FINAL REPORT:
SHASTA AND TEHAMA COUNTIES STREAM BARRIER ASSESSMENT AND EVALUATION

By:

Pacific States Marine Fisheries Commission and
California Department of Fish and Game

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I. INTRODUCTION

This report documents the results of an inventory and prioritization of potential barriers to anadromous fish migration associated with watercourse crossings on the state highway system in Shasta and Tehama Counties, California (Figure 1). The current assessment is a direct outgrowth of the Fish Passage Advisory Committee (FishPAC), an interagency group comprised of representatives from the California Department of Transportation (Caltrans), California Department of Fish and Game (DFG), the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS), and the US Fish and Wildlife Service (USFWS). As outlined in its charter, the mission of FishPAC is to

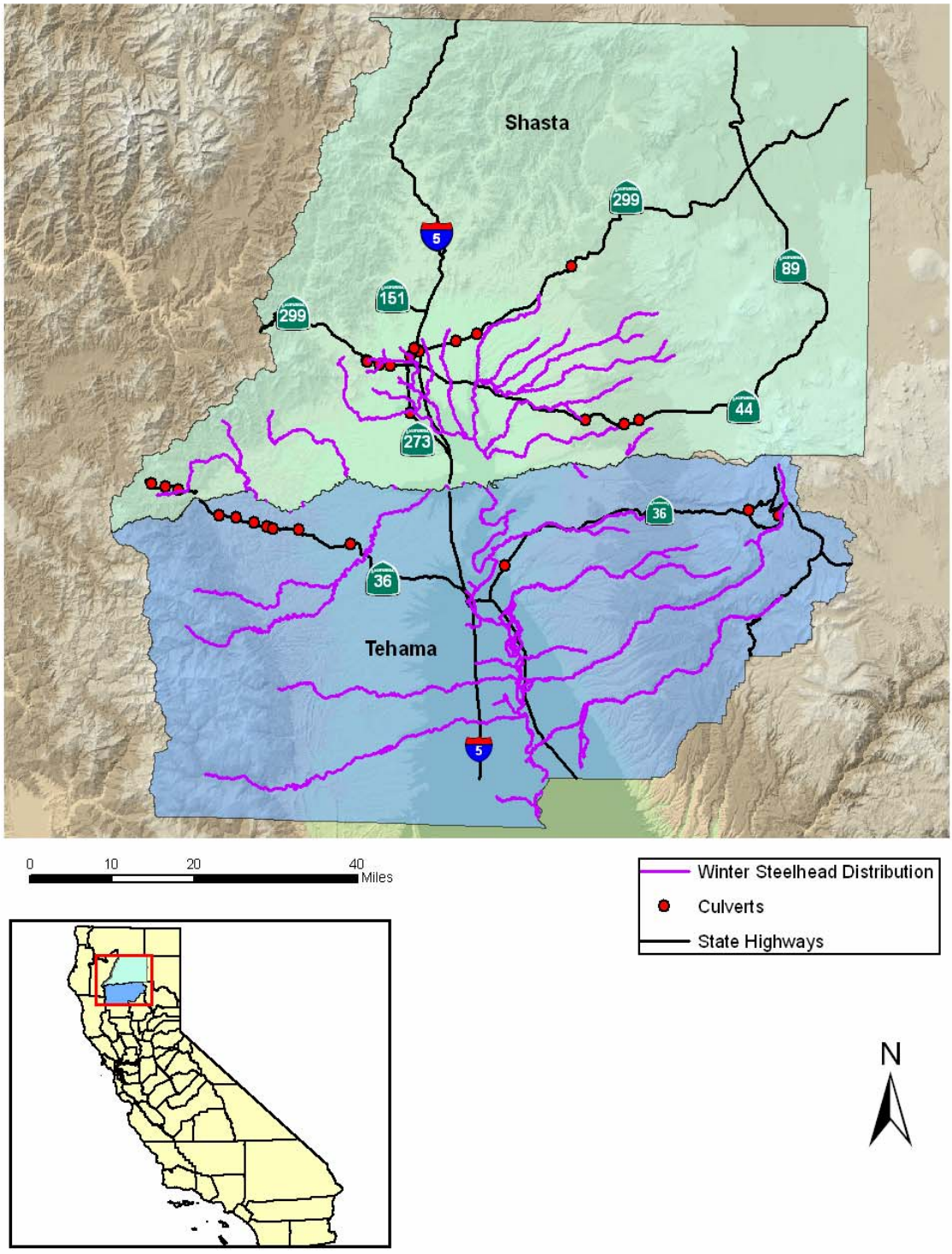
> *"…identify and prioritize barriers to fish passage on the state highway system in Caltrans District 2 and to recommend technical solutions as well as potential funding mechanisms for new barrier removal projects and the long term inspection and maintenance of existing fish passage facilities*."

The FishPAC has maintained an active list of barriers in District 2 since its inception in 2002. However, this working list is based on professional judgment and the local knowledge of regional fisheries experts and not on a comprehensive inventory. While Caltrans crossings in coastal portions of northern California have been inventoried and prioritized (Lang 2005), funding has to date been unavailable to study anadromous stream crossings in the Central Valley. In order to develop regional priorities for fish passage improvement, it quickly became clear that a more comprehensive inventory was needed to determine whether, and to what extent, state highway crossings in Tehama and Shasta Counties are impeding the migration of anadromous fish.

In September 2009, the USWFS provided a $15,000 grant from the National Fish Passage Program (Agreement # 813309G730) to the Pacific States Marine Fisheries Commission (PSMFC) for phase 1 of a barrier assessment in Shasta and Tehama Counties. This inventory includes streams within the known and potential distribution of Central Valley steelhead (*Oncorhynchus mykiss irideus*), a federally designated threatened species. For the purposes of this study, the distribution of steelhead was used as an indicator of the extent of anadromy Shasta and Tehama Counties; it should be noted that Chinook salmon (*Oncorhynchus tshawytscha*) also utilize many of the streams included in the survey area.

Field work under Phase 1 was conducted between March 2010 and May 2010. The objective of phase 1 was to identify crossings on the state highway system that may be accessible to anadromous fish and to collect field survey measurements required to determine whether individual crossings may constitute barriers to fish passage. In August 2010, USFWS provided an additional $15,000 for phase 2 of the project. The objective of the second phase was to analyze the field survey data to determine the degree to which individual

Figure 1. Shasta-Tehama Barrier Assessment Study Area



crossings were impeding fish passage and to develop rough priorities for passage improvement needs. Results from this effort have been incorporated into the Passage Assessment Database (PAD) and made available on the CalFish web page at:

http://www.calfish.org/Programs/CalFishPrograms/FishPassageAssessment/tabid/83/Default.aspx

This project has been a cooperative effort involving support from a number of agencies participating in FishPAC. Project oversight, office space, and vehicle support was provided by DFG. Caltrans contributed the encroachment permit allowing work within the operating right-of-way, as well as safety and surveying equipment. In addition, Caltrans provided field surveys for culverts that required the use of a total station, a more sophisticated survey instrument capable of providing three-dimensional data for points on the ground. Martina Koller of PSMFC provided existing data from the PAD as well as location and descriptive information from the culvert inventory and bridge log maintained by Caltrans' District 2.

Process

The passage inventory process followed a sequential series of steps designed to identify stream crossings that might be accessible to anadromous fish, collect field data on potentially accessible sites to make a first-cut evaluation of whether they meet passage criteria, and then conduct a more detailed evaluation of the extent to which individual crossings impede fish passage. Steps in the inventory phase included:

- Locating stream crossings on state highways within anadromous reaches.
- Determining if crossings are on fish bearing streams and meet passage criteria.
- Collecting specific culvert measurements and conducting longitudinal stream surveys at selected sites.
- Assessing fish passage using the first phase evaluation filter.
- Refining initial passage assessments using *FishXing* software to determine the percentage of passable flows for fish and barrier categories.

Following the inventory phase, a two-step process was used to prioritize individual crossings for future remediation efforts. The initial ranking process ranked culvert sites with numerical scores based on biological and physical criteria including:

- Quality and quantity of available habitat upstream of crossing.
- Diversity of fish species and level of federal concern within stream reaches.

- Extent of barrier to fish species and age classes (based on *FishXing* output)
- Existing condition of culverts.

This initial ranking matrix is a numerical scoring which relies heavily on biological criteria. However, other considerations are also important in making any final prioritization. In an attempt to account for these factors, we grouped crossings into High, Medium, and Low priority categories for the final ranking matrix. Factors considered while making final stream crossing rankings included:

- Uncertainties regarding the presence of anadromous fish,
- Presence or absence of other stream crossings within a stream reach,
- Substantial artificial barriers downstream from surveyed crossings, and
- Artificial and natural barriers upstream from surveyed crossings.

Project Justification

A stream crossing is any artificial crossing over a stream channel including paved roads, unpaved roads, trails, and paths. Stream crossings include culverts, bridges, and low-water crossings such as fords. "A stream crossing encompasses any structure or device designed to pass stream flow, and includes the approach and surface fill material within the crossing prism" (DFG 2003). This project focuses on the negative affects of culverts on the migration of anadromous salmonids.

Upstream fish migration into tributary streams is a significant component of salmonid life history. Culverts and dams operate as anthropogenic barriers to migrating fish and prevent access to vital habitat used for spawning and rearing purposes. Stream crossings that impede or block migration pose a substantial threat to steelhead and salmon fisheries in California. There are possibly thousands of stream crossings that block access to upstream migration. "Many stream crossings create temporal, partial, and total barriers for adult anadromous salmonids during spawning migrations and create flow barriers for juvenile and resident salmonids during seasonal movements" (DFG 2003) (Table 1).

Table 1. Definition of barrier types and their potential impacts (adapted from Robison et al. 1999).

Barrier Category	Definition	Potential Impacts
Temporal	Impassable to all fish at certain flow conditions (based on run timing and flow conditions).	Delay in movement beyond the barrier for some period of time.
Partial	Impassable to some fish species, during part or all life stages at all flows.	Exclusion of certain species during their life stages from portions of a watershed.
Total	Impassable to all fish at all flows.	Exclusion of all species from portions of a watershed.

The following was adapted from (DFG 2003):

"At temporal barriers, the delay imposed by a stream crossing can limit the distance adult fish migrate upstream before spawning. This may result in under-utilization of upstream habitat and superimposition of redds in lower stream reaches. Even if stream crossings are eventually negotiated by adult fish, excess energy expended may result in their death prior to spawning, or reductions in viability of eggs and offspring, Migrating adults and juveniles concentrated below impassable stream crossings are vulnerable to predation by a variety of avian and mammalian species, and to poaching by humans. In addition, this reduction in stream habitat creates competition for space and food among adults and juvenile salmonids and other aquatic species, year round.

Both resident and anadromous salmonids make upstream and downstream migrations. Juvenile coho salmon spend approximately one year in freshwater before migrating to the ocean, and juvenile steelhead trout may rear in freshwater up to four years. Thus, both species are highly dependent on stream habitat throughout the year. Seasonal upstream movement into tributaries by juvenile salmonids has also been observed during the summer. These fish are thought to be seeking cool water refugia from stressful or lethal temperatures in larger river channels."

Many existing culverts have been in service for decades and do not meet the current criteria for passage of flood flows, debris loads and fish. Some of these culverts are showing signs of wear while others were not designed to support fish passage. Examples of these typical passage problems include:

- Excessive water velocities within the culvert
- Excessive drop at the outlet, resulting in a too high entry leap, or too shallow of a jump pool below a crossing
- Lack of water depth within culvert or over crossing
- Excessive water velocity or turbulence at a culvert inlet

- Debris accumulation at a culvert inlet or within a culvert barrel

The evaluation of passage conditions at road crossings surveyed for this project will benefit anadromous salmonids of the Central Valley. With a prioritized list, Caltrans will be able to make informed decisions regarding passage improvements to stream crossings on the state highway system. This report may also serve as a guide for future stream crossing evaluations on other county, state, or federal roads. With a more precise understanding of which culverts are fish barriers, restoration work may take place and anadromous salmonids will be able to reach their historical migration routes.

II. METHODS AND MATERIALS

The fish passage assessments documented in this report follow the methods outlined in Part IX of the California Salmonid Stream Habitat Restoration Manual (DFG 2003). The stream crossing inventory and fish passage assessment for this project was conducted as a series of tasks completed in the following order:

- Location of stream crossings and identification of crossing sites for passage evaluation.
- Stream and culvert measurements from selected sites (completing *Fish Passage Inventory Data Sheet*)
- Data entry and first-phase passage evaluation using the Green-Gray-Red (G-G-R) filtering process as a first cut in identifying sites which either meet or fail to meet fish passage criteria
- Estimation of stream-specific hydrology and fish passage flows
- In-depth passage analysis at sites identified by the first-phase passage evaluation as possible temporal or partial barriers (using *FishXing* software)
- Collection and interpretation of existing habitat information
- Ranking of sites for potential future corrective treatment

Tools and Supplies

The following tools and supplies were utilized while conducting field inventories at road crossings:

- Maps marked with site locations from Caltrans' culvert inventory and bridge log
- Names and phone numbers of property owners
- Data collection sheets, printed on water-proof paper
- Pen/pencils
- Global Positioning System (GPS) unit
- Safety vests
- Hard hats
- Waders, wading shoes

- Survey-level (laser level), auto level, total station
- Tripod
- Tapes (one each): 300' and 100' in 0.1' increments
- Clamps to secure tapes to culverts for accurate measurements
- Leveling rod: 25' in 1/100' increments
- Clinometer- for measuring road prism slopes
- Digital camera
- Machete and pruners for clearing brush
- First-aid kit
- Rebar to anchor measuring tape

Location of Culverts

State highway culverts were located using maps and GIS data provided by Caltrans and the PAD on crossings within known and suspected anadromous stream reaches. Maps were divided by state highways in Shasta and Tehama Counties within the Sacramento River Basin. A brief description of each culvert such as culvert diameter, type, material, and post mile was also included with the data provided. This information is presented in Appendix A. State highway post mile markers were the primary means of locating each road crossing. At each surveyed location, latitude and longitude coordinates were recorded with a hand-held GPS unit using North American 1983 datum (NAD 83). If more than one culvert was present at each stream crossing, a separate number was given to each culvert. Culverts were numbered in ascending order from left bank to right bank, in the downstream direction.

Site Visits and Stream Crossing Measurements

Stream crossings were examined during preliminary site visits to each culvert. Additional evaluations and measurements were conducted only if crossings appeared to be on a fish bearing stream, which includes adequate stream size, flow, and stream gradient. These pre-requisites for passage evaluations were based on visual surveys as well as field knowledge from DFG biologists and environmental professionals. Supplementary stream and culvert measurements were required for the first-phase (G-G-R filter) and in-depth passage (*FishXing*) evaluations and analyses (USFS 1999). These data can be found in Appendix C.

<u>Stream Crossing Information</u>

The following information and observations were collected at each site and stream crossing surveyed:

1. Inlet Type (projecting, headwall, wingwall, mitered, or flared)
2. Alignment with stream (measured in degrees)
3. Presence of Inlet and Outlet aprons

4. Outlet configuration
5. Type of tailwater control
6. Fish presence observed (size, number, age class and location)

This information was utilized during the in-depth passage analyses using *FishXing*.

Culvert Measurements

The following culvert measurements were collected at each site during the surveys:

1. Type (circular, pipe arch, box, open-bottom arch, etc.)
2. Diameter or height/rise and width/span
3. Length (standard)
4. Material of pipe (Structural Steel Plate, Corrugated Steel Pipe, aluminum, plastic, concrete, etc.)
5. Pipe condition
6. Rustline height (only in metal pipes)
7. Presence and depth of embeddedness
8. Presence of previous modifications

Longitudinal Survey

A longitudinal survey was performed at each stream crossing to determine accurate elevation points along the stream bed. These elevation points were used to determine slope and other important information during the FishXing passage analyses. A rotating laser level (Topcon), surveyor's tripod, and leveling rod with increments in 1/100' were used during the surveys. Survey results for individual crossings can be found in Appendix A.

The two person survey crew was trained in safety and participated in a DFG-approved training session prior to working in the field. Both surveyors were required to wear blaze orange reflective vests, hard hats, and hip waders. Vehicles were parked in parking lots or on the right-of-way at least 20 feet from traffic. Land owners were contacted and property was accessed only if permission was granted.

To begin a survey, the tailwater control point both upstream and downstream of the culvert were identified and marked with rebar. The tailwater control points or "riffle crests" represent breaking points in the slope of the stream and are used to indicate the first resting pool for fish passing through a culvert as well as the jump pool below the culvert outlet. A 300' measuring tape was placed down the thalweg of the stream channel from the inlet tailwater control point through the culvert and stopped at the tailwater control point of the outlet pool. Whenever possible, the scope and tripod were positioned in

areas where both the inlet and outlet could be shot from one location. Survey turning points were necessary at certain crossings due to a very high road prism or an extremely long culvert.

Streambed and water surface elevations were recorded at 'stations' along the measuring tape. Station locations were also recorded to determine distances between the top and bottom of the longitudinal survey.

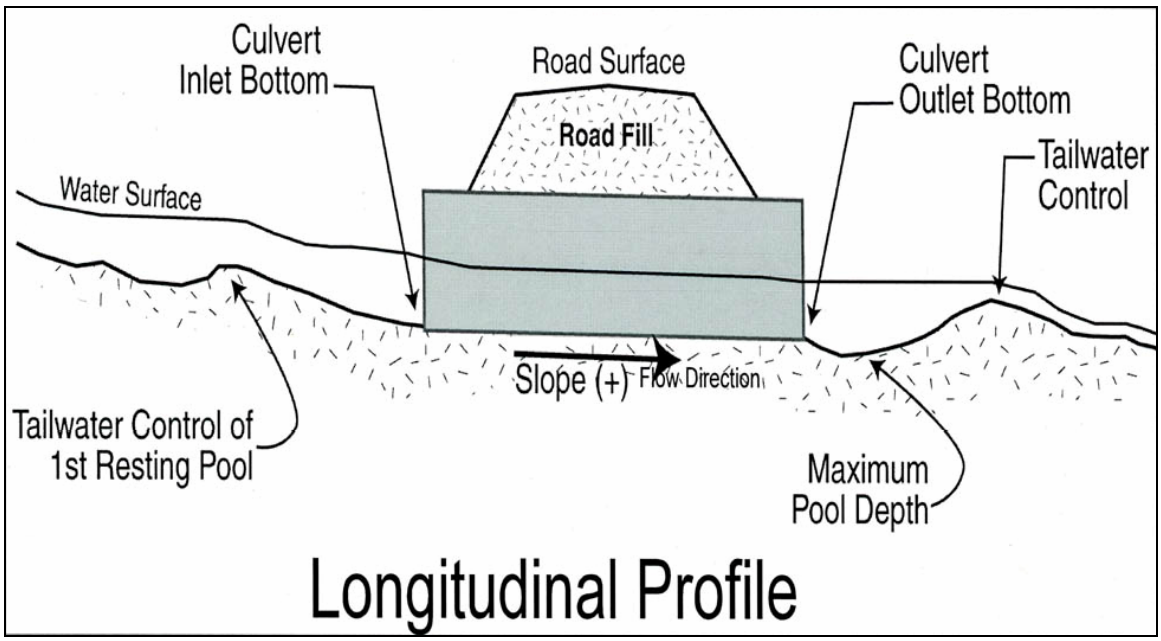
At all stream crossings, a minimum of six elevations and corresponding stations were measured (Figure 2):

1. Tailwater control of first resting pool above culvert inlet
2. Culvert inlet
3. Culvert outlet
4. Maximum depth within five feet downstream of outlet
5. Maximum depth of outlet pool
6. Outlet pool's tailwater control point

Certain sites required additional survey points to assist with site-specific characteristics used for fish passage analyses:

- Points along upstream and downstream channel profile to determine sudden changes in slope which may provide potential velocity barriers outside of culvert.
- Slope of inlet and outlet aprons. Some culvert crossings have concrete aprons located at the inlet and/or outlet to increase flow capacity and prevent scour. Aprons are often steep, creating velocity and lack of depth barriers. The upstream and downstream end of each apron elevation was measured as well as the length to calculate slope.

Figure 2. Diagram of required survey points for a longitudinal stream profile through a culvert (adapted from Part IX of the California Salmonid Stream Habitat Restoration Manual. DFG 2003).



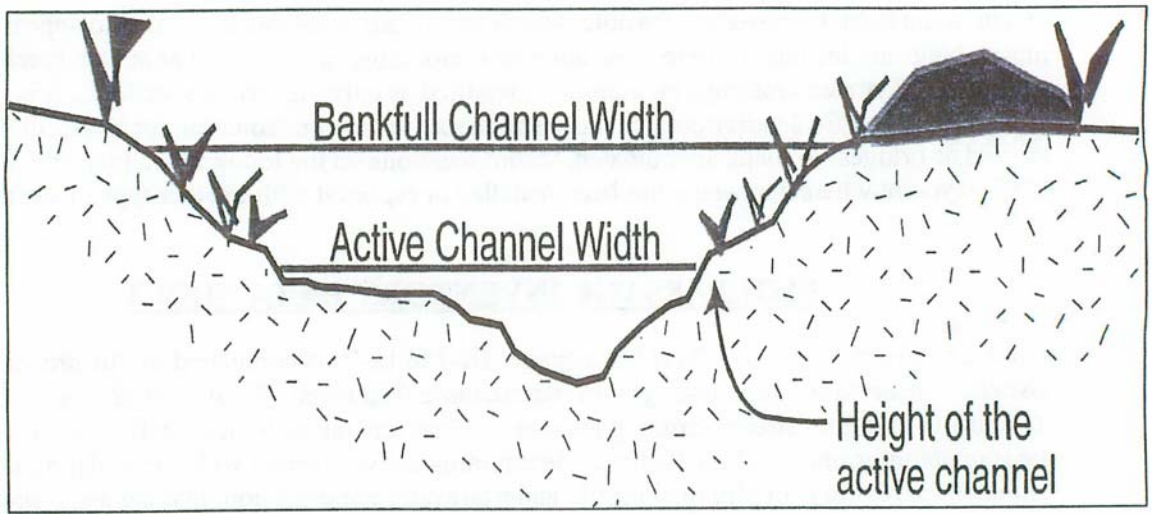
Tailwater Cross-section

Cross-sectional surveys were conducted at the tailwater control of the outlet pool for all sites. If the outlet pool was absent, a cross- sectional survey was conducted several feet from the outlet in addition to the upstream cross-section. A cross-section is used to determine tailwater control height and is useful during passage analysis. The survey started from left bank to right bank and included any breaks in slope. Cross-sections were measured across the stream channel at bankfull width (Figure 3) and included these locations:

- Top of left bank
- Toe of left bank slope
- Water's edge of left bank
- Thalweg
- Water's edge of right bank
- Toe of right bank slope
- Top of right bank

Additional points were measured along the stream bottom in larger cross-sections to increase the accuracy of passage analysis. All elevations were measured to the nearest hundredth of a foot and distances measured to nearest tenth of a foot.

Figure 3. Bankfull width versus active channel width (adapted from Part IX of the California Salmonid Stream Habitat Restoration Manual. DFG 2003).



Channel Widths

At least five channel widths were measured upstream of culvert crossings to determine the active channel width of each stream surveyed. Channel widths were measured to the nearest tenth of a foot and located upstream beyond any influence of the culvert. The five widths were averaged to account for natural variations in channel width.

Site Notes and Observations

Digital photographs of certain stream and culvert characteristics were taken at each surveyed road crossing and can be found in Appendix B. These characteristics include:

- Inlet tailwater control
- Inlet
- Outlet
- Outlet tailwater control
- Temporary bench mark (tbm)
- Other site-specific characteristics and features

Site sketches were included with the *Fish Passage Inventory Data Sheet* and consist of site-specific information such as locations of adjacent roads, north arrow, stream characteristics, direction of stream flow, and location of tailwater control cross-sections. An example site sketch is shown in Figure 5.

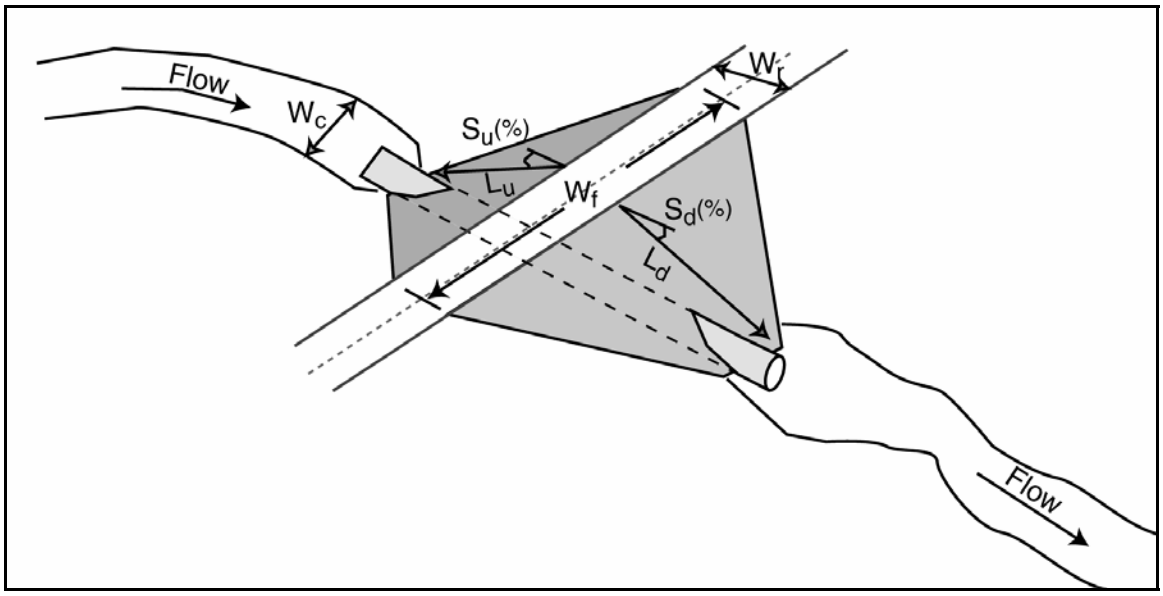
Road Fill Estimates

The volume of road fill located above each culvert road crossing was measured and estimated. The fill volume estimates can be incorporated into the ranking criteria and used for developing cost analyses for barrier removal and can assist in calculating culvert flood capacity and determine potential sediment volumes delivered downstream during culvert failures and blowouts. Road fill measurements conducted during this project are rough estimates for comparison between sites and should not be used for designing replacement culverts.

Road fill volume was estimated using the following procedures outlined in Flannigan et al. (1998). The following measurements were taken to calculate fill volume (Figure 4).

1. Upstream and downstream fill slope lengths (L_u and L_d)
2. Percent slope of upstream and downstream fill slopes (S_u and S_d). Measured with a clinometer.
3. Width of road prism (W_r)
4. Top fill length (W_f)
5. Base fill width (W_c)

Figure 4. Measurements taken to calculate fill volume (adapted from Part IX of the California Salmonid Stream Habitat Restoration Manual, 2003).



Equations (1) through (4) were used to calculate the fill volume.

1.) Upstream prism volume, V_u:

$$V_u = 0.25(W_r + W_c)(L_u \cos S_u)(L_u \sin S_u)$$

2.) Downstream prism volume, V_d:

$V_d = 0.25(W_f + W_c)(L_d \cos S_d)(L_d \sin S_d)$

3.) Volume below road surface, V_r:

$V_r = 0.25(H_u + H_d)(W_f + W_c)\ W_r$

Where $H_u = L_u \sin S_u$ and $H_d = L_d \sin S_d$

4.) Total fill volume, V:

$V = V_u + V_d + V_r$

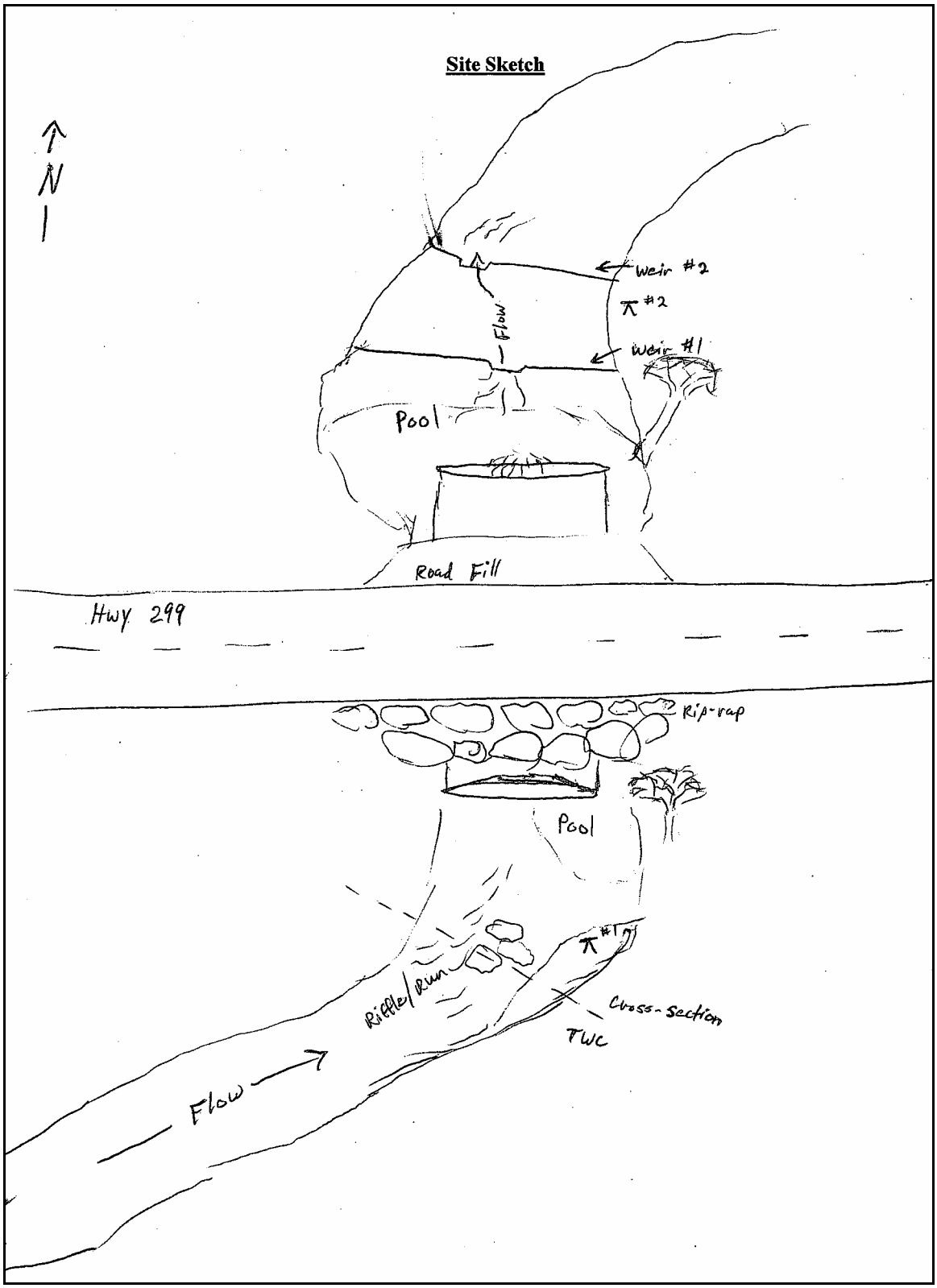


Figure 5. Example Site Sketch

Data Entry and Passage Analyses

All data collected was recorded on the *Fish Passage Inventory Datasheet* provided by DFG in Part IX of the California Salmonid Stream Habitat Restoration Manual. All data were subsequently converted to Microsoft Excel and Microsoft Word formats for analysis.

First Phase Analyses: Green-Gray-Red Filter

All surveyed road crossings were evaluated using the G-G-R filtering process to reduce the number of crossings that require in-depth passage evaluation using *FishXing*. Results of this evaluation are discussed in Section III of this report and can be found in Appendix C. The passage evaluation filter is designed to identify sites which either provide, or fail to provide, fish passage for all fish species and their life stages (DFG 2003). This filtering process required specific data from each road crossing: average channel width, culvert slope, residual inlet depth, and residual depth at the outlet (Figure 6). The filter classifies crossings into one of the following three categories adapted from DFG 2003:

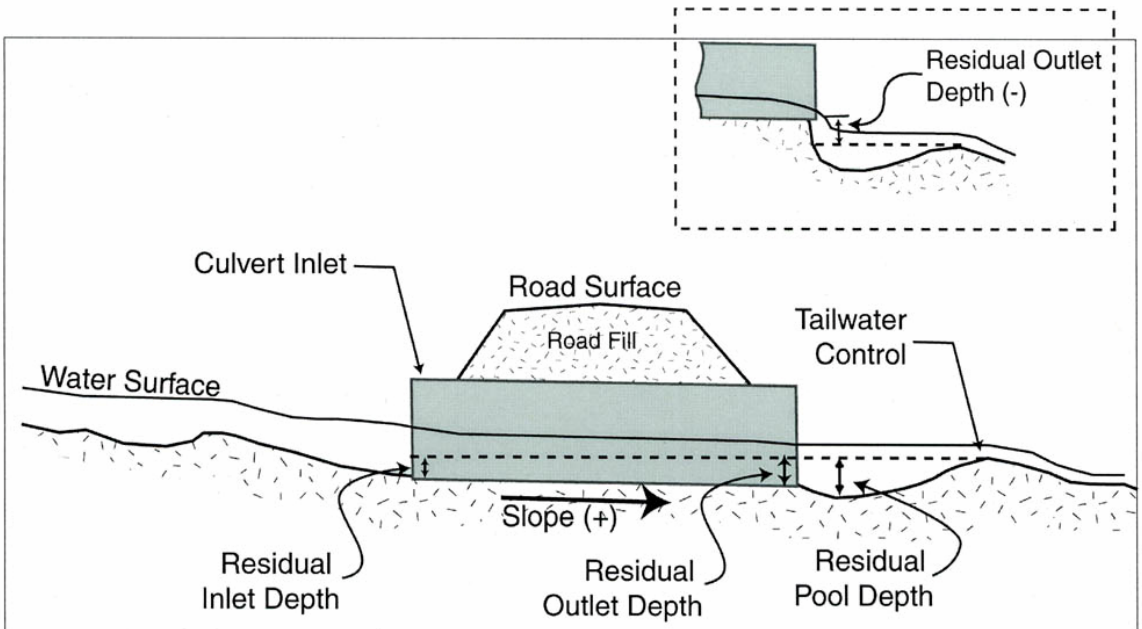
- **GREEN**: Condition assumed adequate for passage of all salmonid life stages or throughout all salmonid life stages.

- **GRAY**: Condition may not be adequate for all salmonid species at all their life stages. *FishXing* is used to determine the extent of barriers for each salmonid life stage.

- **RED**: Condition fails to meet DFG and NOAA passage criteria at all flows for strongest swimming species presumed present. Analysis of habitat quantity and quality upstream of the barrier is necessary to assess the priority of this crossing for treatment.

For crossings meeting the **GREEN** criterion, a review of the inventory data and field notes was necessary to ensure no unique passage problems existed before classifying the stream crossings as “passable”. An in-depth view of the G-G-R filtering process is illustrated as a flow chart in Figure 7.

Figure 6. Measurements used in the G-G-R filtering criteria (adapted from Part IX of the California Salmonid Stream Habitat Restoration Manual. DFG 2003).

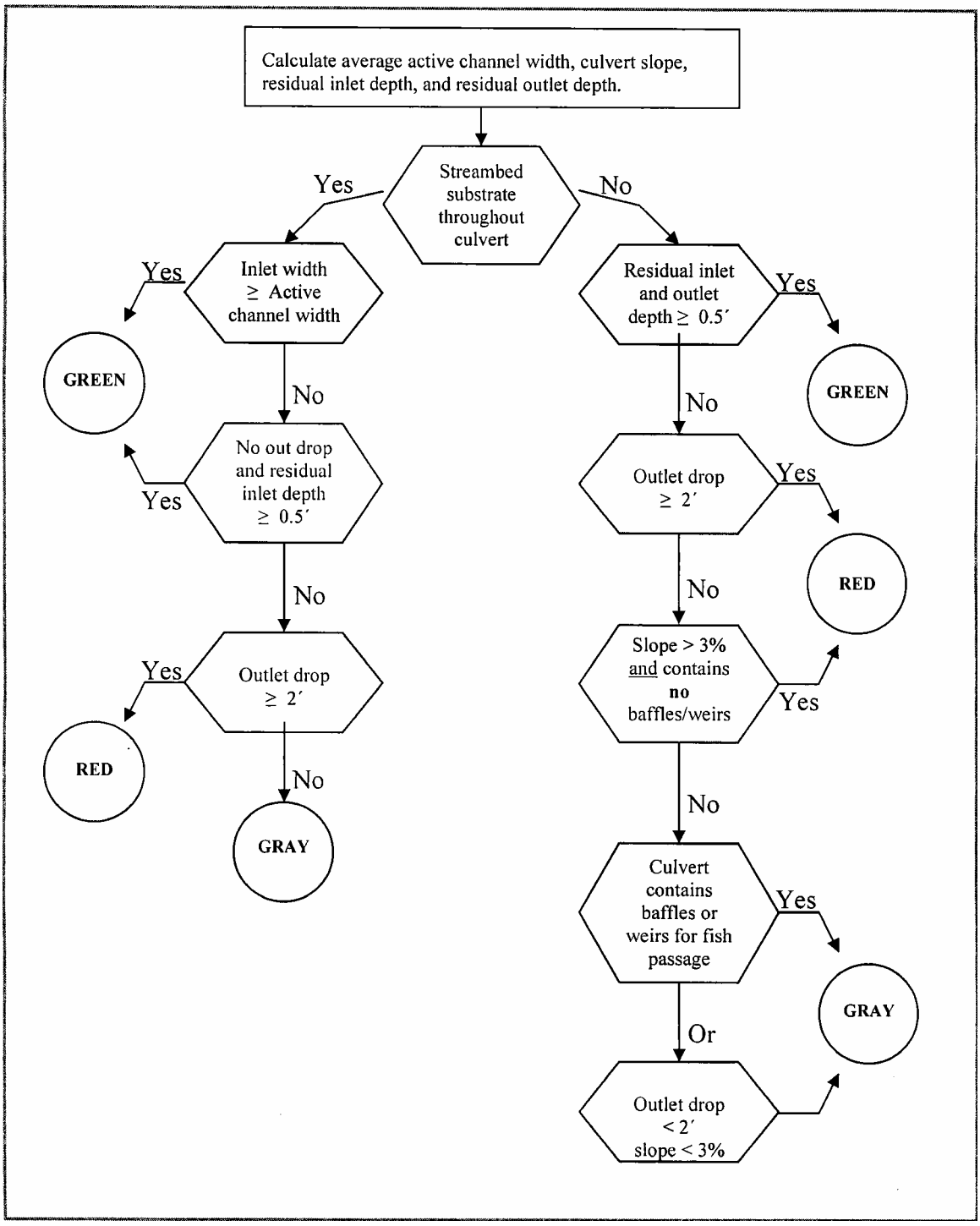


Residual Pool Depth = (Elev $_{\text{Tailwater Control}}$ - Elev $_{\text{Pool Bottom}}$)

Residual Outlet Depth = (Elev $_{\text{Tailwater Control}}$ - Elev $_{\text{Culvert Outlet}}$) (If Residual Outlet Depth is less than zero it is referred to as the Residual Outlet Drop)

Residual Inlet Depth = (Elev $_{\text{Tailwater Control}}$ - Elev $_{\text{Culvert Inlet}}$)

Figure 7. GREEN-GRAY-RED first-phase passage evaluation filter (adapted from Part IX of the California Salmonid Stream Habitat Restoration Manual. DFG 2003).



FishXing Overview

The following was adapted from Part IX of the California Salmonid Stream Habitat Restoration Manual (DFG 2003):

"The subset of stream crossings identified as GRAY was required to have additional analyses conducted to determine the extent to which they were barriers. At these stream crossings, water depths, velocities and outlet conditions were calculated between the lower and upper passage flows to establish whether fish passage requirements were being met. Fish passage conditions were analyzed using *FishXing*, a computer software program developed by the Six Rivers National Forest Watershed Interactions Team. *FishXing* models culvert hydraulics and compares the predicted values with data regarding swimming and leaping abilities and minimum water depth requirements for numerous fish species. *FishXing* software and information is available online at: http://www.stream.fs.fed.us/fishxing/

This software program is divided into two categories: Swimming capabilities and requirements for the fish species of concern and site-specific information about the stream crossing. *FishXing* incorporates these two categories to determine if culverts of concern will pass fish during specific flows and the percent passable. The summary output also describes the type of barrier the culvert poses on fish (Table 2).

Table 2. Types of Barriers as defined in *FishXing*.

Barrier Type	Description
Depth	Water depth in culvert < Minimum Depth
Leap	Required Leap speed to enter outlet > Max Outlet Drop
Velocity	Velocity through culvert > Fish Burst Speed
Pool Depth	Outlet Pool Depth < Length of Fish

Fisheries Inputs and Culvert Information

The fish passage criteria in Table 3 were used for the 'user-defined swim speed' option in the Fish Information portion of *FishXing* analyses. This information describes the physical characteristics and swimming abilities of fish species by age class. Three different age classes were included into all crossing analyses: adult salmonid, resident trout, and juvenile salmonid. The physical components of culverts such as: dimensions, slope, material, roughness, and length are all incorporated into the *FishXing* analyses. These components are necessary to simulate hydraulic conditions through a culvert.

Table 3. Fish passage criteria used in *FishXing* analyses. Fish species and age classes are specific to the Central Valley region. The listed swimming abilities represent "average" fish capabilities. Individual fish may surpass the abilities listed.

Fish Species/Age Class	Adult Salmon and Steelhead	Resident Trout	Juvenile Salmonids
Fish Length	55 cm	22 cm	5 cm
Prolonged Mode Swim Speed Time to Exhaustion	 6.0ft/sec 30 min.	 4.0 ft/sec 30 min.	 1.5 ft/sec 30 min.
Burst Mode Swim Speed Time to Exhaustion	 10.0 ft/sec 5.0 sec	 5.0 ft/sec 5.0 sec	 3.0 ft/sec 5.0 sec
Max. Leaping Speed	15.0 ft/sec	6.0 ft/sec	4.0 ft/sec
Min. Required Water Depth	0.8 feet	0.5 feet	0.3 feet
Velocity Reduction Factors for Corrugated Metal Culverts and Baffles	Inlet = 1.0 Barrel = 1.0 Outlet = 1.0	Inlet = 0.8 Barrel = 0.6 Outlet = 0.8	Inlet = 0.8 Barrel = 0.6 Outlet = 0.8
Lower Passage Flow	3 cfs	2 cfs	1 cfs
Upper Passage Flow	50% of 2-year Recurrence Interval Flow	30% of 2-year Recurrence Interval Flow	10% of 2-year Recurrence Interval Flow

Hydrology and Peak Flows

Three different flows were considered while examining stream crossings that require fish passage. The upper and lower fish passage flows and peak flow. The peak flow, defined as the 2-year recurrence interval discharge, was used to

determine the upper and lower migration flows at each crossing. These fish passage flows vary by species and life stage.

