truckee town. Earthen kilns have been recorded in Martis Valley. In 1877 Sisson Wallace and Company constructed three brick charcoal kilns at Martis Creek Station near the mouth of Martis Creek.

According to the 1880 and 1913 maps of Nevada County and the 1897 map of Placer County, Sisson, Wallace and Company (later Sisson, Crocker and Company) owned considerable land in the central, northern and northwestern portions of Martis Valley.

Shingles

The shingle business in Truckee was brisk, as Edwards noted in his tourist guide:

> One of the leading industries of this section is the manufacturing of shingles. This manufacture is extensive…Of course the motive power is water, taken either

from the Truckee river [sic] or the various reservoirs filled with water from available springs. [Edwards 1883:36]

The earliest shingle manufacturer in Martis Valley may have been Hawthorne and Company, which operated a shingle mill six miles from Truckee on the Old Brockway Hot Springs Road (*Truckee Republican* 5/26/1869; 12/27/1873). In 1869 Hawthorne and Company built a two-mile-long V-flume on Martis Creek to float wood and shingles (*Truckee Republican* 2/20/1868; 5/26/1869) to Martis Creek Station (*Truckee Republican* 10/8/1872:3/1). Sisson, Wallace and Company incorporated the old Hawthorne V-flume into their operations in 1872 (*Truckee Republican* 10/8/1872), extending it in 1873 to a distance of four miles (*Truckee Republican* 10/8/1872). Assessments on the Sisson flume and water rights on "Martys Creek" continued until 1889.

Martyr's Creek Wood Company, one of the earliest outfits in Martis Valley, had from 175 to 500 men cutting cordwood for the railroad (*Truckee Republican* 5/29/1869). They also had a shingle mill located six miles from Truckee on the Old Brockway Hot Springs Road.

Caspar Schoch ran a shingle mill on West Martis Creek (then known as Shingle Mill Creek), sawing 15,000 shingles per day during a 12-hour shift. Schochs Shingle Mill was in operation since at least 1869, when he appropriated water rights on the creek and dammed and diverted the water through a 600-foot long ditch to propel his water-powered mill. According to a court case (Schoch vs. Richardson 1874), in June of 1874 the Richardson Brothers lumber firm unlawfully erected a dam on the creek above Schochs Shingle Mill and diverted water through a flume. The flume discharged water onto Schoch's property, carrying down quantities of earth, rock, stone, sawdust, and rubbish. Debris filled Schoch's ditch, damaged the mill and eroded soil on 80 acres of land Schoch owned in the west ½ of the southeast ¼ of Section 29 (Township 17 North, Range 17 East). Schoch sued for $4,000 damages but the case was dismissed. He moved to Squaw Valley and set up a new shingle mill that operated from 1875 to 1880 (Knowles 1942:21).

Sam McFarland operated a saw mill along the Old Brockway Hot Springs Road (near the present-day entrance to Northstar-at-Tahoe Ski Resort) between 1869-1870 and 1878. (*Truckee Republican* 7/23/1872). McFarland also transported wood (possibly shingles) in the Sisson V-flume *(Truckee Republican* 2/24/1886).

By 1874 the Shaffer Lumber Company built a V-flume which connected to their mill in Martis Valley to Truckee. According to the *Truckee Republican* (1/15/1874:3/2) shingle blocks were dumped from the flume into the Truckee River, upstream from Martis Creek Station and floated down to the H. Hale and R. P. Ferguson's Pacific Shingle Company water-powered mill at Prosser Creek. As many as 80,000 shingles were sawed in a 24-hour period. Chinese labor was used to tie shingles into bundles.

During the 1870s and 1880s, Richardson Brothers cut shingles in its mill at Martis Creek Station (*Truckee Republican* 2/23/1874:2/2; 12/30/1874:3/4).

Wilson Forrest opened a shingle mill in 1879 at the abandoned McFarland saw mill site on the Old Brockway Hot Springs Road. He manufactured 10,000 shingles a week at his mill (*Truckee Republican* 12/14/1878; 2/8/1879; 2/26/1879). Forrest teamed up with David J. Smith and ran the shingle mill at full capacity (*Truckee Republican* 4/16/1879). The shingle mill burned in 1880 and Smith soon opened a new mill (*Truckee Republican* 10/18/1879). In 1881 Andrew H. Miller bought a shingle mill on the Old Brockway Hot Springs Road (probably Smith's former mill). Miller produced 25,000 shingles daily and also cordwood for the railroad (*Reno Evening Gazette* 7/26/1881). In 1882 Miller opened a box plant at his mill. The enterprise was short-lived and he went bankrupt at the end of 1883.

> One of the best shingle mills operated in this section, is that owned by A. H. Miller, located about 6 miles from Truckee, on what is known as the Hot Spring's road…Every tourist and seeker for information should make a trip and watch the wonderful machine saw off from a chunk of wood shingles at the rate of fifty per minute. [Edwards 1883:36]

The end of Truckee's shingle industry was prompted by competition from redwood shingles:

> …pine shingles are not made in this vicinity; a few years ago there were four shingle mills running; redwood shingles have taken their place and driven the mountain product from the market. [*Nevada Daily Transcript* 8/14/1888:3/1]

Lumbering

Several larger lumber companies established logging operations in Martis Valley during the period from 1871 to 1906. George Schaffer, the Richardson Brothers, the Truckee Lumber Company, and later the Floriston Pulp and Paper Company owned timber tracts within Martis Valley (Knowles 1942:17, 20, 33-34, 41, Map; Knowles 1991:22, 34, 36, 37, 44; Myrick 1962:437-438; Wilson 1992).

George Schaffer (1871-1903)

George Schaffer was one of the earliest lumbermen in the Truckee Basin, building Truckee's first sawmill on the Truckee river in 1867 (Knowles 1942:9, 16). In 1871 he established timber holdings in Martis Valley. The 1897 Map of Placer County showing historic land ownership patterns indicates that he may have logged the west and central portions of Martis Valley. Schaffer built two mills along main Martis Creek (Knowles 1942:17). The first mill operated from 1871 to 1882 (Wilson 1992:78). It was located in the vicinity of Gooseneck Flat (present-day Lahontan subdivision, Township 17 North, Range 16 East, Section 25). A large settlement (mill town) sprang up around the new mill, centered at the Schaffer's residence (Coates 1995). In 1872 Schaffer purchased the water rights to main Martis Creek from Sisson, Wallace and Company (Deeds Book V, Page 498; Wilson 1992:78) and constructed a 50-acre millpond in 1873. The pond was located on level land in the valley. (This locale is probably Gooseneck Flat, a place name that first appears on the 1962 map of the Tahoe National Forest, Truckee Ranger District, appearing as a pond on the 1976 U.S. Forest Service, Lake Tahoe Management Unit map.) Schaffer flumed water from one mile above and impounded it by two dams (Coates 1995:9). From the pond logs were hauled by steam tractor to Schafer's mill in Truckee town that he had established in 1867. Another flume carried milled lumber from the pond to his yard in Truckee (Coates 1995:9). The "sawmill" and "flume" that appears on the 1876 Wheeler map in the vicinity of present-day Gooseneck Flat is probably that of Schaffer's. The 1897 Truckee Quad calls out a "sawmill", depicting at least three buildings and a millpond that may correspond to Schaffer's mill.

Schaffer bought Section 35 (Township 17 North, Range 16 East) from the railroad in 1876 and relocated his second mill site in the northeast quarter of the section, farther up main Martis Creek (Wilson 1992:78). The mill is shown in the northwest ¼ of Section 35 and captioned as "Shaffer Mill" on 1911 and 1915 maps of the Tahoe National Forest. A north-south-trending road from the mill to Truckee town appears on the 1915 Tahoe National Forest map and also on subsequent forest maps dating from 1921 and 1930. The road appears on modern USGS topographic and U.S. Forest Service maps. This road is shown as and "improved [dirt] road" on the ca. 1938 Metskers road map, where the mill site is now captioned as the "Old Shaffer Mill." The old mill site is referenced in this way on contemporary USGS topographic maps.

In 1885 Schaffer opened a high-elevation logging camp farther up the creek and now on the "back side" of Northstar-at-Tahoe ski area (Township 16 North, Range 16 East, Section 12). The "Old Schaffer Camp" appears on modern USGS topographic and U.S. Forest Service maps. Schaffer constructed a log chute (Ludwig 2001:NS-42) from the high camp to his mill. Coates (1995:9) describes this feature as a 3½ -mile flume.

Shortly after Schaffer's death in 1903, his second mill was sold to the Taylor Brothers of Grass Valley. In 1905 it accidentally caught fire, concluding 34 years of lumbering by Schaffer in the country around Martis Valley (Coates 1995; Wilson 1992:78). The Decree of Settlement of Accounts and Final Distribution (Deeds Book 86, Pages 455-457), lists as his holdings in Nevada and Placer counties as of December 5, 1905:

<u>Nevada County</u>
-16 lots, one residence, five "dwelling houses", one barn, a hotel and associated improvements, and the "Schaffer Water System, all within the town of Truckee
-2½ miles of lumber flume, together with right of way and leased lumberyard at the town of Truckee;
-800,000 feet of lumber in the yard
-four boilers and two engines in Truckee
-personal property and household furniture in Truckee
-N½NE¼/Sec 14/T17N/R16E containing 80 acres

<u>Placer County</u>
-N½NE¼ & SW¼NE¼ & SE¼/Sec 30/T17N/R17E containing 440 acres
-S½ & NE¼/Sec 23/T17N/R16E containing 480 acres
-Sec 25/T17N/R16E containing 640 acres
-Sec 26/T17N/R16E containing 640 acres
-Sec 36/T17N/R16E containing 640 acres
-Sec 35/T17N/R16E containing 640 acres

-Sec 2/T16N/R16E containing 640 acres
-Sec 11/T16N/R16E containing 640 acres
-Sec 12/T16N/R16E containing 640 acres
-Sec 7/T16N/R17E containing 640 acres
-NW¼/Sec 31/T17N/R17E containing 160 acres
-NE¼/Sec 28/T17N/R17E containing 160 acres
Total timber lands = 6360 acres

A review of Placer County deeds further confirms Schaffer's extensive timber holdings within and surrounding Martis Valley. Beginning in 1872 through 1874, he acquired lands in T17N/R16E/Sections 25-26 and in T16N/R16E/Section 2, and T17N/R17E/Section 31 (Deeds, Book U, Page 182; Book V, Pages 13, 15, 17, 124, 498; Book W, Pages 28, 30, 32, 416; Book Y, Page 408; Book Z, Page 173). In 1876 he bought all of T17N/R16E/Section 5 (Deeds Book Z, Page 679). Placer County assessor's records for 1876 levied taxes on Schaffer's land holdings totaling 3200 acres to include: T17N/R16E/Sec 2, 25, 26, 35, N½Sec36, NW¼Sec31, NW¼Sec30. Improvements on these lands consisted of a dwelling house, fences, steam sawmill, four American horses, (worth $600), five Spanish horses (worth $375), 16 oxen (worth $800), 12 cows (worth $300), five wagons (worth $500), harness (worth $80), eight stock cattle (worth $100), and hogs (worth $60). In 1876, Schaffer's assets were worth $18,815. In 1888 Schaffer purchased all of Section 12 in T16N/R16E, followed by an acquisition in 1889 of Section 11, T16N/R16E.

Richardson Brothers (1874-1906)

Warren Richardson and his older brother, George W. Richardson, operated two mills in Martis Valley. The 1897 Map of Placer County showing historic land ownership patterns indicates that he may have logged the central and eastern portions of Martis Valley. Richardson Brothers' first sawmill and V-flume is depicted on the 1897 Placer County map in the vicinity of West Martis Creek. Their first mill was in operation from 1874 to 1883 on West Martis Creek, six miles southeast of Truckee town and about one mile east of George Schaffer's mill (Coates 1997; Knowles 1942: 20; Wilson 1992:77). This mill shows up on the 1876 Wheeler map. By 1880 Richardson Brothers constructed two reservoirs at their mill on West Martis Creek. The lower reservoir at the mill was used to receive the saw logs that were hauled directly from the water to the mill by machinery (Knowles:1942:34).

In 1874 the Richardson Brothers built a V-flume to ship lumber down to their lumber yards at Martis Creek Station on the line of the Central Pacific Railroad and at the mouth of Martis Creek (Knowles 1942:20). The flume was 1½ miles long and connected with the Sisson, Wallace and Company's flume, for a total fluming distance of about 5½ miles (Knowles 1942:20; *Truckee Republican* 7/25/1874; 8/2/1874; 9/17/1874). A linear feature (either road or flume) that appears on the 1876 Wheeler map may correspond to the Richardson Brothers' operations. The 1921 map of the Tahoe National Forest also shows a road in this approximate location along West Martis Creek. The Richardson flume extension was built in 10 days and was navigable for all kinds of lumber (*Truckee Republican* 8/4/1874) as described by the local newspaper:

> It is a V pattern, with 26-inch sides and is built of boards an inch and a half in thickness. It is constructed in a very substantial manner, is one and a half miles in

length, has an average fall of six inches to the rod and cost about $3,000. Lumber floats down it at the rate of from seven to eight miles an hour. The entire distance through both flumes to the lumber yard on the railroad track is five and a half miles. In the construction of this flume the utmost economy was used and each section of this same, 12 feet long, was made at the mill and floated down to the end, where it was seized by the workmen and placed in position. In this way the cost of the work was materially lessened. All the expense of teams and hauling the lumber and material for trestle work was saved. While we were at the mill yesterday a number of V boxes were sent down to the end of the flume at the lumber yard. These boxes were for an extension to the flume. A piece of board sawed in the form of a V was temporarily nailed and fitted into each end of each box thus making a sort of boat. These were placed in the flume, and men, tools, and provisions were stored in these simple but novel contrivances to save labor and expedite business. Water was then turned into the flume and away went this fleet of boats with their crews, etc., floating down the flume steadily and safely at the rate of eight miles an hour. Another astonishing fact in this connection is that a stream of water of scarcely more than 20 inches miners' measure was the propelling power. The Richardson Brothers are preparing the ground at the mouth of the flume of Sisson, Wallace & Co., for an extensive lumber yard and in a few days they will send down through their flume the 1,200,000 feet now piled up at their mill. They can ship easily 100,000 feet per day if it should be necessary. The total value of their improvements thus far at their mill, including their flume, is about $25,000. [Edwards 1883:33-34; *Truckee Republican* 9/17/1874]

At Martis Creek Station, the Richardson Brothers constructed a planing mill in 1876, operating it until the end of the 1870s (Knowles 1942:20). They built a box factory at Martis Creek Station in 1882, constructing a new V-flume in 1883 to carry material from their mill in Martis Valley to their box factory and planning mills five miles down to Martis Creek Station (Knowles 1942:34).

At first Richardson Brothers logged with five teams of oxen. Later they used a steam wagon, hauling logs from their mill to the lumberyard and box factory at Martis Creek Station on the Central Pacific Railroad east of Truckee (Scott 1973:150). In the early 1870s they incorporated a logging railroad. They originated a unique method for transporting logs by building tracks 1½ miles long of 10-inch pine logs (instead of iron rails) laid end-to-end and partly buried in the ground to maintain the gauge. Their locomotive was built with heavy, flanged concave wheels to ride on top of the log rails that provided sufficient traction to climb grades of more than 15 percent (Edwards 1883:78-79; Knowles 1942:20). A log chute was constructed parallel to one side of the log rails and saw logs were dragged by cable.

