Shasta-Trinity National Forest

Sediment Source Inventory and Aquatic and Riparian Resources Road Risk Analysis Process Report

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Acronyms & Abbreviations

ARD	Acid Rock Drainage
ATV	All Terrain Vehicle
BLM	Bureau of Land Management
CMP	Corrugated Metal Pipe
CWA	Clean Water Act
DMI	Distance Measuring Instrument
EHR	Erosion Hazard Rating
EPA	Environmental Protection Agency
GIS	Geographic Information System
GPS	Global Positioning System
NSR	North State Resources, Inc.
OHV	Off-Highway Vehicle
RAP	Roads Analysis Process
SSI	Sediment Source Inventory
STNF	Shasta-Trinity National Forest
TMDL	Total Maximum Daily Load
USBR	United States Bureau of Reclamation

Section 1 Introduction

This report documents the efforts by North State Resources, Inc. (NSR) for the Shasta-Trinity National Forest (STNF) under Task Order AG-9A28-D-11-0024. Under this task order, NSR conducted a Sediment Source Inventory (SSI) and utilized the STNF Road Analysis Process (RAP) focused on aquatic and riparian resources in portions of seven watersheds: Clear Creek, Grass Valley-Weaver Creek, Browns Creek, Canyon Creek, Upper Hayfork Creek, Lower Hayfork Creek, and Lower South Fork Trinity River watersheds. The SSI effort focused on the road inventory conducted during the 2011 and 2012 field seasons (2012 SSI), as well as data sets provided by the STNF. The RAP component of this report included an analysis of the 2012 SSI data set.

To identify past, present, and future sediment production sites, NSR has conducted a field-based, route-focused SSI based primarily on the STNF 2009 SSI Protocol. Information obtained by the 2012 SSI was used to quantify, categorize, and prioritize sediment producing features. These routes are located on public lands managed by the STNF and the Bureau of Land Management (BLM) and on private lands owned by a diverse group of corporation and individuals. Managed Ownership of the routes varied greatly and included BLM, STNF, and various private land owners.

In addition to the 862 miles of road inventoried by NSR in the 2012 SSI, approximately 309 miles of additional SSI data was provided by the STNF. In an effort to evaluate the SSI at multiple scales, a comparative analysis was conducted at the subwatershed level (Sixth Field Hydrologic Unit Code (HUC 6)) using data collected from past SSI efforts and the 2012 SSI effort. The purpose of the analysis was to characterize the existing condition of the subwatershed and to identify the subwatersheds that contained roads which were hydrologically sensitive (high hydrologic connectivity) and had the greatest potential for increased erosion and sedimentation.

To augment the SSI, NSR performed a desktop-based RAP that focused on aquatic and riparian resources in order to specifically identify road segments (routes) that pose the greatest risk to: water quality, hydrologic processes, and aquatic and riparian habitat as outlined in the *Shasta-Trinity National Forest Roads Analysis Process - Criteria for Watershed/Project Level Analysis* (STNF 2006) and the *Shasta-Trinity National Forest Travel Analysis Process Resource Evaluation Criteria* (STNF 2011). This RAP utilizes a variety of information sources to assign risk ratings to routes based mainly on characteristics of the watershed in which they lay. These risk ratings were developed for routes included in the 2012 SSI at the Seventh Field Hydrologic Unit Code (HUC 7), also referred to as the drainage level.

The overall objective is two-fold: first, to identify current or potential sediment producing sites on the route scale; enabling road managers to initiate immediate restoration programs to mitigate adverse changes to water quality and riparian habitats. Second, to analyze routes at a watershed scale; allowing road managers to develop comprehensive, long-term solutions to maintain the investment while improving water quality and providing benefits to the aquatic and riparian environment.

This report offers a series of general treatment recommendations to maintain or improve the integrity of the route in a manner that reduces impacts to water quality and the associated beneficial uses. These general recommendations are intended to be applicable to those routes with moderate to high RAP risk ratings to aquatic and riparian resource. This report also includes specific treatment recommendations that target the most significant road segments and features within the moderate to high risk routes. Features were identified by first locating high risk route segments in the RAP and cross referencing them with the treatment prioritizations obtained from the SSI. This methodology results in a management program that can be prioritized and implemented at the appropriate scale as resources are available.

This report is organized to provide an introduction to the overall SSI/RAP effort and describe the methodology used to perform the inventory and conduct the analysis for each of the seven watersheds. To facilitate utility by road managers and decision makers, it includes a separate section for each of the seven watersheds. Each watershed section includes narrative text, figures, extensive electronic data sets, and a comprehensive GIS project. Each of the watershed sub-reports include:

- Watershed Description
- 2012 SSI Results and Ranking Matrix Results
- Cumulative SSI Results
- RAP Ranking Results;
- Recommendations

1.1 Location

The analysis area encompasses seven watersheds within the boundary established for the STNF in Northern California, totaling 1,257.2 square miles (Figure 1-1). Six of the watersheds are located in Trinity County and drain into the Trinity River. The Clear Creek watershed is located in Shasta County and drains into the Sacramento River.

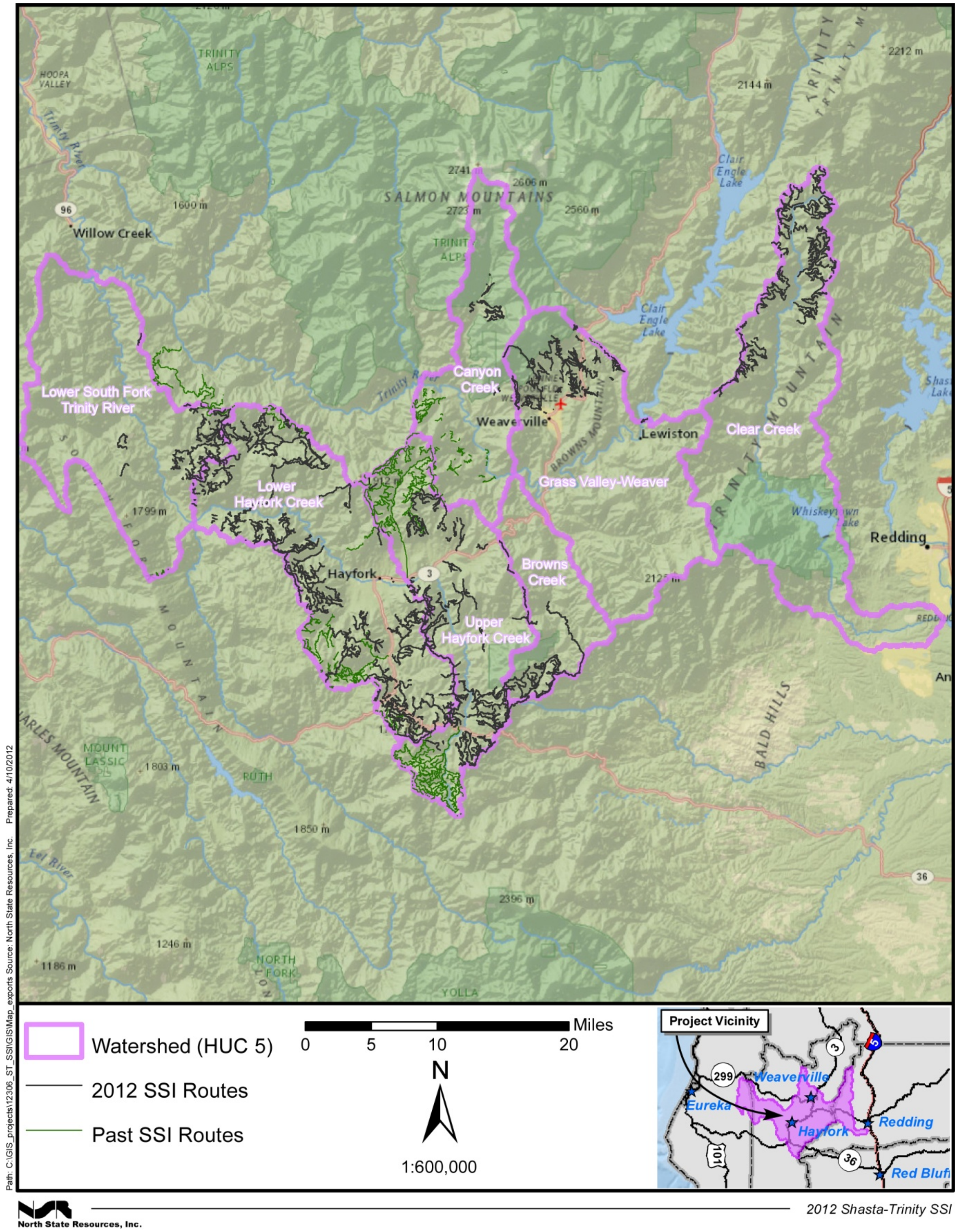


Figure 1-1. Analysis Area Watersheds and Road Map

1.2 Overview

Table 1-1 characterizes the seven watersheds included in the SSI and RAP risk analysis with respect to streams and roads. A more specific discussion of these characteristics is provided in the subsequent watershed sections.

Table 1-1. Analysis Area Watersheds and Drainage Areas

Watershed (HUC 5)	Drainage Area (mi^2)	Stream Length (mi)	Stream Density (mi/ mi^2)	Total Road Length (mi)	Road Density (mi/mi^2)	2012 SSI Road Miles	Past SSI Road Miles
Clear Creek	248.7	737.6	3.5	483.1	1.9	148.3	0.0
Grass Valley-Weaver	221.7	932.7	4.3	632.9	2.9	96.1	2.9
Browns Creek	73.6	290.2	3.9	335.9	4.6	48.3	0.0
Canyon Creek	124.1	533.5	4.3	288.1	2.3	17.7	38.3
Upper Hayfork Creek	165.3	853.3	5.2	683.9	4.1	176.4	175.5
Lower Hayfork Creek	221.9	1129.3	5.1	790.6	3.6	354.7	84.0
Lower S. Fork Trinity River	201.8	199.1	4.0	426.4	2.1	55.4	4.9
Watershed Area Totals	**1257.2**	**4675.7**	**3.7**	**3640.9**	**2.9**	**896.9**	**305.7**

Six of the watersheds are tributary to the Trinity River and are subject to the Water Quality Control Plan (Basin Plan) for the North Coast Region (California Regional Water Quality Control Board, North Coast Region 2011). The Clear Creek watershed is tributary to the Sacramento River and subject to the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins (California Regional Water Quality Control Board, Central Valley Region 2011). Figure 1-1 illustrates the location of these watersheds and the respective road segments. The Clear Creek watershed drains into Whiskeytown Lake, before flowing east into the Sacramento River south of Redding, California. The Grass Valley-Weaver Creek, Browns Creek, and Canyon Creek watersheds drain into the Trinity River sub-basin downstream of Lewiston Dam. The Upper Hayfork Creek, Lower Hayfork Creek, and Lower South Fork Trinity River watersheds flow into the South Fork Trinity River sub-basin. Both the Trinity River and South Fork Trinity River sub-basins drain into the Trinity River, which flows into the Klamath River and eventually to the Pacific Ocean.

Geology and Soils

The watersheds discussed in this report are associated with a wide array of geologic units and rock types generally associated with the Klamath Mountains Province. Table 1-2 provides an overview of the geologic units and related rock types found in this province. Metamorphic lithology dominates the Klamath Mountains Province. The rock types that occur are representative of the diverse depositional environments of the geologic units and the complex tectonic activity that formed the resultant landscape. Rocks of the Klamath Mountain Province can be broadly characterized as series of metavolcanic and metasedimentary rock belts that are highly fractured due to faulting with widespread serpentinization throughout the province.

Table 1-2. Analysis Area Major Geologic Units and Rock Types

	Major Geologic Units	Percent of All Watershed Areas	Specific Units	Rock Types (by abundance)
	Quaternary deposits	0.7%	Modern surface deposits	alluvium, landslide , and surface deposits
	Miocene sedimentary rocks	5.1%		Non-marine sandstone, conglomerate
	Weaverville Formation	0.2%	Weaverville Formation	conglomerate, sandstone, mudstone
	Great Valley Province	0.4%	Great Valley Sequence	mudstone, sandstone, greywacke
	Stuart Fork Terrane	0.1%	Stuart Fork Terrane	metavolcanics, basaltic, metasediments (argillite)
	Plutonic Rocks	17.1%	Plutons: Shasta Bally, Canyon Creek, Wildwood	diorite, quartz diorite, gabbro
	Franciscan Complex	4.1%	Pickett Peak Terrane	schist quartz mica, metavolcanics
			Undifferentiated	metavolcanics, greywacke, metasediments
Klamath Mountains Province	Western Jurassic Belt	4.0%	Galice Formation	slate, serpentine, hornfels
			Josephine Ophiolite	gneiss amphibolite
	Western Paleozoic and Triassic Belt	36.4%	Rattlesnake Creek Terrane	diamictite, metavolcanics, serpentine
			Eastern Hayfork Terrane	argillite, greenschist, limestone
			Western Hayfork Terrane	metavolcanics, argillite, serpentine
			Sawyers Bar Terrane(undiff)	metavolcanics and metasediments
			Salmon River Unit	gabbro, serpentine, diabase
	Central Metamorphic Belt	8.5%	Abrams Schist	metavolcanics & metasediments, serpentine
	Eastern Klamath Belt	15.0%	Bragdon Formation	metasediments, conglomerate, shale
			Copley Greenstone	greenstone, metavolcanics
			Moffett Creek Formation	Metasediments, mudstone, sandstone
			Balaklala Rhyolite	metavolcanic rhyolite, tuff
	Late Paleozoic Limestone	8.4%	Limestone (undifferentiated)	Limestone

Other igneous and sedimentary rock types also underlie the area encompassed by the watersheds included in the SSI. There are a number of younger dioritic (granitic in nature) intrusive rocks throughout the seven watersheds. In some watersheds (e.g., Grass Valley Creek-Weaver Creek), these tock types are widespread and known for their erosional characteristics. Limestone of several different ages also occupies a notable portion of the area. Sandstones, mudstones, and conglomerates that formed more-recently in shallow water or terrestrial environments also are present but not as wide spread as the other geologic units.

Due in part to the varied geology, topography, and microclimates in the seven watersheds, the erosional characteristics of the soils and geomorphic features vary throughout the watershed. Two factors, soil erosion and sensitive geomorphic features (e.g., landslides, inner gorge, and dissected granitic terrain), are of particular concern when designing and maintaining roads, and identifying areas of potential environmental impacts due to excessive sediment delivery to the stream network. These two factors are used to identify and characterize both features and routes throughout the report consistent with established protocols for SSI and RAP analysis. The Erosion Hazard Rating system (EHR) measures the relative vulnerability of forested terrain to soil erosion. The EHR rates terrain based on topographic slope, soil type, and annual precipitation to rate areas as having very high, high, moderate, or low potential for soil erosion. The amount of an area that is covered by sensitive geomorphic terrain is used to characterize the stability of the landforms in a given area.

Section 2 Methods and Materials

This section describes the analytical approach used to:

- conduct a comprehensive SSI of the roads specified by the STNF, with an emphasis on crossings, drainage features, and erosion features in seven watersheds;
- perform an analysis/risk assessment of the 2012 SSI data in order to identify and prioritize problematic features for treatment;
- conduct a comparative analysis of specific features at the subwatershed level utilizing data from previous SSI efforts and 2012 SSI efforts; and
- perform a RAP risk analysis of each 2012 SSI route as they are related to water quality, hydrologic processes, and aquatic and riparian resources.

By analyzing data at a watershed scale followed by road and site scale, a more economically efficient and environmentally effective restoration program can be developed.

2.1 Year 2012 Sediment Source Field Inventory

As described previously, the SSI was conducted within seven watersheds within the administrative boundary of the STNF where right-of-entry was available. The 2012 SSI was focused on routes that occupy, or provide administrative access to lands managed by the STNF. In some instances, access to private lands was restricted and certain roads/trails were excluded from the SSI effort by staff in the field.

Road Selection and Location

NSR used existing GIS data provided by the STNF to preliminarily identify and map roads and trails located within the analysis area. These routes were located on lands managed or owned by various entities, including the STNF, BLM and numerous private landowners. NSR contacted the majority of these stake holders to seek permission to access their lands; subsequently, some routes were removed from the preliminary list due to lack of consent. After the task order was issued, NSR worked closely with the STNF project manager to refine the route list that ultimately was used to conduct the 2012 SSI in the field.

After the preliminary list of routes was finalized, the information was transformed into a geo-referenced digital map. The digital map was uploaded to a hand-held Archer Field PC GPS unit allowing field staff to accurately and efficiently locate routes in the field. Some routes were not located or inaccessible during field efforts and were therefore omitted from the analysis and report. Routes that were not identified in the preliminary list but were located by field staff (commonly referred to as ghost roads) were included in the SSI when field observations (e.g., stream crossing) suggested that the route may contain definitive features and where right-of-entry was authorized.

Data Dictionary

This SSI was based on the STNF's *Route Focused Sediment Source Inventory Protocol* (USDA Forest Service 2009). This protocol was used to create a general road log that catalogs key infrastructure characteristics along each route as well as identify general types of features associated with sediment production and delivery potential. This SSI effort was tailored to augment this protocol based on knowledge of the roads and resource conditions in the analysis area.

NSR developed an electronic data dictionary based on the protocol to expedite the data collection process in the field. The data dictionary provided field staff with a list of typical sediment source vectors and other road features in an easy to use, text-based user interface. The electronic data dictionary was uploaded to the hand-held Archer Field PC GPS unit allowing the field staff to catalog and edit various attributes associated with each feature while simultaneously recording GPS positions.

The data dictionary has three tiers: *Feature, Attribute*, and *Input Option*. The *Feature* category was used to identify the type of feature observed; namely stream crossings, ditches, CMP cross drains, erosion sites. *Attributes* provide the basis for characterizing various aspects of the *Feature* and act as hub for the *Input Options*. *Input Options* implicitly describe the traits associated with each *Attribute* and typically consist of a drop down list or text box. Appendix A provides a comprehensive description of the data dictionary and its components.

An important aspect of the protocol and data dictionary is the distinction between hydrologically connected and non-hydrologically connected features. For a feature to be considered hydrologically connected, it must show field evidence of increased sediment deposition potential into an aquatic or riparian habitat. Although sediments can be transported by wind, water, gravity or ice, the 2012 SSI gives emphasis to the vector mechanisms of water and gravity. Connected features contain more specific attributes and undergo a more robust analysis process due to the increased potential for sediment production and delivery recurrence intervals.

The data dictionary includes an option to rate the condition of the road. The condition rating is a universal rating that describes the general condition of the road. This rating helps to identify problem roads without the need to inspect all the data collected by the SSI. This rating is based on a visual inspection and takes road and soil type into consideration. A road with a poor condition rating does not necessarily suggest the entire length is in poor condition, but the road has enough problem features to make a significantly represent of the road.

In anticipation of the need to develop management recommendations, the data dictionary was programmed with *improvement options* to address common structural failures for many of the road features defined by the data dictionary (see Appendix A). The improvement options were designed to be generic enough to cover a wide spectrum of scenarios yet be specific enough to give insight into the measures needed to correct the problem at hand. With respect to project scoping, the improvement options are intended to provide a filter for managers to get a glimpse of what kind of efforts are needed to improve road conditions throughout a watershed without relying on a detailed analysis of the SSI data.

Field Inventory

The field inventory began in August of 2011 and lasted through October 2012. A total of 862 miles were included in the 2012 SSI effort. Features located on drivable routes were inventoried to the nearest 100th mile with use of a four-wheel drive vehicle equipped with a Nu-Metrics Distance Measuring Instrument (DMI). A loss in DMI precision was expected due to slight meandering of the vehicle over long sections of road. However, because each feature had GPS coordinates associated with it, field staff were able to adjust mileage measurements in the GIS project to account for this discrepancy. All routes and features that were that were included in the 2012 SSI are shown on the Basemap (Appendix E) and included in a GIS based digital dataset (Appendix F).

Routes that were overgrown/abandoned, decommissioned, or unsafe to drive were either walked or inventoried with use of an all-terrain vehicle (ATV). In these instances, mileage was recorded with use of a measuring wheel, or in some cases paced by field staff. For routes that could not be readily measured in the field, mileage was determined electronically in GIS based on GPS coordinates collected for each feature.

Digital photographs were taken for selected features in order to document the existing conditions and provide visual reference for analysis and monitoring purposes. These features include begin/end points, stream crossings, hydrologically connected corrugated metal pipe (CMP) cross drains, and erosion features. Each photograph was assigned a unique identifier based on the digital file name generated by the camera and recorded along with the attributes for each feature. Photographs were filed digitally based on the route ID that their associated feature was cataloged on. All photos can be found on a DVD accompanied with this report (Appendix G).

2.2 Feature Analysis/Risk Assessment

A detailed analysis of the attributes associated with each feature was conducted to corroborate results obtained from the RAP analysis. To do this, risk ranking matrices were created to identify and prioritize features (e.g., stream crossing, cross-drains and active erosion features) that actively deliver or have an increase potential to deliver sediment into the existing stream network. By developing these matrices, this approach offers reliability, is repeatable, and can be easily adjusted as necessary.

Based on similar efforts performed by NSR for the STNF, the matrices were developed by identifying and ranking key attributes of each feature (e.g. diversion potential, fill volume, culvert condition, red flag, etc.). The various input options for each attribute were rank ordered on a scale and assigned a numerical value (rank) between 0 and 5 depending on the potential for contribution to sediment production and delivery. A value of 0 indicates the feature attribute would contribute no increased potential for sediment production and delivery (e.g., a non-connected cross drain with no evidence of scour). A value of 5 indicates the feature attribute has a high potential for contribution to sediment production and delivery (e.g., a CMP Crossing with an inlet or outlet being over 30% plugged with debris).

The various attribute ranks for each feature were summed and compared against each other to prioritize the overall risk of the feature and assign a treatment immediacy rating. Treatment immediacy ratings were categorized as High, Moderate-High, Moderate, Moderate-Low and Low to correspond to total risk scores falling within the 80th, 60th, 40th and 20th percentiles. Using this standardized approach, features with High (80th percentile) or Medium-High (60th percentile) risk ratings are considered "high risk features" for purposes of this assessment. All risk ranking matrices are represented in Appendix B. The results from the risk ranking matrices are included in a GIS based digital dataset (Appendix F).

Although emphasis was given to hydrologically connected features during the RAP, this feature analysis was performed for all relevant feature categories. Because the feature analysis only compares individual features within their respective categories, a more complete representation of total structural integrity of a route system can be made by integrating the results from the RAP analysis. This information will be pertinent in developing more economically efficient and structurally functional treatment opportunities.

2.3 Cumulative SSI Desk-top Analysis

NSR completed a cumulative analysis at the subwatershed level (HUC 6) using 2012 SSI data aggregated with other SSI datasets provided by the STNF for five of the watersheds. Collectively, 1,171 miles of SSI data was used to perform this desk-top analysis for the seven watersheds. The data utilized in the analysis was selected based on the compatibility between the 2012 SSI and previous efforts. SSI protocols and data collected varied with progressive SSI efforts, however most datasets included inventory information on the location and condition of stream crossings, hydrologically-connected cross-drains (with and without culverts), and erosion features. A subset of data was also available for stream crossing condition (e.g., undersized pipe, diversion potential, high-risk crossings).

The density of three key features: hydrologically connected cross-drains, erosion features, and the stream crossing condition per mile of inventoried road was calculated for each subwatershed. The density of the total number of connected features, stream crossings and hydrologically connected cross-drains, were used as a measure of hydrologic connectivity (sensitivity) of the inventoried road network. The density of erosion features was used as an estimate of potential sediment sources within the subwatershed. The density of the aforementioned stream crossing condition (e.g. stream crossing with diversion potential) categories was used to represent the potential for increased erosion due to a potential failure of the crossing.

The analysis was intended to identify the subwatersheds within each watershed that contained above average densities of hydrologically connected features, sediment sources, or impaired features that are or could be potential sediment sources. This analysis allows for a broad characterization of the sensitivity and condition of the inventoried road network as a whole at the subwatershed scale. This characterization is intended to help support road recommendations made using the RAP at drainage (HUC 7) scale.

2.4 Aquatic and Riparian Resources RAP Risk Analysis

The RAP is a standardized narrative developed by the Forest Service to balance the benefits of access to national forests versus the cost of road-associated effects to the ecosystem. The analysis is designed to be scalable, flexible and driven by road-related issues important to the public and to managers (USDA 1999). The process provides a set of road-related issues and analysis questions whose answers are designed to inform the choices made for future road activities.

The Aquatic and Riparian Resources component of the RAP is documented in this report. It was specifically implemented for this SSI to address road-related problems with respect to three resource themes: *Hydrologic Processes, Water Quality, and Aquatic and Riparian Resources.* A risk analysis was conducted at the drainage scale (HUC 7) for all roads included in the 2012 SSI analysis. This risk analysis was performed following the procedures outlined in the *STNF Roads Analysis Process - Criteria for Watershed/Project Level Analysis 2006* and the *STNF Travel Analysis Process Resource Evaluation Criteria* (2011).

To assess the risk associated with the three resources, NSR has answered the following fourteen key analysis questions ((AQ (1) through AQ (14)) as outlined in the RAP protocol per modifications made by STNF:

Hydrologic Processes - AQ (1), AQ (4), AQ (8), and AQ (9)

- **AQ (1):** How and where does the road system modify the surface and subsurface hydrology of the area?
- **AQ (4):** How and where do road-stream crossings influence local stream channels and water quality?
- **AQ (8):** How and where does the road system affect wetlands?
- **AQ(9):** How does the road system alter physical channel dynamics, including isolation of floodplains; constraints on channel migration; and the movement of large wood, fine organic matter, and sediment?

Water Quality – AQ (2)-AQ (7)

- **AQ (2):** How and where does the road system generate surface erosion?
- **AQ (3):** How and where does the road system affect mass wasting?
- **AQ (4):** How and where do road-stream crossings influence local stream channels and water quality?
- **AQ (5):** How and where does the road system create potential for pollutants, such as chemical spills, oils, de-icing salts, or herbicides, to enter surface waters?
- **AQ (6):** How and where is the road system “hydrologically connected” to the stream system? How do the connections affect water quality and quantity?
- **AQ (7):** What downstream beneficial uses of water exist in the area? What changes in uses and demand are expected over time? How are they affected or put at risk by road-derived pollutants?

Aquatic and Riparian Habitat – AQ (10) through AQ (14)

- **AQ (10):** How and where does the road system restrict the migration and movement of aquatic organisms? What aquatic species are affected and to what extent?
- **AQ (11):** How does the road system affect shading, litterfall, and riparian plant communities?
- **AQ (12):** How and where does the road system contribute to fishing, poaching, or direct habitat loss for at-risk aquatic species?
- **AQ (13):** How and where does the road system facilitate the introduction of non-native aquatic species?
- **AQ (14):** How does the road system affect access needed for research, inventory, and monitoring?

Evaluation criteria were developed according to STNF RAP protocol in order to quantitatively assess the risks of roads in the analysis (see Appendix C and STNF RAP guidance documents (2006, 2011)). A total of 20 analyses (Appendix C, Table C-1) were conducted to score the criteria and inform the 14 Key Questions of the RAP risk analysis. Most of the analyses were conducted using ArcGIS 10 and Microsoft Excel using 2012 SSI field data, existing geospatial data provided by the STNF for previous SSI efforts, and GIS layers that were created from publicly available geospatial data. A vast majority of the roads analyses of the RAP were conducted by overlaying or intersecting the SSI geospatial road layer with a geospatial resource layer of interest and then calculating the length of the road or the frequency at which the road layer crossed a specific environmental resource layer.

Each road segment received a score for each criteria based on scoring systems provided in Shasta-Trinity's RAP guidance documents (STNF 2006 & 2011). All criteria utilized a risk rating system based on a scale of 0 to 5; with 0 being no risk, 1 being low risk, and 5 being high risk. For example, Stream Channel Proximity is one of the criteria used to answer Key Question AQ (1) (How and where does the road system modify the surface and subsurface hydrology of the area?) The following Table (Table 2-1) was derived to assess the risk rating associated with stream channel proximity or the percentage of the road within the riparian reserve.

Table 2-1. Example Risk Ratings

Risk Score	Percent of Road in Riparian Reserve
0	< 1%
1	1 – 4.9%
2	5 – 9.9%
3	10 – 19.9%
4	20 – 29.9%
5	> 29.9%

Although most of the analyses were consistent with the scoring systems outlined in guidance documents, some analyses required a more in-depth discussion of the methods due to their complexity, to define the parameters used, or to address modifications made within some analyses; this is included in Appendix C.

A Key Question risk score was calculated for each road by averaging the risk score from all criteria. A resource risk score was calculated for each of the three resources, including, water quality, hydrologic processes, and aquatic and riparian habitat, for each road by averaging the select Key Questions risk scores. For example, the risk scores for Key Questions AQ (1), AQ (4) AQ (8), and

AQ (9) were averaged to determine resource risk score for hydrologic processes. A score of 4.0 would imply that there is a high risk of the road affecting hydrologic processes, while of a score of 1.0 would imply that there is low risk.

Roads with a resource risk score of 3.0 or above for all of the three resources were highlighted for further analysis. These roads were crosschecked with the results from the SSI to determine if evaluation criteria from the RAP matched the actual condition of the road. The number of high immediacy stream crossings, hydrologically connected cross drains, and erosion feature sites was identified to determine if there were actual problems associated with the high risk road. Combining the risk scores from the RAP analysis and the results from the SSI was an effective means of flagging the highest risk roads.

Section 3 Clear Creek

3.1 Introduction

The Clear Creek watershed is approximately 159,170 acres in size and is situated in the eastern portion of the upper Sacramento River basin. Clear Creek originates in the Trinity Mountains, east of Trinity Lake and west of Shasta Lake. Clear Creek flows southeast through the mountains and drains into Whiskeytown Reservoir. Inflow to Whiskeytown Reservoir also comes from water diverted from the Trinity Basin. Eighty-seven percent of the water in Whiskeytown Reservoir is diverted north to Keswick Reservoir through the Spring Creek tunnel. The remaining 13 percent is released from Whiskeytown dam and flows east to its confluence with the Sacramento River, just south of the City of Redding downstream of Keswick Reservoir (WSRCD 1996).

The topography and landscape is diverse in the watershed. The upper section of the watershed is rugged and mountainous, while the lower section, downstream of Whiskeytown dam, is less mountainous and includes foothills and floodplains. Elevations range from 6,209 feet at the top of Shasta Bally to approximately 440 feet at the confluence with the Sacramento River. The vegetation in the upper watershed is dominated by mixed hardwood-conifer, mixed chaparral, and grassland (Tetra Tech 1998). Below Whiskeytown dam, the vegetation is dominated by shrub species in the foothills and mixed conifer and hardwood species in the higher elevations.

The climate of the watershed is seasonal, with warm, dry summer, and cool, wet winters. Temperatures and precipitation vary greatly in the watershed with the elevation differences. Average annual precipitation amounts in the watershed range from 39 inches in the lower elevations near Redding to 85 inches in the mountains on the eastern edge of the watershed (Tetra Tech 1998).

The watershed consists of private lands primarily owned by timber companies, mining companies and rural residents and public lands administered by National Park Service (NPS), Forest Service, California Department of Fish and Game, and Bureau of Land Management. The NPS administers approximately 31,781 acres of land in watershed as part of the Whiskeytown Unit of Whiskeytown-Shasta-Trinity National Recreation Area, which includes 3,220 acres of Whiskeytown Reservoir.

3.2 Overview

For this effort, six subwatersheds (HUC 6) and nine drainages[1] (HUC 7) were delineated for the purpose of the SSI and RAP efforts. Table 3-1 characterizes the hierarchy for the six subwatersheds, including, Buckhorn Summit-Willow Creek, East Fork-Clear Creek (East Fork), French Gulch-Clear Creek (French Gulch), Lower Clear Creek, Upper Clear Creek (Upper), and Whiskeytown Lake. Figure 3-1 illustrates the location of these subwatersheds, drainages and the respective road segments. As shown in Figure 3-1, the 2012 SSI focused on the roads located in the Upper subwatershed, with

[1] Nine drainages were delineated within the STNF; drainages outside of the STNF were not delineated.

minimal effort in the French Gulch and East Fork subwatersheds and no effort in the Buckhorn Summit-Willow Creek, Lower Clear Creek and Whiskeytown Lake subwatersheds.

Table 3-1. Clear Creek Watershed Characteristics

Subwatersheds (HUC 6)	Drainage Area (mi^2)	Total Road Length (mi)	Road Density (mi/mi^2)	Past SSI Road Miles	2012 SSI Road Miles	Total SSI Road Miles
Buckhorn Summit-Willow Creek	33.8	17.8	0.5	0.0	0.0	0.0
East Fork-Clear Creek	42.4	111.9	2.6	0.0	14.7	14.7
French Gulch-Clear Creek	31.2	76.0	2.4	0.0	7.1	7.1
Lower Clear Creek	49.1	11.7	0.2	0.0	0.0	0.0
Upper Clear Creek	44.7	190.3	4.3	0.0	119.5	119.5
Whiskeytown Lake	47.5	75.3	1.6	0.0	0.0	0.0
Watershed Totals	**248.7**	**483.1**	**1.9**	**0.0**	**141.3**	**141.3**

As shown in Table 3-1, the project GIS data indicates there are 483.1 miles of road in the watershed and a road density of 1.9 miles of road per square mile of watershed. Over 78 percent of the total roads in the watershed are located in East Fork, French and the Upper subwatersheds. The Upper subwatershed has more miles of road and a higher road density than any of the subwatersheds within Clear Creek watershed. There are 4.3 miles of road per square mile in the Upper subwatershed compared to 2.4 and 2.6 miles of road per square mile in the French Gulch and East Fork subwatersheds, respectively.

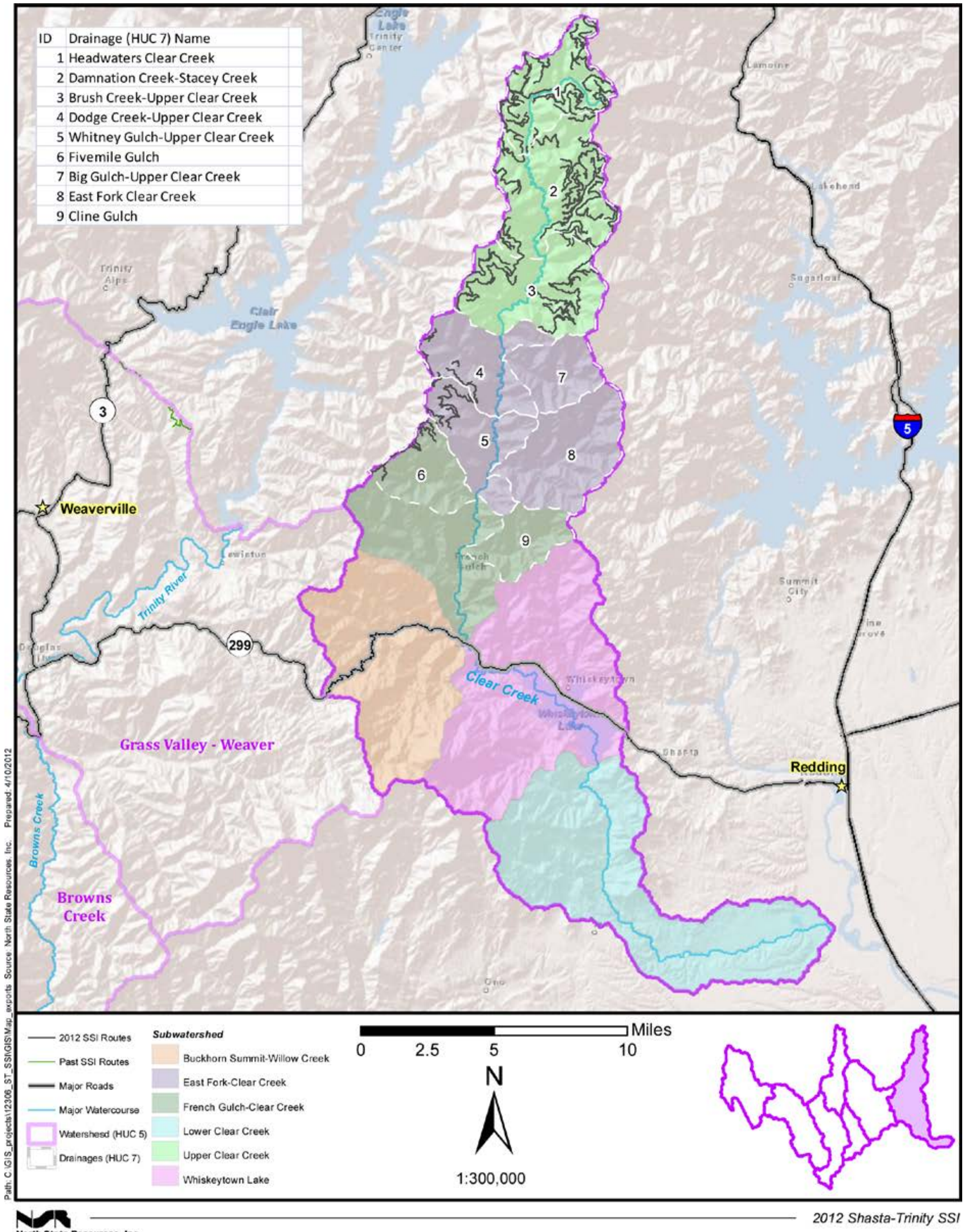


Figure 3-1. Clear Creek Watershed Location

Hydrology

Whiskeytown Reservoir hydrologically splits the watershed. Above Whiskeytown Reservoir, Clear Creek is referred to as Upper Clear Creek and below Whiskeytown Reservoir it is referred to as Lower Clear Creek. Instream flows below Whiskeytown Reservoir have been severely reduced due to hydroelectric use; annual flows are less than a sixth of their pre-Whiskeytown dam average annual flow (WSRCD 1996). Flows in upper Clear Creek are unregulated and are affected by precipitation.

The watershed contains approximately 737.7 miles of stream channels with a stream density of 3.0 miles per square mile (Table 3-2). Approximately 33 percent of the streams are perennial in nature; Slate Creek, East Fork of Clear Creek and Grizzly Gulch are the largest perennial streams in terms of drainage area.

As described above, three of the subwatersheds were included in the SSI and RAP efforts. Of these three subwatersheds, the Upper subwatershed is the highest in the watershed and has a greater stream density, more stream miles, and more perennial stream miles than either the East Fork or French Gulch subwatersheds.

The Upper subwatershed has 159.2 miles of streams and a stream density of 3.6 miles of stream per square mile; approximately 31 percent are perennial in nature. There are three drainages in the Upper subwatershed; Headwaters, Damnation Creek, and Brush Creek (Figure 3-1).

There are approximately 147.3 miles of streams in the East Fork subwatershed and a stream density of 3.5 miles of stream per square mile; approximately 14 percent are perennial in nature. There are four drainages in the East Fork subwatershed, including, Dodge Creek, Big Gulch, East Fork and Whitney Gulch drainages (Figure 3-1).

There are approximately 80.5 miles of stream in the French Gulch subwatershed and a stream density of 2.6 miles of stream per square mile; approximately 46 percent are perennial in nature. There are two delineated drainages within the STNF in this subwatershed, including Fivemile Gulch and Cline Gulch (Figure 3-1).

Table 3-2. Clear Creek Watershed Streams Densities and Fish Bearing Lengths

Subwatersheds (HUC 6)	Stream Length (mi)	Stream Density (mi/ (mi^2))	Miles of Perennial Stream	Perennial Streams as % of Total Miles	Miles of Fish-Bearing Streams	Fish-Bearing Streams as % of Total Miles
Buckhorn Summit-Willow Creek	87.0	2.6	40.2	46.2%	40.2	46.2%
East Fork-Clear Creek	147.3	3.5	21.2	14.4%	21.2	14.4%
French Gulch-Clear Creek	80.5	2.6	37.1	46.1%	36.9	45.9%
Lower Clear Creek	148.7	3.0	42.6	28.7%	40.3	27.1%
Upper Clear Creek	159.2	3.6	49.0	30.8%	49.0	30.8%
Whiskeytown Lake	114.9	2.4	53.7	46.7%	53.5	46.5%
Watershed Totals	**737.6**	**3.0**	**243.8**	**33.1%**	**241.1**	**32.7%**

Water Quality

Two waterbodies in the Clear Creek watershed are listed on the 303(d) list of impaired waterbodies for mercury; Lower Clear Creek and Whiskeytown Lake (U.S. Environmental Protection Agency 2010). Mercury deposits from mining tailing piles are the assumed source of contamination. The expected TMDL completion date is 2021 (U.S. Environmental Protection Agency 2010). Water temperature is a concern in Lower Clear Creek during the summer months when releases from Whiskeytown reservoir are low. Low summer water releases from Whiskeytown dam result in high water temperatures that can be lethal for adult and egg spring-run Chinook and sublethal for yearling steelhead (WSRCD 1996).