Due to the lack of stream gauges in nearby streams of this study area, flows were estimated using regional regression techniques. This method requires information to be developed about the stream crossing's upstream watershed, including:

- Contributing drainage area
- Mean annual precipitation (MAP)
- Average basin elevation (altitude index)

Drainage area was calculated by deriving flow direction from the slope of the terrain above the culvert using digital elevation models (DEM).

The mean annual precipitation was derived from raster digital data produced by The PRISM Group at Oregon State University http://www.prism.oregonstate.edu/. The annual precipitation data was interpolated from monitoring stations to grid points for the climatological period 1971-2000 (The PRISM Group).

Altitude index was calculated by averaging altitudes in thousands of feet at points along the main channel representing 10% and 85% of the distance from the crossing site to the drainage divide. This information was derived from a modified GIS tool.

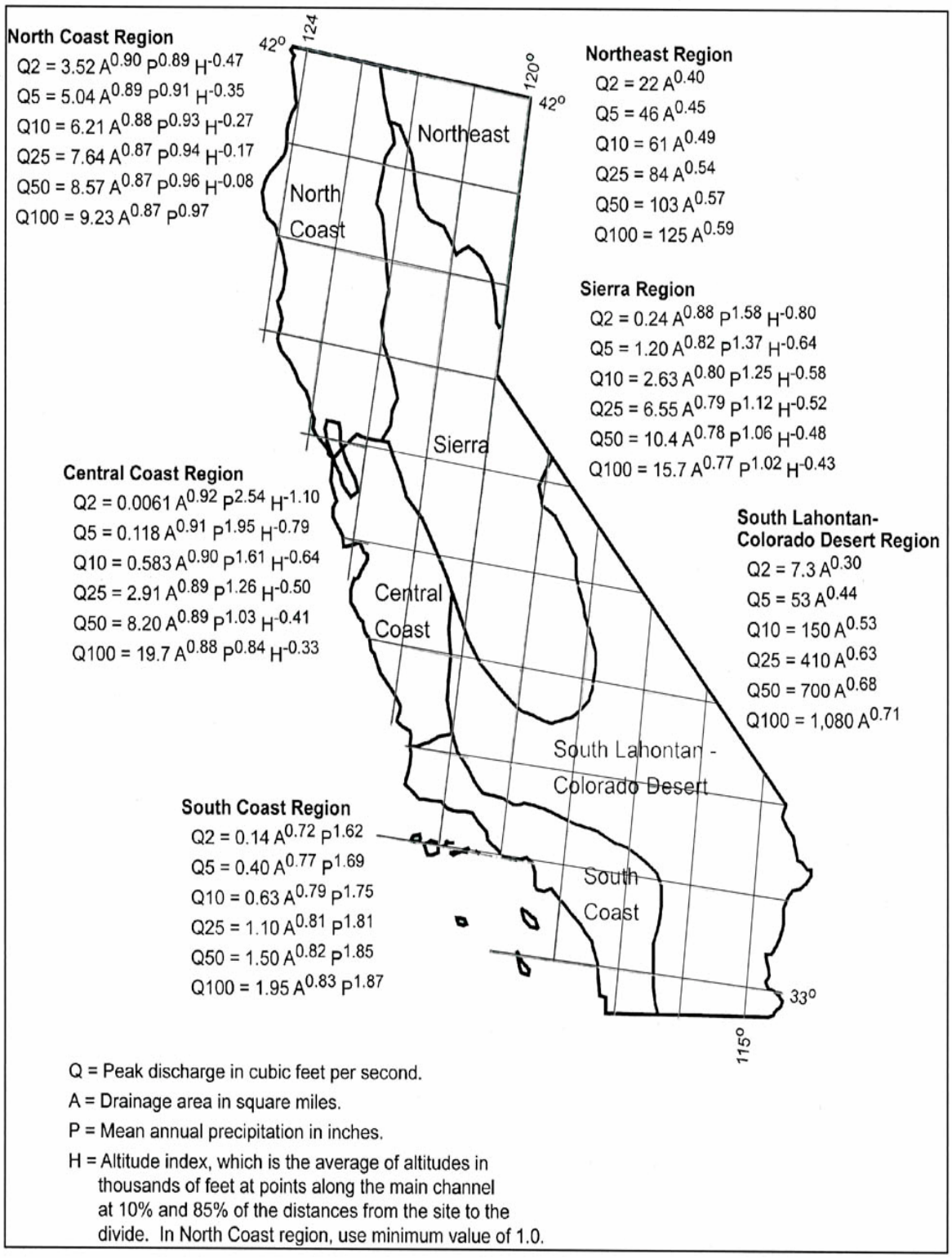
Peak flows were estimated using the regional regression equations associated with this study area (Figure 8). These regions include the North Coast Region and Sierra Region in the state of California.

Calculating Fish Passage Flows

It is widely agreed that designing stream crossings to pass fish at all flows is impractical (Robison et al. 1999; SSHEAR 1998). Fish can only pass through culverts at certain flows when negotiating a stream crossing. There is a small window of opportunity through which certain fish species and age classes are able to swim through. Although adult anadromous salmonids typically migrate upstream during higher flows triggered by rainfall or runoff events, it is presumed that migration is naturally delayed during large flood events. Conversely, during low flow periods water depths within the channel can become impassable for adult and/or juvenile salmonids. The upper and lower flow limits have been defined specifically for streams within California and are listed in Table 3.

The upper fish passage flow limit for adult anadromous salmonids (Q_{hp}) is defined as the 1 percent exceedance flow (the flow equaled or exceeded 1 percent of the time) during an average year, or 50% of the 2-year return flow. For all adult salmonids, the lower fish passage flow (Q_{lp}) equals the 50 percent

Figure 8. California regional regression equations (Adapted from Part IX of California Salmonid Stream Habitat Restoration Manual. DFG 2003). Shasta and Tehama Counties fall within the North Coast and Sierra Regions.



exceedance flow. To evaluate the extent to which a crossing is a barrier to fish, passage was assessed between the lower and upper passage flows for each fish species and life stage of concern.

Fish passage flows were obtained with the following steps:

1.) Measured contributing Drainage Area of stream crossing in square miles.

2.) Obtained the Mean Annual Precipitation amount for given area.

3.) Calculated Altitude Index based on the 10% and 85% distances along the main channel of each stream.

4.) Calculated the estimated 2-year recurrence interval using the Regional Regression Equation.

5.) Determined the upper and lower passage flows for each stream based on recurrence intervals.

Ranking Process for Stream Crossing Prioritization

After completing the passage analysis using *FishXing*, a two step process was used to rank individual crossing sites and develop priorities for future remediation. The ranking process outlined in Part IX of the California Salmonid Stream Habitat Restoration Manual (DFG 2003) was used to develop an initial ranking based primarily on biological values. Crossings were then grouped into high, medium and low categories in a final ranking which considered biological values as well as factors such as documented presence of fish, presence of substantial barriers downstream, and presence of artificial barriers upstream.

Habitat Information

Information about the stream and riparian habitat was very important when prioritizing stream crossings. When ranking the crossings for treatment, both quality and quantity of upstream habitat was considered so that habitat restoration funds are devoted to the greatest benefit of the fisheries resource. Previous stream surveys, communication with local professionals and the utilization of remote sensing were all used to assist with obtaining useful habitat information in the desired watersheds.

Formal field surveys to quantify and qualify stream habitat information were very limited for streams within the study area. Several historical fisheries reports archived in the Redding DFG office were helpful in obtaining important habitat information (Hawks and Ross 1975). Fisheries professionals were consulted for local knowledge of existing conditions of upstream habitat and other potential barriers in Central Valley watersheds (Baumgartner 2010).

Remote sensing and Geographic Information Systems (GIS) were useful tools when estimating the quality of available habitat both downstream and upstream of stream crossings. Google™Earth and ArcMap were the major software programs used to obtain this data. Riparian zone types, water course direction, stream bank erosion, and additional road crossings were some of the key features detected with these tools. Information from the Passage Assessment Database (PAD) was incorporated into GIS to locate known barriers to fish migration on selected streams. This information was vital when making decisions with the ranking process. Information from this project was, in return, submitted to support the expansion of the PAD.

For the purposes of this study, we considered the extent of anadromy within the survey area to be defined by the designated critical habitat for the Central Valley steelhead distinct population segment (NMFS 2005). However, as noted in the draft Central Valley recovery plan (NMFS 2009) Central Valley steelhead is considered to be a "data deficient" species. Although many of the crossings surveyed are on tributaries to known anadromous waters, use of most of these tributaries by anadromous fish is undocumented. When the limits of anadromy were unknown, the upper limit of anadromous habitat was inferred to be the point when the stream channel exceeded a sustained eight to ten percent gradient for approximately 1,000 feet (DFG 2003). This information was determined using digital elevation models (DEM) and a specialized GIS application developed by DFG for this project. These models were utilized in assessing stream gradient to help infer the extent of habitat accessible to anadromous salmonids above road crossings and to determine the presence of natural barriers to salmonids.

The primary objective of the initial ranking was to arrange stream crossings classified as **GRAY** and **RED** in order from high to low priority, using fish habitat information as the primary criteria. This was done using site-specific information weighted heavily towards biological and physical habitat considerations. The rankings generated are categorical and are not intended to be absolute in deciding the specific order of future passage improvements. Professional judgment plays an important part in deciding the order of treatment. As noted by Robison et al. (2000) numerous social economic factors influence the exact order of sites to be treated, as well as treatment options considered.

Ranking Criteria

The initial ranking method assigns scores or values for the following four parameters at each stream crossing location.

1. *Species Diversity* – Number of salmonid species currently present (or historically present which should be restored) within the stream reach at each crossing location.

- **Score** – Each federally or state listed salmonid species; Endangered = 4 points; Threatened or Candidate = 2 points; not listed = 1 point. Maximum total points for Shasta and Tehama Counties = 4 points, Chinook = 2, Steelhead = 2.

2. *Extent of Barrier* – Over the range of estimated migration flows, assign one of the following values from the "percent passable" results generated with *FishXing*. **GREEN** crossings are considered 100 percent passable for all fish, while **RED** crossings are considered 0 percent passable for all fish. Do this for adult salmonids, resident, and juvenile salmonids for each culvert.
   - **Score** – 0 = 80% or greater passable; 1 = 79-60% passable; 2 = 59-40% passable; 3 = 39-20% passable; 4 = 19% or less passable; 5 = 0% passable (**RED**). For a total score, sum the values for all three.

3. *Habitat Value* – Multiply habitat quantity score by habitat quality score.

   Habitat Quantity – Above each crossing, length in feet to a sustained 8% gradient or field identified limit of anadromy.
   - **Score** – 0.5 points for each 500 feet of stream (example: 0.5 points for <500'; 1 point for 1,000'; 2 points for 2,000'; and 5.5 points for 5,500'). The maximum possible score for Habitat Quantity is 10.

   Habitat Quality – For each stream, assign a score of quality after reviewing available habitat information.

   - **Score**:

   1.0 = *Excellent* – Relatively undeveloped, with pristine watershed conditions. Habitat features include dense riparian zones with mix of mature native species, frequent pools, high-quality spawning areas, cool summer water temperatures, complex instream habitat, floodplain relatively intact.

   0.75 = *Good* – Habitat is mostly intact but erosional processes or other factors have altered the watershed with a likelihood of continued occurrence. Habitat includes dense riparian zones of native species, frequent pools, spawning gravels, cool summer water temperatures, complex instream habitat, floodplain relatively intact.

   0.5 = *Fair* – Erosional processes or other factors have altered the watershed with
   negative affects on watershed processes and features, with the likelihood of
   continued occurrence. Indicators include:

a) riparian zone lacking mature conifers
b) infrequent pools
c) sedimentation evident in spawning areas (embeddedness ratings of 3)
d) summer water temperatures periodically exceed stressful levels for salmonids
e) sparse instream complex habitat, and floodplain intact or slightly modified

0.25 = *Poor* – Erosional processes or other factors have significantly altered the watershed. There is a high likelihood of increased erosion and apparent effects to watershed processes. Habitat impacts include riparian zones absent or severely degraded, little or no pool habitat, excessive sedimentation evident in spawning areas (embeddedness ratings of 4), stressful to lethal summer water temperatures common, lack of instream habitat, floodplain severely modified with levees, riprap, and/or residential or commercial development.

4. *Current Condition* – For each crossing, assign one of the following values.

   - **Score** – 0 = good condition; 1 = fair, showing signs of wear; 3 = poor, floor rusting through, crushed by roadbase, etc.; 4 = extremely poor, floor rotted-out, severely crushed, damaged inlets, collapsing wingwalls, slumping roadbase, etc.

5. **Total Habitat Score** – Multiply habitat quantity by habitat quality for a habitat "score". Sum the four ranking criteria values, and compute the total scores.

All surveyed culverts were scored for each ranking criterion and tabulated into a spreadsheet database. The sites were then arranged into an initial ranking by score and subsequently categorized into low, medium and high priorities in the final ranking matrix.

III. RESULTS

Initial Site Visit

Initial site visits were conducted at 264 stream crossings in Shasta and Tehama counties. Of these, 29 crossings on seven state highways required detailed surveys in the field. The remaining 236 road crossings were excluded from further consideration because they were either 1) too ephemeral to support fish, 2) had excessively steep gradients, or 3) consisted of bridges that did not influence channel conditions. An inventory of all road crossings visited and their survey status is located in Table 4 below.

Table 4. List of 264 State Hwy. stream-crossings in Shasta/Tehama Counties.

COUNTY	ROUTE	POST MILE	STREAM	SURVEY STATUS
TEH	172	0.2	Martin Creek	Bridge
TEH	172	0.85	Battle Creek	Bridge
TEH	172	3.38	Unnamed	Non-fish bearing
TEH	172	3.44	Unnamed	Non-fish bearing
TEH	172	4.19	Trib. to Mill Creek	Too steep
TEH	172	4.49	Trib. to Mill Creek	Too steep
TEH	172	4.54	Trib. to Mill Creek	Too steep
TEH	172	5.07	Unnamed	Non-fish bearing
TEH	172	5.48	Trib. to Mill Creek	Non-fish bearing
TEH	172	5.54	Trib. to Mill Creek	Non-fish bearing
TEH	172	6.38	Unnamed	Non-fish bearing
TEH	172	6.98	Unnamed	Non-fish bearing
TEH	172	7.25	Trib. to Mill Creek	Non-fish bearing
TEH	172	7.34	Trib. to Mill Creek	**SURVEYED**
TEH	172	7.7	Trib. to Mill Creek	Non-fish bearing
TEH	172	7.77	Trib. to Mill Creek	Non-fish bearing
TEH	99	0.23	Singer Creek	Bridge
TEH	99	0.72	Trib. to Pine Creek	Non-fish bearing
TEH	99	0.77	Trib. to Pine Creek	Non-fish bearing
TEH	99	1.05	Unnamed	Non-fish bearing
TEH	99	1.32	Unnamed	Non-fish bearing
TEH	99	1.47	Unnamed	Non-fish bearing
TEH	99	1.72	Trib. to Pine Creek	Non-fish bearing
TEH	99	1.98	Unnamed	Non-fish bearing
TEH	99	2.35	Lake Draw	Bridge
TEH	99	3.03	Unnamed	Non-fish bearing
TEH	99	3.17	Unnamed	Non-fish bearing
TEH	99	3.67	Short Creek	Bridge
TEH	99	4.44	Hoag Slough	Private property
TEH	99	4.77	Trib. to Hoag Slough	Non-fish bearing
TEH	99	5	Trib. to China Slough	Non-fish bearing
TEH	99	5.32	China Slough	Non-fish bearing
TEH	99	5.82	Deer Cr. Overflow	Bridge
TEH	99	5.99	Deer Creek	Bridge
TEH	99	6.5	Unnamed	Non-fish bearing
TEH	99	6.7	Unnamed	Non-fish bearing
TEH	99	7.3	Unnamed	Non-fish bearing
TEH	99	7.53	Long Creek	Bridge
TEH	99	8.38	Toomes Creek	Bridge
TEH	99	8.91	Trib. to Champlin Slough	Non-fish bearing
TEH	99	9.14	Champlin Slough	Bridge
TEH	99	12.59	Los Molinos Creek	Bridge
TEH	99	13.2	Trib. to Sacramento River	Non-fish bearing
TEH	99	13.33	Mill Creek	Bridge

COUNTY	ROUTE	POST MILE	STREAM	SURVEY STATUS
TEH	99	13.96	S BR of N FK Mill Creek	Bridge
TEH	99	14.05	N BR of N FK Mill Creek	Bridge
TEH	99	14.63	Trib. to Sacramento River	Non-fish bearing
TEH	99	15.55	Sunset Canal	Bridge
TEH	99	16.6	Dye Creek	Bridge
TEH	99	16.9	Unnamed	Non-fish bearing
TEH	99	16.91	Unnamed	Non-fish bearing
TEH	99	17.37	Unnamed	Non-fish bearing
TEH	99	18.02	Antelope Creek	Bridge
TEH	99	19	Unnamed	Non-fish bearing
TEH	99	19.54	Butler Slough	Bridge
TEH	99	19.56	Butler Slough	Non-fish bearing
TEH	99	20.16	Unnamed	Non-fish bearing
TEH	99	21.13	Craig Creek	Bridge
TEH	99	21.33	Unnamed	Non-fish bearing
TEH	99	22.54	New Creek	Bridge
TEH	99	23.62	Unnamed	Non-fish bearing
TEH	99	24.13	Mill Race Creek	Bridge
TEH	99	24.66	Salt Creek Overflow	Bridge
TEH	99	24.78	Salt Creek Overflow	Bridge
TEH	99	24.84	Salt Creek	Bridge
SHA	299	18.98	Trib. to Middle Creek	**SURVEYED**
SHA	299	19.14	Middle Creek	**SURVEYED**
SHA	299	20.75	Salt Creek	**SURVEYED**
SHA	299	22.1	Jenny Creek	**SURVEYED**
SHA	299	24.69	Boulder Creek	**SURVEYED**
SHA	299	25.18	Unnamed	Road width too wide
SHA	299	25.71	Churn Creek	Bridge
SHA	299	26.5	Unknown	Non-fish bearing
SHA	299	26.85	Unnamed	Non-fish bearing
SHA	299	27.28	W Fork Stillwater Creek	Bridge
SHA	299	27.29	W Fork Stillwater Creek	Non-fish bearing
SHA	299	27.5	Unknown	Non-fish bearing
SHA	299	27.7	Unknown	Non-fish bearing
SHA	299	27.76	Unknown	Non-fish bearing
SHA	299	27.94	Stillwater Creek	Bridge
SHA	299	28.92	Trib. To Salmon Creek	Non-fish bearing
SHA	299	29.5	Salmon Creek	**SURVEYED**
SHA	299	30.09	Trib. To Clough Creek	Non-fish bearing
SHA	299	30.4	Unknown	Non-fish bearing
SHA	299	30.65	Clough Creek	Non-fish bearing
SHA	299	31.03	Trib. To Dry Creek	Non-fish bearing
SHA	299	31.35	Trib. To Dry Creek	Non-fish bearing
SHA	299	31.36	Trib. To Dry Creek	Non-fish bearing
SHA	299	31.5	Dry Creek	Bridge

COUNTY	ROUTE	POST MILE	STREAM	SURVEY STATUS
SHA	299	32.25	Yank Creek	**SURVEYED**
SHA	299	34.56	Salt Creek	Bridge
SHA	299	35.92	Trib. To Woodman Creek	Non-fish bearing
SHA	299	36.9	Trib. To Woodman Creek	Non-fish bearing
SHA	299	40.62	Woodman Creek	Non-fish bearing
SHA	299	43.03	Trib. To Little Cow Creek	Non-fish bearing
SHA	299	43.29	Trib. To Little Cow Creek	Non-fish bearing
SHA	299	44.7	Trib. To Little Cow Creek	Non-fish bearing
SHA	299	46.14	Trib. To Little Cow Creek	Non-fish bearing
SHA	299	46.79	Trib. To Cedar Creek	Non-fish bearing
SHA	299	47.83	McCandless Gulch	**SURVEYED**
SHA	44	0.34	W Branch Churn Creek	Bridge
SHA	44	1.56	Churn Creek	Bridge
SHA	44	1.61	Trib. To Churn Creek	Non-fish bearing
SHA	44	1.8	Clover Creek	Bridge
SHA	44	4.31	Stillwater Creek	Bridge
SHA	44	4.55	Clough Creek	Bridge
SHA	44	5	Trib. To Stillwater Creek	Non-fish bearing
SHA	44	7.4	Cow Creek	Bridge
SHA	44	8.1	Trib. To Cow Creek	Non-fish bearing
SHA	44	9.5	Trib. To Cow Creek	Non-fish bearing
SHA	44	10.45	Trib. To Cow Creek	Non-fish bearing
SHA	44	10.99	Trib. To Cow Creek	Non-fish bearing
SHA	44	11.16	Trib. To Cow Creek	Non-fish bearing
SHA	44	11.79	Trib. To Cow Creek	Non-fish bearing
SHA	44	13.31	Trib. To Bear Creek	Non-fish bearing
SHA	44	13.95	Trib. To Bear Creek	Non-fish bearing
SHA	44	14.45	Bear Creek	Bridge
SHA	44	22.4	Shingle Creek	**SURVEYED**
SHA	44	26.3	Shingle Creek	Non-fish bearing
SHA	44	27.39	Shingle Creek	Non-fish bearing
SHA	44	28.05	Ash Creek	**SURVEYED**
SHA	44	32.81	Brush Creek	Non-fish bearing
SHA	44	33.78	Millseat Creek	**SURVEYED**
SHA	44	34.61	Millseat Creek	Non-fish bearing
SHA	44	39.18	N Fork Battle Creek	Green
SHA	273	3.9	Trib. To Anderson C. Canal	Non-fish bearing
SHA	273	4.52	Acid Canal	Bridge
SHA	273	4.63	Trib. To Anderson C. Canal	Non-fish bearing
SHA	273	5.1	Anderson Creek	Bridge
SHA	273	5.73	Unknown	Non-fish bearing
SHA	273	6.31	Trib. To Anderson Creek	Non-fish bearing
SHA	273	7.1	Spring Creek	Bridge
SHA	273	8.1	Trib. To Sacramento River	Non-fish bearing
SHA	273	9.07	Trib. To Sacramento River	Non-fish bearing
SHA	273	10.03	Trib. To Sacramento River	Non-fish bearing

COUNTY	ROUTE	POST MILE	STREAM	SURVEY STATUS
SHA	273	10.97	China Gulch	**SURVEYED**
SHA	273	11.23	Clear Creek	Bridge
SHA	273	11.45	Unknown	Non-fish bearing
SHA	273	12.41	Unknown	Non-fish bearing
SHA	273	12.58	Olney Creek	Bridge
SHA	273	13.26	Anderson Cottonwood Canal	Non-fish bearing
SHA	273	13.31	Acid Canal	Non-fish bearing
SHA	273	13.88	Oregon Gulch	Bridge
SHA	273	14.13	Unknown	Non-fish bearing
SHA	273	14.31	Canyon Creek	Bridge
SHA	273	14.77	South Redding UP	Bridge
SHA	273	17.08	Sacramento River	Bridge
SHA	273	17.97	Sulphur Creek	**SURVEYED**
SHA	273	18.12	Unknown	Non-fish bearing
SHA	273	19.10	Boulder Creek	**SURVEYED**
SHA	36	1.32	Unknown	Non-fish bearing
SHA	36	1.77	Unknown	Non-fish bearing
SHA	36	3.57	Harrison Gulch	**SURVEYED**
SHA	36	4.38	Trib. To Harrison Gulch	Non-fish bearing
SHA	36	5.14	Trib. To Sunday Gulch	Non-fish bearing
SHA	36	5.57	Sunday Gulch	**SURVEYED**
SHA	36	6.63	Unknown	Non-fish bearing
SHA	36	6.8	Unknown	Non-fish bearing
SHA	36	7.49	Cold Spring Gulch	**SURVEYED**
SHA	36	7.57	Unknown	Bridge
SHA	36	7.72	Unknown	Non-fish bearing
SHA	36	8.12	Unknown	Non-fish bearing
SHA	36	8.59	Unknown	Non-fish bearing
SHA	36	10.03	Unknown	Non-fish bearing
SHA	36	9.77	Unknown	Non-fish bearing
SHA	36	10.59	Unknown	Non-fish bearing
SHA	36	11.91	Beegum Creek	Bridge
SHA	36	11.83	Unknown	Non-fish bearing
TEH	36	0.36	Beegum Creek	Non-fish bearing
TEH	36	0.97	Trib. To Beegum Creek	Non-fish bearing
TEH	36	1.05	Trib. To Beegum Creek	Non-fish bearing
TEH	36	2.4	Trib. To Dry Creek	Non-fish bearing
TEH	36	2.7	Trib. To Dry Creek	Non-fish bearing
TEH	36	3.55	Trib. To Dry Creek	**SURVEYED**
TEH	36	3.92	Trib. To Dry Creek	Non-fish bearing
TEH	36	4.24	Budden Canyon	Non-fish bearing
TEH	36	4.92	Budden Canyon	Non-fish bearing
TEH	36	5.57	Budden Canyon	Non-fish bearing
TEH	36	5.78	Budden Canyon	Non-fish bearing
TEH	36	7.13	Budden Canyon	Non-fish bearing
TEH	36	7.64	Budden Canyon	Non-fish bearing

COUNTY	ROUTE	POST MILE	STREAM	SURVEY STATUS
TEH	36	8.22	Budden Canyon	**SURVEYED**
TEH	36	8.36	Budden Canyon	Non-fish bearing
TEH	36	8.96	Budden Canyon	Non-fish bearing
TEH	36	9.98	Trib. To Dry Creek	**SURVEYED**
TEH	36	10.35	Dry Creek	Bridge
TEH	36	10.73	Trib. To Dry Creek	Non-fish bearing
TEH	36	11.04	Trib. To Dry Creek	Non-fish bearing
TEH	36	11.63	Trib. To Dry Creek	Non-fish bearing
TEH	36	12.13	Trib. To Dry Creek	Non-fish bearing
TEH	36	14.22	Trib. To Dry Creek	**SURVEYED**
TEH	36	15.14	Trib. To Dry Creek	Non-fish bearing
TEH	36	15.76	Unknown	Non-fish bearing
TEH	36	15.9	Unknown	Non-fish bearing
TEH	36	16.49	Unknown	Non-fish bearing
TEH	36	16.98	Unknown	Non-fish bearing
TEH	36	17.21	Unknown	Non-fish bearing
TEH	36	17.05	Unknown	Non-fish bearing
TEH	36	19.17	Salt Creek	Bridge
TEH	36	19.69	Unknown	Non-fish bearing
TEH	36	20.26	Unknown	Non-fish bearing
TEH	36	20.65	Unknown	Non-fish bearing
TEH	36	22.13	Big Crane Creek	**SURVEYED**
TEH	36	23.05	Long Gulch	Bridge
TEH	36	25.54	Trib. To S. Fork Cottonwood	Non-fish bearing
TEH	36	26.02	Unknown	Non-fish bearing
TEH	36	26.18	Unknown	Non-fish bearing
TEH	36	27.56	Unknown	Non-fish bearing
TEH	36	29.69	Trib. To Dibble Creek	Non-fish bearing
TEH	36	29.03	Trib. To Dibble Creek	Non-fish bearing
TEH	36	29.39	Trib. To Dibble Creek	Non-fish bearing
TEH	36	29.57	Trib. To Dibble Creek	Non-fish bearing
TEH	36	29.89	Trib. To Dibble Creek	Non-fish bearing
TEH	36	30.26	Trib. To Dibble Creek	Non-fish bearing
TEH	36	30.34	Trib. To Dibble Creek	Non-fish bearing
TEH	36	30.45	Trib. To Dibble Creek	Non-fish bearing
TEH	36	30.64	Trib. To Dibble Creek	Non-fish bearing
TEH	36	30.73	Trib. To Dibble Creek	Non-fish bearing
TEH	36	30.84	Trib. To Dibble Creek	Non-fish bearing
TEH	36	31.11	Trib. To Dibble Creek	Non-fish bearing
TEH	36	31.39	Trib. To Dibble Creek	Non-fish bearing
TEH	36	31.66	Trib. To Dibble Creek	Non-fish bearing
TEH	36	32.05	Trib. To Dibble Creek	Non-fish bearing
TEH	36	32.41	Trib. To Dibble Creek	Non-fish bearing
TEH	36	32.62	Trib. To Dibble Creek	Non-fish bearing
TEH	36	32.84	Trib. To Dibble Creek	Non-fish bearing
TEH	36	33.1	Trib. To Dibble Creek	Non-fish bearing

COUNTY	ROUTE	POST MILE	STREAM	SURVEY STATUS
TEH	36	34.04	Dibble Creek	Bridge
TEH	36	34.55	Trib. To Dibble Creek	Non-fish bearing
TEH	36	37.32	Trib. To Dibble Creek	Non-fish bearing
TEH	36	37.32	Trib. To Dibble Creek	Non-fish bearing
TEH	36	37.66	Trib. To Dibble Creek	Non-fish bearing
TEH	36	38.01	Trib. To Dibble Creek	Non-fish bearing
TEH	36	38.29	Trib. To Dibble Creek	Non-fish bearing
TEH	36	38.4	Trib. To Dibble Creek	Non-fish bearing
TEH	36	38.42	Trib. To Dibble Creek	Non-fish bearing
TEH	36	38.9	Trib. To Dibble Creek	Non-fish bearing
TEH	36	39.14	S. Fork Dibble Creek	Bridge
TEH	36	39.18	Trib. To Dibble Creek	Non-fish bearing
TEH	36	39.46	Trib. To Dibble Creek	Non-fish bearing
TEH	36	39.86	Trib. To Dibble Creek	Non-fish bearing
TEH	36	40.45	Trib. To Dibble Creek	Non-fish bearing
TEH	36	40.9	Dibble Creek	Bridge
TEH	36	42.5	Paynes Creek Slough	Bridge
TEH	36	44.8	Trib. To Salt Creek	Non-fish bearing
TEH	36	48.04	Trib. To Sevenmile Creek	Non-fish bearing
TEH	36	48.24	Trib. To Sevenmile Creek	Non-fish bearing
TEH	36	48.6	Seven Mile Creek	**SURVEYED**
TEH	36	49.43	Trib. To Sevenmile Creek	Non-fish bearing
TEH	36	53.25	Palmer Gulch	Bridge
TEH	36	53.85	Supan Gulch	Bridge
TEH	36	54.26	Unknown	Non-fish bearing
TEH	36	54.84	Sheep Gulch	Bridge
TEH	36	55.2	De Haven Gulch	Bridge
TEH	36	58.18	Paynes Creek	Bridge
TEH	36	81.48	Battle Creek	Bridge
TEH	36	89.02	Trib. To Mill Creek	Non-fish bearing
TEH	36	89.39	Trib. To Mill Creek	Non-fish bearing
TEH	36	90.2	Trib. To Mill Creek	Non-fish bearing
TEH	36	91.46	Mill Creek	Bridge
TEH	36	91.61	Mill Creek	Bridge
TEH	36	97.67	Gurnsey Creek	Bridge
TEH	36	99	N. Fork Deer Creek	Bridge
SHA	I-5	17.14	Boulder Creek	**SURVEYED**

Of the 29 sites surveyed, 12 were culverts located on State Route 36, one on State Route 172, eight on State Route 299, three on State Route 44, three on State Route 273, one on Interstate 5, and one on a local road, Twin View Blvd. Crossings located on State Route 99 and Interstate 5 were primarily bridges and were excluded from the surveys. Surveyed sites were identified by their County, Route and Post Mile number and later assigned identification numbers 1-29, in the order they were surveyed (Table 5).

Three additional culverts were dropped from the list of sites requiring detailed field surveys. After the initial site visit to these locations, it was determined that surveys were not required for the following locations:

- *Brewery Creek* (pm 40.9) – Located on SR 36 west in Red Bluff. Crossing is a concrete box culvert with an embedded invert that does not appear to impede passage. There are multiple additional crossings located both upstream and downstream of the SR 36 crossing. Poor and very limited habitat exists above crossing. There is not a known steelhead distribution in this stream.

- *Unnamed Tributary to Stillwater Creek* (pm 27.29) – Located on SR 299 east in Redding. Very long concrete box culvert located within a 4-lane freeway interchange with entrance and exit ramps. There is not a known steelhead distribution in this stream. Multiple culverts located immediately upstream of 299 crossing. Poor upstream habitat.

- *Nanny Creek* (pm 85.4) – Located on SR 36 east in Tehama County. This crossing is above the limits of anadromy. Multiple known barriers exist downstream of this culvert.

Site locations and characteristics, a site catalog with maps, and notes from previous stream surveys are located in the Appendices of this report.

Table 5. Site ID and location data for 29 surveyed culverts on State Highways in Shasta and Tehama Counties.

Site ID	County	Route	Post Mile	Stream Name
#1	SHA	36	5.57	Sunday Gulch
#2	SHA	36	3.57	Harrison Gulch
#3	TEH	36	3.55	Tributary to Dry Creek
#4	TEH	36	5.78	Budden Canyon
#5	TEH	36	8.22	Budden Canyon
#6	TEH	36	9.98	Tributary to Dry Creek
#7	TEH	36	22.13	Big Crane Creek
#8	SHA	299	29.50	Salmon Creek
#9	SHA	299	18.98	Tributary to Middle Creek
#10	SHA	299	20.75	Salt Creek
#11	SHA	299	47.83	McCandless Gulch
#12	TEH	36	14.22	Tributary to Dry Creek
#13	TEH	36	48.60	Seven Mile Creek
#14	SHA	44	22.40	Shingle Creek
#15	TEH	36	10.73	Tributary to Dry Creek
#16	SHA	299	32.25	Yank (Lemm) Creek
#17	SHA	44	28.05	Ash Creek

Site ID	County	Route	Post Mile	Stream Name
#18	SHA	299	22.10	Jenny Creek
#19	SHA	273	17.97	Sulphur Creek
#20	SHA	273	10.97	China Gulch
#21	SHA	36	7.49	Cold Spring Gulch
#22	TEH	172	7.34	Tributary to Mill Creek
#23	TEH	36	83.53	Martin Creek
#24	SHA	44	33.78	Millseat Creek
#25	SHA	299	19.14	Middle Creek
#26	SHA	299	24.70	Boulder Creek
#27	SHA	I-5	17.14	Boulder Creek
#28	SHA	273	19.10	Boulder Creek
#29	SHA	Twin View Blvd	N/A	Boulder Creek

Passage Analyses

The first phase evaluation filter reduced the number of sites from 29 to 28 for further analyses. There were a total of eight (27.5%) **RED** crossings, one (3.5%) **GREEN** crossing, and 20 (69%) **GRAY** crossings (Figure 9). Sites with the **RED** output are considered 0% passable at all flows and are a total barrier to all fish and age classes. Sites that fall into the **GREEN** category are considered to be 100% passable to all fish and age classes.

Figure 9. Percentage of crossings rated GREEN, GRAY or RED.

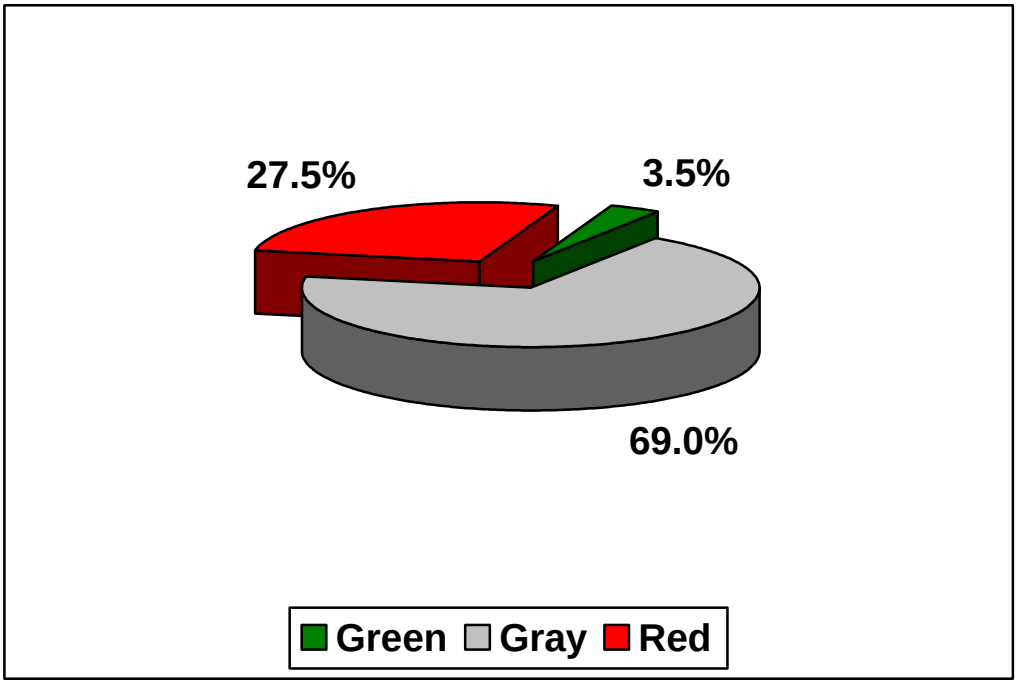


Table 6. GREEN-GRAY-RED Filter Results.