Richardson Brothers built a second mill about a mile southeast of their first mill site near Middle Martis Creek and the Old Brockway Road (near the corner of sections 4 and 5, Township 16 North, Range 17 East and sections 32 and 33, Township 17 North, Range 17 East; Knowles 1942:34; Wilson 1992:78). This mill was in operation from 1883 to 1906. The 1897 Truckee Quad and a 1915 map of the Tahoe National Forest depict a "sawmill" on the Old Brockway Road nearer to Brockway Summit; this mill probably corresponds to Richardson Brothers second mill. In 1887 when their box factory burned at Martis Creek Station, Richardson Brothers built another one at Truckee town and hauled lumber by steam wagon on the eight-mile trip from their second mill in Martis Valley to their lumber yard in Truckee (Knowles 1942:34). The Richardson Brothers operated their sawmill until 1906 and with the death of George Richardson in 1903 and Warren Richardson in 1906, the brothers completed 33 years of cutting in Martis Valley (Knowles 1942:34).

The Richardson Brothers were actively purchasing land in Martis Valley between 1873 and 1889. Acquisitions during the 1870s include lands in T16N/R17E/Sec 5 and 2, in T17N/R17E/Sec 32 and 29 (Deeds Book Z, Page 19; Book BB, Pages 653; Book DD, Page 112; Book FF, Page 576; Book OO, Page 58). Placer County assessments first appear in 1876 for Richardson Brothers and for Warren Richardson. Taxes are levied for lands in T16N/R17E/NW¼Sec 5 and in T17N/R17E/E½Sec 31, SW¼ and S½NW¼Sec 29, and the NW¼Sec 32. Assessed lands total 880 acres along with a steam saw mill and outbuildings. Assets are valued at $9,420. Assessments in 1877 are the same as those listed for 1876, with the addition of 160 acres in T16N/R17E/SE¼Sec 5 and 160 acres in T17N/R17E/E½SW¼Sec 32, and 300,000,000 feet of square timber. In the 1880s, Richardson Brothers bought land in T16N/R17E/Sec 4, 3, 2, and 5 and in T17N/R17E/Sec 29, 31 and 32 (Deeds Book FF, Page 580; Book LL, page 412; Book NN, Page 580, 582, 586; Book WW, Page 152-155; Book 54, Page 275; Book 90, Page 223).

Truckee Lumber Company (1867-1909) and Donner & Tahoe Railroad (1893-1901)

The Truckee Lumber Company (TLC) was established in 1867 by E. J. Brickell and George Geisendorfer. In 1873 W.H. Kruger bought a half interest in the company and together, Kruger and Brickell expanded their timber holdings and mill operations to become the largest and longest-standing lumber firm in the Truckee region. The TLC was unique in its diversification of a variety of markets along the CPRR, operating its sash, blind, door, box, and furniture factories at Truckee (Knowles 1942:17). The last years of company's activities were in 1909 (Knowles 1942:39).

The TLC held considerable land holdings in Martis Valley (Myrick 1962:436) along the flank of Martis Peak and extending westward to the middle fork of Martis Creek and southward to Brockway Summit (Spohr 1990). In 1883 the company controlled some 12,000 acres of timberland in the region. TLC holdings in Martis Valley included 6320 acres in sections 21, 27, 28, 29, 32, 33 in T16N/R17E; 400 acres of Section 15 in T16N/R17E; and sections 9, 15, 16, 21 in T16N/R16E (Wilson 1992:66). The TLC had no means of accessing timber tracts in Martis Valley so the company negotiated a contract with the Pacific Lumber and Wood Company (PLWC), a competitor based out of Clinton (present-day Hirschdale). The PLWC logged the uplands of Juniper Creek by railroad but their stands were becoming depleted by the early 1890s. So the company with a logging railroad but no timber (the PLWC) negotiated a contract to haul logs for the company that had a lot of timber but no railroad (the TLC). The first ten miles of the newly constructed Donner & Tahoe Railroad were in operation by 1893. Construction was staged out of Klondike Meadows and from there, rebuilding of the line commenced westward to the mill ponds of the TLC in Truckee (Spohr 1990:4-8). Spohr (1990:6) describes the route of the railroad:

> As built, the Donner & Tahoe Railroad…came up the side of the south bluff, around the Hilltop area, and along the Truckee-Brockway road for some way. It crossed present day Highway 267 near the golf course and started down the draw which lies between the highway and the airport. About halfway down the draw, the line crossed from the east side to the west on dirt fill and trestle work, skirted a small hill since obliterated by construction of Martis Creek dam, and crossed the main fork of Martis Creek on a bridge…South of the creek, the track ran up grade to follow the south fringe of the meadow into the East Martis Creek canyon. This creek was then followed east, from side to side, up into Klondike Meadows. Spurs were built, at some time, to Dry Lake to the north, and into Monte Carlo Meadow to the south.

Dry Lake first appears on the 1940 (1951 reprint) edition of the Truckee Quad and it is shown again on a 1976 U.S. Forest Service map, Lake Tahoe Basin Management Unit. It is uncertain whether the lake is associated with historic logging activities. Monte Carlo Meadow was a focus of logging operations. At the head of Monte Carlo Valley, a log chute at the rail head of the logging railroad received most of the timber from the Brockway Summit area. The last logging of importance via the Donner & Tahoe Railroad in Martis Valley was completed in 1900. The PLWC sold the railroad to the TLC in 1901. It is believed that the main line was dismantled either immediately before or after the sale.

Floriston Pulp and Paper Company (FPPC) 1899-1929

By the turn of the century timber tracks in Martis Valley were largely stripped of pine, but fir and other species remained. Fir had been largely ignored during the earlier harvesting, as it was considered unsuitable for the production of ties and timbers. With the introduction of paper mills, stands were re-entered to harvest fir for use as pulpwood for paper mills. The greater "digestibility" of fir species (over pine) now made them the targets of harvest.

Organized by the Fleischhacker Brothers, the Floriston Pulp and Paper Company (FPPC) commenced operations on the Truckee River at Floriston in 1899. It operated continuously for 30 years. Control of the company went to Crown-Columbia in 1912, to Crown-Willamette in 1914 and later to the Crown-Zellerbach Corporation. Between 1914 and 1921 the CWPC contracted to log fir on 2120 acres in Placer County that belonged to the TLC (Knowles 1942:53). In 1912 the company held 20,200 acres in Placer County; by 1914 practically all the white and red fir had been cleared off this acreage. The company extended their timber holdings into Martis Valley in the spring of 1922 by purchasing 3,451 acres of the Richardson Brothers' land (Knowles 1942:50) and they operated several miles of logging railroad during the 1920s (Wilson 1992:69). Sawmill Flat may represent a major staging for pulpwood cutting by the FPPC and/or its subsidiaries. The USGS Truckee Quadrangle for 1940 shows a road connecting Sawmill Flat and major log camp for the FPPC above Tahoe City. Twentieth century logging at this site probably targeted pulpwood harvesting of red and white fir, species that were commonly ignored during 19th-century harvesting. During the 1940s Fibreboard Products Inc. began acquiring timber tracks from Crown-Zellerbach Corporation along Lake Tahoe’s north shore and over the divide into Martis Valley (Lindström and Waechter 1996). According to Tahoe National Forest cut plats, Fibreboard Corporation conducted logging in Martis Valley during the 1960s and 1970s. This modern period of logging is substantiated by a marked increase in logging roads constructed sometime after 1952 and before 1966 as shown on aerial photographs, USGS quadrangles (1969) and U.S. Forest Service maps (1976).

The Aftermath of Historic Timber Harvesting

Scientific studies indicate that the structure and composition of modern forests in the Truckee-Tahoe basins are very different from the pre-Euroamerican forests (Leiberg 1902; McKelvey and Johnston 1992; Sudworth 1900; Taylor 1997). Overall, virgin stands were more open, less dense, and composed of trees that varied widely in diameter, and the stems "…often runs 125 feet high without a limb, and often measures 8 feet through at base" (Judah 1862:47). Trees were not only large in size but they grew in unbelievable bounty. In 1883 *Edwards' Tourist's Guide and Directory of the Truckee Basin* boasted: "The [timber] supply may be said to be never ending...it is beyond the power of man to estimate when it will be exhausted." In this setting of superabundance, 19th century logging commenced and continued with such fervor as to nearly wipe-out many of the accessible stands within 25 years. Lumber companies leased or sold cut-over lands to ranching/grazing interests or abandoned them to obtain back taxes, large tracts being sold for as little as 50 cents per acre (Manson 1899:298). During the 20th century, logging continued on a reduced scale and within a more restricted range. Limited species were targeted and harvesting targeted stands ignored by 19th century loggers. Much of this more localized logging commenced after construction of the Floriston Pulp and Paper Company's (FPPC) mill along the Truckee River in 1901, which fir stands were the focus of a growing pulp and paper industry.

However, not all forests were clear-cut; trees were selectively harvested to suit varying wood markets, and for the purposes of environmental reconstruction it is useful to know: (1) the location of both logged and unlogged areas, (2) when areas were logged, and (3) how and to what degree they were logged. Around the turn of the century, G. B. Sudworth (1900) and John Leiberg (1902) surveyed and reported upon cut-over lands in the northern Sierra Nevada as part of a study of forest conditions for the U.S. Bureau of Forestry and U.S. Geological Survey. In 1899 Professor Marsden Manson, civil engineer and conservationist, made similar notes just three years before, and E.A. Sterling reported on forest fire conditions in 1904. Lands examined included the divide between north Lake Tahoe and the Truckee Basin and the uplands of Martis Valley. Their observations on climate, stand assessment, fire, erosion and sediment loading, water diversion and degradation, and reforestation provide clues to the historic patterns of human disturbance within the Martis Watershed.

<u>Climate</u>. Nineteenth-century harvesting targeted stands that had matured during the mid 1600s to mid 1800s, a period of generally cooler and wetter conditions coincident with the Little Ice Age event. During this 200-300 year period, cooler-wetter conditions would have limited the negative impacts of some potential stresses on the forest (droughts, fires, insect infestations, etc.) and would have favored the growth of conifers in the region. These Little Ice Age conditions undoubtedly contributed to the size and vigor of trees that impressed many early observers. Also, high precipitation occurred during the main harvest period, which extended from the 1870s-1910s. High flows of the Truckee River during this period have been matched only by the flows caused by the El Niño events of the early 1980s. Wetter conditions would have facilitated steam-powered logging technology and enhanced water supply engineering and the viability of flumes, pipelines and reservoirs. .

Stand Assessment. In 1900 Sudworth reported a "general lack of herbaceous growth, an irregular reproduction of timber species, and general absence of small-sized timber intermediate between seedlings and the large timber." Leiberg (1902:38) believed climate, fire, insects, and logging and grazing to be "the forces of destruction at work in the forest."

> If the present rate of cutting and grazing is continued, the general condition of the forests at the end of the century, or even fifty years hence, will be about as follows: The...basins will have been wholly denuded of large timber, and in its place will have come a sapling growth, heavy and close set in some places, open, under sized, and brushy in others. Most of it will consist of white fir, for the yellow pine which has given the present forest its chief value will form a comparatively small percentage of it. [Lieberg 1902:51]

> It is not unlikely that before logging operations began in the basin the yellow pine formed the largest percentage of the type, but at the present time the white fir is the superior, the ratio for the entire district being about 10 per cent of white fir to 1 per cent of yellow pine…The forest has been logged throughout, and now consists chiefly of white fir and incense cedar, the sugar pine having been practically exterminated, at least as regards large and medium sized trees. [Leiberg 1902:177]

More specifically, Leiberg (1902) characterized the forest stands in the vicinity of Mount Pluto, which bounds the Martis Watershed on the south.

> The Shasta-fir type [red fir]…is…the prevailing forest on the summit of Mount Pluto Ridge and on the high summits of the connecting ranges south of Truckee Canyon. [page 176]

> In the small areas of unlogged forest of this type on the southwestern slopes of Mount Pluto the yellow pine forms 10 to 15 per cent of the stands. The timber is invariably set in heavy undergrowth, which has come in as a sequel to extensive fires… Where the timber has been thinned by logging, heavy brush growths sometimes come in, but as a rule the Shasta-fir type in this basin is situated above the upper limits of thick brush growth. [page 177]

> The Shasta-fir forest is patchy throughout except along the crest of Mount Pluto Ridge. All along the main range the continuity is broken by bare stretches of rock, grassy or brushy areas marking burns, grassy swards and glades along the valley bottoms, and logged areas. The composition of the type where unmixed with lodgepole pine is commonly Shasta fir, 75 to 95 per cent, the balance being white pine and Patton hemlock. Around swales and glades the Shasta fir is largely replaced by lodgepole pine, sometimes to the extent of 90 per cent… [page 177]

> …the northwestern slopes of Mount Pluto had not been logged at the time of this examination. The summits and slopes of Mount Pluto Ridge from Mount Pluto eastward have been logged, with the exception of a few hundred acres on the crest of ridges directly north of Agate Bay. The timber on those summits was exclusively Shasta fir, 70 per cent logged. On the lower northern slopes of Mount Pluto Ridge the cut has been from 70 per

> cent to nearly total, culls of white fir being the only species of tree left…on all the areas between Truckee and Mount Pluto Ridge…the cut of merchantable timber has been total. [page 178]
>
> Much was cut so long ago that the stumps have rotted down…[page 179]
>
> …yellow pine…some is scattered over the slopes of Mount Pluto Ridge. [page 179]…Tracts north of Mount Pluto Ridge, including slopes of main range: Below elevations of 7,000 feet, white fir, 10 to 60 per cent, the high percentage on logged areas; yellow pine, 5 to 45 per cent in stands of medium density, generally in thick underbrush, not difficult of access; above elevations of 7,000 feet; Shasta fir, 60 to 80 per cent; white pine and Patton hemlock; timber of large size, but in broken stands and difficult of access; average stand 9,900 feet B.M. per acre. [page 180]

Fire. After historic-era harvesting, the cut-over forests were vulnerable to fires as never before. Some of the most serious fires fed upon debris in cutover areas, and owed their origins to sparks from steam-powered logging equipment or friction points in cable skidding. Costly fires occurred along the logging railroads where cordwood, ties, mine timbers, or lumber awaiting shipment were ignited by cinders from wood-fueled locomotives. Very destructive fires also occurred at mills, where burning sawdust and slab piles were constant flammable hazards. Blazes in cutover forests ran virtually unchecked through slash and second growth, creating sufficient heat to destroy humus and harden clay in the soil (Strong 1984:31). Consequently, regeneration of the forest was delayed for years due to damage caused to seedlings and saplings, both by fire and logging. Seldom was there any coordinated attempt at fire suppression. Leiberg made observations on the relative destruction by fire of timber tracks in the Truckee-Tahoe basins.