Water quality in Upper Clear Creek is generally good; Upper Clear Creek is not listed on the 303(d) list of impaired waterbodies. However, Willow Creek, a tributary to Upper Clear Creek several miles upstream above Whiskeytown Reservoir has severe water quality issues due to historic mining. Willow Creek is listed on the 303(d) list of impaired waterbodies for acid mine drainage, copper and zinc. Additional water quality concerns include high coliform bacterial levels downstream of septic tanks in French Gulch (Tetra Tech 1998).

Aquatic and Riparian Habitat

Clear Creek was once a major producer of anadromous salmon; it was one of two tributaries in the Upper Sacramento River basin that provided habitat for three runs of chinook salmon and one run of winter steelhead. However, since the construction of Whiskeytown dam the anadromous fisheries population dramatically decreased. Whiskeytown dam is impassable to fish and has eliminated 12 miles of spring-run and steelhead spawning habitat. Since the construction of the dam, upper Clear Creek and its tributaries mainly support rainbow trout. In addition to acting as a fish barrier, Whiskeytown dam impounds spawning gravel that once flushed downstream, which has greatly reduced spawning habitat downstream (WSRCD 1996).

From 1914 until 2001, the McCormick-Saeltzer diversion dam functioned as a fish migration barrier, 10 miles downstream of Whiskeytown dam. Removal of this dam is part of a large effort to increase salmon populations and provide access to approximately 10 miles of upstream habitat to spring-run salmon and steelhead (WSRCD 1996). Although fish passage has been reestablished in Lower Clear Creek, during the summer months, the water temperatures are elevated due to low flows and are inhospitable to salmon. Increasing flows in Clear Creek below the dam, introducing spawning gravels, riparian revegetation, and increasing habitat are all part of the restoration of Lower Clear Creek (WSRCD 1996).

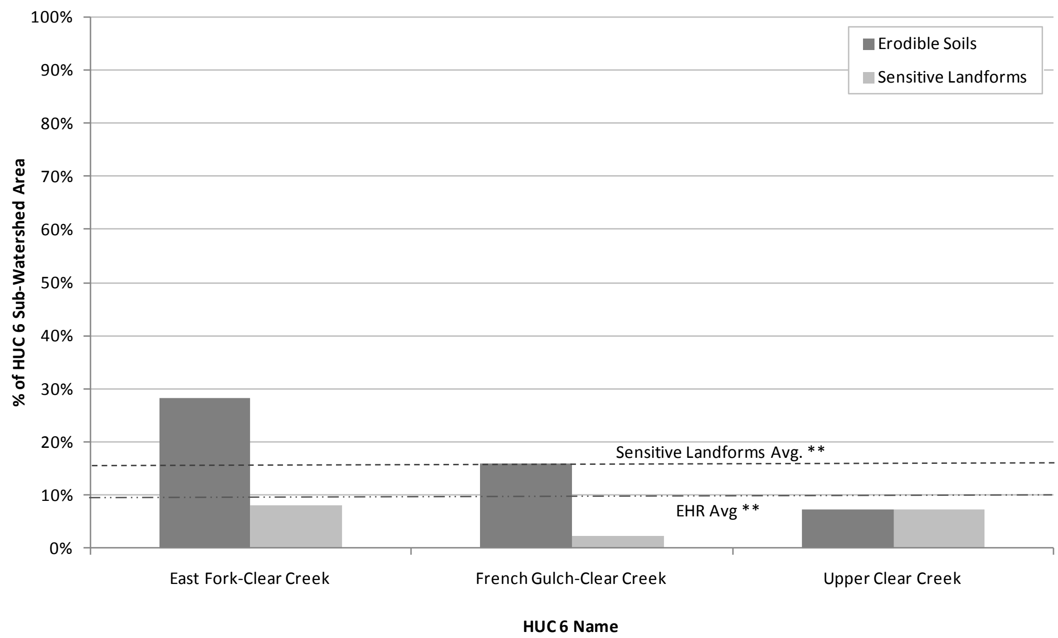
Geology

A vast majority of the northern two-thirds of Clear Creek watershed is underlain by the shale, metaconglomerate, and greenstone of individual members of the Eastern Klamath Belt of the Klamath Mountains (Table 3-3). The Bragdon Formation and the Copley Greenstone discontinuously form the bedrock in most of the watershed with the Balaklala Rhyolite occupying a small area in the south. The quartz diorite and granodiorite of the Shasta Bally Batholith occupies a large area along the southwestern boundary of the watershed.

Table 3-3. Clear Creek Watershed Prominent Geologic Units and Rock Types

Geologic Unit	Percent of Watershed		Dominant Rock Type(s)
Eastern Klamath Belt	79%		
Bragdon Formation		64%	shale, metaconglomerate
Copley Greenstone		12%	greenstone
Balaklala Rhyolite	3%		keratophyre, tuff
Plutonic Rock	20%		
Shasta Bally		19%	quartz diorite, granodiorite

Approximately 12 percent of the Clear Creek watershed contains very high and high potential areas for soil erosion (Figure 3-2). In addition, only seven percent of the watershed is covered by sensitive landforms; mostly dormant landslides and inner gorge terrain, and less competent intrusive rocks. A large portion of the Clear Creek watershed is outside of USFS boundaries, and geomorphic data is limited within the rest of the watershed. As a result, characterization of the watershed does not include the southernmost sub-watersheds.



**Average is for portion of watershed/sub-watershed with associated data (usually USFS lands).

Figure 3-2. Area of Clear Creek Subwatersheds Occupied by Erodible Soils and Sensitive Landforms

3.3 SSI Results

As described in Section 1, roads in the Clear Creek watershed were inventoried during multiple field seasons. In total, approximately 141.3 miles of road were inventoried in the watershed during the 2011 and 2012 field seasons. The following discussion focuses on the results and the assessment of this data set. Unlike the other five of the seven watersheds included in the 2012 SSI, no additional SSI data was provided by the STNF for the Clear Creek watershed.

Year 2012 SSI Results

The objective of the 2012 SSI was to document the condition of existing road-related infrastructure and identify existing and potential erosion and sediment producing features located over 141.3 miles of road in the Clear Creek watershed (Figure 3-1 and Appendices E & F). Inventoried features were prioritized based on their potential for sediment production and delivery to the hydrologic network. This section focuses on the inventoried and prioritized features included in the 2012 SSI. The results are presented at both the subwatershed (HUC 6) and drainage scales (HUC 7).

Inventoried Features

The 2012 SSI identified and characterized 2,271 features; 9.6 miles of gully, 0.6 miles of ditch segments; 181 stream crossings; 16 erosion features; 439 hydrologically connected cross-drain sites; 1,570 non-hydrologically connected cross-drains; and 65 springs (Table 3-4 and Appendices E & F).

Approximately 85 percent of the total 141.3 miles of road inventoried in the Clear Creek watershed were located in the Upper subwatershed. Of the three subwatersheds included in the 2012 SSI, the

Upper is the largest subwatershed (44.7 square miles) and has the greatest road density, with 4.3 miles of road per square mile of watershed. A total of 1,943 features, seven miles of gully and 0.5 miles of ditch were identified in the Upper subwatershed within three drainages (see Table 3-4).

The East Fork subwatershed is only 2.3 square miles smaller than the Upper Clear Creek subwatershed, but has a much lower road density, with 2.6 miles of road per square mile of watershed. Ten percent (14.7 miles) of the total miles of inventoried road were located in the East Fork subwatershed; a total of 189 features, 2.0 miles of gully and 0.1 miles of ditch were identified within two drainages (see Table 3-4).

French Gulch subwatershed is the smallest of all three inventoried subwatersheds and also has lowest density of roads, with 2.4 miles of road per square mile of watershed. Five percent (7.1 miles) of the total roads inventoried were located in the French Gulch subwatershed and a total of 139 features, 0.6 miles of gully and less than 0.1 miles of ditch were identified within one drainage (see Table 3-4).

Table 3-4. 2012 Inventoried Features for Clear Creek Subwatersheds (HUC 6) and Drainages (HUC 7)

Subwatersheds (HUC 6) Drainages (HUC 7)	Road Miles	Gully Miles	Ditch Miles	Stream Crossings	Erosion Features	Connected Cross-Drains	Non-Connected Cross-Drains	Springs
East Fork-Clear Ck.	14.7	2.0	0.1	17	1	34	134	3
Dodge Ck.-Upper Clear Ck.	6.1	1.3	0.1	4	0	12	64	1
Whitney Gulch-Upper Clear Ck.	8.6	0.7	<0.1	13	1	22	70	2
French Gulch-Clear Ck.	7.1	0.6	<0.1	9	0	21	106	3
Fivemile Gulch	7.1	0.6	<0.1	9	0	21	106	3
Upper Clear Ck.	119.5	7.0	0.5	155	15	384	1330	59
Brush Ck.-Upper Clear Ck.	29.3	1.5	0.2	39	6	73	324	12
Damnation Ck.-Stacey Ck.	49.7	3.0	0.1	71	5	179	586	35
Headwaters Clear Ck.	40.5	2.5	0.2	45	4	132	420	12
Watershed Totals	**141.3**	**9.6**	**0.6**	**181**	**16**	**439**	**1570**	**65**

Feature Analysis/Risk Assessment

As described in Section 2, risk ranking matrices were created to identify features that currently do, or potentially could deliver elevated levels of sediment to nearby streams or waterbodies. The number of high risk features and the proportion by subwatershed are listed in Table 3-5. The accompanying GIS project is organized to extract the type and location of features by risk rating at multiple scales. The density of high risk feature types for each subwatershed and drainage is shown in Figure 3-3.

As illustrated in Table 3-5, the 2012 SSI identified the following high risk features: total of 5.3 miles of gully, 0.2 miles of ditch, 60 stream crossings, four erosion features, 33 connected cross-drains with

CMP, and 29 springs were identified as high risk in the 2012 SSI. A total of 126 features or 31 percent of the total 2012 SSI features (excluding non-connected cross-drains and connected cross-drains without CMP) are characterized as high risk in the Clear Creek watershed.

As discussed previously, the majority of the SSI miles and features were inventoried in the Upper subwatershed; logically the majority of the high risk features were located in this subwatershed. A total of 114 high risk features, 4.1 miles of high risk gully, and 0.14 miles of high risk ditch were located in the Upper subwatershed.

The proportion of high risk features in the Upper subwatershed is slightly higher than the proportion of roads inventoried in the subwatershed. For example, the Upper subwatershed contains approximately 85 percent of the road miles inventoried in 2012 SSI and it contains approximately 90 percent of the total number of high risk features. The proportion of high risk features in both the East Fork and French Gulch subwatersheds is slightly lower than the proportion of roads in the Clear Creek watershed.

Table 3-5. High Risk Features for Clear Creek Subwatersheds (HUC 6) and Drainages (HUC 7)

Subwatersheds (HUC 6) Drainages (HUC 7)	Gully Miles	Ditch Miles	Stream Crossings	Erosion Features	Connected Cross-Drain w/CMP	Springs
East Fork-Clear Ck.	1.1 (54%)	0.04 (42%)	6 (35%)	0 (0%)	1 (11%)	1 (33%)
Dodge Ck.-Upper Clear Ck.	0.6 (47%)	0.03 (34%)	2 (50%)	0 (0%)	1 (25%)	1 (100%)
Whitney Gulch-Upper Clear Ck.	0.4 (67%)	0.01(100%)	4 (31%)	0 (0%)	0 (0%)	0 (0%)
French Gulch-Clear Ck.	0.2 (31%)	0.03(100%)	2 (22%)	0 (0%)	0 (0%)	2 (67%)
Fivemile Gulch	0.2 (31%)	0.03(100%)	2 (22%)	0 (0%)	0 (0%)	2 (67%)
Upper Clear Ck.	4.1 (58%)	0.14 (30%)	52 (34%)	4 (27%)	32 (25%)	26 (44%)
Brush Ck.-Upper Clear Ck.	0.7 (45%)	0.01 (7%)	12 (31%)	2 (33%)	1 (8%)	5 (42%)
Damnation Ck.-Stacey Ck.	2.0 (68%)	0.02 (20%)	28 (39%)	1 (20%)	18 (29%)	15 (43%)
Headwaters Clear Ck.	1.3 (53%)	0.11 (57%)	12 (27%)	1 (25%)	13 (24%)	6 (50%)
Watershed Totals	**5.3** (55%)	**0.22** (37%)	**60** (33%)	**4** (25%)	**33** (23%)	**29** (45%)

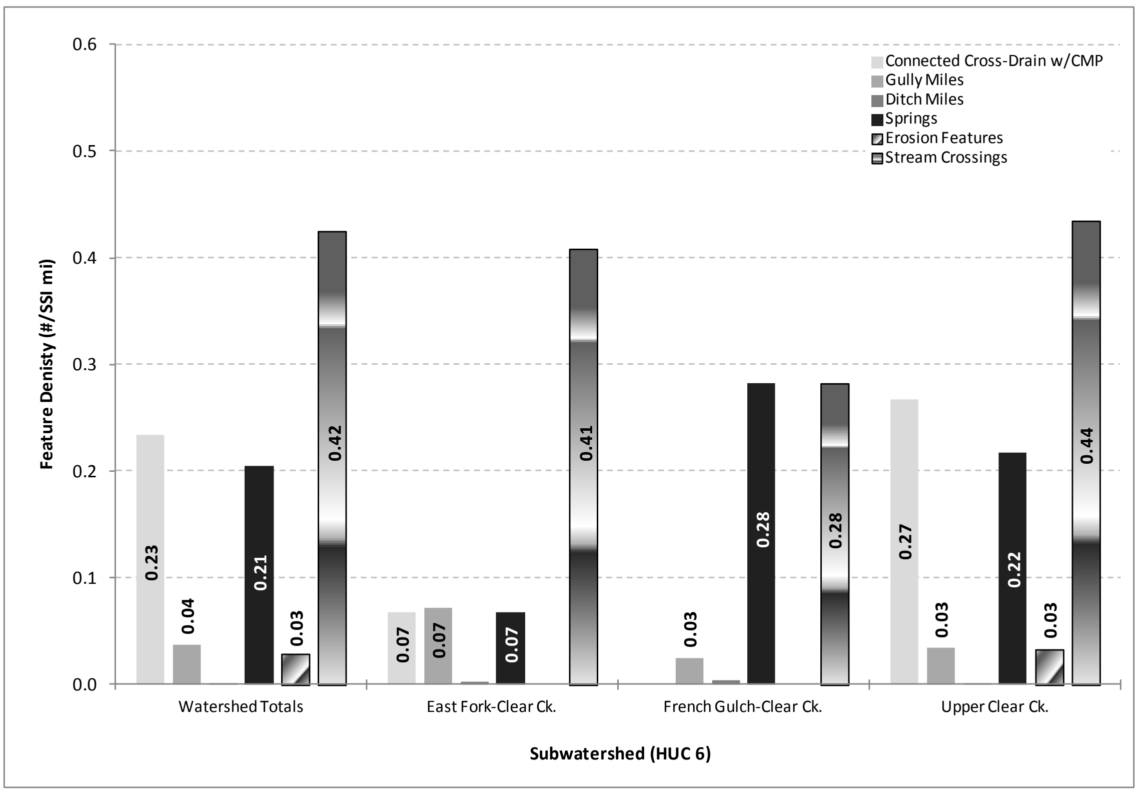
Figure 3-3 illustrates the variability in the number and type of high risk features per mile of inventoried road by subwatershed and for the Clear Creek watershed as a whole. Stream crossing features are the most dense high risk features and erosion features are the least dense high risk feature in each of the three subwatersheds. The density of high risk gully and ditch miles in each of the three subwatersheds is similar, ranging between less than 0.01 miles and 0.07 miles of ditch per inventoried mile of road.

3.4 Aquatic and Riparian Resources RAP Risk Analysis

The main focus of the RAP risk analysis was to identify road segments that could pose a moderate to high risk to aquatic and riparian resources. Three resources; water quality, hydrologic processes, aquatic and riparian habitat are analyzed in the following discussion. The RAP risk analysis is presented at both the drainage and road segment scales.

Aquatic and Riparian Resources RAP Risk Score per Drainage

The total Aquatic and Riparian Resources RAP risk score (total RAP risk score) for road segments within each of the five drainages that constitute the Clear Creek watershed are discussed in this section. The total RAP risk score is the average of the individual water quality, hydrologic processes, and aquatic and riparian habitat scores. As described in Section 2.4, the key questions specific to the three resources, and the associated criteria required to answer these questions have been developed in accordance with the STNF RAP protocol (Shasta-Trinity National Forest 2011) in order to rate the road segments at the drainage scale.



Note: Gullies and ditch densities reported as miles of feature per mile of SSI road.

Figure 3-3. Density of High Risk Features for Clear Creek Subwatersheds

The RAP risk scores for water quality, hydrologic processes, aquatic and riparian habitat, including the total scores for each road and drainage are listed in Appendix D. Figure 3-4 illustrates the total miles of road per drainage and the associated total RAP risk score. This figure displays the relative risk per drainage for the various sections of roads included in the RAP analysis. For the Clear Creek watershed, the RAP analysis was specific to the 2012 SSI data set; no additional datasets were provided by the STNF.

The Aquatic and Riparian RAP effort indicated that approximately 0.8 miles (less than 1%) of the inventoried road mileage scored high risk and 20.7 miles (15%) of the inventoried roads scored moderate-high risk to aquatic and riparian resources within the Clear Creek watershed. The total RAP risk score for each of the watersheds and drainages are shown in Figure 3-4.

As shown in Figure 3-4, all of the roads that scored high risk were located in the Damnation Creek-Stacey Creek drainage, within the Upper Clear Creek subwatershed. A third of the roads that scored moderate-high risk (7.6 miles) were also located in Damnation Creek-Stacey Creek drainage. In total, 8.4 miles or 39 percent of the SSI roads that scored moderate-high to high risk were located in Damnation Creek-Stacey Creek drainage. An additional 7.9 miles of road that scored moderate-high risk was located in Headwaters Clear Creek drainage, also within the Upper Clear Creek drainage. Approximately 80 percent (16.6 miles) of the roads that are considered moderate-high to high risk to aquatic and riparian resources were located in the Upper Clear Creek subwatershed. This is not alarming, because 85 percent of the inventoried roads were located in the Upper Clear Creek subwatershed.

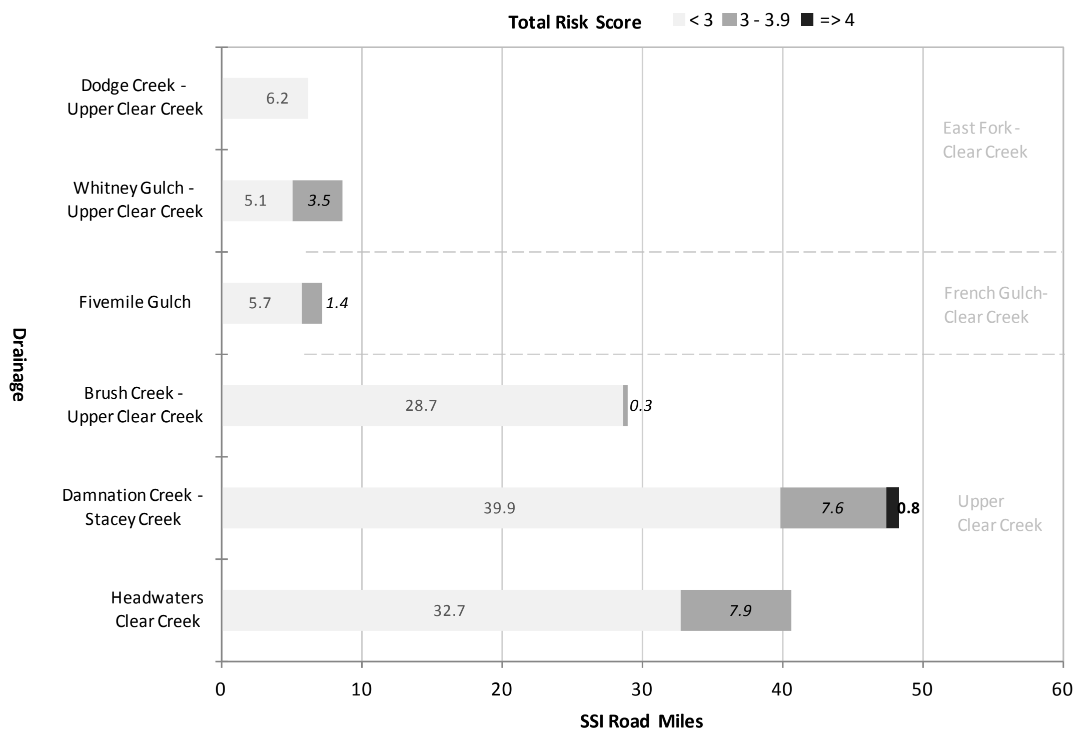


Figure 3-4. Aquatic and Riparian Resources RAP Total Risk Score for Clear Creek Watershed Drainages

Overall, 83 percent of the roads included in the 2012 SSI within the Clear Creek watershed had a risk score less than 3.0 (low-moderate risk). Based on the assumptions used for the RAP analysis, this suggest that a large number of the roads pose a low to moderate risk of affecting aquatic and riparian resources. All the roads included in the 2012 SSI within the Dodge Creek-Upper Clear Creek drainage and nearly all the roads in the Brush Creek-Upper Clear Creek drainage, scored less than 3.0.

Moderate to High Risk Road Segments

Table 3-6 lists those road segments by drainage included in the 2012 SSI that scored 3.0 or above in the RAP risk analysis. Based on this analysis, these road segments have a moderate-high to high risk of affecting water quality, hydrologic processes, and aquatic and riparian habitats. In total, one road segment equaling approximately 0.8 miles scored high risk and 18 road segments equaling 20.7 miles scored moderate-high risk. Figures 3-5a and 3-5b illustrate the location of the moderate-high to high risk roads segments in the Clear Creek watershed.

As shown in Table 3-6, the water quality risk score is generally the highest score of all three resource risk scores, with the exception of three road segments in which the water quality score is equal to or slightly lower than the one of the other scores. Twelve of the 19 road segments (76% of the inventoried road mileage) scored high risk to water quality (scores equal to or above 4.0). This suggests that many of the moderate-high and high risk road segments are hydrologically connected and intersect areas prone to erosion. Evaluation of previous RAP risk analysis indicates that the large number of stream crossings and/or the road segments that are in close proximity to aquatic and riparian habitat provide a direct pathway for transport and delivery of sediment to water bodies in the Clear Creek watershed. For example, Road 34N29 scored high risk to water quality; it intersects several drainages within Whitney Gulch that drain directly into Clear Creek allowing for potential transport and delivery of sediment and other materials to Clear Creek (Figure 3-5b). Road 36N50 is another example of road that it is hydrologically connected and a high risk to water quality due to its location near the headwaters of Clear Creek (Figure 3-5a). The road segment is 4.1 miles in length and parallels the creek for much of its length offering numerous opportunities to affect the water quality of Clear Creek.

Table 3-6. Routes in Clear Creek Watershed with Total RAP Risk Scores of 3.0 and Greater

			Resource Risk Scores			
Route ID	Drainage Name	Miles	Aquatic, Riparian	Hydrologic Process	Water Quality	Total Risk
35N12A	Damnation Creek-Stacey Creek	0.825	4.3	3.8	4.3	4.1
35N12F	Damnation Creek-Stacey Creek	0.718	3.5	3.8	4.5	3.9
35N12	Damnation Creek-Stacey Creek	4.202	3.7	3.8	4.3	3.9
34N29	Whitney Gulch-Upper Clear Creek	3.512	3.7	3.8	4.2	3.9
36N74A	Damnation Creek-Stacey Creek	0.413	3.2	3.8	4.6	3.9
35N12E	Damnation Creek-Stacey Creek	0.197	3.4	3.8	4.4	3.8
36N50	Headwaters Clear Creek	4.102	3.5	3.8	4.0	3.8
34N86	Fivemile Gulch	1.047	3.3	3.8	4.2	3.7
36N72B	Headwaters Clear Creek	0.354	3.2	3.8	4.2	3.7
36N73	Headwaters Clear Creek	1.998	3.4	3.8	3.9	3.7
35N05YC	Damnation Creek-Stacey Creek	2.045	3.3	3.8	3.9	3.7
36N71A	Headwaters Clear Creek	0.390	3.2	3.8	3.9	3.6
36N75	Headwaters Clear Creek	0.221	3.2	3.8	3.9	3.6

Table 3-6. Routes in Clear Creek Watershed with Total RAP Risk Scores of 3.0 and Greater

			Resource Risk Scores			
Route ID	**Drainage Name**	**Miles**	**Aquatic, Riparian**	**Hydrologic Process**	**Water Quality**	**Total Risk**
36N71B	Headwaters Clear Creek	0.360	3.2	3.8	3.9	3.6
36N70	Headwaters Clear Creek	0.102	3.2	3.8	3.7	3.6
36N63D	Headwaters Clear Creek	0.034	3.2	3.8	3.7	3.6
35N89	Brush Creek-Upper Clear Creek	0.301	1.4	3.8	4.8	3.3
34N48A	Fivemile Gulch	0.384	1.2	3.8	4.3	3.1
36N16Y	Headwaters Clear Creek	0.325	1.2	3.8	4.1	3.0

The hydrologic processes scores for all road segments equal to 3.8; indicating that all of these segments are considered a moderate-high risk that pose similar risk to hydrologic processes in the Clear Creek watershed. These roads may potentially affect the routing of water by intercepting and diverting flows from their natural path. At various locations, the road prism and associated alignment may constrict the channel, isolate floodplains, influence riparian vegetation, and/or constrain channel migration.

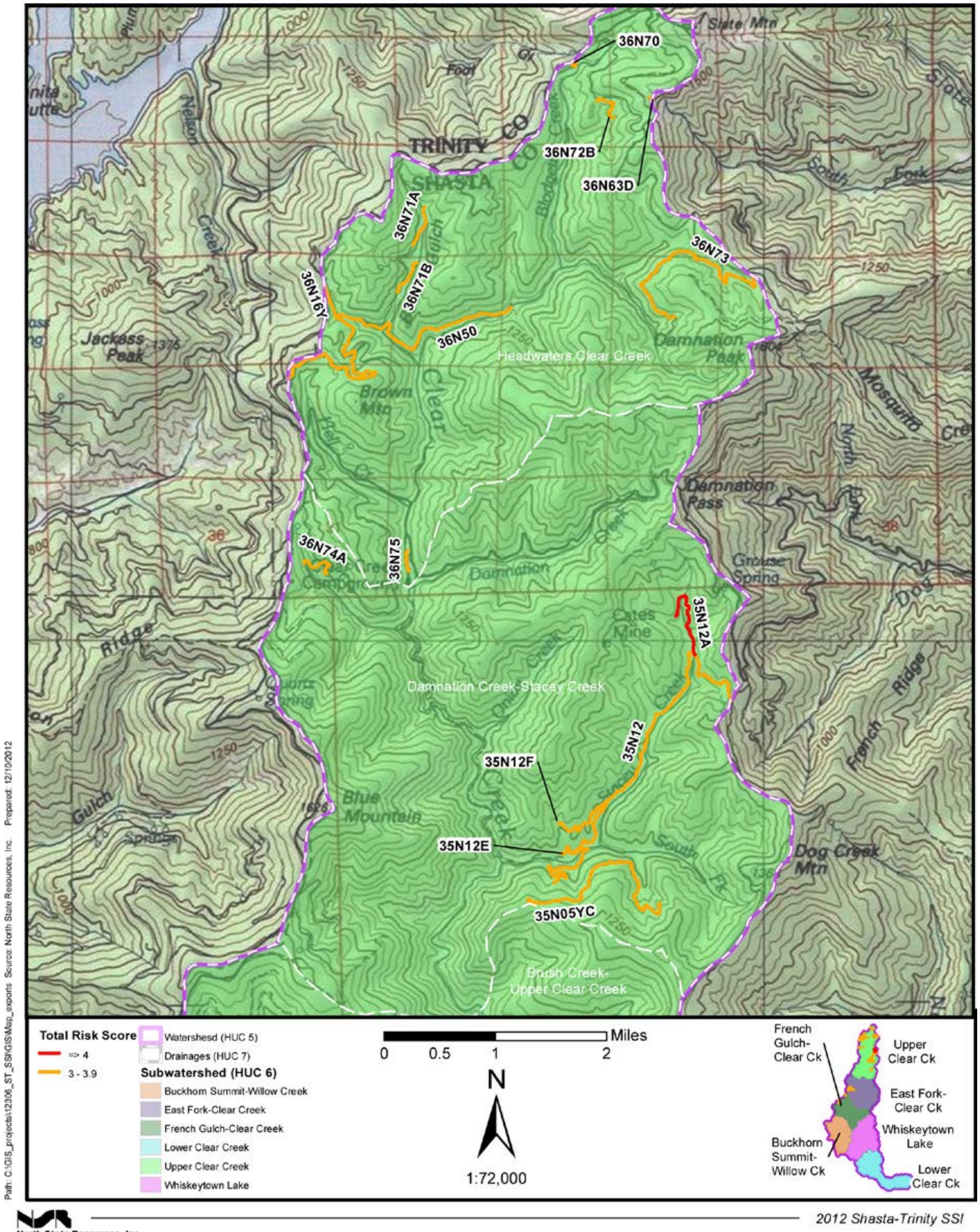


Figure 3-5a. Location of Moderate-High to High Risk Roads Segments in the Clear Creek Watershed

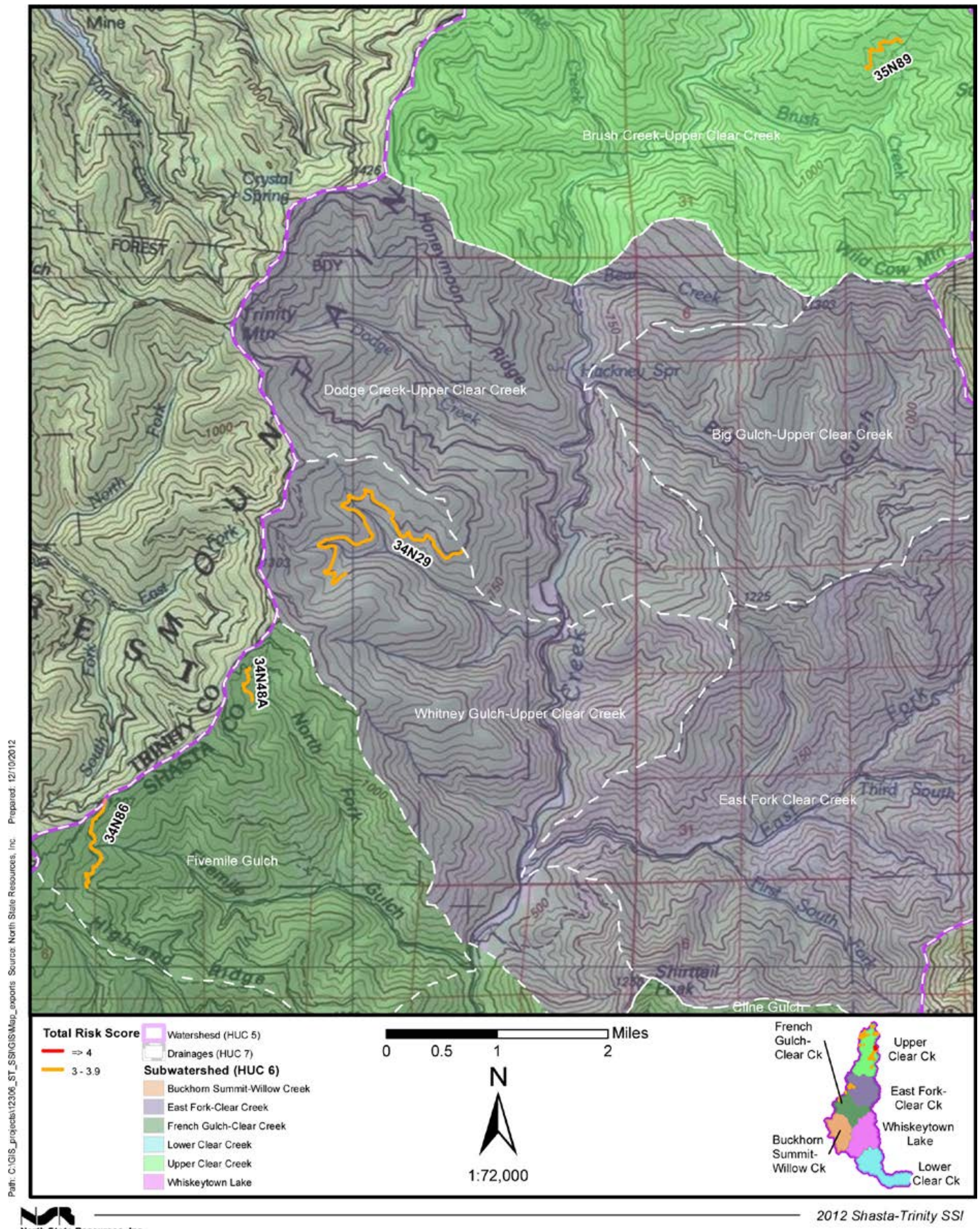


Figure 3-5b. Location of Moderate-High to High Risk Roads Segments in the Clear Creek Watershed

The road segment scores for aquatic and riparian habitat range between 1.2 and 4.3. The large range in this score is likely due to the location of the road segments in proximity to the fish bearing and perennial streams. These scores correlate the risk to aquatic and riparian habitat relative to the individual road segments with respect to affects on the functions and values of aquatic and riparian habitat, including attributes such as connectivity, flow and fish passage. Road 35N12A had the highest aquatic and riparian score of all road segments, which is an indication that the road segment has a negative effect on the aquatic and riparian habitat of Clear Creek and its tributaries due to its location near Stacey Creek, a fish bearing stream.

3.5 Recommendations

Moderate-High Road Segments General Recommendations

The general recommendations for routes in the Clear Creek watershed with a total RAP risk score of 3.0 and above are listed in Table 3-7. Four different recommendations are presented, including: maintain, upgrade, decommission, and evaluate. Maintain includes activities such as cleaning out inlets and outlets of culverts and cross-drain with culverts, cleaning rolling dips and ditches, and spot-grading. Also included in this category are roads that have been decommissioned or abandoned and do not have significant erosion issues; maintain indicates that they should retain their current route status. Upgrading roads includes renovation of existing features, construction of new features, large-scale grading and placement of aggregate, combined with normal maintenance activities. Decommissioning the road includes either full road obliteration or a temporary road decommission. Evaluate includes routes that were not inventoried because they could not be located or were inaccessible due to land ownership. This recommendation suggests that USFS remove non-existent routes from database and evaluate legal access to roads that were inaccessible due to land ownership. The recommendations are based on the RAP risk score, the density and condition of the features in the 2012 SSI data set, and the road-related hydrologic connectivity to the stream network.

Table 3-7. General Recommendations for Moderate-High to High Risk Routes in the Clear Creek Watershed

Route ID	Drainage Name	Miles	Total Risk	General Recommendation
35N12A	Damnation Creek-Stacey Creek	0.825	4.1	Decommission or Upgrade
35N12F	Damnation Creek-Stacey Creek	0.718	3.9	Upgrade
35N12	Damnation Creek-Stacey Creek	4.202	3.9	Upgrade
34N29	Whitney Gulch-Upper Clear Creek	3.512	3.9	Upgrade
36N74A	Damnation Creek-Stacey Creek	0.413	3.9	Maintain
35N12E	Damnation Creek-Stacey Creek	0.197	3.8	Maintain
36N50	Headwaters Clear Creek	4.102	3.8	Maintain
34N86	Fivemile Gulch	1.047	3.7	Maintain
36N72B	Headwaters Clear Creek	0.354	3.7	Decommission
36N73	Headwaters Clear Creek	1.998	3.7	Upgrade
35N05YC	Damnation Creek-Stacey Creek	2.045	3.7	Maintain

Table 3-7. General Recommendations for Moderate-High to High Risk Routes in the Clear Creek Watershed

Route ID	Drainage Name	Miles	Total Risk	General Recommendation
36N71A	Headwaters Clear Creek	0.390	3.6	Maintain
36N75	Headwaters Clear Creek	0.221	3.6	Maintain
36N71B	Headwaters Clear Creek	0.360	3.6	Decommission
36N70	Headwaters Clear Creek	0.006	3.6	Evaluate
36N63D	Headwaters Clear Creek	0.034	3.6	Evaluate
35N89	Brush Creek-Upper Clear Creek	0.301	3.3	Maintain
34N48A	Fivemile Gulch	0.384	3.1	Maintain
36N16Y	Headwaters Clear Creek	0.325	3.0	Maintain

Specific Recommendations to Upgrade Roads

Specific recommendations are listed below for the roads listed under 'upgrade' in Table 3-7 and for seven additional road segments. The recommendations focus on the sections of each road that either contained a high density of high risk features or individual features that could be treated to help decrease their impacts to water resources. Locations are denoted by Route ID, mile marker, and drainage. The feature type and associated problem are also included, along with recommendations for upgrades.

Route ID: 35N12A
Drainage: Damnation Creek-Stacey Creek
Location: Mile Marker 0.142-0.566, Clear Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.142	Stream Crossing CMP	Inlet partially plugged with woody debris. Stream channel is perennial.	Clear inlet.
0.147-0.284	Gully & Cross-Drain	Moderate gully caused by road runoff and by a partially functional cross-drain (MM 0.216). Gully directly connected to perennial stream with sediment delivery.	Reconstruct and armor cross drain at MM 0.216. Install two additional armored cross-drain, one upslope and one downslope of MM 0.216
0.363-0.436	Gully & Cross-Drain	Gully caused by surface runoff and partially functioning cross-drain (MM 0.396). Gully not connected but within 150 feet of Stacey Creek.	Reconstruct cross drain at MM 0.396. Install additional cross-drain if necessary.
0.551 – 0.566	Spring and Connected Cross-Drain	Ponding of spring flow between the source and the cross-drain. Spring flow connected to Stacey Creek.	Develop drainage structure (armored dip, cross-drain with CMP, French drain) to alleviate ponding and convey subsurface flow through the road prism. Reconstruct cross-drain at MM 0.566 to allow for conveyance of spring flow.

Route ID: 35N12F
Drainage: Damnation Creek-Stacey Creek
Location: Mile Marker 0.001 – 0.163, Clear Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.001-0.012	Gully	Upslope gully forms on 35N12F and continues onto the 35N12 where it is connected to a perennial stream at a CMP stream crossing.	Install armored rolling dip near MM 0.05 or add aggregate to road base to disperse runoff.
0.019	Stream Crossing CMP	Intermittent stream crossing has gully erosion at outlet. Structure is located upstream of a crossing on the 35N12.	Armor CMP outlet with rip rap
0.035-0.045	Gully	Small gully forms on road surface and drains to intermittent stream at a cross-drain.	Install armored rolling dip near MM 0.040 or add road base aggregate to disperse road runoff.
0.093	Connected Cross-Drain	Partially functioning dip with moderate scour that is connected to a perennial stream. Scour likely caused by upslope road gully runoff.	Reshape and armor cross-drain.
0.094-0.12	Gully	Short gully on road surface conveys flow and sediment to a perennial stream. Gully causes erosion of downslope cross-drain.	Install armored rolling dip near MM 0.105 or add road base aggregate to disperse road runoff.
0.163	Erosion Feature (Gully)	Road runoff concentrates at the site and causes erosion of road fill and hillslope. Feature not large but connected to intermittent stream and is located above stream crossing on the 35N12.	Install armored rolling dip and armor outlet with rip rap or add road base aggregate to disperse road runoff.
0.001 – 0.163	Route Surface	Concentrated road runoff forms gullies and erodes existing cross drain. The 35N12F is stacked above the 35N12, and both roads are connected to Stacey Creek in this road segment.	Consider adding road base aggregate and additional cross-drains to this segment of the road to help disperse runoff and limit gully formation.