SHASTA/TEHAMA COUNTY GREEN-GRAY-RED FILTER															
Stream Location				Natural Channel Option				Hydraulic Option					Filter Output		FINAL OUTPUT
									Depth	Leap	Velocity Criteria				
ID #	Stream Name	Road Name	Drainage	Culvert Type	Culvert Embedded (yes/no/partial)	Culvert Width (ft)	Active Channel Width (ft)	Residual Pool Depth (ft)	Residual Inlet Depth (ft)	Residual Outlet Depth (ft)	Culvert Slope (%)	Barrel Retrofit (yes/no)	Natural Channel Option Green/Gray/Red	Hydraulic Option Green/Gray/Red	Conclusion from Filter Output
1	Sunday Gulch	Sha Hwy 36	Cottonwood	Circular	No	11.6	10.1	1.04	-3.70	-0.72	3.25	No	NO	RED	**RED**
2 (LB)	Harrison Gulch	Sha Hwy 36	Cottonwood	Box	No	10.0	10.7	-0.42	-3.63	-1.37	1.92	No	NO	GRAY	**GRAY**
2 (RB)	Harrison Gulch	Sha Hwy 36	Cottonwood	Box	No	10.0	10.7	-0.42	-3.87	-1.39	2.11	No	NO	GRAY	**GRAY**
3	Unknown	Teh Hwy 36	Cottonwood	Circular	No	7.1	6.6	1.39	-2.58	-0.77	1.59	No	NO	GRAY	**GRAY**
4	Budden Canyon	Teh Hwy 36 W	Dry Creek	Circular	No	5.0	6.7	1.67	-5.30	-1.57	2.63	no	NO	GRAY	**GRAY**
5	Budden Canyon	Teh Hwy 36	Cottonwood	Circular	Partial	8.5	14.8	1.47	-9.56	-2.33	3.09	No	NO	RED	**RED**
6 (LB)	Dry Creek	Teh Hwy 36	Cottonwood	Box	No	8.0	20.4	1.20	-3.08	-1.87	2.19	No	NO	GRAY	**GRAY**
6 (RB)	Dry Creek	Teh Hwy 36	Cottonwood	Box	No	8.0	20.4	1.20	-3.10	-1.87	2.22	No	NO	GRAY	**GRAY**
7	Little/Big Crane Creek	Teh Hwy 36	Cottonwood	Arch	No	16.2	13.9	0.36	-1.47	-0.99	0.47	No	NO	GRAY	**GRAY**
8 (LB)	Salmon Creek	Sha Hwy 299 E	Stillwater	Box	No	6.7	21.3	8.34	0.26	0.15	-0.15	No	NO	GRAY	**GRAY**
8 (Center)	Salmon Creek	Sha Hwy 299 E	Stillwater	Box	No	6.7	21.3	8.34	0.26	0.15	-0.15	No	NO	GRAY	**GRAY**
8 (RB)	Salmon Creek	Sha Hwy 299 E	Stillwater	Box	No	6.7	21.3	8.34	0.26	0.15	-0.15	No	NO	GRAY	**GRAY**
9 (LB)	Middle Creek	Sha Hwy 299 W	Sacramento	Circular	No	6.0	8.2	0.85	-3.32	-1.71	2.10	No	NO	GRAY	**GRAY**
9 (RB)	Middle Creek	Sha Hwy 299 W	Sacramento	Circular	No	6.0	8.2	0.51	-1.20	-1.09	3.60	No	NO	RED	**RED**
10	Salt Creek	Sha Hwy 299 W	Sacramento	Circular	No	10.0	16.6	3.06	-2.07	-0.54	1.20	Yes	NO	GRAY	**GRAY**
11 (LB)	McCandles Gulch	Sha Hwy 299 E	Cow Creek	Box	Partial	8.0	11.6	-2.86	-2.64	-2.89	-0.63	No	NO	RED	**RED**
11 (RB)	McCandles Gulch	Sha Hwy 299 E	Cow Creek	Box	Partial	8.0	11.6	-2.06	-2.61	-2.34	0.68	No	NO	RED	**RED**

Stream Location				Natural Channel Option				Hydraulic Option					Filter Output		FINAL OUTPUT
									Depth	Leap	Velocity Criteria				
ID #	Stream Name	Road Name	Drainage	Culvert Type	Culvert Embedded (yes/no/partial)	Culvert Width (ft)	Active Channel Width (ft)	Residual Pool Depth (ft)	Residual Inlet Depth (ft)	Residual Outlet Depth (ft)	Culvert Slope (%)	Barrel Retrofit (yes/no)	Natural Channel Option Green/Gray/Red	Hydraulic Option Green/Gray/Red	Conclusion from Filter Output
12 (LB)	Unknown	Teh Hwy 36	Cottonwood	Circular	No	4.4	14.6	3.24	-2.65	-0.63	4.36	No	NO	RED	**RED**
12 (RB)	Unknown	Teh Hwy 36	Cottonwood	Circular	No	4.4	14.6	3.24	-0.78	-2.33	3.35	No	NO	RED	**RED**
13 (LB)	Sevenmile	Teh Hwy 36 E	Sacramento	Box	No	12.8	34.6	2.67	-1.94	-0.70	1.39	No	NO	GRAY	**GRAY**
13 (RB)	Sevenmile	Teh Hwy 36 E	Sacramento	Box	No	12.8	34.6	2.67	-1.94	-0.82	1.30	No	NO	GRAY	**GRAY**
14 (1of5)	Shingle Creek	Sha Hwy 44	Bear	Circular	No	4.0	40.8	1.98	0.04	0.24	0.23	No	NO	GRAY	**GRAY**
14 (2of5)	Shingle Creek	Sha Hwy 44	Bear	Circular	No	4.0	40.8	1.98	0.13	0.27	0.16	No	NO	GRAY	**GRAY**
14 (3of5)	Shingle Creek	Sha Hwy 44	Bear	Circular	No	4.0	40.8	1.98	-0.16	0.20	0.42	No	NO	GRAY	**GRAY**
14 (4of5)	Shingle Creek	Sha Hwy 44	Bear	Circular	No	4.0	40.8	1.98	-0.24	0.22	0.53	No	NO	GRAY	**GRAY**
14 (5of5)	Shingle Creek	Sha Hwy 44	Bear	Circular	No	4.0	40.8	1.98	-0.14	0.49	0.73	No	NO	GRAY	**GRAY**
15	Unknown	Teh Hwy 36 W	Cottonwood	Circular	No	6.0	10.8	2.23	-1.98	-3.76	1.95	No	NO	RED	**RED**
16 (LB)	Yank Creek	Sha Hwy 299 E	Cow Creek	Box	No	8.0	21.1	2.48	-1.73	-1.77	-0.07	No	NO	GRAY	**GRAY**
16 (Center)	Yank Creek	Sha Hwy 299 E	Cow Creek	Box	No	8.0	21.1	2.48	-1.73	-1.73	0.00	No	NO	GRAY	**GRAY**
16 (RB)	Yank Creek	Sha Hwy 299 E	Cow Creek	Box	No	8.0	21.1	2.48	-1.73	-1.73	0.00	No	NO	GRAY	**GRAY**
17	Ash Creek	Sha Hwy 44	Sacramento	Circular	No	4.9	7.0	0.64	-0.69	-0.36	0.50	No	NO	GRAY	**GRAY**

Stream Location				Natural Channel Option				Hydraulic Option					Filter Output		FINAL OUTPUT
									Depth	Leap	Velocity Criteria				
ID #	Stream Name	Road Name	Drainage	Culvert Type	Culvert Embedded (yes/no/partial)	Culvert Width (ft)	Active Channel Width (ft)	Residual Pool Depth (ft)	Residual Inlet Depth (ft)	Residual Outlet Depth (ft)	Culvert Slope (%)	Barrel Retrofit (yes/no)	Natural Channel Option Green/Gray/Red	Hydraulic Option Green/Gray/Red	Conclusion from Filter Output
18 (LB)	Jenny Creek	Sha Hwy 299 W	Sacramento	Circular	No	7.0	10.3	0.75	-3.14	-0.87	0.85	No	NO	GRAY	**GRAY**
18 (RB)	Jenny Creek	Sha Hwy 299 W	Sacramento	Circular	No	7.0	10.3	0.75	-3.37	-0.89	0.93	No	NO	GRAY	**GRAY**
19 (LB)	Sulfur Creek	Sha Hwy 273	Sacramento	Box	Partial	12.0	23.3	1.49	-1.10	0.30	0.69	No	No	GRAY	**GRAY**
19 (RB)	Sulfur Creek	Sha Hwy 273	Sacramento	Box	Partial	12.0	23.3	1.49	-1.10	0.30	0.69	No	No	GRAY	**GRAY**
20 (LB)	China Gulch	Sha Hwy 273	Sacramento	Box	No	11.7	12.0	0.26	-1.80	-0.82	0.80	No	NO	GRAY	**GRAY**
20 (RB)	China Gulch	Sha Hwy 273	Sacramento	Box	Yes	11.7	12.0	0.26	-1.80	-0.82	0.80	No	GRAY	GRAY	**GRAY**
21 (LB)	Cold Spring Gulch	Sha Hwy 36	Cottonwood	Circular	No	6.0	8.1	0.79	-2.47	-1.02	2.75	No	NO	GRAY	**GRAY**
21 (RB)	Cold Spring Gulch	Sha Hwy 36	Cottonwood	Circular	No	6.0	8.1	0.79	-2.34	-0.40	3.72	No	NO	RED	**RED**
22 (1of3)	Unknown	Sha Hwy 172	Mill Creek	Arch	Partial	6.0	13.8	0.19	-1.29	-0.53	1.25	No	NO	GRAY	**GRAY**
22 (2of3)	Unknown	Sha Hwy 172	Mill Creek	Arch	Partial	6.0	13.8	0.19	-1.47	-0.60	1.43	No	NO	GRAY	**GRAY**
22 (3of3)	Unknown	Sha Hwy 172	Mill Creek	Arch	Partial	6.0	13.8	0.19	-4.00	0.82	7.90	No	NO	RED	**RED**
23 (LB)	Martin Creek	Teh Hwy 36 E	Mill Creek	Box	No	5.2	13.7	2.66	-4.30	-2.77	2.24	No	NO	RED	**RED**
23 (Center)	Martin Creek	Teh Hwy 36 E	Mill Creek	Box	No	5.2	13.7	2.66	-4.30	-2.77	2.24	No	NO	RED	**RED**
23 (RB)	Martin Creek	Teh Hwy 36 E	Mill Creek	Box	No	5.2	13.7	2.66	-4.30	-2.77	2.24	No	NO	RED	**RED**
24	Millseat Creek	Sha Hwy 44 E	N.Fork Battle Creek	Circular	No	6.0	40.4	0.79	-3.94	-1.39	2.26	No	NO	GRAY	**GRAY**

Stream Location				Natural Channel Option				Hydraulic Option					Filter Output		FINAL OUTPUT
									Depth	Leap	Velocity Criteria				
ID #	Stream Name	Road Name	Drainage	Culvert Type	Culvert Embedded (yes/no/partial)	Culvert Width (ft)	Active Channel Width (ft)	Residual Pool Depth (ft)	Residual Inlet Depth (ft)	Residual Outlet Depth (ft)	Culvert Slope (%)	Barrel Retrofit (yes/no)	Natural Channel Option Green/Gray/Red	Hydraulic Option Green/Gray/Red	Conclusion from Filter Output
25	Middle Creek	Sha Hwy 299 W	Sacramento	Circular	No	7.5	10.7	2.75	-8.49	-4.45	2.24	No	NO	RED	**RED**
26	Boulder Creek	Sha Hwy 299	Churn Creek	Box	No	10.0	20.8	1.52	-0.50	0.40	0.28	No	NO	GRAY	**GRAY**
27	Boulder Creek	Sha I-5	Churn Creek	Box	No	10.0	19.8	1.29	1.48	2.19	0.27	No	NO	**GREEN**	**GREEN**
28	Boulder Creek	Sha Hwy 273	Churn Creek	Box	No	10.0	11.7	2.64	-0.42	0.13	0.46	No	NO	GRAY	**GRAY**
29	Boulder Creek	Twin View Blvd.	Churn Creek	Box	No	10.0	21.2	9.94	-4.28	-3.32	1.12	No	NO	RED	**RED**

It is interesting to note that after further analyses with *FishXing*, the single site initially classified as **GREEN** failed to pass fish at all flows:

(#27) Boulder Creek: - Juvenile salmonids = 54.4% passable
- Resident trout = 54.4% passable
- Adult salmonids = 52.1% passable

The *FishXing* software assigned 17 (58.6%) of the 29 culverts to partial or temporal passage barriers to fish from at least one age class of salmonids. By age class, 14 (48.2%) culverts will partially or temporally pass adult salmonids, four (13.7%) will pass resident trout, and four (13.7%) will pass juvenile salmonids. Detailed information and data on the passage evaluation results are located in Appendix C.

Of the 29 total sites surveyed, thirteen (44.8%) are total barriers to all fish and age classes. From the output summary of *FishXing* analyses, none (0%) of the surveyed culverts will pass fish 100% of the time for all passage flows and all age classes. All surveyed stream crossings are considered either partial, temporal, or total barriers to fish passage.

Priorities for Future Remediation

As a first cut at developing priorities for future passage improvements, all surveyed culverts were scored and ranked according to the criteria described in Part IX of the California Salmonid Stream Habitat Restoration Manual (DFG 2003). Results of this scoring are presented in an initial ranking matrix in Table 7. The criteria used in the DFG methodology are heavily weighted toward biological factors, including species diversity and the extent and quality of instream habitat that exist above individual crossings. While biological criteria are important components of any ranking exercise, there are additional factors that should be taken into account in making a final ranking for passage improvements. These include the presence of natural or artificial barriers existing downstream from a given crossing. In addition, the types of downstream barriers should be considered, with relatively permanent structures such as dams being given more weight than individual road crossings.

It was assumed that if there were no impassable downstream barriers between a state highway crossing and stream with documented anadromy, then anadromous fish may be present. However, conducting detailed evaluations of natural or artificial barriers below the crossings in the survey area was beyond the scope of the current study. Similarly, we were unable to conduct the stream surveys necessary to accurately document presence of anadromous fish in the stream reaches crossed by state highways. When available, we relied on existing data such as DFG's working steelhead distribution maps (DFG 2010) to document fish presence; however many of the streams in the study area have not been the subject of fisheries surveys.

Table 7. Initial Ranking Matrix

Rank	Site ID#	Stream Name	Road Name	Species Diversity	Species Diversity Score	Extent of Barrier Score	Length of Upstream Habitat	Habitat Quantity Score	Habitat Quality Modifier	Total Habitat Score	Existing Conditions Score	TOTAL SCORE
1	2	Harrison Gulch	Hwy 36 W Sha.	Steelhead	2	15	13,728'	10	0.75	7.5	1	25.5
2	23	Martin Creek	Hwy 36 E Teh.	Steelhead	2	15	10,560'	10	0.75	7.5	0	24.5
2	28	Boulder Creek	Hwy 273 Sha.	Steelhead	2	15	5,016'	5	0.5	2.5	0	24.5
3	19	Sulfur Creek	Hwy 273 Sha	Steelhead, Chinook	3	14	9,504'	9.5	0.75	7.125	0	24.125
4	12	Trib. to Dry Creek	Hwy 36 W Teh.	Steelhead	2	15	12,258'	10	0.25	2.5	4	23.5
5	13	Seven Mile Creek	Hwy 36 E Teh.	Steelhead	2	15	14,678'	10	0.5	5	1	23
6	10	Salt Creek	Hwy 299 W Sha.	Steelhead, Chinook	3	12	12,144'	10	0.75	7.5	0	22.5
7	5	Budden Canyon	Hwy 36 W Teh.	Steelhead	2	14	18,163'	10	0.5	5	1	22
7	16	Yank Creek	Hwy 299 E Sha.	Steelhead	2	14	19,008'	10	0.5	5	1	22
8	24	Millseat Creek	Hwy 44 E Sha.	Steelhead	2	14	8,113'	8.5	0.5	4.25	1	21.25
9	25	Middle Creek	Hwy 299 W Sha.	Steelhead	2	15	1,260'	1.5	0.5	0.75	3	20.75
10	6	Trib. to Dry Creek	Hwy 36 W Teh.	Steelhead	2	15	30,624'	10	0.25	2.5	1	20.5
11	11	McCandless Gulch	Hwy 299 E Sha.	Steelhead	2	11	8,834'	8.5	0.75	6.375	1	20.375
12	21	Cold Spring Gulch	Hwy 36 W Sha.	Steelhead	2	15	4,224'	4.5	0.5	2.25	1	20.25
13	7	Big Crane Creek	Hwy 36 W Teh.	Steelhead	2	13	30,096'	10	0.5	5	0	20
14	20	China Gulch	Hwy 273 Sha	Steelhead	2	15	7,392'	7.5	0.25	1.875	1	19.875
15	4	Budden Canyon	Hwy 36 W Teh.	Steelhead	2	14	4,963'	5	0.5	2.5	1	19.5
16	3	Trib. to Dry Creek	Hwy 36 W Teh.	Steelhead	2	15	4,699'	4.5	0.25	1.125	1	19.125
17	8	Salmon Creek	Hwy 299 E Sha.	Steelhead	2	15	5,280'	5	0.25	1.25	0	18.25
18	1	Sunday Gulch	Hwy 36 W Sha.	Steelhead	2	14	1,372'	1.5	0.5	0.75	1	17.75
19	9	Trib. to Middle Creek	Hwy 299 W Sha.	Steelhead	2	12	459'	0.5	0.25	0.125	3	17.125
19	29	Boulder Creek	Twin View Blvd.	Steelhead	2	15	90'	0.5	0.25	0.125	0	17.125
20	22	Trib. to Mill Creek	Hwy 172 Teh.	Steelhead	2	13	6,864'	6.5	0.25	1.625	0	16.625
21	15	Trib. Dry Creek	Hwy 36 W Teh.	Steelhead	2	13	158'	0.5	0.25	0.125	1	16.125
22	17	Ash Creek	Hwy 44 Sha.	Steelhead	2	12	1,478'	1.5	0.25	0.375	1	15.375
23	18	Jenny Creek	Hwy 299 W Sha.	Steelhead	2	12	2,851'	2.5	0.25	0.625	0	14.625
23	26	Boulder Creek	Hwy 299 Sha.	Steelhead	2	12	2,927'	2.5	0.25	0.625	0	14.625
24	14	Shingle Creek	Hwy 44 Sha.	Steelhead	2	9	23,760'	10	0.25	2.5	0	13.5
25	27	Boulder Creek	I-5 Sha.	Steelhead	2	6	4,168'	4.5	0.25	1.125	0	9.125

In order to develop a more realistic site ranking, further analysis was conducted using existing information on:

- The distribution of anadromous fish,
- Natural limits to anadromy on individual watercourses when known,
- Substantial artificial barriers downstream from surveyed crossings, and
- Artificial barriers upstream from surveyed crossings.

Federally designated critical habitat for Central Valley steelhead (NMFS 2005) and DFG's working winter steelhead distribution were used to evaluate the potential for anadromous fish at road crossing sites. The PAD and local road maps were consulted for the presence of potential barriers both upstream and downstream from individual crossings.

A final ranking was constructed considering the above factors in addition to the biological criteria (Table 8). Crossings were assigned to High, Medium, and Low priority groups based on documented presence of anadromous fish, available fish habitat above the crossing, and the number and types of barriers downstream. Sixteen crossings were removed from the priority ranking due to substantial uncertainty regarding the presence of anadromy. These include seven tributaries to Dry Creek on SR 36 in western Tehama County. Dry Creek has no documented use by either salmon or steelhead. In addition, three crossings (Martin Creek, Millseat Creek, and Ash Creek) were removed because of substantial dams located downstream. Two crossings (unnamed tributary to Middle Creek and McCandless Gulch) were excluded because they are above natural barriers. In the case of the unnamed tributary to Middle Creek, a bedrock cascade approximately 25 feet high blocks passage just upstream of its confluence with Middle Creek. Four crossings on Boulder Creek were dropped because of numerous road crossings located both downstream and upstream.

Table 8. Final Ranking Matrix.

Priority	Site ID#	Stream Name	Route	Initial Rank	Comments
HIGH	2	Harrison Gulch	SHA 36	2nd	High priority due to its close proximity to a stream with a known steelhead distribution. Stream has over 2 miles of "Good" potential upstream habitat. Initially ranked higher due to a lack of depth within culvert.
	19	Sulphur Creek	SHA 273	3rd	High priority due to the known steelhead and Chinook distribution in this stream. Initially ranked higher because site failed to meet fish passage during all flows due to the lack of depth within culvert. There are no known barriers downstream of this crossing.
	16	Yank Creek	SHA 299	7th	High priority due to: severity of barrier = excessive outlet drop and lack of depth. Stream is a tributary to creek with known steelhead distribution. Stream has over 19,000' of "Fair" habitat upstream of crossing.
MEDIUM	25	Middle Creek	SHA 299	9th	Medium priority. Although stream has a known steelhead distribution, there is a limited amount of upstream habitat. Concrete dam located 1,260 feet above road crossing.
	1	Sunday Gulch	SHA 36	18th	Medium priority. Although stream is in close proximity to a stream with a known steelhead distribution, there is very limited habitat upstream of the road crossing (1,372').
	13	Seven Mile Creek	TEH 36	5th	Medium priority due to: site failed to meet fish passage at all flows due to excessive leap and lack of depth. Although there are over 14,000' of upstream habitat, the quality rated as "Fair". There is a possible natural barrier downstream close to mouth of creek.

Priority	Site ID#	Stream Name	Route	Initial Rank	Comments
MEDIUM	8	Salmon Creek	SHA 299	17th	Medium priority due to: although crossing failed to meet fish passage requirements at all flows and life stages, upstream habitat rated as "Poor". Unknown steelhead distribution in this creek.
LOW	20	China Gulch	SHA 273	14th	Low priority due to: although crossing failed to meet fish passage criteria, upstream habitat was rated as "Poor" due to the lack of mature trees on riparian zone. There is no known steelhead distribution in this stream.
	14	Shingle Creek	SHA 44	24th	Low priority due to: site was "Gray" and assumed some fish passage. The upstream habitat is rated as "Poor" due to the lack of mature trees in the riparian zone and low water flows.
	22	Tributary to Mill Creek	TEH 172	20th	Low priority due to: low water flows and no known steelhead or Chinook distribution.
	21	Cold Spring Gulch	TEH 36	12th	Low priority due to: small stream with very little upstream habitat.
	10	Salt Creek	SHA 299	6th	Low priority. Culvert has been retro-fitted in past with corner baffles and downstream weirs. Salmonids have been observed upstream of crossing post retro-fit.

Priority	Site ID#	Stream Name	Route	Initial Rank	Comments
UNRANKED		**Dry Creek Tributaries**			
	12	Tributary to Dry Creek	TEH 36	4th	Anadromy not documented in Dry Creek.
	5	Budden Canyon	TEH 36	7th	Anadromy not documented in Dry Creek.
	6	Tributary to Dry Creek	TEH 36	10th	Anadromy not documented in Dry Creek.
	7	Big Crane Creek	TEH 36	13th	Anadromy not documented in Dry Creek.
	4	Budden Canyon	TEH36	15th	Anadromy not documented in Dry Creek.
	3	Tributary to Dry Creek	TEH 36	16th	Anadromy not documented in Dry Creek.
	15	Tributary to Dry Creek	TEH 36	21st	Anadromy not documented in Dry Creek.
		Battle Creek Tributaries			
	23	Martin Creek	TEH 36	Tied 2nd	Known downstream barriers on Battle Creek
	24	Millseat Creek	SHA 44	8th	Known downstream barriers on Battle Creek
		Boulder Creek Tributaries			
	28	Boulder Creek	SHA 273	Tied 2nd	Series of known barriers downstream.
	29	Boulder Creek	Twin View Blvd	19th	Known barriers upstream and downstream.
	26	Boulder Creek	SHA 299	23rd	Known barriers upstream.
	27	Boulder Creek	I-5	25th	Known barriers upstream.
		Known Downstream Barriers			
	9	Tributary to Middle Creek	SHA 299	19th	Known natural barrier downstream at confluence of Middle Creek.
	11	McCandless Gulch	SHA 299	11th	Known natural barrier downstream on Little Cow Creek.
	17	Ash Creek	SHA 44	22nd	Substantial known barrier downstream at Woodbridge Lake.

IV. CONCLUSION & RECOMMENDATIONS

The current project has identified a number of crossings on the state highway system that impede the passage of adult and juvenile salmonids. Of over 260 crossings visited, 29 culverts were subject to detailed surveys and passage analyses. Of these 29 sites, three locations were rated as “high” priority for future passage improvement; four sites were rated “medium” priority, and five were rated as “low” priority. Sixteen sites were eliminated from the final ranking due to substantial uncertainty regarding the presence of anadromous fish or the presence of substantial or natural barriers downstream. The three “high” priority sites, Harrison Gulch (Site ID #2), Sulphur Creek (Site ID #19), and Yank Creek (Site ID #16) are located on State Route 36, State Route 273, and State Route 299 respectively. All three are in Shasta County. Details for these sites can be seen by referencing the respective site numbers in Appendix B.

This effort has also brought to light information gaps that need to be filled before informed decisions can be made about which crossings are most in need of improvement. Chief among these is information on the distribution of anadromous fish and their use of selected habitats within the study area. While the distribution of anadromous fish is well documented in the major streams of the Central Valley, the extent to which anadromous fish use the frequently-seasonal tributaries to these streams is less well known. While a rough prioritization of state highway crossings is made in this report, it is recommended that additional barrier assessments be conducted on county and local road systems within the study area. This information would be useful in refining the current prioritization and would help ensure that restoration dollars are spent wisely. A future survey of county roads may reveal additional barriers to fish passage. In addition, new information showing use of the stream segments in this study by anadromous fish should cause a reevaluation of the current rankings.

Results of the current study have provided much needed data on the status of potential barriers to anadromous fish migration on the state highway system in Shasta and Tehama Counties. In contrast to coastal areas in Humboldt, Del Norte, and Mendocino Counties, relatively few state highways in the Central Valley have had detailed passage assessments conducted at stream crossings. The results of this report have helped fill this gap. Moreover, it is hoped these results will improve the utility of the PAD by increasing the number of crossing sites having detailed passage assessment data. It is recommended that Caltrans District 2 integrate these rankings into the working prioritization list developed by FishPAC and consider seeking funding for passage improvements at the three high priority sites.

V. LITERATURE CITED

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APPENDIX A

SHASTA-TEHAMA BARRIER ASSESSMENT:

SITE LOCATIONS AND CHARACTERISTICS

Culvert locations and characteristics

SHASTA/TEHAMA COUNTY CULVERT LOCATIONS AND CHARACTERISTICS

ID #	Stream Name	Road Name	Drainage	Township, Range, Section	Latitude and Longitude Coordinates	Milemarker or Name and Distance to nearest Crossroad	Type of Culvert	Construction Material	Corrugation Dimensions	Culvert Length (ft)	Culvert Dimensions: Diameter, height/width, or rise/span (ft)	% Slope thru Culvert
1	Sunday gulch	Hwy 36 W Sha	Cottonwood	T29N R10W S13	N 40.21924 W 122.56461	5.57 Sha	Circular	SSP	6" x 2"	92.0	12' 9" x 11' 6"	3.25
2	Harrison Gulch (LB)	Hwy 36 W Sha	Cottonwood	T29N R10W S15	N 40.36963 W 122.97408	3.57 Sha	box	concrete	0	117.5	10' x 10'	1.92
2	Harrison Gulch (RB)	Hwy 36 W Sha	Cottonwood	T29N R10W S15	N 40.36963 W 122.97408	3.57 Sha	box	concrete	0	117.5	10' x 10'	2.11
3	Trib. Of Dry Creek	Hwy 36 W T	Cottonwood	T29N R8W S31	N 40.31967 W.12281556	3.55 T	Circular	SSP	3" x 1"	113.8	7' 1" diameter	1.59
4	Budden Canyon	Hwy 36 W T	Cottonwood	T29N R8W S33	N 40.31630 W 122.77619	5.78 T	Circular	SSP	3" x 1"	141.7	5' diameter	2.63
5	Budden Canyon	Hwy 36 W T	Cottonwood	T28N R8W S2	N 40.30760 W 122.73512	8.22	Circular	SSP	6" x 2"	245.3	8' 6" diameter	3.09
6	Dry Creek (LB)	Hwy 36 W T	Cottonwood	T28N R7W S6	N 40.30166 W 122.70455	9.98	box	concrete	0	55.3	6' x 8'	2.19
6	Dry Creek (RB)	Hwy 36 W T	Cottonwood	T28N R7W S6	N 40.30166 W 122.70455	9.98	box	concrete	0	55.3	6' x 8'	2.22
7	Little/Big Crane Creek	Hwy 36 W T	Cottonwood	T34N R1W S31	N 40.27634 W. 122.50988	22.13	Pipe arch	SSP	6" x 2"	102	11' 7" x 16' 2"	0.5
8	Salmon Creek (1 of 3)	Hwy 299 E Sha	Stillwater Creek	T34N R1W S31	N 40.62983 W 122.27721	29.5	box	concrete	0	71	6' x 6'7"	-3.52
8	Salmon Creek (2 of 3)	Hwy 299 E Sha	Stillwater Creek	T34N R1W S31	N 40.62983 W 122.27721	29.5	box	concrete	0	71	6' x 6'7"	-2.11
8	Salmon Creek (3 of 3)	Hwy 299 E Sha	Stillwater Creek	T34N R1W S31	N 40.62983 W 122.27721	29.5	box	concrete	0	71	6' x 6'7"	-2.39
9	Middle Creek (LB)	Hwy 299 W Sha	Sacramento River	T32N R5W S30	N 40.59267 W 122.48426	18.98	Circular	CSP	3" x 1"	76.2	6' diameter	2.1
9	Middle Creek (RB)	Hwy 299 W Sha	Sacramento River	T32N R5W S30	N 40.59267 W 122.48426	18.98	Circular	CSP	3" x 1"	76.2	6' diameter	3.6
10	Salt Creek	Hwy 299 W Sha	Sacramento River	T34N R1W S31	N 40.58619 W 122.45402	20.75	Circular	CSP	6" x 2"	125.3	10' diameter	1
11	McCandless Gulch (LB)	Hwy 299 W Sha	Cow Creek/Battle Creek	T34N R1W S31	N 40.76257 W 122.01225	47.83	box	concrete	0	39.5	8'3" x 8'	-0.63
11	McCandless Gulch (RB)	Hwy 299 W Sha	Cow Creek/Battle Creek	T34N R1W S31	N 40.76257 W 122.01225	47.83	box	concrete	0	39.5	8'3" x 8'	0.68
12	Unnamed trib. to Dry Creek (LB)	Hwy 36W T	Cottonwood	T28N R7W S11	N 40.29766 W 122.63102	14.22	Circular	SSP	3" x 1"	46.3	3'9" x 4'4"	4.36
12	Unnamed trib. to Dry Creek (RB)	Hwy 36W T	Cottonwood	T28N R7W S11	N 40.29766 W 122.63102	14.22	Circular	SSP	3" x 1"	46.3	3'9" x 4'4"	3.35

ID #	Rustline Height (ft)	Inlet Type	Inlet Alignment to Channel	Outlet Configuration	Outlet Apron	Culvert Embedded?	Culvert Condition	Average Active Channel Width (ft)	Estimated Road fill (cubic yards)	Previous Modifications to Culvert	Additional Comments from Initial Site Visit
1	0.0	apron and wingwall	30-45	pool tailout	no	no	good	10.1	715		Juvenile salmonids in the 3-6 inch size class were observed downstream of crossing during survey.
2	0.0	wingwall	30-45	at stream grade	no	no	fair	10.7	1,891		Unknown juvenile fish in the 3-6 inch size class were observed downstream of the crossing during survey.
2	0.0	wingwall	30-45	at stream grade	no	no	fair	10.7	1,891		Unknown juvenile fish in the 3-6 inch size class were observed downstream of the crossing during survey.
3	1' 3"	mitered	>45	free-fall into pool	no	no	good	6.64	2,169		No fish were observed during survey.
4	1'	wingwall	>45	pool tailout	no	no	fair	6.72	4,207		No fish were observed during survey.
5	2' 2.5"	mitered	<30	cascade over rip rap	no	yes	good	14.8	16,825		Unknown juvenile fish in the 3-6 inch size class were observed downstream of crossing during survey.
6	o	headwall	>45	free-fall into pool	no	no	good	20.4	505		Unknown juvenile fish in the <3 inch size class were observed upstream and downstream of crossing during survey.
6	o	headwall	>45	free-fall into pool	no	no	good	20.4	505		Unknown juvenile fish in the <3 inch size class were observed upstream and downstream of crossing during survey.
7	0	wingwall	<30	pool tailout	no	no	fair	13.9	2,036		No fish were observed during survey. Culvert contains concrete bottom and partially sides. Top and sides SSP material culvert. Large log/debris jam at inlet.
8	0	wingwall	<30	no control point	no	no	good	21.3	61		Unknown juvenile fish in the <3 inch size class were observed upstream and downstream of crossing during survey.
8	0	wingwall	<30	no control point	no	no	good	21.3	61		multiple(>50) unknown juvenile fish <3" observed upstream and downstream.road fill measurements do not include width of road due to 4 lane highway
8	0	wingwall	<30	no control point	no	no	good	21.3	61		multiple(>50) unknown juvenile fish <3" observed upstream and downstream.road fill measurements do not include width of road due to 4 lane highway
9	8"	flared	<30	free-fall into pool	yes	no	poor	8.24	814		No fish were observed during survey. Culvert has a rustline height of 8 inches and is rusted through at inlet.
9	8"	flared	<30	free-fall into pool	yes	no	poor	8.24	814		No fish were observed during survey. Culvert has a rustline height of 8 inches and is rusted through at inlet.
10	0	headwall	30-45	free-fall into pool	no	no	good	16.6	1,158	11 baffles through culvert and 2 weirs at outlet	unknown juvenile fish in the <3 inch size class were observed upstream of crossing during survey. Culvert has 11 baffles and 2 weirs at outlet. Concrete culvert bottom.
11	0	wingwall	<30	no control point	no	yes	fair	11.6	253		Unknown juvenile fish in the 3-6 inch size class were observed upstream of crossing during survey. Major log/debris jam located at inlet.
11	0	wingwall	<30	no control point	no	yes	fair	11.6	253		Unknown juvenile fish in the 3-6 inch size class were observed upstream of crossing during survey. Major log/debris jam located at inlet.
12	1'	projecting	>45	free-fall into pool	no	no	poor	14.6	83		No fish were observed during survey. Culvert has a rustline height of 1 foot and bottom rusted through 50 percent.
12	1'	projecting	>45	free-fall into pool	no	no	poor	14.6	83		No fish were observed during survey. Stream alignment is >45 degrees with crossing. Culvert has a rustline height of 1 foot and bottom rusted through 50 percent.

ID #	Stream Name	Road Name	Drainage	Township, Range, Section	Latitude and Longitude Coordinates	Milemarker or Name and Distance to nearest Crossroad	Type of Culvert	Construction Material	Corrugation Dimensions	Culvert Length (ft)	Culvert Dimensions: Diameter, height/width, or rise/span (ft)	% Slope thru Culvert
13	Seven Mile Creek (LB)	Hwy 36 E. T	Sacramento River	T28N R03 S25	N 40.24536 W 122.15184	48.6	box	concrete	0	89.4	12' X 10'	1.4
13	Seven Mile Creek (RB)	Hwy 36 E. T	Sacramento River	T28N R03 S25	N 40.24536 W 122.15184	48.6	box	concrete	0	86.4	12' X 10'	1.3
14	Shingle Creek (1 of 5)	Hwy 44 Sha	Sacramento River	T31N R01W S 34	N 40.49975 W 121.97235	22.4	Circular	SSP	3"x 1"	86.2	4' diameter	0.23
14	Shingle Creek (2 of 5)	Hwy 44 Sha	Sacramento River	T31N R01W S 34	N 40.49975 W 121.97235	22.4	Circular	SSP	3"x 1"	85.8	4' diameter	0.16
14	Shingle Creek (3 of 5)	Hwy 44 Sha	Sacramento River	T31N R01W S 34	N 40.49975 W 121.97235	22.4	Circular	SSP	3"x 1"	86.4	4' diameter	0.42
14	Shingle Creek (4 of 5)	Hwy 44 Sha	Sacramento River	T31N R01W S 34	N 40.49975 W 121.97235	22.4	Circular	SSP	3"x 1"	86.3	4' diameter	0.53
14	Shingle Creek (5 of 5)	Hwy 44 Sha	Sacramento River	T31N R01W S 34	N 40.49975 W 121.97235	22.4	Circular	SSP	3"x 1"	86.1	4' diameter	0.73
15	Unnamed trib. to Dry Creek	Hwy 36 W T	Cottonwood	T28N R7W S8	N 40.29957 W 122.69048	10.73	Circular	SSP	3" x 1"	89.1	6' diameter	1.95
16	Yank Creek (LB)	Hwy 299 E Sha	Cow Creek	T32N R03W S08	N 40.64302 W 122.22858	32.25	box	concrete	0	58.5	6' x 8'	-0.07
16	Yank Creek (Center)	Hwy 299 E Sha	Cow Creek	T32N R03W S08	N 40.64302 W 122.22858	32.25	box	concrete	0	58.5	6' x 8'	0
16	Yank Creek (RB)	Hwy 299 E Sha	Cow Creek	T32N R03W S08	N 40.64302 W 122.22858	32.25	box	concrete	0	58.5	6' x 8'	0
17	Ash Creek	Hwy 44 Sha	Sacramento River	T31N R01E S32	N 40.49300 W 121.88388	28.05	Circular	SSP	3" x 1"	66	3'3" x 4'9"	0.5
18	Jenny Creek (LB)	Hwy 299 Sha	Sacramento River	T30N R04W S	N 40.58360 W 122.42876	22.1	Circular	aluminum	3" x 1"	266.5	7' diameter	0.85
18	Jenny Creek (RB)	Hwy 299 Sha	Sacramento River	T30N R04W S	N 40.58360 W 122.42876	22.1	Circular	aluminum	3" x 1"	258.8	7' diameter	0.96
19	Sulfur Creek (LB)	Hwy 273 Sha	Sacramento River	T32N R05 S25	N 40.60154 W 122.38255	17.97	box	concrete	0	204	6' x 12'	0.68
19	Sulfur Creek (RB)	Hwy 273 Sha	Sacramento River	T32N R05 S25	N 40.60154 W 122.38255	17.97	box	concrete	0	204	6' x 12'	0.68
20	China Gulch (LB)	Hwy 273 Sha	Sacramento River	T30N R04W S	N 40.50439 W 122.37888	10.97	box	concrete	0	123	6' x 11'7"	0.8
20	China Gulch (RB)	Hwy 273 Sha	Sacramento River	T30N R04W S	N 40.50439 W 122.37888	10.97	box	concrete	0	123	6' x 11'7"	0.8
21	Unnamed trib. to Middle Fork (LB)	Hwy 36 W Sha	Cottonwood	T29N R9W S17	N 40.36089 W 122.91164	7.49 Sha	Pipe arch	SSP	3" x 1"	52.7	2.9' x 6'	2.75
21	Cold Spring Gulch (LB)	Hwy 36 W Sha	Cottonwood	T29N R9W S17	N 40.36089 W 122.91164	7.49 Sha	Pipe arch	SSP	3" x 1"	52.2	2.9' x 6'	3.72
22	Unnamed tributary to Mill Creek (1 of 3)	Hwy 36 E. T	Mill Creek	T30N R05E S34	N 40.34104 W 121.52160	7.34	box	concrete	0	61	3'6" x 6'	1.25
22	Unnamed tributary to Mill Creek (2 of 3)	Hwy 36 E. T	Mill Creek	T30N R05E S34	N 40.34104 W 121.52160	7.34	box	concrete	0	61	3'6" x 6'	1.43
22	Unnamed tributary to Mill Creek (3 of 3)	Hwy 36 E. T	Mill Creek	T30N R05E S34	N 40.34104 W 121.52160	7.34	box	concrete	0	61	3'6" x 6'	7.9

ID #	Rustline Height (ft)	Inlet Type	Inlet Alignment to Channel	Outlet Configuration	Outlet Apron	Culvert Embedded?	Culvert Condition	Average Active Channel Width (ft)	Estimated Road fill (cubic yards)	Previous Modifications to Culvert	Additional Comments from Initial Site Visit
13	0	wingwall	<30	free-fall into pool	yes	no	good	34.6	998		No fish were observed during survey.
13	0	wingwall	<30	free-fall into pool	yes	no	good	34.6	998		No fish were observed during survey.
14	1' 4"	projecting	<30	pool tailout	no	no	fair	40.8	604		
14	1' 4"	projecting	<30	pool tailout	no	no	fair	40.8	604		No fish were observed during survey. Site consist of 5 culverts relative in size and condition. Adjacent landowner claims Caltrans replaced culverts and dredged stream channel at inlet during summer 2009. Upstream of inlet, stream spreads out over flood plain and produces a smaller secondary side stream. These two streams were measured together for cross-sectional survey and upstream active channel widths.
14	1' 4"	projecting	<30	pool tailout	no	no	fair	40.8	604		
14	1' 4"	projecting	<30	pool tailout	no	no	fair	40.8	604		
14	1' 4"	projecting	<30	pool tailout	no	no	fair	40.8	604		
15	7"	wingwall	<30	pool tailout	no	no	fair	10.8	561		No fish were observed during survey.
16	0	wingwall	<30	cascade over rip rap	yes	no	good	21.14	164		Unknown juvenile fish in the <3 inch size class were observed upstream and downstream of crossing during survey. Inlet and outlet apron present. Apron is a uniform slab of concrete that is uniform throughout bridge with a total width of 28.6 feet. Apron at outlet leads to cascade over rip rap.
16	0	wingwall	<30	cascade over rip rap	yes	no	good	21.14	164		
16	0	wingwall	<30	cascade over rip rap	yes	no	good	21.14	164		Unknown juvenile fish in the <3 inch size class were observed upstream and downstream of crossing during survey. Inlet and outlet apron present. Apron is a uniform slab of concrete that is uniform throughout bridge with a total width of 28.6 feet. Apron at outlet leads to cascade over rip rap.
17	1' 1"	projecting	>45	free-fall into pool	no	no	good	7.02	131		No fish were observed during survey.
18	0	wingwall	<30	free-fall into pool	no	no	good	10.3	-		Juvenile largemouth bass (Micropterus salmoides) in the 3-6 inch size class were observed upstream of crossing during survey. Culvert is lined with a concrete bottom through entire length and about 6 inches in height.
18	0	wingwall	<30	free-fall into pool	no	no	good	10.3	-		
19	0	wingwall	<30	free-fall into pool	no	yes	good	23.3	-		>100 Juvenile salmonids in the <3 inch size class were observed upstream and downstream of crossing during survey.
19	0	wingwall	<30	free-fall into pool	no	yes	good	23.3	-		
20	0	wingwall	<30	free-fall into pool	no	no	good	12	281		No fish were observed during survey. Creek flows into large wingwall which aligns flow with inlet. Culvert is a 2-sided concrete box bridge. The right side of box does not contain any flow or water. The right side also contains several feet of boulder and cobble substrate throughout entire length. There may be possile barrier to juvenile fish downstream of culvert, under railroad bridge crossing.
20	0	wingwall	<30	free-fall into pool	no	yes	good	12	281		
21	5"	mitered	30-45	at stream grade	no	yes	fair	8.14	116		Unknown juvenile fish in the 3-6 inch size class were observed upstream of crossing during survey.
21	5"	mitered	30-45	at stream grade	no	yes	fair	8.14	116		Unknown juvenile fish in the 3-6 inch size class were observed upstream of crossing during survey.
22	0	wingwall	<30	free-fall into pool	no	yes	good	13.8	83		No fish were observed during survey. Crossing consists of 3 culverts with concrete headwall. Crossing looks newly constructed.
22	0	wingwall	<30	free-fall into pool	no	yes	good	13.8	83		No fish were observed during survey. Crossing consists of 3 culverts with concrete headwall. Crossing looks newly constructed.
22	0	wingwall	<30	free-fall into pool	no	yes	good	13.8	83		No fish were observed during survey. Crossing consists of 3 culverts with concrete headwall. Crossing looks newly constructed.