> There is not a great deal of forest land in the portion of the [Truckee-Tahoe] basin examined which does not show clearly traces of fire. Most of the area is merely fire marked, less than 25 percent having been badly burned…the tracts exhibiting traces of fire or showing a considerable percentage of loss due to this cause embrace a trifle over 96 per cent of the forested districts. All portions of the region have been visited by fires, but most of the destruction has been confined to the Shasta-fir stands, or to those tracts of yellow-pine forest in which white fir formed a considerable proportion. [Leiberg 1902:181]
>
> Owing to logging operations it is not possible to state, except approximately, the amount of timber consumed by fire. It is very clear that many of the fires were subsequent to the removal of most of the timber by the loggers, but the extensive brush growths which have come to occupy some of the sections indicate that large areas were burned previous to the cuttings. I should say that, taking the [Truckee-Tahoe] basin as a whole, 30 per cent of the present volume of timber is a moderate estimate to cover the fire losses during the last fifty years. [Leiberg 1902:182]

Historic harvesting practices, followed by 20th century policies of fire suppression, have created a vegetational change and ecosystem response over the last century. The greater vulnerability of Truckee-Tahoe forests to fire fostered the philosophy that fire was a destructive force to be eliminated if possible. By the mid 1920s all national forests (and national parks) in

California and the Sierra had fully developed policies, procedures, and organizations to suppress fire in their jurisdictions. These policies were forged despite period observations by foresters, who acknowledged the frequency of both natural and human-caused fires and their potential positive effects and led them to question the validity of fire suppression.

> Fires ravaged the forest long before the American occupation of California. The aboriginal inhabitants undoubtedly started them at periodic intervals to keep down the young growth and the underbrush. When the miners came, fires followed them. Contemporaneous with the advent of the miners, or soon after, came the flock masters with their sheep. [Leiberg 1902:41]

> ...Let anyone...examine the sapling stands now springing up in old-growth forests where fire has been kept out during the last twelve or fifteen years...These sapling stands, composed of yellow pine, red and white fir, and incense cedar, singly or combined, are so dense that a man can with difficulty force his way through. But for the stature of the species composing them they would constitute chaparral. [Leiberg 1902:43]

Some perspective on changing fire management policies is gained from a public relations article that appeared on the back of a 1930 map of the Tahoe National Forest.

> The `Light Burning' Fallacy - The fire-protection policy of the Forest Service seeks to prevent fires from starting and to suppress quickly those that may start. This established policy is criticized by those who hold that the deliberate and repeated burning of forest lands offers the best method of protecting those lands from the devastation of summer fires. Because prior to the inauguration of systematic protection California timberlands were repeatedly burned over without the complete destruction of the forest, many people have reached the untenable conclusion that the methods of Indian days are the best that can be devised for the present….Fire exclusion is the only practical principal on which our forests can be handled if we are to protect what we have and insure new and more fully stocked forests for the future. [excerpted from "The `Light Burning' Fallacy", USFS Tahoe National Forest Map, California-Nevada, 1930--forest visitor comments on the back of the map; map on file Special Collections, Shields Library, University of Nevada, Reno, NC72/2/7 Box 3]

Fire suppression formed the basis of forest service policy until the 1960s, after which time doubt over the merits of total suppression has led the national forests to employ the reintroduction of fire as a management strategy through a somewhat controversial program of controlled burns.

<u>Erosion and Sediment Loading</u>. A potential source of sediment may have been attributed to the miles of historic and modern log haul roads and skid trails. Over the years, these entrenched logging features may have served as conduits introducing sediments into Martis Creek and its tributaries (and they may continue to do so). Sediment loading may have been particularly extreme in shallower rocky soils, especially immediately following a logging event and before the ground surface had an opportunity to stabilize. If the timing of historic-era road construction coincided

with a period of increased moisture and runoff, erosion problems would have been further aggravated.

Water Diversion and Degradation. To maintain a supply of water to flumes, streams and lakes were dammed and diverted, creating unnatural reservoirs and raising water levels of existing water bodies. These activities presumably converted low-land vegetation and riparian communities to aquatic systems.

Reforestation. Leiberg (1902) observed considerable chaparral in the early 20th century forest, noting that the timber had become invariably set in heavy undergrowth which had come in as a sequel to extensive forest.

> In past times, before logging operations commenced, it [yellow pine] may have been the dominant species as regards the number of trees, but owing to the vast amount of cutting it is so no longer. It has been more exhaustively logged than any other species in the type except the sugar pine, and restocking has not kept pace with the cutting. [Leiberg 1902]
>
> White fir is increasing its ratio in the restockings…In the Truckee Basin it is largely replacing the yellow pine on the logged areas, and in the coming forest will amount to 60 to 75 per cent of growth, against 25 to 40 per cent in the original uncut stands. [Leiberg 1902]
>
> This species [red fir] is abundant and vigorous in all reforestation of the yellow-pine type, whether after logging or fires. [Leiberg 1902]
>
> On all areas, like the slopes of Mount Pluto…where a thick undergrowth has obtained a substantial foothold, reforestation is practically lacking….Shasta fir [red fir] is the leading species in the restockings at the higher elevations, white fir at lower altitudes, yellow pine appearing in smaller quantities than in the old forest; incense cedar is abundant, while sugar pine is practically obliterated. The grassy or weedy fire glades along the higher slopes of the main range are not reforesting, owing to the grazing and trampling of sheep. [Leiberg 1902:182]

Sterling (1904) also observed that Jeffrey pine was rare and that considerable areas had reverted to brush, with original forests remaining only on inaccessible slopes.

> The forest is much reduced in density; brush and reproduction are competing for possession of the openings. The sugar pine has disappeared almost entirely...the finest of the Jeffrey pine and yellow pine and white fir has been removed, fir production in general [is] replacing the pine; while considerable areas have reverted entirely to brush. [Sterling 1904:4]

In his study of forest sample plots in the Carson Range, Taylor (1997) confirmed these early 20th century observations on how the modern forest has been shaped by circumstances involving climate, historic timber harvesting practices and fire suppression policies. Jeffrey pine forests are mostly 100-130 year old second growth stands in which trees are relatively small in diameter (less than 20-inch DBH) and up to nearly 10 times more dense than pre-Euroamerican forests (Taylor 1997:18-19, 22). Furthermore, lodgepole pine has regenerated prolifically (Taylor 1997:22). It is these dense white-fir dominated forests that experienced significant insect attacks and subsequent mortality during the severe droughts of 1921 and 1937 (Elliot-Fisk *et al.* 1996) and during the drought of 1987 to 1994.

RANCHING/DAIRYING

Plentiful feed and water at the mouth of Martis Valley would have accommodated the influx of emigrants in the mid 1840s to 1850s who traveled up the Truckee River along the Truckee Route of the Emigrant Trail. However, the valley is not specifically chronicled until the mid 1860s. When traveling through this area in the summer of 1864, William H. Brewer of the Whitney Survey referred to the area as "Timilick Valley" and wrote:

> Timilick Valley, a chasm, with several fine terraces, the upper one a table several miles in extent -- once an outlet North to the Truckee – an old lake undoubtedly…We passed the town [Elizabethtown] and camped two miles beyond, in Tim-i-lick Valley. The day had been warm, but the night was cold enough to make it up, the temperature sank to 20˚ F. [Farquar 1974:444].

Lieut. George M. Wheeler and his party of surveyors camped in Martis Valley in October 1876 during topographc mapping north of Lake Tahoe (Wheeler 1876:1282). The view of Martis Valley from Proctor's Station, a rail siding near Martis Creek, was described in Williams' 1876 tourist guide:

> On the left [south] will be noticed a large tract of flat land covered with timber, or stumps, and a ranche [sic] or two. Across this and over the range of hills beyond, lies Lake Tahoe. [Williams 1876:225]

The valley is shown as "Murtis Valley" on the 1865 General Land Office Survey Plat and the creek is shown as "Martus Creek" on the 1890 Nevada County map. On the "Map of the Placerville Route" (ca. 1867-1868), Martis Valley is shown to extend north of the Truckee River towards Prosser Creek. "Martis Valley" is described as "open valley" on Von Leicht and Hoffman's 1874 map. It is supposed (but unconfirmed) that Martis, ultimately for whom the creek, peak, and valley were named, was a rancher in the valley (Lekisch 1988:87; Scott 1973:467).

The rich meadowlands of Martis Valley became a center for dairying operations. Notable land owners in Martis Valley included the Cavitts, Joergers and Waddles. "Families in our area were the Cavitts and the Joergers and our relatives, Uncle Roy's family [Roy Joerger], Uncle Elmer's family [Elmer Joerger], and later, the Waddles, our cousins, who owned the land but did not live in the area" (Gladys Joerger Gray n.d.:1). The dairy business in the Truckee Basin flourished on a large scale from the 1860s until about 1930 (McGlashan 1982:13-17). During the 1880s up to 20 dairy farms had been established around Truckee (Edwards 1883:69-70; *Truckee Republican* 3/14/1883). Butter was the chief product, since milk would spoil without refrigeration. Truckee also boasted of beef grazed in high meadows where grass grew sweet and tender (Meschery 1978:48). However, the quality of grazing lands was sometimes affected by drought that dried up the grass and the water in the creeks before the end of the summer season.

Joergers

The Joerger family grazed both dairy and beef cattle for local and California markets. Born in Alsace-Lorraine in 1830, Joseph Joerger, Sr. came to this country in 1848. From 1851-1856 he worked at gold mining in the Folsom area. To support the demands of the surrounding mining and lumber camps, he bought 700 head of cattle and then for the next eight or 10 years he established his cattle business in El Dorado County, wintering herds in Clarksville with summer ranges around Silver Creek and Wright's Lake (McMills 1994:11). Although research sources are conflicting, Joerger may also have driven herds to Martis Valley as early as 1856, camping with his men and cattle until 1875 (Barte 1982:6; Jackson et al. 1982:166). Joerger homesteaded land in Martis Valley in 1876 and grazed 150 dairy cattle and 600-700 young beef cattle (Carter 1983:95; Huggins 1993:18; McMills 1994:11). He built a modest ranch complex in the northern half of the valley near Martis Creek; the "Old Joerger Ranch" remains as a prominent landmark on modern maps of Martis Valley. An undated historic photo serves as a representative example of the typical layout of a ranch complex. Luckily, captions are written above each building (with view to the northeast, structures are described from left to right): "chicken house, privy, Mabel and Joe Joerger Home, milk house, corrals, May and Roy Joerger Home, boys cabin." The location of the ranch complex (along with the road accessing it) is depicted as "Joergers" on 1911 and 1930 maps of the Tahoe National Forest. The ca. 1939 Metskers road map notes "Joergers" and shows at least one building and the access road. The ranch complex appears on the 1939 aerial photograph. On the 1940/1951 edition of the Truckee Quad, the ranch is referred to as "Old Joerger Ranch", with one building still appearing. The "Old Joerger Ranch" continues to be referenced on modern USGS topographic maps and U.S. Forest Service maps.

Joerger owned considerable land in Martis Valley (Oest 1998) and by the mid 1870's the family had taken over the largest and best pastureland in the valley. Joerger negotiated a series of land purchases, including the sale of holdings from Truckee lumberman, George Schaffer, and from Sisson, Crocker and Company. Joerger family tracts extended to the north bank of the Truckee River and cattle were grazed along the river (Cindy Tong, personal communication 2006 in Lindström et al. 2007). The 1913 Map of Nevada County shows considerable Joerger land holdings due north of present SR 267. The family also owned land south of the highway, as shown on an Eldorado National Forest Grazing Map dating ca. 1944-1945.

Joerger began producing butter almost exclusively in order to supply the lumber camps proliferating around Martis Creek, but not only for human consumption. Local legend maintains that Joerger sold thousands of pounds of butter to the Richardson Brothers to grease the log skids of their pine pole railroad.

Joseph Joerger, Sr. retired from the ranching business in 1900 at age 70; he died in 1914 at the age of 84 (McMills 1994:11). He had six children and upon retirement he turned the ranch management over to his two sons, LeRoy and Joseph Emil Joerger (Anon n.d.:15; Barte 1982:6; Carter 1983; McMills 1994:11). The brothers worked together as partners from 1905 until 1916 when LeRoy left the area. Joseph E. Joerger continued operations for many years, just as his father had done. Early on he operated a creamery and sold milk and cream. Later on he installed milking machines. A separator and churn were run by steam from an outdoor boiler fired up with limbs cleared from the timber (Gladys Joerger Gray n.d.:2). Also, veal was slaughtered on the ranch and the meat sold in Truckee. By the 1930s increased road traffic made cattle drives unfeasible so Joerger began shipping cattle -- first by train and later by truck. Eventually dairying was discontinued in favor of raising beef cattle (Anon n.d.:15; Barte 1982:6; McMills 1994:11).

A "new" ranch house was built in 1941 on the southwest side of the valley (McMills 1994:11). It appears on the 1952 aerial photograph and is referenced as "Joerger Ranch" on modern USGS topographic maps and U.S. Forest Service maps. Truckee pioneer, Frank Titus, visited the ranch in 1948 and recalls the presence of a house and barn. Joerger delivered milk to the Titus family in town (Frank Titus, personal communication 2010). Joseph E. Joerger, Jr. continued the cattle business in Martis Valley until his death in 1961 (Anon n.d.:15; Carter 1983; McMills 1994:11). The high costs of cattle transport and increasing property taxes forced the family to sell the cattle and most of the land shortly thereafter (Barte 1982:6; Carter 1983).

Born in 1877, Joseph E. Joerger Jr. was the oldest son. He had three children, including Bertha Joerger Wolverton and Gladys Joerger Gray. Both women have provided valuable oral histories regarding family life. Gladys has summarized some of her father's endeavors and accomplishments (Gladys Joerger Gray oral history n.d.:1).

> Our father had nothing of his own except his own hard work and vision and he began to buy land whenever he could. And he was the first of the early conservationists in Martis Valley. He began many ranch practices early that are now common.
>
> 1. He made experiments on the Airport land with various seeds and grasses to improve the natural grasses of the area.
> 2. He welcomed and protected the beaver that were brought in to stock the creek areas and to build beaver dams to conserve the runoff of winter water.
> 3. He protected the sage brush from thoughtless people who would run cars over it because the sage gave protection to the grass.
> 4. He build [sic] many rock dams so that water could be used to irrigate the meadow areas and to stop erosion of the soil and to slow the run off of winter snow.
> 5. He developed springs so the water could be used, put in tanks to hold the water for later use.
> 6. He had a fine well dug near the office in the area of the Airport.
> 7. He cut contour furrows around the base of the low hills to irrigate, sodded in the furrows to hold winter rains. This tended to anchor the soil.
> 8. Fertilizer from the corrals was spread on the calf lot and other fields to improve the land and grass production.

Cavitts

Martis Valley resident and Joerger family member, Art Tong, has confirmed Cavitt ownership of the meadowlands surrounding the present Wildlife Viewing Parking Area (personal communication 2010). More precisely, land ownership maps dating from 1909 and 1915 and miscellaneous Placer County township and range maps dating from ca. 1938 indicate that Cavitts owned all of Section 30 (Township 17 North, Range 17 East) except the east ½ of the southeast ¼ and the southwest ¼ of the southeast ¼, which was owned by Joseph Joerger.

> ..they [the Joergers] were the only neighbors we had. That ranch right now is right across from the Truckee Airport. [Willma Cavitt 1989:7]

The Cavitt ranch complex was situated in sections 19 and 30 (Township 17 North, Range 17 East). On a ca. 1944-1945 Eldorado National Forest Grazing Map, the word "Cavitt" is hand-written in the southwest ¼ of Section 19. A historic photo dating from 1956 pictures the Cavitt's "mountain ranch" in Martis Valley (McGlashan 1982:16-17). The complex (as shown on aerial photographs dating from 1939, 1952, and 1966) comprised a number of structures (residence, sheds, corral, well, etc.), access road, and possibly a number of outlying ranch features to include fences, irrigation ditches, a dam, and miscellaneous ranch roads and stock trails. These features appear on the 1939 aerial photograph, but the network of trails is considerably enlarged on the 1966 aerial photo.