Route ID: 34N29
Drainage: Damnation Creek-Stacey Creek
Location: Mile Marker 3.152 – 4.806, Clear Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
3.152	Gully	Short route surface gully connects directly to perennial stream.	Install two armored rolling dips to mitigate concentration of road runoff.
4.792	Erosion Feature (Gully)	Small gully in route surface and fillslope caused by overtopping of CMP at stream crossing (MM 4.806).	Install armored critical dip between crossing and the erosion feature.
4.806	Stream Crossing CMP	Intermittent stream crossing with a CMP has overtopped and created a gully in the route surface. Inlet is > 31% plugged with bedload.	Clear inlet and evaluate culvert size and installation. Pipe may need to be replaced.

Route ID: 35N12
Drainage: Damnation Creek-Stacey Creek
Location: Mile Marker 0.115 – 3.413, Clear Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.115-.0.191	Gully	Small route surface gully transports a relatively high amount of sediment to a swale at an existing cross drain.	Install additional cross-drains drain to disperser road runoff.
0.454	Cross-Drain	Partially functioning cross-drain does not effectively drain route surface and gully on route past structure.	Repair and armor existing cross-drain.
0.455-0.481	Gully	Small route gully caused by partially functioning upslope cross-drain. Drains to ephemeral channel 500 feet upstream of a perennial stream.	Install new rolling dip and repair existing cross-drain (MM 0.454).
2.55-2.566	Gully	Route surface gully formed from runoff of 35N12F and continues onto route and is connected to a perennial stream.	Install armored cross-drain near intersection with 35N12F to deter gully formation and add aggregate to road surface.
3.413	Bridge & Erosion Feature	Approach to bridge crossing has been significantly eroded by stream flow that went around the structure. Compromises access and may eventually compromise the structure. Stream is a large perennial stream.	Reshape approach and armor slopes with rip-rap. Add oversized aggregate to route to prevent further erosion.

Route ID: 36N73
Drainage: Headwaters Clear Creek
Location: Mile Marker 0.494 – 0.495, Clear Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.494, 0.495	Stream Crossing CMP, Erosion Feature (Streambank Erosion)	Significant loss of fill at perennial stream crossing with a CMP. Upstream side shows fill loss, but it appears the downstream side of the road fill slid and comprises most of the fill loss. Features compromise access and remaining fill and risk of transport to stream network.	Crossing needs to be rebuilt and CMP may need to have increased diameter to accommodate flow. Install armored critical dip with new construction.

Additional Features of Concern

Feature Type	Mile Marker	Route ID	Problem	Recommendations
Stream Crossing CMP, Erosion Feature (Streambank Erosion)	7.527, 7.528	35N77	Significant road fill loss on the downstream side of CMP stream crossing. It appears erosion at the outlet of the CMP scoured the toe of the road fill and compromised the stability of the road fill causing a slide. Shotgun outlet and large cavity exist. OSD placed at outlet for scour protection ineffective.	Pull back road fill to stable slope. Add rip-rap to fillslope void for stability. Add rip-rap at CMP outlet for scour protection or add downspout.
Stream Crossing CMP	2.364	35N17X	Sediment from upstream erosion has plugged the culvert causing it to divert across the road prism.	Replace structure with larger size culvert to accommodate sediment load. Or, clean inlet and install armored critical dip at current diversion point.
Stream Crossing CMP	0.697	34N50Y	Culvert is plugged with bedload causing overtopping and erosion of road surface. Stream is ephemeral.	Clean inlet and install armored critical dip.
Stream Crossing CMP	0.414	35N09Y	Perennial stream flow under culvert through upper half of culvert. Flow emerges in culvert through holes in CMP.	Evaluate CMP conveyance and integrality of road fill. Replace culvert in required,
Connected Cross-Drain w/CMP & Erosion Feature (Gully)	0.132 - 0.147	35N74B	Inlet of CMP buried. Flow overtops structure and diverts down to road and forms gully in roadbed, road fill, and hillslope below.	Clean inlet. Install critical dip and armor outlet with rip-rap. Fill in void of existing road fillslope gully with rip-rap to prevent further erosion.
Cross-Drain w/CMP	0.03	36N71	Inlet completely buried does not convey flow. Site has diversion potential.	Clear inlet or replace CMP.
Spring	3.416	36N29	Spring flow has no drainage structure. Flows on road and creates gully in fillslope down to perennial stream.	Install French Drain with perforated pipe to drain road prism and mitigate surface erosion. A dip with a thick layer of aggregate placed in the low point may also mitigate the issue.

Section 4 Grass Valley-Weaver Creek

4.1 Introduction

The Grass Valley-Weaver Creek watershed is approximately 141,888 acres in size and is part of the larger, encompassing Trinity River Sub-Basin and Klamath Basin. The watershed straddles the Trinity River, just downstream of the Lewiston-Trinity Reservoir. Both Highway 299 and Highway 3 run through the watershed. The north side of the watershed includes the Weaver Creek drainages and the south side of the watershed includes the Grass Valley Creek drainages. The Weaver Creek drainages originate near Monument Peak in the Trinity Mountains and flow south towards the Trinity River, while the Grass Valley Creek drainages originate from the north side of Bully Choop Mountain, Paradise Peak, and Shoemaker Bally.

The majority of watershed is mountainous, with steep valleys and high gradient channels. The most northern section of the watershed is located within Trinity Alps Wilderness. The south side of the watershed elevations range from 7,600 feet at the top of Monument Peak on the north side to approximately 6,000 feet at Shoemaker Bally on the south side, with the lowest point along the Trinity River at 1,600 feet. The vegetation in the watershed varies according to soils, aspect and slope. At the higher elevations the vegetation is dominated by mixed evergreen conifer forests and Oregon white oak forest can be found at lower elevations, near the mainstem of the Trinity River. In general the vegetation is dominated by coniferous forests, hardwood forests, montane chaparral and grasslands (U.S. Bureau of Land Management 1995).

The climate of the watershed is Mediterranean, with warm, dry summer, and cool, wet winters. Temperatures and precipitation vary in the watershed with the elevation differences. The majority of the rainfall occurs in the winter and spring months. Average annual rainfall ranges from about 30 inches at the lower elevation to 70 inches in the higher elevations. Snow does occur in the watershed; it generally accumulates above 5000 feet.

4.2 Overview

For this effort, seven subwatersheds (HUC 6) and seven drainages[2] (HUC 7) were delineated for the purposes of the SSI and RAP efforts. Table 4-1 characterizes the hierarchy for the seven subwatersheds, including, Deadwood Creek, Dulton Creek, Grass Valley Creek, Indian Creek, Reading Creek, Rush Creek, and Weaver Creek. Figure 4-1 illustrates the location of these subwatersheds, drainages and the respective road segments. As shown in Figure 4-1 and Table 4-1, the 2012 SSI focused on the north side of the watershed, primarily the Rush Creek and Weaver Creek subwatersheds, with minimal effort in Deadwood Creek subwatershed. The 2012 SSI excluded the Dulton Creek, Grass Valley Creek, Indian Creek, and Reading Creek subwatersheds on the south side of the watershed.

[2] Seven drainages were delineated within the STNF; drainages outside of the STNF were not delineated.

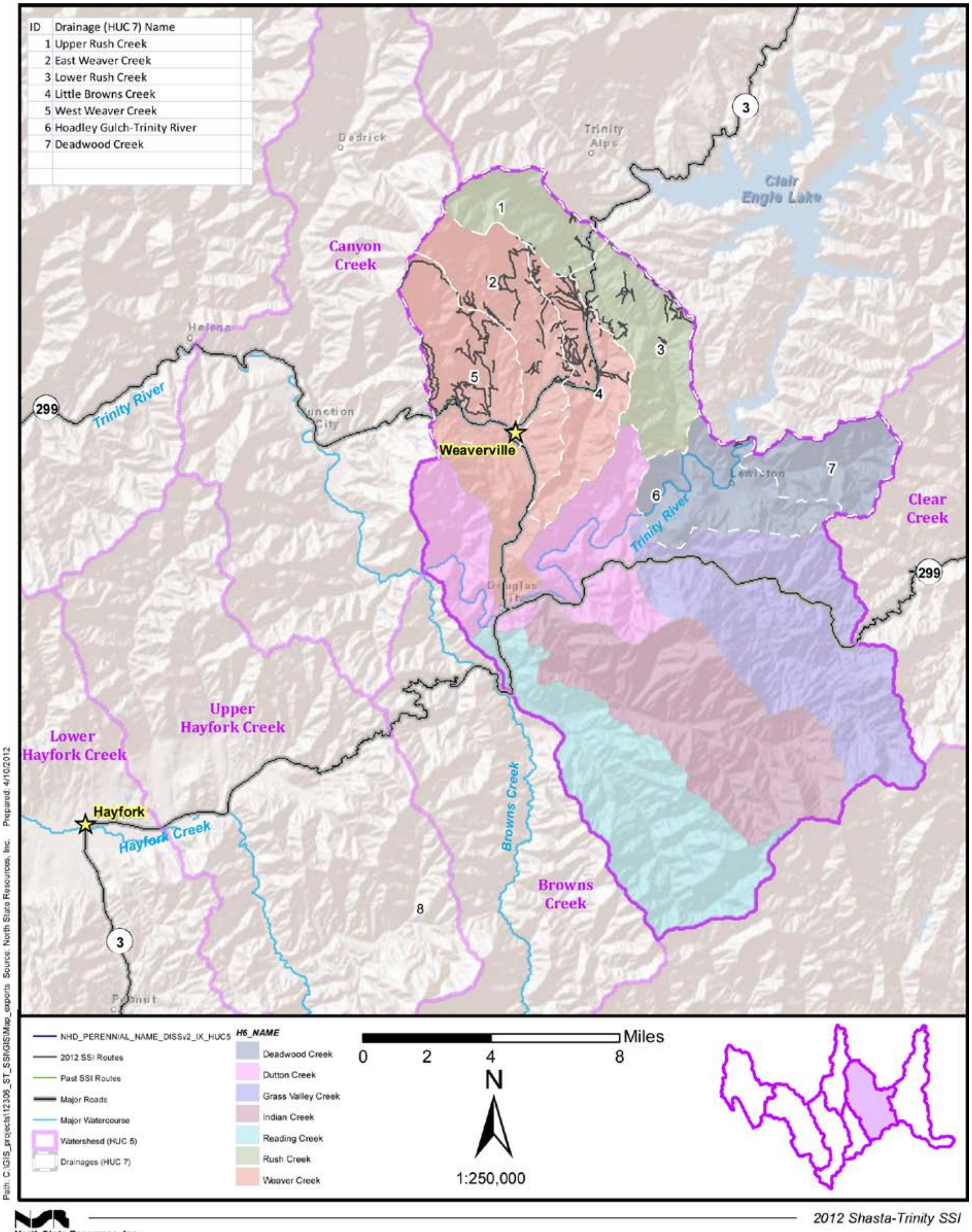


Figure 4-1. Grass Valley-Weaver Creek Watershed Location

Table 4-1. Grass Valley-Weaver Creek Watershed Characteristics

Subwatersheds (HUC 6)	Drainage Area (mi^2)	Total Road Length (mi)	Road Density (mi/mi^2)	Past SSI Road Miles	2012 SSI Road Miles	Total SSI Road Miles
Deadwood Creek	22.2	74.3	3.3	0.0	0.7	0.7
Dutton Creek	25.7	88.4	3.4	0.0	0.0	0.0
Grass Valley Creek	36.8	43.6	1.2	0.0	0.0	0.0
Indian Creek	33.6	18.9	0.6	0.0	0.0	0.0
Reading Creek	31.2	36.9	1.2	0.0	0.0	0.0
Rush Creek	22.5	99.6	4.4	2.9	16.3	19.2
Weaver Creek	49.7	271.3	5.5	0.0	70.0	70.0
Watershed Totals	**221.7**	**632.9**	**2.9**	**2.9**	**87.0**	**89.8**

As shown in Table 4-1, the project GIS data indicates there are 632.9 miles of road in the watershed and a road density of 2.9 miles of road per square mile of watershed. Weaver Creek subwatershed has the largest drainage area within the watershed (49.7 square miles), and the greatest road mileage and road density of all subwatersheds, with 105.8 miles of road and 5.5 miles of road per square mile. Rush Creek and Deadwood Creek are the smallest subwatersheds in the watershed and are similar in size, 22.5 and 22.2 square miles, respectively. Rush Creek has more roads and higher road density than Deadwood Creek, with 99.6 miles of road and 4.4 miles per square mile compared to 74.3 miles and 3.3 miles per square mile.

Hydrology

The watershed contains approximately 932.7 miles of stream channels with a stream density of 4.2 miles per square mile (Table 4-2). Approximately 67 percent of the streams are perennial in nature; Weaver Creek, Rush Creek, Indian Creek and Grass Valley Creek are some of the largest perennial streams in terms of drainage area.

As described above, three of the seven subwatersheds, Deadwood Creek, Rush Creek and Weaver Creek, were included in the SSI and RAP efforts. Of these subwatersheds, Weaver Creek has greatest stream mileage and the highest stream density, with 239.2 miles of stream and 4.6 miles of stream per square mile (Table 4-2). Approximately 47 percent of the streams are perennial in nature and 24 percent of the streams are fish bearing. There are three drainages delineated within the SNTF area of the Weaver Creek subwatershed, including, East Weaver, West Weaver, and Little Browns Creek (Figure 4-1).

The two smallest subwatersheds within Grass Valley-Weaver Creek watershed, Rush Creek and Deadwood Creek, have the lowest stream mileage of all subwatersheds. Rush Creek subwatershed has 101.9 miles of stream (41 percent perennial) and stream density of 4.5 miles of stream per square mile in (Table 4-2). Approximately 41 percent of the streams are perennial in nature and 32 percent are fish bearing. Deadwood Creek has 84.3 miles of stream (87 percent perennial) and 3.8 miles of stream per square mile (Table 4-2). Approximately 87 percent are perennial in nature and 46 percent are fish bearing. There are two drainages, Upper and Lower Rush Creek, nested within the Rush

Creek subwatershed and two drainages within Deadwood Creek subwatershed, including, Hoadley Gulch and Deadwood Creek (Figure 4-1).

Table 4-2. Grass Valley-Weaver Creek Watershed Streams Densities and Fish Bearing Lengths

Subwatersheds (HUC 6)	Stream Length (mi)	Stream Density (mi/ (mi^2))	Miles of Perennial Stream	Perennial Streams as % of Total Miles	Miles of Fish-Bearing Streams	Fish-Bearing Streams as % of Total Miles
Deadwood Creek	84.3	3.8	73.5	87.1%	21.8	25.8%
Dutton Creek	117.8	4.6	83.1	70.6%	27.1	23.0%
Grass Valley Creek	151.5	4.1	121.9	80.5%	27.3	18.0%
Indian Creek	143.4	4.3	127.2	88.7%	29.3	20.4%
Reading Creek	107.0	3.4	73.6	68.8%	26.4	24.7%
Rush Creek	101.9	4.5	41.9	41.1%	32.6	32.0%
Weaver Creek	226.8	4.6	105.8	46.6%	54.9	24.2%
Watershed Totals	**932.7**	**4.2**	**627.0**	**67.2%**	**219.4**	**23.5%**

Water Quality

The Trinity River, including tributaries such as Deadwood, Grass Valley, Indian, Reading, Rush and Weaver Creeks are included on California's CWA Section 303(d) list as water quality limited due to sediment (Environmental Protection Agency 2010). The sediment impairment in the Trinity River and its tributaries resulted in non-attainment of designated beneficial uses, primarily the cold-water fishery, including spawning, migration, and reproduction and fish habitat (Environmental Protection Agency 2001). A total maximum daily load (TMDL) for, with numeric targets, was prepared for the Trinity River, and the listed tributaries in 2001. The water qualities objectives addressed in the TMDL include settleable material, suspended material, sediment, and turbidity (Environmental Protection Agency 2001).

The sediment source inputs in Deadwood, Grass Valley, Indian, and Reading Creeks are primarily associated with historic and ongoing land management activities (i.e. roads, timber harvest, abandoned roads, and historic mining activities). Natural disturbance processes (e.g. landslides, bank erosion) result in the principal transport and delivery of sediment to Weaver and Rush Creeks. Grass Valley Creek drainage is a major sediment contributor to the Trinity River; it has the highest annual sediment delivery rates within the upper section (below Lewiston dam) of the Trinity River basin. The drainage is underlain by highly erodible decomposed granite. The primary source of sediment inputs in the Grass Valley Creek drainage is from decades of timber management and road construction activities. Since the 1980s, there has been a concentrated effort by a number of entities to control erosion and reduce the sediment input to the Trinity River from the Grass Valley Creek drainage. The TMDL for the Trinity River specified the following reductions in management sediment sources are needed to attain the allocated TMDL (Environmental Protection Agency 2001).

- Weaver Creek and Rush Creek = 41 percent

- Deadwood Creek = 88 percent
- Grass Valley Creek = 97 percent
- Indian Creek = 96 percent
- Reading Creek = 82 percent

Aquatic and Riparian Habitat

The Trinity River and its tributaries was historically a major producer of steelhead trout and chinook and coho salmon. Anadromous fish populations have declined throughout the Trinity River basin over the last several decades due to habitat degradation, exacerbated by human activities (Environmental Protection Agency 2001). Due to the decline in population, the Southern Oregon Northern California Coastal Coho salmon have been listed as threatened under the Endangered Species Act (National Oceanic and Atmospheric 2011).

The Grass Valley-Weaver Creek watershed provides potential habitat for steelhead, chinook and coho salmon (U.S. Forest Service 2012). Studies indicate that chinook and coho salmon do populate various tributaries within the Grass Valley-Weaver Creek watershed. Studies conducted in 1965 by LaFaunce report adult spawning chinook in Rush Creek and Reading Creeks (La Faunce 1965). A more recent study conducted by the U.S. Bureau of Land Management in 1995 identified coho salmon carcasses in various un-named tributaries within the Grass Valley-Weaver Creek watershed (Environmental Protection Agency 2001). A separate study conducted in 1989 reported salmonid populations in the following tributaries within the Grass Valley-Weaver Creek watershed (U.S. Bureau of Land Management 1995):

- Steelhead, coho and chinook salmon were observed in the lower 7 miles of Reading Creek
- Juvenile steelhead and juvenile coho salmon were observed in East Weaver Creek.
- Steelhead, coho, chinook and brown trout were observed in the lower 6 miles of Weaver Creek.
- Juvenile steelhead and 0+ chinook were observed in Indian Creek.

Ongoing monitoring efforts are conducted by various agencies to assess the habitat conditions of creeks within the Grass Valley-Weaver Creek watershed. Snorkel surveys, Stream Conditions Inventories (SCI), pool habitat surveys and continuous temperature monitoring are conducted in the Weaver Creek drainages. A very recent field report, from November 2012, confirmed that coho salmon are actively spawning in Grass Valley Creek (Chilcote 2012).

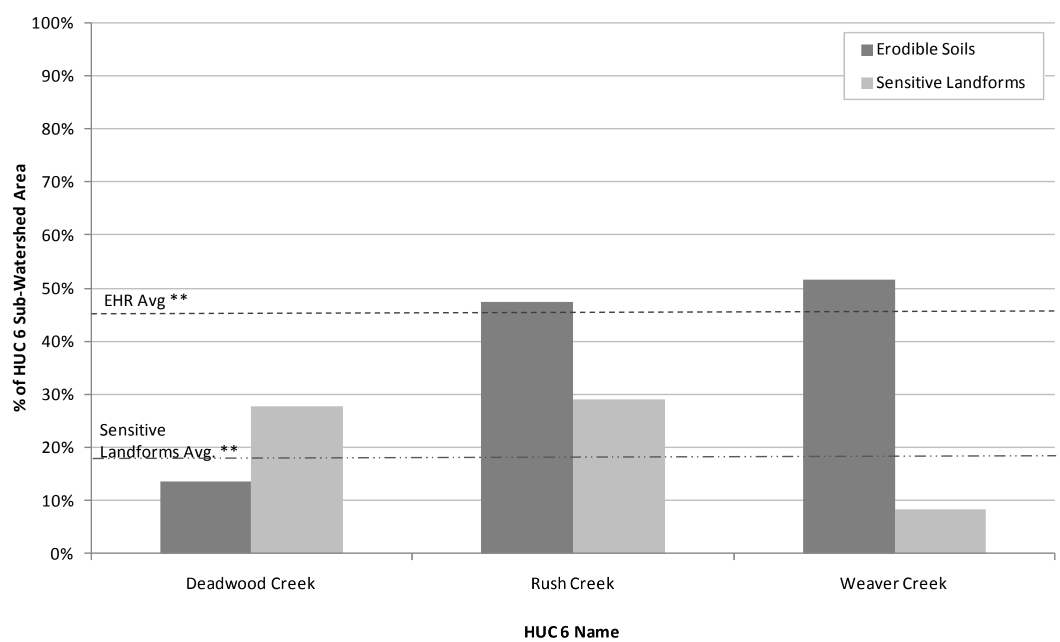
Geology

The Grass Valley-Weaver Creek watershed contains several different geologic terrains (Table 4-3). The western portion of the watershed contains metamorphic rocks of the Abrams Schist with some localized areas of serpentine. Whereas, the eastern portion of the watershed is dominated by intrusive rocks of the Shasta Bally Pluton. Late Paleozoic limestone and Miocene aged sandstone and conglomerate occupy most of the northern portion of the watershed. Within the watershed there may be some localized areas of accelerated erosion due to multiple structural contacts between geologic units and the relative weakness of plutonic rocks and some sedimentary lithologies.

Table 4-3. Grass Valley-Weaver Creek Watershed Prominent Geologic Units and Rock Types

Geologic Unit	Percent of Watershed	Dominant Rock Type(s)
Central Metamorphic Belt	34%	
Abrams Schist	30%	mica schist, impure marble, amphibolite
Undifferentiated unit	4%	peridotite, serpentine
Plutonic Rock	21%	
Shasta Bally Pluton	19%	quartz diorite, granodiorite
Miocene Sedimentary Rock	14%	non-marine sandstone & conglomerate
Late Paleozoic Limestone	14%	limestone (undifferentiated)
Eastern Klamath Belt	12%	
Bragdon Formation	7%	shale and conglomerate
Moffet Creek Formation	4%	sandstone & slaty mudstone
Quaternary surface deposits	3%	alluvium, landslide deposits

Approximately 21 percent of the Grass Valley-Weaver Creek watershed is covered by STNF soil data. Of the 21 percent that is covered by soil data, approximately 47 percent contains very high and high potential areas for soil erosion (Figure 4-2). In addition, 18 percent of the entire watershed is covered by sensitive landforms; mostly steep-sloped intrusive rocks, dormant and active landslides, and inner gorge terrain. A large portion of the Grass Valley-Weaver Creek watershed is outside of USFS boundaries, and geomorphic and soils data is limited within the rest of the watershed. As a result, characterization of the watershed does not include the southernmost sub-watersheds.



**Average is for portion of watershed/sub-watershed with associated data (usually USFS lands).

Figure 4-2. Area of Grass Valley-Weaver Creek Subwatersheds Occupied by Erodible Soils and Sensitive Landforms

4.3 SSI Results

As described in Section 1, roads in the Grass Valley-Weaver Creek watershed were inventoried during multiple field seasons. In total, approximately 89.8 miles of road were inventoried in the watershed. As part of the 2012 SSI, NSR inventoried 87.0 miles of road in the watershed during the 2011 and 2012 field seasons. The following discussion focuses on the 2012 SSI data set. The data acquired during the 2012 SSI was in addition to SSI data provided by the STNF, including information acquired by NSR and other entities over the past several years under various types of contracts and agreements. The cumulative SSI data set is presented following the 2012 SSI discussion.

2012 SSI Results

The objective of the 2012 SSI was to document the condition of existing road-related infrastructure and identify existing and potential erosion and sediment producing features located over 87.0 miles of road in the Grass Valley-Weaver Creek watershed (Figure 4-1 and Appendices E & F). Inventoried features were prioritized based on their potential for sediment production and delivery to the hydrologic network. This section focuses on the inventoried and prioritized features included in the 2012 SSI. The results are presented at both the subwatershed (HUC 6) and drainage scales (HUC 7).

Inventoried Features

The 2012 SSI identified and characterized 1,682 features; 7.1 miles of gully, 7.3 miles of ditch segments; 81 stream crossings; 11 erosion features; 373 hydrologically connected cross-drain sites; 1,200 non-hydrologically connected cross-drains; and 17 springs (Table 4-4 and Appendices E & F).

Table 4-4. 2012 Inventoried Features for Grass Valley-Weaver Creek Subwatersheds (HUC 6) and Drainages (HUC 7)

Subwatersheds (HUC 6) Drainages (HUC 7)	Road Miles	Gully Miles	Ditch Miles	Stream Crossings	Erosion Features	Connected Cross-Drains	Non-Connected Cross-Drains	Springs
Deadwood Ck.	0.7	0.2	0.3	0	0	0	8	0
Hoadley Gulch-Trinity River	0.7	0.2	0.3	0	0	0	8	0
Rush Ck.	16.3	0.8	0.6	21	2	101	225	3
Lower Rush Ck.	13.3	0.5	0.3	13	2	88	184	3
Upper Rush Ck.	3.0	0.3	0.3	8	0	13	41	0
Weaver Ck.	69.9	6.1	6.5	60	9	272	967	14
East Weaver Ck.	18.9	2.4	2.5	16	8	63	233	8
Little Browns Ck.	24.3	2.1	1.7	27	0	135	358	3
West Weaver Ck.	26.7	1.6	2.3	17	1	74	376	3
Watershed Totals	**87.0**	**7.1**	**7.3**	**81**	**11**	**373**	**1200**	**17**

Approximately 70 of the 87 road miles inventoried were located in the Weaver Creek subwatershed (80%). A total of 6.1 gully miles, 6.5 ditch miles, and 1,322 features were identified in this subwatershed. Of the remaining 17 road miles inventoried, 16.3 miles were located in the Rush Creek subwatershed. Only 0.7 miles were inventoried in the Deadwood Creek subwatershed; 0.2 gully miles, 0.3 ditch miles and eight non-hydrologically connected cross-drains were inventoried.

The Rush Creek subwatershed has a greater feature density than the Weaver Creek subwatershed, with 21.6 features per road mile compared to 18.9 features per road mile. The difference in feature density can mainly be attributed to the greater number of stream crossings and hydrologically connected cross-drains (per road mile) in the Rush Creek subwatershed.

Feature Analysis/Risk Analysis

As described in Section 2, risk ranking matrices were created to identify features that currently do, or potentially could deliver elevated levels of sediment to nearby streams or waterbodies. The number of high risk features and the proportion by subwatershed are listed in Table 3-5. The accompanying GIS project is organized to extract the type and location of features by risk rating at multiple scales. The density of high risk features types for each subwatershed and drainage is shown in Figure 4-3.

As illustrated in Table 4-5, the 2012 SSI identified the following high risk features: 3.9 gully miles, 2.8 ditch miles, 28 stream crossings, three erosion sites, 26 connected cross-drains with CMP, and five spring sites. A total of 62 features or 32 percent of the total 2012 Grass Valley-Weaver Creek features (excluding non-connected cross-drains and connected cross-drains without CMP) are characterized as high risk.

Table 4-5. High Risk Features for Grass Valley-Weaver Creek Subwatersheds (HUC 6) and Drainages (HUC 7)

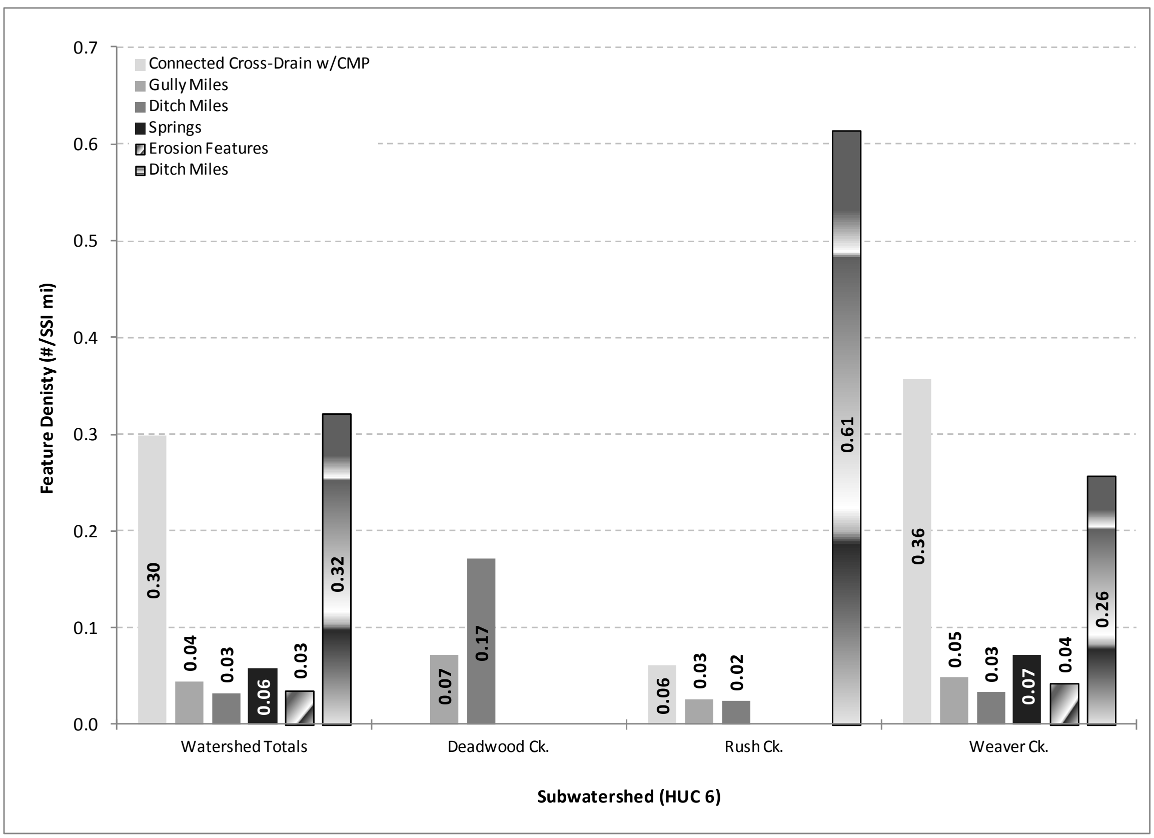
Subwatersheds (HUC 6) Drainages (HUC 7)	Gully Miles	Ditch Miles	Stream Crossings	Erosion Features	Connected Cross-Drain w/CMP	Springs
Deadwood Ck.	0.1 (29%)	0.1 (48%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Hoadley Gulch-Trinity River	0.1 (29%)	0.1 (48%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Rush Ck.	0.4 (54%)	0.4 (67%)	10 (48%)	0 (0%)	1 (4%)	0 (0%)
Lower Rush Ck.	0.2 (36%)	0.2 (58%)	3 (23%)	0 (0%)	1 (4%)	0 (0%)
Upper Rush Ck.	0.2 (89%)	0.2 (77%)	7 (87%)	0 (0%)	0 (0%)	0 (0%)
Weaver Ck.	3.4 (56%)	2.3 (36%)	18 (30%)	3 (33%)	25 (41%)	5 (36%)
East Weaver Ck.	1.8 (73%)	0.7 (29%)	9 (56%)	3 (38%)	13 (62%)	3 (38%)
Little Browns Ck.	0.9 (43%)	0.5 (29%)	8 (30%)	0 (0%)	3 (20%)	1 (33%)
West Weaver Ck.	0.7 (46%)	1.1 (48%)	1 (6%)	0 (0%)	9 (36%)	1 (33%)
Watershed Totals	**3.9 (55%)**	**2.8 (39%)**	**28 (35%)**	**3 (27%)**	**26 (30%)**	**5 (29%)**

Note: Values in parenthesis represent percentage of watershed feature totals.

Approximately 82 percent of the high risk features (51 features) were located in the Weaver Creek subwatershed. This is not surprising, since 79 percent of the total inventoried features were located in the Weaver Creek subwatershed. The remaining 18 percent or 11 high risk features were located in the Rush Creek subwatershed and no high risk features were located in the Deadwood Creek subwatershed.

When compared to the total number of high risk features and total road miles inventoried in the SSI, the proportion of these features within each subwatershed is relatively consistent with the proportion of roads inventoried within the subwatershed. For example, the Weaver Creek subwatershed contains approximately 80 percent of the road miles inventoried within the watershed and it also contains 82 percent of the total number of high risk features and nearly 80 percent of the total miles of high risk gullies. Similarly, the Rush Creek subwatershed contains approximately 19 percent of the road miles inventoried with the watershed and 18 percent of the high risk features. The Deadwood Creek subwatershed contains so few inventoried miles, it is difficult to compare to the other subwatersheds.

Figure 4-3 illustrates the variability in the number and type of high risk features per mile of inventoried road by subwatershed. However, since the majority of the road miles were inventoried in the Weaver Creek subwatershed, and much less in Rush Creek subwatershed (and nearly zero in Deadwood Creek subwatershed), Figure 4-3 is not necessarily a fair comparison of the three subwatersheds or of the watershed average.



Note: Gullies and ditch densities reported as miles of feature per mile of SSI road.

Figure 4-3. Density of High Risk Features for Grass Valley-Weaver Creek Subwatersheds

Cumulative SSI Data

Prior to conducting the 2012 SSI effort, the STNF acquired SSI data in the Rush Creek subwatershed; no other data was available in the other subwatersheds within the Grass Valley-Weaver Creek watershed. Table 4-6 illustrates the total road miles inventoried relative to the cumulative number and feature types that have been documented through other SSI efforts in the Grass Valley-Weaver Creek watershed, by subwatershed/drainage.

The following discussion is based on cumulative SSI efforts conducted for the STNF on approximately 14 percent of all roads within the Grass Valley-Weaver Creek watershed. Of the 89.8 miles of inventoried roads in the Grass Valley-Weaver Creek watershed, only 2.9 miles were inventoried prior to the 2012 SSI. Cumulatively, the SSI data set documents the occurrence of 11 erosion sites and 466 hydrologically connected features, which includes stream crossings and connected cross-drains (Table 4-6). Four hundred and twenty of these features were stream crossings, of which 30 percent were identified as high risk sites. These include crossings that were unable to, or were in danger of, not being able to adequately convey peak flow events at the site. Approximately 27 percent of the total stream crossings were identified with diversion potential, and 3 percent were undersized pipes. Field indicators of undersized pipe were evidence of overtopping; substantially plugged features, poor structural integrity (i.e. holes, separated, etc.), poor positioning, or a significant loss of fill at the inlet.

Table 4-6. Grass Valley-Weaver Creek Watershed Cumulative SSI Data

Subwatersheds (HUC 6) Drainages (HUC 7)	Total SSI Miles	Erosion Features	Connected Features[1]	Stream Crossings			
				Total	High Risk	Diversion Potential	FEUP[2]
Deadwood Ck.	0.7	0	0	0	0	0	0
Deadwood Ck.	0.0	0	0	0	0	0	0
Hoadley Gulch-Trinity River	0.7	0	0	0	0	0	0
Rush Ck.	19.2	2	134	33	10	10	0
Lower Rush Ck.	16.2	113	25	3	3	0	0
Upper Rush Ck.	3.0	21	8	7	7	0	0
Weaver Ck.	69.9	9	332	60	18	15	3
East Weaver Ck.	18.9	79	16	9	8	3	3
Little Browns Ck.	24.3	162	27	8	5	0	0
West Weaver Ck.	26.7	91	17	1	2	0	0
Watershed Totals	**89.8**	11	466	93	28	25	3

[1]Includes all stream crossings and Connected Cross-Drains; indicator of hydrologic connectivity of roads
[2]Field Evidence of Undersized Pipe (FEUP); see methods for explanation.

The additional 2.9 miles of road inventoried by STNF previous to the 2012 SSI were located in the Rush Creek subwatershed. This data set represents the second highest mileage inventoried for any of the subwatersheds in the Grass Valley-Weaver Creek watershed, with 19.2 miles of inventoried road. The Rush Creek subwatershed also has the second highest total road miles (99.6 miles) and second highest road density in the Grass Valley-Weaver Creek watershed, with 4.4 miles of road per square mile (Table 4-1). Approximately 19 percent of the total roads in Rush Creek subwatershed were included in the cumulative SSI data set. The cumulative data set includes 2 erosion features and 134 hydrologically connected features, of which 33 are stream crossings (see Table 4-6). Of the 33 stream crossings, 10 were determined to have diversion potential and 10 were characterized as high risk.

Comparatively, the Weaver Creek subwatershed has almost three times the total road mileage as Rush Creek (271.3) and a denser road network, with 5.5 miles of road per square mile (Table 4-1). Approximately 25 percent (69.9 miles) of the total roads in the Weaver Creek subwatershed were inventoried, all during the 2012 SSI. Nine erosion features and 332 connected features, including 60 stream crossings were documented. Of the 60 stream crossings, 18 were considered high risk; 15 had diversion potential, and three had field evidence of undersized pipes (Table 4-6).

Figure 4-4 illustrates the variability in the number and type of cumulative features (listed in Table 4-6) per mile of inventoried road by subwatershed. As shown in Figure 4-4, the Rush Creek subwatershed has a greater density of connected features, high risk stream crossings, and crossings with diversion potential than the Weaver Creek subwatershed. The two subwatersheds have a similar density of erosion features.

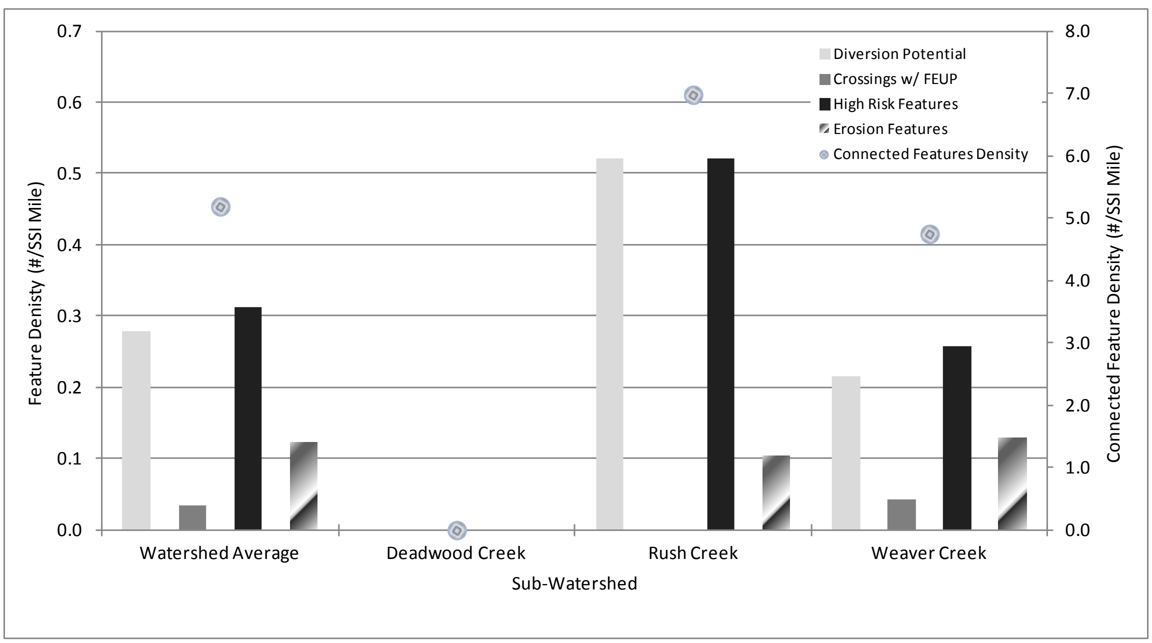


Figure 4-4. Density per Mile of SSI Road of Selected Features for Grass Valley-Weaver Creek Subwatershed

4.4 Aquatic and Riparian Resources RAP Risk Analysis

The main focus of the RAP risk analysis was to identify road segments that could pose a moderate to high risk to aquatic and riparian resources. Three resources, including, water quality, hydrologic processes, aquatic and riparian habitat are analyzed in the following discussion. The RAP risk analysis is presented at both the HUC 7 drainage and road segment scales.