ID #	Stream Name	Road Name	Drainage	Township, Range, Section	Latitude and Longitude Coordinates	Milemarker or Name and Distance to nearest Crossroad	Type of Culvert	Construction Material	Corrugation Dimensions	Culvert Length (ft)	Culvert Dimensions: Diameter, height/width, or rise/span (ft)	% Slope thru Culvert
23	Martin Creek	Hwy 36 E. T	Mill Creek	T29N R4E S30	N 40.34948 W 121.59108	83.53	box	concrete	0	68.2	4'1" x 5'2"	2.2
23	Martin Creek	Hwy 36 E. T	Mill Creek	T29N R4E S30	N 40.34948 W 121.59108	83.53	box	concrete	0	68.2	4'1" x 5'2"	2.2
23	Martin Creek	Hwy 36 E. T	Mill Creek	T29N R4E S30	N 40.34948 W 121.59108	83.53	box	concrete	0	68.2	4'1" x 5'2"	2.2
24	Millseat Creek	Hwy 44 Sha	N. Fork Battle Creek	T31N R2E S34	N 40.50030 W 121.84867	33.78	Circular	SSP	3" x 1"	113	6' diameter	2.25
25	Middle Creek	Hwy 299 W Sha	Churn Creek	T32 R5W S31	N 40.59116 W - 122.48202	19.14	Circular	SSP	6" X 1.5"	180	7.5' diameter	2.24
26	Boulder Creek	Hwy 299 Sha	Churn Creek	T32N R4W S19	N 40.61185 W - 122.3657	24.7	box	concrete	0	323.9	8'3" X 10'	0.28
27	Boulder Creek	I-5	Churn Creek	T32N R4W S19	N 40.60971 W - 122.36268	17.14	box	concrete	0	254	8'3" X 10'	0.27
28	Boulder Creek	Hwy 273 Sha	Churn Creek	T32N R5W S24	N 40.61594 W- 122.37462	19.1	box	concrete	0	120	7' X 10'	0.46
29	Boulder Creek	Twin View Blvd.	Churn Creek	T32N R4W S19	N 40.61569 W - 122.3740	N/A	box	concrete	0	86.2	7' X 10'	1.12

ID #	Rustline Height (ft)	Inlet Type	Inlet Alignment to Channel	Outlet Configuration	Outlet Apron	Culvert Embedded?	Culvert Condition	Average Active Channel Width (ft)	Estimated Road fill (cubic yards)	Previous Modifications to Culvert	Additional Comments from Initial Site Visit
23	0	wingwall	<30	free-fall into pool	yes	yes	good	13.7	202		No fish were observed during survey. Outlet apron present and is at a slight downgrade from outlet (1-2 ft. drop). Crossing consists of 3 box concrete box with wingwalls at inlet and outlet. Long metal structures to block debris at inlet.
23	0	wingwall	<30	free-fall into pool	yes	yes	good	13.7	202		No fish were observed during survey. Outlet apron present and is at a slight downgrade from outlet (1-2 ft. drop). Crossing consists of 3 box concrete box with wingwalls at inlet and outlet. Long metal structures to block debris at inlet.
23	0	wingwall	<30	free-fall into pool	yes	yes	good	13.7	202		No fish were observed during survey. Outlet apron present and is at a slight downgrade from outlet (1-2 ft. drop). Crossing consists of 3 box concrete box with wingwalls at inlet and outlet. Long metal structures to block debris at inlet.
24	> 1'	projecting	<30	free-fall into pool	no	no	poor	40.4	4,726		Unknown juvenile fish in the >6 inch size class were observed upstream of the crossing during the survey. Stream alignment is <30 degrees with crossing. Outlet configuration is free-fall into pool. Average upstream channel width is 40.4 feet. Culvert pipe is slightly caved in towards inlet top. Large log/debris jam at outlet. High velocity all the way through culvert.
25	1.3'	projecting	>45	free-fall into pool	no	no	poor	10.7	18,744		
26	0	wingwall	<30	at stream grade	yes	no	good	20.8	2,845		
27	0	wingwall	<30	at stream grade	yes	no	good	19.8	4,022		
28	0	wingwall	<30	at stream grade	no	no	good	11.7	1,256		
29	0	wingwall	<30	at stream grade	yes	no	good	21.2	1,072		

SURVEYED Elevations for Crossings in Shasta and Tehama Counties

SITE #1 SUNDAY GULCH – PM 5.57 Hwy 36 Sha						
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.1				100.34	6.27%	TW Control of 1st resting habitat
36.8				97.52		Inlet Apron/Riprap
41.6				97.74	3.25%	Inlet Depth
133.4				94.76		Outlet Depth
						Outlet Apron/Riprap
135.6				93.00		Max. Depth Within = 1.04’
135.6				93.00		Max. Pool Depth= 1.04
150.0				94.04		TW Control
171.4				93.26		Active Channel Stage #1
						Active Channel Stage #2
198.3				92.85		Downstream Channel Slope

SITE #2 HARRISON GULCH - PM 3.57 Hwy 36 W Sha						1 of 2 LB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				97.31	1.70%	TW Control of 1st resting habitat
87.4				95.95		Inlet Apron/Riprap
101.0				95.59	1.92%	Inlet Depth
218.6				93.33		Outlet Depth
232.4				93.12		Outlet Apron/Riprap
235.8				92.38		Max. Depth Within =
235.8				92.38		Max. Pool Depth=
292.5				91.96		TW Control
					0.60%	Downstream Channel Slope

TAILWATER CROSS-SECTION at Station 223		
Station (ft)	Elevation (ft)	Station Description, Comments
0.0	94.29	Left bank
1.5	93.01	Edge of water
4.6	92.32	Thalweg
9.9	92.76	Stream
12.0	93.92	Stream
14.7	93.84	Stream
16.6	93.36	Stream
19.5	94.24	Stream
23.3	93.88	
28.4	92.48	
32.8	94.96	Toe of left slope
43.0	94.99	Right bank

SITE #2 HARRISON GULCH - mile 3.57 Sha Hwy 36 W						2 of 2 RB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				97.31	1.47%	TW Control of 1st resting habitat
87.4				95.95		Inlet Apron/Riprap
101.0				95.83	2.11%	Inlet Depth
218.6				93.35		Outlet Depth
232.4				93.06		Outlet Apron/Riprap
235.8				92.38		Max. Depth Within =
235.8				92.38		Max. Pool Depth=
292.5				91.96		TW Control
					0.60%	Downstream Channel Slope

SITE #3 TRIB TO DRY CREEK - PM 3.55 Hwy 36 W Teh						
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
168.8				100		Temporary Bench Mark-TBM
31.0				102.70	3.74%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
54.8				101.81	1.59%	Inlet Depth
168.8				100.00		Outlet Depth
						Outlet Apron/Riprap
172.0				97.84		Max. Depth Within = 1.56'
172.0				97.84		Max. Pool Depth= 1.56'
185.0				99.23		TW Control
183.2				99.25		Active Channel Stage #1
180.0				99.60		Active Channel Stage #2

SITE #4 BUDDEN CANYON - PM 7.34 Hwy 36 E Teh						
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
26.0				100		Temporary Bench Mark-TBM
0.0				100.29	1.12%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
26.0				100.00	2.63%	Inlet Depth
167.7				96.27		Outlet Depth
						Outlet Apron/Riprap
170.3				93.03		Max. Depth Within = 1.97’
170.3				93.03		Max. Pool Depth= 1.97’
189.0				94.70		TW Control d= 0.41’
192.0				95.00		Active Channel Stage #1
197.3				95.00		Active Channel Stage #2
202.0				94.67		Downstream Channel Slope

SITE #5 BUDDEN CANYON - PM 8.22 Hwy 36					
Station (ft)			Elevation (ft)	Slope	Station Description, Comments
268.7			100		Temporary Bench Mark-TBM
0.0			109.37	9.15%	TW Control of 1st resting habitat
					Inlet Apron/Riprap
23.4			107.23	3.09%	Inlet Depth
268.7			100.00		Outlet Depth
					Outlet Apron/Riprap
272.5			96.58		Max. Depth Within = 1.34’
275.8			96.20		Max. Pool Depth= 1.72’
284			96.82		TW Control
285.3			97.67		Active Channel Stage #1
294.6			97.92		Active Channel Stage #2

TAILWATER CROSS-SECTION at Station 284			
Station (ft)	Elevation (ft)	Slope	Station Description, Comments
0.4	97.67		Left bankfull
3.5	97.52		Left toe of bank
4.0	97.51		Left edge of water
6.0	96.91		stream
9.0	96.82		Thalweg
12.0	97.14		stream
14.6	96.54		stream
15.8	97.09		Right edge of water
18.4	97.57		Right toe of bank
21.1	98.05		Right bankfull

SITE #6 DRY CREEK -PM 9.98 Hwy 36 W Teh					1 of 2 RB
Station (ft)			Elevation (ft)	Slope	Station Description, Comments
121.4			100		Temporary Bench Mark-TBM
0.0			102.09	1.33%	TW Control of 1st resting habitat
					Inlet Apron/Riprap
66.1			101.21	2.18%	Inlet Depth
121.4			100.00		Outlet Depth
					Outlet Apron/Riprap
124.4			96.93		Max. Depth Within = 1.2'
124.4			96.93		Max. Pool Depth= 1.2'
151.7			98.13		TW Control

SITE #6 DRY CREEK - PM 9.98 Hwy 36 W Teh						2 of 2 LB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
121.4				100		Temporary Bench Mark-TBM
0.0				102.09	1.30%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
66.1				101.23	2.22%	Inlet Depth
121.4				100.00		Outlet Depth
						Outlet Apron/Riprap
124.4				96.93		Max. Depth Within = 1.2’
124.4				96.93		Max. Pool Depth= 1.2’
151.7				98.13		TW Control

SITE #7 LITTLE/BIG CRANE CREEK - PM 22.13 Sha Hwy 36 W						
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
177.0				100		Temporary Bench Mark-TBM
0.0				102.61	2.84%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
75.0				100.48	0.47%	Inlet Depth
177.0				100.00		Outlet Depth
						Outlet Apron/Riprap
178.6				98.65		Max. Depth Within = 0.76'
178.6				98.65		Max. Pool Depth= 0.76'
210.6				99.01		TW Control
225.2				99.61		Active Channel Stage #1
235.6				99.21		Active Channel Stage #2
237.8				98.44		Downstream Channel Slope

SITE #8 SALMON CREEK - PM 29.50 Hwy 299 E Sha							1 of 3 LB
Station (ft)	BS (+)	**HI**	FS (-)	Elevation (ft)	WS	Slope	Station Description, Comments
0.0				609.05		-0.05%	Temporary Bench Mark-TBM TW Control of 1st resting habitat
							Inlet Apron/Riprap
19.7				609.06		-0.15%	Inlet Depth
91.0				609.17			Outlet Depth Outlet Apron/Riprap
96.0				609.11			Max. Depth Within = 1.4'
127.8				600.98			Max. Pool Depth= 1.4'
170.6				609.32			TW Control
229.9				607.01		3.89%	Downstream Channel Slope

SITE #8 SALMON CREEK - mile 29.50 sha Hwy 299 E							2 of 3 Center
Station (ft)	BS (+)	**HI**	FS (-)	Elevation (ft)	WS	Slope	Station Description, Comments
0.0				609.05		-0.05%	Temporary Bench Mark-TBM TW Control of 1st resting habitat
							Inlet Apron/Riprap
19.7				609.06		-0.15%	Inlet Depth
91.0				609.17			Outlet Depth Outlet Apron/Riprap
96.0				609.11			Max. Depth Within = 1.4'
127.8				600.98			Max. Pool Depth= 1.4'
170.6				609.32			TW Control Downstream
229.9				607.01		3.89%	Channel Slope
TAILWATER CROSS-SECTION at Station 160.0							
Station (ft)	BS (+)	**HI**	FS (-)	Elevation (ft)	WS	Slope	Station Description, Comments
0.0				617.63			Left bank
62.0				615.96			
69.5				611.81			
85.2				610.21			
107.9				610.05			Water surface elevation
116.2				608.51			Thalweg
123.9				610.16			Water surface elevation
126.6				610.93			Top of bank
136.2				610.99			
182.7				610.70			

SITE #8 SALMON CREEK - mile 29.50 sha Hwy 299 E							3 of 3 RB
Station (ft)	BS (+)	**HI**	FS (-)	Elevation (ft)	WS	Slope	Station Description, Comments
0.0				609.05		-0.05%	Temporary Bench Mark-TBM TW Control of 1st resting habitat
							Inlet Apron/Riprap
19.7				609.06		-0.15%	Inlet Depth
91.0				609.17			Outlet Depth Outlet Apron/Riprap
96.0				609.11			Max. Depth Within = 1.4'
127.8				600.98			Max. Pool Depth= 1.4'
170.6				609.32			TW Control Downstream
229.9				607.01		3.89%	Channel Slope

SITE #9 TRIB TO MIDDLE CREEK - PM 18.98 Hwy 299W Sha						1 of 2 LB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
156.0				100		Temporary Bench Mark-TBM
0.0				102.52	1.10%	TW Control of 1st resting habitat
72.5				101.85		Inlet Apron/Riprap
79.8				101.61	2.10%	Inlet Depth
156.0				100.00		Outlet Depth
163.4				99.89		Outlet Apron/Riprap
164.7				98.91		Max. Depth Within = 0.65'
184.0				97.44		Max. Pool Depth= 1.36'
198				98.29		TW Control
184.0				98.80		Active Channel Stage #1
190.0				98.75		Active Channel Stage #2
198.0				98.29	2.40%	Downstream Channel Slope
TAILWATER CROSS-SECTION at outlet						
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
0.0				101.45		Left Bankfull
2.5				99.73		Left toe of bank
3.5				99.57		Left edge of water
5.7				98.96		Thalweg
14.4				99.85		Mid-channel bar
16.8				98.71		In stream
20.5				97.71		Thalweg
26.0				98.92		Right edge of water
27.2				99.11		Right toe of bank
31.5				100.69		Right bankfull

SITE #9 TRIB TO MIDDLE CREEK -PM 18.98 Hwy 299W Sha						2 of 2 RB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
156.0				100		Temporary Bench Mark-TBM
0.0				102.52	0.92%	TW Control of 1st resting habitat
72.5				101.85		Inlet Apron/Riprap
79.8				101.61	3.60%	Inlet Depth
156.0				100.00		Outlet Depth
163.4				99.89		Outlet Apron/Riprap
164.7				98.91		Max. Depth Within = 0.65'
184.0				97.44		Max. Pool Depth= 1.36'
198				98.29		TW Control
184.0				98.80		Active Channel Stage #1
190.0				98.75		Active Channel Stage #2
198.0				98.29	2.40%	Downstream Channel Slope

SITE #10 SALT CREEK - PM 20.75 Hwy 299 W Sha						
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				101.39	6.70%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
13.9				100.45	1.20%	Inlet Depth = 1.65’
139.1				98.92		Outlet Depth = 1.32’
						Outlet Apron/Riprap
144.0				96.25		Max. Depth Within = 3.0'
146.5				95.32		Max. Pool Depth= 3.95'
155.5				98.38	Weir #1	TW Control d= 0.89'
158.5				99.30		Active Channel Stage #1
168.3				99.25		Active Channel Stage #2
170.2				97.65	Weir #2	Downstream Channel Slope

SITE #11 MCCANDLESS GULCH - PM 47.83 Hwy 299 E Sha						1 of 2 LB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
70.5				100		Temporary Bench Mark-TBM
0.0				102.44	6.90%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
31.0				100.30	-0.63%	Inlet Depth = 1.49'
70.5				100.55		Outlet Depth = 0.78'
						Outlet Apron/Riprap
73.4				99.72		Max. Depth Within = 0.56'
73.4				99.72		Max. Pool Depth= 0.56'
94.5				97.66		TW Control
75.3				100.52		Active Channel Stage #1
81.6				100.05		Active Channel Stage #2
94.5				97.66	9.76%	Downstream Channel Slope

SITE #11 MCCANDLESS GULCH - PM 47.83 Hwy 299 E Sha						2 of 2 RB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
70.5				100		Temporary Bench Mark-TBM
0.0				102.44	7.00%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
31.0				100.27	0.68%	Inlet Depth = 0.78
70.5				100.00		Outlet Depth = 0.74
						Outlet Apron/Riprap
73.4				99.72		Max. Depth Within = 0.56'
73.4				99.72		Max. Pool Depth= 0.56'
94.5				97.66		TW Control
75.3				100.52		Active Channel Stage #1
81.6				100.05		Active Channel Stage #2
94.5				97.66	9.76%	Downstream Channel Slope

MCCANDLESS GULCH TAILWATER CROSS-SECTION at 2 ft. from outlet						
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
0.0				101.72		Left bankfull (drop to water)
0.6				101.28		Left edge of water
5.0				100.47		water
10.0				100.08		water
14.0				99.87		Thalweg
18.0				100.65		Right edge of water
19.5				100.88		Right bankfull

SITE #12 UNNAMED TRIB TO DRY CREEK - PM 14.22 Hwy 36 W Teh						1 of 2 LB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				98.56	2.16%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
26.8				97.98	4.36%	Inlet Depth = 0.01'
73.1				95.96		Outlet Depth
						Outlet Apron/Riprap
78.2				93.04		Max. Depth Within = 2.51'
82.5				92.09		Max. Pool Depth= 3.51'
99.4				95.33		TW Control d= 0.22'
91.8				95.46		Active Channel Stage #1
95.0				95.64		Active Channel Stage #2

SITE #12 UNNAMED TRIB TO DRY CREEK - mile 14.22 Hwy 36 W Teh						2 of 2 RB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				98.56	3.36%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
26.8				97.66	3.35%	Inlet Depth = 0.3'
73.1				96.11		Outlet Depth = 0.2'
						Outlet Apron/Riprap
78.2				93.04		Max. Depth Within = 2.51'
82.5				92.09		Max. Pool Depth= 3.51'
99.4				95.33		TW Control d= 0.22'
91.8				95.46		Active Channel Stage #1
95.0				95.64		Active Channel Stage #2

SITE #13 SEVENMILE CREEK - PM 48.6 Hwy 36 W Teh						1 of 2 LB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
29.1				100		Temporary Bench Mark-TBM
0.0				100.86	2.96%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
29.1				100.00	1.44%	Inlet Depth
115.5				98.76		Outlet Depth
115.5				98.88		Outlet Apron/Riprap
119.5				96.59		Max. Depth Within =
137.0				95.39		Max. Pool Depth=
168.0				98.06		TW Control

SITE #13 SEVENMILE CREEK - PM 48.6 Hwy 36 W Teh						2 of 2 RB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
29.1				100		Temporary Bench Mark-TBM
0.0				100.86	2.96%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
29.1				100.00	1.30%	Inlet Depth
115.5				98.88		Outlet Depth
115.5				98.88		Outlet Apron/Riprap
119.5				96.59		Max. Depth Within =
137.0				95.39		Max. Pool Depth=
168.0				98.06		TW Control

SITE #14 SHINGLE CREEK - PM 22.4 Hwy 44 Sha						1 of 5 LB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				97.79	1.74%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
79.5				96.40	0.23%	Inlet Depth
165.9				96.20		Outlet Depth
						Outlet Apron/Riprap
162.2				95.56		Max. Depth Within = 1.17'
179.0				94.46		Max. Pool Depth= 2.27'
195.4				96.44		TW Control d= 0.29'
204.5				96.82		Active Channel Stage #1
209.0				96.64		Active Channel Stage #2

SITE #14 SHINGLE CREEK - PM 22.4 Hwy 44 Sha						2 of 5
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				97.79	1.86%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
79.5				96.31	0.16%	Inlet Depth
165.9				96.17		Outlet Depth
						Outlet Apron/Riprap
162.2				95.56		Max. Depth Within = 1.17'
179.0				94.46		Max. Pool Depth= 2.27'
195.4				96.44		TW Control d= 0.29'
204.5				96.82		Active Channel Stage #1
209.0				96.64		Active Channel Stage #2

SITE #14 SHINGLE CREEK - PM 22.4 Hwy 44 Sha						3 of 5
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				97.79	1.50%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
79.5				96.60	0.42%	Inlet Depth
165.9				96.24		Outlet Depth
						Outlet Apron/Riprap
162.2				95.56		Max. Depth Within = 1.17'
179.0				94.46		Max. Pool Depth= 2.27'
195.4				96.44		TW Control d= 0.29'
204.5				96.82		Active Channel Stage #1
209.0				96.64		Active Channel Stage #2

SITE #14 SHINGLE CREEK - PM 22.4 Hwy 44 Sha						4 of 5
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				97.79	1.39%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
79.5				96.68	0.53%	Inlet Depth
165.9				96.22		Outlet Depth
						Outlet Apron/Riprap
162.2				95.56		Max. Depth Within = 1.17'
179.0				94.46		Max. Pool Depth= 2.27'
195.4				96.44		TW Control d= 0.29'
204.5				96.82		Active Channel Stage #1
209.0				96.64		Active Channel Stage #2
						Downstream Channel Slope

SITE #14 SHINGLE CREEK - PM 22.4 Hwy 44 Sha						5 of 5 RB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				97.79	1.52%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
79.5				96.58	0.73%	Inlet Depth
165.9				95.95		Outlet Depth
						Outlet Apron/Riprap
162.2				95.56		Max. Depth Within = 1.17'
179.0				94.46		Max. Pool Depth= 2.27'
195.4				96.44		TW Control d= 0.29'
204.5				96.82		Active Channel Stage #1
209.0				96.64		Active Channel Stage #2

SITE #15 UNNAMED TRIB TO DRY CREEK - PM 10.73 Hwy 36 W Teh						
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
123.4				100		Temporary Bench Mark-TBM
0.0				103.41	5.05%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
32.3				101.78	1.95%	Inlet Depth
123.4				100.00		Outlet Depth
						Outlet Apron/Riprap
128.0				95.79		Max. Depth Within = 2.23'
128.0				95.79		Max. Pool Depth= 2.23'
146.0				98.02		TW Control
148.3				98.15		Active Channel Stage #1
157.0				97.89		Active Channel Stage #2

SITE #16 YANK CREEK - PM 32.25 Hwy 299 Sha						1 of 3 LB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				99.91	-0.08%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
120.0				100.00	-0.07%	Inlet Depth = 0.4'
178.5				100.04		Outlet Depth = 0.29'
						Outlet Apron/Riprap
182.3				98.61		Max. Depth Within = 0.82'
206.0				95.79		Max. Pool Depth= 3.64'
293.0				98.27		TW Control d= 1.16'
253.0				99.44		Active Channel Stage #1
289.0				99.46		Active Channel Stage #2
300.0				97.90		Downstream Channel Slope

SITE #16 YANK CREEK - PM 32.25 Hwy 299 Sha						2 of 3 Center
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				99.91	-0.08%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
120.0				100.00	0.00%	Inlet Depth = 0.36'
178.5				100.00		Outlet Depth =
						Outlet Apron/Riprap
182.3				98.61		Max. Depth Within = 0.82'
206.0				95.79		Max. Pool Depth= 3.64'
293.0				98.27		TW Control d= 1.16'
253.0				99.44		Active Channel Stage #1
289.0				99.46		Active Channel Stage #2
300.0				97.90		Downstream Channel Slope

SITE #16 YANK CREEK - PM 32.25 Hwy 299 Sha						3 of 3 RB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				99.91	-0.08%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
120.0				100.00	0.00%	Inlet Depth = 0.41'
178.5				100.00		Outlet Depth =
						Outlet Apron/Riprap
182.3				98.61		Max. Depth Within = 0.82'
206.0				95.79		Max. Pool Depth= 3.64'
293.0				98.27		TW Control d= 1.16'
253.0				99.44		Active Channel Stage #1
289.0				99.46		Active Channel Stage #2
300.0				97.90		Downstream Channel Slope

SITE #17 ASH CREEK - PM 28.05 Hwy 44 Sha						
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				97.51	0.41%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
103.4				97.09	0.50%	Inlet Depth
169.4				96.76		Outlet Depth
						Outlet Apron/Riprap
170.7				95.76		Max. Depth Within = 1.14'
170.7				95.76		Max. Pool Depth= 1.14'
176.6				96.40		TW Control d= 0.5'
191.0				96.87		Active Channel Stage #1
196.2				96.94		Active Channel Stage #2
200.0				95.80		Downstream Channel Slope

SITE #18 JENNY CREEK - PM 22.1 Hwy 299 Sha						1 of 2 LB
Station (ft)	BS (+)	**HI**	FS (-)	Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				103.65	4.08%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
30.1				102.27	0.85%	Inlet Depth = 0.53'
296.6				100.00		Outlet Depth = 0.20'
						Outlet Apron/Riprap
301.4				98.38		Max. Depth Within = 0.91'
301.4				98.38		Max. Pool Depth= 0.91'
363.0				99.13		TW Control d= 0.16'
323.0				99.31		Active Channel Stage #1
327.0				99.28		Active Channel Stage #2
367.6				97.50		Downstream Channel Slope

SITE #18 JENNY CREEK - PM 22.1 Hwy 299 Sha						2 of 2 RB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				103.65	3.00%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
37.8				102.50	0.93%	Inlet Depth = 0.53'
286.6				100.02		Outlet Depth = 0.20'
						Outlet Apron/Riprap
301.4				98.38		Max. Depth Within = 0.91'
301.4				98.38		Max. Pool Depth= 0.91'
363.0				99.13		TW Control d= 0.16'
323.0				99.31		Active Channel Stage #1
327.0				99.28		Active Channel Stage #2
367.6				97.50		Downstream Channel Slope

SITE #19 SULPHUR CREEK - PM 17.79 Hwy 273 Sha						
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				103.17	1.13%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
156.2				101.40	0.69%	Inlet Depth = 0.18'
360.2				100.00		Outlet Depth = 0.66'
						Outlet Apron/Riprap
362.2				99.76		Max. Depth Within = 0.76'
395.2				98.81		Max. Pool Depth= 1.71'
452.2				100.30		TW Control d= 0.22'
419.2				100.75		Active Channel Stage #1
429.2				100.30		Active Channel Stage #2
474.8				100.00		Downstream Channel Slope

SITE #20 CHINA GULCH - PM 10.97 Hwy 273 Sha						
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
160.7				100		Temporary Bench Mark-TBM
0.0				100.88	-0.27%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
37.7				100.98	0.80%	Inlet Depth
160.7				100.00		Outlet Depth
						Outlet Apron/Riprap
164.4				98.92		Max. Depth Within = 0.61'
164.4				98.92		Max. Pool Depth= 0.61'
178.0				99.18		TW Control d= 0.35'
169.6				99.87		Active Channel Stage #1
173.7				99.98		Active Channel Stage #2
177.5				99.86		Downstream Channel Slope

SITE #21 COLD SPRING GULCH - PM 7.49 Hwy 36 W Sha						1 of 2 LB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				95.00	2.25%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
48.0				93.92	2.75%	Inlet Depth
100.2				92.47		Outlet Depth
						Outlet Apron/Riprap
105.0				91.67		Max. Depth Within = 0.09'
117.2				90.66		Max. Pool Depth= 1.1'
122.6				91.45		TW Control d= 0.31'
114.0				91.76		Active Channel Stage #1

SITE #21 COLD SPRING GULCH - PM 7.49 Hwy 36 W Sha						2 of 2 RB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				95.00	2.52%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
48.0				93.79	3.72%	Inlet Depth
100.2				91.85		Outlet Depth
						Outlet Apron/Riprap
105.0				91.67		Max. Depth Within = 0.09'
117.2				90.66		Max. Pool Depth= 1.1'
122.6				91.45		TW Control d= 0.31'
114.0				91.76		Active Channel Stage #1

SITE #22 UNNAMED TRIB TO Mill CREEK - PM 7.34 Hwy 172 Teh						1 of 3 LB
Station (ft)				Elevation (ft)	Slope	Station Description,Comments
108.0				100		Temporary Bench Mark-TBM
0.0				102.76	4.40%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
47.0				100.69	1.25%	Inlet Depth = 0.47'
108.0				99.93		Outlet Depth = 0.30'
						Outlet Apron/Riprap
109.5				99.21		Max. Depth Within = 0.9'
109.5				99.21		Max. Pool Depth= 0.9'
112.4				99.40		TW Control d= 0.71'
124.0				100.14		Active Channel Stage #1
130.5				100.08		Active Channel Stage #2
193.0				98.98	0.98%	Downstream Channel Slope

SITE #22 UNNAMED TRIB TO Mill CREEK - PM 7.34 Hwy 172 Teh						2 of 3
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
108.0				100		Temporary Bench Mark-TBM
0.0				102.76	4.02%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
47.0				100.87	1.43%	Inlet Depth = 0.37'
108.0				100.00		Outlet Depth = 0.38'
						Outlet Apron/Riprap
109.5				99.21		Max. Depth Within = 0.9'
109.5				99.21		Max. Pool Depth= 0.9'
112.4				99.40		TW Control d= 0.71'
124.0				100.14		Active Channel Stage #1
130.5				100.08		Active Channel Stage #2
193.0				98.98	0.98%	Downstream Channel Slope

TAILWATER CROSS-SECTION at station 112.4, outlet			
Station (ft)	Elevation (ft)	Slope	Station Description, Comments
0.0	102.61		left bankfull
4.7	100.85		left bank toe
7.2	100.13		left bank water edge
11.0	99.77		culvert #1 thalweg
13.6	99.95		gravel bar
17.8	99.40		culvert #2 thalweg
21	99.71		gravel bar
24.2	99.31		culvert #3 thalweg
29.3	100.12		right bank water edge
30.0	100.41		right bank toe
32.8	102.14		right bankfull

SITE #22 UNNAMED TRIB TO Mill CREEK - PM 7.34 Hwy 172 Teh						3 of 3 RB
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
108.0				100		Temporary Bench Mark-TBM
0.0				102.76	-1.36%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
47.0				103.40	7.90%	Inlet Depth = 0.75'
108.0				98.58		Outlet Depth = 0.5'
						Outlet Apron/Riprap
109.5				99.21		Max. Depth Within = 0.9'
109.5				99.21		Max. Pool Depth= 0.9'
112.4				99.40		TW Control d= 0.71'
124.0				100.14		Active Channel Stage #1
130.5				100.08		Active Channel Stage #2
193.0				98.98	0.98%	Downstream Channel Slope

SITE #23 MARTIN CREEK- PM 83.53 Hwy 36 E Teh						
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				99.72	1.22%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
47.5				99.14	2.24%	Inlet Depth = 0.61'
115.7				97.61		Outlet Depth = 0.41'
121.5				97.41		Outlet Apron/Riprap
126.0				92.18		Max. Depth Within = 2.8'
126.0				92.18		Max. Pool Depth= 2.8'
146.0				94.84		TW Control d= 0.16'
156.0				95.38		Active Channel Stage #1
171.2				94.75		Active Channel Stage #2
183.0				94.06		Downstream Channel Slope

SITE #24 MILLSEAT CREEK – PM 33.78 Hwy 44 E Sha						
Station (ft)				Elevation (ft)	Slope	Station Description, Comments
				100		Temporary Bench Mark-TBM
0.0				96.50	3.18%	TW Control of 1st resting habitat
						Inlet Apron/Riprap
100.2				93.31	2.26%	Inlet Depth
213.0				90.76		Outlet Depth
						Outlet Apron/Riprap
230.0				88.58		Max. Depth Within = 0.79'
230.0				88.58		Max. Pool Depth= 0.79'
264.0				89.37		TW Control
264.0				89.37		Active Channel Stage #1
280.0				86.30		Active Channel Stage #2

SITE #25 MIDDLE CREEK - PM 19.18 Hwy 299 W Sha							1 of 1
Station (ft)	BS (+)	**HI**	FS (-)	Elevation (ft)	WS	Slope	Station Description, Comments
0.0				845.34			Temporary Bench Mark-TBM TW Control of 1st resting habitat
71.7				840.83			Inlet Apron/Riprap
72.3				841.69		2.25%	Inlet Depth
252.6				837.65			Outlet Depth
252.9				834.99			Outlet Apron/Riprap
254.9				832.72			Max. Depth Within = 1.45'
282.5				830.45			Max. Pool Depth= 3.72'
316.1				833.20			TW Control d= 0.31'
114.0				91.76			Active Channel Stage #1
339.3				823.36		42.40%	Downstream Channel Slope
TAILWATER CROSS-SECTION at Station 0.0							
Station (ft)	BS (+)	**HI**	FS (-)	Elevation (ft)	WS	Slope	Station Description, Comments
0.0				849.08			
10.0				843.34			top of left bank
18.9				833.99			Toe of left bank
25.4				833.85			Water surface elevation
30.0				833.20			Thalweg
34.5				833.91			Water surface elevation
39.4				834.94			Top of right bank
53.7				836.80			
70.1				850.15			

SITE #26 BOULDER CREEK - PM 24.7 Hwy. 299 Sha							1 of 1
Station (ft)	BS (+)	**HI**	FS (-)	Elevation (ft)	WS	Slope	Station Description, Comments
4.4				609.52		2.45%	Temporary Bench Mark-TBM TW Control of 1st resting habitat
108.9				608.58			Inlet Apron/Riprap
119.8				606.69		0.28%	Inlet Depth
443.7				605.79			Outlet Depth
458.2				606.31			Outlet Apron/Riprap
463.3				606.56			Max. Depth Within = 1.45'
478.3				604.67			Max. Pool Depth= 3.72'
546.0				606.19			TW Control d= 0.31'
558.2				605.78		3.36%	Downstream Channel Slope
TAILWATER CROSS-SECTION at Station 0.0							
Station (ft)	BS (+)	**HI**	FS (-)	Elevation (ft)	WS	Slope	Station Description, Comments
0.0				613.62			
23.0				613.42			Top of left bank
25.1				610.28			
29.6				608.59			
36.2				607.54			water surface elevation
44.0				606.36			
54.3				606.48			
63.5				607.56			
66.8				608.13			water surface elevation
69.3				612.48			
84.1				612.41			right bank

SITE #27 BOULDER CREEK - PM 17.14 I-5 Sha							1 of 1
Station (ft)	BS (+)	**HI**	FS (-)	Elevation (ft)	WS	Slope	Station Description, Comments
9.8				600.71		0.69%	Temporary Bench Mark-TBM TW Control of 1st resting habitat
118.9				602.01			Inlet Apron/Riprap
129.7				599.89		0.28%	Inlet Depth
383.5				599.18			Outlet Depth
393.5				600.08			Outlet Apron/Riprap
393.5				600.08			Max. Depth Within = 1.45'
393.5				600.08			Max. Pool Depth= 3.72'
466.3				601.37			TW Control d= 0.31'
							Active Channel Stage #1
							Active Channel Stage #2
516.3				599.51		3.72%	Downstream Channel Slope

TAILWATER CROSS-SECTION at Station 0.0

Station (ft)	BS (+)	**HI**	FS (-)	Elevation (ft)	WS	Slope	Station Description, Comments
0.0				606.21			
39.2				604.27			Top of left bank
41.3				602.59			
44.4				601.24			water surface elevation
48.8				600.99			Thalweg 2
54.3				601.11			water surface elevation
56.5				601.52			
75.7				601.07			Thalweg 1
80.7				601.55			water surface elevation
91.1				603.94			
99.9				608.55			Top of bank
129.6				605.94			

SITE #28 BOULDER CREEK - PM 19.10 Hwy 273 Sha							1 of 1
Station (ft)	BS (+)	**HI**	FS (-)	Elevation (ft)	WS	Slope	Station Description, Comments
198.3				626.65			Temporary Bench Mark-TBM TW Control of 1st resting habitat
							Inlet Apron/Riprap
252.9				626.46			Inlet Depth
372.9				625.91			Outlet Depth
							Outlet Apron/Riprap
376.7				624.66			Max. Depth Within = 1.45'
390.9				623.40			Max. Pool Depth= 3.72'
414.4				626.04			TW Control d= 0.31'
							Active Channel Stage #1
							Active Channel Stage #2
426.9				625.95			Downstream Channel Slope
TAILWATER CROSS-SECTION at Station 0.0							
Station (ft)	BS (+)	**HI**	FS (-)	Elevation (ft)	WS	Slope	Station Description, Comments
0.0				629.69			Fence
12.4				629.09			
16.4				627.09			
18.4				627.09			Wing wall
18.6				626.04			Thalweg
34.5				626.03			
				626.23			Water surface elevation
39.3				626.05			
39.7				627.88			Wing wall
44.2				627.82			
54.9				629.87			Fence

SITE #29 BOULDER CREEK - Twin View Blvd.							1 of 1
Station (ft)	BS (+)	**HI**	FS (-)	Elevation (ft)	WS	Slope	Station Description, Comments
414.4				626.04			Temporary Bench Mark-TBM TW Control of 1st resting habitat
							Inlet Apron/Riprap
426.9				625.95		1.11%	Inlet Depth
513.1				624.99			Outlet Depth
525.5				624.97			Outlet Apron/Riprap
530.5				618.12			Max. Depth Within = 1.45'
554.3				611.73			Max. Pool Depth= 3.72'
606.3				621.67			TW Control d= 0.31'
							Active Channel Stage #1
							Active Channel Stage #2
628.4				619.84		8.27%	Downstream Channel Slope
TAILWATER CROSS-SECTION at Station 0.0							
Station (ft)	BS (+)	**HI**	FS (-)	Elevation (ft)	WS	Slope	Station Description, Comments
0.0				623.32			
10.0				622.76			
17.3				622.06			Water surface elevation
27.1				621.51			
36.4				621.28			Thalweg
42.8				622.02			
50.9				622.52			
55.2				620.60			
56.1				621.45			water surface elevation
58.0				621.96			
67.9				624.95			
86.1				625.63			

APPENDIX B

SHASTA-TEHAMA BARRIER ASSESSMENT:

SITE CATALOG

This section contains a brief description of each culvert surveyed in this inventory. Maps of each stream crossing's upstream drainage area and the predicted limits of anadromy are provided. Photographs of each culvert inlet and outlet are also included.

Site # 1: Sunday Gulch Bridge/Hwy 36 East; Middle Fork Cottonwood Creek; Sacramento River

Location: Mile post= 5.57 Shasta. USGS Quad: Beegum. T29N, R10W, Section13. Lat/Long.= N 40.21924 W 122.56461

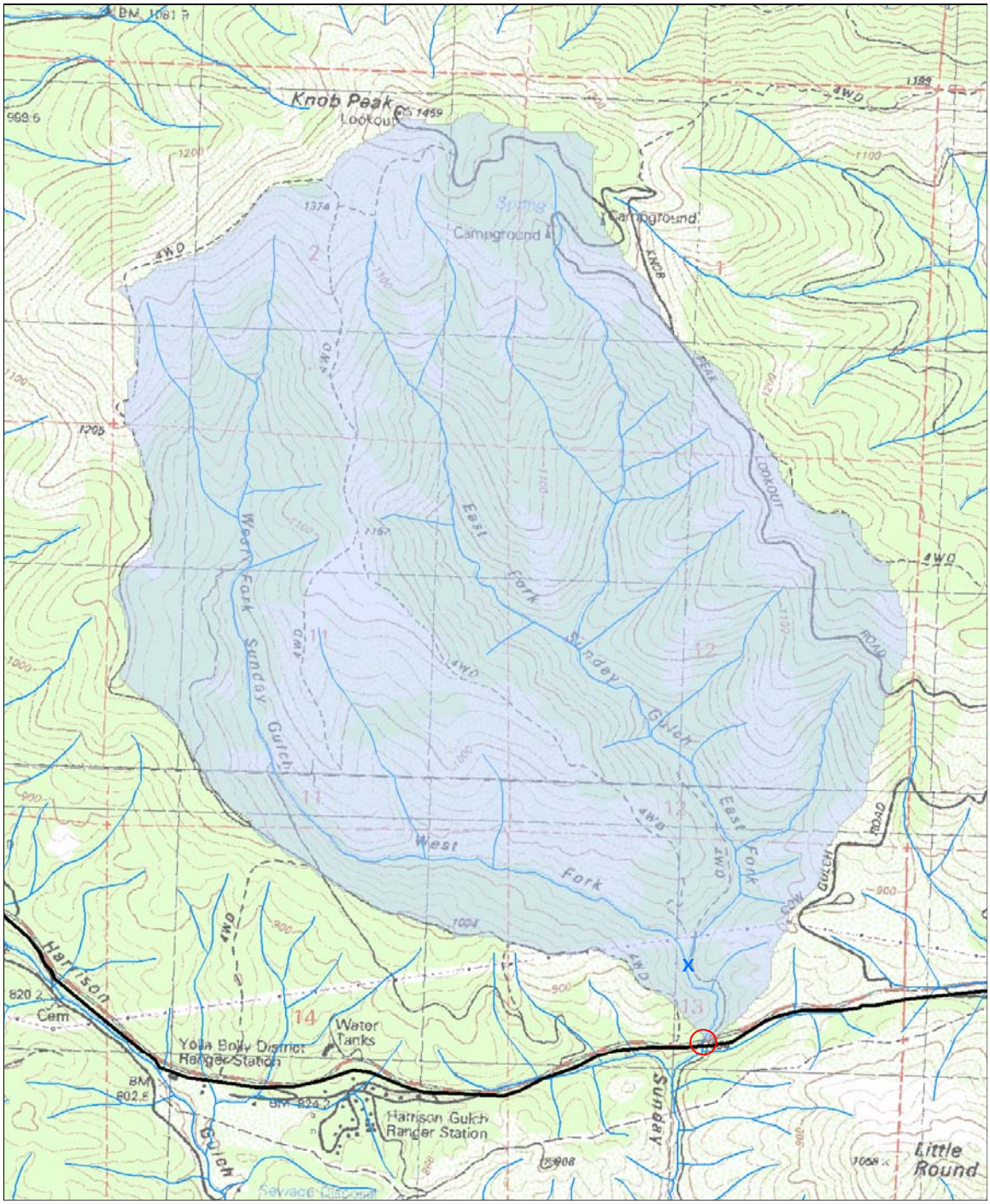
Crossing Information: Type: Circular pipe, SSP **Dimensions:** 12'9" x 11'6" **Length:** 92' **Corrugations:** 6" x 2" **Slope:** 3.25% **Overall conditions:** Good **Modifications:** None **Fill Estimate:** 715 cubic yards **Average Channel Width:** 10.1' **Substrate at cross section:** 1) boulder 2) cobble 3)pebble

Hydrology: Drainage area upstream of crossing = **3.13 square miles**. Mean Annual Precipitation (MAP) = **37 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **3,452'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 136.56 cfs; Q_5 = 241.1 cfs; Q_{10} = 348.59 cfs; Q_{25} = 497.57 cfs; Q_{50} = 670.7 cfs; Q_{100} = 826.95 cfs

Barrier Status: **RED** due to the greater than 3% slope of the culvert as determined by the Green-Gray-Red first-phase evaluation filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 68.28 cfs (50% of Q_2 discharge). Only 11.5% (18.77 cfs to 26.27 cfs) of flows were passable to adult salmonids. A lack of depth occurred at flows less than 18.77 cfs and excessive velocities occurred above flows of 26.28 cfs. FishXing determined that the crossing did not meet passage criteria for resident trout or juvenile salmonids due to excessive velocities.

Habitat: Quality = Rated as "fair" due to the fairly small size of stream. Steelhead distribution moves past Sunday Gulch on the Middle Fork of Cottonwood Creek. Steelhead could be present if no barriers exist downstream. Riparian habitat is present but not dense. Steep gradient towards headwaters. Juvenile salmonids in the 3-6 inch size class were observed downstream of crossing during site visit. Quantity = ~1,372' of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site # 1: Sunday Gulch Bridge/Hwy 36 East; Middle Fork Cottonwood Creek; Sacramento River



Upstream drainage area = 3.13 miles

X = Limit of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site #1: Sunday Gulch Bridge/PM 5.57; Hwy 36 W Sha.

Site # 2: Harrison Gulch Bridge/Hwy 36 West; Middle Fork Cottonwood Creek; Sacramento River

Location: Mile post= 3.57 Shasta. USGS Quad: Beegum. T29N, R10W, Sedtion15. Lat/Long.= N 40.36963 W 122.97408

Culvert Information: Type: 2-sided Concrete Box **Dimensions:** 10'x10' **Length:** 117.5' **Slope:** left bank = 1.92%; right bank = 2.11% **Overall conditions:** Fair **Modifications:** None **Fill Estimate:** 1,891 cubic yards **Average Channel Width:** 10.7' **Substrate at cross section:** 1) cobble 2) boulder 3) pebble

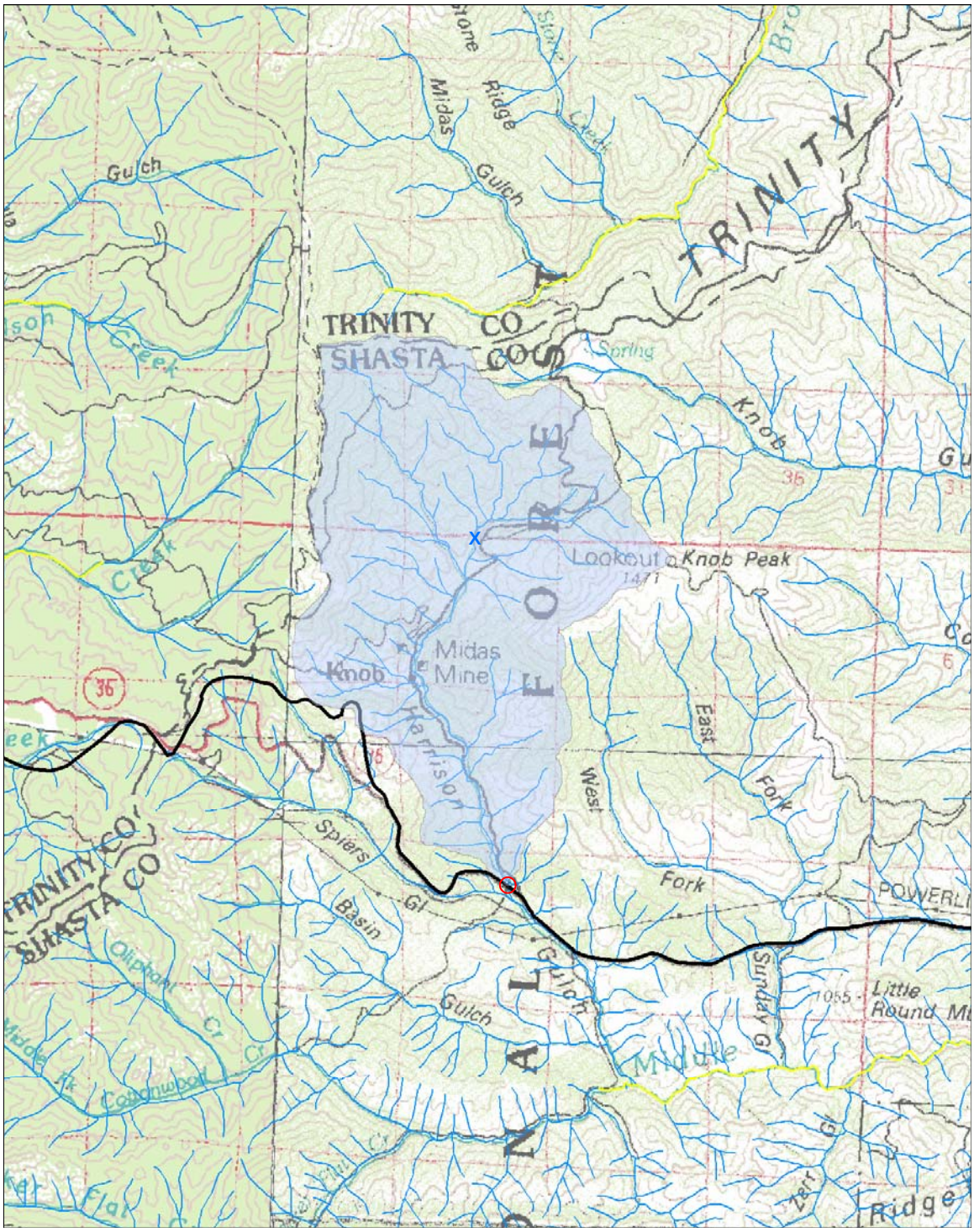
Hydrology: Drainage area upstream of crossing = **4.92 square miles**. Mean Annual Precipitation (MAP) = **38 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **3,343'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 213.29 cfs; Q_5 = 373.62 cfs; Q_{10} = 536.66 cfs; Q_{25} = 760.32 cfs; Q_{50} = 1022.47 cfs; Q_{100} = 1257 cfs.