In 1905 local dairyman, Samuel Cavitt started dairying in Martis Valley, grazing 50 cows on land first homesteaded by his uncle years earlier. The family had their winter range in western Placer County (Roseville) and eastern Sacramento County (Folsom). Sam was the son of James H. Cavitt who first operated a business on River Street in Truckee town. Sam sold his dairy to the Joergers in 1917 and bought another in Sardine Valley (McGlashan 1982:17); however, he still maintained holdings in Martis Valley. Sam Cavitt died in 1911 and was survived by his wife and three sons -- Jerry, William ("Bus") and Jim (Lois Cavitt 1989) who all continued the family dairy business (McGlashan 1982:17). Jim Cavitt had a ranch in Sierra Valley (Carter 1983) and Jerry Cavitt and his wife, Lois, built their ranch on Prosser Creek. Bus Cavitt and his wife Willma bought the family winter ranch in Roseville/Rocklin and the mountain ranch on Martis Creek from Sam Cavitt's widow in 1937 (Willma Cavitt 1989:1, 3, 9). In the 1960s, the couple had to sell their ranch to the USACE in advance of construction of the Martis Dam. Their mountain ranch encompassed 474 acres (Lois Cavitt 1989:3). Oral histories provided by Lois Cavitt (wife of Jerry) and Willma Cavitt (wife of Bus) provide insights into ranch life on Martis Creek.

> Mr. Cavitt [Bus] was a dairyman and in May we would always go to our mountain ranch which was in Martis Valley, which is across from the Truckee airport. [Lois Cavitt 1989:2]

> The Mountain Ranch was a happy, happy, happy place because Martis Creek was right by the house. People would come out there and go fishing and they could get fish right out of that creek and from the creek right into the frying pan. [W. Cavitt 1989:6]

> …we dammed the creek. We had loads of company up there. The house was small – I had a kitchen – there was a middle room and a bedroom. I had two beds, one bed in the middle room and a wood stove for heat in the wintertime. In the other room there was a double bed and a twin bed. Then we put – I called it a dormitory – the whole length of the house – and if necessary, I could sleep 13 people – upstairs and downstairs too. We built a bathroom – that house had been – the outside had been renovated several times because it was so old.

" …I don't know [who built the house]. It was there when we arrived. But we had loads of company" (W. Cavitt 1989:6-7). Ranch buildings likely predate 1937 when Bus and Willma Cavitt bought the property. At least some of the buildings may have been built by Sam Cavitt, sometime between 1905 and 1937.

> We had an old Ford…Kids used to play in that. There was a radiator there and they would fill it up with water from the ditch…We'd go across the meadow and look for arrowheads – and go up by the old oak [sic, pine] tree and look for arrowheads. I've got a lot of them that we found. [W. Cavitt 1989:7]
>
> The war took all the helpers that we had – we had three boys that helped milk the cows. The cows were milked by machinery. [Lois Cavitt 1989:3]
>
> When the cows ate all the feed on that ranch, we would move to Boca and would stay there until they ate all the food there [sic] was there, then we would go back to Martis Valley. Then we would go back to Boca. They were driven back and forth. After the Little Truckee was damned in Boca, we lost all that feed. We moved to Prosser Creek. I used to move five times a year…In the fall, we'd come back to this ranch down here [Roseville-Rocklin area]. [Lois Cavitt 1989:3]
>
> When we moved out for the winter and came down to Folsom, we took everything from the pipes to the light globes out of the house. One year I forgot to take the chandelier…" and the house was vandalized. [Lois Cavitt 1989:9]
>
> We had to sell the Mountain Ranch to Douglas [sic, Placer] County because they wanted to dam Martis Creek. They said that Reno needed water. I had a letter from the Army Corps of Engineers saying that they would never do that, that it was a political deal. [Carter 1983; Willma Cavitt 1989:9]

Ranchlands owned by both the Cavitts and the Joergers were included in this transaction under the right of eminent domain. Buildings on the "Old Joerger Ranch" were torn down (Carter 1983; Gladys Joerger Gray oral history n.d.:2; McMills 1994:11); it is uncertain whether the USACE also demolished structures on the Cavitt Ranch.

SHEEPHERDING

During the height of the Sierran sheep industry, sheepherders grazed the lower quality grasslands on the margins of Martis Valley. George Mills ran some of the largest herds of sheep in northern California, in addition to dairy stock. He leased land west of Martis Creek for grazing (*Truckee Republican* 5/18/1907). Sheepherding continued in Martis Valley through the 1960s (Richards, personal communication 2005 in Lindström et al. 2007).

Gladys Joerger Gray (n.d.) recalls: "…there were Basque men who ran sheep in the area of the back mountains where the cattle couldn't go." Notations on an Eldorado National Forest Grazing Map (n.d.) further confirm the presence of Basques in Martis Valley, referring to a sheepherder named "Sagadi." "Sagadi Land Used by Joergers 1944-1945" is hand-written in the northwest ¼ of Section 29 (Township 17 North, Range 17 East. Historic photos document a Basque camp and rock oven once located near the golf club house. These may be remnants of the Sagadi camp.

During the 1850s over 500,000 sheep crossed Nevada on their way to California markets. By the 1860s the trend had been reversed, as millions of California sheep were trailed from California to the mining camps of the Great Basin and railheads in the plains (Douglass and Bilbao 1975:214). Some bands were large, numbering 1,000 at a minimum (Mallea-Olaetxe 1992:30) and seasonal transhumance of the herds sometimes involved treks of several hundred miles. Most of the herding was done by Basque shepherds. Itinerant Basque shepherds left a legacy of their passing in the form of carved aspens. Crossroads, streamlands and popular sheep camps were chosen as strategic locales to carve "billboards" in the aspen groves. These carvings served to mark territories and the names and dates carved on trees document the years sheep were grazed and identify the roads and trails they followed (Mallea-Olaetxe 1992:33). In the Truckee-Tahoe basins, carvings commonly date from the months of June through September after the turn of the century, with the most intense grazing dating during 1920s-1930s and even into the 1950s-1960s. Grazing was curtailed in the last half of the 20th century due to stricter government regulation and competition for grazing lands by recreational and residential/commercial development in the Sierra Nevada.

Environmental Impacts

A livestock business developed around the lush meadows and valleys, which generally supported cattle and the high meadows, which were used for sheep. With little or no restrictions on grazing, sheepherders in particular grazed their livestock at will, sometimes too early in the season. Persistent small fires were started by shepherds in order to improve forage for the following season. These practices had a variety of negative ecological consequences. Sheep and cattle denuded high-elevation alpine areas and lower-elevation wetlands, meadows and forest floors. Sheep were thought to be more destructive than cattle. The Washoe were especially affected by the impacts of livestock grazing in the basin, which altered the composition and vigor of native plants (Elliott-Fisk *et al.* 1996). Over-grazing in many wetlands and meadows and on forest floors during the first half of the 20th century produced lasting changes in communities of grasses, forbs and shrubs (McKelvey and Johnston 1992). By 1902 the decline of rangelands in Martis Valley was noticeable, as Leiberg observed:

> The flats of Martis Valley…afford good locations for farms. Although the climate is too cold to make general agriculture successful, it is nevertheless probably that much of the level tracts…would produce crops of hay of the hardier kinds of grasses under irrigation….All of the Basin [Truckee Basin], whether under fence or unenclosed, is utilized for pasture. The slopes and summit of the main range are closely pastured by sheep, the levels by cattle. All the unenclosed flats along Prosser Creek, Little Truckee River, and in Martis Valley have been overpastured and their grass eaten out long ago, only sagebrush remaining. [Leiberg 1902:175]

Early-season entry into rangelands and excessive over-grazing exterminated native browse species in many areas, increased erosion, slowed forest regeneration, and altered forest stand structure.

> In the northern areas of the basin [southern Truckee Basin] restocking of the logged areas is moderate, while on many of the burned tracts the brush growths are giving way to dense masses of sapling white firs…excessive grazing and trampling of sheep kill out the seedling growth. [Leiberg 1902:182]

> Excepting in high mountain meadows, all of which are fenced and which are grazed by cattle, the principal forage for sheep and cattle on the open forest range consists of a few hardy shrubs and low broad-leaf trees. There are practically no grasses or other herbaceous plants. The forest floor is clean. The writer can attest the inconvenience of this total lack of grass forage, for in traveling over nearly 3,000,000 acres not a single day's feed for saddle and pack animals was secured on the open range...it is evident that formerly there was an abundance of perennial forage grasses throughout the forest in this territory...it would seem that this bare condition of the surface in the open range has been produced only through years of excessive grazing by millions of sheep - a constant overstocking of the range. [Sudworth 1900:554-555]

> The trampling of thousands of sheep pastured on these slopes during summer and fall reduces the soil, to a depth of 6 or 8 inches, to the consistency of dust. Rain washes this dust into the creeks and rivers, and heavy winds lift it up and carry it far away....[tree] seeds are largely shed in July and are trampled into the ground and destroyed. All seedling trees on the sheep runs are either cut off below the ground by the sharp hoofs of the animals or uprooted and trampled. In these runs, where trees have succeeded in establishing themselves, they are bent and stunted. Nothing whatever except excessive sheep grazing prevents a uniform stand of timber of medium density on these grassy glades, and while sheep are pastured there they never will return to forest cover. [Leiberg 1902:45]

Upon leaving "fed-out" seasonal grazing lands, Basque shepherds set fire to high-elevation meadows and shrublands and burned many large downed trees. They were criticized for deliberately setting fires to improve the range and facilitate movement of sheep through the forest.

> The chaparral areas will be brush covered, very much as they are, because they will be burned now and then so as to furnish fresh browse for the sheep, and the burnings will serve only to increase the density of the next stand of chaparral. [Leiberg 1902:52]

> The belief is generally held that the sheep herders fired the country in all directions and have been responsible for most of the fires of recent years...all the fires observed during the last summer closely followed the sheep camps. [Leiberg 1902:41]

> No less than seventeen such fires of this kind were found on the trail of one band of sheep, covering a distance of 10 miles. [Sudworth 1900:555-556]

ICE INDUSTRY

From 1868 through the 1920s, ice harvesting rivaled the economic importance of the lumber industry (Earl 2004; Hansen 1987; Itogowa 1974; Lord 1994:36). "There was quite an industry of ice cutting at Polaris to ice the fruit cars before being shipped to the East…" (Gladys Joerger Gray n.d.). Eastern ice and Alaskan ice were costly and undependable so closer sources were sought.

With the completion of the first transcontinental railroad across Donner Pass in 1869, ice could be harvested and transported cost-effectively and Truckee-Donner ice soon dominated the industry (Macaulay 2002:2). Sierra ice was noted for its superior quality and crystal purity and it was proudly served in grand hotels throughout the nation. Yet, the Truckee ice industry targeted commercial demands for cooling rather than the market for domestic consumption. Truckee ice allowed the expansion of Comstock mining and was shipped to the mines of Virginia City where miners found temporary relief from the 140-degree temperatures in ice-cooled chambers (Earl 1996:12; Lord 1994:36; Meschery 1978:48). Truckee ice enabled the growth of California's agricultural industry, whereby iced box cars shipped produce to meet the demands of eastern markets.

Ice works were established in Martis Valley. In 1873 attempts by the Nevada Ice Company to manufacture ice along upper Martis Creek failed because the firm lacked adequate transportation to distribute their product directly from their ponds to the railroad (*Truckee Republican* 1/23/1874:3/2; 2/11/1873:3/1). In 1884 Sisson Crocker and Company created a new ice company that was strategically located at the mouth of Martis Creek, with easy access to rail transport at Martis Creek Station. The Truckee Ice Company was one of the smaller plants in the Truckee Basin. Although it was considered to be an independent company, its principals (including A. W. Sisson) were part of a deep and profitable financial network. Construction of the ice works commenced in 1885, ice harvests continued until 1895 (*Nevada County Mining Review* 1/1/1895) and competition finally forced the plant out of business in 1898 (*Truckee Republican* 8/8/1898).

RECREATION AND COMMUNITY DEVELOPMENT

With construction of the first transcontinental railroad through the Truckee Basin, and with the coming of the first transcontinental highway through Truckee, local businessmen were poised to take full advantage of the region's summer and winter recreation and tourism opportunities. However, this new-found population base in Truckee impacted traditional lifeways in Martis Valley, as expressed in the oral histories of some of its pioneer residents.

> Deer ate the salt put out by the cattle people but our family did not kill the deer, they were too busy to hunt, though many outside people came to the area to hunt in the fall. [Gladys Joerger Gray oral history n.d.:2]

> Martis Creek was stocked with fish regularly by the Fish and Game, but again, we did not fish, we had no time, it was the sportsmen who caught them. [Gladys Joerger Gray oral history n.d.:2]

> Ranch hands put out many lightning-set fires in the large pine trees near the ranch. Now the rangers take care of that. Through the years, Christmas trees have been cut under supervision to thin the groves and to bring in income to help meet land taxes. There have been many years when cattle prices were so low, the rancher would have nothing to eat on if he hadn't been very frugal. [Gladys Joerger Gray oral history n.d.:2]

Martis Valley's first airfield was completed in 1929 on the nearly flat sagebrush-covered plateau on the former Joerger family's ranch. The project was partly financed by the Tahoe Sierra Association and Charles Tanner, a local taxicab/limousine/air service operator. The one-mile-airstrip was enlarged after the late 1950s (Scott 1973:155-156). "Martis Valley Airport" appears on a 1962 map of the Tahoe National Forest, Truckee Ranger District. Further improvements in 1964 allowed increased air access to Tahoe's north shore for vacationers and part-time businessmen. The airport is referenced as "Truckee Tahoe Airport" on the 1976 U.S. Forest Service, Lake Tahoe Basin Management Unit map. Joseph E. Joerger donated and sold land along Highway 267 for the construction of the airport; he even tractor-cleared the land so planes could land (Gladys Joerger Gray n.d.:2; McMills 1994:11). However, airport development virtually cut the Joerger ranch in half and rendered the parts at the creek barely usable (Barte 1982:6; Carter 1983). Ranchers were already struggling with the high cost of cattle shipment and increasing property taxes and with the construction of the Truckee-Tahoe Airport, cattle-raising in Martis Valley was ultimately phased out (Barte 1982:6).

Martis Valley ranchers were further discouraged by the influx of visitors and the growing emphasis on recreation and subdivision development, which made the wanderings of stock particularly unwelcomed (Barte 1982:6). Sierra Meadows and Ponderosa Palisades subdivisions backed up to Joerger property. "They began to get into people's yards and we got complaints. That was when we had to fence…Prior to that the cattle ran clear to Truckee" (Carter 1983). The development of the ski and residential community at Northstar, which began during the 1970s (as shown on the 1972 aerial photograph), further altered the character of Martis Valley, as lamented by Lois Cavitt (1989:10): "I've never gone back to the Mountain Ranch, and I never will go back…It's heart-breaking. Now North Star is there…"

Construction on the Martis Dam and Martis Lake by the U.S. Army Corps of Engineers commenced ca. 1970, with completion in 1972. The 1972 aerial photograph shows the lake starting to fill. In advance of dam construction, during the mid 1960s (ca. 1965) the USACE acquired approximately 1,800 acres in Martis Valley (Barte 1982). Ranchlands owned by the Joergers and Cavitts were procured in this transaction under the right of eminent domain. Buildings on the "Old Joerger Ranch" were torn down (Carter 1983; Gladys Joerger Gray oral history n.d.:2; McMills 1994:11); it is uncertain whether the USACE also demolished structures on the Cavitt Ranch.