Aquatic and Riparian Resources Total RAP Risk Score per Drainage

The total Aquatic and Riparian Resources RAP risk score (total RAP risk score) for road segments within each of the 15 drainages (HUC 7) that constitute the Grass Valley-Weaver Creek watershed are discussed in this section. The total RAP risk score is the average of the individual water quality, hydrologic processes, and aquatic and riparian habitat scores. As described in Section 2.4, the key questions specific to the three resources, and the associated criteria required to answer these questions have been developed in accordance with the STNF RAP protocol (Shasta-Trinity National Forest 2011) in order to rate the road segments at the drainage scale.

The RAP risk scores for water quality, hydrologic processes, aquatic and riparian habitat, including the total scores for each road and drainage are listed in Appendix D. Figure 4-5 illustrates the total miles of road per drainage and the associated total RAP risk score. This figure displays the relative risk per drainage for the various sections of roads included in the RAP analysis. A key point in this discussion is that the RAP analysis focused on the 2012 SSI data set due to inconsistencies in previous SSI data sets.

The Aquatic and Riparian Rap effort indicates that a small proportion of the 2012 SSI roads in the Grass-Valley-Weaver Creek watershed scored as high risk; approximately 2 percent or 1.6 miles scored 4 or above. As shown in Figure 4-5, the high risk roads were split equally between the Rush Creek and Weaver Creek subwatersheds. Half of the high risk roads (0.8 miles) were located in Upper Rush Creek drainage.

As shown in Figure 4-5, all three subwatersheds and all six drainages included in the 2012 SSI have roads that scored between a 3.0 and 4.0 in the RAP risk analysis. Approximately 15 percent or 13.8 miles of road inventoried in the 2012 SSI scored as moderate-high risk to aquatic and riparian resources within the Grass Valley-Weaver Creek watershed (Figure 4-5). The majority (82%) of these roads were located in Weaver Creek subwatershed, with 40 percent in Little Browns Creek drainage (Figure 4-5).

The Little Browns Creek drainage had the most road mileage, 5.9 miles, scored moderate-high to high risk to aquatic and riparian resources. West Weaver Creek drainage had the second highest mileage, 3.9 miles, scored moderate-high to high risk to aquatic and riparian resources. Both of these drainages are located in the Weaver Creek subwatershed.

Overall, 83 percent of the roads included in the 2012 SSI within the Grass Valley-Weaver Creek watershed had scores less than 3.0 (low-moderate risk). Based on the assumptions used for the RAP analysis, this suggest that a large number of the roads pose a low to moderate risk of affecting aquatic and riparian resources.

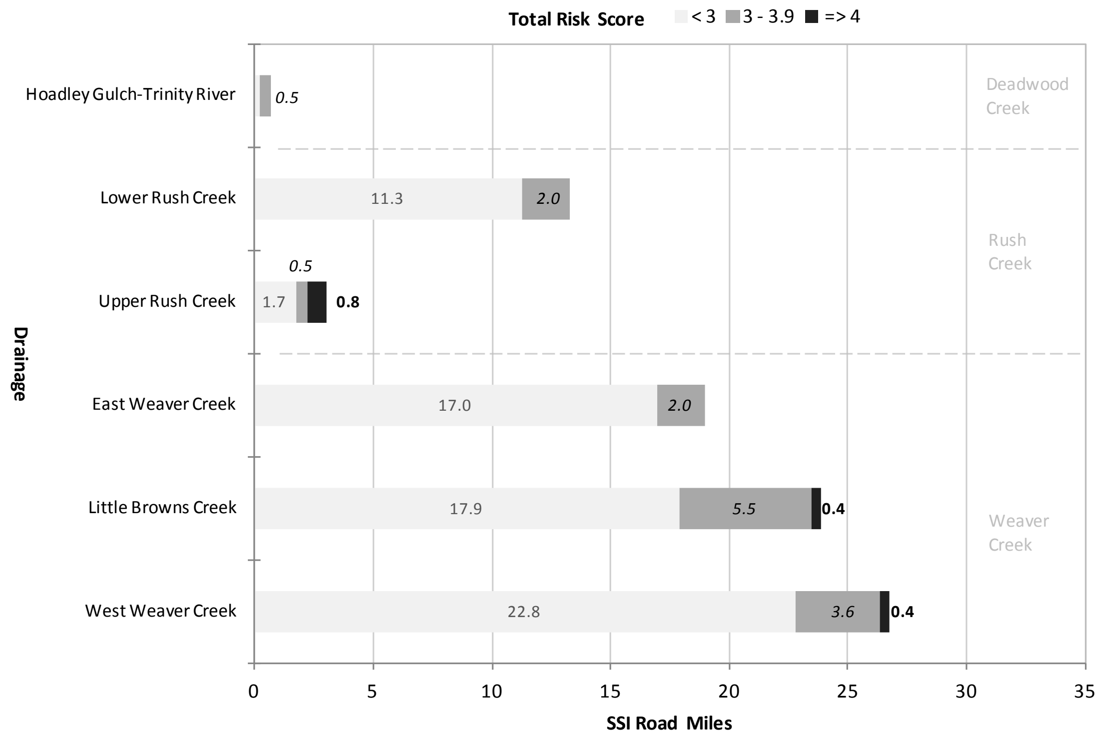


Figure 4-5. Aquatic and Riparian Resources RAP Total Risk Score for Grass Valley-Weaver Creek Watershed Drainages

Moderate-High to High Risk Road Segments

Table 4-7 lists those road segments by drainage included in the 2012 SSI that scored 3.0 or above in the RAP risk analysis. Based on this analysis, these road segments have a moderate-high to high risk of affecting water quality, hydrologic processes, and aquatic and riparian habitats. In total, four road segments equaling approximately 1.6 miles scored high risk and 57 road segments equaling 13.8 miles scored moderate-high risk. Figures 4-6a and 4-6b illustrate the location of the moderate-high to high risk roads segments in the Grass Valley-Weaver Creek watershed.

As shown in Table 4-7, the score for water quality is generally the highest of the three resource risk scores, with the exception of a few road segments where the score for water quality is equal to or slightly less than the score for hydrologic processes scores. Seventy percent of the moderate-high to high risk road segments have water quality scores equal to or above 4.0. This suggests that many of these road segments are hydrologically connected and intersect areas prone to erosion. Evaluation of the location of the moderate-high to high risk roads show that many of the roads are located adjacent to major streams and tributaries and/or cross streams. The close proximity of the roads to aquatic and riparian habitat and provide a direct pathway for transport and delivery of sediment to water bodies within the Grass Valley-Weaver Creek watershed. For example, Road 34N97 received a water quality score of 4.7 and is located near the headwaters of Rush Creek, and runs adjacent to Rush Creek.

Table 4-7 indicates that all road segments with one exception scored 3.8 for hydrologic processes. This analysis indicates that all moderate-high risk road segments pose a similar risk to hydrologic processes throughout the Grass Valley-Weaver Creek watershed. These roads may potentially affect the routing of water by intercepting and diverting flows from their natural path. This is also an indication that the road alignment and fill may constrict the channel, isolate floodplains, and/or constrain channel migration.

The road segment scores for aquatic and riparian habitat are lower than the water quality and hydrologic processes score. The aquatic and riparian habitat risk scores ranged between 2.0 and 3.8. These scores correlate the risk to aquatic and riparian habitat relative to the individual road segments with respect to affects on the functions and values of aquatic and riparian habitat, including attributes such as connectivity and flow. For example Road U33N38B is located in the West Weaver Creek drainage and received the highest aquatic and riparian risk score (3.8). The road segment is considered higher risk than others analyzed because it located in between two fish bearing streams, one of which is McKinzey Gulch, and it also crosses a fish bearing stream.

Table 4-7. Grass Valley-Weaver Creek Watershed Routes with Total RAP Risk Scores of 3.0 and Greater

			Resource Risk Scores			
Route ID	**Drainage Name**	**Miles**	**Aquatic, Riparian**	**Hydrologic Process**	**Water Quality**	**Total Risk**
34N97	Upper Rush Creek	0.795	3.5	3.8	4.7	4.0
U34N96B	Little Browns Creek	0.149	3.5	3.8	4.7	4.0
U230A	Little Browns Creek	0.290	3.5	3.8	4.6	4.0
U33N38B	West Weaver Creek	0.365	3.8	3.8	4.3	4.0
U3TRI01	Little Browns Creek	0.113	3.5	3.8	4.5	3.9
U3TRI02	Little Browns Creek	0.043	3.5	3.8	4.5	3.9
34N96	Little Browns Creek	1.429	3.5	3.8	4.4	3.9
33N01	West Weaver Creek	0.435	3.5	3.8	4.3	3.9
U34N77A	Little Browns Creek	0.378	3.5	3.8	4.3	3.8
U33N38A	West Weaver Creek	0.439	3.5	3.8	4.2	3.8
34N97A	Upper Rush Creek	0.273	3.5	3.8	4.1	3.8
U33N01K	West Weaver Creek	0.436	3.5	3.8	4.1	3.8
33N42	West Weaver Creek	1.168	3.5	3.8	4.0	3.8
U34N96BF	Little Browns Creek	0.203	3.5	3.8	4.0	3.8
U3TRI01A	Little Browns Creek	0.066	3.5	3.8	4.0	3.8
34N99	East Weaver Creek	0.163	3.5	3.8	3.9	3.7
U228A	East Weaver Creek	0.957	3.5	3.8	3.9	3.7
34N24	Lower Rush Creek	0.573	3.5	3.8	3.9	3.7
34N96B	Little Browns Creek	0.214	3.5	3.8	3.9	3.7
33N80	Hoadley Gulch-Trinity River	0.500	3.5	3.8	3.9	3.7
U33N01B	West Weaver Creek	0.181	3.5	3.8	3.9	3.7

Table 4-7. Grass Valley-Weaver Creek Watershed Routes with Total RAP Risk Scores of 3.0 and Greater

			Resource Risk Scores			
Route ID	Drainage Name	Miles	Aquatic, Riparian	Hydrologic Process	Water Quality	Total Risk
34N97_G1	Upper Rush Creek	0.038	3.5	3.8	3.8	3.7
U3TRI03F	Little Browns Creek	0.150	3.5	3.8	3.8	3.7
33N42A	West Weaver Creek	0.353	3.5	3.8	3.8	3.7
33N36	West Weaver Creek	0.228	3.5	3.8	3.7	3.7
33N40	West Weaver Creek	0.145	3.5	3.8	3.7	3.7
U33N01BA	West Weaver Creek	0.173	3.5	3.8	3.7	3.7
U33N01C	West Weaver Creek	0.006	3.5	3.8	3.7	3.7
U34N77AAB	Little Browns Creek	0.006	3.5	3.8	3.7	3.6
U34N77AB	Little Browns Creek	0.006	3.5	3.8	3.7	3.6
U34N96BA	Little Browns Creek	0.006	3.5	3.8	3.7	3.6
U34N96BAA	Little Browns Creek	0.006	3.5	3.8	3.7	3.6
U34N96BB	Little Browns Creek	0.006	3.5	3.8	3.7	3.6
U34N96BC	Little Browns Creek	0.019	3.5	3.8	3.7	3.6
U34N96BD	Little Browns Creek	0.006	3.5	3.8	3.7	3.6
U34N96BE	Little Browns Creek	0.006	3.5	3.8	3.7	3.6
U34N96G	Little Browns Creek	0.019	3.5	3.8	3.7	3.6
U34N96L	Little Browns Creek	0.086	3.5	3.8	3.7	3.6
U3TRI05	Little Browns Creek	0.118	3.5	3.8	3.7	3.6
U3TRI05B	Little Browns Creek	0.006	3.5	3.8	3.7	3.6
U3TRI05C	Little Browns Creek	0.073	3.5	3.8	3.7	3.6
U3TRI06	Little Browns Creek	0.006	3.5	3.8	3.7	3.6
U236A	East Weaver Creek	0.326	2.0	3.8	4.9	3.5
U236AA	East Weaver Creek	0.145	2.0	3.8	4.9	3.5
34N34	Upper Rush Creek	0.199	2.0	3.8	4.8	3.5
U236AC	East Weaver Creek	0.100	2.0	3.8	4.7	3.5
34N95G	Little Browns Creek	0.241	2.0	3.8	4.7	3.5
U34N95I	Little Browns Creek	0.424	2.0	3.8	4.5	3.4
34N28A	Lower Rush Creek	0.807	2.0	3.8	4.2	3.3
U34N33YA	Lower Rush Creek	0.479	2.0	3.8	4.1	3.3
34N89A	East Weaver Creek	0.256	2.0	3.8	4.0	3.3
U34N52YD	Little Browns Creek	0.881	2.0	3.8	4.0	3.3
U34N96C	Little Browns Creek	0.387	2.0	3.8	4.0	3.3

Table 4-7. Grass Valley-Weaver Creek Watershed Routes with Total RAP Risk Scores of 3.0 and Greater

			Resource Risk Scores			
Route ID	**Drainage Name**	**Miles**	**Aquatic, Riparian**	**Hydrologic Process**	**Water Quality**	**Total Risk**
U34N05YB	Little Browns Creek	0.144	2.0	3.8	3.9	3.2
34N41A	Lower Rush Creek	0.020	2.0	3.8	3.8	3.2
U34N52YC	Little Browns Creek	0.235	2.0	3.8	3.8	3.2
U34N96M	Lower Rush Creek	0.129	2.0	3.8	3.8	3.2
U34N95A9AA	East Weaver Creek	0.019	2.0	3.8	3.8	3.2
U34N95NA	East Weaver Creek	0.006	2.0	3.8	3.8	3.2
U34N52YCA	Little Browns Creek	0.006	2.0	3.8	3.7	3.1
U34N52YCB	Little Browns Creek	0.006	2.0	3.8	3.7	3.1

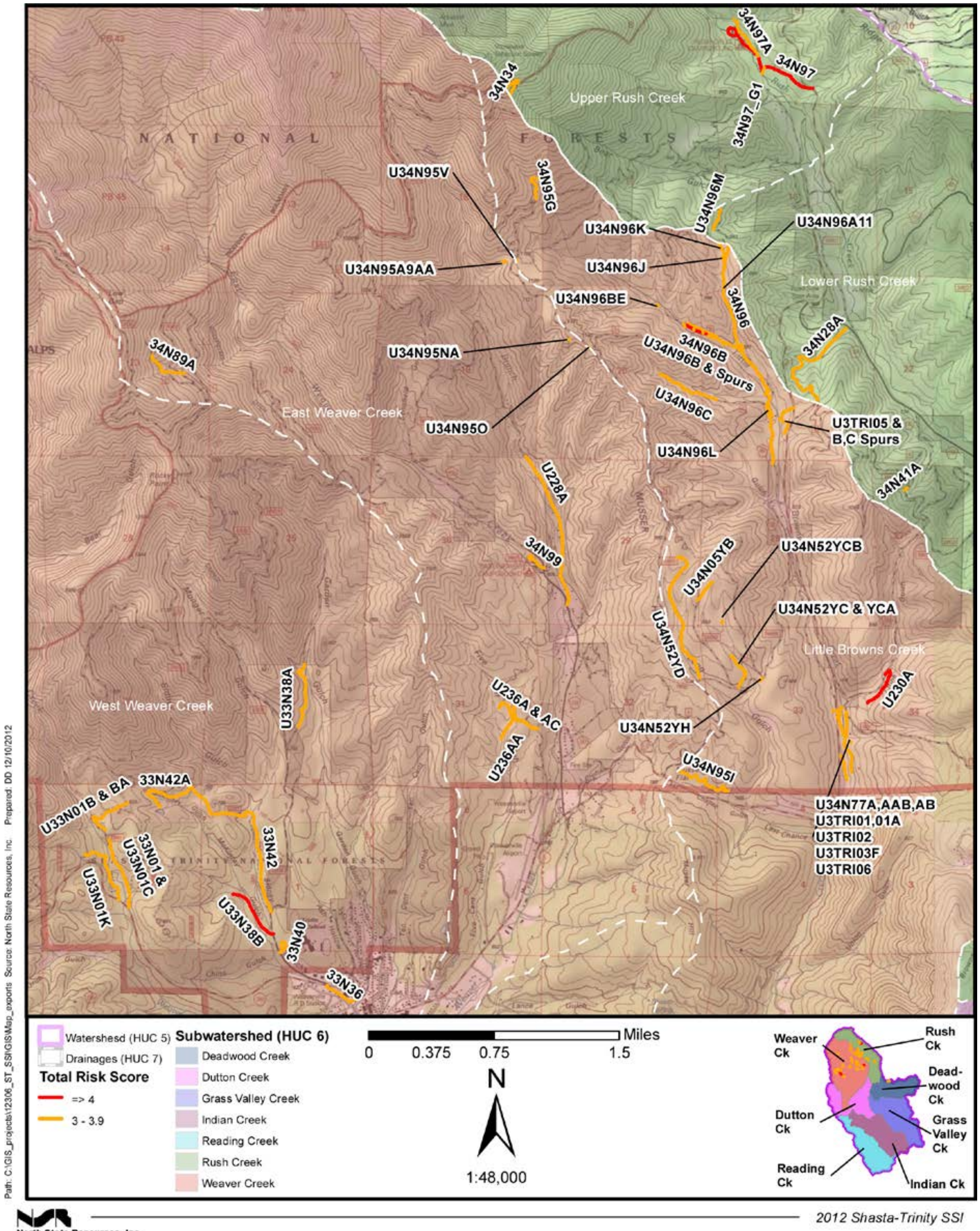


Figure 4-6a. Location of Moderate-High to High Risk Roads Segments in the Grass Valley-Weaver Creek Watershed

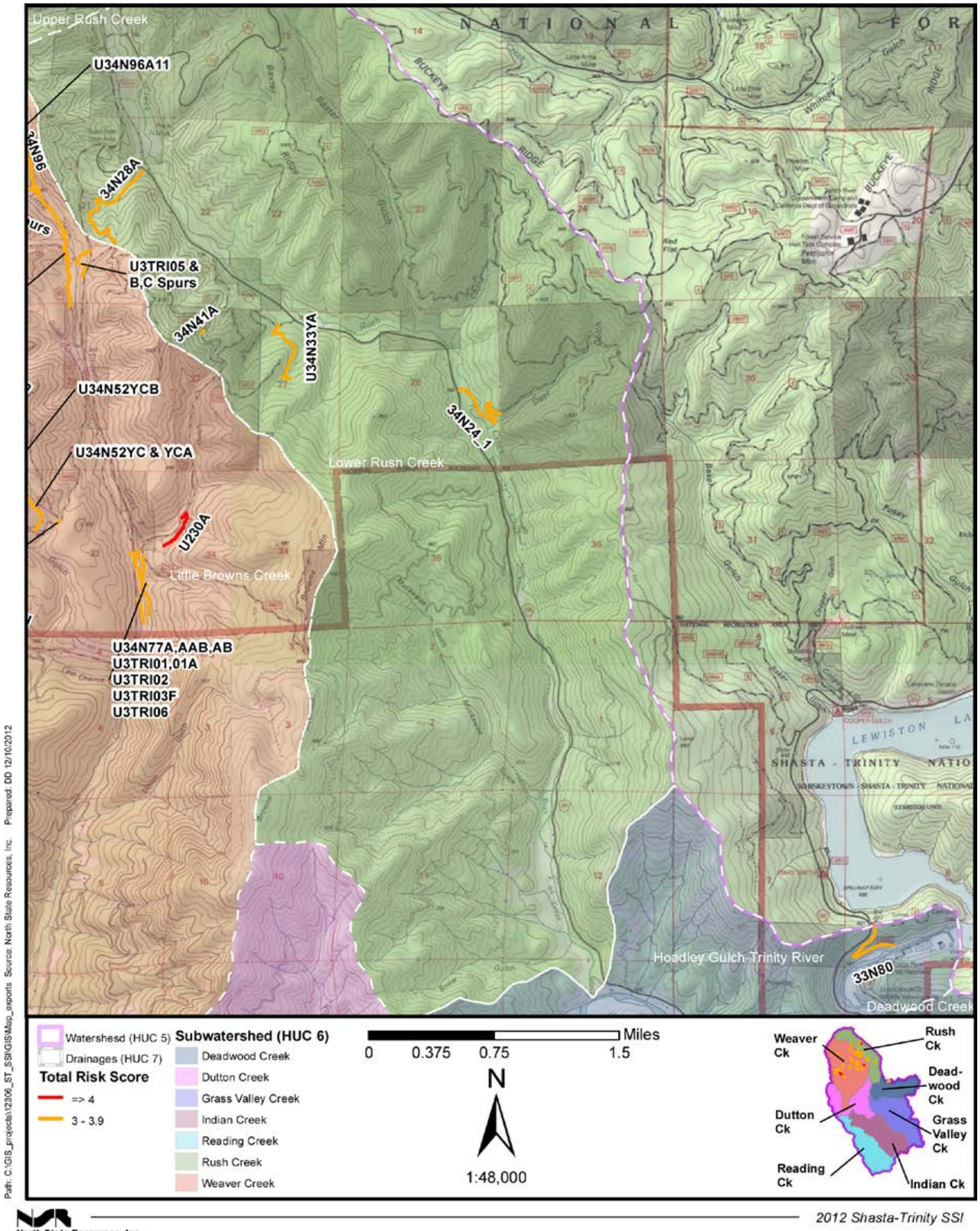


Figure 4-6a. Location of Moderate-High to High Risk Roads Segments in the Grass Valley-Weaver Creek Watershed

4.5 Recommendations

Moderate-High and High Risk Road Segments General Recommendations

Table 4-8 provides general recommendations for routes in the Grass Valley-Weaver Creek watershed with a total RAP risk score of 3.0 and greater. Four different recommendations are presented, including: maintain, upgrade, decommission, and evaluate. Maintain includes activities such as cleaning out inlets and outlets of culverts and cross-drain with culverts, cleaning rolling dips and ditches, and spot-grading. Also included in this category are roads that have been decommissioned or abandoned and do not have significant erosion issues; maintain indicates that they should retain their current route status. Upgrading roads includes renovation of existing features, construction of new features, large-scale grading and placement of aggregate, combined with normal maintenance activities. Decommissioning the road includes either full road obliteration or a temporary road decommission. Evaluate includes routes that were not inventoried because they could not be located or were inaccessible due to land ownership. This recommendation suggests that USFS remove non-existent routes from database and evaluate legal access to roads that were inaccessible due to land ownership. The recommendations are based on the RAP risk score, the density and condition of the features in the 2012 SSI data set, and the road-related hydrologic connectivity to the stream network.

Table 4-8. General Recommendations for Moderate-High to High Risk Routes in the Grass Valley-Weaver Creek Watershed

Route ID	Drainage Name	Miles	Total Risk	General Recommendation
34N97	Upper Rush Creek	0.795	4.0	Upgrade
U34N96B	Little Browns Creek	0.149	4.0	Maintain or Decommission
U230A	Little Browns Creek	0.290	4.0	Maintain or Decommission
U33N38B	West Weaver Creek	0.365	4.0	Maintain
U3TRI01	Little Browns Creek	0.113	3.9	Maintain
U3TRI02	Little Browns Creek	0.043	3.9	Maintain or Decommission
34N96	Little Browns Creek	1.429	3.9	Maintain
33N01	West Weaver Creek	0.435	3.9	Maintain
U34N77A	Little Browns Creek	0.378	3.8	Maintain
U33N38A	West Weaver Creek	0.439	3.8	Maintain
34N97A	Upper Rush Creek	0.273	3.8	Maintain
U33N01K	West Weaver Creek	0.436	3.8	Maintain
33N42	West Weaver Creek	1.168	3.8	Maintain
U34N96BF	Little Browns Creek	0.203	3.8	Maintain
U3TRI01A	Little Browns Creek	0.066	3.8	Maintain
34N99	East Weaver Creek	0.163	3.7	Maintain
U228A	East Weaver Creek	0.957	3.7	Maintain
34N24_1	Lower Rush Creek	0.573	3.7	Maintain
34N96B	Little Browns Creek	0.214	3.7	Maintain

Table 4-8. General Recommendations for Moderate-High to High Risk Routes in the Grass Valley-Weaver Creek Watershed

Route ID	Drainage Name	Miles	Total Risk	General Recommendation
33N80	Hoadley Gulch-Trinity River	0.500	3.7	Upgrade
U33N01B	West Weaver Creek	0.181	3.7	Maintain
34N97_G1	Upper Rush Creek	0.038	3.7	Maintain or Decommission
U3TRI03F	Little Browns Creek	0.150	3.7	Maintain
33N42A	West Weaver Creek	0.353	3.7	Maintain or Decommission
33N36	West Weaver Creek	0.228	3.7	Maintain
33N40	West Weaver Creek	0.145	3.7	Maintain
U33N01BA	West Weaver Creek	0.173	3.7	Maintain
U33N01C	West Weaver Creek	0.006	3.7	Evaluate
U34N77AAB	Little Browns Creek	0.006	3.6	Evaluate
U34N77AB	Little Browns Creek	0.006	3.6	Evaluate
U34N96BA	Little Browns Creek	0.006	3.6	Evaluate
U34N96BAA	Little Browns Creek	0.006	3.6	Evaluate
U34N96BB	Little Browns Creek	0.006	3.6	Evaluate
U34N96BC	Little Browns Creek	0.019	3.6	Decommission
U34N96BD	Little Browns Creek	0.006	3.6	Evaluate
U34N96BE	Little Browns Creek	0.006	3.6	Evaluate
U34N96G	Little Browns Creek	0.019	3.6	Decommission
U34N96L	Little Browns Creek	0.086	3.6	Decommission
U3TRI05	Little Browns Creek	0.118	3.6	Maintain
U3TRI05B	Little Browns Creek	0.006	3.6	Evaluate
U3TRI05C	Little Browns Creek	0.073	3.6	Maintain
U3TRI06	Little Browns Creek	0.006	3.6	Evaluate
U236A	East Weaver Creek	0.326	3.5	Upgrade or Decommission
U236AA	East Weaver Creek	0.145	3.5	Upgrade or Decommission
34N34	Upper Rush Creek	0.199	3.5	Maintain
U236AC	East Weaver Creek	0.100	3.5	Decommission
34N95G	Little Browns Creek	0.241	3.5	Maintain
U34N95I	Little Browns Creek	0.424	3.4	Maintain
34N28A	Lower Rush Creek	0.807	3.3	Maintain
U34N33YA	Lower Rush Creek	0.479	3.3	Maintain
34N89A	East Weaver Creek	0.256	3.3	Maintain
U34N52YD	Little Browns Creek	0.881	3.3	Maintain
U34N96C	Little Browns Creek	0.387	3.3	Maintain

Table 4-8. General Recommendations for Moderate-High to High Risk Routes in the Grass Valley-Weaver Creek Watershed

Route ID	Drainage Name	Miles	Total Risk	General Recommendation
U34N05YB	Little Browns Creek	0.144	3.2	Maintain
34N41A	Lower Rush Creek	0.020	3.2	Maintain
U34N52YC	Little Browns Creek	0.235	3.2	Maintain
U34N96M	Lower Rush Creek	0.129	3.2	Decommission
U34N95A9AA	East Weaver Creek	0.019	3.2	Decommission
U34N95NA	East Weaver Creek	0.006	3.2	Evaluate
U34N52YCA	Little Browns Creek	0.006	3.1	Evaluate
U34N52YCB	Little Browns Creek	0.006	3.1	Evaluate

Specific Recommendations to Upgrade Roads

Specific recommendations are listed below for the roads listed under 'upgrade' in Table 4-8 and for four additional road segments. The recommendations focus on the sections of each road that either contained a high density of high risk features or individual features that could be treated to help decrease their impacts to water resources. Locations are denoted by Route ID, mile marker, and drainage. The feature type and associated problem are also included, along with recommendations for upgrades.

Route ID: U236AA
Drainage: East Weaver Creek
Location: Mile Marker 0.001 – 0.163, Grass Valley – Weaver Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.001 – 0.163	Route Surface	Spur road parallels perennial stream and crosses an intermittent. Stream eroding the road prism at erosion feature (MM 0.066) and road erosion and sediment delivery apparent at most features on route.	Recommend decommissioning the road segment or upgrade the route. Recommend upgrades are provided are provided below.
0.066	Erosion Feature (Streambank Erosion)	Road fill slid into perennial channel from cutbank erosion and narrowed the route. Cutbank erosion continues to erode the fillslope.	Remove road fill from stream corridor and pull back to a stable slope. Add rip-rap to fill slope for bank erosion protection and rehabilitate road section.
0.111	Stream Crossing (Ford)	Un-engineered crossing of an ephemeral stream; more similar to a cross-drain. Erodes route surface and is likely connected to perennial stream.	Install crossing structure. Preferably a CMP with rip-rap armor at outlet. An armored ford would also be a solution.

Route ID: 34N97
Drainage: Upper Rush Creek
Location: Mile Marker 0.135-0.642, Grass Valley – Weaver Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.154	Stream Crossing CMP	High diversion potential at intermittent stream crossing. Existing route surface gully indicates route surface erosion is a current erosion mechanism. Diversion of stream crossing would amplify erosion. Some erosion at CMP outlet.	Install armored critical dip and add rip-rap at CMP outlet.
0.135 – 0.318	Gully	Road surface gully persists for nearly 1,000 feet and connects to ephemeral stream in close proximity to its confluence with Rush Creek.	Install rolling dip near MM 0.145. Install 2-3 rolling dips between MM 0.204 – 0.312. Spot rock as needed to disperse surface flow.
0.204	Stream Crossing CMP	Intermittent stream crossing has history of overtopping and has high diversion potential that connects to crossing at MM 0.154. Some erosion at CMP outlet, also.	Install armored critical dip and add rip-rap at CMP outlet.
0.312	Stream Crossing CMP	High diversion potential at intermittent stream crossing. Existing route surface gully indicates route surface erosion is a current erosion mechanism. Diversion of stream crossing would amplify erosion.	Install armored critical dip at crossing. Dip would help mitigate route surface gully erosion.
0.412	Stream Crossing CMP	Erosion of downstream fill at intermittent crossing caused by concentrated road runoff. Site also has high diversion potential.	Install armored critical dip at crossing at current route drain point. Armor outlet of cross-drain with rip-rap.
0.442 – 0.587	Connected Cross-Drains	Six cross-drains are non-functional, partially functional, or have limited capacity. All are connected to the stream network in close proximity to Rush Creek.	Rehabilitate and armor existing cross-drains.
0.606	Stream Crossing CMP	Structure in good condition but has high diversion potential in close proximity to Rush Creek.	Install armored critical dip at crossing.
0.642	Stream Crossing CMP	Structure in good condition but some fill erosion occurs on the upstream side of the crossing.	Install armored critical dip at current route surface drain point. Add rip-rap to the outlet.

Route ID: 33N80
Drainage: Hoadley Gulch-Trinity River
Location: Mile Marker 0.118 – 0.33, Grass Valley – Weaver Creek

Mile Marker	Feature Type	Problem	Recommendation
0.118 – 0.235	Gully	Route surface gully drains to large clearing and may add additional runoff to the section of road below the switch back and may be connected to Trinity River.	Add aggregate to road surface install rolling dip to disperse concentration of road runoff.
0.161 – 0.279	Ditch	Ditch has no cross drain and drains to hillslope near switchback. Ditch runoff is connected to Trinity River and may add additional flow at times to route gully down grade.	Add rip-rap near outlet to limit erosion on road surface and sediment transport to the Trinity River.
0.277 – 0.33	Gully	Route surface gully drains to large clearing and has some connectivity to Trinity River.	Add aggregate to road surface install rolling dip to disperse concentration of road runoff.

Route ID: U236A
Drainage: East Weaver Creek
Location: Mile Marker 0.1801 – 0.2982, Grass Valley – Weaver Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.1801 – 0.2982	Route Surface	Multiple erosion features , inadequately designed fords, eroding cross-drain, and a road surface gully that are all connected to perennial streams. Erodible soils in area.	Recommend decommissioning the road segment from the intersection with the U236AD to the intersection with U236AB. Also recommend decommission spurs off this segment. If not decommissioned, upgrades are provided below.
0.181	Stream Crossing Ford	Active delivery of sediment at ford to perennial stream. Aggradation constricts channel at ford.	Install rolling dips on both sides of ford to prevent direct delivery of road runoff to stream. Armor approach slopes and rehabilitate channel through crossing.
0.203	Erosion Feature (Gully)	Two natural hillslope gullies converge across road surface and drain directly to perennial stream.	Install cross-drain for hillslope/gully flow. Use CMP or armored rolling dip with rip-rap at outlet.
0.235	Stream Crossing Ford	Ephemeral ford and route surface gully confluence erode hillslope below and deposit sediment directly in perennial stream.	Install rolling dip on route upslope of ford to dissipate route runoff. Armor ford and outlet to mitigate erosion of the road prism and fillslope.
0.241	Erosion Feature (Gully)	Ephemeral stream crossing road prism with no engineered crossing and erodes route surface and fillslope; direct delivery to perennial stream.	Install cross-drain for hillslope/gully flow. Use CMP or armored ford/rolling dip with rip-rap at outlet.
0.251 – 0.2982	Connected Cross-Drains and Gully	Route surface gullies form on erodible soils and erode cross-drains, outlets, and hillslopes below. Most flow is connected to a perennial stream.	Reshape and armor existing cross-drains and install additional cross drains to disperse route runoff. Armor all outlets to mitigate fillslope erosion. Coarse aggregate on route surface may also provide a solution.

Additional Features of Concern

Feature Type	Mile Marker	Route ID	Problem	Recommendations
Stream Crossing CMP	0.09	34N34	Outlet and Inlet > 60% plugged at ephemeral crossing. CMP bent and moderate diversion potential.	At a minimum, clear inlet and outlet. Replace CMP, increase diameter to facilitate high sediment load, and install critical dip is the preferred option.
Stream Crossing CMP	1.9891	34N34	CMP not well aligned and causes impoundment at inlet even at low flow. Structure has history of overtopping and high diversion potential. Perennial stream and ephemeral confluence at structure.	Evaluate CMP size and potentially increase diameter. At least, install armored critical dip to mitigate erosion during overtopping.
Ditch	0.241 – 0.309	34N34	Ditch connected to CMP that has history of overtopping due to plugging with sediment. Ditch has moderate sediment production and transport.	Install grade control structures or light armoring to lower sediment production in the ditch.
Connected Cross-Drain CMP	0.34	34N34	No outlet located and 50% plugged at inlet. Structure has evidence overtopping and diversion to route surface.	Clean inlet and install dropped inlet to mitigate elevated sediment deposition. Install critical dip to mitigate any future diversion.
Erosion Feature (Deep-Seated Earth Flow)	2.5732	34N34	Large deep-seated failure that has up to 10 feet of vertical offset along 300 feet of road prism. Site has been surveyed.	Rebuild section of road to allow for access and to mitigate erosion.
Gully	0.959-1.238	34N34	Route surface gully is connected to ephemeral stream. Gully is caused by road surface runoff and a ditch diverts onto the road near MM 1.0. Erodible soils.	Repair and armor rolling dips along this segment of road and reshape ditches as needed. Install additional rolling dips if necessary.
Cross-Drain CMP	1.137, 1.024, 0.506	34N34	Inlets/Outlets buried or partially buried and divert or have potential to divert flow down the road contributing to gully.	Clean inlet and outlets.
Spring	0.02	34N82	Spring surfaces in route surface forms and contributes to a gully that formed from the overtopping of an Intermittent stream crossing with CMP (MM 0.037).	Construct drainage structure to mitigate surface erosion.
Stream Crossing CMP	0.037	34N82	Intermittent crossing is currently partially plugged and has overtopped and formed a road gully in the past.	Clear inlet and install armored critical dip to prevent future diversion.
Gully	0.001-0.035	34N82	Gully from stream crossing (MM 0,037) overtopping and spring (0.02) flows onto the 34N34.	Install critical dips at stream crossing a spring drainage structure. Install berm at start of route to keep water off of the 34N34 and to deter wet weather ATV use.

Feature Type	Mile Marker	Route ID	Problem	Recommendations
Connected Cross-Drain CMP	8.442	33N38	Structure located in a segment of road with 4 springs in 0.1 mile. Structure has evidence of overtopping and formed a small gully. Inlet currently partially (25%) plugged.	Clean inlet and install new dropped inlet to accommodate flow volume. Install critical dip to prevent future road diversion.
Erosion Feature (Gully)	0.061	U236AB	Road built through old canal. Runoff from old canal converges on road and creates a gully through the road prism that is connected to perennial stream with sediment transport apparent.	Armor crossing at canal and install armored rolling dips to mitigate runoff from canal flow. Road could also be decommissioned.

Section 5 Browns Creek Watershed

5.1 Introduction

The Browns Creek watershed is approximately 47,104 acres in size and is located within the Klamath River basin, in Trinity County. Browns Creek originates in the southern Klamath Mountains and runs north approximately 22 miles to its confluence with the Trinity River. Browns Creek meets the Trinity River 23 miles downstream of Lewiston Dam, and flows west towards the Klamath River.

The watershed is bound by Hayfork Divide on the west, Horsemane and Blanchard Ridge on the east, and by Deerlick Ridge on the west. The terrain is predominately mountainous and forested, with elevations ranging from 1,500 feet above msl at the confluence with Trinity River and nearly 5,400 feet in the headwaters area. Most of the watershed ranges between 2,500 and 4,000 feet. Evergreen conifer forest with chinquapin, madrone, black oak and canyon oak are dominant in the upper portions of Browns Creek watershed. The Oregon white oak forest is typical throughout the lower elevations near the mainstem of the Trinity River (U.S. Bureau of Land Management 1995).

Precipitation is highly seasonal, and most of it falls between October and April. Approximately half the annual precipitation occurs as snowfall. Snowfall occurs at lower elevations; however, it does not typically accumulate below 4,000 feet. Average annual precipitation in the Browns Creek watershed ranges from 35 inches at the lower end to 49 inches in the upper portions of the watershed (National Resource Conservation Service Water and Climate Center 1998).

5.2 Overview

For this effort, two subwatersheds (HUC 6) and six drainages (HUC 7) were delineated for the purposes of the SSI and RAP efforts. Table 5-1 characterizes the hierarchy for the two subwatersheds, East Fork Browns Creek (East Fork) and Lower Browns Creek (Lower), included in the SSI and RAP risk analysis. Figure 5-1 illustrates the location of these subwatersheds, drainages and the respective road segments that were included the 2012 SSI efforts. As shown in Figure 5-1, the road inventory was primarily conducted in the upper elevations of the East Fork subwatershed, with only 1.4 miles inventoried in the Lower subwatershed.