Barrier Status: GRAY as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 106.64 cfs (50% of Q_2 discharge). A lack of depth and excessive velocities resulted in 0% passable flows to adult, resident, and juvenile salmonids.

Habitat: Quality = rated as "good" due to dense riparian zone. Steelhead distribution ends just upstream of confluence on M.F Cottonwood. Could have possible distribution on Harrison due to no known barriers. Very dense riparian zone. Steep gradient towards headwaters. Unknown juvenile fish in the 3-6 inch size class were observed downstream of the crossing during survey. Quantity = ~13,728' of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Comments: Potential natural barrier ¼ mile upstream of road crossing caused by log and rock jam.

Site # 2: Harrison Gulch Bridge/Hwy 36 West; Middle Fork Cottonwood Creek; Sacramento River



Upstream drainage area = 4.92 square miles

X = Limit of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

_____ = Existing steelhead distribution

Site #2: Harrison Gulch Bridge/PM 3.57; Hwy 36 W Sha.

Site # 3: Unnamed Tributary to Dry Creek/Hwy 36 West. Dry Creek; Cottonwood Creek; Sacramento River

Location: Mile post= 3.55 Tehama. USGS Quad: Beegum. T29N, R8W, Section31. Lat/Long.= N 40.31967 W 122.81556

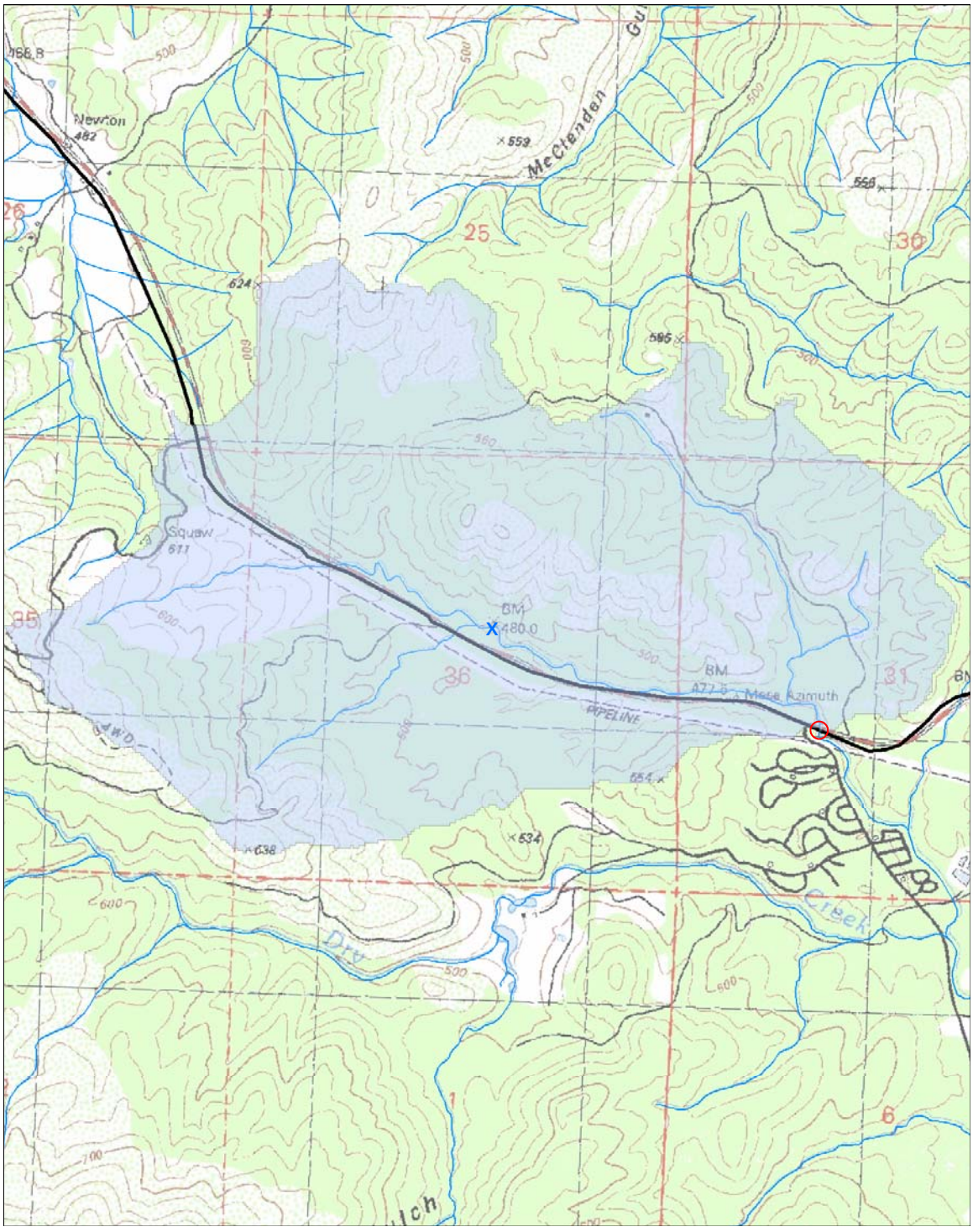
Culvert Information: Type: Circular,SSP **Dimensions:** 7'1" diameter **Length:** 113.8' **Corrugations:** 3"x1" **Slope:** 1.59% **Overall conditions:** good **Modifications:** None **Fill Estimate:** 2,169 cubic yards **Average Channel Width:** 6.64' **Substrate at cross section:** 1) cobble 2) pebble 3) gravel

Hydrology: Drainage area upstream of crossing = **1.75 square miles**. Mean Annual Precipitation (MAP) = **31 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **1,622'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 98.59 cfs; Q_5 = 159.35 cfs; Q_{10} = 217.37 cfs; Q_{25} = 288.87 cfs; Q_{50} = 362.51 cfs; Q_{100} = 420.01 cfs.

Barrier Status: GRAY as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, Adult Salmonid passage was assessed for flows between 3 cfs and 49.29 cfs (50% of Q_2 discharge). An excessive outlet drop height resulted in 0% passable flows to adult, resident, and juvenile salmonids.

Habitat: Quality = rated as "poor". Small stream with poor riparian zone. Stream flows through pasture without riparian trees. Ideal spawning substrate in stream (cobble, pebble, gravel). There were no fish observed at time of survey. It is a tributary to Dry Creek which has no known steelhead distribution. Quantity = 4,699' of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site # 3: Unnamed Tributary to Dry Creek/Hwy 36 West. Dry Creek; Cottonwood Creek; Sacramento River



Upstream drainage area = 1.75 square miles
X = Limit of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site #3: Unnamed Tributary to Dry Creek/ PM 3.55; Hwy 36 W Sha.

Site # 4: Budden Canyon Creek/Hwy 36 West, Dry Creek; Cottonwood Creek; Sacramento River

Location: Mile post= 5.78 Tehama. USGS Quad: Beegum. T29N, R8W, Sedtion33. Lat/Long.= N 40.31630 W 122.77619

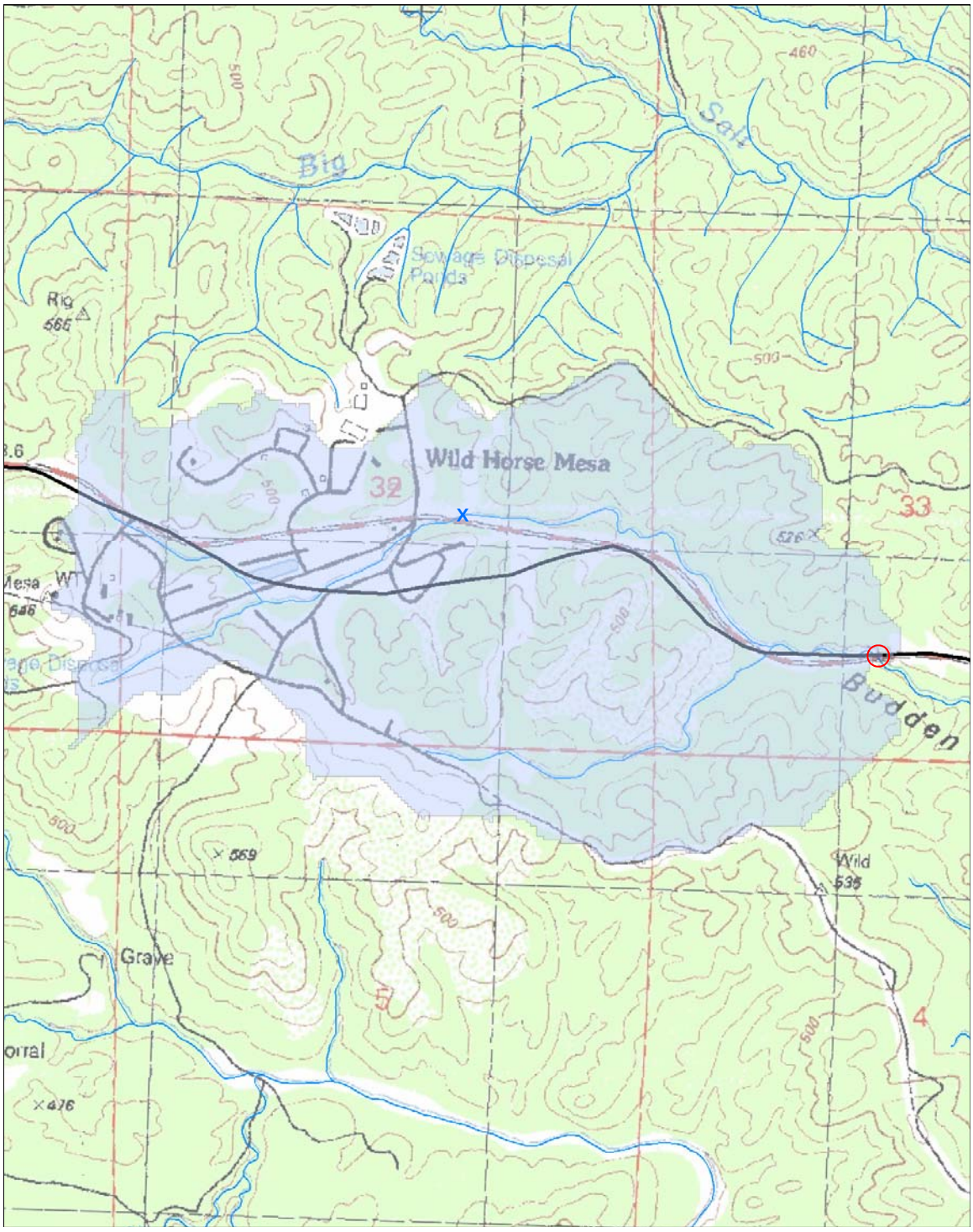
Culvert Information: Type: Circular pipe, SSP **Dimensions:** 5' diameter **Length:** 141.7' **Corrugations:** 3" x 1" **Slope:** 2.63% **Overall conditions:** Fair **Modifications:** None **Fill Estimate:** 4,207 cubic yards **Average Channel Width:** 6.72' **Substrate at cross section:** 1) cobble 2) organics/grass 3) pebble

Hydrology: Drainage area upstream of crossing = **0.99 square miles**. Mean Annual Precipitation (MAP) = **32 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **1,548'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 60.73 cfs; Q_5 = 98.59 cfs; Q_{10} = 135.62cfs; Q_{25} = 181.31 cfs; Q_{50} = 227.67 cfs; Q_{100} = 263.87 cfs.

Barrier Status: GRAY as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 30.36 cfs (50% of Q_2 discharge). Only 9.5% of flows were passable to adult salmonids. A lack of depth occurred during flows below 11.32 cfs and excessive velocities occurred at flows above 13.89 cfs. FishXing determined that the crossing did not meet passage criteria for resident trout or juvenile salmonids due to excessive velocities.

Habitat: Quality = Rated as "fair" due to its small size and very dense riparian zone. Substrate composed of cobble, aquatic vegetation, and pebble. This stream is a tributary to Dry Creek which has no known distribution of steelhead. There were no fish observed at time of survey. Quantity = ~ 4,963' of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site # 4: Budden Canyon Creek/Hwy 36 West, Dry Creek; Cottonwood Creek; Sacramento River



Upstream drainage area = 0.99 square miles
X = Limit of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site # 4- Budden Canyon/PM 5.78; Hwy 36 W Teh.

Site # 5: Budden Canyon Creek/Hwy 36 West, Dry Creek; Cottonwood Creek; Sacramento River

Location: Post Mile= 8.22 Tehama. USGS Quad: Chickabally Mountain. T28N, R8W, Section2. Lat/Long.= N 40.30760 W 122.73512

Culvert Information: Type: Circular pipe, SSP **Dimensions:** 8'6" diameter **Length:** 245.3' **Corrugations:** 6" x 2" **Slope:** 3.09% **Overall conditions:** Good **Modifications:** None **Fill Estimate:** 16,825 cubic yards **Average Channel Width:** 14.8' **Substrate at cross section:** 1)cobble 2) pebble 3)gravel

Hydrology: Drainage area upstream of crossing = **3.28 square miles**. Mean Annual Precipitation (MAP) = **33 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **1,417'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 195.5 cfs; Q_5 = 309.33 cfs; Q_{10} = 135.62 cfs; Q_{25} = 541.44 cfs; Q_{50} = 672.13 cfs; Q_{100} = 770.85 cfs.

Barrier Status: **RED** due to the greater than 3% slope of the culvert as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 97.75 cfs (50% of Q_2 discharge). Only 8.7% (13.78 cfs to 22.02 cfs) of flows were passable to adult salmonids. A lack of depth occurred at flows below 13.78 cfs and an excessive outlet drop height occurred at flows over 29.49 cfs. Excessive velocities and lack of pool depth also occurred during flows above 22.02 cfs. Excessive velocities and outlet drop height resulted in 0% passage for both resident and juvenile salmonids.

Habitat: Quality = rated as "fair" due to moderate riparian zone. Substrate is composed of cobble, pebble, and gravel. This stream is a tributary to Dry Creek which as no known steelhead distribution. Unknown juvenile fish in the 3-6 inch size class were observed downstream of crossing during survey. Quantity = ~18,163' of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site # 5: Budden Canyon Creek/Hwy 36 West, Dry Creek; Cottonwood Creek; Sacramento River

Upstream drainage area = 3.28 square miles
X = Limit of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site #5: Budden Canyon/PM 8.22; Hwy 36 W Teh.

Site # 6: Unnamed Tributary to Dry Creek/Hwy 36 West, Dry Creek; Cottonwood Creek; Sacramento River

Location: Mile post= 9.98 Tehama. USGS Quad: Chickabally Mountain. T28N, R7W, Sedtion6. Lat/Long.= N 40.30166W 122.70455

Culvert Information: Type: Concrete box (2 sides) **Dimensions:** 6' x 8' **Length:** 55.3' **Slope:** left bank = 2.19%; right bank = 2.22% **Overall conditions:** Good **Modifications:** None **Fill Estimate:** 16,825 cubic yards **Average Channel Width:** 14.8' **Substrate at cross section:** 1) cobble 2) boulder 3)pebble

Hydrology: Drainage area upstream of crossing = **5.13 square miles**. Mean Annual Precipiation (MAP) = **33 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **1,251'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 310.03 cfs; Q_5 = 481.1 cfs; Q_{10} = 636.72 cfs; Q_{25} = 816.14 cfs; Q_{50} = 1001.78 cfs; Q_{100} = 1137.52 cfs.

Barrier Status: GRAY as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 155 cfs (50% of Q_2). A lack of depth and excessive velocities through the culvert resulted in 0% passable to adult, resident, and juvenile salmonids.

Habitat: Quality = rated as "poor" due to non-existing riparian zone. Stream flows through pasture land lacking mature trees. This stream is a tributary to Dry Creek which has no known steelhead distribution. Unknown juvenile fish in the < 3 inch size class were observed upstream and downstream of crossing during survey.
Quantity = ~30,624' of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site # 6: Unnamed Tributary to Dry Creek/Hwy 36 West, Dry Creek; Cottonwood Creek; Sacramento River

Upstream drainage area = 5.13 square miles

X = Limit of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site # 6- Unnamed Tributary to Dry Creek/PM 9.98; Hwy 36 W Teh.

Site # 7: Little/Big Crane Creek/Hwy 36 West, Dry Creek; Cottonwood Creek; Sacramento River

Location: Mile post= 22.13 Tehama. USGS Quad: Chickabally Mountain. T34N, R1W, Sedtion31. Lat/Long.= N 40.27634 W 122.50988

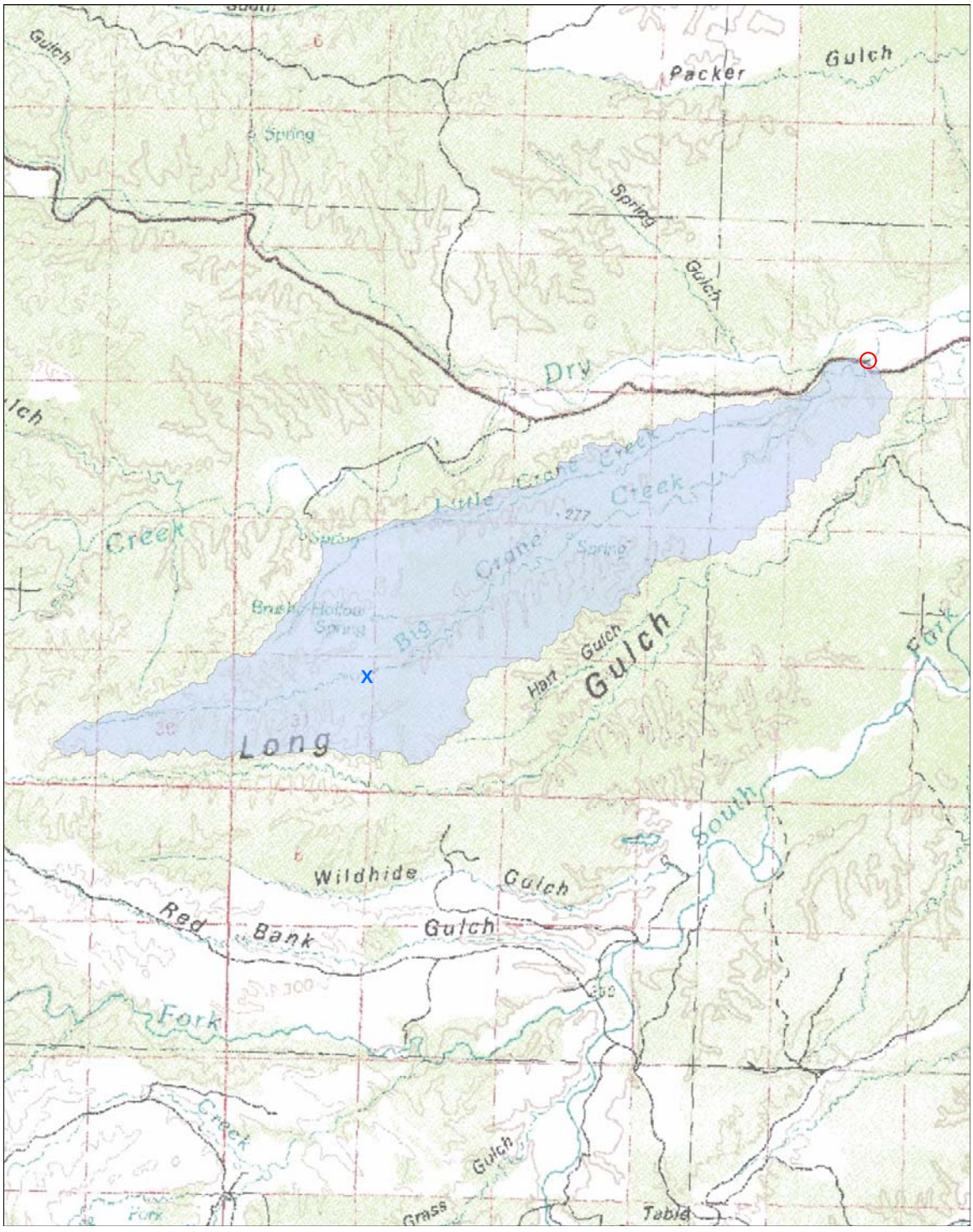
Culvert Information: Type: Culvert pipe, SSP **Dimensions:** 11'7" x 16'2" **Corrugations:** 6" x 2" **Length:** 102' **Slope:** 0.5% **Overall conditions:** Fair **Modifications:** None **Fill Estimate:** 2,036 cubic yards **Average Channel Width:** 13.9' **Substrate at cross section:** 1) cobble 2) pebble 3)gravel

Hydrology: Drainage area upstream of crossing = **5.95 square miles**. Mean Annual Precipitation (MAP) = **30 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **778'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 406.89 cfs; Q_5 = 594.41 cfs; Q_{10} = 754.78 cfs; Q_{25} = 920.34 cfs; Q_{50} = 1080.36 cfs; Q_{100} = 1179.88 cfs.

Barrier Status: GRAY as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 203.4 cfs (50% of Q_2 discharge). Only 32% (52.2 cfs to 115.9 cfs) of flows were passable to adult salmonids. The lack of depth occurred at flows less than 51.2 cfs and excessive velocities occurred at flows above 116 cfs. FishXing determined that the crossing did not meet passage criteria for resident trout or juvenile salmonids due to excessive velocities and excessive outlet drop height.

Habitat: Quality = Rated as "fair" due to lack of water during warmer months and fairly dense riparian zone. Stream has a wide but shallow channel with an average wetted upstream width = 13.9 feet. Stream is a tributary to Dry Creek which has no known steelhead distribution. No fish were observed during survey. Quantity = 30,096' of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site # 7: Little/Big Crane Creek/Hwy 36 West, Dry Creek; Cottonwood Creek; Sacramento River



Upstream drainage area = 5.95 square miles

X = Limit of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site #7 – Little/Big Crane Creek/PM 22.13 Hwy 36 W Teh.

Site # 8: Salmon Creek/Hwy 299 East, Stillwater Creek; Sacramento River

Location: Mile post= 29.5 Shasta USGS Quad: City of Shasta Lake. T34N, R1W, Sedtion31. Lat/Long.= N 40.62983 W 122.27721

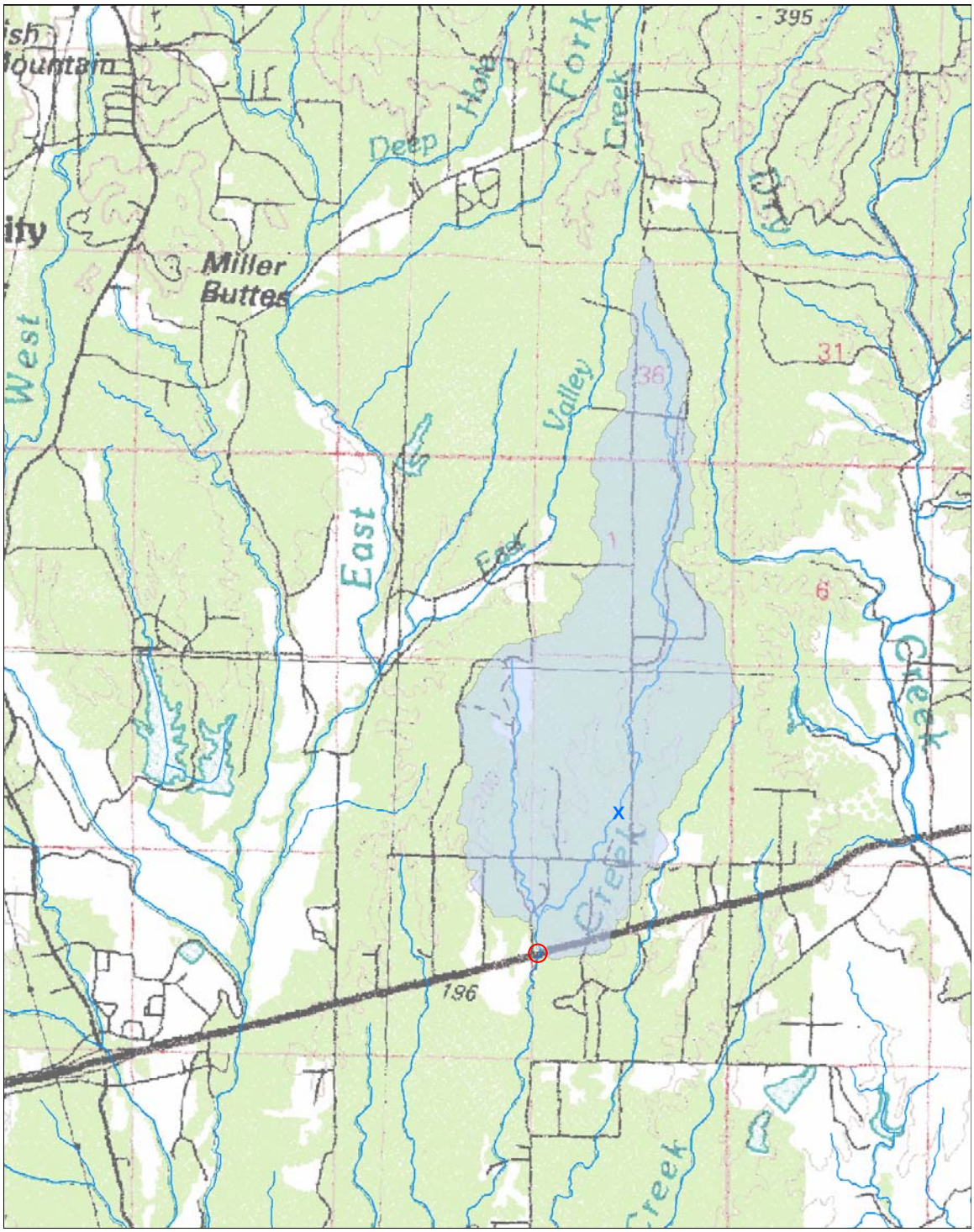
Culvert Information: Type: Concrete box (3 sides) **Dimensions:** 6' X 6'7"
Length: 71' **Slope:** left bank = -3.52%; center = -2.11; right bank = -2.39%
Overall conditions: Good **Modifications:** None **Fill Estimate:** 61 cubic yards
Average Channel Width: 21.3' **Substrate at cross section:** 1) Organics 2) gravel 3) sand

Hydrology: Drainage area upstream of crossing = **2.39 square miles**. Mean Annual Precipitation (MAP) = **43 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **680'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 196.8 cfs; Q_5 = 423.9 cfs; Q_{10} = 581.4 cfs; Q_{25} = 880.3 cfs; Q_{50} = 1105.7 cfs; Q_{100} = 1423.6 cfs

Barrier Status: GRAY as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 98.4 cfs (50% of Q_2 discharge). A lack of depth occurred at all flows through the culvert and resulted in 0% passage for adult, resident, and juvenile salmonids.

Habitat: Quality = rated as "poor". This stream flows through residential area and has no in-stream habitat. There is a lack of riparian vegetation and mature tree cover. The main channel tapers off shortly upstream. Quantity = 5,280' of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site # 8: Salmon Creek/Hwy 299 East, Stillwater Creek; Sacramento River



Upstream drainage area = 2.39 square miles
X = Limit of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site # 8- Salmon Creek/PM 29.50; Hwy 299 Sha.

Site # 9: Unnamed Tributary to Middle Creek/Hwy 299 West ; Sacramento River

Location: Post Mile= 18.98 Shasta USGS Quad: Redding. T32N, R5W, Section30. Lat/Long.= N 40.59267 W 122.48426

Culvert Information: Type: Circular pipe, SSP. **Dimensions:** 6' diameter **Corrugations:** 3" x 1" **Length:** 76.2' **Slope:** left bank = 2.1%; right bank = 3.60% **Overall conditions:** poor **Modifications:** None **Fill Estimate:** 61 cubic yards **Average Channel Width:** 8.24' **Substrate at cross section:** 1) cobble 2) sand 3)boulder

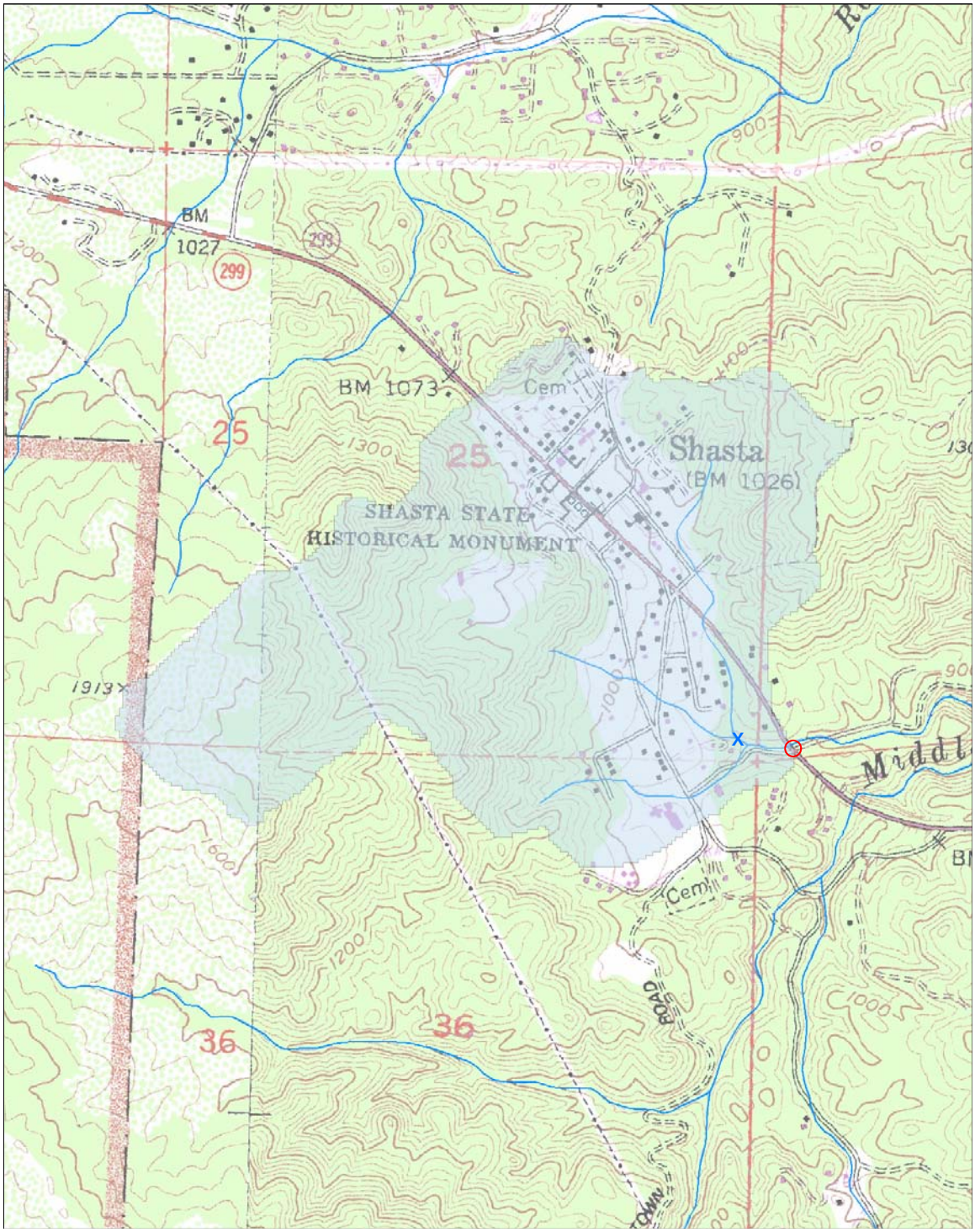
Hydrology: Drainage area upstream of crossing = **0.66 square miles**. Mean Annual Precipitation (MAP) = **53 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **1,206'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 75.94 cfs; Q_5 = 120.9 cfs; Q_{10} = 164.4 cfs; Q_{25} = 215.32 cfs; Q_{50} = 265.9 cfs; Q_{100} = 302.5 cfs.

Barrier Status: GRAY as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 38 cfs (50% of Q_2 discharge). Only 44.6% (22 cfs to 38 cfs) of flows were passable to adult salmonids. A lack of depth occurred at flows below 22 cfs. Excessive velocities resulted in 0% passage for both resident and juvenile salmonids.

Habitat: Quality = rated as "poor" due to lack of upstream riparian vegetation. Known steelhead distribution on south branch of Middle Creek. Upstream channel flows through residential area and crosses underneath other roads. There were no fish observed during the survey. Quantity = ~1,531' of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Comments: Natural barrier located downstream at confluence with main stem of Middle Creek. Located 0.4 miles downstream of Hwy 299 road crossing and consists of a 25' high bedrock cascade.

Site # 9: Unnamed Tributary to Middle Creek/Hwy 299 West ; Sacramento River



Upstream drainage area = 0.66 square miles

X = Limit of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site # 9- Unnamed Tributary to Middle Creek/PM 18.98; Hwy 299 Sha.

Site # 10: Salt Creek/Hwy 299 West ; Sacramento River

Location: Mile post= 20.75 Shasta USGS Quad: Redding. T34N, R1W, Sedtion31. Lat/Long.= N 40.58619 W 122.45402

Culvert Information: Type: Circular pipe, SSP. **Dimensions:** 10' diameter **Corrugations:** 6" x 2" **Length:** 125.3' **Slope:** 1% **Overall conditions:** Good **Modifications:** Retrofitted with baffles and (2) weirs **Fill Estimate:** 1,158 cubic yards **Average Channel Width:** 16.6' **Substrate at cross section:** 1) cobble 2) gravel 3) bedrock

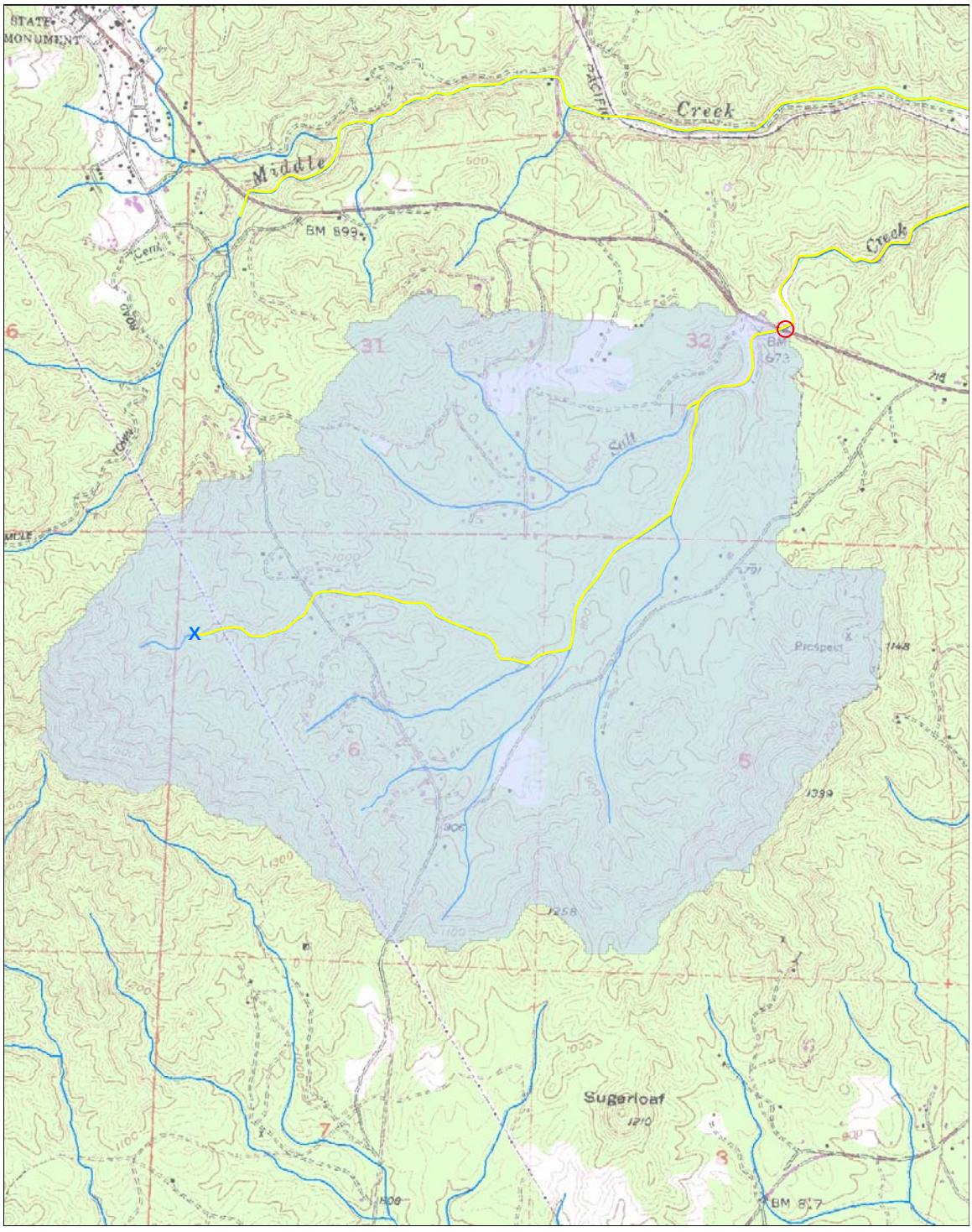
Hydrology: Drainage area upstream of crossing = **2.95 square miles**. Mean Annual Precipitation (MAP) = **46 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **862'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 301.6 cfs; Q_5 = 453.1 cfs; Q_{10} = 589.2 cfs; Q_{25} = 734.1 cfs; Q_{50} = 877.26 cfs; Q_{100} = 970 cfs.

Barrier Status: GRAY as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 150 cfs (50% of Q_2 discharge). A lack of depth and excessive velocities resulted in 0% passable flows to adult, resident, and juvenile salmonids.

Habitat: Quality = rated as "good". There is a known steelhead distribution upstream of Hwy 299 road crossing. Riparian zone lacks mature trees in some areas. Stream contains good gravel and substrate for spawning conditions. Unknown fish in the < 3 inch size class were observed upstream of crossing during survey. Quantity = 12,144' of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Comments: This culvert has been retrofitted in the past with steel corner baffles and two concrete outlet weirs. FishXing software does not account for these corrections which would explain the depth and velocity barriers associated with this crossing. Adult and juvenile salmonids have been observed upstream of the stream crossing post retrofitting.

Site # 10: Salt Creek/Hwy 299 West; Sacramento River



Upstream drainage area = 2.95 square miles

X = Limit of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

_____ = Known steelhead distribution

Site # 10- Salt Creek/PM 20.75; Hwy 299 Sha.

Site # 11: McCandless Gulch/Hwy 299 East; Cedar Creek; Cow creek; Sacramento River

Location: Mile post= 47.83 Shasta USGS Quad: Devil's rock T34N, R1W, Section31. Lat/Long.= N 40.76257 W 122.01225

Culvert Information: **Type:** Concrete box (2 sides) **Dimensions:** 8'3" x 8' **Length:** 39.5' **Slope:** left bank = -0.68%; right bank = 0.68 **Overall conditions:** Fair **Modifications:** None **Fill Estimate:** 253 cubic yards **Average Channel Width:** 11.6' **Substrate at cross section:** 1) boulder 2) cobble 3) gravel

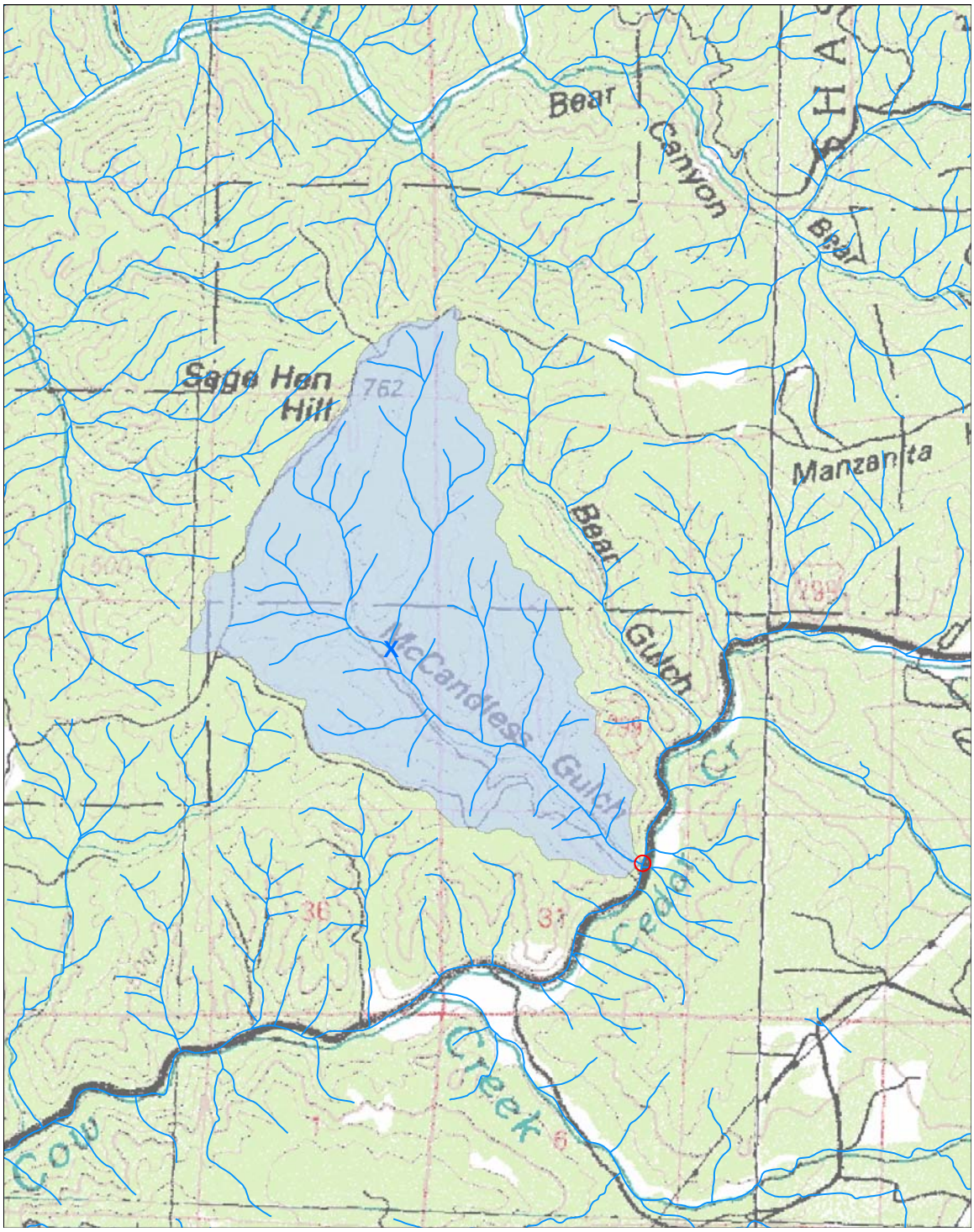
Hydrology: Drainage area upstream of crossing = **2.8 square miles**. Mean Annual Precipitation (MAP) = **58 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **1,782'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 228.6 cfs; Q_5 = 502.5 cfs; Q_{10} = 686.1 cfs; Q_{25} = 1032.9 cfs; Q_{50} = 1702.2 cfs.