> We had to sell the Mountain Ranch to Douglas [sic Placer] County because they wanted to dam Martis Creek. They said that Reno needed water. I had a letter from the Army Corps of Engineers saying that they would never do that, that it was a political deal. [Carter 1983; Willma Cavitt 1989:9]

The development of subdivisions and roadway construction and improvements in the 1960s and the construction of Martis Dam in 1970 required gravel materials, which were readily available on properties owned by ranchers in Martis Valley.

> Gravel is in plentiful supply in Martis Valley and it has always been used to advantage on the roads and in construction and has been almost the only source of income with which to pay taxes since ranching no longer pays in the Valley. [Gladys Joerger Gray n.d.:2]

> Back in those days, you could do all these things on your property – log the land, run the

cows and then dig sand and gravel pits. [Art Tong, personal communication 2010]

The Joergers had a borrow pit from where materials were dug to sand the summit. (This "quarry" is shown on modern USGS maps, being located on the north side of SR 267, west of the Martis Creek crossing, and east of the Wildlife Viewing Parking Area.) One winter they let water into the sand, it froze, couldn't be dug out so they lost their contract. To further supplement income, the Joergers also mined subsurface gravels that were used in construction of the dam. In addition the family operated a sand and gravel quarry on their land near the present Sierra Meadows subdivision (Art Tong, personal communication 2010). Another large gravel borrow pit is located near the center of Martis Valley. The quarry is accessed by a dirt road that exists westward from the Wildlife Viewing Parking Area. This access road appears to connect the borrow pit south of SR 267 to another large gravel pit on the north side of SR 267 (directly across from the Wildlife Viewing Parking Area). During the 1960s Art Tong worked at a batch plant inside this gravel pit on the south side of the highway. The plant operated for a few years and supplied materials for subdivision development at North Lake Tahoe (personal communication 2010). This gravel pit does not appear on the 1966 aerial photographs but shows on the 1972 aerials. Development of both quarries is coincident with construction of Martis Dam.

HERITAGE RESOURCE SENSITIVITY

From the prior discussion, it is clear that all of the Martis Watershed is at least moderately sensitive to contain heritage resources, with some areas being highly sensitive. Martis Valley is renowned for its large number of prehistoric archaeological sites, some of which exhibit relatively unique characteristics as compared to other sites in the region. There is a high density of surface remains and some sites contain midden (i.e., subsurface cultural deposit) that is visible to the eye. Possible year-round (including winter) occupation is reported. The site inventory for Martis Valley includes a rock shelter. A somewhat rare form of rock art (known as cupules) is present at several sites. An extensive prehistoric site complex occupies low and gently-sloping, sagebrush/bitterbrush-covered glacial terraces that border lush wet-meadows along Martis Creek and its unnamed tributaries. These sites tend to be large in size. Artifact assemblages document prehistoric occupation dating from at least the Middle to Late Archaic Period (4,000-500 years ago) and possibly extending into the protohistoric and ethnohistoric period. Oral histories provided by Washoe Elders and descendents of pioneer families evoke contact-period occupation in Martis Valley, although this has yet to be confirmed in the ethnographic and archaeological records. Archaeological evidence (albeit meager) provides further support for contact-period occupation in the valley, as marked by the presence of trade beads, late-period arrow points and miscellaneous tools fashioned from historic glass, etc. Unauthorized artifact collecting by residents and visitors has occurred since pioneer days and several large private collections of Martis Valley artifacts are housed locally and in the Reno area. Fortunately, a considerable body of systematic archaeological work has been accomplished in Martis Valley to counter this vandalism.

Euroamerican occupation of the valley's meadowlands tends to reflect cattle ranching/grazing activities by the Joerger and Cavitt families, who grazed stock from the 1870s into the 1960s. Indications are represented by ranch complex remains and outlying linear features such as irrigation ditches and dams, dirt roads, stock trails, and fence lines. Sheep were grazed in the uplands of the watershed. The most intensive period was during the 1920s-1930s, with grazing continuing until the 1960s. Evidence of grazing activities includes Basque aspen carvings, camps containing distinctive rock ovens, and a network of stock trails and drive ways.

In 1863 a number of quartz ledges were discovered in Martis Valley's Red, White, and Blue Mining District. The strike was short-lived and mining towns and diggings were deserted within several months. Mine exploration pits, adits and tunnels (representative of hard rock mining during this early era) have been recorded in the hills surrounding Martis Valley and placer tailings occur along the creek bottoms. In advance of recreation, residential and commercial development beginning in the 1960s, Martis Valley's gravelly bottomlands were again mined, but this time for the gravel and sand needed to construct an expanding transportation network and subdivision development.

The periodic occurrence of historic high-cut stumps throughout the Martis Watershed is testimony to historic logging activities. From the early 1870s until about 1906, intense harvesting of pine stands began with George Schaffer in the southern and western portions of the watershed and the Richardson Brothers on its southeastern flanks. The Truckee Lumber Company logged its lands in the eastern part of the watershed during the late 1890s, with logging of their lands in the vicinity of Sawtooth Ridge in the extreme western part of the watershed in the decade following the turn of the century. Floriston Pulp and Paper Company (and its subsidiaries including Crown-Columbia, Crown-Willamette and Crown-Zellerbach corporations) re-entered timber stands in the southern half of the watershed to harvest fir after 1900 and into the 1920s. Fibreboard Products Inc. began acquiring timber tracks from Crown-Zellerbach Corporation during the 1940s. The operations of Fibreboard are responsible for most modern-era logging into the 1970s, particularly in the vicinity of the present Northstar resort and subdivision.

PROTOCOL FOR FURTHER HERITAGE RESOURCE STUDY

The cultural overview and historical context presented in the *Martis Valley Workbook* provide the necessary background information to conduct further heritage resource studies that may be required as part of site specific watershed restoration and protection projects. The Truckee River Water Council has not yet finalized plans for project development. In that event, conditions of project approval in future stages of project planning are likely to involve: (1) heritage resource inventory to locate and record cultural resources; (2) formal evaluation of resource significance, (3) determination of project effect, and (4) mitigation of project impacts. These tasks, which are outside the current project scope, would be accomplished concurrently with the preparation of the CEQA and/or NEPA document and in consultation with appropriate agency officials and with the Washoe Tribe. Environmental review policies, which are in compliance with federal antiquities mandates (under Section 106 of the National Historic Preservation Act) and guidelines established by the California Environmental Quality Act (CEQA Section 5024, Public Resources Code), require that a study be performed to inventory and record heritage resources prior to any ground disturbance activities that may be associated with any restoration and protection projects within the watershed. Such heritage resource studies are customarily performed in a series of phases, each one building upon information gained from the prior study.

PHASE 1 INVENTORY: First, archival research and an archaeological field reconnaissance are performed to ***inventory*** and ***record*** known heritage resources and identify potential project constraints. Phase 1A of the inventory generally involves prefield research and a records search at the designated state archaeological clearing house, in this case the North Central Information Center at California State University, Sacramento. Contact with the appropriate Native American group, in this case the Washoe Tribe, is also initiated. Prefield research is followed by a field reconnaissance to identify surface sites, features and/or artifacts. If heritage resources are discovered, Phase 1B heritage resource recording is accomplished.

PHASE 2 EVALUATION: If heritage properties are present and if they may be subject to project-related impacts, their significance is ***evaluated***. For significant resources, a ***determination of project impacts*** (or effects) is assessed and detailed measures to mitigate impacts are proposed. If project redesign to avoid impacts is unfeasible, then ***mitigation measures*** are ***recommended*** in order to recover the significant information contained within these heritage properties, exhausting their data potential prior to project ground disturbance activities. Evaluations done at prehistoric or ethnographic/ethnohistoric sites include further consultation with the local Native American community.

PHASE 3 IMPACT MITIGATION AND DATA RECOVERY: A final phase may involve the ***implementation of mitigation measures*** recommended during the prior evaluation phase. Mitigation (or data recovery) typically involves additional archival research, field excavation, photo documentation, mapping, archaeological monitoring, interpretation, etc. Impact mitigation for prehistoric or ethnographic/ethnohistoric sites is also done in cooperation with the local Native American community.

SIGNIFICANCE

The significance of a heritage resource is typically evaluated in terms of criteria established in the National Register of Historic Places (NRHP), as authorized under the National Historic Preservation Act of 1966, as amended. The California Environmental Quality Act (CEQA) also includes provisions for significance criteria related to historic and prehistoric archaeological resources [Public Resources Code Section 21083.2(g) and 21084.1]. The Public Resource Code was amended (in 1992) with the addition of Section 5024.1, which authorized the establishment of the California Register of Historical Resources (CRHR). The NRHP is an elite register of heritage properties that falls under jurisdiction of the federal government. While the NRHP is considered to be the register of heritage properties on a national scale, the CRHR ascribes to similar but less stringent criteria, targeting properties of state and local significance. If a heritage property is determined to be eligible for the NRHP, generally it then automatically qualifies for the CRHR. However, the situation does not necessarily work in the reverse and properties that qualify for the CRHR may not be eligible for the NRHP.

The criteria inherent in state evaluation standards, guidelines, and advisories incorporate the basic tenants of significance criteria established by the NRHP. National Register criteria (defined in 36 CFR 60.4) focus on a resource's associations with significant ***events*** (Criterion A) and ***personalities*** (Criterion B) in the nation's history and cultural heritage; a property's ***distinctive*** technical, architectural or artistic ***characteristics*** (Criterion C); and/or a property's ***information***

potential (Criterion D). Resources are evaluated within a specific and important time frame or ***period of significance*** during which time the property was occupied or used. (Sequential or overlapping periods of significance are possible.) A property must be at least 50 years old (unless it is an "exceptional" younger property) and archaeological remains must be associated with an era that has been designated as significant.

To be listed in the NRHP or CRHR, a property must not only be shown to be significant under one or more of these criteria, but it must also have ***integrity***. The quality of significance in American history, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association. In other words, the property must remain in its original location and retain the ability to convey its historic associations.

IMPACTS

Once a heritage resource has been recorded and if it is determined to be significant, the potential impacts (or effects) of a project on a heritage property are assessed. Federal regulatory impact thresholds are contained in Section 106 of the National Historic Preservation Act and accompanying regulations (36 CFR Part 800). A project is considered to have an adverse effect when the effect on a historic property may diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association, or the quality of data suitable for scientific analysis

An assessment of potential project impacts at the state and county level is conducted within the context of CEQA Section 15064.4-5 Guidelines. For the purposes of CEQA, impacts to "historical resources" and "unique archaeological resources" that are significant are defined in CEQA Guidelines Section 15064.5(b). Adverse effects include physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings (Section 15064.5(b-1,2).

For watershed restoration and protection projects located on federal lands, consultation with the appropriate agency official, the State of California Office of Historic Preservation, and the Washoe Tribe (if Native American resources are involved) is generally required to assure that the inventory and evaluation process is complete and that appropriate mitigation measures are incorporated into project planning to avoid adverse effects to heritage resources. In the event of eminent project related impacts, options for mitigation measures and management alternatives might include: (1) preservation; (2) interpretation; (3) data recovery; (4) management as a ruin; and/or (5) removal from management consideration.

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APPENDIX A

- Washoe Plants and Use Categories

CORRESPONDENCE

- Washoe Tribe of Nevada and California

MAPS

PHOTOGRAPHS

OVERSIZED MAPS

- Historic Land Ownership: ca. 1869-1909 (county maps and deeds)
- Historic Land Ownership: ca. 1909-1938 (county maps and deeds)
- Cut-Over Private Land (U.S. Forest Service Cut Plats)
- Heritage Resources (approximate locations)

APPENDIX A

WASHOE PLANTS AND USE CATEGORIES

(reproduced from *An Ethnobotanical Assessment of the Sunset Stables Reach of the Upper Truckee River with Notes on Washoe Environmental Knowledge*, prepared by Penny Rucks, June 2007)

Table 1. Washoe Plants and Use Categories

Scientific/ Common Name	Washoe Name	F/M	RF	C
Achillea millefolium/ yarrow	*Wémši* (wemsheh)	X		
Allium companulatum/ dusky onion	*Bošdi* (bosh-dee)	X		
A. validum/ swamp onion	*Búye* or *pu yeli* (booyeh or puh-yeh-lit		X	
Amelanchier ainifloia var. *pumlia*/ western service berry	*Šu wet k* (shoo-wet-uk)	X		X
Arctostaphylos patula/greenleag manzanita	*eyéye e* (ay-eh-yeh)	X		
Balsamorhiza sagittata/arrow-leaf balsam root	*Šú'gilá' ći'* (shoo-gil-au-tzee)	X		
Camassia quamash/small camas	*Sésmi*		X	
Fragaria virginiana/mountain strawberry	*Ma alaŋi* (Mah-all-aung-eeh)	X		
Heracleum lanatum/cow parsnip	*K'ómho* (kh-om-ho)	X		
Lilium parvum/Sierra tiger lily	*Silá't́whu* (Silah-tz-aw-hoo)	X		

F/M = foods consumed seasonally or medicines
Real Food = food plants collected and processed for storage
C = construction

Scientific/ Common Name	**Washoe Name**	**F/M**	**RF**	**C**
Lupinus polyphyllus var. *burkei*/bigleaf lupine	*Wadaša* or *Wadákša*		X	
Mentzelia dispersa/ bushy blazing star	*Dáhal* (dah-hall)		X	
Peonia brownii/ Mountain peony	*Tuyá'g mhu* (too-yah-gum-hoo)	X		
Perideridia spp./ Yampah	*Déguš* (day-gush)		X	
Pteridim aquilinum var. *pubescens/* bracken fern	*Megé eš* (me-gee-ish) or mešewé'geši			X
Ribes rozelii/Sierra gooseberry	*Séw t yá'g l*	X		
Rorippa nasturtium-aquaticum/water cress	*ulipánt́za* (oolee-pon-tza) Watercress	X		
Rosa woodsii var. *ultramontane*/ interior rose	*Pećumeli* (petz-umel-eeh)	X		X
Triteleia hyacinthine/white brodiaea	*Ma hal* (mah-all)	X		
Typha latifolia/broadleaf cattail	*Mahat́álal* (ma-hat-alal)	X		X
Verattrum californicum var. *californicum/* California corn lily	*Badópo* (baa-doe-po)	X		
Wyethia mollis/wooly wyethia/mules ear	*Šú'gil* (shoo-gil)		X	

APPENDIX B

TIME LINE OF HUMAN HISTORY IN MARTIS VALLEY
(Summary by Heritage Themes)

TIME LINE OF HUMAN HISTORY IN MARTIS VALLEY
(Detail)