Table 5-1. Browns Creek Watershed Characteristics

Subwatersheds (HUC 6)	Drainage Area (mi^2)	Total Road Length (mi)	Road Density (mi/mi^2)	Past SSI Road Miles	2012 SSI Road Miles	Total SSI Road Miles
East Fork Browns Creek	40.0	155.8	3.9	0.0	46.9	46.9
Lower Browns Creek	33.6	180.1	5.4	0.0	1.3	1.4
Watershed Totals	**73.6**	**335.9**	**4.6**	**0.0**	**48.3**	**48.3**

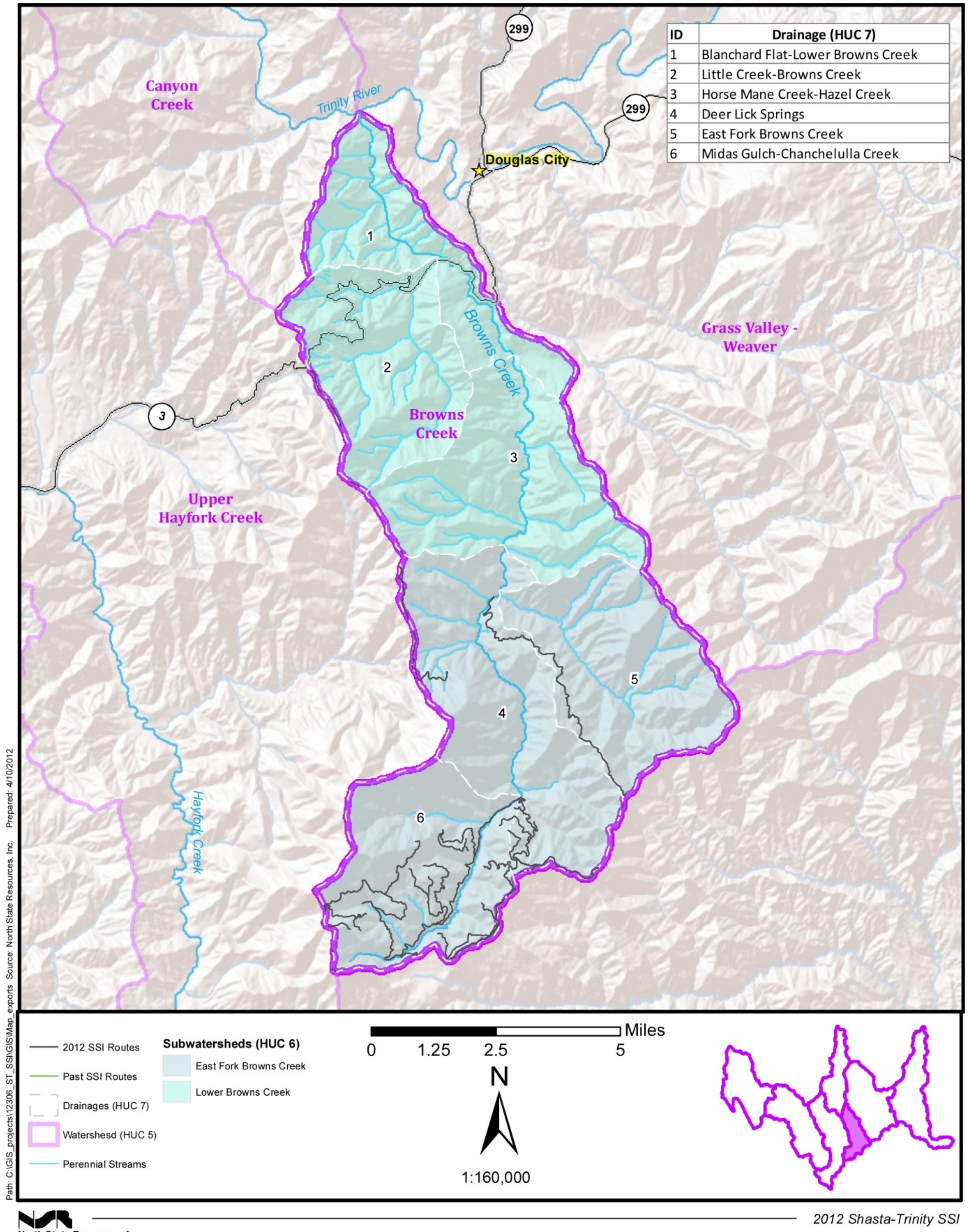


Figure 5-1. Browns Creek Watershed Location

As shown in Table 5-1, the project GIS data indicates there are 73.6 miles of road in the watershed and a road density of 4.6 miles of road per square mile of watershed. The East Fork subwatershed is located at higher elevations in the watershed relative to the Lower subwatershed with fewer miles of road and lower road densities. There is155.8 miles of road and 3.9 miles of road per square mile in the East Fork watershed compared to 180.1 miles of road and 5.4 miles of road per square mile in the Lower watershed.

Hydrology

The watershed contains approximately 290.2 miles of stream channels with a stream density of 3.9 miles per square mile (Table 5-2). Approximately 34 percent of the streams are perennial in nature; East Fork Browns Creek and Little Creek are the largest perennial streams in terms of drainage area.

Table 5-2. Browns Creek Watershed Streams Densities and Fish Bearing Lengths

Subwatersheds (HUC 6)	Stream Length (mi)	Stream Density (mi/ (mi^2))	Miles of Perennial Stream	Perennial Streams as % of Total Miles	Miles of Fish-Bearing Streams	Fish-Bearing Streams as % of Total Miles
East Fork Browns Creek	139.1	3.5	38.2	27.5%	31.3	22.5%
Lower Browns Creek	151.1	4.5	61.6	40.7%	37.3	24.7%
Watershed Totals	**290.2**	**3.9**	**99.8**	**34.4%**	**68.6**	**23.6%**

The East Fork subwatershed drains the higher elevations in the watershed and has a lower stream density with 3.5 miles of per square mile, compared to 4.5 miles of per square mile in the Lower subwatershed. There are approximately 139.1 miles of streams in the East Fork subwatershed; 28 percent are perennial in nature. There are three drainages in the East Fork subwatershed; Deer Lick Springs, East Fork Browns Creek and Midas Gulch-Chanchelulla Creek drainages.

There are approximately 151.1 miles of stream in the Lower subwatershed and 41 percent are perennial in nature. There are three drainages in the Lower subwatershed; Blanchard Flow-Lower Browns Creek, Little Creek-Browns Creek, and Horse Mane Creek-Hazel (see Figure 5-1).

Water Quality

The Trinity River, including tributaries such as Browns Creek is included on California's CWA Section 303(d) list as water quality limited due to sediment (Environmental Protection Agency 2001). The sediment impairment in the Trinity River and its tributaries resulted in non-attainment of designated beneficial uses, primarily the cold-water fishery, including spawning, migration, and reproduction and fish habitat (Environmental Protection Agency 2001). A total maximum daily load (TMDL), with numeric targets, was prepared for the Trinity River, including Browns Creek in 2001. The water quality objectives addressed in the TMDL include settleable material, suspended material, sediment, and turbidity (Environmental Protection Agency 2001).

The sediment source inputs in the Browns Creek watershed is primarily associated with historic and ongoing land management activities (e.g., mining, timber harvest); natural disturbance processes also result in the transport and delivery of sediment to Browns Creek and its tributaries. The primary management sediment sources include timber harvest, followed by roads, and legacy (i.e. abandoned roads and historic mining activities). The TMDL for the Trinity River specified that an 82 percent reduction in management sediment sources is needed for attainment in the Browns Creek and Reading Creek watersheds (Environmental Protection Agency 2001).

During sampling events in Water Years 2000 and 2001 monitored for EPA, Browns Creek had turbidity values in excess of 500 NTUs (Environmental Protection Agency 2001). These high values indicate that sediment transport and delivery in the watershed correlates may be related to high levels of disturbance (anthropogenic and natural) throughout the watershed. Studies conducted for EPA indicate that sediment inputs to the Browns Creek watershed are nearly equal to sediment outputs delivered to the Trinity River (Environmental Protection Agency 2001).

Aquatic and Riparian Habitat

The Trinity River and its tributaries was historically a major producer of steelhead trout and chinook and coho salmon. Anadromous fish populations have declined throughout the Trinity River basin over the last several decades due to habitat degradation, exacerbated by human activities (Environmental Protection Agency 2001). Due to the decline in population, the Southern Oregon Northern California Coastal Coho salmon have been listed as threatened under the Endangered Species Act (National Oceanic and Atmospheric 2011).

Specific information regarding salmonid use in the Browns Creek watershed downstream of Lewiston Dam is limited. Studies have indicated that coho utilized accessible tributaries and adult spawning chinook were observed in tributaries downstream of Lewiston Dam in 1965 (U.S. Bureau of Land Management 1995). Of all anadromous species, steelhead extend the furthest up the tributary streams (Environmental Protection Agency 2001). In 1990, both juvenile coho and steelhead were documented in Browns Creek during a fish habitat assessment (Douglas Parkinson & Associates 1990).

Geology

A majority of the Browns Creek watershed is dominated by metasediments, metavolcanics, and serpentinized rock units of the Western Paleozoic and Triassic Belt (Table 5-3); which occur primarily in the western portion of the watershed. The metamorphic rocks from the Abrams Schist member of the Central Metamorphic Belt also occupy nearly a quarter of the watershed along the eastern margin. Small outcrops of limestone occur along the contact between these two metamorphic belts towards the center of the watershed. The diorite and gabbro rock units of the Wildwood Pluton also occur in the southwestern portion of the East Fork subwatershed. Most roads included in the 2012 SSI are underlain by the rock units of Western Paleozoic and Triassic Belt with some overlap into the Wildwood Pluton.

Table 5-3. Browns Creek Watershed Prominent Geologic Units and Rock Types

Geologic Unit	Percent of Watershed	Dominant Rock Type(s)
Western Paleozoic and Triassic Belt	53%	
Sawyers Bar Terrane	25%	metavolcanics, metasediments
Eastern Hayfork Terrane	22%	metasediments (argillite), serpentine
Western Hayfork Terrane	4%	metavolcanics, metasediments
Central Metamorphic Belt	23%	
Abrams Schist	23%	metavolcanics, metasediments, marble
Plutonic Rock	11%	
Wildwood Pluton	10%	diorite, gabbro, pyroxenite
Late Paleozoic Limestone	11%	limestone (undifferentiated)

U.S. Forest Service soil erosion data is available for 39 percent of the entire Browns Creek watershed and as a result erosion characterization of the soils resources is limited. Soil erosion data covers 66 percent of the East Fork Browns Creek subwatershed but only eight percent of the Lower Browns Creek subwatershed For the portion of the watershed where soil mapping data is available, the data indicates that erosive soils occupy about 16 percent of the watershed, most of these occur in close proximity to the Wildwood Pluton ((Figure 5-2).

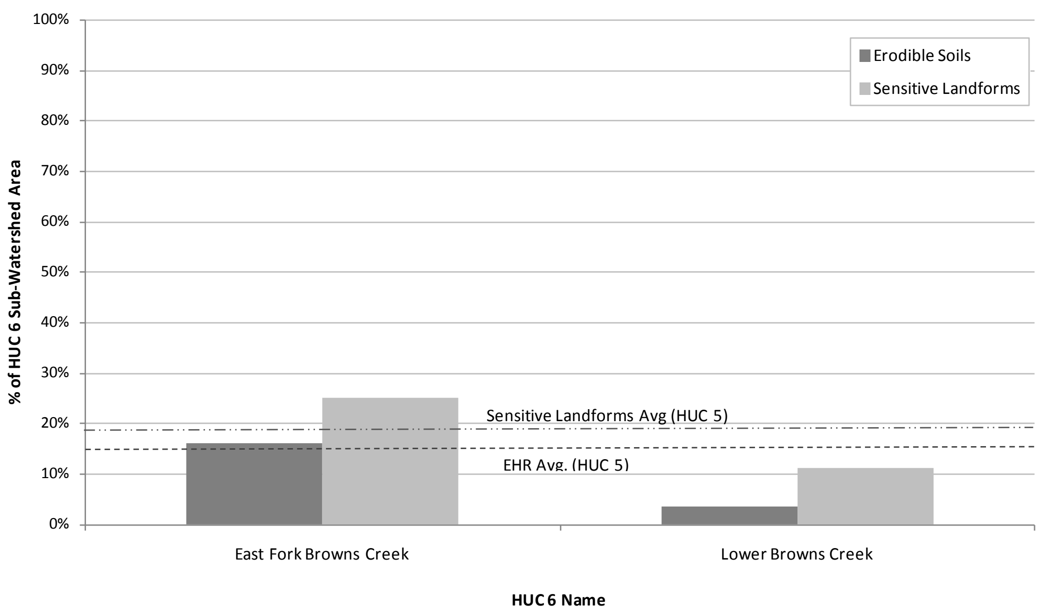


Figure 5-2. Area of Browns Creek Subwatershed Occupied by Erodible Soils and Sensitive Landforms

Conversely, sensitive landform data is available for the entire watershed. These data indicate that nineteen percent of the watershed is covered by sensitive landforms; primarily dormant landslides and steep granitic terrain associated with the Wildwood Pluton. A majority of these dormant landslide deposits are associated with rock units of the Western Paleozoic and Triassic Belt.

5.3 SSI Results

Roads in the Browns Creek watershed were inventoried during the 2012 field season. The 2012 SSI acquired data on 48.3 miles of road in the watershed. The following discussion focuses on the results and the assessment of this data set. Unlike the five of the seven total watersheds included in the 2012 SSI, no additional SSI data was provided by the STNF for the Browns Creek watershed.

2012 SSI Results

The objective of the 2012 SSI was to document the condition of existing road-related infrastructure and identify existing and potential erosion and sediment producing features located over 48.3 miles of road in the Browns Creek watershed (Figure 5-1 and Appendices E & F). Inventoried features were prioritized based on their potential for sediment production and delivery to the hydrologic network. This section focuses on the inventoried and prioritized features included in the 2012 SSI. The results are presented at both the subwatershed (HUC 6) and drainage scales (HUC 7).

Inventoried Features

The 2012 SSI identified and characterized 656 features; 4.1 miles of gully, 2.6 miles of ditch segments; 44 stream crossings; eight erosion features; 141 hydrologic ally connected cross-drain features; 428 non-hydrologically connected cross-drains; and 35 springs (Table 5-4 and Appendices E & F).

Table 5-4. 2012 SSI Inventoried Features for Browns Creek Subwatersheds (HUC 6) and Drainages (HUC 7)

Subwatersheds (HUC 6) Drainages (HUC 7)	Road Miles	Gully Miles	Ditch Miles	Stream Crossings	Erosion Features	Connected Cross-Drains	Non-Connected Cross-Drains	Springs
East Fork Browns Creek	46.9	4.1	2.6	44	8	141	428	35
Deer Lick Springs	13.0	1.9	0.6	11	2	63	99	16
East Fork Browns Ck.	4.2	0.2	0.1	1	1	5	22	3
Midas Gulch-Chanchelulla Ck	29.7	2.0	1.9	32	5	73	307	16
Lower Browns Creek	1.3	0.0	0.0	0	0	0	0	0
Horse Mane Ck.-Hazel Ck.	0.1	0.0	0.0	0	0	0	0	0
Little Creek-Browns Ck.	1.3	0.0	0.0	0	0	0	0	0
Watershed Totals	**48.3**	**4.1**	**2.6**	**44**	**8**	**141**	**428**	**35**

Note: The drainages included in the 2012 SSI are shown in Table 5-4; other drainages within the watershed are not listed.

Approximately 46 miles of road were inventoried in the East Fork subwatershed, with the approximately 62 percent of the total inventoried mileage in the Midas-Gulch Chanchelulla Creek drainage. Only 1.3 miles of road was inventoried in the Lower subwatershed; no erosion features, gullies or ditches were identified in the 2012 SSI. In the East Fork subwatershed, of the total features identified in the 2012 SSI, 433 feature or 66 percent of the total number occurred in the Midas-Gulch Chanchelulla Creek drainage (Table 5-4).

Feature Analysis/Risk Assessment

As described in Section 2, risk ranking matrices were created to identify features that currently do, or potentially could deliver elevated levels of sediment to nearby streams or waterbodies. The number of high risk features and the proportion by subwatershed are listed in Table 5-5. The accompanying GIS project is organized to extract the type and location of features by risk rating at multiple scales. The density of high risk feature types for each subwatershed and drainage is shown in Figure 5-3.

Table 5-5. High Risk Features for Browns Creek Subwatersheds (HUC 6) and Drainages (HUC 7)

Subwatersheds (HUC 6) Drainages (HUC 7)	Gully Miles	Ditch Miles	Stream Crossings	Erosion Features	Connected Cross-Drain w/CMP	Springs
East Fork Browns Creek	1.3 (33%)	0.0	15 (34%)	3 (38%)	14 (10%)	9 (26%)
Deer Lick Springs	0.6 (14%)		3 (7%)		6 (4%)	3 (9%)
East Fork Browns Ck.				1 (13%)	1 (1%)	1 (3%)
Midas Gulch-Chanchelulla Ck.	0.8 (19%)		12 (27%)	2 (25%)	7 (5%)	5 (14%)
Lower Browns Creek[1]	0.0	0.0	0	0	0	0
Watershed Totals	**1.3 (33%)**	**0.0**	**15 (34%)**	**3 (38%)**	**14 (10%)**	**9 (26%)**

Note: Values in parenthesis represent percentage of watershed feature totals.
[1]No high risk features were identified in the subwatershed

As illustrated in Table 5-5, the 2012 SSI identified the following high risk features: total of 1.3 miles of gully, 15 stream crossings, three erosion features, 14 connected cross-drains with CMP, and nine springs were identified as high risk in the 2012 SSI. A total of 41 features or 30 percent of the total 2012 SSI features (excluding non-connected cross-drains and connected cross-drains without CMP) are characterized as high risk in the Browns Creek watershed.

As discussed previously, no features were identified in the Lower subwatershed, therefore no high risk features, gullies or roads were identified either. All 41 high risk features were located in the East Fork subwatershed; with 12 high risk features and 0.6 miles of gully in the Deer Lick Springs drainage; three high risk features in the East Fork Browns Creek drainage; and 26 features and 0.8 miles of high risk gully located in the Midas Gulch-Chanchelulla Creek drainage. The proportion of high risk features within each of the drainages is consistent with the proportion of road miles inventoried in each drainage. For example, 62 percent of the total inventoried mileage was located in Midas Gulch-Chanchelulla Creek drainage and 63 percent of the high risk features were also identified in this drainage.

Figure 5-3 illustrates the variability in the number and type of high risk features per mile of inventoried road by subwatershed and for the Browns Creek watershed as a whole. Because so few miles and no features were inventoried in the Lower subwatershed, the difference between the watershed average and the East Fork subwatershed average is very minimal.

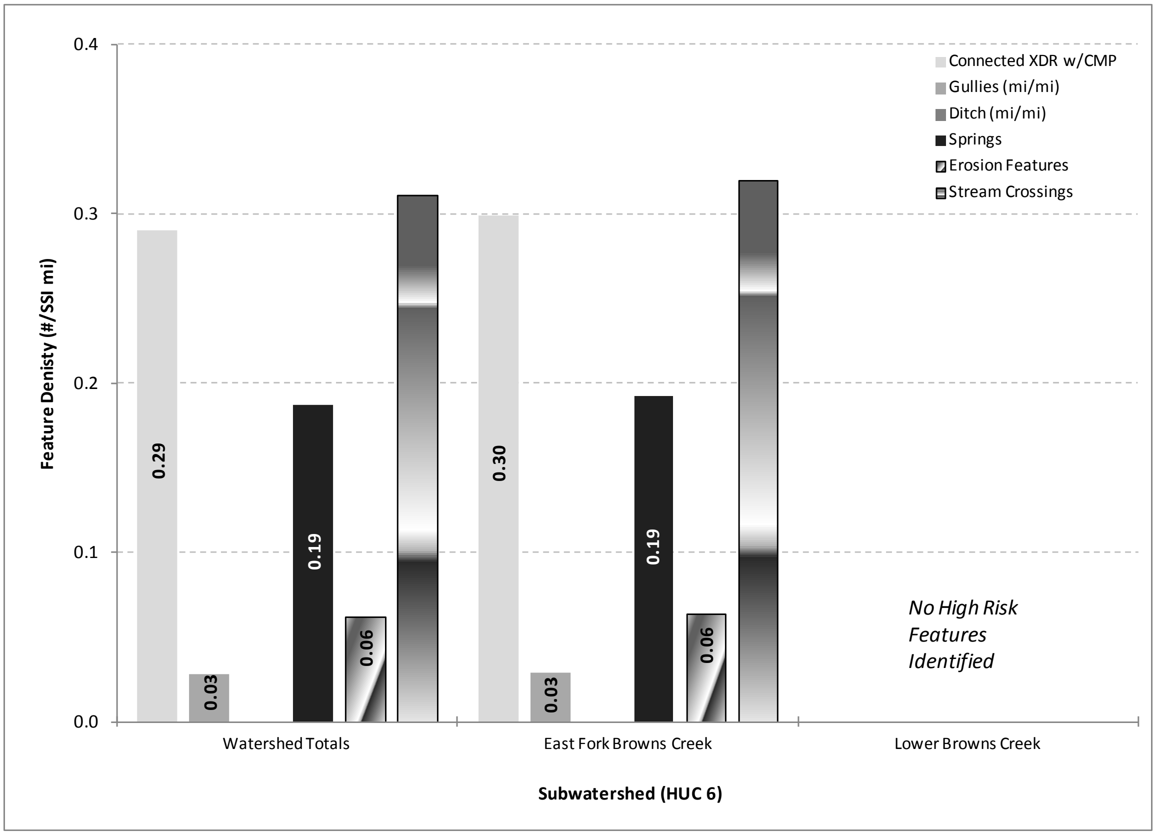


Figure 5-3. Density of High Risk Features for Browns Creek Subwatersheds
Note: Gullies and ditch densities reported as miles of feature per mile of SSI road.

Stream crossing features followed by connected CMP cross-drain are the most dense high risk features in the East Fork subwatershed. This is an indication that non-functional stream crossings and connected CMP cross-drains have the highest potential to deliver sediment to stream channels. Common factors that contribute to the risk of potential sediment input to the stream network at stream crossings and connected CMP cross-drains sites include: diversion potential, plugging of the inlet, the presence of large fill, and overtopping of the road prism. Overtopping at stream crossings and cross-drains, coupled with high diversion potential and large fills, can have serious impacts to the road system and introduce large amounts of sediment into the stream network.

5.4 Aquatic and Riparian Resources RAP Risk Analysis

The main focus of the RAP risk analysis was to identify road segments that could pose a moderate to high risk to aquatic and riparian resources. Three resources; water quality, hydrologic processes, aquatic and riparian habitat are analyzed in the following discussion. The RAP risk analysis is presented at both the drainage and road segment scales.

Aquatic and Riparian Resources RAP Risk Score per Drainage

The total Aquatic and Riparian Resources RAP risk score (total RAP risk score) for road segments within each of the five drainages that constitute the Browns Creek watershed are discussed in this section. The total RAP risk score is the average of the individual water quality, hydrologic processes, and aquatic and riparian habitat scores. As described in Section 2.4, the key questions specific to the three resources, and the associated criteria required to answer these questions have been developed in accordance with the STNF RAP protocol (Shasta-Trinity National Forest 2011) in order to rate the road segments at the drainage scale.

The RAP risk scores for water quality, hydrologic processes, aquatic and riparian habitat, including the total scores for each road and drainage are listed in Appendix D. Figure 5-4 illustrates the total miles of road per drainage and the associated total RAP risk score. This Figure displays the relative risk per drainage for the various sections of roads included in the RAP analysis. For the Browns Creek watershed, the RAP analysis was specific to the 2012 SSI data set; no additional datasets were provided by the STNF.

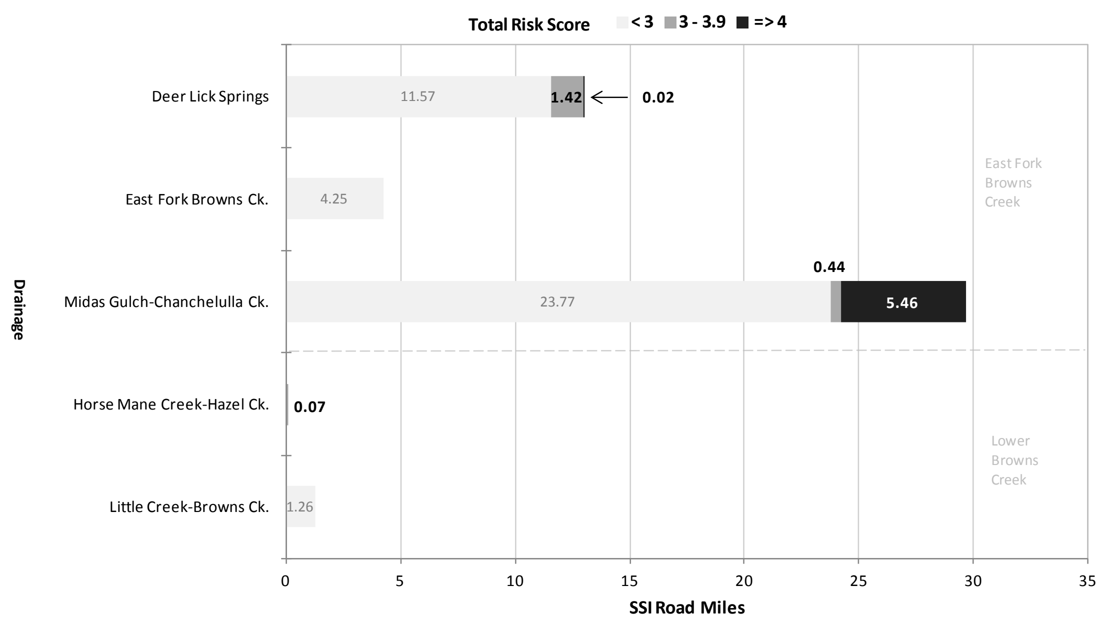


Figure 5-4. Aquatic and Riparian Resources RAP Total Risk Score for Browns Creek Watershed Drainages

The Aquatic and Riparian RAP effort indicated that approximately 5.5 miles (11%) of the inventoried road mileage scored high risk and 1.9 (4%) of the inventoried roads scored moderate-high risk to aquatic and riparian resources within the Browns Creek watershed (Figure 5-4). In total, 7.4 miles of road or 19 percent of the total roads included in the 2012 SSI are considered to be moderate-high to high risk to aquatic and riparian resources.

As shown in Figure 5-4, all of the roads that scored high risk were located in the Midas Gulch-Chanchelulla Creek drainage, with the exception of 0.02 miles located in the Deer Lick Springs drainage. The proportion of road miles that scored high risk and the proportion of road miles inventoried in the Midas Gulch-Chanchelulla Creek drainage are not equal; nearly 100 percent of the high risk road miles are located in this drainage, but only 62 percent of the inventoried roads are in the drainage. In other words, there are a higher percentage of roads the Midas Gulch-Chanchelulla Creek drainage that pose a high risk to aquatic and riparian resources than other drainages in Browns Creek watershed.

Approximately 1.42 miles or 74 percent of the roads that scored moderate-high risk were located in the Deer Lick Springs drainage. The remaining 0.44 miles of moderate-high risk roads were located in the Midas Gulch-Chanchelulla Creek drainage, with less than .08 miles in the Horse Mane Creek-Hazel Creek drainage.

Overall, 81 percent of the roads included in the 2012 SSI within the Browns Creek watershed had a risk score less than 3 (low-moderate risk). Based on the assumptions used for the RAP analysis, this suggest that a large number of the roads pose a low to moderate risk of affecting aquatic and riparian resources. Within the East Fork Browns Creek and Little Creek-Brown Creek drainages, all the roads included in the 2012 SSI scored less than three.

Moderate to High Risk Road Segments

Table 5-6 lists those road segments by drainage included in the 2012 SSI that scored 3.0 or above in the RAP risk analysis. Based on this analysis, these road segments have a moderate-high to high risk of affecting water quality, hydrologic processes, and aquatic and riparian habitats. In total, two road segments equaling approximately 5.5 miles of road scored high risk and four road segment equaling 2.9 scored moderate-high risk. Figure 5-5 illustrates the location of the moderate-high to high risk roads segments in the Browns Creek watershed.

As shown in Table 5-6, the water quality risk score is generally the highest score of all three resources, with the exception of two road segments in which the water quality score is equal to or slightly less than the hydrologic processes scores. Four of the six road segments, or 98 percent of the mileage in Table 5-6, score high risk to water quality (scores equal to or above 4.0). This suggests that many of the moderate-high and high risk road segments are hydrologically connected and intersect areas prone to erosion. Evaluation of previous RAP risk analysis indicates that the large number of stream crossings and/or the road segments that are in close proximity to aquatic and riparian habitat provide a direct pathway for transport and delivery of sediment to water bodies in the Browns Creek watershed.

Table 5-6. Browns Creek Watershed Routes with Total RAP Risk Scores of 3.0 and Greater

			Resource Risk Scores			
Route ID	Drainage Name	Miles	Aquatic, Riparian	Hydrologic Process	Water Quality	Total Risk
30N01	Deer Lick Springs	0.024	4.0	3.8	4.9	4.2
30N01	Midas Gulch-Chanchelulla Ck.	5.465	4.2	3.8	4.2	4.0
31N09	Deer Lick Springs	1.420	3.6	3.8	4.3	3.9
30N16E	Midas Gulch-Chanchelulla Ck.	0.354	3.5	3.8	4.3	3.9
32N35	Horse Mane Ck.-Hazel Ck.	0.074	3.5	3.8	3.8	3.7
30N02	Midas Gulch-Chanchelulla Ck.	0.085	3.3	3.8	3.9	3.6

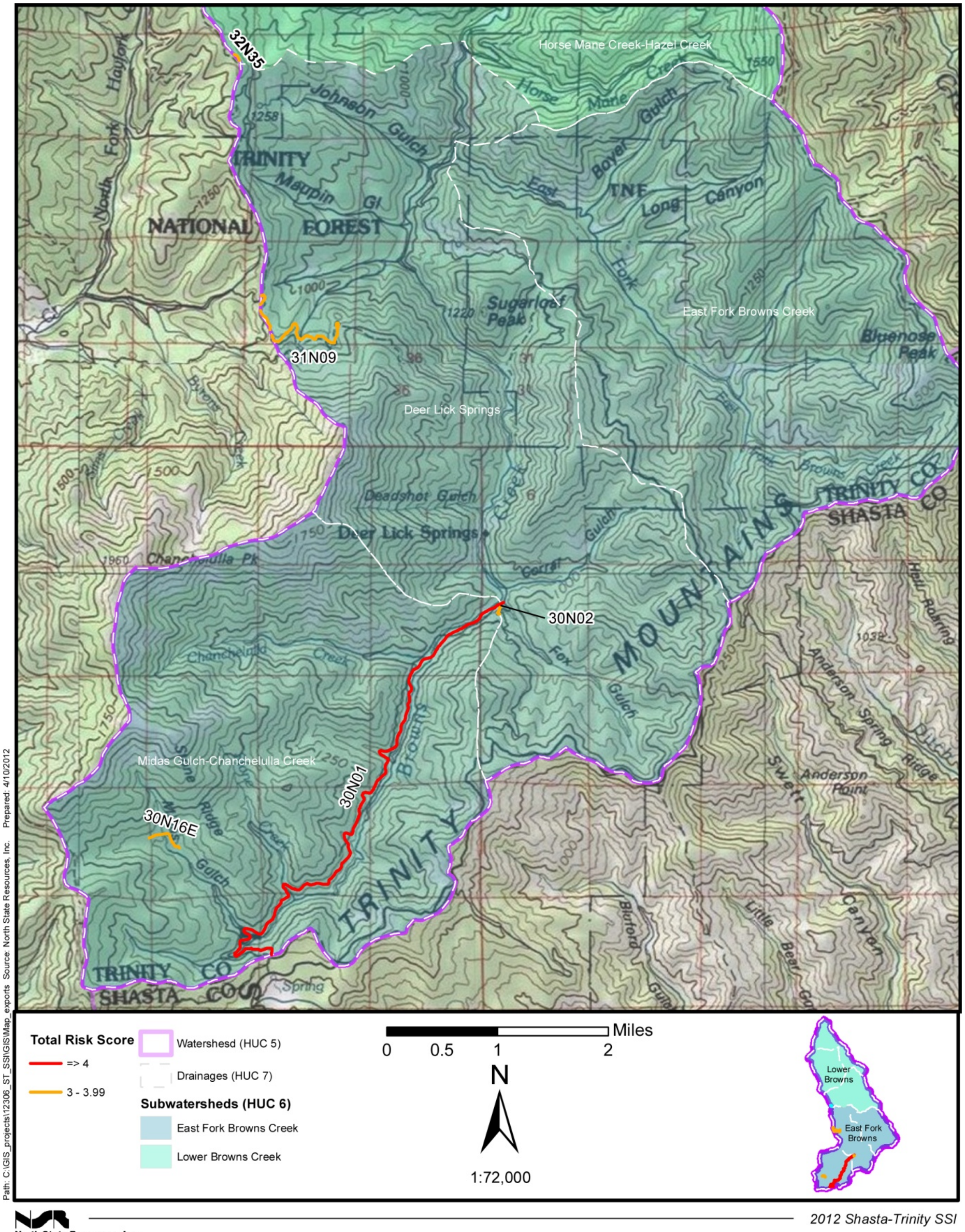


Figure 5-5. Browns Creek Watershed Roads with Aquatic and Riparian Resources RAP Total Risk Scores of 3.0 and Above

For example, Road 30N01 scored high risk to water quality; it parallels Browns Creek for over 5.4 miles offering numerous direct pathways for transport and delivery of sediment and other materials to Browns Creek (see Figure 5-6). Additionally, there are numerous tributaries that cross Road 30N01 in route to Browns Creek (see Figure 5-6)

The hydrologic processes scores for all road segments equal to 3.8; indicating that all of these moderate to high risk road segments pose a similar risk to hydrologic processes in the Browns Creek watershed. These roads may potentially affect the routing of water by intercepting and diverting flows from their natural path. At various locations, the road prism and associated alignment may constrict the channel, isolate floodplains, influence riparian vegetation, and/or constrain channel migration.

The road segment scores for aquatic and riparian habitat range between 3.3 and 4.2. These scores correlate the risk to aquatic and riparian habitat relative to the individual road segments with respect to affects on the functions and values of aquatic and riparian habitat, including attributes such as connectivity, flow and fish passage. Road 30N01 had the highest aquatic and riparian score of all road segments, which is an indication that the road segment has a negative effect on the aquatic and riparian habitat of Browns Creek and its tributaries due to its location and high number of stream crossings.

Of the roads included in this RAP effort, three road segments, totaling 5.9 miles, in the Midas Gulch-Chanchelulla Creek drainage have total RAP risk scores above 3.0; these are identified as moderate-high to high risk. The longest road segment in this drainage Road 30N01 (5.465 miles) scored the highest in the drainage and is considered a high risk to aquatic and riparian resources, especially to water quality and aquatic and riparian habitat.

The Deer Lick Springs drainage has two road segments with RAP scores over 3.0, collectively 1.44 miles of road. Approximately .024 miles of Road 30N01 continued into the Deer Lick Springs drainage from the Midas Gulch-Chanchelulla Creek drainage and scored the highest in the watershed, with a total RAP risk score of 4.2. Road 31N09 scored just less than 4.0 and is considered a moderate-high risk to aquatic and riparian resources; with a high risk to water quality.

Approximately .07 miles of road in the Horse Mane Creek-Hazel Creek drainage scored moderate-high, with a total RAP risk score of 3.7. Road 32N35 is considered a moderate-high risk to water quality, hydrologic process, and aquatic and riparian habitat.

5.5 Recommendations

Moderate-High Road Segments General Recommendations

The general recommendations for routes in the Browns Creek watershed with a total RAP risk score greater than 3.0 are listed in Table 5-7. Three different recommendations are possible, including: maintain, upgrade, and decommission. Maintaining includes activities such as cleaning out inlets and outlets of culverts and cross-drain with culverts, cleaning rolling dips and ditches, and spot-grading. Road upgrade includes renovation of existing features, construction of new features, large-scale grading and placement of aggregate, combined with normal maintenance activities. Decommissioning the road includes either full road obliteration or a temporary road decommission.

The recommendations are based on the RAP risk score, the density and condition of the features in the 2012 SSI data set, and the road-related hydrologic connectivity to the stream network.

Table 5-7. General Recommendations for Moderate-High to High Risk Routes in the Browns Creek Watershed

Route ID	Drainage Name	Miles	Total Risk	General Recommendation
30N01	Deer Lick Springs	0.024	4.2	Maintain
30N01	Midas Gulch-Chanchelulla Ck.	5.465	4.0	Upgrade
31N09	Deer Lick Springs	1.420	3.9	Upgrade
30N16E	Midas Gulch-Chanchelulla Ck.	0.354	3.9	Upgrade / Decommission
32N35	Horse Mane Ck.-Hazel Ck.	0.074	3.7	Maintain
30N02	Midas Gulch-Chanchelulla Ck.	0.085	3.6	Maintain

Specific Recommendations to Upgrade Roads

Specific recommendations are listed below for the roads listed under 'upgrade' in Table 5-7 and for one additional road segment. The recommendations focus on the sections of each road that either contained a high density of high risk features or individual features that could be treated to help decrease their impacts to water resources. Locations are denoted by Route ID, mile marker, and drainage. The feature type and associated problem are also included, along with recommendations for upgrades.

Route ID: 30N16E
Drainage: Midas Gulch-Chanchelulla Ck.
Location: Mile Marker 0.026 – 0.102,Browns Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
.026	Connected Cross-Drain	Cross-drain flattened and is currently the primary diversion point for upgrade route gully. Connected to perennial stream.	Construct armored rolling dip with armored outlet.
.027 - .102	Gully (Route)	Two gully segments caused by partially or non-functional cross-drain and erosive soils. Lower gully (MM .027-.044) is connected. Upper gully (MM .073-.102) not connected but if not mitigated could merge with lower gully.	Repair and armor existing cross-drain (MM 0.045, 0.056, 0.103). Grade route surface. Install additional cross drains and add aggregate to surface to disperse runoff.

Route ID: 31N09
Drainage: Deer Lick Springs
Location: Mile Marker 1.913 – 3.009**,** Browns Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
1.913-1.957	Erosion (Gully)	Route surface gully exits road prism and creates gully on fillslope. May compromise fill. Not connected.	Grade route (MM 1.914-1.957) and install 2 armored rolling dips to mitigate concentrated runoff. Add rip-rap at gully outlet to prevent further erosion and to stabilize fill. Add surface aggregate as needed.
2.531 – 2.63	Gully (Route)	Gully caused by concentrated flow on route surface. Gully connected to perennial stream.	Install 2 armored rolling dips and add surface aggregate as needed.
2.78 – 2.839	Gully (Route)	Gully caused by concentrated flow on route surface. Gully connected to intermittent stream near confluence with perennial stream	Install 2 armored rolling dips and add surface aggregate as needed.
2.867 – 3.043	Gully (Route)	Gully caused by a series of partially-functioning and non-functional cross-drains on erodible soils. Gully connected to intermittent stream near confluence with perennial stream	Reconstruct/Reshape existing cross-drains (MM 2.925, 2.955, 3.01) and armor features and outlets. Add additional rolling dips appropriate for grade. Add aggregate to route surface as needed.
3.009	Erosion (Gully)	Outlet gully at cross-drain caused by concentrated flow and erosive soils. Could compromise road fill.	Add rip rap at outlet as part of cross-drain restoration.

Route ID: 30N01
Drainage: Midas Gulch-Chanchelulla Ck.
Location: Mile Marker 6.032 – 9.469, Browns Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
6.032	Connected Cross-Drain	Partially functioning cross-drain in close proximity to Browns Creek. Deferred maintenance may cause gully and increase sedimentation.	Reconstruct dip and armor outlet or spot rock are below cross-drain.
6.29 - 6.516	Cross-Drains w/CMP	3 features (MM 6.29, 6.43, 6.516) with inlets 98% plugged with rocks; all have diversion potential. Contributing ditches also plugged. Failure of cross-drains may cause gullying of route in proximity to Browns Creek.	Clean inlet and potentially install dropped inlets or check dams in ditches upgrade of cross-drains. Clean contributing ditches. Install critical dips at cross-drains to prevent diversion.
7.637	Stream Crossing	Inlet to perennial stream crossing partially plugged.	Clean inlet.
7.729 - 6.516	Cross-Drains w/CMP	3 partially functioning or non-functioning features (MM 7.729, 7.856, 7.985) due to plugged inlets; all have diversion potential. Failure of cross-drains may cause gullying of route in proximity to Browns Creek.	Clean inlet and potentially install dropped inlets. Install armored critical dips at cross-drains to prevent diversion.

Route ID: 30N01 *(Continued)*
Drainage: Midas Gulch-Chanchelulla Ck.
Location: Mile Marker 6.032 – 9.469, Browns Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
8.089	Erosion (Gully)	Road runoff concentrates and exits route at feature; direct delivery to perennial stream. Out sloping not effective due to grading berm.	Knock down grading berm. Add aggregate to road surface. Add rip rap to gully cavity at outlet to prevent further scour.
8.986	Connected Cross-Drain w/CMP	Partially functioning cross-drain due to partially plugged dropped inlet. Site in close proximity to Browns Creek and has diversion potential	Clean inlet and potentially install check dams in ditches upgrade of cross-drains. Clean contributing ditches. Install critical dips at cross-drains to prevent diversion.
9.14	Connected Cross-Drain w/CMP	Non-functioning cross-drain that conveys hillslope runoff. CMP is perforated and has high diversion potential.	Clean Inlet. Evaluate pipe capacity and replace if necessary.
9.469	Connected Cross-Drain	Partially functioning cross-drain and OSD that drain route ditch.	Reconstruct as armored rolling dip and adjust OSD to capture flow of feature or armor outlet.