Barrier Status: **RED** as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 114 cfs (50% of Q_2 discharge). Only 19.3% (93 cfs to 114.4 cfs) of flows were passable to adult salmonids. A lack of depth occurred at flows below 63.8 cfs. Excessive velocities resulted in 0% passage for both resident trout and juvenile salmonids.

Habitat: Quality = rated as "good" due to the very dense riparian vegetation and cobble substrate. Unknown juvenile fish in the 3-6 inch size class were observed upstream of the crossing during survey. Quantity = 10,137' of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Comments: Natural barrier downstream on Little Cow Creek.

Site # 11: McCandless Gulch/Hwy 299 East; Cedar Creek; Cow creek; Sacramento River



Upstream drainage area = 2.8 square miles

X = Limit of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site # 11- McCandless Gulch/47.83; Hwy 299 Sha.

Site # 12: Unnamed Tributary to Dry Creek/Hwy 36 West ;Cottonwood Creek; Sacramento River

Location: Mile post= 14.22 Tehama USGS Quad: Chickabally Mountain . T28N, R7W, Section 11. Lat/Long.= N 40.29766 W 122.63102

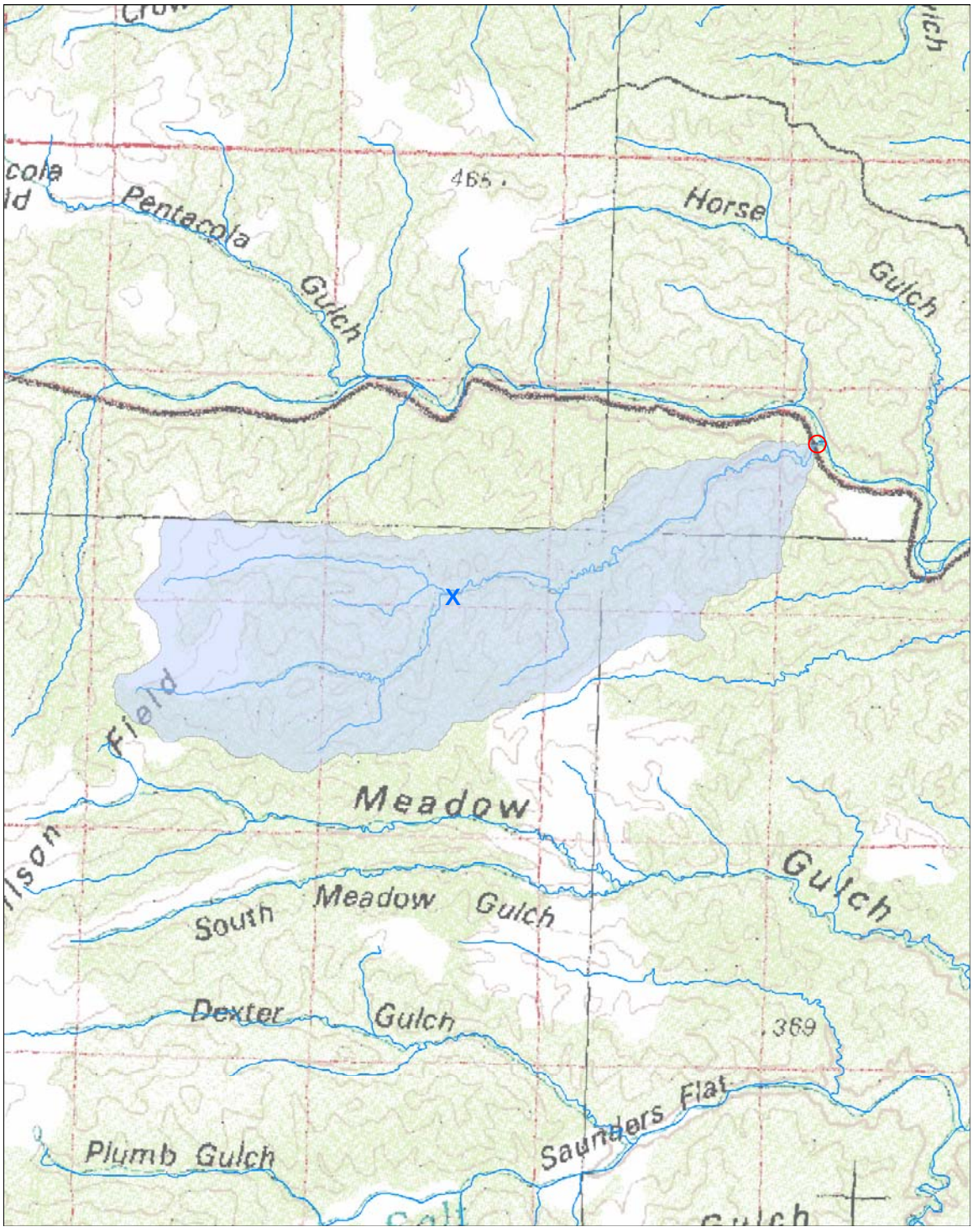
Culvert Information: Type: Circular pipe, SSP. **Dimensions:** 3'9" x 4'4"
Corrugations: 3" x 1" **Length:** 46.3" **Slope:** left bank = 4.36 %; right bank = 3.35%
Overall conditions: Poor **Modifications:** None **Fill Estimate:** 83 cubic yards
Average Channel Width: 14.6" **Substrate at cross section:** 1) cobble 2) boulder 3) pebble

Hydrology: Drainage area upstream of crossing = **2.4 square miles**. Mean Annual Precipitation (MAP) = **31 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **1,012'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 163.5 cfs; Q_5 = 248.9 cfs; Q_{10} = 326 cfs; Q_{25} = 411.9 cfs; Q_{50} = 495.5 cfs; Q_{100} = 552.8 cfs

Barrier Status: **RED** due to the greater than 3% slope of the culvert as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 81.7 cfs (50% of Q_2 discharge). A lack of depth during flows below 33.4 cfs and excessive velocities above 16.8 cfs resulted in 0% passage for adult salmonids. FishXing also determined that the crossing failed to meet passage criteria for resident trout and juvenile salmonids due to excessive velocities and outlet drop heights.

Habitat: Quality = rated as "poor" due to the riparian conditions and small size. There are very few trees present on stream banks as stream flows through pasture. This stream is a tributary to Dry Creek which has no known steelhead distribution. No fish were observed during site visit. Quantity = 10,032' of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site # 12: Unnamed Tributary to Dry Creek/Hwy 36 West ;Cottonwood Creek; Sacramento River



Upstream drainage area = 2.4 square miles

X = Limit of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site # 12- Unnamed Tributary to Dry Creek/PM 14.22; Hwy 36 W Teh.

Site # 13: Seven Mile Creek/Hwy 36 East ; Sacramento River

Location: Mile post= 48.6 Tehama USGS Quad: Red Bluff East . T28N, R3W, Section 25. Lat/Long.= N 40.24536 W 122.151584

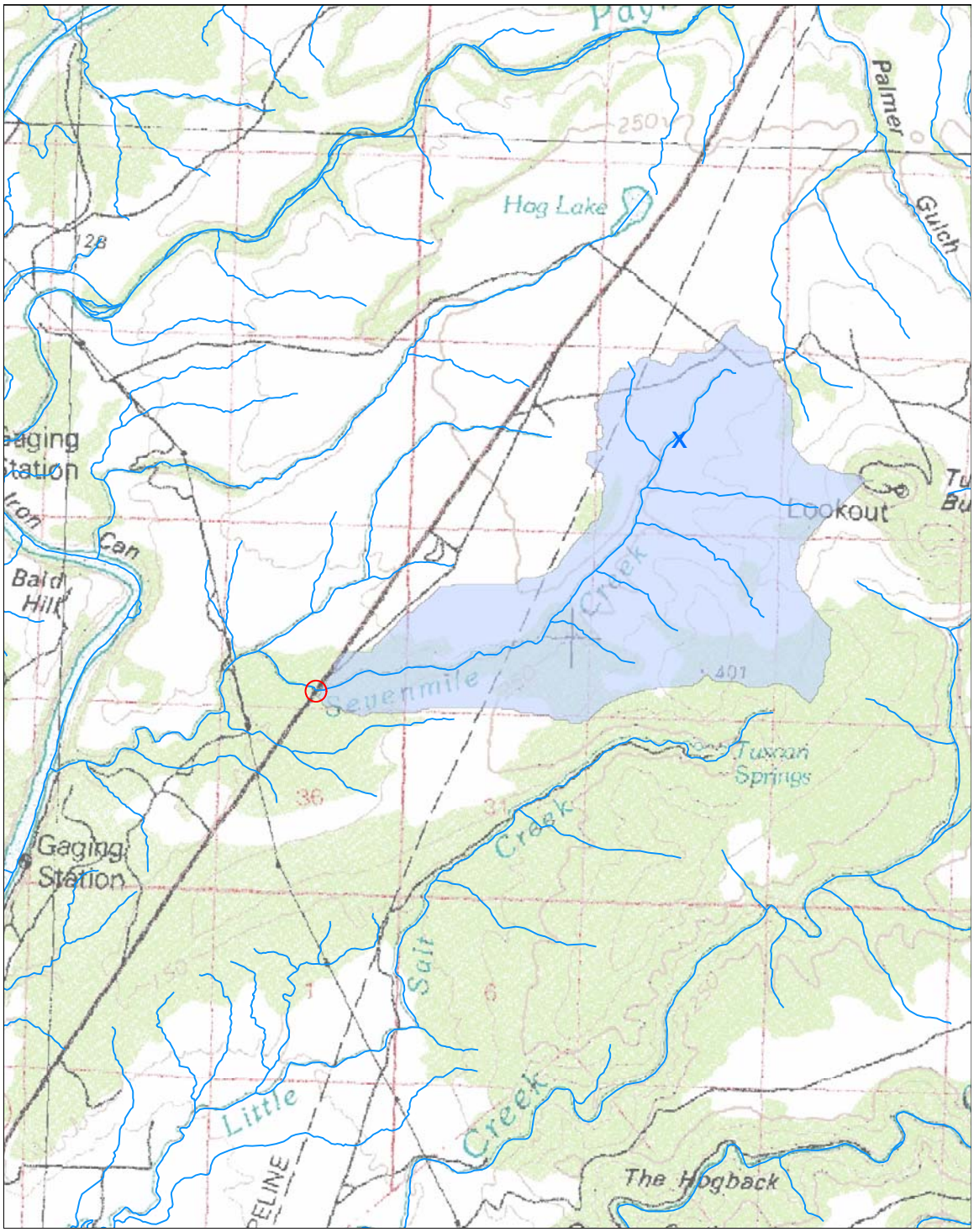
Culvert Information: Type: Concrete box (2 sides) **Dimensions:** 12' x 10' **Length:** 86.4' **Slope:** left bank = 1.4 %; right bank = 1.3% **Overall conditions:** Good **Modifications:** None **Fill Estimate:** 998 cubic yards **Average Channel Width:** 34.6' **Substrate at cross section:** 1) boulder 2) cobble 3) pebble

Hydrology: Drainage area upstream of crossing = **3.03 square miles**. Mean Annual Precipitation (MAP) = **31 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **763'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 144.6 cfs; Q_5 = 329 cfs; Q_{10} = 467 cfs; Q_{25} = 736 cfs; Q_{50} = 950.6 cfs; Q_{100} = 1224 cfs.

Barrier Status: GRAY as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 72.3 cfs (50% of Q_2 discharge). A lack of depth and excessive velocities through the culvert resulted in 0% passable to adult, resident, and juvenile salmonids.

Habitat: Quality = rated as "fair" due to the descent amount of riparian vegetation along stream bank upstream of crossing. Creek has very large substrate and wide channel with a low gradient and low flows. Stream is almost completely dry during warmer months. No fish were observed at time of survey. Quantity = 14,678' of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site # 13: Seven Mile Creek/Hwy 36 East ; Sacramento River



Upstream drainage area = 3.03 square miles
X = Limit of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site # 13- Seven Mile Creek/PM 48.60; Hwy 36 E Teh.

Site # 14: Shingle Creek/Hwy 44 East ; Ash Creek; Sacramento River

Location: Mile post= 22.4 Shasta USGS Quad: Shingletown. T31N, R1W, Section 34. Lat/Long.= N 40.49975W -121.97235

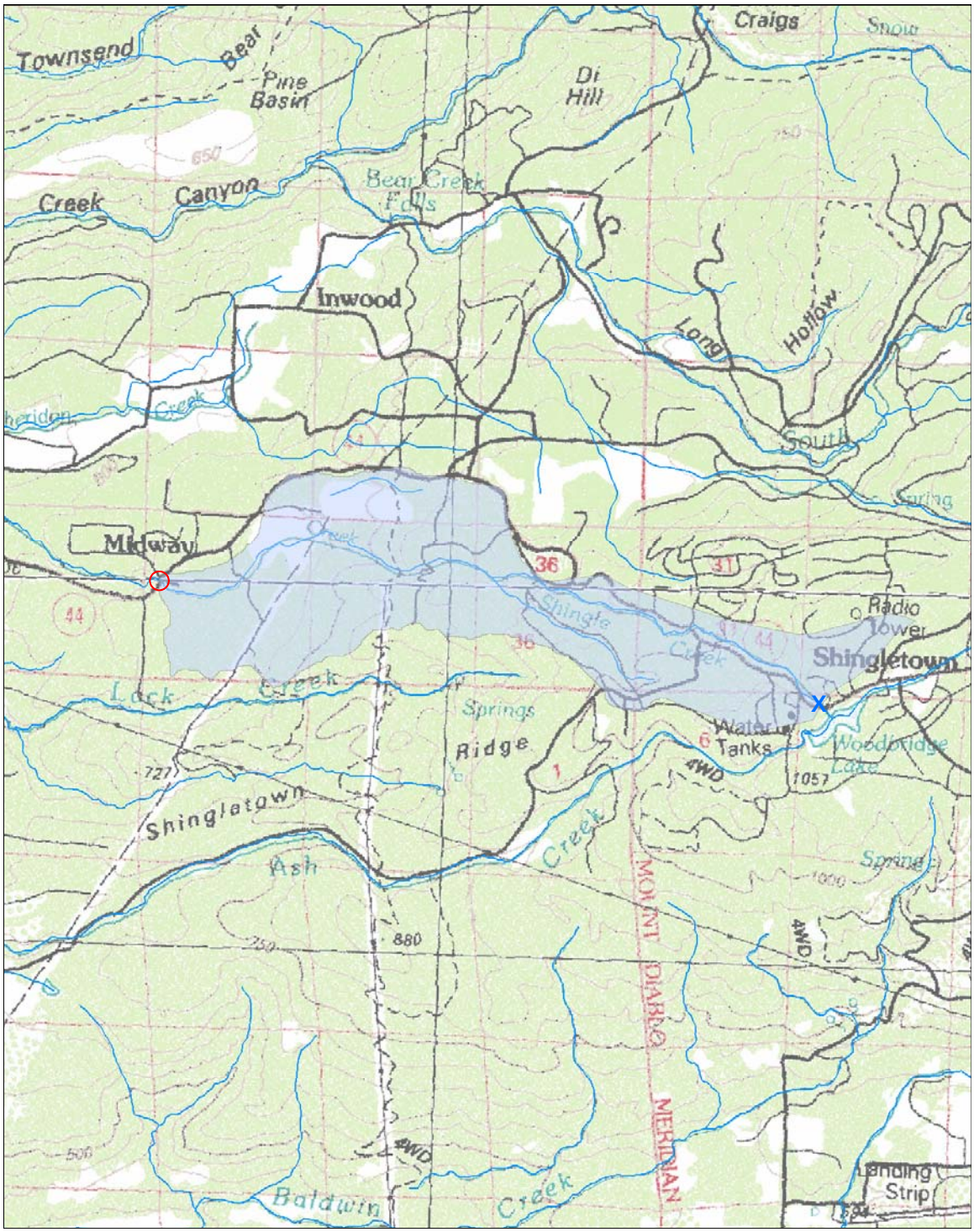
Culvert Information: Type: (5) Circular, SSP **Dimensions:** 4' diameter **Corrugations:** 3" x 1" **Length:** #1 = 86.2'; #2 = 85.8'; #3 = 86.4'; #4 = 86.3'; #5 = 86.1' **Slope:** #1 = 0.23%; #2 = 0.16%; #3 = 0.42%; #4 = 0.53%; #5 = 0.73% **Overall conditions:** Fair **Modifications:** None **Fill Estimate:** 604 cubic yards **Average Channel Width:** 40.8' **Substrate at cross section:** 1) boulder 2) organics/grass 3) cobble

Hydrology: Drainage area upstream of crossing = **4.12 square miles**. Mean Annual Precipitation (MAP) = **36 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **2,801'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 105.3 cfs; Q_5 = 268.6 cfs; Q_{10} = 396 cfs; Q_{25} = 649.3 cfs; Q_{50} = 854.3; Q_{100} = 1160 cfs.

Barrier Status: GRAY as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 52.6 cfs (50% of Q_2). Only 2.3% (51.51 cfs to 52.65 cfs) of flows were passable to adult salmonids. A lack of depth occurred at all flows through all culverts. Only 46.2% of flows were passable to resident trout and 65.8% percent were passable to juvenile salmonids. During higher flows, water depth is not an issue and resident and juvenile salmonids are able to swim through.

Habitat: Quality = rated as "poor". Creek drains from a small lake 4.2 miles upstream of Hwy 44 road crossing. Riparian zone is very dense with mature trees. Upstream channel is very small and not well defined causing flow to spread over vegetated flood plain. Substrate composed of boulder, submerged macrophytes, and cobble. Creek is completely dry during warm season. No fish were observed at time of survey. Quantity = 23,760' of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site # 14: Shingle Creek/Hwy 44 East ; Ash Creek; Sacramento River



Upstream drainage area = 4.12 square miles

X = Limit of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site # 14- Shingle Creek/PM 22.4; Hwy 44 Sha.

Site # 15: Unnamed tributary to Dry Creek/Hwy 36 West; Cottonwood Creek; Sacramento River

Location: Mile post= 10.73 Tehama USGS Quad: Chickabally Mountain. T28N, R7W, Section 8. Lat/Long.= N 40.29957 122.69048

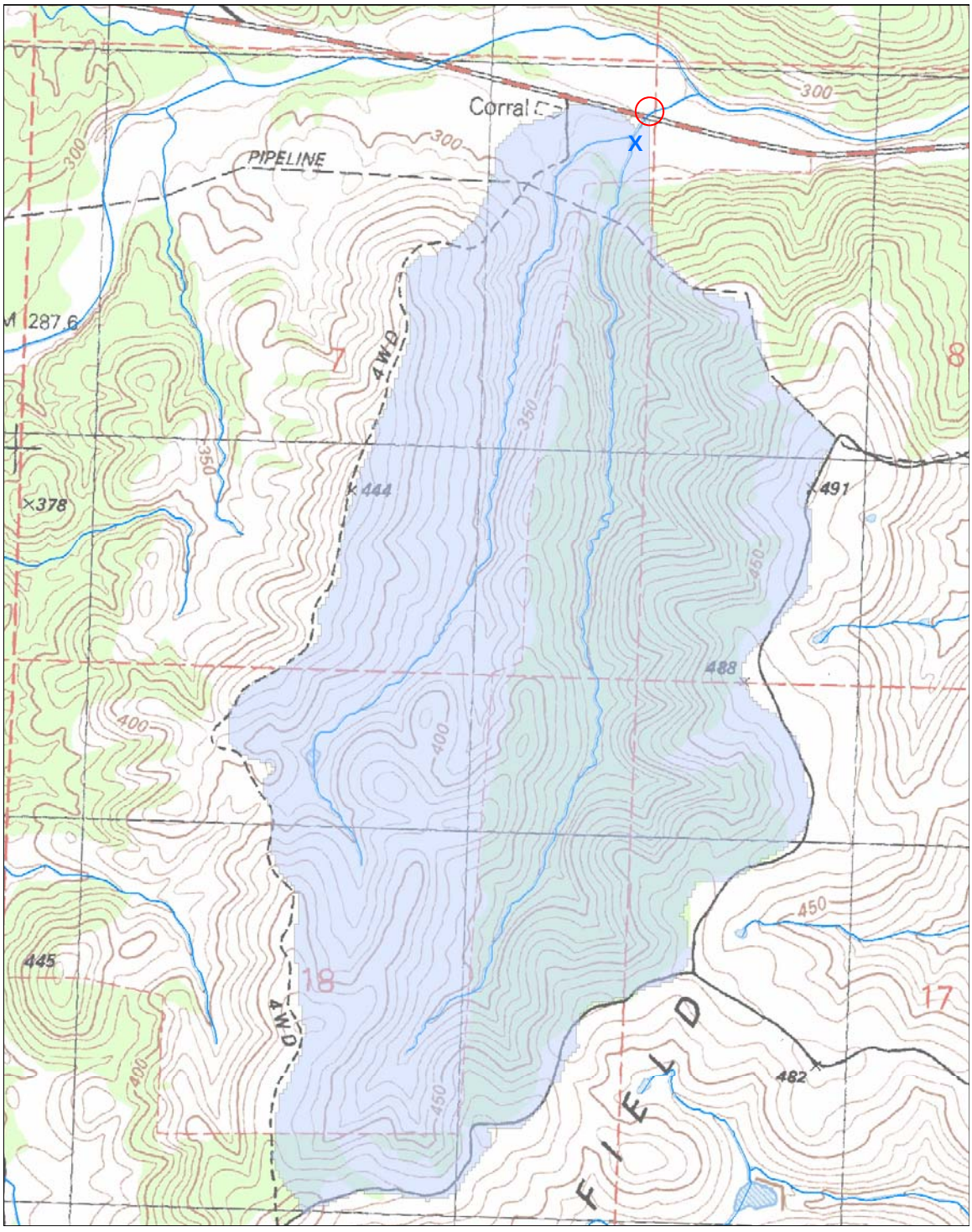
Culvert Information: **Type:** Circular, SSP **Dimensions:** 6' diameter
Corrugations: 3" x 1" **Length:** 89.1' **Slope:** 1.95 % **Overall conditions:** Fair
Modifications: None **Fill Estimate:** 561 cubic yards **Average Channel Width:** 10.8'
Substrate at cross section: 1) cobble 2) boulder 3) sand

Hydrology: Drainage area upstream of crossing = **1.05 square miles**. Mean Annual Precipitation (MAP) = **33 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **1,132'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 77.9 cfs; Q_5 = 121.4 cfs; Q_{10} = 162 cfs; Q_{25} = 208.8 cfs; Q_{50} = 254 cfs; Q_{100} = 286 cfs.

Barrier Status: **RED** as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 40 cfs (50% of Q_2 discharge). Only 28.1% (11 cfs to 21.11 cfs) of flows were passable to adult salmonids. A lack of depth occurred below flows of 11 cfs and excessive velocities occurred above flows of 21 cfs. Excessive velocities and outlet drop height resulted in 0% passage for both resident and juvenile salmonids.

Habitat: Quantity = rated as "poor" due to its very small size and lack of riparian vegetation through pasture land. Stream splits 0.033 miles upstream of crossing. This stream is a tributary to Dry Creek which has no known steelhead distribution. No fish were observed at time of survey. Quantity = 1,372' of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site # 15: Unnamed tributary to Dry Creek/Hwy 36 West; Cottonwood Creek



Upstream drainage area = 1.05 square miles
X = Limit of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site # 15- Unnamed Tributary to Dry Creek/PM 10.73; Hwy 36 W Teh.

Site # 16: Yank Creek/Hwy 299 East; Dry Creek; Cow Creek; Sacramento River

Location: Mile post= 32.25 Shasta USGS Quad: Bella Vista. T32N, R3W, Section 8. Lat/Long.= N 40.64302 122.22858

Culvert Information: Type: Concrete box (3 sides) **Dimensions:** 6' x 8'
Length: 58.5' **Slope:** left bank = -0.07%; center = 0.0%; right bank = 0.0%
Overall conditions: Good **Modifications:** None **Fill Estimate:** 164 cubic yards
Average Channel Width: 21.14' **Substrate at cross section:** 1) cobble 2) gravel 3) sand

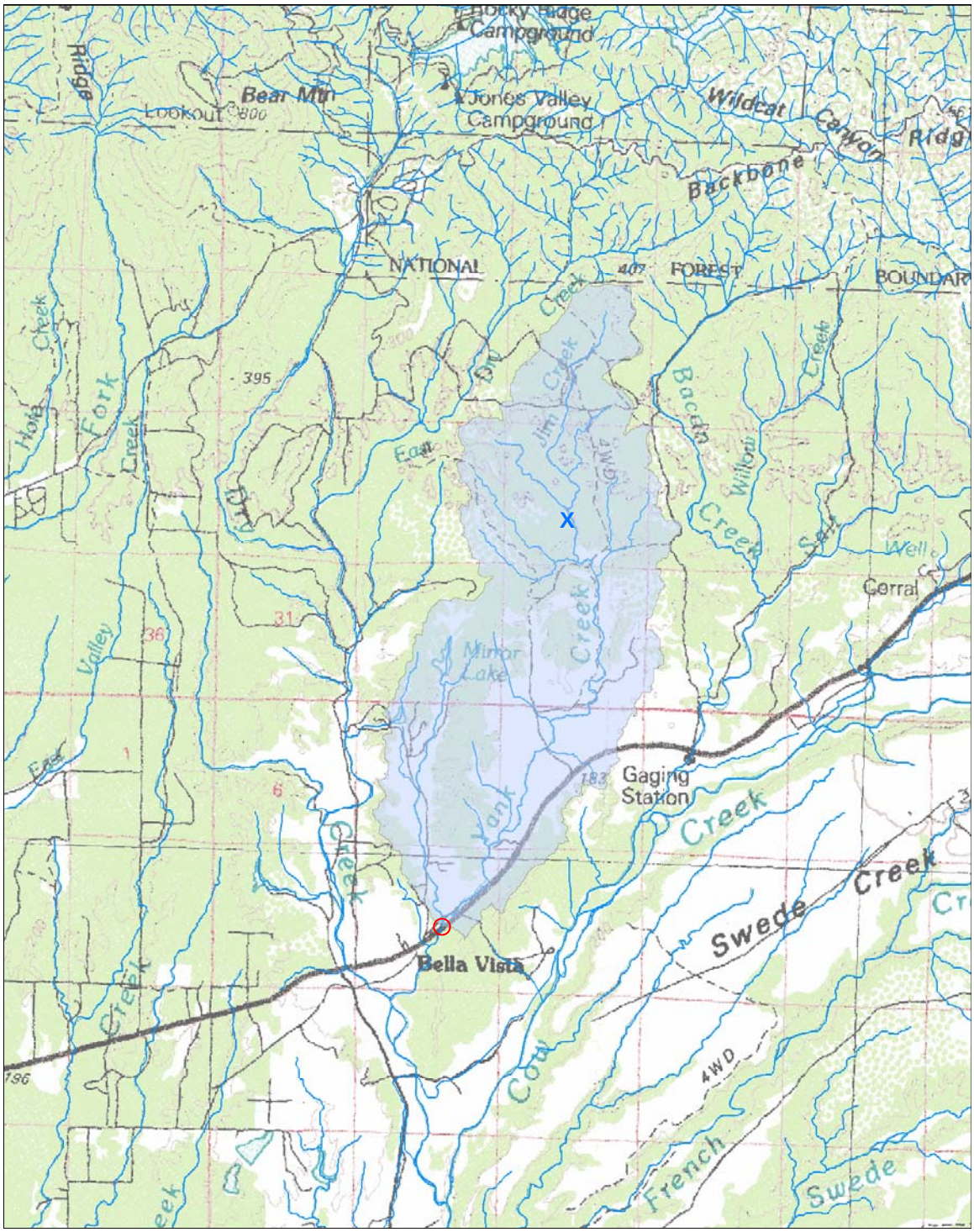
Hydrology: Drainage area upstream of crossing = **5.48 square miles**. Mean Annual Precipitation (MAP) = **42 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **684'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 393.6 cfs; Q_5 = 810.6 cfs; Q_{10} = 1096.6 cfs; Q_{25} = 1651.6 cfs; Q_{50} = 2060.2 cfs; Q_{100} = 2633.14 cfs.

Barrier Status: GRAY as determined by the Gray-Green-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 196.8 cfs (50% of Q_2 discharge). Only 17.5% (162 cfs to 196 cfs) of flows were passable to adult salmonids. A lack of depth occurred at flows below 162 cfs. Excessive outlet drop height resulted in 0% passage for both resident and juvenile salmonids.

Habitat: Quality = rated as "fair". Substrate composed of cobble and gravel. Riparian zone is lacking mature conifers. Yank Creek is a tributary to Cow Creek which has known steelhead distribution. Unknown juvenile fish in the < 3 inch size class were observed upstream and downstream of crossing during survey. Quantity = 19,008' of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Comments: Adjacent landowner claims culvert causes occasional flooding and large debris jams. Large woody debris jam present at time of survey.

Site # 16: Yank Creek/Hwy 299 East; Dry Creek; Cow Creek; Sacramento River



Upstream drainage area = 5.48 square miles

X = Limit of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site # 16- Yank Creek/PM 32.25; Hwy 299 E Sha.

Site # 17: Ash Creek/Hwy 44 East; Sacramento River

Location: Mile post= 28.05 Shasta USGS Quad: Shingletown. T31N, R1W, Section 32. Lat/Long.= N 40.49300 121.88388

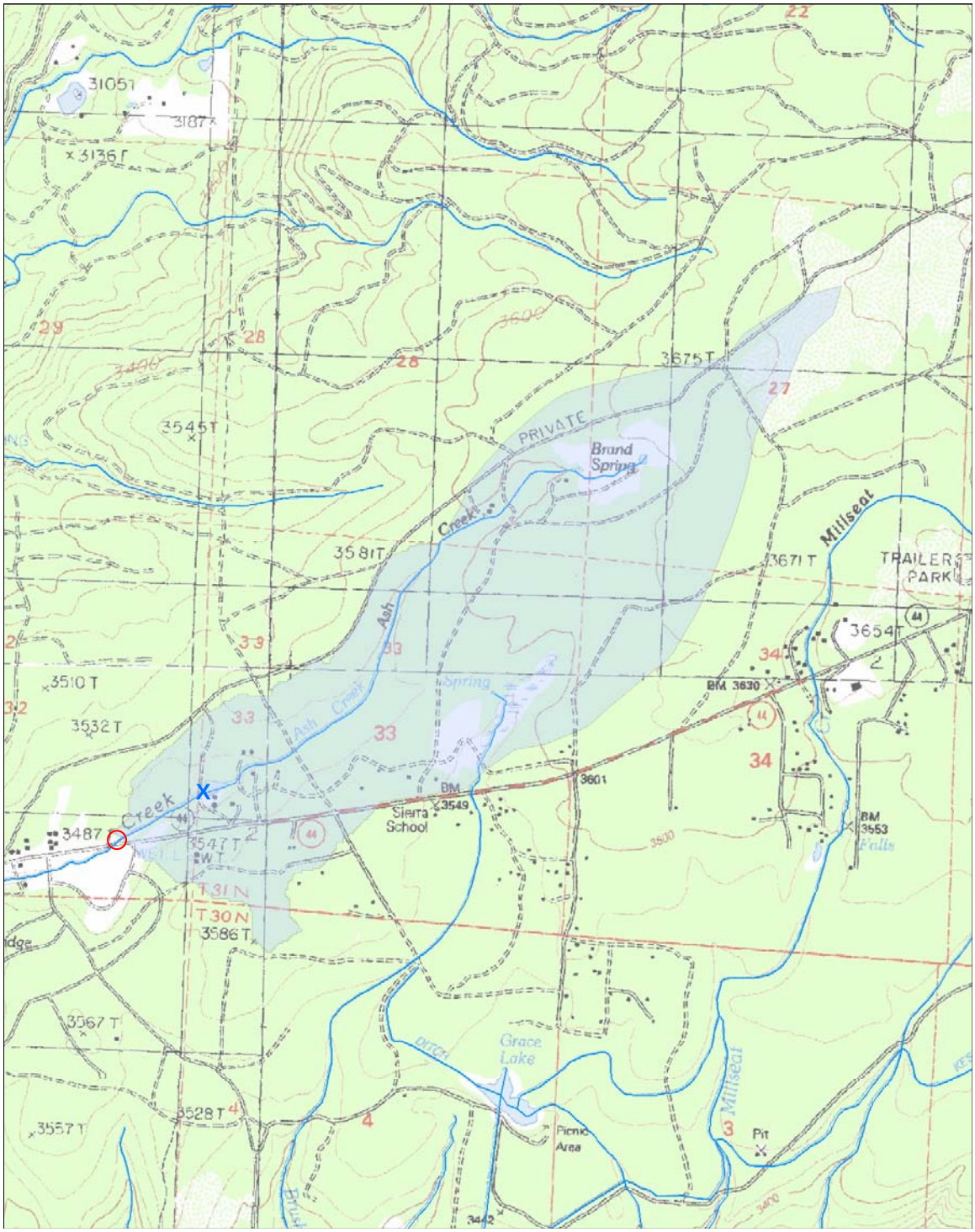
Culvert Information: Type: Circular pipe, SSP **Dimensions:** 3'3" x 4'9" **Length:** 66' **Slope:** 0.5 % **Overall conditions:** Good **Modifications:** None **Fill Estimate:** 131 cubic yards **Average Channel Width:** 7.02' **Substrate at cross section:** 1) clay 2) sand 3) organics

Hydrology: Drainage Area upstream of crossing = **1.59 square miles**. Mean Annual Precipitation (MAP) = **44 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **3,596'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 51.2 cfs; Q_5 = 138 cfs; Q_{10} = 205.59 cfs; Q_{25} = 396.1; Q_{50} = 446 cfs; Q_{100} = 614.17 cfs.

Barrier Status: GRAY as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 25.61 cfs (50% of Q_2 discharge). Only 44.4% (15.5 cfs to 25.6 cfs) of flows were passable to adult salmonids. A lack of depth through the culvert occurred at flows below 15.5 cfs. Excessive velocities and outlet drop height resulted in 0% passage for both resident and juvenile salmonids.

Habitat: Quality = rated as "poor" due to small stream size and available substrate which consists of clay, sand, and bedrock. Ash Creek has a known steelhead distribution. However, Ash Creek flows into Woodbridge Lake downstream of Hwy 44 road crossing. Dam at outlet of lake is a known barrier to migrating salmonids. Quantity = 1,478' of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%. Ash Creek flows out of a small lake ~0.5 miles upstream of the Hwy. 44 crossing.

Site # 17: Ash Creek/Hwy 44 East; Sacramento River



Upstream drainage area = 1.59 square miles

X = Limit of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site #17- Ash Creek/PM 28.05; Hwy 44 Sha.

Site # 18: Jenny Creek/Hwy 299 West; Sacramento River

Location: Mile post= 22.1 Shasta USGS Quad: Redding. T30N, R4W, Section
Lat/Long.= N 40.58360 W 122.42876

Culvert Information: Type: Circular pipe, aluminum **Dimensions:** 7' diameter
Length: left pipe = 266.5'; right pipe = 258.8' **Slope:** left bank = 0.85%;
right bank = 0.93% **Overall conditions:** Good **Modifications:** None
Fill Estimate: 131 cubic yards **Average Channel Width:** 10.3'
Substrate at cross section: 1) cobble 2) boulder 3) gravel

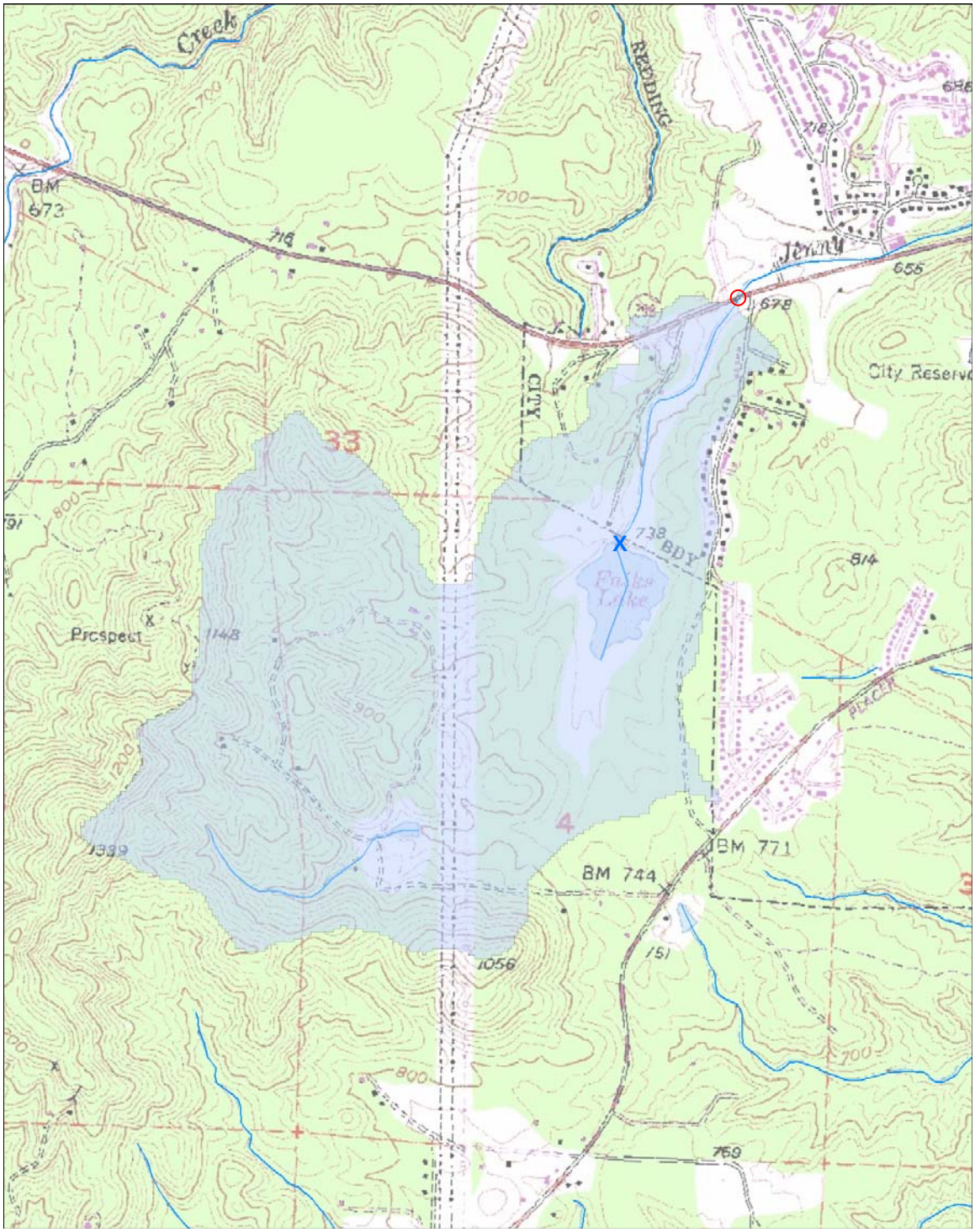
Hydrology: Drainage area upstream of crossing = **0.9 square miles**. Mean Annual Precipitation (MAP) = **45 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **803'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 105 cfs; Q_5 = 158.29 cfs; Q_{10} = 207 cfs; Q_{25} = 259.12 cfs; Q_{50} = 307.5 cfs; Q_{100} = 338 cfs.

Barrier Status: GRAY as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 52.53 cfs (50% of Q_2 discharge). Only 40.5% of flows were passable to adult salmonids. A Lack of depth within the culvert occurred during flows below 32.4 cfs. Excessive velocities, excessive leap at outlet and the shallow depth of outlet pool resulted in 0% passage for both resident and juvenile salmonids.

Habitat: Quality = rated as "poor". Jenny Cr. is the outlet stream of Falks (Mary) Lake which is ~0.5 miles upstream from the Hwy. 299 road crossing. Substrate consists of aquatic vegetation, cobble and boulder. Fairly dense riparian zone upstream of crossing, through residential area. Quantity = 2,851' of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Comments: Two CMP culverts at the confluence with the Sacramento River are likely a partial barrier to upstream migration, especially when the river is at lower flow. Another road crossing is located downstream of the Hwy. 299 crossing in a residential area.

Site # 18: Jenny Creek/Hwy 299 West; Sacramento River



Upstream drainage area = 0.9 square miles
X = Limit of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site # 18- Jenny Creek; Hwy 299 Sha.

Site #19: Sulphur Creek/Hwy 273; Sacramento River

Location: Mile post= 17.97 Shasta USGS Quad: Redding. T32N, R5W, Section 25 Lat/Long.= N 40.60154 W 122.38255

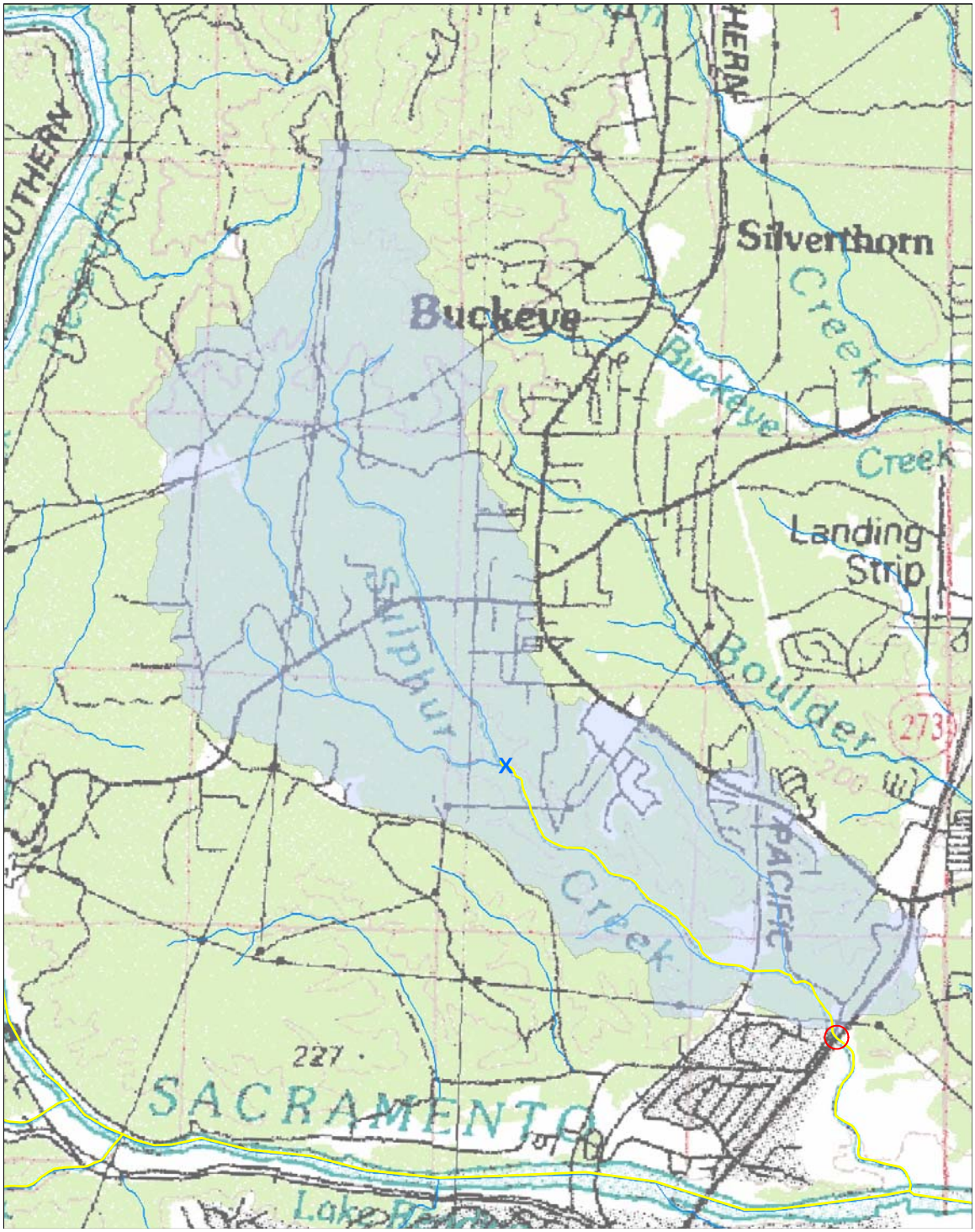
Culvert Information: Type: Concrete box (2 sides) **Dimensions:** 6' x 12'
Length: 204' **Slope:** 0.68 % **Overall conditions:** Good **Modifications:** None
Fill Estimate: Not available **Average Channel Width:** 23.3'
Substrate at cross section: 1) cobble 2) boulder 3) gravel

Hydrology: Drainage area upstream of crossing = **4.06 square miles**. Mean Annual Precipitation (MAP) = **42 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **700'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 302.3 cfs; Q_5 = 634 cfs; Q_{10} = 862.65 cfs; Q_{25} = 1303.2 cfs; Q_{50} = 1630.5 cfs; Q_{100} = 2090.15 cfs.