MARTIS WATERSHED ASSESSMENT
TIME LINE OF HUMAN HISTORY IN MARTIS VALLEY
SUMMARY BY HERITAGE THEMES

Date	**Event**
Prehistory	
9,000 years ago-1840s	prehistoric period
Mining	
1863	Red, White and Blue Mining District (hardrock and placer mining)
Transportation	
1840s-1850s	emigrant travel
1868-1869	first transcontinental railroad/Martis Creek Station
1869	Old Brockway Road (modern State Route 267)
1913-1914	first transcontinental highway
Logging	
1869-1906	intensive logging of pine forests
1900-1920s	intensive logging of fir forests
1940s-1970s	stand re-entry/modern-era logging
Ranching/Grazing	
1870s-1950s	intensive cattle ranching and dairying
1920s-1950s	intensive sheep grazing
Recreation and Community Development	
1960s-present	aggregate mining; subdivision and ski area development; Martis Dam

MARTIS WATERSHED ASSESSMENT
TIME LINE OF HUMAN HISTORY IN MARTIS VALLEY
DETAIL

Date	*Prehistory*
9,000 years ago	prehistoric ancestors of Washoe Indians begin to populate region
	Historic Events
1844-1850s	-Emigrant travelers pass through Truckee River corridor and the mouth of Martis Creek
5/1863	-Houton & Ives survey of the Nevada and California state line enter Martis Valley -survey of trans sierran wagon roads begin with alternate route of the Dutch Flat and Donner Lake Wagon Road surveyed along the present State Route (SR) 267 -surveyors discover silver/gold deposits
5-9/1863	-Red, White and Blue Mining District established; hundreds of miners enter the valley, digging coyote holes and tunnels; two mining towns established; strike is over by 1864; miners leave and towns abandoned
1863	-Grays Toll Station (present Truckee) established
1868-1869	-Completion of Transcontinental Railroad through Truckee; Martis Station established at mouth of Martis Creek
8/1869	-Billy Campbell and George Schaffer grade first wagon road (Old Brockway Road) through Martis Valley connecting Truckee and north Lake Tahoe (route along present route of SR 267)
1869-1874	-Caspar Schoch Shingle Mill on West Martis Creek
1869	-Martyr's Creek Wood Company had from 175 to 500 men cutting shingles and cordwood for the railroad
1869	-Hawthorne & Company builds two-mile-long V-flume to float shingles to Martis Station
1869-1878	-Sam McFarland operated a saw mill along the Old Brockway Hot Springs Road
1871-1903	-George Schaffer logs south-southwestern quadrant of Martis Valley in the headwaters of Martis Creek, constructing two sawmills, high-elevation logging camp, millpond, two-mile-long logging railroad, and a 3 ½ -mile-long V-flume to his mill in Truckee
1872-1886	-Sisson, Wallace and Company upgrade old Hawthorne & Company's V-flume, extending it a distance of four miles; flume transported wood for McFarland and Richardson Brothers sawmills
1873	-Nevada Ice Company attempts to build ice works along upper Martis Creek but is unsuccessful

1874-1906	-Richardson Brothers log east-southeastern quadrant of Martis Valley in the headwaters of West Martis, Middle Martis and East Martis creeks, constructing two sawmills, 10-mile-long logging railroad, and V-flume connecting to the Sisson, Wallace and Company flume and their mill at Martis Station
1876	-Dairyman and stockman Joseph Joerger homesteads land in Martis Valley
1876-1961	-Joerger family bases operations out of "Old Joerger Ranch" along Martis Creek -ranch complex relocated to southwestern part of the valley in 1941
1883	-Upgrades along Old Brockway Road
1885-1895	-Sisson, Crocker and Company operates ice works at the mouth of Martis Creek
1893-1901	-Pacific Lumber & Wood Company built Donner & Tahoe Railroad to transport logs to Truckee from timber tracts owned by the Truckee Lumber Company along the flanks of Martis Peak; logging staged out of Klondike and Monte Carlo meadows and Dry Lake
1899-1929	-Floriston Pulp & Paper Company (later known as Crown-Columbia/Crown-Zellerbach Corporation) begin acquiring timber tracts around north Lake Tahoe and Martis Valley to harvest fir for paper production
1905	-Dairyman/stockman Sam Cavitt establishes ranch in Martis Valley (ranch complex is built along Martis Creek in the vicinity of the present Wildlife Viewing Parking Area)
1910s-1960s	-Basque sheep-herders grazed sheep in the uplands of Martis Valley
1922	-Crown-Zellerbach Corporation purchases 3,500 acres from Richardson Brothers, operating several miles of logging railroads and staging pulpwood cutting from Sawmill Flat
1929	-Martis Valley airfield (later known as Truckee-Tahoe Airport) commenced operations
1937	-Sam Cavitt's son (William "Bus" Cavitt) buys the ranch and continues operations until ca. 1950s
1940s	-Fibreboard Corporation purchases land from Crown-Zellerbach
Late 1950s	-Truckee-Tahoe Airport's one-mile-long airstrip enlarged
1964	-Further improvements at Truckee-Tahoe Airport
1960s (ca. 1950s?)	-Fibreboard Corporation logs in the vicinity of Northstar-at-Tahoe
1964	-Old Brockway Road paved (SR 267)
1960s-1970s	-Period of active aggregate quarrying to facilitate subdivision developments on Lake Tahoe's north shore and construction of Martis Dam by U.S. Army Corps of Engineers
1970	-Begin construction of Martis Dam; completion of dam in 1972
1970s	-Northstar ski area and subdivision developments

CORRESPONDENCE

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DATE: April 6, 2011

TO: Darrel Cruz, Tribal Historic Preservation Officer
Washoe Tribe of Nevada and California
919 Hwy 395 South, Gardnerville, NV 89460
775-888-0936 (775-546-3421 cell)
darrelcruz@washoetribe.us

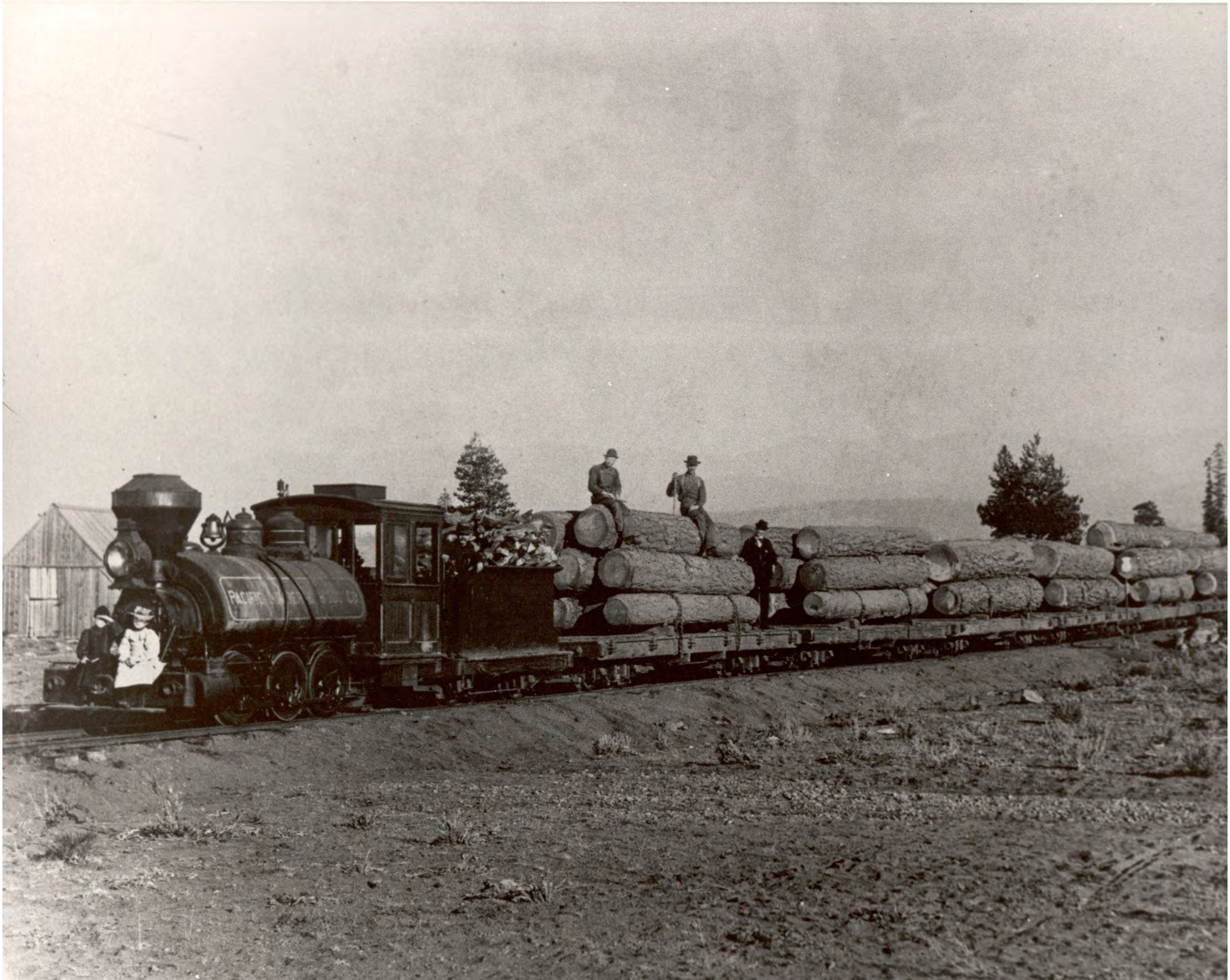
RE: Martis Watershed Assessment
Truckee River Watershed Council

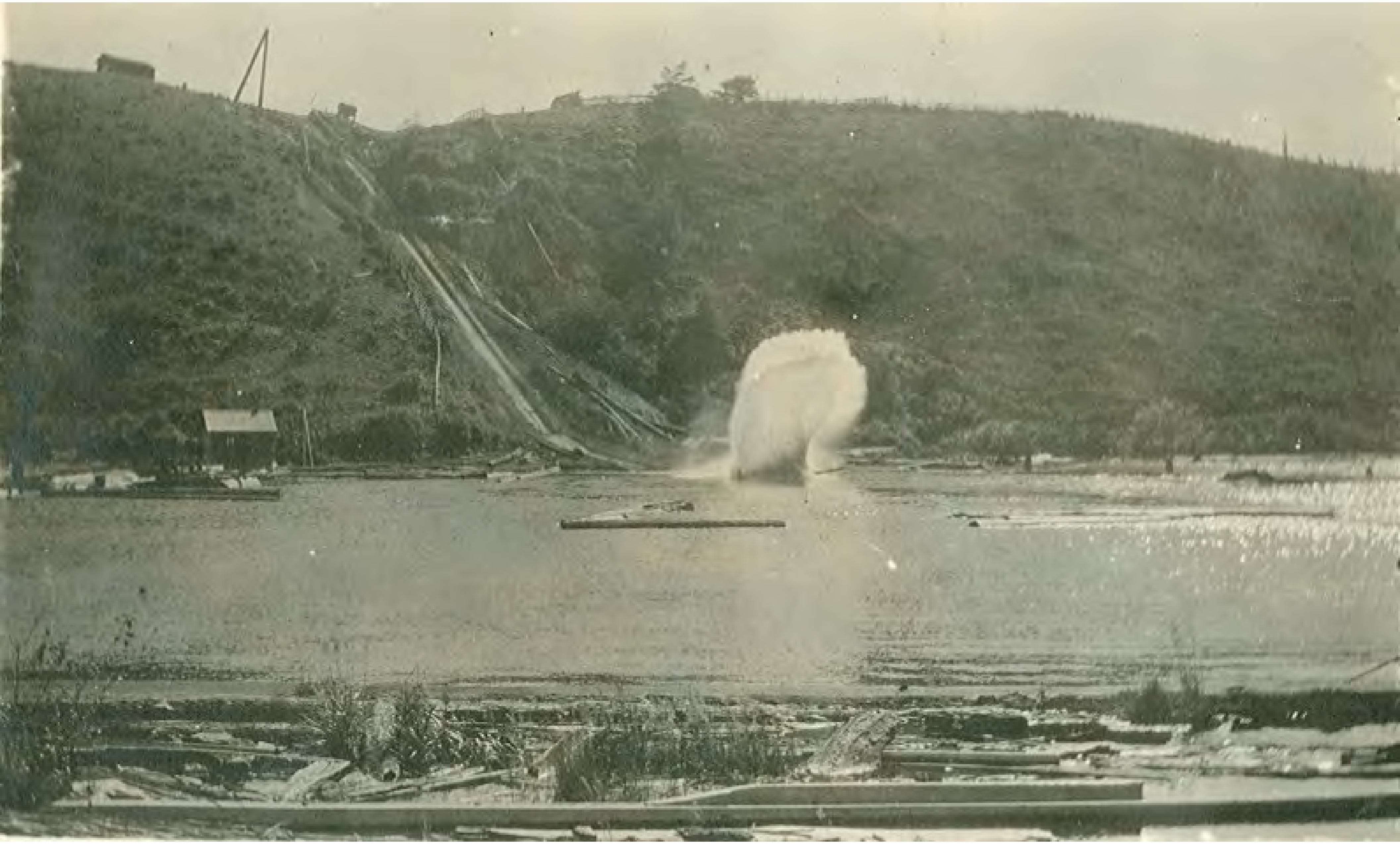
As a following up to our various email and telephone communications and field tours regarding Martis Valley over the past several months, I want to inform you of yet another project. The Truckee River Watershed Council is undertaking a study involving the entire 26,204-acre Martis Watershed. Despite existing and planned development in the watershed, the Council believes that there is a significant opportunity for restoration work that will result in real gains in water quality, habitat and watershed function. The goal of the Martis Watershed Assessment is to provide the science and policy information needed to direct restoration and protection projects within the watershed.

The Truckee River Watershed Council has contracted with Balance Hydrologics, Inc. to prepare the necessary environmental documentation to initiate these restoration and protection projects. In turn, I am subcontracted with Balance Hydrologics to prepare contextual background regarding the human history of the watershed. As you know, the watershed has a long and complex pattern of human occupation, beginning with use by the Washoe and their prehistoric ancestors. Because the Washoe Tribe is considered to be one of the key stakeholders in Martis Valley, I invite the Tribe's opinions, knowledge and sentiments regarding any potential concerns specific to the watershed. With this mailing, I have enclosed a full-sized topographic map of the project area, which can form the basis of our future communications. I'll be contacting you shortly to discuss more project details and your feelings regarding the potential role of the Washoe Tribe in these planning efforts. With the onset of milder weather, Balance Hydrologics is planning a field visit to selected areas within the watershed and we hope that you may be able to tour with us. Also, a series of stakeholder or public meetings on the Martis Watershed Assessment are planned in the coming months and you will be notified of these events. I look forward to talking with you soon.