Additional Features of Concern

Feature Type	Mile Marker	Route ID	Problem	Recommendations
Connected Cross-Drain w/CMP	0.127	30N20	Site has past evidence of overtopping and is partially plugged. Site is upslope of highly connected segment of 30N01, which may have cumulative effects.	Clean Inlet, install trash rack, and armor existing critical dip.
Erosion (Stream Bank Erosion)	1.107	30N16F	Low-water ford of ephemeral heavily gullied; route compromised	Construct armored low water ford or install CMP stream crossing.
Spring	0.234	30N02B	Spring flow on route is compromising road fill and amplifies route gully runoff. Not connected but needed to maintain drivability of route.	Install French Drain and armor drain point.
Multiple Features	0.00-1.097	30N80	Road is on erosive soils. Route surface gullies on majority of route. Most features semi-functional or have excessive erosion due to lack or armoring or maintenance. Road at top of watershed, so connectivity is to swales and ephemeral streams	Grade road and add surface aggregate. Repair existing cross-drains. Clear inlets and armor outlets of most features. Consider decommission.

Section 6 Canyon Creek Watershed

6.1 Introduction

The Canyon Creek watershed is approximately 79,423 acres in size and is located within the northern portion of the Klamath River basin. Canyon Creek originates in the Trinity Alps Wilderness and runs through mountainous terrain south towards the Trinity River. At Junction City, Canyon Creek meets the Trinity River and flow west towards the Klamath River.

Approximately 20 percent of the watershed is located in the Trinity Alps Wilderness. The watershed is a very popular summer destination for campers, backpackers and outdoor enthusiasts. The high mountain lakes, trails, waterfalls, and granite faces attract more recreational users than any other area within the Trinity Alps Wilderness (USDA Forest Service 2003).

The terrain is predominately mountainous and forested, with elevations ranging from 2,000 feet above mean sea level in Junction City to nearly 9,000 feet above mean sea level in the headwaters area. The vegetation varies throughout the different regions of the watershed, however is dominated by conifer forests and mixed conifer/hardwood forests. The vegetation in the upper elevations is primarily white and red fir, interspersed with mountain meadows, alder stringers and riparian areas. Douglas fir and tan oak are prominent in the middle and lower elevation areas (USDA Forest Service 2003).

The Mediterranean-like climate zone of the region results in hot dry summers and cool wet winters. Precipitation is highly seasonal, and most of it falls between October and April. Snowfall occurs at lower elevation; however, it does not typically accumulate below 4,000 feet above mean sea level. Average annual precipitation in the Canyon Creek watershed ranges from 40 inches at the lower end to 70 inches in the upper portions of the watershed (USDA Forest Service 2003).

6.2 Overview

For this effort, three subwatersheds (HUC 6) and twelve drainages (HUC 7) were delineated for the purposes of the SSI and RAP efforts. Table 6-1 characterizes the hierarchy for the three subwatersheds, Lower Canyon Creek (Lower), Middle Canyon Creek (Middle), and Upper Canyon Creek (Upper), included in the SSI and RAP risk analysis. Figure 6-1 illustrates the location of these subwatersheds, drainages and the respective road segments. As shown in Figure 6-1, 2012 SSI focused on the Middle subwatershed, with minimal effort in the Upper subwatershed and no effort in the Lower subwatershed..

As shown in Table 6-1, the project GIS data indicates there is approximately 288.1 miles of roads in the Canyon Creek watershed. The relatively low road density, of 2.3 miles of road per square mile of watershed, can be attributed the fact that a large portion of the watershed is within the administrative boundary of the Trinity Alps Wilderness. The Lower subwatershed has the greatest road mileage, as well as the highest road density, with 3.5 miles of road per square mile, in the watershed.

The majority of the Upper subwatershed is located in the Trinity Alps Wilderness and has very low road density; 0.8 miles of road per square mile of watershed.

Table 6-1. Canyon Creek Watershed Characteristics

Subwatersheds (HUC 6)	Drainage Area (mi^2)	Total Road Length (mi)	Road Density (mi/mi^2)	Past SSI Road Miles	2012 SSI Road Miles	Total SSI Road Miles
Lower Canyon Creek	60.0	211.3	3.5	38.3	0.3	38.6
Middle Canyon Creek	35.4	53.4	1.5	0.0	14.4	14.4
Upper Canyon Creek	28.7	23.4	0.8	0.0	3.0	3.0
Watershed Totals	**124.1**	**288.1**	**2.3**	**38.3**	**17.7**	**56.0**

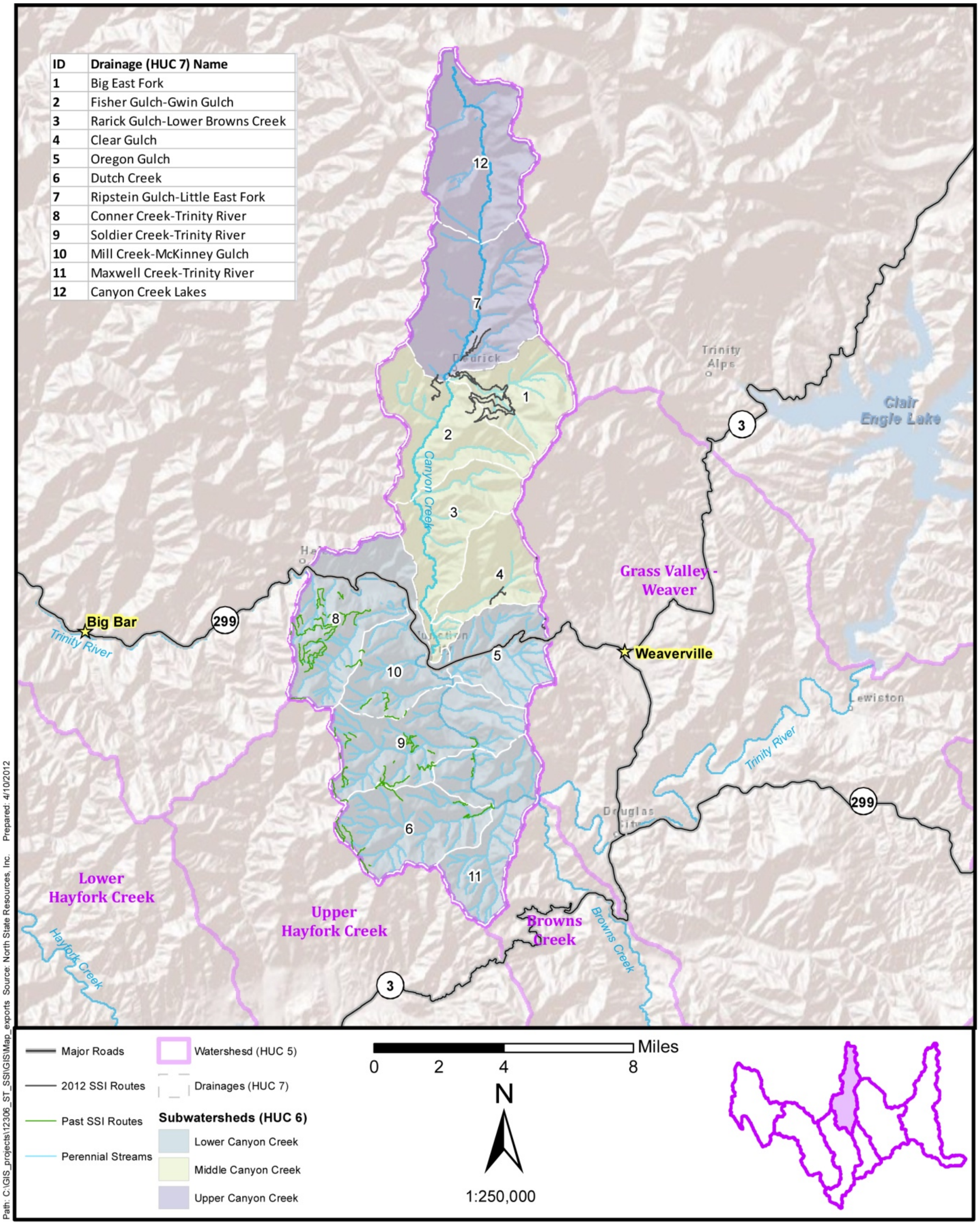
Hydrology

STNF GIS data indicates that there are approximately 533.5 miles of stream channels within the watershed and a stream density of 4.3 miles of stream per square mile (see Table 6-2). Approximately 249 miles (47%) of the streams are perennial streams.

The Upper subwatershed includes the headwaters of Canyon Creek and a number of its tributaries; it has the least miles of streams and the lowest stream density, with 3.5 miles of stream per square mile of watershed (see Table 6-2). Approximately 37 percent of the streams are perennial in nature, including Little East Fork Creek and Ripstein Gulch.

The Middle subwatershed drains that portion of the watershed that is primarily between the boundary of the Trinity Alps Wilderness and the confluence with the Trinity River near Junction City, California (see Figure 6-1). This subwatershed has a higher stream density than the Upper subwatershed, with 4.5 miles of stream per square mile of watershed, but only 28 percent of the streams are perennial in nature (see Table 6-2). Some of the larger streams (drainage area) that contribute to this subwatershed include Big East Fork Creek, Lower Browns Creek, and Clear Gulch.

The Lower subwatershed does not directly drain into Canyon Creek. The boundary for this is subwatershed includes drainages on both the east and west side of the Trinity River that drain directly to the Trinity River (see Figure 6-1). This subwatershed has a stream density of 4.5 miles per square mile of watershed and approximately 61 percent of the streams are perennial in nature (see Table 6-2). Maxwell Creek, Mill Creek, Conner Creek, and Soldier Creek are some of the larger streams in terms of drainage area.



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North State Resources, Inc. 2012 Shasta-Trinity SSI

Figure 6-1. Canyon Creek Watershed Location

Table 6-2. Canyon Creek Watershed Streams Densities and Fish Bearing Lengths

Subwatersheds (HUC 6)	Stream Length (mi)	Stream Density (mi/ (mi^2))	Miles of Perennial Stream	Perennial Streams as % of Total Miles	Miles of Fish-Bearing Streams	Fish-Bearing Streams as % of Total Miles
Lower Canyon Creek	272.8	4.5	165.9	60.8%	58.6	21.5%
Middle Canyon Creek	160.2	4.5	46.1	28.7%	39.7	24.8%
Upper Canyon Creek	100.4	3.5	37.2	37.0%	33.9	33.8%
Watershed Totals	**533.5**	**4.3**	**249.1**	**46.7%**	**132.3**	**24.8%**

Water Quality

The Trinity River is included on California's CWA Section 303(d) list because water quality standards are exceeded due to excessive sediment (Environmental Protection Agency 2001). As tributaries to the mainstem Trinity River, Canyon Creek and tributaries within the Lower subwatershed (i.e. Soldier Creek, Oregon Gulch, Dutch Creek and Conner Creek) are included on this list. Sediment impairment in the Trinity River and its tributaries resulted in non-attainment of designated beneficial uses, primarily the cold-water fishery, including spawning, migration, and reproduction and fish habitat (Environmental Protection Agency 2001). A total maximum daily load (TMDL) for sediment, with numeric targets, was prepared for the mainstem Trinity River, including its tributaries in 2001. The water quality objectives addressed in the TMDL include settleable material, suspended material, sediment, and turbidity (Environmental Protection Agency 2001). The dominant source of sediment delivery in the Canyon Creek watershed is from erosion from roads, including roads on steep slopes, stream crossings, and the proximity of the roads to the streams (Environmental Protection Agency 2001).

According to the Trinity River TMDL, Canyon Creek is at risk with regard to several aquatic habitat indicators including water quality, stream vegetation, channel stability, and aquatic integrity. The unstable channel conditions are primarily due to historic mining activity and land use activities (Environmental Protection Agency 2001).

Aquatic and Riparian Habitat

Extensive mining has adversely affected the riparian conditions and the composition of the channel substrate and stream banks in the Canyon Creek watershed. Mining actives have increased channel degradation and created wider, shallower, less complex channels. Mining began in the watershed in the 1850's with the discovery of gold. Many forms of mining took place in the Canyon Creek watershed through the late-1800's and 1900's, including, hydraulic mining, hard rock mining in the Big and Little East Forks Canyon Creek; in recent years, open pit mining and suction dredging have continued intermittently on both public and private lands at various locations in the watershed. Historically, hydraulic mining (including large-scale trans-basin water diversions) had the most extensive effects on the watershed, predominately in the Middle subwatershed. Other activities have negatively affected the aquatic habitat, including large flood events (1964), the 1987 fires, and roads. In addition, Canyon Creek was damned for power-generation until the 1940's, when the dam was removed (U.S.D.A Forest Service 2003).

.Anadromous fish have declined throughout the Trinity River basin over the last several decades due to habitat degradation. Recent, site-specific information on juvenile salmonid use of Canyon Creek and its tributaries is limited and non-existent for other species of fish. It has been reported than steelhead, chinook, and potential coho habitat is present in the Canyon Creek watershed (Chilcote 2012). Previous studies have indicated that Canyon Creek is primarily a summer steelhead stream with moderate use by spring run Chinook salmon (U.S.D.A Forest Service 2003). Juvenile snorkel counts of steelhead and chinook population showed declining runs through the late 1970's until the 1990's, at which point populations appeared to be stabilizing. The Southern Oregon Northern California Coastal Coho salmon have been listed as threatened under the Endangered Species Act in the mainstem Trinity River, including tributaries like Canyon Creek (National Oceanic Atmospheric Administration 2011).

Various monitoring efforts are conducted in the Canyon Creek watershed to assess the in-stream habitat conditions. The stream temperature is continuously recorded and both biotic and abiotic conditions are actively monitored. Redd and dive surveys are conducted on an annual basis to identify spatial distribution and abundance trends in holding and spawning adult fish (Chilcote 2012).

Geology

Nearly half of the Canyon Creek watershed is underlain by a limestone formation, which occupies nearly all of the Middle subwatershed and significant amount of the Upper and Lower subwatersheds (Table 6-3). All of the roads inventoried as part of the 2012 SSI are underlain by this limestone. This large limestone deposit is flanked by the diorite and tonalite rock units associated with the Canyon Creek Pluton in the northern half of Upper subwatershed. Rocks of the Western Paleozoic and Triassic Belt, the Abrams Schist of the Central Metamorphic Belt, and the metasediments of the Eastern Klamath Belt underlie a vast majority of the Lower subwatershed on either side of the Trinity River.

Table 6-3. Canyon Creek Watershed Prominent Geologic Units and Rock Types

Geologic Unit	Percent of Watershed		Dominant Rock Type(s)
Late Paleozoic Limestone	49%		Limestone (undifferentiated)
Western Paleozoic and Triassic Belt	28%		
Eastern Hayfork Terrane		10%	metasediments (argillite), serpentine
Sawyers Bar Terrane		8%	metavolcanics, metasediments
Salmon River Unit		5%	gabbro, serpentine
Western Hayfork Terrane		5%	metavolcanics, metasediments
Plutonic Rock	13%		
Canyon Creek Pluton		12%	diorite, tonalite
E.Klamath and C. Metamorphic Belts	10%		metavolcanics, metasediments

Approximately 86 percent of the Canyon Creek watershed contains very high and high potential areas for soil erosion (Figure 6-2). In addition, nearly 27 percent of the watershed contains sensitive landforms including; steep granitic terrain, inner gorges, and active and dormant landslides. These erosive soils and sensitive landforms features are generally evenly distributed throughout the watershed.

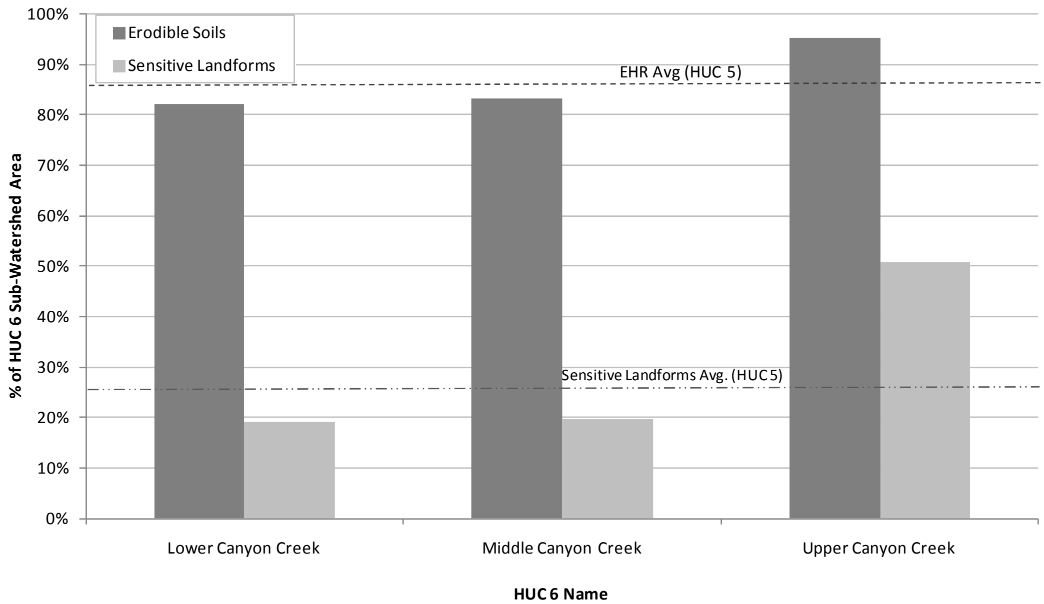


Figure 6-2. Area of Canyon Creek Subwatersheds Occupied by Erodible Soils and Sensitive Landforms

6.3 SSI Results

As described in Section 2, roads in the Canyon Creek watershed were inventoried during multiple field seasons. In total, 56 miles of road were inventoried in the watershed. As part of the 2012 SSI, 17.7 miles were inventoried by NSR during the 2011 and 2012 field season. The following discussion focuses on the 2012 SSI data set. The data acquired during the 2012 SSI supplements the STNF data set available through previous SSI efforts over the past several years under various types of contracts and/or agreements. The cumulative SSI data set is presented following the 2012 SSI discussion.

2012 SSI Results

The objective of the 2012 SSI was to document the condition of existing road-related infrastructure and identify existing and potential erosion and sediment producing features located over 17.7 miles of road in the Canyon Creek watershed (Figure 6-1 and Appendices E & F). Inventoried features were prioritized based on their potential for sediment production and delivery to the hydrologic network. This section focuses on the inventoried and prioritized features included in the 2012 SSI. The results are presented at both the subwatershed (HUC 6) and drainage scales (HUC 7).

Inventoried Features

The 2012 SSI identified and characterized 312 features; 1.3 miles of gully, 2.0 miles of ditch segments; 24 stream crossings; eight erosion features; 78 hydrologically connected cross-drain features; 193 non-hydrologically connected cross-drains; and nine springs (Table 6-4 and Appendices E & F).

Table 6-4. 2012 SSI Inventoried Features for Canyon Creek Subwatersheds (HUC 6) and Drainages (HUC 7)

Subwatersheds (HUC 6) Drainages (HUC 7)	Road Miles	Gully Miles	Ditch Miles	Stream Crossings	Erosion Features	Connected Cross-Drains	Non-Connected Cross-Drains	Springs
Lower Canyon Creek	0.3	0.0	0.0	0	0	0	0	0
Dutch Creek	< 0.05	0.0	0.0	0	0	0	0	0
Oregon Gulch	0.3	0.0	0.0	0	0	0	0	0
Middle Canyon Creek	14.4	0.7	1.4	23	8	76	167	9
Big East Fork	9.5	0.5	1.4	22	7	66	94	9
Clear Gulch	1.1	0.2	0.0	1	0	6	22	0
Fisher Gulch-Gwin Gulch	3.8	0.0	0.0	0	1	4	51	0
Upper Canyon Creek	3.0	0.6	0.7	1	0	2	26	0
Ripstein Gulch-Little East Fork	3.0	0.6	0.7	1	0	2	26	0
Watershed Totals	**17.7**	**1.3**	**2.0**	**24**	**8**	**78**	**193**	**9**

Note: The drainages included in the 2012 SSI are shown in Table 6-4; other drainages within the watershed are not listed.

Over 80 percent of roads included in the 2012 SSI were located in the Middle subwatershed, with the majority located in the Big East Fork drainage. This drainage accounted for nearly 66 percent of inventoried mileage within the subwatershed and 54 percent of the overall mileage included in the 2012 SSI. Accordingly, the Middle subwatershed contained the greatest number of features in comparison to other subwatersheds; the Big East Fork drainage contained the greatest number of features in comparison to other drainages. Of the total features identified in the 2012 SSI, 283 features or 91 percent of the total were inventoried in the Middle subwatershed. Almost 70 percent of these features were concentrated in the Big East Fork drainage.

Compared to the Middle subwatershed, very few miles were inventoried in the Lower and Upper subwatersheds. Only 0.3 miles of road were inventoried in the Lower subwatershed and no features were identified. Three miles of road were inventoried in the Upper subwatershed; 29 features, 0.6 miles of gully, and 0.7 miles of ditch were identified (Table 6-4).

Feature Analysis/Risk Analysis

As described in Section 2, risk ranking matrices were created to identify features that currently do, or potentially could deliver elevated levels of sediment to nearby streams or waterbodies. The number of high risk features and the proportion by subwatershed are listed in Table 6-5. The accompanying GIS project is organized to extract the type and location of features by risk rating at multiple scales. The density of high risk features types for each subwatershed and drainage is shown in Figure 6-3.

Table 6-5. High Risk Features for Canyon Creek Subwatersheds (HUC 6) and Drainages (HUC 7)

Subwatersheds (HUC 6) Drainages (HUC 7)	Gully Miles	Ditch Miles	Stream Crossings	Erosion Features	Connected Cross-Drain w/CMP	Springs
Lower Canyon Creek	0.0	0.0	0	0	0	0
Middle Canyon Creek	0.3 (21%)	0.0	9 (38%)	7 (88%)	8 (10%)	2 (22%)
Big East Fork	0.2 (15%)		9 (38%)	6 (75%)	8 (10%)	2 (22%)
Clear Gulch	0.1 (6%)					
Fisher Gulch-Gwin Gulch				1 (13%)		
Upper Canyon Creek	0.1 (11%)	0.0	0	0	0	0
Ripstein Gulch-Little East Fork	0.1 (11%)					
Watershed Totals	**0.4 (32%)**	**0.0**	**9 (38%)**	**7 (88%)**	**8 (10%)**	**2 (22%)**

Note: Values in parenthesis represent percentage of watershed feature totals.

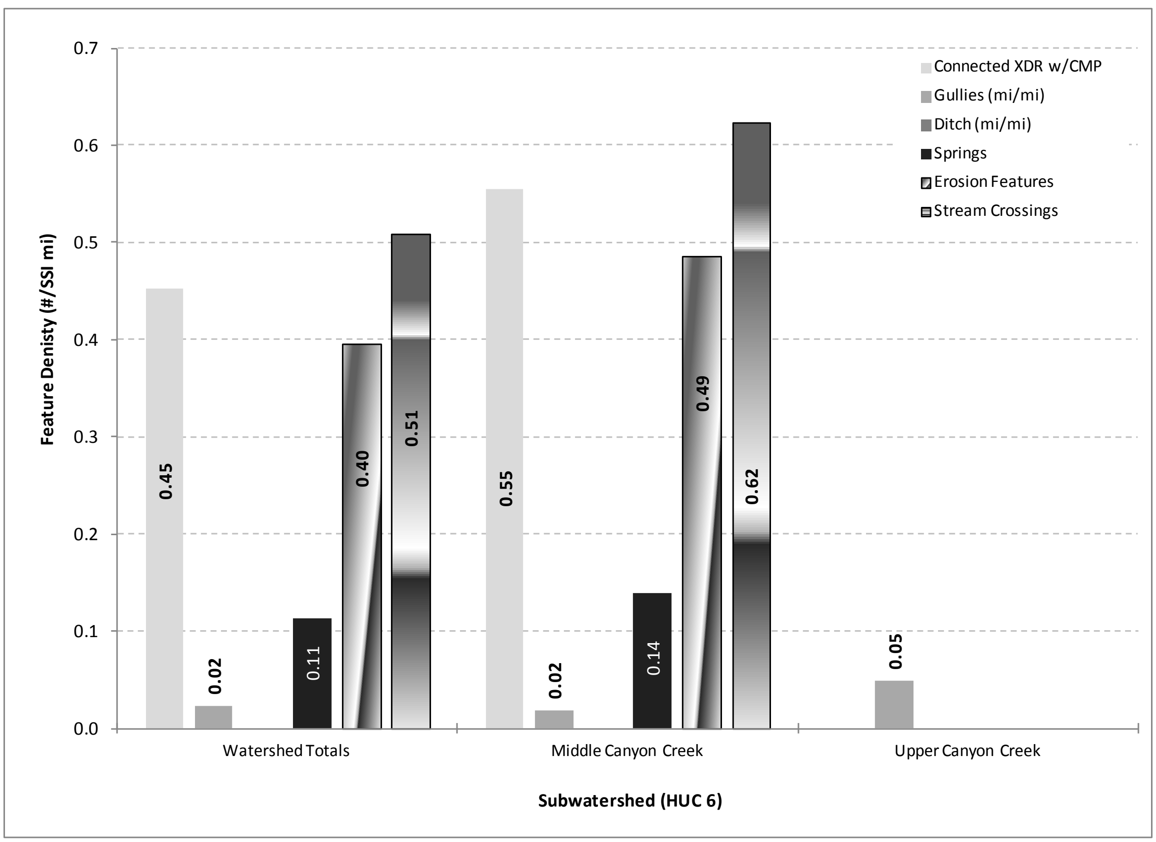


Figure 6-3. Density of High Risk Features for Canyon Creek Subwatersheds
Note: Gullies and ditch densities reported as miles of feature per mile of SSI road.

As illustrated in Table 6-5, the 2012 SSI identified the following high risk features: 0.4 miles of gully, nine stream crossings, seven erosion features, eight connected cross-drains with CMP, and two springs were identified as high risk in the 2012 SSI. A total of 26 features or 45 percent of the total 2012 SSI features (excluding non-connected cross-drains and connected cross-drains without CMP) are characterized as high risk in the Canyon Creek watershed.

Both the Upper and the Lower subwatersheds did not contain any high risk features, except for 0.1 mile of gully in the Upper subwatershed. All 26 high risk features were found in Middle subwatershed, with 25 of those features and 0.3 miles of high risk gully located in the Big East Fork drainage. The Big East Fork drainage has a disproportionate amount of high risk features, when compared to the road miles inventoried in the drainage. Approximately 96 percent of the high risk features were found in the Big East Fork drainage, however, only 54 percent of the total 2012 road miles were inventoried in the Big East Fork drainage.

Figure 6-3 illustrates the variability in the number and type of high risk features per mile of inventoried road by subwatershed. The Lower and Upper subwatersheds have a much lower density of high risk features than the average for the Middle subwatershed and the entire Canyon Creek watershed; however it is difficult to discern if results are skewed due to the minimal SSI data set available for the Lower and Upper subwatersheds.

Cumulative SSI Data

Prior to conducting the 2012 SSI effort, the STNF acquired SSI data in the Lower subwatershed over the course of several field seasons. Table 6-6 illustrates the total road miles inventoried relative to the cumulative number and type features that have been documented through various SSI efforts in the Canyon Creek watershed, by subwatershed/drainage.

The following discussion is based on cumulative SSI efforts conducted for the STNF on approximately 56 miles of road within the Canyon Creek watershed; this is approximately 19 percent of all roads within the Canyon Creek watershed. Approximately 68 percent of the total roads or 38.3 miles were inventoried prior to the 2012 SSI and 32 percent of the total roads or 17.7 miles were inventoried in the 2012 SSI effort.

Cumulatively, the SSI data set documents the occurrence of nine erosion features and 138 hydrologically connected features, which includes stream crossings and connected cross-drains (Table 6-6). Sixty of these features were stream crossings, of which 12 percent were identified as high risk features. These include crossings that were unable to, or were in danger of not being able to adequately convey peak flow events at that feature. Ten percent were identified as having diversion potential, and 7 percent were undersized pipes. Field indicators of undersized pipe were: evidence of overtopping; substantially plugged features, poor structural integrity (i.e. holes, separated, etc.), poor positioning, or a significant loss of fill at the inlet.

Approximately 38.6 miles of the total roads in the Lower subwatershed were included in the cumulative SSI data set; none of these miles were inventoried in the 2012 SSI. This data set represents the highest mileage inventoried for any of the subwatersheds in Canyon Creek, with 69 percent of the total inventoried miles. The proportion of inventoried features in the Lower subwatershed is not consistent with the proportion of roads inventoried; only 11 percent of the inventoried erosion features and 26 percent of the inventoried connected features were located in the Lower subwatershed (Table 6-6). Of the 36 stream crossings inventoried, none were identified as high risk, with diversion potential or undersized. As shown in Figure 6-4, the density of connected features, erosion features, at at-risk stream crossings in the Lower subwatershed is lower than watershed average.

Table 6-6. Canyon Creek Watershed Cumulative SSI Data

Subwatersheds (HUC 6) Drainages (HUC 7)	Total SSI Miles	Erosion Features	Connected Features[1]	Stream Crossings			
				Total	High Risk	Diversion Potential	FEUP[2]
Lower Canyon Creek	38.6	1	36	36	0	0	0
Conner Creek-Trinity River	17.0	0	22	22	0	0	0
Dutch Creek	6.8	0	7	7	0	0	0
Maxwell Ck-Trinity River	1.0	0	0	0	0	0	0
Mill Creek-McKinney Gulch	2.3	0	1	1	0	0	0
Oregon Gulch	0.3	0	0	0	0	0	0
Soldier Creek-Trinity River	11.2	1	6	6	0	0	0
Middle Canyon Creek	14.4	8	99	23	7	6	4
Big East Fork	9.5	7	88	22	7	6	4
Clear Gulch	1.1	0	7	1	0	0	0
Fisher Gulch-Gwin Gulch	3.8	1	4	0	0	0	0
Upper Canyon Creek	3.0	0	3	1	0	0	0
Canyon Creek Lakes	0.0	0	0	0	0	0	0
Ripstein Gulch-Little E. Fork	3.0	0	3	1	0	0	0
Watershed Totals	**56.0**	**9**	**138**	**60**	**7**	**6**	**4**

[1]Includes all stream crossings and Connected Cross-Drains; indicator of hydrologic connectivity of roads
[2]Field Evidence of Undersized Pipe (FEUP); see methods for explanation.

Approximately 26 percent of the cumulative SSI roads (14.4 miles) were located in the Middle subwatershed. The Middle subwatershed actually had the greatest number of inventoried features, with 8 erosion features and 99 connected features. All of the high risk stream crossings, stream crossings with diversion potential and stream crossings with FEUP were located in the Middle subwatershed. As shown in Figure 6-4, the Middle subwatershed has a greater than average density of connected features, erosion features and at risk stream crossings compared to the watershed average.

The discrepancy in the density of erosion and connected features and in the Middle and Lower subwatershed may be a result of different inventory methods used for various SSI efforts. The Lower subwatershed was inventoried in previous SSI efforts, while the Middle subwatershed was inventoried in the 2012 SSI.

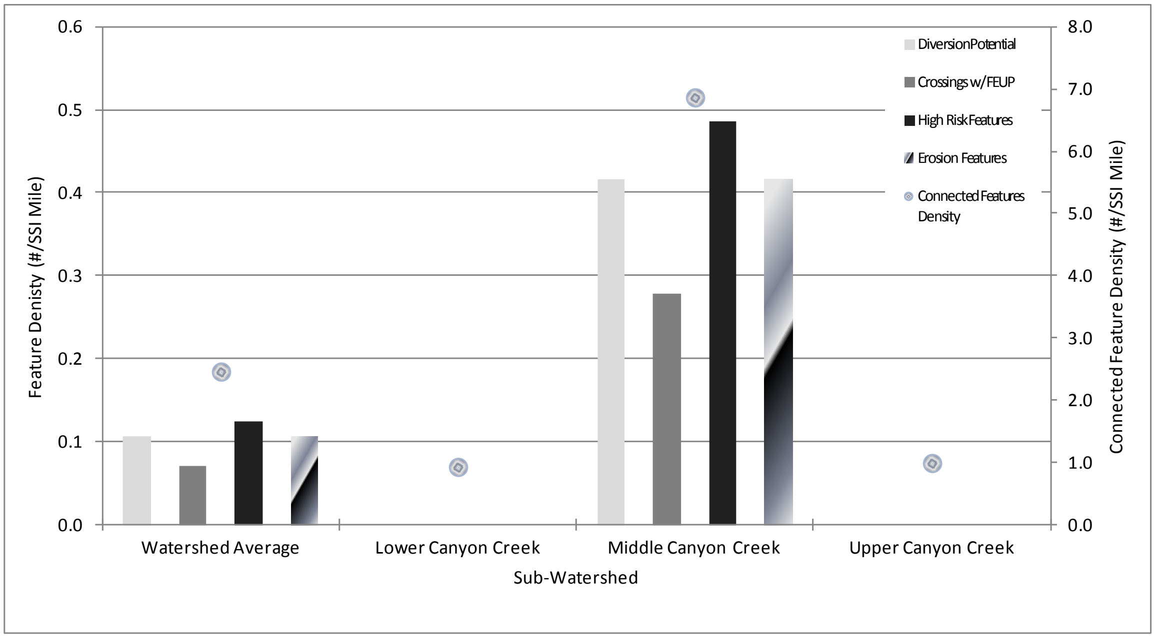


Figure 6-4. Density per Mile of SSI Road of Selected Features for Canyon Creek Subwatersheds

Approximately 5 percent of the cumulative SSI roads (3 miles) were inventoried in the Upper subwatershed; no erosion features and 3 connected features were identified. One stream crossing was identified and it was not considered at risk. As shown in Figure 6-4, the density of connected features, erosion features and at-risk stream crossings in the Upper subwatershed is lower than average for the Canyon Creek Watershed. However, with only three miles inventoried, the data is likely not very representative of the entire Upper subwatershed.

6.4 Aquatic and Riparian Resources RAP Risk Analysis

The main focus of the RAP risk analysis was to identify road segments that could pose a moderate to high risk to aquatic and riparian resources. Three resources, including, water quality, hydrologic processes, aquatic and riparian habitat are analyzed in the following discussion. The RAP risk analysis is presented at both the HUC 7 drainage and road segment scales.

Aquatic and Riparian Resources RAP Risk Score per Drainage

The total Aquatic and Riparian Resources RAP risk score (RAP total risk score) for road segments within each of the 6 drainages (HUC 7) that constitute the Canyon Creek watershed are discussed in this section. The RAP total risk score is the average of the individual water quality, hydrologic processes, and aquatic and riparian habitat scores. As described in Section 2, the key questions specific to the three resources, and the associated criteria required to answer these questions have been developed in accordance with the STNF RAP protocol (Shasta-Trinity National Forest 2011) in order to rate the road segments at the drainage scale.

The RAP risk scores for water quality, hydrologic processes, and aquatic and riparian habitat, including the total scores for each road and drainage are listed in Appendix D. Figure 6-5 illustrates the total miles of road per drainage and the associated Aquatic and Riparian RAP risk score. This figure displays the relative risk per drainage for the various sections of roads included in the RAP analysis. A key point in this discussion is that the RAP analysis focused on the 2012 SSI data set due to inconsistencies in previous SSI data sets.

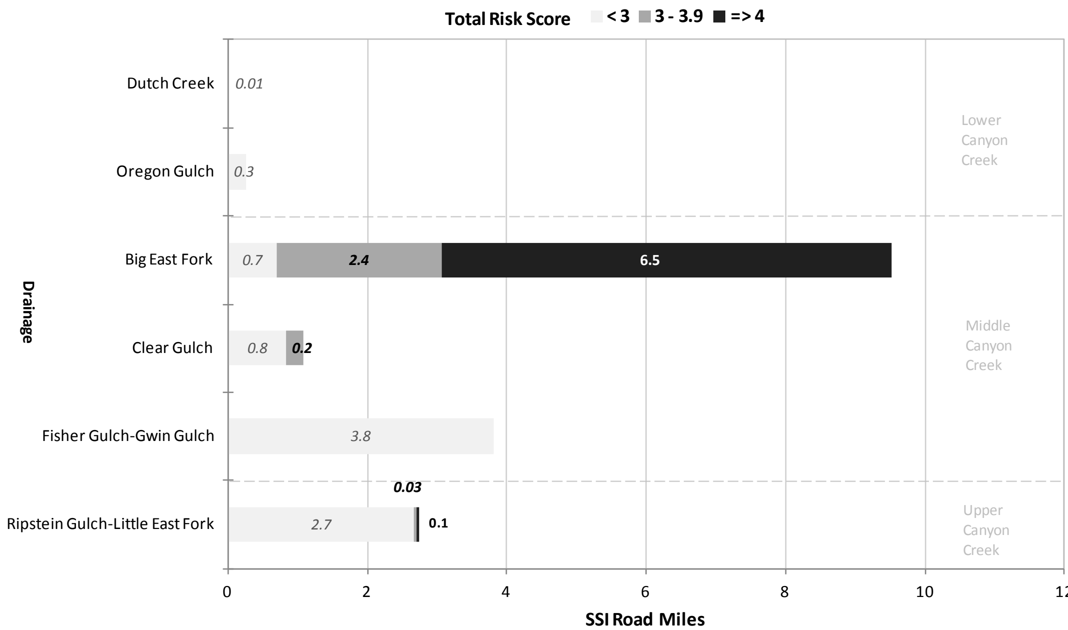


Figure 6-5. Aquatic and Riparian Resources RAP Total Risk Score for Canyon Creek Watershed Drainages

The Aquatic and Riparian Rap effort identified approximately 6.5 miles (37%) of the SSI 2012 data set scored as high risk and 2.9 miles (16%) scored as moderate-high risk to aquatic and riparian resources within the Canyon Creek watershed (Figure 6-5). In total, 9.4 miles of road (53%) of the total roads included in the 2012 SSI are considered a moderate-high to high risk to aquatic and riparian resources (Figure 6-5)

As shown in Figure 6-5, the majority of moderate-high to high risk roads were located in the Middle subwatershed. There was over 8.8 miles and 0.2 miles of road RAP total risk scores over 3.0 in Big East Fork and the Clear Gulch drainages, respectively. Over 90 percent of the moderate-high to high risk roads in the Canyon Creek watershed were located in Big East Fork drainage, yet only 54 percent of the 2012 inventoried roads were located in Big East Fork drainage. The proportion of moderate-high to high risk roads in Big East Fork drainage inventoried is not equal to the proportion of roads inventoried in the drainage. In other words, there is a higher percentage of roads in Big East Fork drainage that pose a moderate-high to high risk to aquatic and riparian resources than other drainages in the Canyon Creek watershed.

Of the 3 miles inventoried (in the 2012 SSI) in the Upper subwatershed, there was 0.05 miles of road that scored high risk and 0.3 miles that scored moderate-high risk roads in the Ripstein Gulch-Little East Fork drainage (Figure 6-5). Approximately 10 percent of the inventoried mileage in the subwatershed is considered moderate-high to high risk to aquatic and riparian resources.

Overall, 47 percent roads included in the 2012 SSI within the Canyon Creek watershed had scores less than 3 (low-moderate risk). Based on the assumptions used for the RAP analysis, this suggest that a large number of the roads pose a low to moderate risk of affecting aquatic and riparian resources. All roads within Dutch Creek and Oregon Gulch drainages (Lower subwatershed), had aquatic and riparian RAP risk scores less than 3.

Moderate-High to High Risk Road Segments

Table 6-7 lists those road segments by drainage included in the 2012 SSI that scored 3.0 or above in the RAP risk analysis. The location of these roads is shown in Figure 6-6. Based on this analysis, these roads have a moderate-high to high risk of affecting water quality, the natural function of hydrologic processes, and aquatic and riparian habitats. In total four road segments equaling 6.5 miles scored moderate-high risk; and six road segments equaling 2.9 miles scored high risk.