Barrier Status: GRAY as determined by the Green, Gray, Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 151.15 cfs (50% of Q_2 discharge). A lack of depth occurred during flows below 144.9 cfs and excessive velocities occurred above 75.4 cfs resulting in 0% passage for adult and resident salmonids. Only 5% of flows were passable to juvenile salmonids. Excessive velocities occurred during flows above 15.7 cfs and a lack of depth occurred at flows below 14.3 cfs.

Habitat: Quality = rated as "good" due to the ideal substrate sizes and riparian zone. The riparian zone is relatively intact with a recent restoration enhancement project. More than 100 juvenile salmonid fry were observed both upstream and downstream of crossing during survey. Quantity = 9,504' of potential anadromous habitat upstream o road crossing based on channel slope sustaining <8%.

Site # 19: Sulphur Creek/Hwy 273; Sacramento River



Upstream drainage area = 4.06 square miles
X = Limit of potential anadromous habitat upstream o road crossing based on channel slope sustaining <8%.

Site # 19-Sulphur Creek/PM 17.97; Hwy 273 Sha.

Site # 20: China Gulch Creek/Hwy 273; Clear Creek; Sacramento River

Location: Mile post= 10.97 Shasta USGS Quad: Redding. T30N, R4W, Section Lat/Long.= N 40.50439 W 122.37888

Culvert Information: Type: Concrete box **Dimensions:** 6' x 11.7' **Length:** 123' **Slope:** 0.8 % **Overall conditions:** Good **Modifications:** None **Fill Estimate:** 281 cubic yards **Average Channel Width:** 12' **Substrate at cross section:** 1) cobble 2) gravel 3) boulder

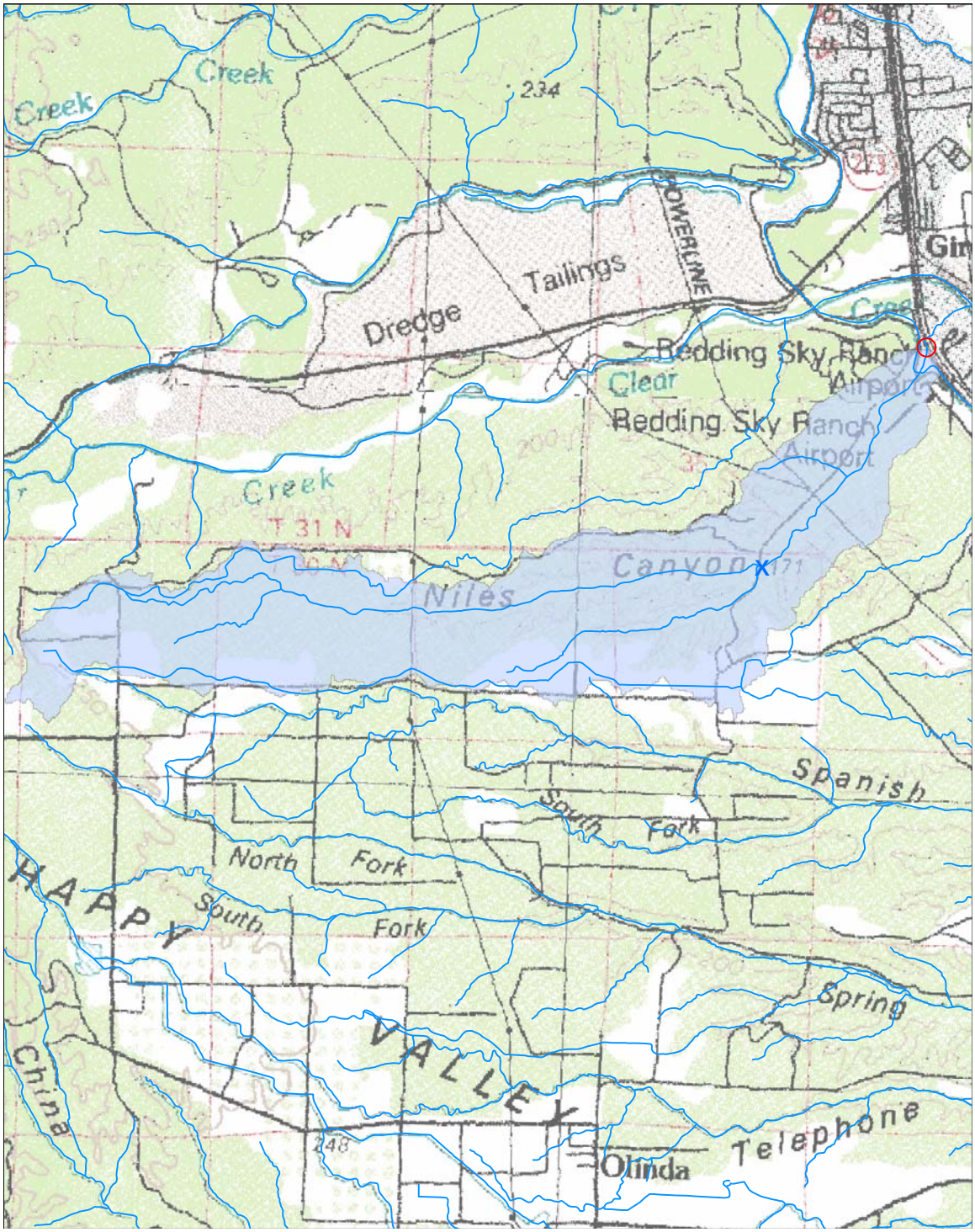
Hydrology: Drainage area upstream of crossing = **3.11 square miles**. Mean Annual Precipitation (MAP) = **37 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **646'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 298.4 cfs; Q_5 = 421 cfs; Q_{10} = 545 cfs; Q_{25} = 658 cfs; Q_{50} = 762.67 cfs; Q_{100} = 822.35 cfs.

Barrier Status: GRAY as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 149.2 cfs (50% of Q_2 discharge). A lack of depth through the culvert occurred during all flows resulting in 0% passable to adults, resident, and juvenile salmonids. Excessive leap at outlet and shallow pool depths were also barriers to resident and juvenile salmonids.

Habitat: Quality = rated as "poor" due to lack of mature trees and other vegetation along riparian zone. Upstream channel crosses under ACID Canal and could result in possible barrier. Upstream channel looks as if it had been channelized in past. Poor riparian zone up to Niles Canyon, dense riparian zone from there upstream. Substrate composed of cobble and gravel. China Gulch is a direct tributary to Clear Creek which has known steelhead and Chinook salmon distribution. Quantity = 7,392' of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Comments: Possible barrier immediately downstream of Hwy. 273 at a rail road bridge crossing.

Site # 20: China Gulch Creek/Hwy 273; Clear Creek; Sacramento River



Upstream drainage area = 3.11 square miles
X = Limit of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site # 20- China Gulch Creek/PM 10.97; Hwy 273 Sha.

Site # 21: Cold Spring Gulch/Hwy 36 West; Middle Fork Cottonwood Creek; Sacramento River

Location: Mile post= 7.49 Shasta USGS Quad: Beegum. T29N, R9W, Section 17. Lat/Long.= N 40.36089 W 122.91164

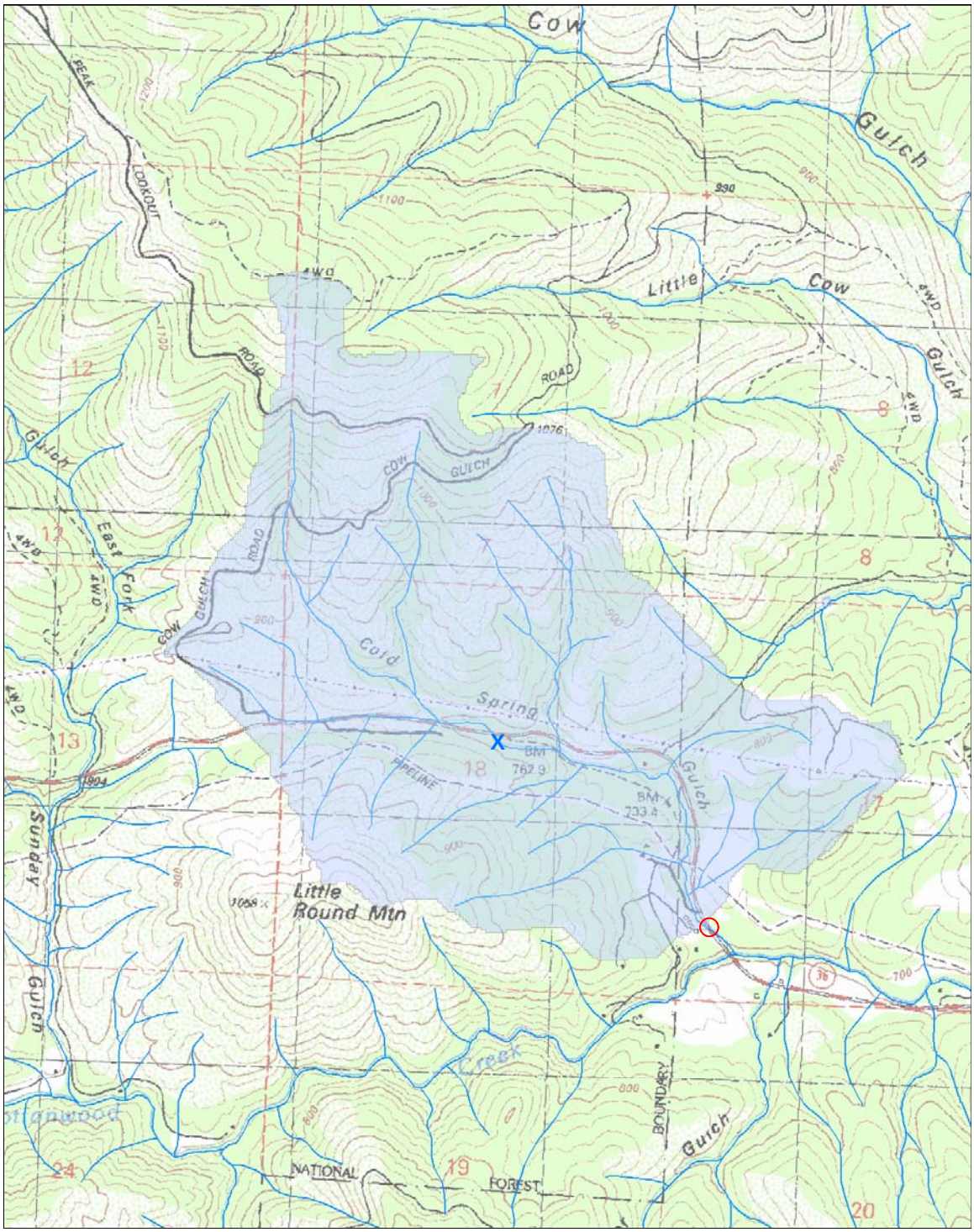
Culvert Information: **Type:** Pipe Arch, SSP **Dimensions:** 2'9" x 6' **Length:** left pipe = 52.7'; right pipe = 52.2' **Slope:** left bank = 2.75%; right bank = 3.72% **Overall conditions:** Fair **Modifications:** None **Fill Estimate:** 116 cubic yards **Average Channel Width:** 8.14' **Substrate at cross section:** 1) bedrock 2) gravel 3) pebble

Hydrology: Drainage area upstream of crossing = **1.64 square miles**. Mean Annual Precipitation (MAP) = **37 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **2,952'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 82.15 cfs; Q_5 = 143.2 cfs; Q_{10} = 205.9 cfs; Q_{25} = 291.2 cfs; Q_{50} = 387 cfs; Q_{100} = 471.2 cfs.

Barrier Status: **RED** due to the greater than 3% slope of the culvert as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 41 cfs (50% of Q_2 discharge). A lack of depth occurred at flows below 38.9 cfs resulting in 0% passage to adult salmonids. A lack of depth through the culvert also resulted in 0% passage for resident and juvenile salmonids.

Habitat: Quality = rated as "fair" due to the small size of stream and bedrock substrate. The presence of deep pools with gravel and pebble substrate are located upstream of crossing. Riparian zone is well vegetated. Unknown juvenile fish in the 3-6 inch size class were observed upstream of crossing during survey. Quantity = 4,224' of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%. Stream follows road for a couple of thousand feet and constricts along the way.

Site # 21: Cold Spring Gulch/Hwy 36 West; Middle Fork Cottonwood Creek



Upstream drainage area = 1.64 square miles

X = Limit of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site # 21- Coldspring Gulch/PM 7.49; Hwy 36 W Sha.

Site # 22: Unnamed tributary to Mill Creek/Hwy 172; Mill Creek; Sacramento River

Location: Mile post= 7.34 Tehama USGS Quad: Mount Diablo. T30N, R5E, Section 34. Lat/Long.= N 40.34104 W 121.52160

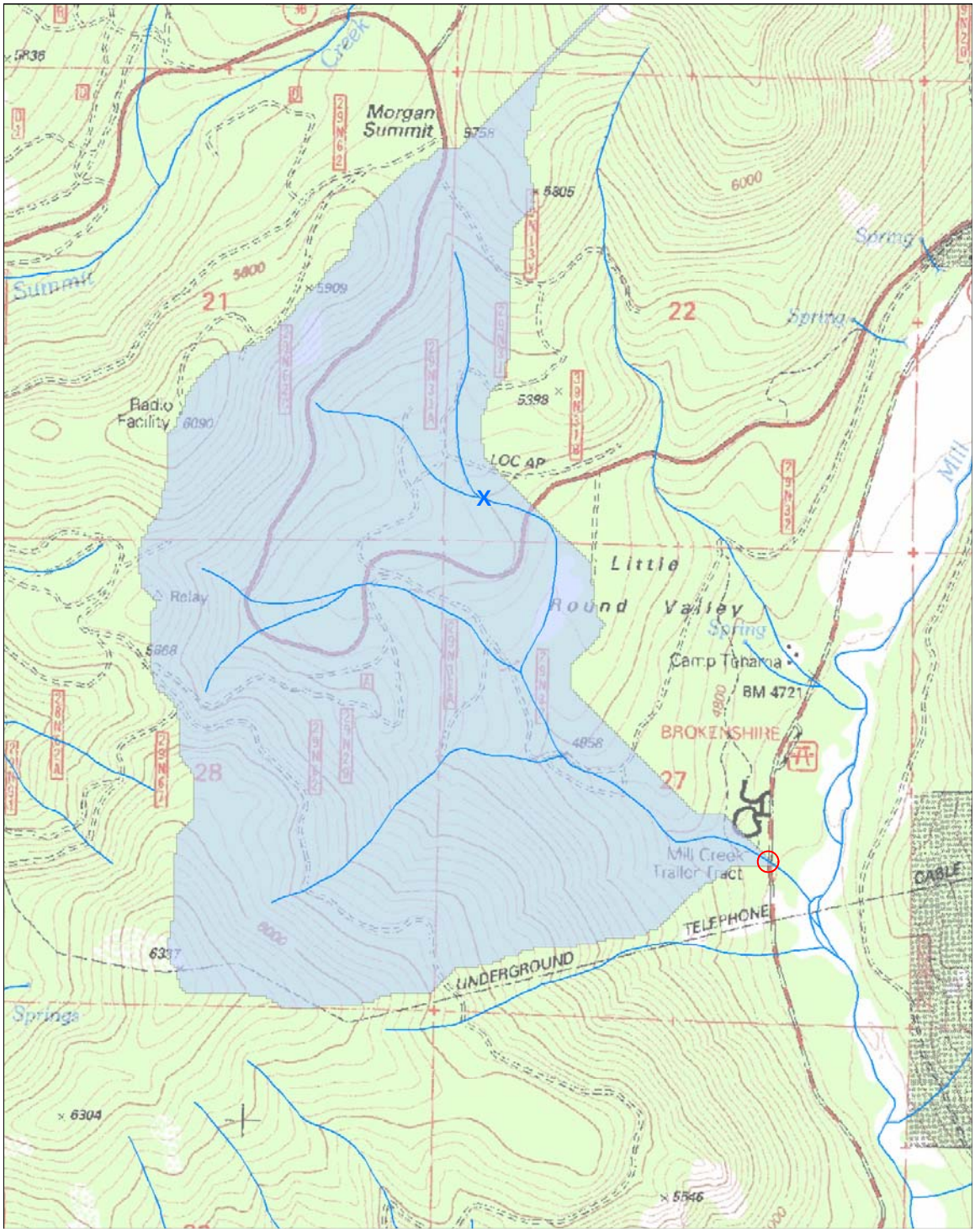
Culvert Information: Type: Concrete box (2 sides) **Dimensions:** 3'6" x 6'
Length: 61' **Slope:** left bank = 1.42 %; center = 1.43%; right bank = 7.90%
Overall conditions: Good **Modifications:** None **Fill Estimate:** Not available
Average Channel Width: 13.8' **Substrate at cross section:** 1) boulder 2) cobble 3) gravel

Hydrology: Drainage area upstream of crossing = **1.47 square miles**. Mean Annual Precipitation (MAP) = **57 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **5,272'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 52.98 cfs; Q_5 = 144.5 cfs; Q_{10} = 213.75 cfs; Q_{25} = 346.4 cfs; Q_{50} = 459.4 cfs; Q_{100} = 638.67 cfs.

Barrier Status: GRAY determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 26.5 cfs (50% of Q_2 discharge). Only 9% (24.37 cfs to 26.5 cfs) of flows were passable to adult salmonids. A lack of depth occurred at almost all flows. Only 27.9% of flows were passable to resident trout. A lack of depth through the culvert occurred at flows below 12 cfs. The lack of depth and excessive leap were barriers to juvenile salmonids resulting in 0% passage.

Habitat: Quality = rated as "poor" due to small stream size and warm water temperatures during summer. It is a tributary to Mill Creek which as a known steelhead distribution. Has very dense riparian zone with mature trees. This is an intermittent stream with no known salmonid distribution. Quantity = 6,864' of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site # 22: Unnamed tributary to Mill Creek/Hwy 172; Mill Creek> Sacramento River



Upstream drainage area = 1.47 square miles
X = Limit of potential anadromous habitat upstream of road crossing based on channel slope sustaining <8%.

Site # 22- Unnamed Tributary to Mill Creek/PM 7.34; Hwy 172 Teh.

Site # 23: Martin Creek/Hwy 36 East; South Fork Battle Creek; Sacramento River

Location: Mile post= 83.53 Tehama USGS Quad: Mount Diablo. T39N, R4E, Section 30. Lat/Long.= N 40.34948 W 121.59108

Culvert Information: Type: Concrete box **Dimensions:** 4'1" x 5'2" **Length:** 68.2'
Slope: 2.2 % **Overall conditions:** Good **Modifications:** None
Fill Estimate: 202 cubic yards **Average Channel Width:** 13.7'
Substrate at cross section: 1) boulder 2) cobble 3) pebble

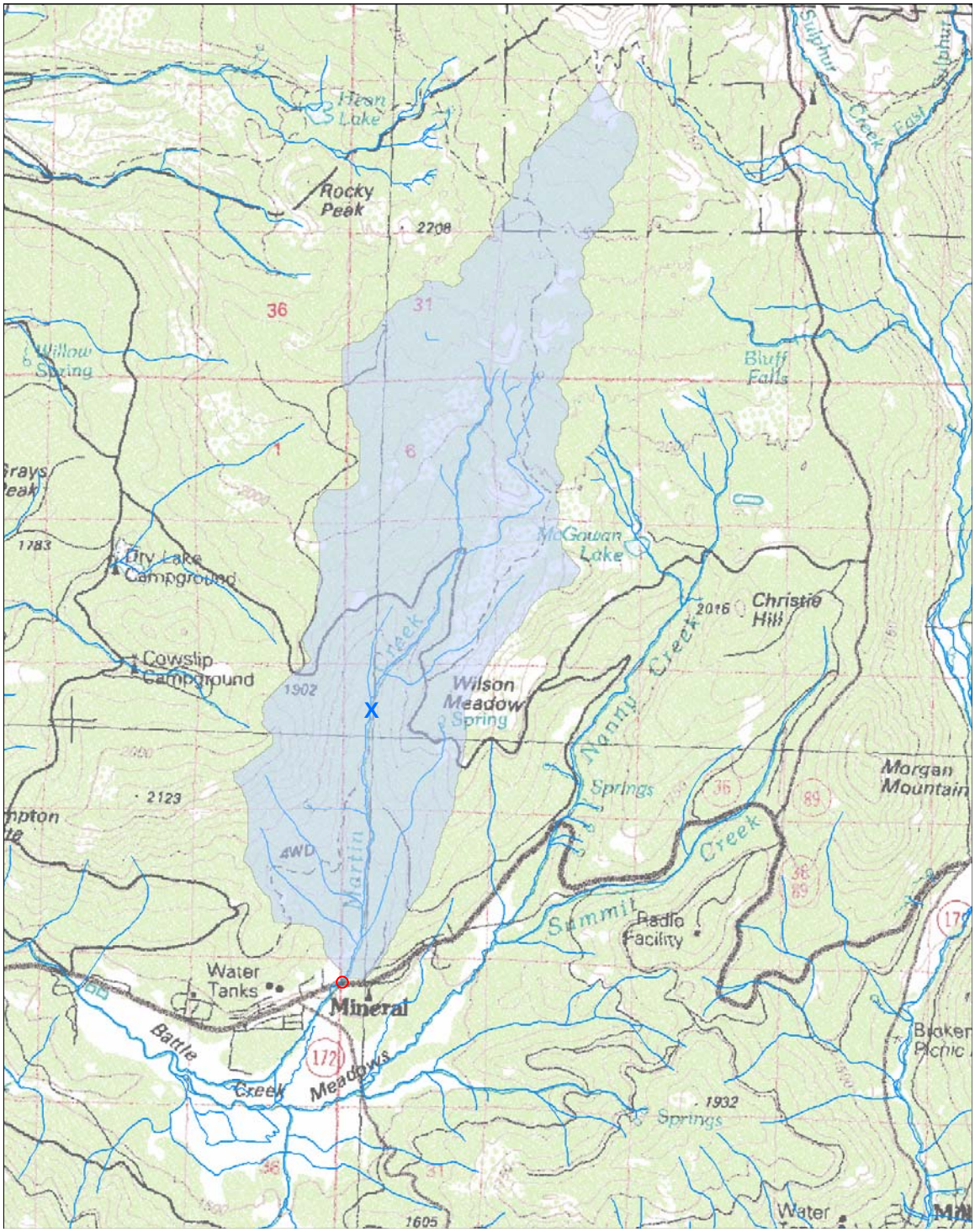
Hydrology: Drainage area upstream of crossing = **7.15 square miles**. Mean Annual Precipitation (MAP) = **57 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **6,199'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 187.25 cfs; Q_5 = 476.6 cfs; Q_{10} = 689.7 cfs; Q_{25} = 1111 cfs; Q_{50} = 1459.8 cfs; Q_{100} = 2013.7 cfs.

Barrier Status: **RED** as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 93.6 cfs (50% of Q_2 discharge). A lack of depth through the culvert resulted in 0% passage for adult, resident, and juvenile salmonids during all flows. Excessive outlet drop heights and excessive velocities were other violations that occurred during various flows for all three life stages.

Habitat: Quality = rated as "good" due to the very dense riparian zone with mixed mature conifers. Stream also has ideal spawning substrate. Quantity = 10,560' of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Comments: Known barrier 1 mile upstream of Hwy. 36 road crossing on a Forest Service road. There are several known barriers downstream of Hwy. 36 road crossing on South Fork Battle Creek, which prevent further upstream migration.

Site # 23: Martin Creek/Hwy 36 East; South Fork Battle Creek; Sacramento River



Upstream drainage area = 7.15 square miles

X = Limit of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site # 23- Martin Creek/PM 83.53; Hwy 36 E Teh.

Site # 24: Millseat Creek/Hwy 44 East; North Fork Battle Creek; Sacramento River

Location: Mile post= 33.78 Shasta USGS Quad: Manton/Hagaman Gulch. T31N, R2E, Section 34. Lat/Long.= N 40.50030 W 121.84867

Culvert Information: Type: Circular pipe, SSP **Dimensions:** 6' diameter **Length:** 113.2' **Slope:** 2.26 % **Overall conditions:** Poor **Modifications:** None **Fill Estimate:** 4,709 cubic yards **Substrate at cross section:** 1) Boulder 2) Cobble 3) Pebble **Average Channel Width:** 40.4' (man-made rock dams influence upstream width)

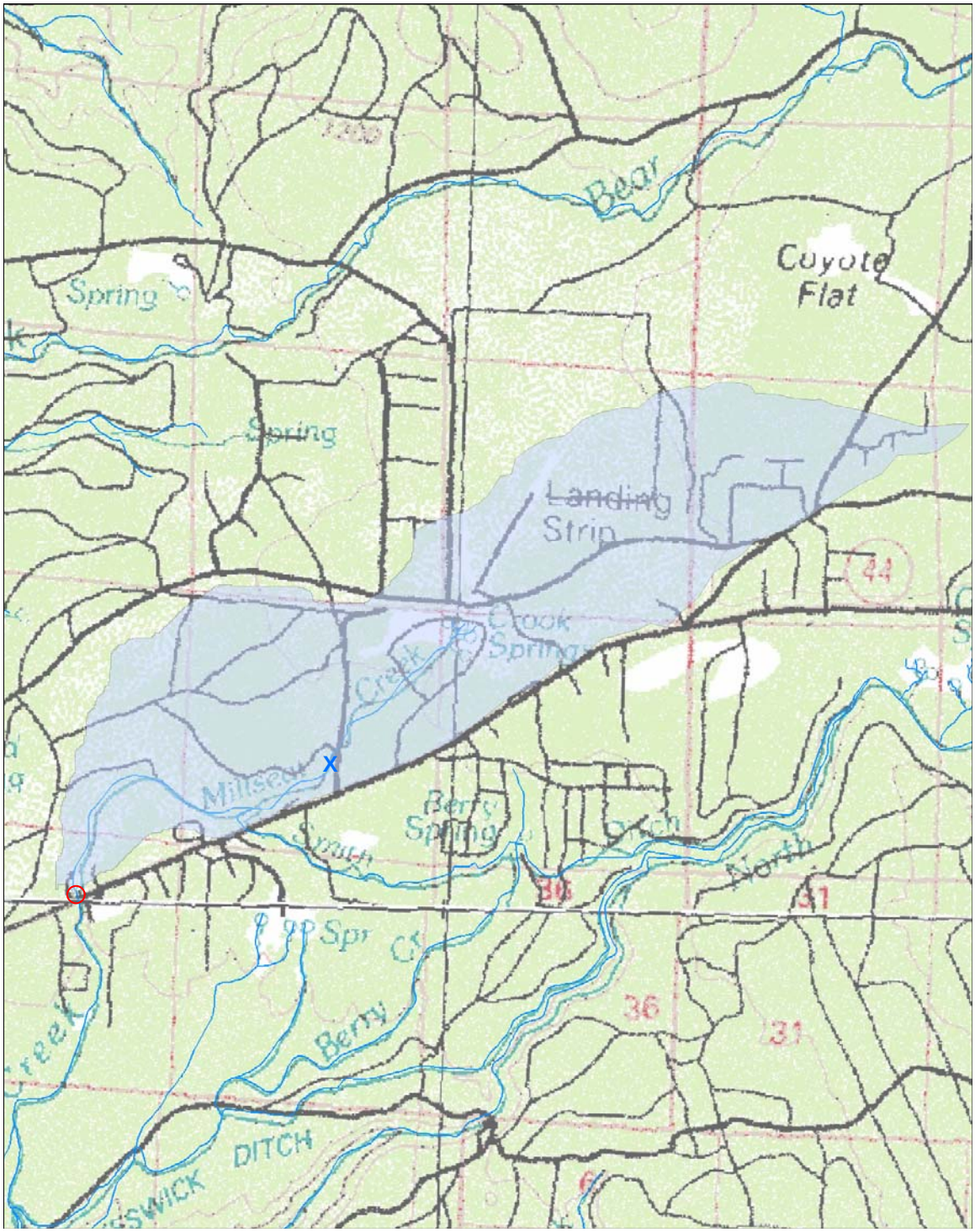
Hydrology: Drainage area upstream of crossing = **3.37 square miles**. Mean Annual Precipitation (MAP) = **47 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **3,807'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 105.18 cfs; Q_5 = 269.8 cfs; Q_{10} = 393.95 cfs; Q_{25} = 636.67 cfs; Q_{50} = 836.2 cfs; Q_{100} = 1143 cfs.

Barrier Status: GRAY as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 53.59 cfs (50% of Q_2 discharge). Only 13% (11.68 cfs to 18.2 cfs) of flows were passable to adult salmonids. A lack of depth occurred during flows below 11.68 cfs and excessive velocities occurred during flows above 18.21 cfs. Excessive velocities and excessive leap speeds resulted in 0% passage to resident and juvenile salmonids.

Habitat: Quality = rated as "fair". The average upstream channel width= 40.4 feet but is influenced by a series of man-made rock check dams upstream of culvert. The riparian zone has dense mature tree cover. Quantity = 10,401' of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Comments: Downstream dam located at the Volta Power House is a known barrier to salmonids and prevents upstream migration. Another dam is located ~0.12 miles downstream of Hwy. 44 road crossing.

Site # 24: Millseat Creek/Hwy 44 East; North Fork Battle Creek; Sacramento River



Upstream drainage area = 3.37 square miles
X = Limit of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site # 24- Millseat Creek/PM 33.78; Hwy 44 E Sha.

Site #25: Middle Creek/Hwy. 299 W; Sacramento River

Location: Mile post = 19.14 Shasta; USGS Quad: Redding. T32N, R5W, Section 31. Lat/Long. = N 40.59267 W122.48426

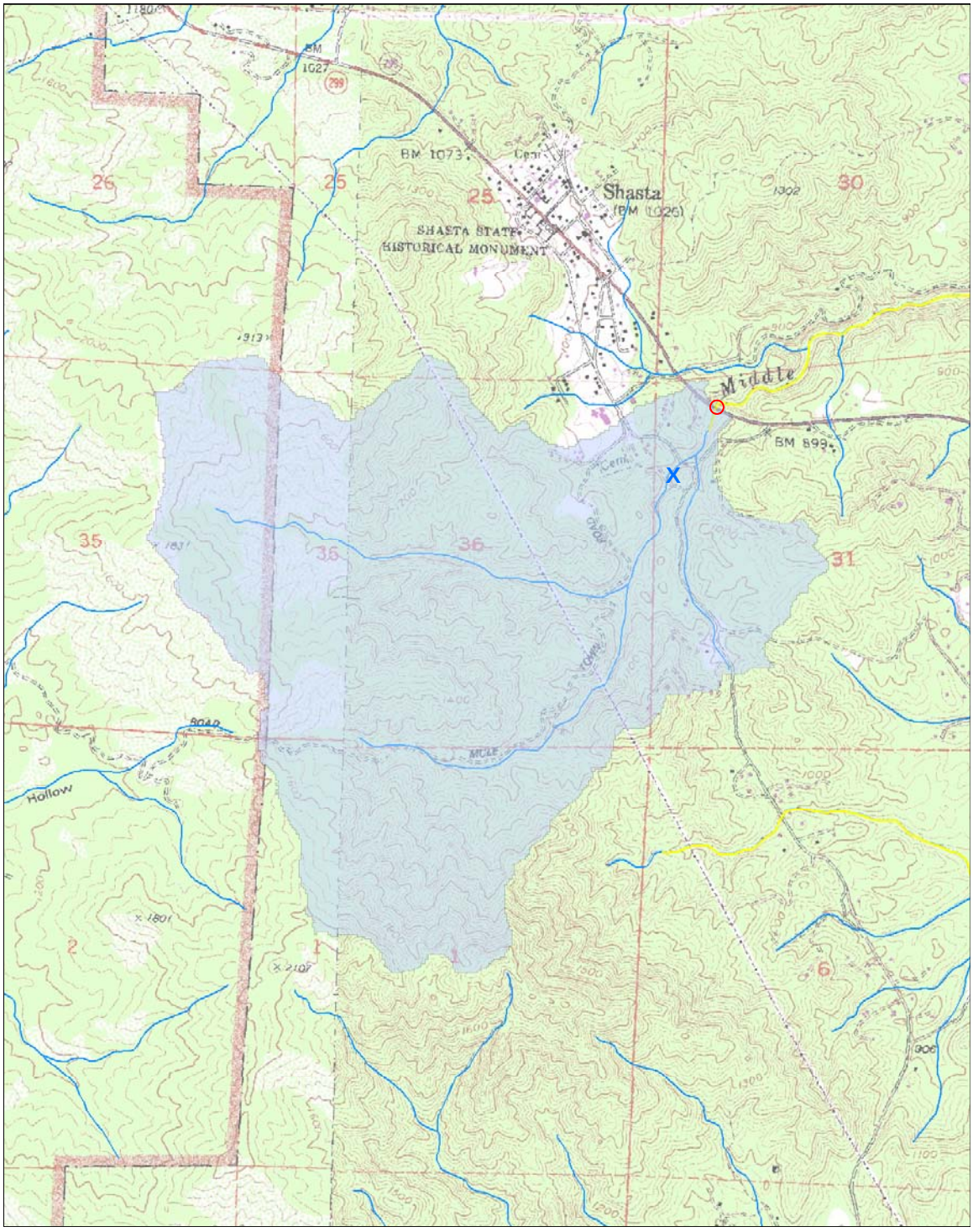
Culvert Information: Type: Circular, SSP **Corrugations:** 6 X 1.5"
Dimensions: 7.5' diameter **Length:** 180' **Slope:** 2.24% **Overall Conditions:** Poor
Modifications: None **Fill Estimate:** Not available **Average Channel Width:** 10.7'
Substrate at Cross section: 1) Cobble 2) Gravel 3) Boulder

Hydrology: Drainage area upstream of crossing = **1.84 square miles**. Mean Annual Precipitation (MAP) = **53 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **340'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 346.4 cfs; Q_5 = 469 cfs; Q_{10} = 570.4 cfs; Q_{25} = 651.5 cfs; Q_{50} = 718 cfs; Q_{100} = 738.1 cfs.

Barrier Status: **RED** as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 173.2 cfs (50% of Q_2 discharge). An excessive outlet drop, velocities, and a lack of depth through the culvert resulted in 0% passable to adult, resident, and juvenile salmonids at all flows.

Habitat: Quality = rated as "good". Riparian zone has mature tree cover. The current steelhead distribution stops just above the Hwy. 299 road crossing. Quantity = 1,260' of potential anadromous habitat located upstream of crossing based on channel slope sustaining <8%. An old road and concrete dam are located 1,260' above highway crossing and constitute a total barrier to anadromous fish.

Site #25: Middle Creek/PM 19.14; Hwy. 299 W; Sacramento River



Upstream drainage area = 1.84 square miles

X = Limit of potential anadromous habitat located upstream of crossing based on channel slope sustaining <8%.

_____ = Current steelhead distribution

Site #25 – Middle Creek/PM 19.19; Hwy. 299 W

Site #26: Boulder Creek/Hwy. 299; Churn Creek; Sacramento River

Location: Mile post= 24.7 Shasta; USGS Quad: Redding. T32N, R4W, Section 19. Lat/Long.= N 40.61185 W -122.36571

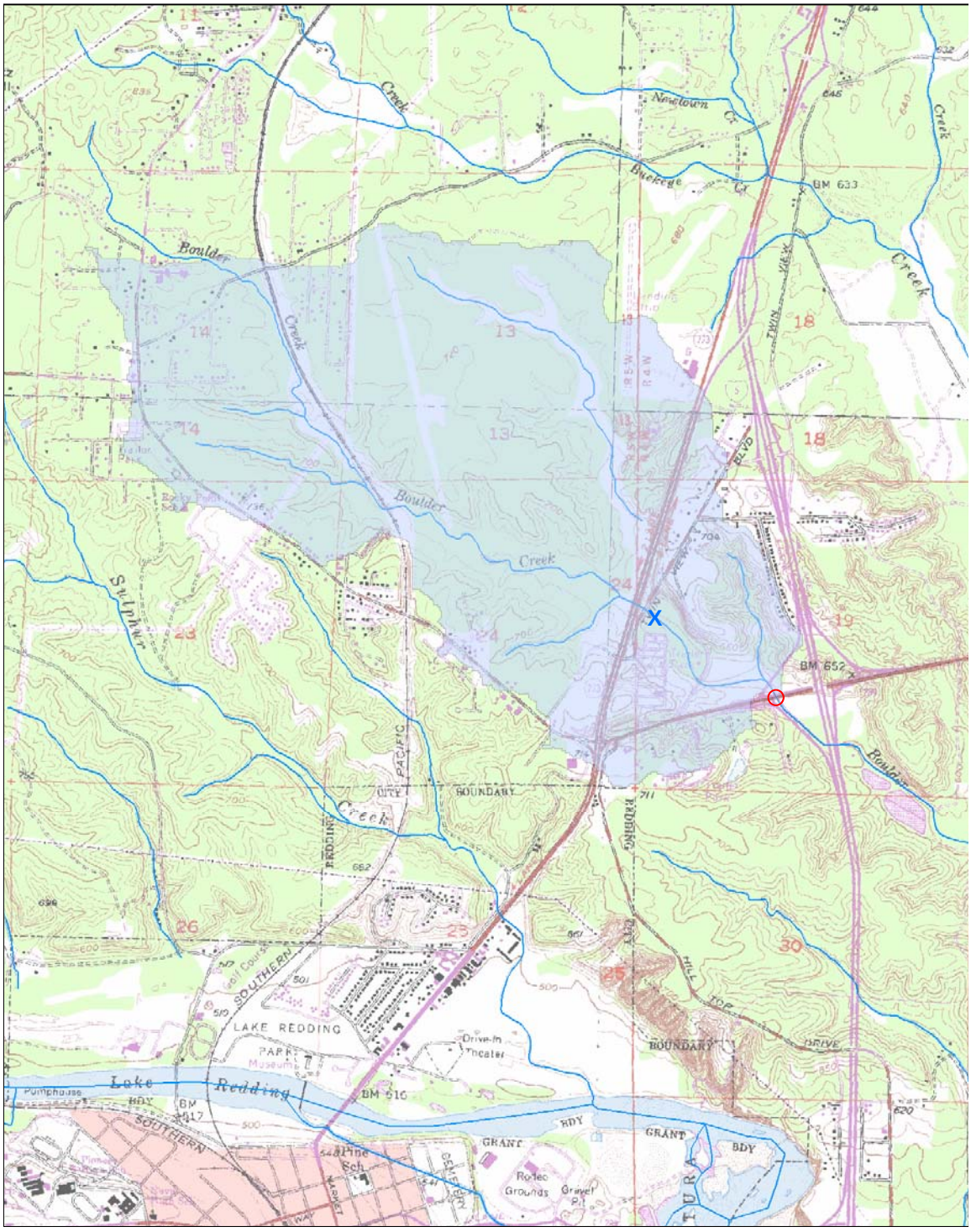
Culvert Information: Type: 2-sided box **Dimensions:** 8'3" x 10' **Length:** 323.9' **Slope:** 0.28% **Overall conditions:** Good **Modifications:** None **Fill Estimate:** 2,845 cubic yards **Average Channel Width:** 20.8'

Hydrology: Drainage area upstream of crossing = **2.31 square miles**. Mean Annual Precipitation (MAP) = **43 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **203'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 684 cfs; Q_5 = 1143.9 cfs; Q_{10} = 1426.7 cfs; Q_{25} = 1963.7 cfs; Q_{50} = 2314.8 cfs; Q_{100} = 2752.9 cfs.

Barrier Status: GRAY as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 342 cfs (50% of Q_2 discharge). Only 23.8% (73.9 cfs to 154.5 cfs) of flows were passable to adult salmonids. A lack of depth occurred during flows below 73.9 cfs and excessive velocity occurred during flows of 154.5 cfs to 342 cfs. Only 2.6% of flows were passable to resident trout. A lack of depth and excessive velocities resulted in 0% passable to juvenile salmonids.

Habitat: Quality = rated as "poor" due to the lack of riparian vegetation. The upstream channel has been straightened in the past. Quantity = 2,927' of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%. Upstream habitat is limited due to the known barrier on Twin View Blvd. road crossing.