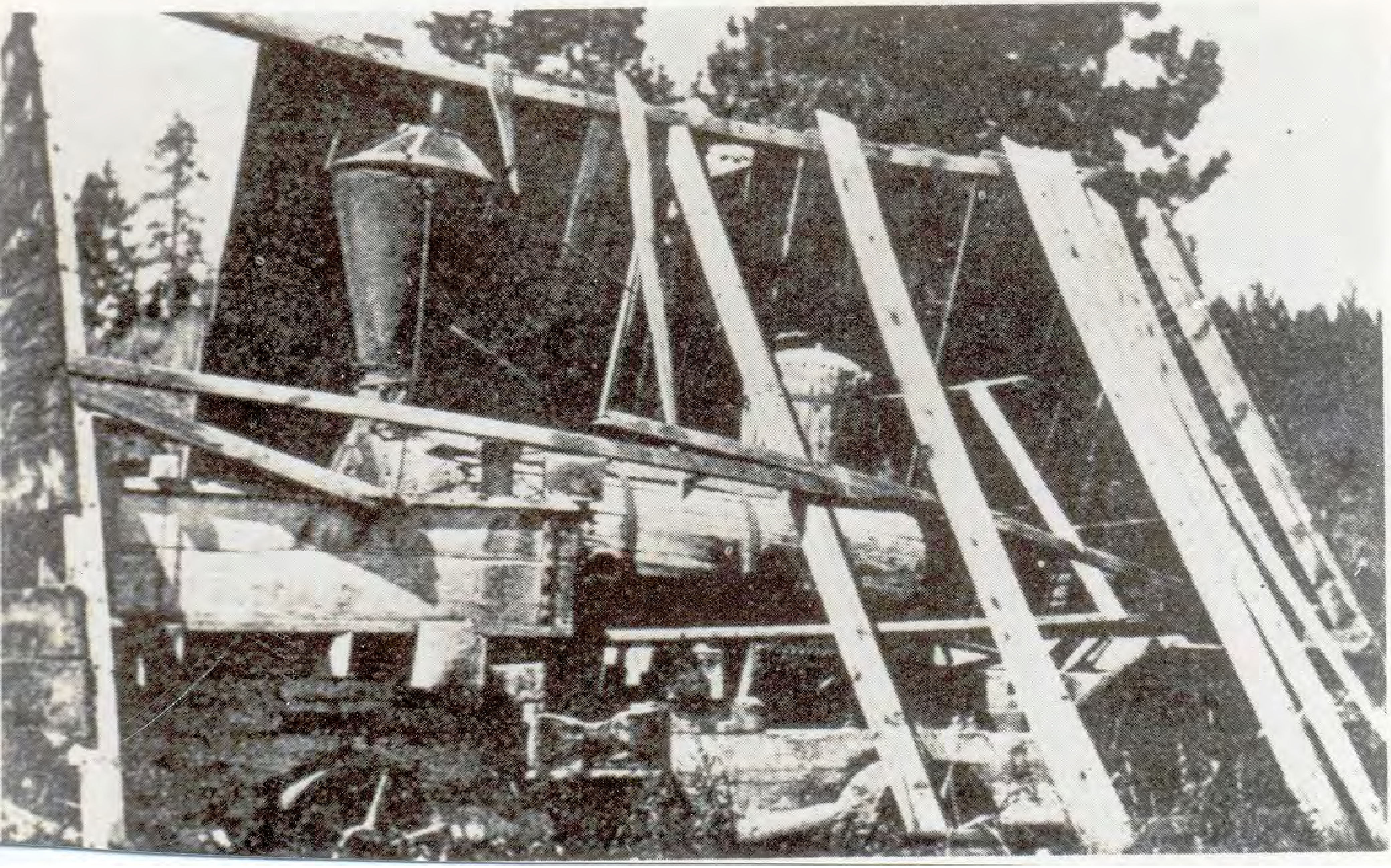
MAPS

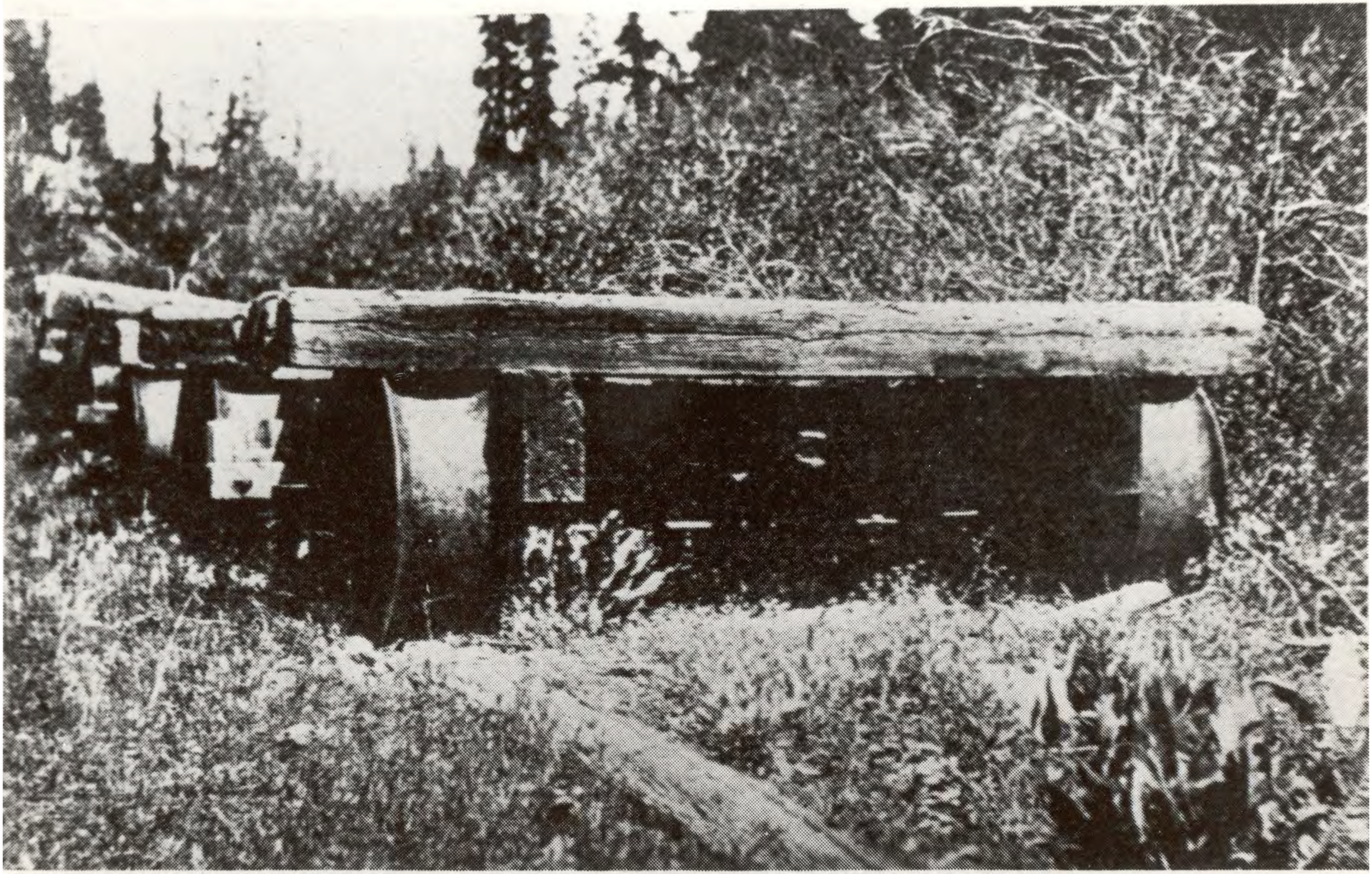
PHOTOGRAPHS


PACIFIC

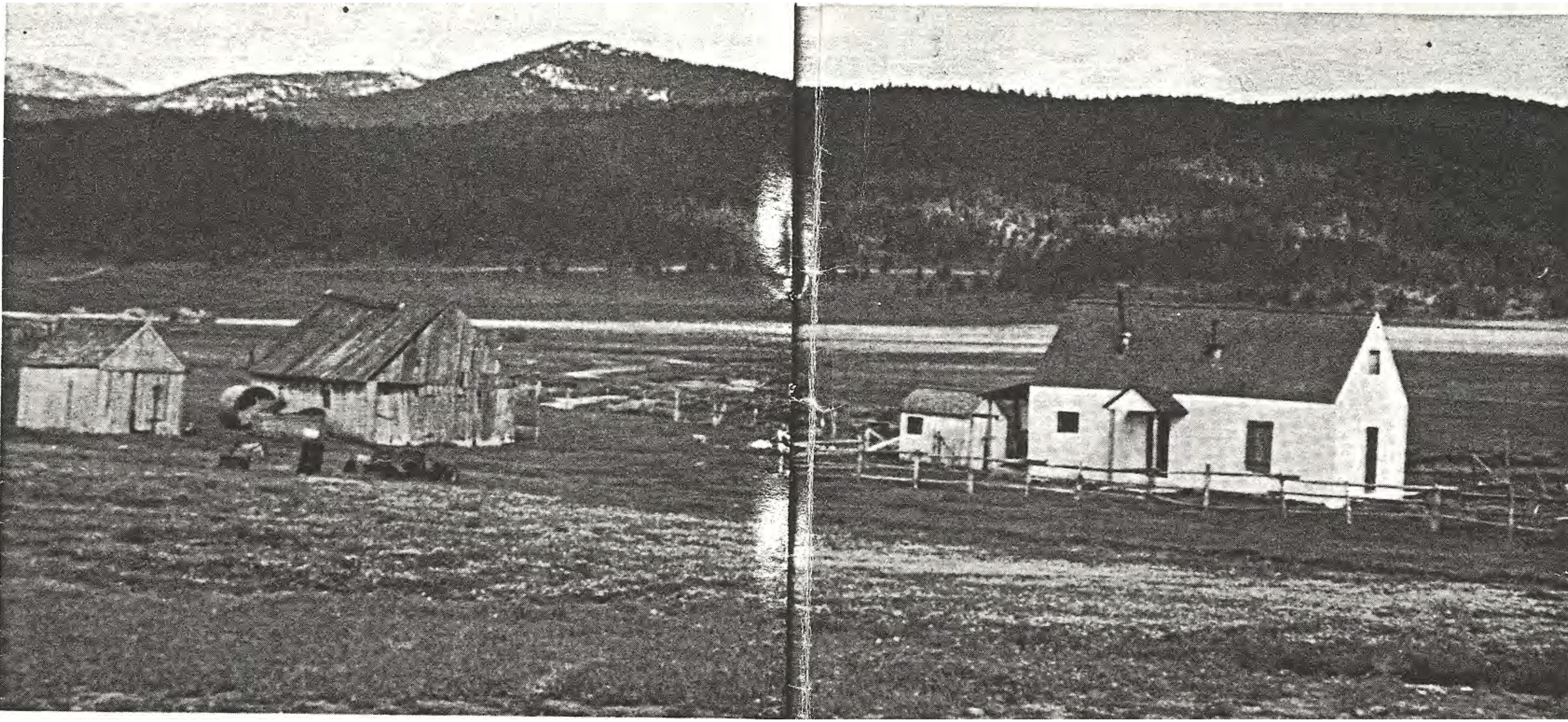


Richardson Bros. Lumber





The abandoned logging railroad of the Richardson Bros. in the Truckee River Basin about 1920 using pole-rails and concave wheels. The operation is described in David Myrick's "Railroads of Nevada" at page 437. The photos from "The Timberman" courtesy of S. T. Borden.




A LOGGING TRAIN
ON THE
BOCA & LOYALTON
R.R.


EM

APPENDIX B

Appendix A. Selected Previous Studies and Reports (Annotated Bibliography)
Martis Watershed, Placer and Nevada Counties, California

Study or Report Title	Summary	Author(s), year	Where it can be found	Who to Contact	Comments
COMPLETED OR FINAL STUDIES					
Martis Valley Community Plan	Expresses a vision of the future of the community and directions for growth in a manner that is consistent with the Valley's land use, population, natural and cultural resoruces and satisfies the requirements of the California Planning and Zoning laws. The Plan includes goals, policies, standards, and implementation programs for relevant land use planning activities.	Placer County, Pacific Municipal Consultants, LSC Associates, Placer County Water Agency, 2003	Placer County Planning Commission 11414 B Avenue, Auburn, CA 95603	Placer County Planning Commission (530) 886-3000 www.placer.ca.gov/planning	Supercedes the Martis Valley Community Plan, 1975
Waddle Ranch Watershed Assessment (Year 1 Summary Report)	Developed a watershed approach to water quality protection, planning and improvement through field-based experiments designed to implement improvements while it developed transferrable tools (handbooks) to be used elsewhere. Project described watershed characteristics, implemented field-based, quantitative studies, and identified erosion-focused 'hot-spots' within Waddle Ranch which includes areas of the East Martis Creek and Dry Lake subwatersheds. Assessment identified legacy impacts on water quality from roads and logging practices, data gaps and recommended next steps.	Integrated Environmental Restoration Services, Inc., 2011	Integrated Environmental Restoration Services, Inc.	Kevin Drake or Michael Hogan Integrated Environmental Restoration Services 530.581.IERS kdrake@IERStahoe.com mhogan@IERStahoe.com	Due to unforeseen circumstances, continued work and reports for Waddle Ranch are not anticipated.
Truckee River Water Quality Monitoring Plan: 2010 Monitoring Report	Provides initial results from the first year of implenting the Truckee River Water Quality Monitoring Plan. Rapid Assessments were carried out to document IBI scores and streambed material composition. High IBI scores and relatively low fine sediment bed accumulation were recorded in the upper watershed steep streams. In Martis Valley, 22 percent (on average) of the Martis Creek bed was covered with fines, 28 percent of the Middle Martis Creek bed (on average), and 19 percent of the East Martis Creek bed (on average).	CDM, 2010	Placer Co Dept of Public Works: http://www.placer.ca.gov/Departments/Works/StrmWtr/StmWtrMonitoring.aspx	Mary Keller, Placer County Department of Public Works	Future studies will include sampling for additional water quality parameters
Measurement of groundwater discharge to streams tributary to the Truckee River in Martis Valley, Placer and Nevada Counties, California	Provides a supplemental study to analyses of groundwater discharge by other consultants (HydroSearch, 1995; Kennedy/Jenks, 2002; and Nimbus Engineers, 2001). Summarizes hydrologic conditions for WY2002. Study quantifies groundwater discharge to including spring discharges to streams in Martis Valley. Water chemistry analysis and estimates of total annual flows for completed for subwatersheds. Results for a water balance for Martis Reservoir was performed and reported.	Interflow Hydrology, Inc and Cordilleran Hydrology, Inc.	Placer County Planning Commission 11414 B Avenue, Auburn, CA 95603	Placer County Planning Commission (530) 886-3000 www.placer.ca.gov/planning	2002 was the third year of a multi-year drought; Estimates of groundwater discharge in this report are not bracketed by average to wet years.
Groundwater quality data for the Tahoe-Martis study unit, 2007: Results from the California GAMA program	Evaluated raw groundwater quality from wells in the Martis Valley groundwater basin. Groundwater samples were sampled and analyzed over 240 constituents including, metals, nutrients, minerals, organic compounds, pesticides, radioactive and microbial indicators. Results suggested....	USGS: Fram, M.S., Munday, C., and Belitz, K, 2007	http://pubs.usgs.gov/ds/432/	1-888-ASK-USGS	"Raw" groundwater are waters sampled directly from wells and prior to filtration, disinfection and mixing used before consumption.