Table 6-7. Canyon Creek Watershed Routes with Total RAP Risk Scores of 3.0 and Greater

			Resource Risk Scores			
Route ID	Drainage Name	Miles	Aquatic, Riparian	Hydrologic Process	Water Quality	Total Risk
35N48Y	Big East Fork	1.59	4.4	3.8	4.3	4.1
35N47Y	Big East Fork	4.67	4.0	3.8	4.4	4.0
U35N47YBA_x	Big East Fork	0.21	4.0	3.8	4.3	4.0
35N56Y	Ripstein Gulch-Little East Fork	0.05	3.5	3.8	4.6	4.0
35N49Y	Big East Fork	1.49	3.8	3.8	4.3	3.9
33N67A	Clear Gulch	0.24	3.5	3.8	4.6	3.9
U35N47YB	Big East Fork	0.34	3.5	3.8	4.3	3.8
U35N47YBA	Big East Fork	0.51	3.5	3.8	4.0	3.8
35N47Y-GHT1	Big East Fork	0.01	3.5	3.8	3.8	3.7
35N52Y	Ripstein Gulch-Little East Fork	0.30	3.5	3.8	3.8	3.7

As shown in Table 6-7, the score for water quality is the highest of the three values, with the exception of two road segments where the score for water quality is equal to or slightly less than the score for hydrologic processes scores. Approximately 97 percent of the moderate-high to high risk roads have water quality scores equal, or exceeding 4.0. This suggests that nearly all of the moderate-high to high risk roads are hydrologically connected and intersect areas prone to erosion. Evaluation of previous RAP risk analysis indicates that where there are large concentrations of stream crossings and/or the road segments are in close proximity to aquatic and riparian habitat, a direct pathway for transport and delivery of sediment to water bodies within the Canyon Creek watershed can develop. Additionally, the broad array of road segments that traverse erosive soils and sensitive landforms have the potential to deliver sediment to these water bodies.

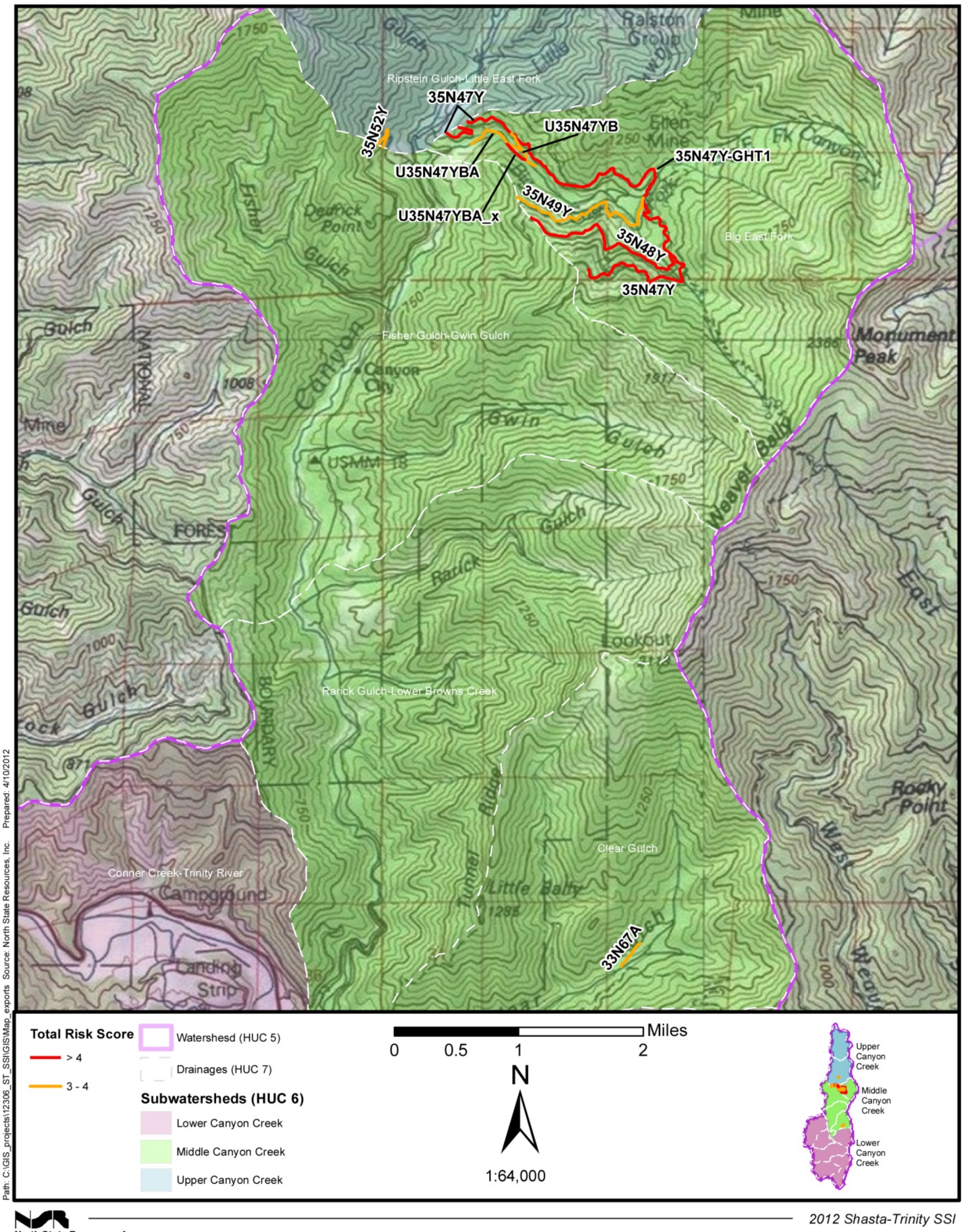


Figure 6-6. Canyon Creek Watershed Roads with Aquatic and Riparian Resources RAP Total Risk Scores of 3.0 and Above

Table 6-7 indicates that all road segments scored 3.8 for hydrologic processes. This analysis indicated that the all moderate-high to high risk road segments pose a similar risk to hydrologic processes throughout the Canyon Creek watershed. These roads may potentially affect the routing of water by intercepting and diverting flows from their natural path. This is also an indication that where a portion of the road prism intersects the riparian or aquatic habitat, the location and nature of the road prism may constrict the channel, isolate floodplains, and/or constrain channel migration.

The road segment scores for aquatic and riparian habitat range between 3.5 and 4.4. These scores correlate the risk to aquatic and riparian habitat relative to the individual road segments with respect to affects on the functions and values of aquatic and riparian habitat, including attributes such as connectivity, flow and fish passage. The 2012 SSI focused on roads in the lower elevations of the Middle subwatershed where the density of fish-bearing streams and proximity to streams is high for most roads. The range of scores is likely a result of the number of fish passage barriers identified in the 2012 SSI; crossings that posed a barrier to fish or other aquatic organisms score high in the RAP analysis.

6.5 Recommendations

Moderate-High Road Segments General Recommendations

Table 6-8 provides general recommendations for routes in the Canyon Creek watershed with a total RAP risk score greater than 3.0. Three different recommendation categories are included in this section directed at maintaining, upgrading or decommissioning road segments with moderate-high risk scores. Maintain includes activities such as cleaning out inlets and outlets of culverts and cross-drain with culverts, cleaning rolling dips and ditches, and spot-grading. Upgrading roads includes renovation of existing features, construction of new features, large-scale grading and resurfacing all or part of a segment, combined with normal maintenance activities. Decommissioning roads includes either full road obliteration or a temporary road decommission (e.g., stormproofing). The recommendations in this section are based on the RAP risk score in conjunction with SSI data such as road density and specific information on the type and number of features that could pose a risk to aquatic and riparian values.

Specific Recommendations to Upgrade Roads

Specific recommendations are listed below for the roads listed under ‘upgrade’ in Table 6-8 and for one additional road segment.   The recommendations focus on the sections of each road that either contained a high density of high risk features or individual features that could be treated to help decrease their impacts to water resources. Locations are denoted by Route ID, mile marker, and drainage. The feature type and associated problem are also included, along with recommendations for upgrades.

Table 6-8. General Recommendations for Moderate-High to High Risk Routes in the Canyon Creek Watershed

Route ID	Drainage Name	Miles	Total Risk	General Recommendation
35N48Y	Big East Fork	1.59	4.1	Upgrade & Decommission
35N47Y	Big East Fork	4.67	4.0	Upgrade
U35N47YBA_x	Big East Fork	0.21	4.0	Maintain
35N56Y	Ripstein Gulch-Little East Fork	0.05	4.0	Maintain
35N49Y	Big East Fork	1.49	3.9	Upgrade
33N67A	Clear Gulch	0.24	3.9	Maintain
U35N47YB	Big East Fork	0.34	3.8	Maintain & Decommission
U35N47YBA	Big East Fork	0.51	3.8	Maintain
35N47Y-GHT1	Big East Fork	0.01	3.7	Upgrade
35N52Y	Ripstein Gulch-Little East Fork	0.30	3.7	Maintain

Route ID: 35N48Y
Drainage: Big East Fork
Location: Mile Marker 0.101 – 0.982, Canyon Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.101	Stream Crossing (CMP)	Heavy woody debris covering inlet and boulders/cobbles blocking outlet. Evidence of overtopping in past. Perennial stream.	Clear inlet and outlet. Consider resizing culvert or creating armored ford to allow for passage of woody debris. Armor fill at upstream /downstream overflow tie into existing improved armored critical dip.
0.183	Stream Crossing (Ford)	Steep approach and exit rutted and actively delivering sediment to perennial stream.	Add aggregate to road base and/or install waterbars on approach and exit. If seasonal use, add waterbars after last exit.
0.832	Stream Crossing (CMP)	Stream crossing has failed several times in past; inlet is separated and partially buried; outlet is shotgun onto unstable slope. Crossing provides access to mine.	Reconstruct crossing to accommodate anticipated flows and to divert excess water off of unstable hillslope. Recommend using large diameter culvert with downspout.
0.965 – .982	Decommission Route & Features	Route surface compromised and failed in sections due to mass wasting and poorly designed stream crossing.	Obliterate road prism and remove landslide material (MM 0.965 & 0.971) as necessary and reconstruct failed stream crossing (MM 0.982) to original grade. Retain mine access.

Route ID: 35N47Y
Drainage: Big East Fork
Location: Mile Marker 0.452 – 3.438, Canyon Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.452 - 0.537	Cross-Drains	Series of four non-functioning or partially functioning cross-drains that create a gully that could deliver excess sediment into to Canyon Creek.	Clean, reshape, and armor existing cross-drains. Repair OSD as needed. Add additional cross-drains.
1.372	Cross-Drain	Flattened cross-drain partially functioning causes excess sediment to be transported to adjacent connected ditch.	Clean, reshape, and armor existing cross-drain. Repair OSD as needed
1.963 – 2.126	Connected Cross-Drain	Series of four partially functioning cross-drains that amplify route surface erosion and deliver excess sediment to Big East Fork.	Clean, reshape, and armor existing cross-drain. Repair OSD as needed. Add additional road base aggregate as needed.
2.244	Connected Cross-Drain w/CMP	Outlet 100 % buried with high diversion potential.	Clean outlet. Install armored rolling dip.
2.894	Erosion (Mass Wasting)	Large active earthflow . Route maintained over displaced material. Direct delivery to Big East Fork.	Reinforce toe slope and dewater road prism to maintain stability. Widen route for safety and add aggregate to road surface.
2.9161	Connected Cross-Drain w/CMP	Downspout separated from outlet. Excess water saturates slope below route.	Reconnect downspout to outlet.
2.992	Erosion (Mass Wasting)	Debris flow onto road and is a direct sediment source to a connected ditch	Stabilize toe zone with boulders. Add a check dam at ditch inception to limit sediment transport into ditch. Add coarse aggregate at base of slide to limit concentrated flow into ditch.
2.995 – 3.03	Ditch	Ditch is connected to Ellen Gulch and conveys excess sediment from a debris flow (MM 2.992).	Clean ditch and construct a series of check dams in ditch to limit sediment transport.
3.438	Connected Cross-Drain	Partially-functioning dip that causes spring flow to pond on route surface. High erosion potential. Upgrade spring (MM 3.451) may also contribute	Reconstruct cross-drain. Armor cross-drain and outlet.
3.468	Stream Crossing (CMP)	Upstream fill eroding and being transported downstream.	Clear inlet and armor fillslope. Consider pipe capacity analysis of site.
4.058	Stream Crossing (Ford)	Crossing difficult for even high-clearance vehicles. West side of approach is gullied and sediment source	Reconstruct crossings if vehicle access needed.

Route ID: 35N49Y
Drainage: Big East Fork
Location: Mile Marker 0.348 -0.519, Canyon Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.348	Erosion (Mass Wasting)	Large slide removed road prism; impassable and direct delivery to perennial stream.	Reroute road around slide and connect to stream crossing (MM 0.519). Or, decommission first 0.519 of route and use 35N48Y for access to west side of Bear Creek.
0.519	Stream Crossing (CMP)	CMP in channel banks of road fill steep and eroding into Bear Creek	Remove CMP. Pull road fill back to a stable grade; grade determined by use. Armor banks to protect against scour erosion.

Route ID: 35N47YB
Drainage: Big East Fork
Location: Mile Marker 0.1585 – 0.3496, Canyon Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.1585 – 0.3496	Road Prism	Road is in very close proximity to Big East Fork and only provides access to a decommissioned route (U35N47YBA_x).	Decommission (or abandon) route from low-water ford (MM 0.1585) to end of route.

Route ID: 35N47Y-GHT1
Drainage: Big East Fork
Location: Mile Marker 0.00 – 0.022, Canyon Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.00-0.022	Road Surface	Water drafting access enters riparian corridor. Some road erosion and rutting.	Add aggregate to road surface.

Additional Features of Concern

Feature Type	Mile Marker	Route ID	Problem	Recommendations
Route Gully	0.158 – 0.110	**33N67A**	Gully direct delivery into E. Fork Clear Gulch.	Add armored rolling dips and armor outlets. Add aggregate to route surface.

Section 7 Upper Hayfork Creek Watershed

7.1 Introduction

The Upper Hayfork Creek watershed is approximately 105,766 acres in size and is located within the southern portion of the Klamath River basin. Hayfork Creek originates in the Yolla Bolly Mountains and runs steeply down forested mountains in a northerly direction, before turning west through the broad flat Hayfork Valley. The boundary between the Upper Hayfork Creek and Lower Hayfork Creek watersheds is just west of the community of Hayfork, California. Hayfork Creek is the largest tributary to the South Fork Trinity River; the confluence is just upstream of Hyampom, California.

The watershed consists of forested mountains with a well-defined drainage network. The vegetation consists of mid to late-seral mixed conifer/Douglas fir forest with spotty distribution of ponderosa pine, chaparral/gray pine stands, and knobcone pine stands (U.S.D.A Forest Service 1998). The topography is generally very mountainous, with minimal arable land. The elevations rise over 6,000 feet in the watershed, dropping to approximately 2,500 feet in valley.

The Mediterranean-like climate zone of the region results in hot dry summers and cool wet winters. Precipitation is highly seasonal, and most of it falls between October and April. Below 4,000 feet above msl, most of the precipitation falls as rain. While snowfall occurs throughout the watershed on an annual basis, it does not typically accumulate below 4,000 feet. Average annual precipitation in the Upper Hayfork Creek watershed ranges from 40 inches near the lower northern limits of the watershed to 70 inches in the mountains (USDA Forest Service 1998).

7.2 Overview

For this effort, six subwatersheds (HUC 6) and sixteen drainages (HUC 7) were delineated for the purposes of the SSI and RAP efforts. Table 7-1 characterizes the hierarchy for the six subwatersheds included in the SSI and RAP risk analysis. Figure 7-1 illustrates the location of these subwatersheds, drainages and the respective road segments.

Table 7-1. Upper Hayfork Creek Watershed Characteristics

Subwatersheds (HUC 6)	Drainage Area (mi^2)	Total Road Length (mi)	Road Density (mi/mi^2)	Past SSI Road Miles	2012 SSI Road Miles	Total SSI Road Miles
Big Creek-Hayfork Creek	27.3	99.6	3.6	82.5	1.1	83.6
Carr Creek	28.3	118.9	4.2	0.0	18.9	18.9
Dubakella Creek	50.8	244.6	4.8	83.6	87.5	171.1
Duncan Gulch-Barker Creek	17.1	71.4	4.2	9.5	29.3	38.8
East Fork Hayfork Creek	26.4	98.2	3.7	0.0	7.9	7.9
Natural Bridge	15.4	51.2	3.3	0.0	31.6	31.6
Watershed Totals	**165.3**	**683.9**	**4.1**	**175.5**	**176.4**	**351.9**

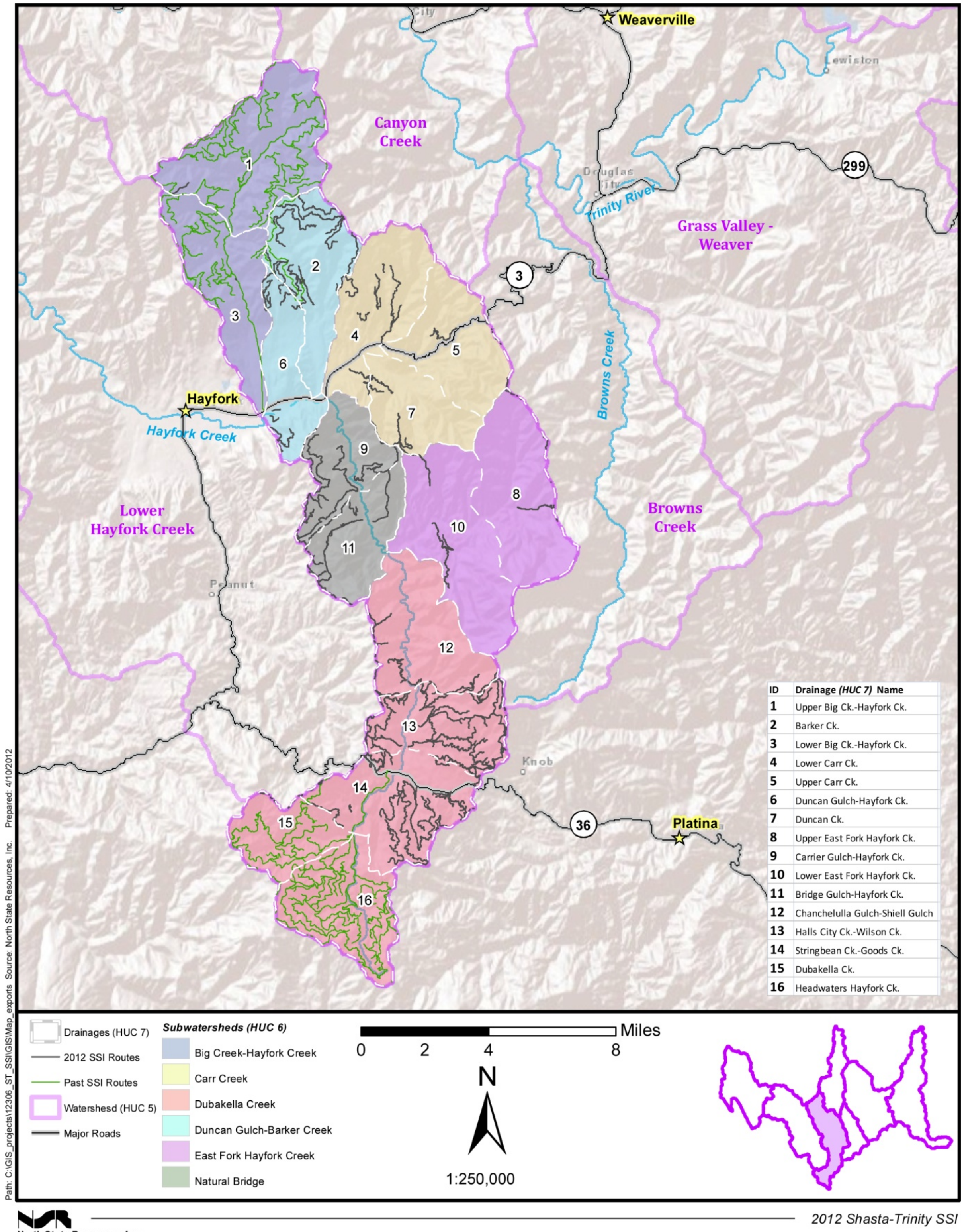


Figure 7-1. Upper Hayfork Creek Watershed Location

As shown in Table 7-1, the project GIS data indicates there is 683.9 miles of roads in the watershed, with a road density of 4.1 miles of road per square mile of watershed. Dubakella Creek subwatershed has the greatest road mileage, as well as the highest road density, with 4.8 miles of road per square mile, in the watershed. Many of the roads in the watershed were originally constructed to support historic mining and logging activities; over time the road system has been expanded to support other land management activities (e.g., fire suppression, recreation, utilities, and commercial development).

Hydrology

A dendritic channel network drains the Upper Hayfork Creek watershed. STNF GIS data indicates that there are 853 miles of stream channels, of which almost 400 miles are perennial streams. East Fork Hayfork Creek, Dubakella Creek, and Big Creek are some of the larger perennial streams in the watershed in terms of drainage area. However, most major tributaries are generally small within the watershed.

As shown in Table 7-2, the Natural Bridge subwatershed has the highest density of streams, with 6.1 miles of stream per square mile, while Dubakella Creek and East Fork Hayfork Creek subwatersheds have the lowest density of streams, with 4.8 miles of streams per square mile. The total stream density of the watershed is 5.2 miles of stream per square mile.

Stream channel conditions and characteristics vary throughout the watershed due to differences in soils and geology. In the lower elevations of the watershed, soils are highly erosive and stream channels are more susceptible to down cutting and widening during peak flows; essentially more sensitive to the types of land management activities that have occurred throughout the watershed over time. Historic placer and hydraulic mining and logging, coupled with more recent activities (e.g., fire suppression, and localized development) have affected some of these stream channels and the condition of the adjacent riparian areas. A number of the streams in the headwaters of the watershed are have bedrock controls and appear to be less sensitive to natural and anthropogenic disturbances (U.S.D.A Forest Service 1998).

Table 7-2. Upper Hayfork Creek Watershed Streams Densities and Fish Bearing Lengths

Subwatersheds (HUC 6)	Stream Length (mi)	Stream Density (mi/ (mi^2))	Miles of Perennial Stream	Perennial Streams as % of Total Miles	Miles of Fish-Bearing Streams	Fish-Bearing Streams as % of Total Miles
Big Creek-Hayfork Creek	144.5	5.3	74.1	51.3%	27.8	19.2%
Carr Creek	162.3	5.7	115.6	71.3%	31.7	19.5%
Dubakella Creek	242.4	4.8	45.7	18.9%	45.7	18.8%
Duncan Gulch-Barker Creek	83.1	4.9	52.8	63.5%	16.6	20.0%
East Fork Hayfork Creek	127.1	4.8	54.8	43.1%	34.5	27.1%
Natural Bridge	93.9	6.1	48.2	51.4%	15.9	16.9%
Watershed Totals	**853.3**	**5.2**	**391.4**	**45.9%**	**172.2**	**20.2%**

Water Quality

The South Fork Trinity River, including tributaries such as Hayfork Creek is included on California's CWA Section 303(d) list as water quality limited due to sediment (Environmental Protection Agency 1998). The sediment impairment resulted in non-attainment of designated beneficial uses, primarily the cold water fishery. A total minimum daily load (TMDL) for sediment, with numeric targets, was prepared for the South Fork Trinity River and Hayfork Creek in 1998. The water quality objectives addressed in the TMDL include settleable material and sediment (Environmental Protection Agency 1998). The dominant source of sediment delivery in the Hayfork Creek sub-basin is bank erosion processes, followed by surface erosion process. Most reports discussing sediment yield within the sub-basin concentrate on the South Fork Trinity River and the lower reaches of Hayfork Creek (Lower Hayfork Creek watershed). The Upper Hayfork Creek watershed has been classified as having low to moderate sediment yield. Sources of sediment in the upper reaches of Hayfork Creek are primarily from erosion from roads in close proximity to streams (USDA Forest Service 1998).

The 303(d) listing for the South Fork Trinity River and Hayfork Creek was updated to include temperature impairment in 1998, but to date a TMDL has not been developed (Environmental Protection Agency 1998). A number of monitoring efforts have documented that high water temperatures occur during low-flow conditions in the lower reaches of Hayfork Creek (Lower Hayfork watershed), likely as a result of water diversions, loss of riparian vegetation, natural conditions, and excess sedimentation

Aquatic and Riparian Habitat

Hayfork Creek and its tributaries are occupied by steelhead trout, rainbow trout, chinook salmon, pacific lamprey, and speckled dace. Steelhead trout will spawn in ephemeral and intermittent channels and juveniles will rear in these channels provided there is sufficient water. Southern Oregon Northern California Coastal Coho salmon have been listed as threatened under the Endangered Species Act, however, it is debated whether Hayfork Creek ever supported coho salmon (Oceanic Atmospheric Administration 2011 and USDA Forest Service 1998).

Various monitoring efforts are conducted to assess the habitat conditions of Upper Hayfork Creek. Stream Conditions Inventories (SCI) and redd surveys are conducted intermittently, while stream temperature and abiotic conditions are monitored actively (Chilcote 2012).

As shown in Table 7-2, the STNF GIS data indicates that approximately 172 miles of stream or 20 percent of the streams in the watershed are fish bearing streams. In general, most of the perennial and, to varying degrees intermittent streams provide some degree of habitat for aquatic and riparian dependent organisms (flora and fauna). Approximately 27 percent of the streams in the East Fork Hayfork Creek subwatershed are fish bearing, which is the highest amongst the subwatersheds. The wide array of natural and anthropogenic disturbances that have occurred throughout the watershed have affected the function and value of aquatic and riparian habitat (USDA Forest Service 1998).

Geology

A majority of the Upper Hayfork Creek watershed is underlain by metasediments, metavolcanics, and serpentinized deposits of the Eastern and Western Hayfork Terranes and the Rattlesnake Creek Terrane of the Western Paleozoic and Triassic Geologic Belt of the Klamath Mountains Province

(Table 7-3). Dioritic rock from the Wildwood Pluton occupies large areas in the Dubakella Creek and East Hayfork Creek subwatershed, located in the southern portion of the watershed. Non-marine sandstone and conglomerate underlies alluvial fill at various locations throughout the Hayfork Valley (Strand 1977, Wagner & Saucedo 1983).

Table 7-3. Upper Hayfork Creek Watershed Prominent Geologic Units and Rock Types

Geologic Unit	Percent of Watershed	Dominant Rock Type(s)
Western Paleozoic and Triassic Belt	77%	
Eastern Hayfork Terrane	48%	metasediments (argillite)
Western Hayfork Terrane	16%	metavolcanics
Rattlesnake Creek Terrane	13%	metavolcanics, serpentine
Plutonic Rock	15%	
Wildwood Pluton	13%	diorite
Miocene Sedimentary Rock	8%	sandstone, conglomerate

Approximately 24 percent of the Upper Hayfork Creek watershed area contains erosive soils and/or sensitive landforms (Figure 7-2). Most of the erosive soils occur in Dubakella Creek and East Hayfork Creek subwatersheds in proximity to the Wildwood Pluton and in the Big Creek-Hayfork Creek subwatershed upslope of Hayfork Valley. More than 20 percent of the watershed is associated with sensitive landforms (e.g., dormant landslides, inner gorges and steep granitic terrain). Most of this type of terrain occurs in the same vicinity as the erosive soils (Elder 2008).

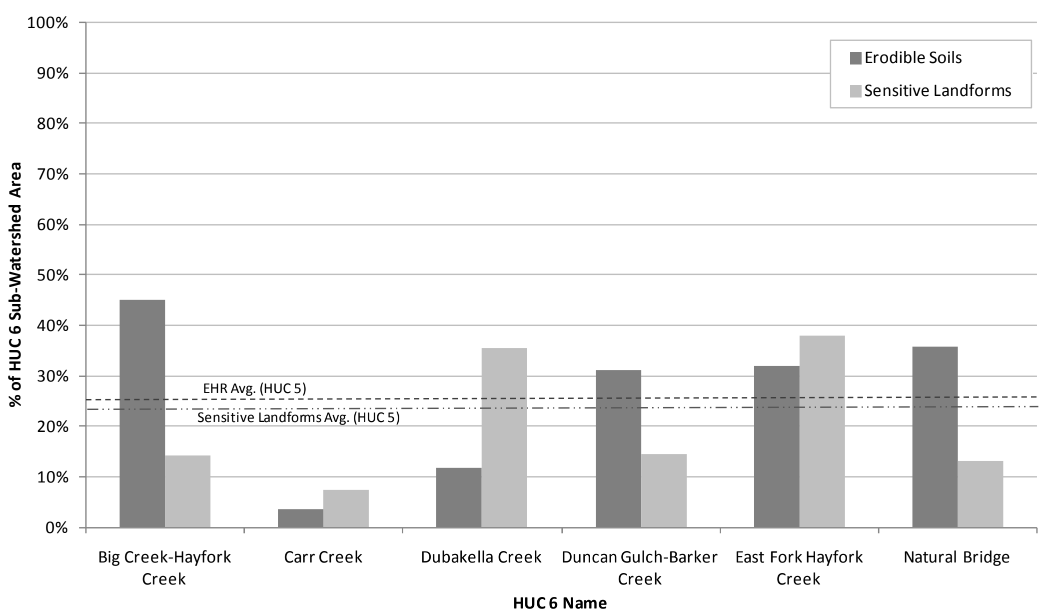


Figure 7-2. Area of Upper Hayfork Creek Subwatersheds Occupied by Erodible Soils and Sensitive Landforms

7.3 SSI Results

As described in Section 1, roads in Upper Hayfork Creek watershed were inventoried during multiple field seasons. In total, approximately 351.9 miles of road were inventoried in the watershed. As part of the 2012 SSI, NSR inventoried 176.4 miles of road in the watershed during the 2011 and 2012 field seasons. The following discussion focuses on the 2012 SSI data set. The data acquired during the 2012 SSI was in addition to SSI data provided by the STNF, including information acquired by NSR and other entities over the past several years under various types of contracts and agreements. The cumulative SSI data set is presented following the 2012 SSI discussion.

Year 2012 SSI Results

The objective of the 2012 SSI was to document the condition of existing road-related infrastructure and identify existing and potential erosion and sediment producing features located over 176.4 miles of road in the Upper Hayfork Creek watershed (Figure 7-1 and Appendices E & F). Inventoried features were prioritized based on their potential for sediment production and delivery to the hydrologic network. This section focuses on the inventoried and prioritized features included in the 2012 SSI. The results are presented at both the subwatershed (HUC 6) and drainage scales (HUC 7).

Inventoried Features

The 2012 SSI identified and characterized 2,858 features; 23.1 miles of gully, 11.1 miles of ditch segments; 147 stream crossings; 36 erosion features; 608 hydrologically connected cross-drain sites; 2,040 non-hydrologically connected cross-drains; and 27 springs (Table 7-4 and Appendices E & F).

Approximately 50 percent of the road miles included in the 2012 SSI were located in two drainages within the Dubakella Creek subwatershed; Hall City Creek – Wilson Creek and Stringbean Creek – Goods Creek. These drainages accounted for nearly 86 percent of inventoried mileage within the subwatershed and 40 percent of the overall mileage included in the 2012 SSI. Accordingly, the Dubakella Creek subwatershed contained the greatest number of features relative to the other subwatersheds; the Hall City Creek – Wilson Creek and Stringbean Creek – Goods Creek drainages contained the greatest number of features. Of the total features identified in the 2012 SSI, 1,397 features or 49 percent of the total number occur within the Dubakella Creek subwatershed. Almost 90 percent of these features are concentrated in the Wilson Creek and Stringbean Creek – Goods Creek drainages.

Feature Analysis/Risk Analysis

As described in Section 2, risk ranking matrices were created to identify features that currently do, or potentially could deliver elevated levels of sediment to nearby streams or waterbodies. The number of high risk features and the proportion by subwatershed are listed in Table 7-5. The accompanying GIS project is organized to extract the type and location of features by risk rating at multiple scales. The density of high risk features types for each subwatershed and drainage is shown in Figure 7-3.

As illustrated in Table 7-5, the 2012 SSI identified the following high risk features: 3.13 gully miles, 2.8 ditch miles, 9 stream crossings, 10 erosion sites, 28 connected cross-drains with CMP, and 8 spring sites. A total of 55 features or 13 percent of the total 2012 Upper Hayfork SSI features (excluding non-connected cross-drains and connected cross-drains without CMP) are characterized as high risk in the Upper Hayfork Creek watershed.

Table 7-4. 2012 Inventoried Features for Upper Hayfork Creek Subwatersheds (HUC 6) and Drainages (HUC 7)

Subwatersheds (HUC 6) Drainages (HUC 7)	Road Miles	Gully Miles	Ditch Miles	Stream Crossings	Erosion Features	Connected Cross-Drains	Non-Connected Cross-Drains	Springs
Big Ck.-Hayfork Ck.	1.1	0.0	0.0	1	0	3	15	2
Lower Big Ck.-Hayfork Ck.	0.2			0		3	2	
Upper Big Ck.-Hayfork Ck.	0.9		0.0	1		0	13	2
Carr Ck.	18.9	3.8	0.5	18	6	71	286	3
Duncan Ck.	5.7	0.9	0.1	4	1	10	63	
Lower Carr Ck.	10.6	2.8	0.4	14	5	59	164	3
Upper Carr Ck.	2.6	0.1	0.0	0		2	59	
Dubakella Ck.	87.5	11.2	7.3	79	17	341	950	10
Chanchelulla Gulch-Shiell Gulch	11.2	0.9	0.0	1	1	19	124	
Dubakella Ck.	1.1			0		0	3	
Halls City Ck.-Wilson Ck.	42.0	5.8	4.3	45	10	181	488	7
Stringbean Ck.-Goods Ck.	33.2	4.5	3.0	33	6	141	335	3
Duncan Gulch-Barker Ck.	29.3	1.7	1.3	22	2	87	305	7
Barker Ck.	20.7	0.8	1.2	15	2	67	201	7
Duncan Gulch-Hayfork Ck.	8.7	0.9	0.1	7		20	104	
East Fork Hayfork Ck.	7.9	1.3	0.9	8	0	44	87	1
Lower East Fork Hayfork Ck.	5.1	0.8	0.4	5		27	84	1
Upper East Fork Hayfork Ck.	2.7	0.6	0.4	3		17	3	
Natural Bridge	31.6	5.1	1.0	19	11	62	397	4
Bridge Gulch-Hayfork Ck.	10.5	2.5	0.6	5	3	28	205	2
Carrier Gulch-Hayfork Ck.	21.2	2.6	0.4	14	8	34	192	2
Watershed Totals	**176.4**	**23.1**	**11.1**	**147**	**36**	**608**	**2040**	**27**

Table 7-5. High Risk Features for Upper Hayfork Creek Subwatersheds (HUC 6) and Drainages (HUC 7)

Subwatersheds (HUC 6) Drainages (HUC 7)	Gully Miles	Ditch Miles	Stream Crossings	Erosion Features	Connected Cross-Drain w/CMP	Springs
Big Ck.-Hayfork Ck.						1 (4%)
Lower Big Ck.-Hayfork Ck.						
Upper Big Ck.-Hayfork Ck.						1 (4%)
Carr Ck.	0.63 (3%)	0.23 (2%)		1 (3%)	2 (1%)	1 (4%)
Duncan Ck.	0.20 (1%)				1 (0%)	
Lower Carr Ck.	0.43 (2%)	0.23 (2%)		1 (3%)	1 (0%)	1 (4%)
Upper Carr Ck.						
Dubakella Ck.	1.21 (5%)	2.20 (20%)	6 (4%)	5 (14%)	10 (5%)	2 (7%)
Chanchelulla-Shiell Gulch	0.36 (2%)				1 (0%)	
Dubakella Ck.						
Halls City Ck.-Wilson Ck.	0.64 (3%)	0.74 (7%)	5 (3%)	3 (8%)	6 (3%)	2 (7%)
Stringbean Ck.-Goods Ck.	0.21 (1%)	1.45 (13%)	1 (1%)	2 (6%)	3 (1%)	
Duncan Gulch-Barker Ck.		0.08 (1%)	3 (2%)	1 (3%)	10 (5%)	4 (15%)
Barker Ck.		0.03 (0%)	1 (1%)	1 (3%)	8 (4%)	4 (15%)
Duncan Gulch-Hayfork Ck.		0.05 (0%)	2 (1%)		2(1%)	
East Fork Hayfork Ck.	0.43 (2%)	0.07 (1%)				
Lower East Fork Hayfork Ck.	0.03 (0%)	0.03 (0%)				
Upper East Fork Hayfork Ck.	0.40 (2%)	0.04 (0%)				
Natural Bridge	0.87 (4%)	0.23 (2%)		3 (8%)	6 (3%)	
Bridge Gulch-Hayfork Ck.	0.15 (1%)	0.11 (1%)			1 (0%)	
Carrier Gulch-Hayfork Ck.	0.72 (3%)	0.12 (1%)		3 (8%)	5 (2%)	
Watershed Totals	**3.13 (14%)**	**2.80 (12%)**	**9 (6%)**	**10 (28%)**	**28 (13%)**	**8 (30%)**

Note: Values in parenthesis represent percentage of watershed feature totals.

The Dubakella Creek subwatershed contained the greatest number of high risk features, with the Hall City Creek – Wilson Creek and String Bean Creek – Goods Creek drainages accounting for 96 percent of them. Big Creek-Hayfork Creek subwatershed had the lowest number, only one feature.

When compared to the total number of high risk features and total road miles inventoried in the SSI, the proportion of these features within each subwatershed is not necessarily consistent with the proportion of roads contained within the subwatershed. For example, the Dubakella Creek subwatershed contains approximately 50 percent of the road miles inventoried in the Upper Hayfork watershed during the 2012 SSI and it also contains 42 percent of the total number of high risk features and nearly 80 percent of the total miles of high risk gullies. Figure 7-3 illustrates the variability in the number and type of high risk features per mile of inventoried road by subwatershed.

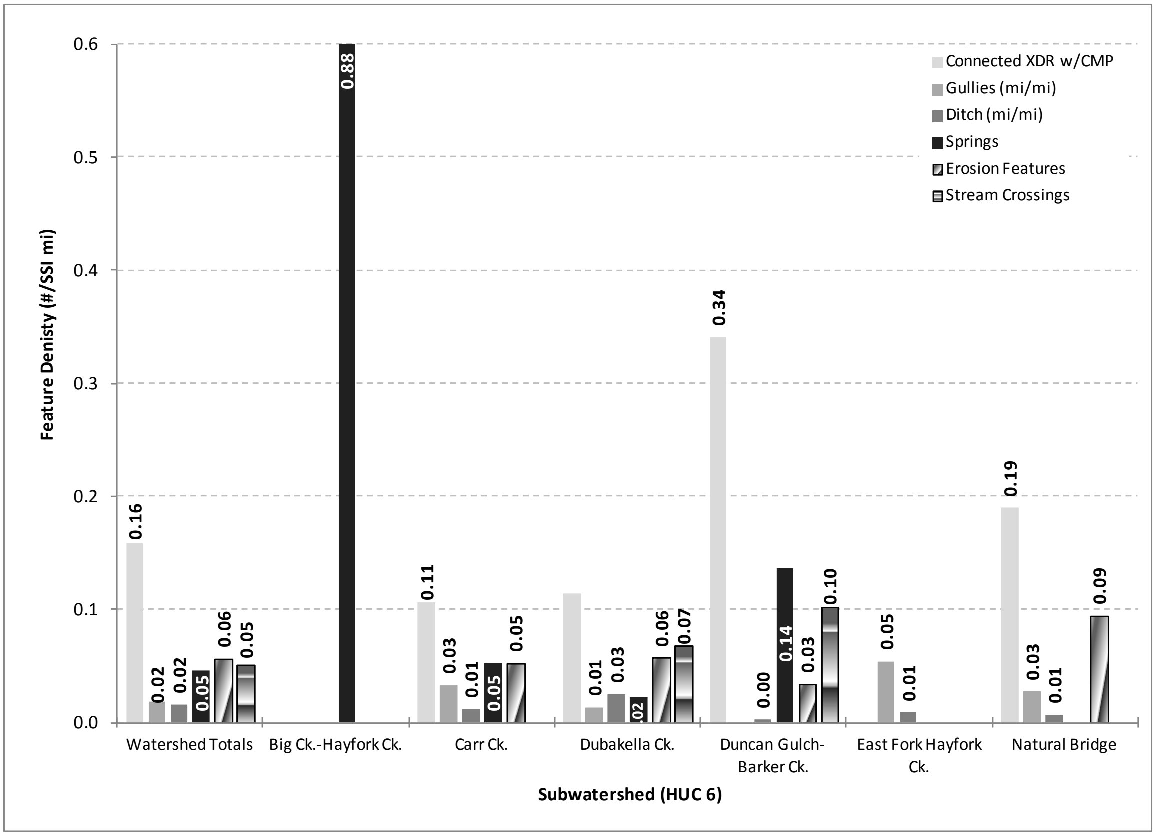


Figure 7-3. Density of High Risk Features for Upper Hayfork Creek Subwatersheds

Note: Gullies and ditch densities reported as miles of feature per mile of SSI road.