Site #26: Boulder Creek/Hwy. 299; Churn Creek; Sacramento River



Upstream drainage area = 2.31 square miles

X = Limit of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site #26: Boulder Creek/PM 24.7; Hwy. 299

Site #27: Boulder Creek/I-5; Churn Creek; Sacramento River

Location: Post mile= 17.14 Shasta; USGS Quad: Redding. T32N, R4W, Section 19. Lat/Long. = N 40.60971; W -122.36268

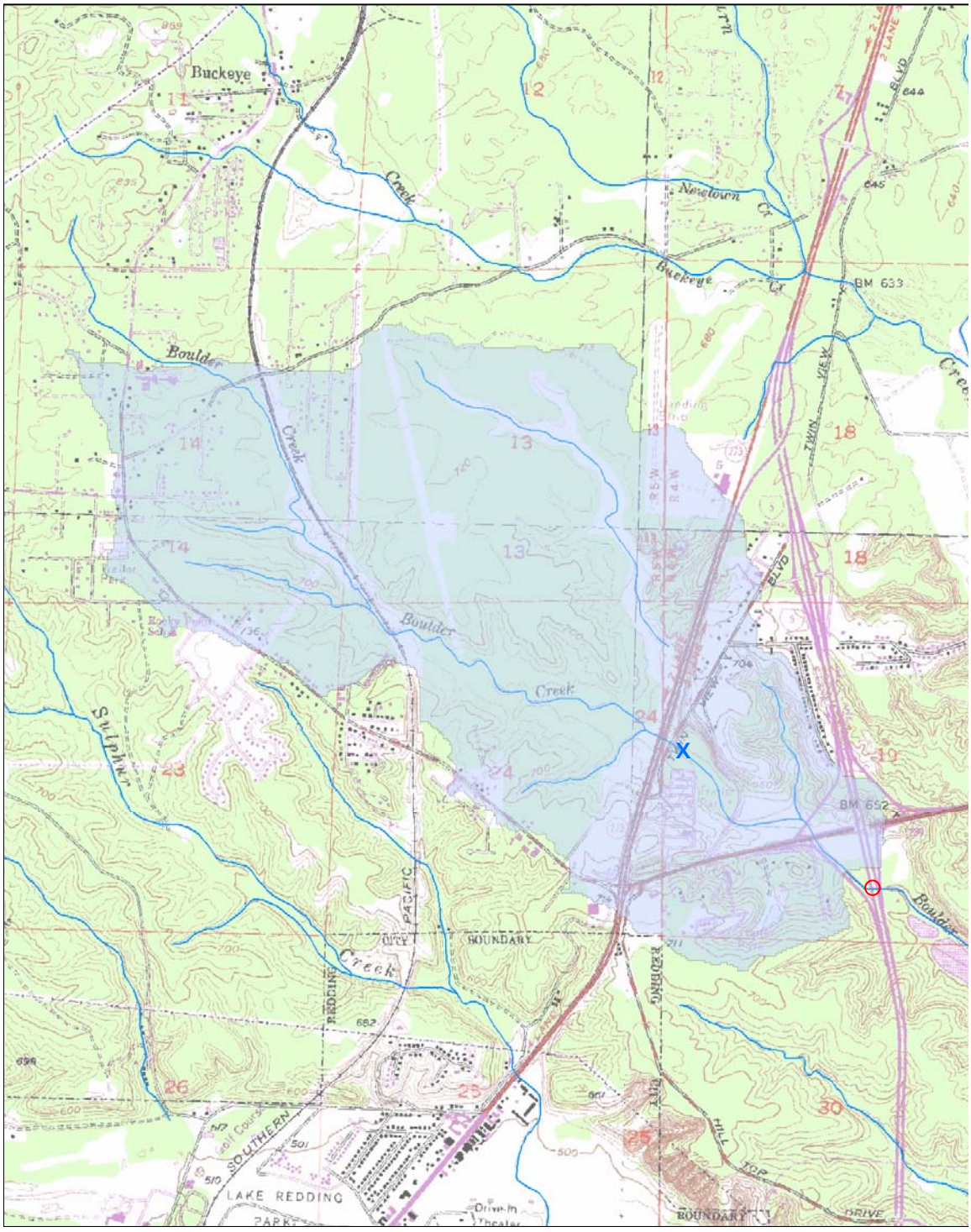
Culvert Information: Type: Concrete box (2-sides) **Dimensions:** 8'3" x 10' **Length:** 254' **Slope:** 0.27% **Overall conditions:** Good **Modifications:** None **Fill Estimate:** 4,022 cubic yards **Average Channel Width:** 19.8'

Hydrology: Drainage area upstream of crossing = **2.45 square miles**. Mean Annual Precipitation (MAP) = **43 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **202'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 723.2 cfs; Q_5 = 1204.2 cfs; Q_{10} = 1499.7 cfs; Q_{25} = 2062.4 cfs; Q_{50} = 2429.3 cfs; Q_{100} = 2886.6 cfs.

Barrier Status: **GREEN** as determined by the Green-Gray-Red first-phase filter. During FishXing Analyses, adult salmonid passage was assessed for flows between 3 cfs and 361 cfs (50% of Q_2 discharge). Only 52.1% (3 cfs to 189.8 cfs) of flows were passable to adult salmonids. Excessive velocity occurred above 189.8 cfs. Excessive velocities resulted in only 54.4% passage to resident and juvenile salmonids.

Habitat: Quality = rated as "poor" due to the series of culvert road crossings immediately upstream of the I-5 crossing. Stream channel has been straightened in the past. Quantity = 4,168' of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site #27: Boulder Creek/Interstate 5; Churn Creek; Sacramento River



Upstream drainage area = 2.45 square miles

X = Limit of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site #27: Boulder Creek/PM 17.14; Interstate-5

Site #28: Boulder Creek/Hwy. 273; Churn Creek; Sacramento River

Location: Post mile = 19.10 Shasta; USGS Quad: Redding. T32N, R5W, Section 24. Lat./Long. = N 40.61594 W -122.37462

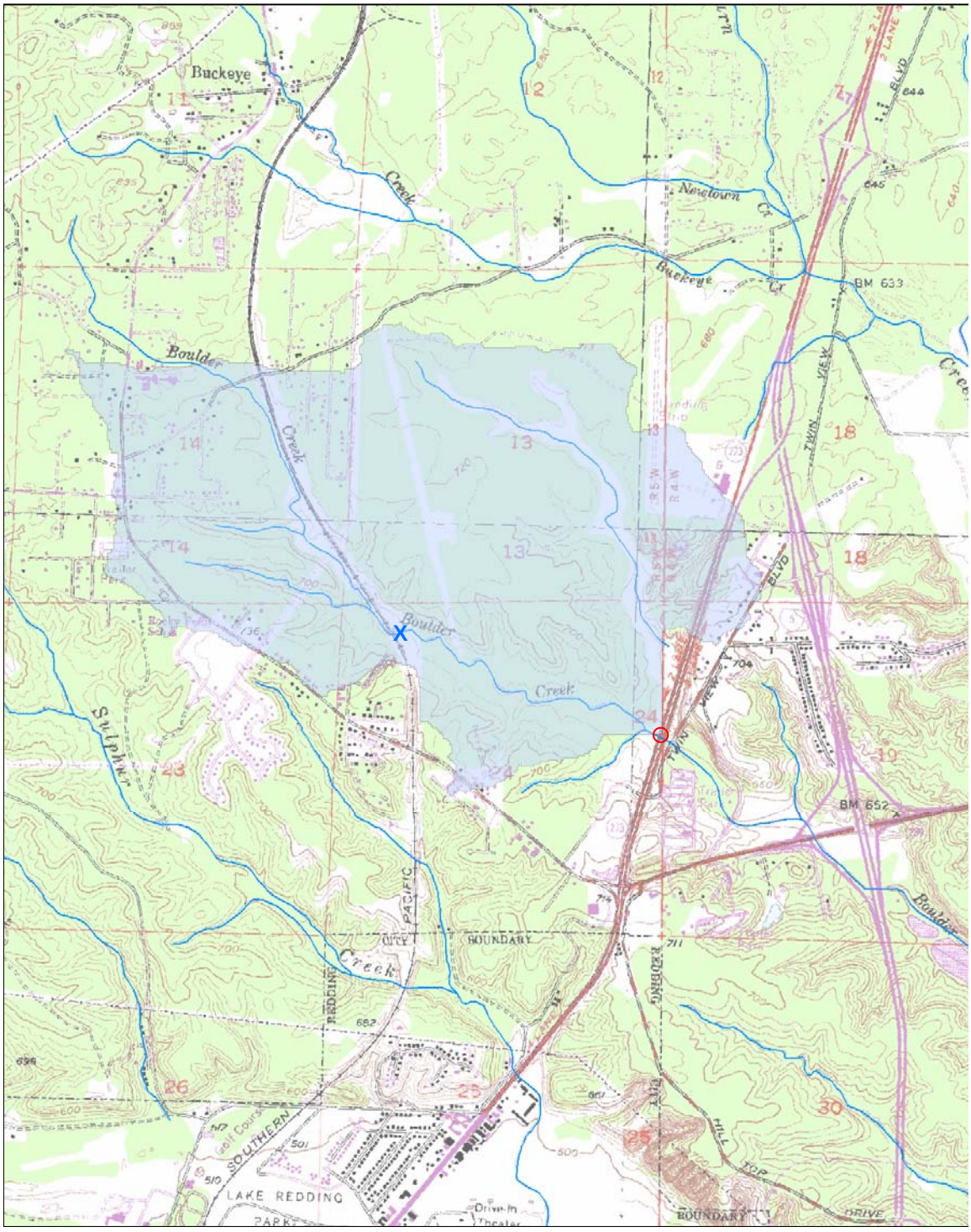
Culvert Information: Type: Concrete box (2 sided) **Dimensions:** 7' x 10'
Length: 120' **Slope:** 0.46% **Overall Conditions:** Good
Fill Estimate: 1,256 cubic yards. **Average Channel Width:** 11.7'

Hydrology: Drainage area upstream of crossing = **1.77 square miles**. Mean Annual Precipitation (MAP) = **44 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **206'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 565.6 cfs; Q_5 = 940.1 cfs; Q_{10} = 1176.5 cfs; Q_{25} = 1620.3 cfs; Q_{50} = 1913.6 cfs; Q_{100} = 2281.3 cfs.

Barrier Status: GRAY as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 277.3 cfs (50% of Q_2 discharge). There is a 0% passage for adult, resident, and juvenile salmonids due to excessive velocities and a lack of depth through culvert.

Habitat: Quality = rated as "fair" due to the good in-stream habitat and limited mature trees in riparian zone. Quantity = 5,016' of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%. Road crossing on Redwood Blvd. immediately upstream of Hwy. 273 crossing.

Site #28: Boulder Creek/Hwy. 273 Sha; Churn Creek; Sacramento River



Upstream drainage area = 1.77 square miles

X = Limit of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%.

Site #28: Boulder Creek/PM 19.1; Hwy. 273

Site #29: Boulder Creek/Twin View Blvd; Churn Creek; Sacramento River

Location: Post mile: N/A (City road) USGS Quad: Redding. T32N, R4W, Section 19. Lat./Long. = N 40.61569 W -122.37400

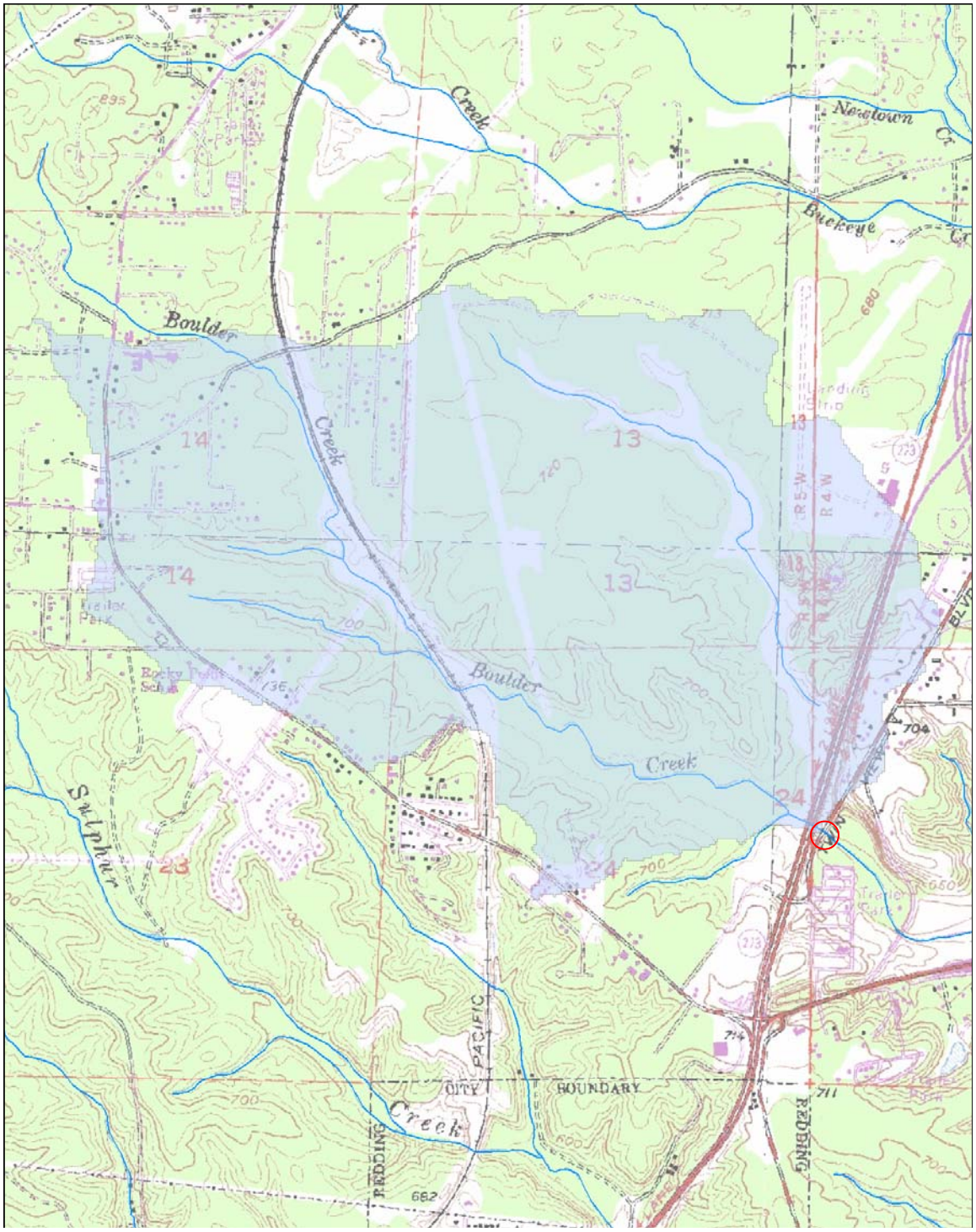
Culvert Information: Type: Concrete box (2-sided) **Dimensions:** 7' x 10'
Length: 86.2' **Slope:** 1.12% **Overall Conditions:** Good
Fill Estimate: 1,072 cubic yards. **Average Channel Width:** 21.2'

Hydrology: Drainage area upstream of crossing = **1.81 square feet**. Mean Annual Precipitation (MAP) = **44 inches**. Altitude Index (average of altitudes in thousands of feet at points along the main channel at 10% and 85% of distances from site to divide) = **206'**. Peak flows as estimated by the California Regional Regression Equations (Waananen and Crippen 1977): Q_2 = 565.6 cfs; Q_5 = 957.4 cfs; Q_{10} = 1197.7 cfs; Q_{25} = 1649.1 cfs; Q_{50} = 1947.2 cfs; Q_{100} = 2320.9 cfs.

Barrier Status: **RED** as determined by the Green-Gray-Red first-phase filter. During FishXing analyses, adult salmonid passage was assessed for flows between 3 cfs and 282.8 cfs (50% of Q_2 discharge). Due to excessive leap heights, outlet drop, and velocities, there is a 0% passage to adult, resident, and juvenile salmonids.

Habitat: Quality = rated as "poor" due to the lack of riparian vegetation and the immediate upstream road crossing. Quantity = 90' of potential anadromous habitat upstream of crossing based on channel slope sustaining <8%. Immediate upstream road crossing at State Route 273 was determined a barrier by FishXing.

Site #29: Boulder Creek/Twin View Blvd.; Churn Creek; Sacramento River



Upstream drainage area = 1.81 square miles.

Site #29: Boulder Creek; Twin View Blvd.

APPENDIX C:

SHASTA-TEHAMA BARRIER ASSESSMENT

PASSAGE EVALUATION RESULTS

Estimated peak flows and associated recurrence interval for all inventoried stream crossings, calculated using the California regional regression equations.

Site #	Road	Stream	Drainage Area (mi^2)	MAP (in.)	Altitude Index (thousands of ft.)	2-year Flow (cfs)	5-year Flow (cfs)	10-year Flow (cfs)	25-year Flow (cfs)	50-year Flow (cfs)	100-year Flow (cfs)	Region
1	Hwy 36 W	Sunday Gulch	3.13	37	3.452	136.56	241.1	348.59	497.57	670.7	826.95	North Coast
2	Hwy 36 W	Harrison Gulch	4.92	38	3.343	213.29	373.62	536.66	760.32	1022.47	1257.77	North Coast
3	Hwy 36 W	Trib. Dry Creek	1.75	31	1.622	98.59	159.35	217.37	288.87	362.51	420.01	North Coast
4	Hwy 36 W	Budden Canyon	0.99	32	1.548	60.73	98.59	135.62	181.31	227.67	263.87	North Coast
5	Hwy 36 W	Budden Canyon	3.28	33	1.417	195.5	309.33	415.34	541.446	672.13	770.85	North Coast
6	Hwy 36 W	Trib. Dry Creek	5.13	33	1.251	310.03	481.1	636.72	816.14	1001.78	1137.52	North Coast
7	Hwy 36 W	Little/Big Crane Cr.	5.95	30	0.778	406.89	594.41	754.78	920.34	1080.36	1179.88	North Coast
8	Hwy 299 E	Salmon Creek	2.39	43	0.68	196.82	423.95	581.44	880.36	1105.75	1423.65	Sierra
9	Hwy 299 W	Middle Creek	0.66	53	1.206	75.94	120.9	164.4	215.32	265.93	302.51	North Coast
10	Hwy 299 W	Salt Creek	2.95	46	0.862	301.68	453.16	589.26	734.16	877.26	970.11	North Coast
11	Hwy 299 E	McCandless Gulch	2.8	58	1.782	228.66	502.53	686.18	1032.91	1302.01	1702.22	Sierra
12	Hwy 36 W	Trib. Dry Creek	2.4	31	1.012	163.53	248.96	326.02	411.98	495.51	552.84	North Coast
13	Hwy 36 E	Sevenmile Creek	3.03	31	0.763	144.62	328.94	466.99	736.04	940.59	1224.05	Sierra
14	Hwy 44	Shingle Creek	4.12	36	2.801	105.3	268.68	396.1	649.33	854.32	1159.99	Sierra
15	Hwy 36 E	Trib. Dry Creek	1.05	33	1.132	77.94	121.42	161.96	208.82	254.02	286.15	North Coast
16	Hwy 299 E	Yank Creek	5.48	42	0.684	393.61	810.64	1096.58	1651.64	2060.28	2633.14	Sierra
17	Hwy 44	Ash Creek	1.59	44	3.596	51.22	138.08	205.59	336.5	446.05	614.17	Sierra
18	Hwy 299 W	Jenny Creek	0.9	45	0.803	105.07	158.29	207.03	259.12	307.52	338.07	North Coast
19	Hwy 273	Sulfur Creek	4.06	42	0.7	302.3	633.9	862.65	1303.21	1630.52	2090.15	Sierra
20	Hwy 273	China Gulch	3.11	37	0.646	298.48	430.99	544.98	657.9	762.67	822.35	North Coast
21	Hwy 36 W	Cold Spring Gulch	1.64	37	2.952	82.15	143.27	205.89	291.2	387.04	471.27	North Coast
22	Hwy 172	Trib. Mill Creek	1.47	57	5.272	52.98	144.49	213.75	346.39	459.43	638.67	Sierra
23	Hwy 36 E	Martin Creek	7.15	57	6.199	187.25	476.62	689.75	1111	1459.83	2013.76	Sierra
24	Hwy 44	Millseat Creek	3.37	47	3.807	105.18	269.79	393.95	636.67	836.23	1143.04	Sierra
25	Hwy 299 W	Middle Creek	1.84	53	0.34	346.48	469.02	570.43	651.55	718.05	738.14	North Coast
26	Hwy 299	Boulder Creek	2.31	43	0.203	684.02	1143.92	1426.70	1963.72	2314.88	2752.93	Sierra
27	I-5	Boulder Creek	2.45	43	0.202	723.23	1204.27	1499.75	2062.45	2429.35	2886.65	Sierra
28	Hwy 273	Boulder Creek	1.77	44	0.206	554.61	940.1	1176.54	1620.3	1913.62	2281.38	Sierra
29	Twin View	Boulder Creek	1.81	44	0.206	565.62	957.48	1197.76	1649.16	1947.27	2320.97	Sierra

FishXing Analysis: Adult salmon and steelhead flows and existing passage conditions.

ID	Stream Name	Road Name	Conclusion from Filter Output	Alternate Low Flow (cfs)	Upper Q1%	Percent Passable	Depth		Leap		Velocity		Pool	
							Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)
1	Sunday Gulch	Hwy 36 W Sha	RED	3	68.28	**11.5%**	3	18.77	None	None	26.28	68.28	None	None
2	Harrison Gulch (LB)	Hwy 36 W Sha	GRAY	3	106.64	**0%**	-	-	None	None	21.41	106.64	None	None
2	Harrison Gulch (RB)	Hwy 36 W Sha	GRAY	3	106.64	**0%**	-	-	None	None	35.16	106.64	None	None
3	Trib. to Dry Creek	Hwy 36 W T	GRAY	3	49.29	**0%**	-	-	-	-	-	-	None	None
4	Budden Canyon	Hwy 36 W T	GRAY	3	30.36	**9.4%**	3	11.32	None	None	13.89	30.36	None	None
5	Budden Canyon	Hwy 36 W T	RED	3	97.75	**8.7%**	3	13.78	29.49	97.75	22.02	97.75	29.49	97.75
6	Dry Creek (LB)	Hwy 36 W T	GRAY	3	155.01	**0%**	3	137.09	76.42	155.01	20.73	155.01	3	155.01
6	Dry Creek (RB)	Hwy 36 W T	GRAY	3	155.01	**0%**	3	139.55	77.19	155.01	21.47	155.01	3	155.01
7	Little/Big Crane Creek	Hwy 36 W T	GRAY	3	203.44	**32.2%**	3	51.26	127.39	203.44	115.9	203.44	127.39	203.44
8	Salmon Creek (1 of 3)	Hwy 299 E Sha	GRAY	3	98.41	**0%**	-	-	None	None	None	None	None	None
8	Salmon Creek (2 of 3)	Hwy 299 E Sha	GRAY	3	98.41	**0%**	-	-	None	None	None	None	None	None
8	Salmon Creek (3 of 3)	Hwy 299 E Sha	GRAY	3	98.41	**0%**	-	-	None	None	None	None	None	None
9	Middle Creek (LB)	Hwy 299 W Sha	GRAY	3	37.97	**44.6%**	3	22.39	None	None	None	None	None	None
9	Middle Creek (RB)	Hwy 299 W Sha	RED	3	37.97	**0%**	3	29.70	None	None	21.46	37.97	None	None
10	Salt Creek	Hwy 299 W Sha	GRAY	3	150.84	**0%**	3	35.96	136	150.84	25.41	150.84	None	None

Adult Salmon and Steelhead Barriers

Passage Flows (cfs)

ID	Stream Name	Road Name	Conclusion from Filter Output	Alternate Low Flow (cfs)	Upper Q1%	Percent Passable	*Depth* Lower Limit barrier<Q (cfs)	*Depth* Upper Limit barrier>Q (cfs)	*Leap* Lower Limit barrier<Q (cfs)	*Leap* Upper Limit barrier>Q (cfs)	*Velocity* Lower Limit barrier<Q (cfs)	*Velocity* Upper Limit barrier>Q (cfs)	*Pool* Lower Limit barrier<Q (cfs)	*Pool* Upper Limit barrier>Q (cfs)
11	McCandless Gulch (LB)	Hwy 299 W Sha	GRAY	3	114.43	**19.3%**	3	92.97	None	None	None	None	None	None
11	McCandless Gulch (RB)	Hwy 299 W Sha	GRAY	3	114.43	**0%**	3	65.31	None	None	45.56	114.43	None	None
12	Unnamed trib. To Dry Creek (LB)	Hwy 36W T	RED	3	81.76	**0%**	3	33.45	None	None	20.1	81.76	None	None
12	Unnamed trib. To Dry Creek (RB)	Hwy 36W T	RED	3	81.76	**0%**	3	20.07	None	None	16.88	81.76	None	None
13	Seven Mile Creek (LB)	Hwy 36 E. T	GRAY	3	72.31	**0%**	-	-	None	None	47.14	72.31	None	None
13	Seven Mile Creek (RB)	Hwy 36 E. T	GRAY	3	72.31	**0%**	-	-	None	None	50.32	72.31	None	None
14	Shingle Creek (1 of 5)	Hwy 44 Sha	GRAY	3	52.65	**0%**	-	-	None	None	None	None	None	None
14	Shingle Creek (2 of 5)	Hwy 44 Sha	GRAY	3	52.65	**2.3%**	3	51.51	None	None	None	None	None	None
14	Shingle Creek (3 of 5)	Hwy 44 Sha	GRAY	3	52.65	**0%**	-	-	None	None	None	None	None	None
14	Shingle Creek (4 of 5)	Hwy 44 Sha	GRAY	3	52.65	**0%**	-	-	None	None	None	None	None	None
14	Shingle Creek (5 of 5)	Hwy 44 Sha	GRAY	3	52.65	**0%**	-	-	None	None	None	None	None	None
15	Unnamed trib. To Dry Creek	Hwy 36 W T	RED	3	38.97	**28.1%**	3	11.01	32.92	38.97	21.11	38.97	32.92	38.97
16	Yank Creek (LB)	Hwy 299 E Sha	GRAY	3	196.8	**14.9%**	3	164.46	193.43	196.8	None	None	193.42	196.8
16	Yank Creek (Center)	Hwy 299 E Sha	GRAY	3	196.8	**17.5%**	3	162.04	195.98	196.8	None	None	195.97	196.8

Adult Salmon and Steelhead Barriers

Passage Flows (cfs)

ID	Stream Name	Road Name	Conclusion from Filter Output	Alternate Low Flow (cfs)	Upper Q1%	Percent Passable	*Depth* Lower Limit barrier<Q (cfs)	*Depth* Upper Limit barrier>Q (cfs)	*Leap* Lower Limit barrier<Q (cfs)	*Leap* Upper Limit barrier>Q (cfs)	*Velocity* Lower Limit barrier<Q (cfs)	*Velocity* Upper Limit barrier>Q (cfs)	*Pool* Lower Limit barrier<Q (cfs)	*Pool* Upper Limit barrier>Q (cfs)
16	Yank Creek (RB)	Hwy 299 E Sha	GRAY	3	196.8	17.5%	3	162.04	195.98	196.8	None	None	195.97	196.8
17	Ash Creek	Hwy 44 Sha	GRAY	3	25.61	44.4%	3	15.56	None	None	None	None	None	None
18	Jenny Creek (LB)	Hwy 299 Sha	GRAY	3	52.53	40.5%	3	32.48	None	None	None	None	None	None
18	Jenny Creek (RB)	Hwy 299 Sha	GRAY	3	52.53	12.5%	3	46.34	None	None	None	None	None	None
19	Sulfur Creek (LB)	Hwy 273 Sha	GRAY	3	151.15	0%	3	144.93	None	None	75.4	151.15	None	None
19	Sulfur Creek (RB)	Hwy 273 Sha	GRAY	3	151.15	0%	3	144.93	None	None	75.4	151.15	None	None
20	China Gulch (LB)	Hwy 273 Sha	GRAY	3	149.24	0%	-	-	None	None	66.21	149.24	None	None
20	China Gulch (RB)	Hwy 273 Sha	GRAY	3	149.24	0%	-	-	None	None	66.21	149.24	None	None
21	Cold Spring Gulch (LB)	Hwy 36 W Sha	GRAY	3	41.07	0%	3	38.93	None	None	38.82	41.07	None	None
21	Cold Spring Gulch (RB)	Hwy 36 W Sha	RED	3	41.07	0%	3	39.38	None	None	24.02	41.07	None	None
22	Tributary to Mill Creek (1 of 3)	Hwy 36 E. T	GRAY	3	26.49	0%	-	-	None	None	None	None	None	None
22	Tributary to Mill Creek (2 of 3)	Hwy 36 E. T	GRAY	3	26.49	9%	3	24.37	None	None	None	None	None	None
22	Tributary to Mill Creek (3 of 3)	Hwy 36 E. T	RED	3	26.49	0%	-	-	None	None	None	None	None	None
23	Martin Creek	Hwy 36 E. T	RED	3	93.62	0%	-	-	38.7	93.62	20.83	93.62	3	93.62
23	Martin Creek	Hwy 36 E. T	RED	3	93.62	0%	-	-	38.7	93.62	20.83	93.62	3	93.62
23	Martin Creek	Hwy 36 E. T	RED	3	93.62	0%	-	-	38.7	93.62	20.83	93.62	3	93.62
24	Millseat Creek	Hwy 44 Sha	GRAY	3	53.59	12.9%	3	11.68	47.21	53.59	18.21	53.59	47.21	53.59

Adult Salmon and Steelhead Barriers

Passage Flows (cfs)

ID	Stream Name	Road Name	Conclusion from Filter Output	Alternate Low Flow (cfs)	Upper Q1%	Percent Passable	*Depth*		*Leap*		*Velocity*		*Pool*	
							Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)
25	Middle Creek	Hwy 299 W Sha	RED	3	173.23	0	-	-	-	-	3	173.24	-	-
26	Boulder Creek	Hwy 299 Sha	GRAY	3	342	23.8	3	73.9	None	None	154.56	342.01	None	None
27	Boulder Creek	I-5	GREEN	3	361.61	52.1	None	None	None	None	189.86	361.61	None	None
28	Boulder Creek	Hwy 273 Sha	GRAY	3	277.3	0	3	97.09	None	None	91.81	277.3	None	None
29	Boulder Creek	Twin View Blvd.	RED	3	282.81	0	3	71.1	19.95	282.81	22.36	282.81	3	282.81

FishXing Analysis: Juvenile salmonid flows and existing passage conditions.

Juvenile Salmonid Barriers Passage Flows (cfs)					*Depth*		*Leap*		*Velocity*		*Pool*	
ID	Stream Name	Alternate Low Flow (cfs)	Upper Q10%	Percent Passable	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)
1	Sunday Gulch	1	13.65	**0%**	1	2.98	-	-	1.43	13.65	1	13.65
2	Harrison Gulch (LB)	1	21.32	**0%**	-	-	1	10.78	1	21.32	1	2.18
2	Harrison Gulch (RB)	1	21.32	**0%**	-	-	5.9	11.27	1	21.32	None	None
3	Trib. to Dry Creek	1	9.85	**0%**	1	2.32	-	-	1.33	9.85	1	9.85
4	Budden Canyon	1	6.07	**0%**	1	1.44	-	-	1	6.07	-	-
5	Budden Canyon	1	19.55	**0%**	1	1.71	-	-	1	19.55	-	-
6	Dry Creek (LB)	1	31	**0%**	-	-	-	-	1	31	-	-
6	Dry Creek (RB)	1	31	**0%**	-	-	-	-	1	31	-	-
7	Little/Big Crane Creek	1	40.68	**0%**	1	3.84	-	-	3.22	40.68	-	-
8	Salmon Creek (1 of 3)	1	19.68	**0%**	-	-	None	None	6	19.68	None	None
8	Salmon Creek (2 of 3)	1	19.68	**0%**	-	-	None	None	6	19.68	None	None
8	Salmon Creek (3 of 3)	1	19.68	**0%**	-	-	None	None	6	19.68	None	None
9	Middle Creek (LB)	1	7.59	**0%**	1	2.69	-	-	1.9	7.59	-	-
9	Middle Creek (RB)	1	7.59	**0%**	1	3.93	-	-	1	7.59	1	4.53
10	Salt Creek	1	30.16	**0%**	1	8.23	-	-	1.42	30.16	None	None
11	McCandless Gulch (LB)	1	22.86	**0%**	-	-	1	11.66	9.48	22.86	1	1.26
11	McCandless Gulch (RB)	1	22.86	**10.6%**	1	3.62	None	None	5.94	22.86	None	None

Juvenile Salmonid Barriers Passage Flows (cfs)					Depth		Leap		Velocity		Pool	
ID	Stream Name	Alternate Low Flow (cfs)	Upper Q10%	Percent Passable	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)
12	Unnamed trib. To Dry Creek (LB)	1	16.35	**0%**	1	2.92	-	-	1	16.35	None	None
12	Unnamed trib. To Dry Creek (RB)	1	16.35	**0%**	1	2.92	-	-	1	16.35	None	None
13	Seven Mile Creek (LB)	1	14.46	**0%**	-	-	-	-	None	None	None	None
13	Seven Mile Creek (RB)	1	14.46	**0%**	-	-	-	-	None	None	None	None
14	Shingle Creek (1 of 5)	1	10.53	**0%**	1	6.64	None	None	4.65	10.53	None	None
14	Shingle Creek (2 of 5)	1	10.53	**0%**	1	5.14	None	None	3.39	10.53	None	None
14	Shingle Creek (3 of 5)	1	10.53	**0%**	-	-	None	None	8.48	10.53	None	None
14	Shingle Creek (4 of 5)	1	10.53	**0%**	-	-	None	None	10.44	10.53	None	None
14	Shingle Creek (5 of 5)	1	10.53	**65.8%**	1	4.25	None	None	None	None	None	None
15	Unnamed trib. To Dry Creek	1	7.79	**0%**	1	1.39	-	-	1.07	7.79	-	-
16	Yank Creek (LB)	1	39.36	**0%**	1	38.64	-	-	7.12	39.36	None	None
16	Yank Creek (Center)	1	39.36	**0%**	1	36.79	-	-	5.66	39.36	None	None
16	Yank Creek (RB)	1	39.36	**0%**	1	36.79	-	-	5.66	39.36	None	None
17	Ash Creek	1	5.12	**0%**	1	2.09	-	-	1.69	5.12	1	5.12
18	Jenny Creek (LB)	1	10.5	**0%**	1	3.12	-	-	1.71	10.5	-	-

ID	Stream Name	Alternate Low Flow (cfs)	Upper Q10%	Percent Passable	Depth		Leap		Velocity		Pool	
	Juvenile Salmonid Barriers Passage Flows (cfs)				Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)
18	Jenny Creek (RB)	1	10.5	**0%**	1	6.86	-	-	3.69	10.50	1	10.50
19	Sulfur Creek (LB)	1	30.23	**4.9%**	1	14.31	None	None	15.76	30.23	None	None
19	Sulfur Creek (RB)	1	30.23	**4.9%**	1	14.31	None	None	15.76	30.23	None	None
20	China Gulch (LB)	1	29.84	**0%**	-	-	-	-	1.77	29.84	-	-
20	China Gulch (RB)	1	29.84	**0%**	-	-	-	-	1.77	29.84	-	-
21	Cold Spring Gulch (LB)	1	8.21	**0%**	1	5.44	-	-	3.14	8.21	-	-
21	Cold Spring Gulch (RB)	1	8.21	**0%**	1	3.95	-	-	1.07	8.21	1	8.21
22	Unnamed tributary to Mill Creek (1 of 3)	1	5.29	**0%**	1	3.66	-	-	2.86	5.29	1	1.33
22	Unnamed tributary to Mill Creek (2 of 3)	1	5.29	**0%**	-	-	-	-	None	None	1	1.09
22	Unnamed tributary to Mill Creek (3 of 3)	1	5.29	**0%**	-	-	None	None	None	None	None	None
23	Martin Creek (LB)	1	18.72	**0%**	-	-	-	-	2.09	18.72	-	-
23	Martin Creek (center)	1	18.72	**0%**	-	-	-	-	2.09	18.72	-	-
23	Martin Creek (RB)	1	18.72	**0%**	-	-	-	-	2.09	18.72	-	-
24	Millseat Creek	1	10.51	**0%**	1	1.47	-	-	1	10.51	-	-

	Juvenile Salmonid Barriers Passage Flows (cfs)				***Depth***		***Leap***		***Velocity***		***Pool***	
ID	**Stream Name**	**Alternate Low Flow (cfs)**	**Upper Q10%**	**Percent Passable**	**Lower Limit barrier<Q (cfs)**	**Upper Limit barrier>Q (cfs)**	**Lower Limit barrier<Q (cfs)**	**Upper Limit barrier>Q (cfs)**	**Lower Limit barrier<Q (cfs)**	**Upper Limit barrier>Q (cfs)**	**Lower Limit barrier<Q (cfs)**	**Upper Limit barrier>Q (cfs)**
25	Middle Creek	1	34.64	0	-	-	-	-	-	-	-	-
26	Boulder Creek	1	68.4	0	1	15.81	None	None	4.32	68.4	None	None
27	Boulder Creek	1	72.32	54.4	None	None	None	None	39.82	72.32	None	None
28	Boulder Creek	1	55.46	0	1	20.1	None	None	2.34	55.46	None	None
29	Boulder Creek	1	56.56	0	1	31.23	-	-	1.23	56.56	1	56.56

FishXing Analysis: Resident Trout flows and existing passage conditions.

ID	Stream Name	Alternate Low Flow (cfs)	Upper Q5%	Percent Passable	Depth		Leap		Velocity		Pool	
	Resident Trout Barriers Passage Flows (cfs)				Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)
1	Sunday Gulch	2	40.96	**0%**	2	6.73	-	-	17.27	40.96	-	-
2	Harrison Gulch (LB)	2	63.98	**0%**	-	-	None	None	5.01	63.98	None	None
2	Harrison Gulch (RB)	2	63.98	**0%**	-	-	None	None	15.89	63.98	None	None
3	Trib. To Dry Creek	2	29.57	**0%**	2	4.66	-	-	14.28	29.57	2	29.57
4	Budden Canyon	2	18.21	**0%**	2	4.26	-	-	10.35	18.21	-	-
5	Budden Canyon	2	58.65	**0%**	2	5.09	-	-	11.58	58.65	-	-
6	Dry Creek (LB)	2	93	**0%**	2	71.62	-	-	21.93	93	-	-
6	Dry Creek (RB)	2	93	**0%**	2	73.45	-	-	22.66	93	-	-
7	Little/Big Crane Creek	2	122.06	**0%**	2	23.78	-	-	26.83	122.06	-	-
8	Salmon Creek (1 of 3)	2	59.04	**0%**	-	-	None	None	57.55	59.04	None	None
8	Salmon Creek (2 of 3)	2	59.04	**0%**	-	-	None	None	57.55	59.04	None	None
8	Salmon Creek (3 of 3)	2	59.04	**0%**	-	-	None	None	57.55	59.04	None	None
9	Trib. to Middle Creek (LB)	2	36.27	**0%**	2	8.45	-	-	26.21	36.27	-	-
9	Trib. to Middle Creek (RB)	2	36.27	**0%**	2	8.45	-	-	26.21	36.27	-	-
10	Salt Creek	2	90.5	**0%**	2	7.65	-	-	15.53	90.5	None	None
11	McCandless Gulch (LB)	2	68.59	**0%**	2	42.94	None	None	22.23	68.59	None	None

	Resident Trout Barriers Passage Flows (cfs)				***Depth***		***Leap***		***Velocity***		***Pool***	
ID	**Stream Name**	**Alternate Low Flow (cfs)**	**Upper Q5%**	**Percent Passable**	**Lower Limit barrier<Q (cfs)**	**Upper Limit barrier>Q (cfs)**	**Lower Limit barrier<Q (cfs)**	**Upper Limit barrier>Q (cfs)**	**Lower Limit barrier<Q (cfs)**	**Upper Limit barrier>Q (cfs)**	**Lower Limit barrier<Q (cfs)**	**Upper Limit barrier>Q (cfs)**
11	McCandless Gulch (RB)	2	68.59	**0%**	2	42.94	None	None	22.23	68.59	None	None
12	Unnamed trib. To Dry Creek (LB)	2	49.05	**0%**	2	14.16	2.04	49.05	11.95	49.05	None	None
12	Unnamed trib. To Dry Creek (RB)	2	49.05	**0%**	2	6.28	-	-	7.52	49.05	None	None
13	Seven Mile Creek (LB)	2	43.38	**0%**	-	-	3.15	43.38	15.87	43.38	None	None
13	Seven Mile Creek (RB)	2	43.38	**0%**	-	-	-	-	17.81	43.38	None	None
14	Shingle Creek (1 of 5)	2	31.59	**37.2%**	2	20.58	None	None	None	None	None	None
14	Shingle Creek (2 of 5)	2	31.59	**46.2%**	2	17.93	None	None	None	None	None	None
14	Shingle Creek (3 of 5)	2	31.59	**13.3%**	2	27.67	None	None	None	None	None	None
14	Shingle Creek (4 of 5)	2	31.59	**3.4%**	2	30.58	None	None	None	None	None	None
14	Shingle Creek (5 of 5)	2	31.59	**22.3%**	2	25	None	None	None	None	None	None
15	Unnamed trib. To Dry Creek	2	23.38	**0%**	2	4.11	-	-	13.55	23.38	-	-
16	Yank Creek (LB)	2	118.08	**0%**	2	81.95	-	-	34.58	118.08	None	None
16	Yank Creek (Center)	2	118.08	**0%**	2	79.75	-	-	32.76	118.08	None	None
16	Yank Creek (RB)	2	118.08	**0%**	2	79.75	-	-	32.76	118.08	None	None
17	Ash Creek	2	15.36	**0%**	2	6.02	-	-	11.34	15.36	-	-

Resident Trout Barriers

Passage Flows (cfs)

ID	Stream Name	Alternate Low Flow (cfs)	Upper Q5%	Percent Passable	*Depth* Lower Limit barrier<Q (cfs)	*Depth* Upper Limit barrier>Q (cfs)	*Leap* Lower Limit barrier<Q (cfs)	*Leap* Upper Limit barrier>Q (cfs)	*Velocity* Lower Limit barrier<Q (cfs)	*Velocity* Upper Limit barrier>Q (cfs)	*Pool* Lower Limit barrier<Q (cfs)	*Pool* Upper Limit barrier>Q (cfs)
18	Jenny Creek (LB)	2	31.52	**0%**	2	14.26	-	-	9.7	31.52	-	-
18	Jenny Creek (RB)	2	31.52	**0%**	2	24.24	-	-	15.24	31.52	2	31.52
19	Sulfur Creek (LB)	2	90.69	**0%**	2	68.23	None	None	25.53	90.69	None	None
19	Sulfur Creek (RB)	2	90.69	**0%**	2	68.23	None	None	25.53	90.69	None	None
20	China Gulch (LB)	2	89.54	**0%**	2	59.54	-	-	18.09	89.54	-	-
20	China Gulch (RB)	2	89.54	**0%**	-	-	-	-	40.76	89.54	-	-
21	Cold Spring Gulch (LB)	2	24.64	**0%**	2	15.13	-	-	24.62	24.64	-	-
21	Cold Spring Gulch (RB)	2	24.64	**0%**	2	13.66	-	-	16.1	24.64	2	24.64
22	Unnamed tributary to Mill Creek (1 of 3)	2	15.89	**27.9%**	2	12.01	None	None	None	None	None	None
22	Unnamed tributary to Mill Creek (2 of 3)	2	15.89	**0%**	-	-	None	None	None	None	None	None
22	Unnamed tributary to Mill Creek (3 of 3)	2	15.89	**0%**	-	-	None	None	None	None	None	None
23	Martin Creek (LB)	2	56.17	**0%**	-	-	-	-	7.19	56.17	-	-
23	Martin Creek (center)	2	56.17	**0%**	-	-	-	-	7.19	56.17	-	-
23	Martin Creek (RB)	2	56.17	**0%**	-	-	-	-	7.19	56.17	-	-
24	Millseat Creek	2	31.55	**0%**	2	4.36	-	-	8.04	31.55	-	-

ID	Stream Name	Alternate Low Flow (cfs)	Upper Q5%	Percent Passable	Depth		Leap		Velocity		Pool	
	Resident Trout Barriers Passage Flows (cfs)				Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)
25	Middle Creek	2	103.94	0	-	-	-	-	2	103.94	-	-
26	Boulder Creek	2	205.2	2.6	2	35.85	None	None	41.14	205.2	None	None
27	Boulder Creek	2	216.96	54.4	None	None	None	None	118.85	216.96	None	None
28	Boulder Creek	2	166.38	0	2	45.95	None	None	30.57	166.38	None	None
29	Boulder Creek	2	169.68	0	2	71.39	-	-	15.45	169.68	2	169.68