Appendix A. Selected Previous Studies and Reports (Annotated Bibliography)
Martis Watershed, Placer and Nevada Counties, California

Study or Report Title	Summary	Author(s), year	Where it can be found	Who to Contact	Comments
Martis Valley Regional Trail, Initial Study	Initial Study (IS) is a pre-requisite to future planning efforts and environmental effects analysis under CEQA. This document describes the proposed multi-use trail to connect the communities of Truckee, Kings Beach, and Tahoe City; it outlines the objectives, trail construction techniques, trail features and benefits, as well as environmental regulatory requirements and environmental factors potentially affected.	Northstar Community Services District, 2010	Northstar Community Services District 908 Northstar Drive Northstar, CA 96161	Mike Staudenmayer, General Manager (530) 562-0747	IS is lacking information sufficient to evalute potential impacts on hydrology and biology; no mitigation strategies are provided. Studies on-going
Use of Hi-Resolution LiDAR in Discovering the Polaris Fault, Martis Creek Dam, Truckee, CA, 2009	Mitigation studies were conducted to assess and mitigate seepage concerns during high reservoir levels. LiDAR was used to evaluate tectonic geomorphology. The analysis resulted in the recognition of a previously unknown fault trace which runs beneath the Martis Creek Dam.	Hunter, L.E., Rose, R.S., Hilton, B., McCormick, W., and Crampton, T.	US Army Corp of Engineer, Sacramento District	Lewis Hunter, US Army Corps of Engineers, Sacramento, CA 95814 Lewis.E.Hunter@usace.army.mil	Fault Trace is associated with vegetation shifts on the Martis Creek Fan as well as some meadows and sag pond development in the Martis Valley as identified from related studies
Geotechnical Investigations at Martis Creek Dam, Truckee, California, 2010	Divides the Tertiary Prosser Formation into 3 members in the eastern portion of Martis Valley: 1) fluvial, 2) lacustrine, and 3) undiferrentiated. The lacustrine is also referred to as the 'Blue Silt,' and acts as an aquitard in this area, forcing water laterally and to the surface where it outcrops	Brown, V.W., 2010	http://ussdams.com/proceedings/2010Proc/683-698.pdf		
Truckee River Water Quality Study	Serves as part of the basis for the Middle Truckee River TMDL. Includes an analysis of suspended sediment transport data to develop loading estimates for the watershed on a subwatershed basis. Also includes a GIS-based model of road-generated sediment in the Martis Watershed, concluding that road decommissioning and increased canopy cover could reduce suspended sediment loads.	McGraw, D., McKay, A., Duan, G., Bullard, G., Minor, T., Kuchnicki, J., 2001	http://www.truckee.dri.edu/trwa/TRWA.pdf	David McGraw and Alan McKay, PIs	
Martis Dam Spillway Adequacy Study	To evaluate safety of the dam, dam configurations for flood safety; a HEC-HMS hydrologic model was developed, calibrated, and used to whether Martis Dam could contain the probable maximum flood event	USACE Hydrology Office Report, 2002	US Army Corp of Engineer, Sacramento District	John High <John.M.High@usace.army.mil>	Balance Hydrologics is in possession of HEC-HMS model files and other background references used in the study.
STUDIES IN PROGRESS OR PLANNED					
Northstar Environmental Program Development and Watershed Assessment	To identify opportunities for improved watershed and forest management, including restoration projects	Integrated Environmental Restoration Services, Inc.			
Martis Valley Regional Trail	Study will evaluate trail location through Martis Valley with least impacts to wetlands, meadow, habitat and water quality. Cultural resources and wetland studies are to accommodate the planning process.	Northstar Community Services District	Ms. Mariah Garr at (916) 557-7702, e-mail: Mariah.M.Garr@usace.army.mil,		

Appendix A. Selected Previous Studies and Reports (Annotated Bibliography)
Martis Watershed, Placer and Nevada Counties, California

Study or Report Title	Summary	Author(s), year	Where it can be found	Who to Contact	Comments
Martis Valley Groundwater Plan	To evaluate surface-groundwater interactions as well as climate change to forecast potential groundwater availability; study will also evaluate potential groundwater recharge benefits associated with potential restoration projects	Placer County, Balance Hydrologics, Inc., Truckee Donner PUD, and Northstar Community Services District	Placer County Planning Commission 11414 B Avenue, Auburn, CA 95603	Placer County Planning Commission (530) 886-3000 www.placer.ca.gov/planning	Expected 2012
Martis Dam EIS	To evaluate safety of the dam, dam configurations for flood safety; a HEC-HMS hydrologic model has been developed and will be utilized in this assessment.	US Army Corps of Engineers			Expected late 2011 / early 2012
Northstar Habitat Management Plan	An effort to maintain and enhance the values of forests, aquatic, riparian, and meadow habitat in the vicinity of Northstar. The document will outline locations where riparian and other habitats will be conserved and maintained.	Northstar / EDAW	Northstar-at-Tahoe	Jen Mader or Tim Beck, Northstar	unknown release date
Martis Creek Streamflow Gaging	stream gage and instrumentation at Franks Fish bridge (pedestrian bridge) on the Martis Trail as part of the TRWQMP	CDM	Annual Water Quality monitoring reports	Mary Keller, Placer County	On-going
	USGS Gage #10339400 MARTIS C NR TRUCKEE CA transferred to the USACE on 10/5/10	USACE	http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=MTK		On-going

Appendix C

Synthesis of existing assessments of water quality and ecological condition within the middle Truckee River as of April 2008.

Goal 4 of the TRWQMP is to facilitate collaboration, effort-sharing and integration of multiple independent private and public water quality assessment efforts. Appendix A presents a synthesis of existing water quality assessment efforts within the project area. The purpose of this exercise is to identify existing monitoring efforts, particularly those within high disturbance sub-watersheds, and to evaluate whether or not each of these efforts has the potential to be integrated into the TRWQMP. Figure A.1 spatially displays sampling locations and general assessment types for the monitoring programs described below. Monitoring stations with unknown locations and those stations located in ponds or other surface drainages that do not drain to the Truckee River or its tributaries are not included in Figure A.1 (Timilick, Old Greenwood Golf Course). A summary of the key components of the monitoring programs are also presented in Table A.1.

Section 5.0 indicates which existing assessments will be incorporated into the TRWQMP to meet the standards, goals and objectives of the comprehensive monitoring plan.

Martis Creek Sub-watershed

Monitoring Program: Martis Camp (MAR-1)
Operating Entity: DMB/Highlands

Pursuant to Placer County's "Martis Valley Community Plan", and the water quality certification requirements (Resolution R6T-2006-0021) of the Lahontan Regional Water Quality Control Board (the Board), DMB/Highlands has developed and implemented a monitoring plan for Martis Camp (formerly Siller Ranch) on Martis Creek.

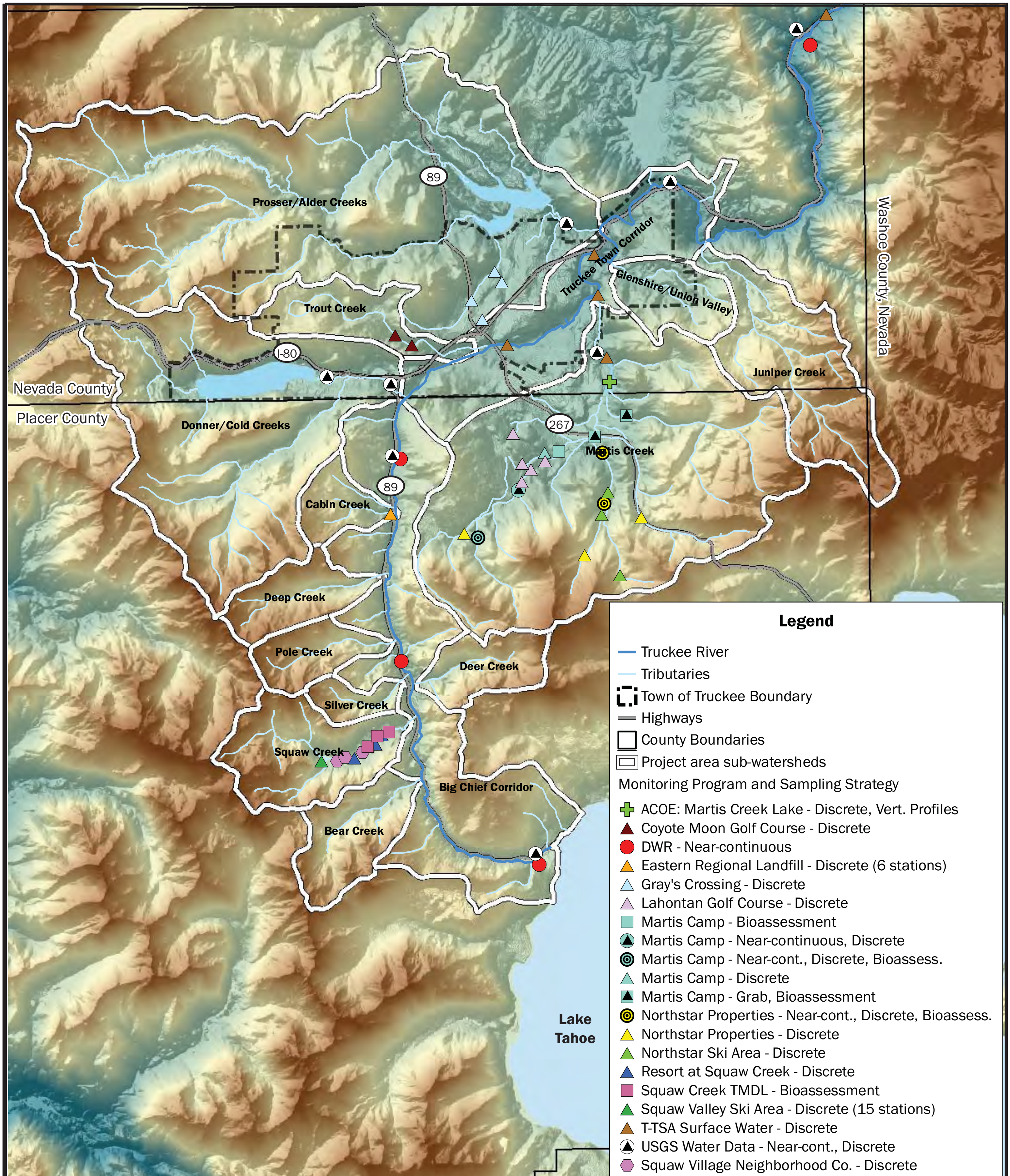
The Martis Camp Monitoring Program is meant to be consistent with the Martis Valley Community Plan, which states:

"The County shall work with the Lahontan WQCB, the ACOE, TSA, and private landowners to initiate a comprehensive water quality monitoring program to address the cumulative impacts on water quality in Martis Creek Lake and the creeks which drain into it. The programs shall strive to coordinate existing water quality monitoring efforts underway presently and modify those as necessary to create a comprehensive program."

The purpose of the Martis Camp program is to:

1) Demonstrate compliance with Board Resolution R6T-2006-0021;
2) Develop a better understanding of whether and where water quality impacts may be occurring; and
3) Develop an adaptive management program as a contingency and mitigation measure for project related impacts to water quality within the Project Area.

The Martis Camp compliance monitoring program emphasizes testable hypotheses to track the frequency of exceedance of either Lahontan Basin Plan standards or the non-degradation standards for specific water quality parameters.



2NDNATURE LLC

Map of existing surface water quality monitoring efforts in the project area of the Middle Truckee River.

0 1 2 3 4 Miles N

FIGURE A.1

Table A.1. Summary of existing assessments within the TRWQMP project area (April 2008)

Monitoring Program	Program Code	Operating Entity	# of Sites	Spatial area of assessment	General Area of Assessment	Site name (Site code)	Performance Assessment Type	Monitoring Span	Frequency of Sampling	Parameters	Hydrology data	Strategy for Data Analysis	Purpose
MARTIS CREEK SUB-WATERSHED													
Martis Camp	MAR-1	DMB/Highlands	5	Community	Martis Creek, and Martis Camp Golf Course	MC-1 to MC-5	Near Continuous at MC1&2; Discrete only at MC3-5	2004-present at MC1 & 2; 2007-present at MC3-5	Weekly	Nut., TSS, TDS, Turb., C	Continuous at MC1 & MC2, 2004-06	Upstream/downstream and WQO comparisons	The purposes of the Martis Camp monitoring program are 1) to demonstrate compliance with Board Resolution R6T-2006-0021; 2) to identify where and when WQ impacts are occurring so that corrective action can be taken.
			5		Surface runoff to and from Martis Camp	G-1 to G5	Discrete WQ	2007-present	6X/yr, when flowing	Nut., TSS	not measured	Comparison to WQO	
			20	BMP Effectiveness	Golf course greens & treatement BMPs	O1-O6; GRN1-18; GRN28-2929	Discrete WQ	2007-present	4-6X/yr, when flowing	Nut., TSS	not measured	Comparison to WQO	
Lahontan Golf Course	MAR-2	Lahontan Golf Course	4	Community	Martis Creek	QW1 - QW-4	Discrete WQ	3/1/03 - present	Quarterly	Nut., Met., TSS, PHC, OG	not measured	Comparison to WQO	The purposes are to assure compliance with the Basin Plan standards, and to identify WQ problems so that they can be corrected.
			12			5-16	Discrete WQ	3/1/03 - present	Quarterly	Nut., Met., TSS, PHC, OG	not measured	Comparison to WQO	
Northstar Properties	MAR-3	Northstar Mountain Properties, LLC (East West Partners)	2	Community	Martis Creek	West Martis Creek at Bridge (Northstar-4), West Martis Creek (Northstar - 7)	Automated, continuous	2007-present	Near-continuous	C, T, Turb., pH	Continuous	Comparison to WQO	The purpose of Northstar Mountain Properties' monitoring program is to 1) demonstrate compliance with the Board's Order; 2) to comply with the Martis Valley Community Plan, and 3) to identify water quality problems so they can be corrected.
			5			West Martis Creek at Bridge (Northstar-4), Martis Creek (Northstar-5), Middle Martis Creek (Northstar-6), West Martis Creek (Northstar - 7), West Fork of West Martis Creek (Northstar-8)	Discrete WQ	2007-present	Varies by parameter (weekly to yearly)	Nut., Met., TSS, TDS, Pest., D	Instantaneous at time of sample	Upstream/downstream, WQO and baseline comparisons	
			2			West Martis Creek at Bridge (Northstar-4), West Martis Creek (Northstar - 7)	Bioassessment	2007-present	Yearly	Invertebrate metrics	not measured	Annual repetition of bioassessment	
Northstar Ski Area	MAR-4	Northstar-at-Tahoe (Trimont Properties)	3	Community	West Martis Creek	N-1, N-2, N-3	Discrete WQ	1993-present	Weekly during snowmelt	Nut., Turb., OG	Instantaneous at time of sample (estimated)	Comparison to WQO	The purposes of the monitoring program for the Ski Area are 1) to ensure compliance with Board Order 93-89A1; 2) identify problems so that they can be corrected.
Timilick	MAR-5	Martis Valley Associates, LLC	4	Community	Timilick GC and runoff from development	WC4, 5, 8 & 9	Discrete WQ	3/2007-present	monthly	Nut., TTS, TDS, Turb., C, OG, TPH	not measured	Comparison to WQO	The purpose is to comply with Board Order and with the Martis Valley Community Plan. Some plan details may be renegotiated.
Martis Creek Lake	MAR-6	U.S. Army Corps of Engineers	4	Receiving waters	All developments in West and Upper Martis Creeks	WC4, 5, 8 & 9	Discrete WQ	1974-1978; 1996-present	2x/yr	Clarity, Nut., MTBE, pH, T, Alk., DO, Met., phytoplankton	not measured	Long-term time series	The purpose is to ensure a continuous level of water quality in the lake for both recreation and environmental health and to satisfy the Department of Army Engineering Regulation 1110-2-8154, "Water Quality and Environmental Management for Corps Civil Works Projects".