Cumulative SSI Data

Prior to conducting the 2012 SSI effort, the STNF acquired SSI data in three of the subwatersheds; Big Creek-Hayfork Creek, Dubakella Creek, and Duncan Creek-Barker Creek over the course of several field seasons. Table 7-6 illustrates the total road miles inventoried relative to the cumulative number and type features that have been documented through various SSI efforts in the Upper Hayfork Creek watershed, by subwatershed/drainage.

The following discussion is based on cumulative SSI efforts conducted for the STNF on approximately 51 percent of all roads within the Upper Hayfork watershed. Of 351.9 miles of inventoried roads in the Upper Hayfork watershed, almost exactly half, 175.5 miles, were inventoried prior to the 2012 SSI. Cumulatively, the SSI data set documents the occurrence of 55 erosion sites and 1,271 hydrologically connected features, which includes stream crossings and connected cross-drains (see Table 7-6). Four hundred and twenty of these features were stream crossings, of which 12 percent were identified as high risk sites. These include crossings that were unable to or were in danger of not being able to adequately convey peak flow events at the site. Twenty-five percent of the total stream crossings were identified with diversion potential, and 12 percent were undersized pipes. Field indicators of undersized pipe were evidence of overtopping; substantially plugged features, poor structural integrity (i.e. holes, separated, etc.), poor positioning, or a significant loss of fill at the inlet.

Table 7-6. Upper Hayfork Creek Watershed Cumulative SSI Data

Subwatersheds (HUC 6) Drainages (HUC 7)	Total SSI Miles	Erosion Features	Connected Features[1]	Stream Crossings			
				Total	High Risk	Diversion Potential	FEUP[2]
Big Ck.-Hayfork Ck.	83.6	0	217	186	9	40	40
Lower Big Ck.-Hayfork Ck.	27.5	0	80	77	1	11	14
Upper Big Ck.-Hayfork Ck.	56.1	0	137	109	8	29	26
Carr Ck.	18.9	6	89	18	0	1	2
Duncan Ck.	5.7	1	14	4	0	0	0
Lower Carr Ck.	10.6	5	73	14	0	1	2
Upper Carr Ck.	2.6	0	2	0	0	0	0
Dubakella Ck.	171.1	36	714	158	39	60	38
Chanchelulla--Shiell Gulch	11.2	1	20	1	0	0	0
Dubakella Ck.	23.2	5	64	16	8	7	10
Halls City Ck.-Wilson Ck.	42.0	10	227	45	5	20	2
Headwaters Hayfork Ck.	57.2	13	196	51	22	16	23
Stringbean Ck.-Goods Ck.	37.4	7	207	45	4	17	3
Duncan Gulch-Barker Ck.	38.8	2	118	31	3	10	5
Barker Ck.	29.6	2	91	24	1	7	1
Duncan Gulch-Hayfork Ck.	9.2	0	27	7	2	3	4
East Fork Hayfork Ck.	7.9	0	52	8	0	4	0
Lower East Fork Hayfork Ck.	5.1	0	32	5	0	4	0
Upper East Fork Hayfork Ck.	2.7	0	20	3	0	0	0
Natural Bridge	31.6	11	81	19	0	7	1
Bridge Gulch-Hayfork Ck.	10.5	3	33	5	0	3	0
Carrier Gulch-Hayfork Ck.	21.2	8	48	14	0	4	1
Watershed Totals	**351.9**	**55**	**1271**	**420**	**51**	**122**	**86**

[1]Includes all stream crossings and Connected Cross-Drains; indicator of hydrologic connectivity of roads
[2]Field Evidence of Undersized Pipe (FEUP); see methods for explanation.

Similar to the 2012 SSI, the majority of the roads inventoried in previous efforts were in the Dubakella Creek subwatershed, with over 171 miles inventoried. The Dubakella Creek subwatershed also has the most road miles (244.6) and the highest road density in the Upper Hayfork Creek; 4.8 miles of road per square mile. Cumulatively, the Dubakella Creek subwatershed has the highest number of inventoried features; 36 erosion features, 714 hydrologically connected features, and 158 stream crossings (see Table 7-6). Of the 158 stream crossing, 25 percent were determined to be undersized and characterized as high risk. As shown in Figure 7-4, the Dubakella Creek subwatershed has a greater than average density of connected features, high risk crossings, crossings with diversion potential and erosion features.

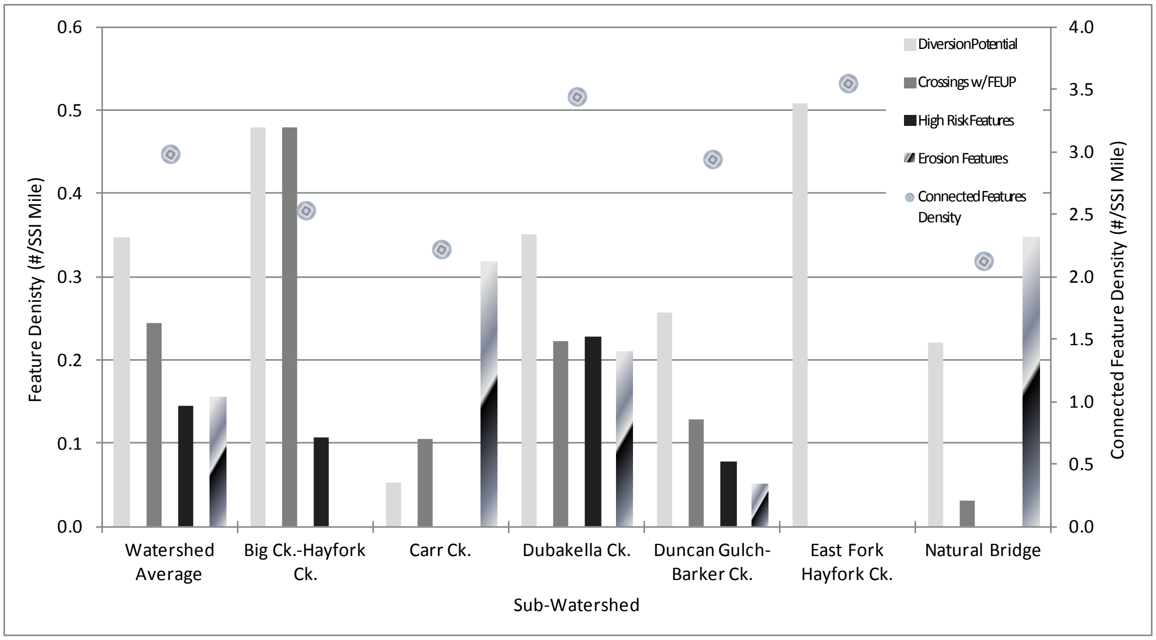


Figure 7-4. Density per Mile of SSI Road of Selected Features for Upper Hayfork Creek Subwatershed

Approximately 84 percent of the total roads in the Big Creek-Hayfork Creek subwatershed were included in the cumulative SSI data set. This data set represents the second highest mileage inventoried for any of the subwatersheds in Upper Hayfork Creek with 83.9 miles of inventoried road. The cumulative SSI data set contains 217 connected features, of which 186 are stream crossings. No erosion features were identified Big Creek-Hayfork Creek subwatershed; it is unclear whether erosion features were included in previous SSI efforts or if these types of features are not present in this subwatershed. As shown in Figure 7-4, this subwatershed has a lower than average density of connected features relative to other subwatersheds. However, the density of crossings with diversion potential and crossings with undersized pipes is higher than the watershed average.

As shown in Figure 7-4, roads within East Fork Hayfork Creek subwatershed had the most connected features per road mile relative to other subwatersheds. The majority of the 52 connected features were cross-drains; the SSI data set only contains eight stream crossings (Table 7-6). None of these stream crossings were considered undersized (high risk); however the number of stream crossings with diversion potential per road mile was above the watershed average. There were no erosion features in the SSI data set; however this might be explained by the low number of road miles (7.9 miles) included in the SSI effort for this subwatershed.

Approximately 54 percent of the roads in the Duncan Gulch subwatershed were included in the SSI efforts; two erosion features and 117 connected features were documented. Of the 31 stream crossings, three were considered high risk; ten had diversion potential, and five FEUP (Table 7-6). Overall, the density of features in this subwatershed was less than the average for the Upper Hayfork Creek watershed.

Both Carr Creek and Natural Bridge subwatersheds had higher than average densities of erosion features per mile, but lower than average densities of connected features and stream crossing with field evidence of undersized pipe, diversion potential and no stream crossings with high risk. Approximately 60 percent of the total roads in Carr Creek and 16 percent of the total roads in Natural Bridge subwatershed were included in the SSI cumulative data set.

7.4 Aquatic and Riparian Resources RAP Risk Analysis

The main focus of the RAP risk analysis was to identify road segments that could pose a moderate to high risk to aquatic and riparian resources. Three resources, including, water quality, hydrologic processes, aquatic and riparian habitat are analyzed in the following discussion. The RAP risk analysis is presented at both the HUC 7 drainage and road segment scales.

Aquatic and Riparian Resources Total RAP Risk Score per Drainage

The total Aquatic and Riparian Resources RAP risk score (total RAP risk score) for road segments within each of the 15 drainages (HUC 7) that constitute the Upper Hayfork Creek watershed are discussed in this section. The total RAP risk score is the average of the individual water quality, hydrologic processes, and aquatic and riparian habitat scores. As described in Section 2.4, the key questions specific to the three resources, and the associated criteria required to answer these questions have been developed in accordance with the STNF RAP protocol (Shasta-Trinity National Forest 2011) in order to rate the road segments at the drainage scale.

The RAP risk scores for water quality, hydrologic processes, aquatic and riparian habitat, including the total scores for each road and drainage are listed in Appendix D. Figure 7-5 illustrates the total miles of road per drainage and the associated total RAP risk score. This Figure displays the relative risk per drainage for the various sections of roads included in the RAP analysis. A key point in this discussion is that the RAP analysis focused on the 2012 SSI data set due to inconsistencies in previous SSI data sets.

The Aquatic and Riparian Rap effort indicates that a small proportion of the roads in the Dubakella Creek subwatershed (0.37 miles, less than 1 percent) of the SSI 2012 data set is scored as high risk; 40.3 miles or 23 percent of the data set is scored as moderate-high risk to aquatic and riparian resources within the Upper Hayfork Creek watershed (Figure 7-5).

As shown in Figure 7-5, the Stringbean Creek-Goods Creek drainage had the most mileage, 9.4 miles, scored moderate-high to aquatic and riparian resources. Four other drainages had over four miles of road that scored moderate-high; including, Carrier Gulch-Hayfork Creek, Halls City Creek-Wilson Creek, Lower Carr Creek, and Bridge Gulch-Hayfork Creek drainages.

The majority of roads that scored moderate-high were located in the Dubakella Creek subwatershed; of the 87.5 miles of roads included in the 2012 SSI, 17.2 miles or 20 percent scored moderate-high. The Natural Bridge subwatershed ranks second with 10.5 miles scored moderate-high. However a larger percentage (33 percent) of the 2012 inventoried roads in the Natural Bridge subwatershed scored moderate-high, compared to 20 percent in Dubakella Creek subwatershed. The Carr Creek watershed had the highest percentage roads that scored of moderate-high in the Upper Hayfork Creek watershed. Approximately 37 percent of the 2012 SSI roads within the Carr Creek subwatershed scored moderate-high.

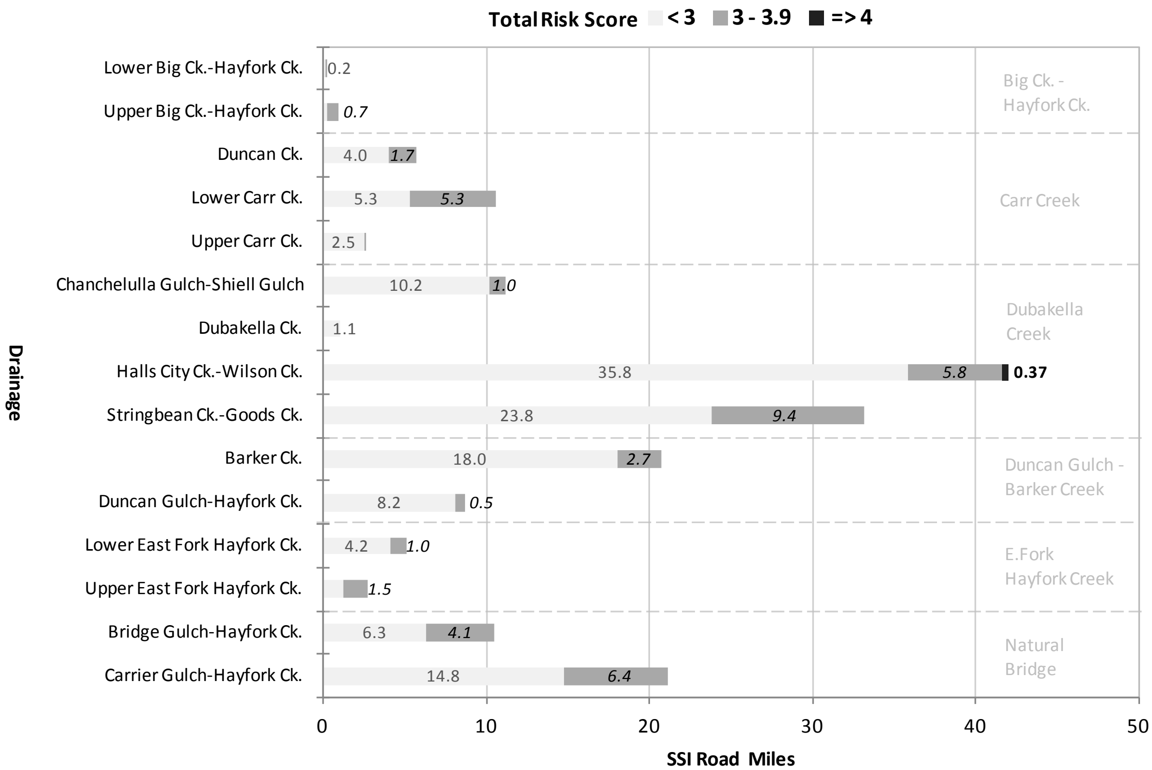


Figure 7-5. Aquatic and Riparian Resources RAP Total Risk Score for Upper Hayfork Creek Watershed Drainages

Overall, 77 percent of the roads included in the 2012 SSI within the Upper Hayfork Creek watershed had scores less than 3 (low-moderate risk). Based on the assumptions used for the RAP analysis, this suggest that a large number of the roads pose a low to moderate risk of affecting aquatic and riparian resources. Within the Upper Carr Creek and Dubakella drainages, all the roads included in the 2012 SSI scored less than 3.

Moderate-High to High Risk Road Segments

Table 7-7 lists those road segments by drainage included in the 2012 SSI that scored 3.0 or above in the RAP risk analysis. Based on this analysis, these road segments have a moderate-high to high risk of affecting water quality, hydrologic processes, and aquatic and riparian habitats. In total, 39 road segments or approximately 40.2 miles road scored moderate-high risk; one road segment (0.37 miles) scored high risk. Figures 7-6a and 7-6b illustrate the location of the moderate-high to high risk roads segments in the Upper Hayfork watershed.

As shown in Table 7-7, the score for water quality is the highest of the three values, with the exception of four road segments where the score for water quality is equal to or slightly less than the score for hydrologic processes scores. Seventy-five percent of the moderate-high risk road segments have water quality scores equal to or above 4.0. This suggests that many of the moderate-high risk road segments are hydrologically connected and intersect areas prone to erosion. Evaluation of previous RAP risk analysis is an indication that the large number of stream crossings and/or the road segments that are in close proximity to aquatic and riparian habitat and provide a direct pathway for transport and delivery of sediment to water bodies within the Upper Hayfork Creek watershed. Additionally, broad array of road segments that traverse erosive soils and sensitive landforms have the potential to deliver sediment to these water bodies.

Table 7-7 indicates that all road segments with one exception scored 3.8 for hydrologic processes; Road 29N07 scored 2.6. This analysis indicates that all moderate-high risk road segments pose a similar risk to hydrologic processes throughout the Upper Hayfork Creek watershed. These roads may potentially affect the routing of water by intercepting and diverting flows from their natural path. This is also an indication that the road alignment and fill may constrict the channel, isolate floodplains, and/or constrain channel migration.

The road segment scores for aquatic and riparian habitat is generally lower, with a wider range of values (1.3 to 3.6) relative to water quality and hydrologic processes. These scores correlate the risk to aquatic and riparian habitat relative to the individual road segments with respect to affects on the functions and values of aquatic and riparian habitat, including attributes such as connectivity and flow. The 2012 SSI focused on roads in the upper elevations of the Upper Hayfork Creek watershed where the density of fish-bearing streams is much lower than in lower portions of the watershed. This may accounts for the lower scores in this resource category.

Of the roads included in this RAP effort, eight road segments, totaling 6.2 miles, in the Halls City Creek-Wilson Creek drainage have total RAP risk scores above 3.0; these are identified as moderate-high and high risk. Of the these roads, only one segment or 0.4 miles of Road 29N07A are has a score of slightly over 4.0, high risk. Within the Halls City Creek-Wilson Creek drainage, roads 29N07A, U29N07HA, and U29NO7G were considered the highest risk to aquatic and riparian resources, and especially water quality. All three of those roads had a water quality risk score over 4.5.

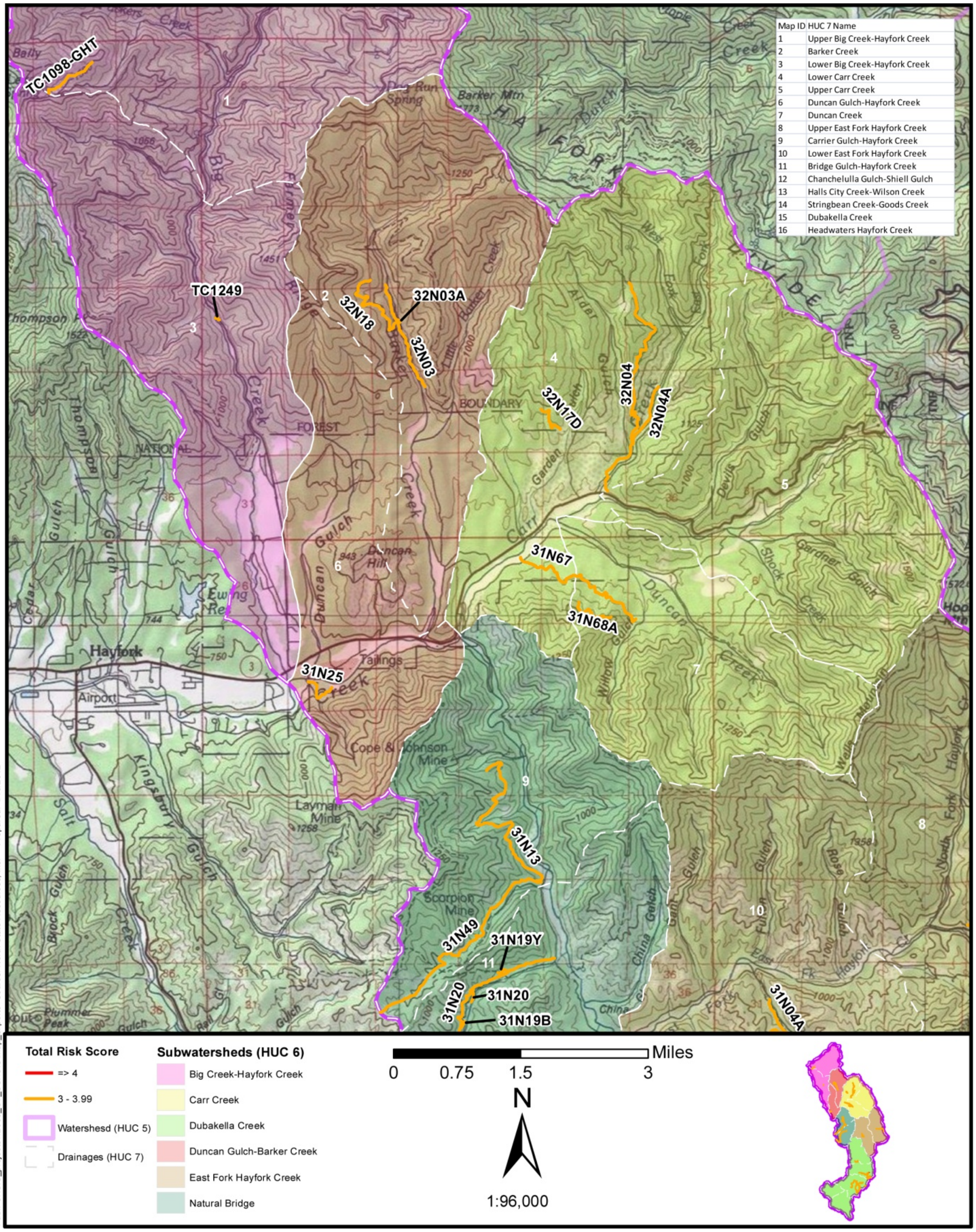
Stringbean Creek-Goods Creek drainage has only four segments with total RAP risk scores over 3.0, collectively 9.4 miles of road. Similar to the moderate-high risk roads in Halls City Creek-Wilson Creek drainage, these roads have higher water quality risk scores relative to hydrologic processes or aquatic and riparian habitat.

Table 7-7. Upper Hayfork Creek Watershed Routes with Total RAP Risk Scores of 3.0 and Greater

Route ID	Drainage Name	Miles	Resource Risk Scores			
			Aquatic, Riparian	Hydrologic Process	Water Quality	Total Risk
29N07A	Halls City Ck.-Wilson Ck.	0.366	3.6	3.8	4.8	4.0
32N04A	Lower Carr Ck.	0.796	3.3	3.8	4.8	3.9
U29N07HA	Halls City Ck.-Wilson Ck.	0.297	3.3	3.8	4.7	3.9
31N19B	Bridge Gulch-Hayfork Ck.	0.089	3.3	3.8	4.6	3.9
TC1249	Lower Big Ck.-Hayfork Ck.	0.058	3.3	3.8	4.6	3.9
U29N07G	Halls City Ck.-Wilson Ck.	0.135	3.3	3.8	4.5	3.9
31N20	Bridge Gulch-Hayfork Ck.	0.171	3.3	3.8	4.4	3.8

Table 7-7. Upper Hayfork Creek Watershed Routes with Total RAP Risk Scores of 3.0 and Greater

			Resource Risk Scores			
Route ID	Drainage Name	Miles	Aquatic, Riparian	Hydrologic Process	Water Quality	Total Risk
32N03	Barker Ck.	1.349	3.3	3.8	4.4	3.8
30N04	Chanchelulla Gulch-Shiell Gulch	0.742	3.4	3.8	4.2	3.8
31N09	Upper East Fork Hayfork Ck.	1.521	3.3	3.8	4.2	3.8
31N49	Carrier Gulch-Hayfork Ck.	2.857	3.3	3.8	4.2	3.8
29N83	Stringbean Ck.-Goods Ck.	0.672	3.5	3.8	4.0	3.8
32N03A	Barker Ck.	0.057	3.3	3.8	4.2	3.7
31N04A	Lower East Fork Hayfork Ck.	0.964	3.3	3.8	4.1	3.7
U30N04D	Chanchelulla Gulch-Shiell Gulch	0.074	3.3	3.8	4.1	3.7
32N04	Lower Carr Ck.	3.148	3.4	3.8	4.0	3.7
31N13	Carrier Gulch-Hayfork Ck.	2.717	3.4	3.8	4.0	3.7
29N27	Stringbean Ck.-Goods Ck.	4.718	3.3	3.8	4.1	3.7
29N28	Stringbean Ck.-Goods Ck.	3.247	3.3	3.8	4.1	3.7
31N19	Bridge Gulch-Hayfork Ck.	3.699	3.3	3.8	4.1	3.7
31N25	Duncan Gulch-Hayfork Ck.	0.501	3.3	3.8	4.0	3.7
29N83A	Stringbean Ck.-Goods Ck.	0.522	3.3	3.8	3.9	3.7
30N17	Chanchelulla Gulch-Shiell Gulch	0.018	3.3	3.8	3.9	3.6
29N27B	Stringbean Ck.-Goods Ck.	0.044	3.3	3.8	3.8	3.6
31N19Y	Bridge Gulch-Hayfork Ck.	0.162	3.3	3.8	3.8	3.6
U29N07AAAA	Halls City Ck.-Wilson Ck.	0.042	3.3	3.8	3.8	3.6
U29N07F	Halls City Ck.-Wilson Ck.	0.291	3.3	3.8	3.8	3.6
32N04	Upper Carr Ck.	0.004	3.3	3.8	3.7	3.6
U29N07H	Halls City Ck.-Wilson Ck.	0.898	2.3	3.8	4.3	3.4
31N67	Duncan Ck.	1.139	2.3	3.8	4.2	3.4
U29N07E	Halls City Ck.-Wilson Ck.	0.188	1.3	3.8	4.7	3.3
29N25A	Stringbean Ck.-Goods Ck.	0.188	1.3	3.8	4.4	3.1
32N18	Barker Ck.	1.261	1.6	3.8	4.1	3.1
31N67	Lower Carr Ck.	0.890	1.3	3.8	4.3	3.1
32N17D	Lower Carr Ck.	0.486	1.3	3.8	4.3	3.1
29N07	Halls City Ck.-Wilson Ck.	3.981	3.0	2.6	3.5	3.1
31N68A	Duncan Ck.	0.585	1.3	3.8	4.0	3.0
TC1098-GHT	Upper Big Ck.-Hayfork Ck.	0.695	1.3	3.8	4.0	3.0
30N43A	Chanchelulla Gulch-Shiell Gulch	0.173	1.3	3.8	3.9	3.0
31N18A	Carrier Gulch-Hayfork Ck.	0.837	1.3	3.8	3.9	3.0



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2012 Shasta-Trinity SSI

Figure 7-6a. Location of Moderate-High to High Risk Roads Segments in the Upper Hayfork Watershed

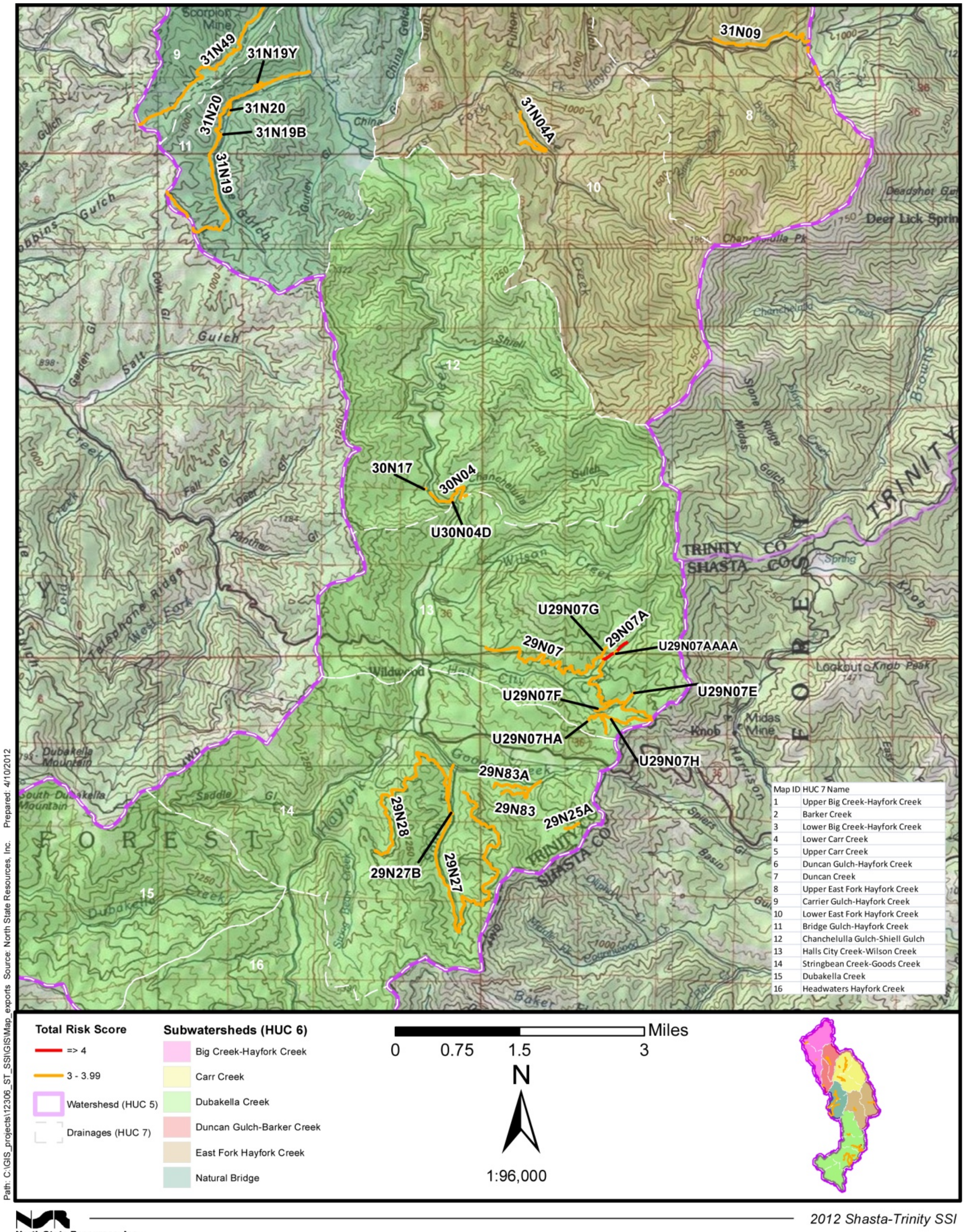


Figure 7-6b. Location of Moderate-High to High Risk Roads Segments in the Upper Hayfork Watershed

7.5 Recommendations

Moderate-High and High Risk Road Segments General Recommendations

Table 7-8 provides general recommendations for routes in the Upper Hayfork Creek watershed with a total RAP risk score greater than 3.0. Three different recommendation categories are included in this section directed at maintaining, upgrading or decommissioning road segments with moderate-high and high risk scores. Maintain includes activities such as cleaning out inlets and outlets of culverts and cross-drain with culverts, cleaning rolling dips and ditches, and spot-grading. Upgrading roads includes renovation of existing features, construction of new features, large-scale grading and resurfacing all or part of a segment, combined with normal maintenance activities. Decommissioning roads includes either full road obliteration or a temporary road decommission (e.g., storm-proofing). The recommendations in this section are based on the RAP risk score in conjunction with SSI data such as road density and specific information on the type and number of features that could pose a risk to aquatic and riparian values.

Table 7-8. General Recommendations for Moderate-High to High Risk Routes in the Upper Hayfork Creek Watershed

Route ID	Drainage Name	Miles	Total Risk	General Recommendation
29N07A	Halls City Ck.-Wilson Ck.	0.366	4.0	Maintain
32N04A	Lower Carr Ck.	0.796	3.9	Maintain
U29N07HA	Halls City Ck.-Wilson Ck.	0.297	3.9	Maintain
31N19B	Bridge Gulch-Hayfork Ck.	0.089	3.9	Maintain
TC1249	Lower Big Ck.-Hayfork Ck.	0.058	3.9	Maintain
U29N07G	Halls City Ck.-Wilson Ck.	0.135	3.9	Maintain
31N20	Bridge Gulch-Hayfork Ck.	0.171	3.8	Upgrade
32N03	Barker Ck.	1.349	3.8	Maintain
30N04	Chanchelulla Gulch-Shiell Gulch	0.742	3.8	Upgrade
31N09	Upper East Fork Hayfork Ck.	1.521	3.8	Maintain
31N49	Carrier Gulch-Hayfork Ck.	2.857	3.8	Upgrade
29N83	Stringbean Ck.-Goods Ck.	0.672	3.8	Maintain
32N03A	Barker Ck.	0.057	3.7	Decommission/Maintain
31N04A	Lower East Fork Hayfork Ck.	0.964	3.7	Maintain
U30N04D	Chanchelulla Gulch-Shiell Gulch	0.074	3.7	Decommission/Maintain
32N04	Lower Carr Ck.	3.148	3.7	Upgrade
31N13	Carrier Gulch-Hayfork Ck.	2.717	3.7	Maintain
29N27	Stringbean Ck.-Goods Ck.	4.718	3.7	Upgrade
29N28	Stringbean Ck.-Goods Ck.	3.247	3.7	Upgrade
31N19	Bridge Gulch-Hayfork Ck.	3.699	3.7	Upgrade
31N25	Duncan Gulch-Hayfork Ck.	0.501	3.7	Maintain

Table 7-8. General Recommendations for Moderate-High to High Risk Routes in the Upper Hayfork Creek Watershed

Route ID	Drainage Name	Miles	Total Risk	General Recommendation
29N83A	Stringbean Ck.-Goods Ck.	0.522	3.7	Maintain
30N17	Chanchelulla Gulch-Shiell Gulch	0.018	3.6	Maintain
29N27B	Stringbean Ck.-Goods Ck.	0.044	3.6	Decommission/Maintain
31N19Y	Bridge Gulch-Hayfork Ck.	0.162	3.6	Maintain
U29N07AAAA	Halls City Ck.-Wilson Ck.	0.042	3.6	Decommission/Maintain
U29N07F	Halls City Ck.-Wilson Ck.	0.291	3.6	Maintain
32N04	Upper Carr Ck.	0.004	3.6	Maintain
U29N07H	Halls City Ck.-Wilson Ck.	0.898	3.4	Maintain
31N67	Duncan Ck.	1.139	3.4	Upgrade
U29N07E	Halls City Ck.-Wilson Ck.	0.188	3.3	Maintain
29N25A	Stringbean Ck.-Goods Ck.	0.188	3.1	Maintain
32N18	Barker Ck.	1.261	3.1	Upgrade
31N67	Lower Carr Ck.	0.890	3.1	Upgrade
32N17D	Lower Carr Ck.	0.486	3.1	Maintain
29N07	Halls City Ck.-Wilson Ck.	3.981	3.1	Upgrade
31N68A	Duncan Ck.	0.585	3.0	Maintain
TC1098-GHT	Upper Big Ck.-Hayfork Ck.	0.695	3.0	Maintain
30N43A	Chanchelulla Gulch-Shiell Gulch	0.173	3.0	Decommission/Maintain
31N18A	Carrier Gulch-Hayfork Ck.	0.837	3.0	Maintain

Specific Recommendations to Upgrade Roads

Specific recommendations are listed below for the roads listed under ‘upgrade’ in Table 7-8 and for two additional road segments. The recommendations focus on the sections of each road that either contained a high density of high risk features or individual features that could be treated to help decrease their impacts to water resources. Locations are denoted by Route ID, mile marker, and drainage. The feature type and associated problem are also included, along with recommendations for upgrades.

Route ID: 31N20
Drainage: Bridge Gulch-Hayfork Creek
Location: Mile Marker 0.55-0.99, Upper Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
.55 - .99	Gully	Long road gully connected to ford of intermittent stream near confluence with fish-bearing stream.	Grade road, add rolling dips with armored outlets, and add aggregate to road surface.

Route ID: 30N04
Drainage: Chanchelulla Gulch-Shiell Gulch
Location: Mile Marker 3.665 -4.425, Upper Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
3.625 – 3.734	Erosion	Connected route surface gully caused by non-functional cross drain.	Repair existing cross-drain (MM 3.669) install additional armored rolling dips, and add aggregate to road base.
3.791 – 3.923	Gully	Long s route surface gully connected to perennial stream.	Install additional armored rolling dips, and add aggregate to road base.
4.002 – 4.1	Gully	Route surface gully connected to perennial stream.	Repair existing cross-drain (MM 4.101) install additional armored rolling dips, and add aggregate to road base.
4.296 – 4.425	Gully	Route surface gully runs parallel and connected to perennial stream.	Add aggregate to road base.

Route ID: 31N49
Drainage: Carrier Gulch-Hayfork Creek
Location: Mile Marker 0.120 – 2.616, Upper Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.120	Erosion Feature (Gully)	Gully caused by surface runoff on road. Connected to intermittent stream.	Grade road, install rolling dips, add aggregate to road base as needed.
0.777	Erosion Feature (Gully)	Gully caused by surface runoff on road. Connected to intermittent stream.	Regrade road, install rolling dips, add aggregate to road base as needed.
2.616	Connected Cross-Drain w/CMP	Inlet > 31% plugged with bedload	Clean inlet and evaluate CMP design.

Route ID: 29N27
Drainage: Stringbean Ck.-Goods Creek
Location: Mile Marker 1.655-4.3200, Upper Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
1.655	Stream Crossing	Minor fill loss and erosion on downstream side of crossing.	Armor CMP outlet and adjacent fillslope.
3.818	Erosion	Slide/Gully compromises road.	Reconstruct and armor.
4.004	Cross-Drain	Cross-drain does not drain to intended OSD. Some ponding on road. Cross-drain connected to ephemeral at times.	Reconstruct cross-drain and realign OSD.
4.3200	Cross-Drain	Flattened structure causes road gully.	Reshape and armor structure.

Route ID: 32N04
Drainage: Lower Carr Creek
Location: Mile Marker 0.120 – 1.026, Upper Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.0 – 1.026	Road Surface	Surface heavily rutted and potholed	Grade route surface and spot rock as needed.
0.09 - .53	Ditch	Ditches in poor condition; eroded with heavy sediment deposition in spots	Clean and Recontour ditches. Add rip-rap of aggregate to deter erosion
0.139	Connected Cross-Drain w/CMP	Current perforated CMP doesn't capture spring flow as intended; subgrade compromised	Reconstruct cross-drain
0.444	Spring	CMP previously installed for spring drainage, but subsurface spring flow is compromising road base.	Improve existing ditch or reconstruct section as French drain.
0.437 – .501 0.546 -.616	Gully	Gully caused by continuous surface flow on route.	Add aggregate road base and construct armored rolling dips with armored outlets.
0.713-0.984	Connected and Non-Connected Cross-Drains	Flattened cross-drains are ineffective; runoff continues down road and scours road base and functional cross-drains.	Repair/Reconstruct existing cross-drains and add armor for durability. Increase frequency of cross-drains.
0.716 – 1.026	Gully	Gullies caused by ineffective cross-drains.	Repair/Reconstruct existing cross-drains and add armor.

Route ID: 29N28
Drainage: Stringbean Ck.-Goods Creek
Location: Mile Marker 0.056 – 2.174, Upper Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.056 – 0.472	Gully	3 route surface gullies in proximity to perennial stream	Install cross drains or add aggregate to road base.
0.242 -0.659	Ditch	3 connected ditches with moderate sediment accumulation	Increase maintenance intervals.
0.674 – 0.789	Ditch	Connected ditch with excessive sediment deposition	Clean ditch, install retention structure, and increase maintenance.
1.070- 3.225	Gully	Multiple gullies that may be connected under certain conditions and compromises driver safety.	Repair existing and install new cross-drains to disperse surface flow.
1.951 – 2.174	Ditch	Connected ditch with moderate sediment accumulation	Increase maintenance intervals

Route ID: 31N19
Drainage: Bridge Gulch-Hayfork Creek
Location: Mile Marker 5.462 – 6.74, Upper Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
5.462 – 5.570	Gully	Surface flow and partially functioning CMP cause gully; direct deposition into intermittent near Bridge Gulch.	Install armored rolling dip, repair existing partially functioning cross-drain (MM 5.75)
6.74	Connected Cross Drain w/CMP	CMP plugged with bedload and non-functioning.	Clean inlet and install critical dip. Evaluate design.

Route ID: 32N18
Drainage: Barker Creek
Location: Mile Marker 0.688 – 0.9977, Upper Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.688	Stream Crossing	Center of culvert is plugged or crushed. Site has diversion potential.	Replace culvert or remove culvert and convert to low-water ford on intermittent stream. Add critical dip.
0.9977	Stream Crossing	Unstable crossing; culvert may have washed out.	Replace culvert or armor existing ford. Add critical dip

Route ID: 31N67
Drainage: Barker Creek
Location: Mile Marker 0.272 – 0.761, Upper Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.272 - 0.329 0.383 – 0.389	Gully	Route surface gully connected to stream network.	Install cross-drains to disperse surface flow.
0.761	Stream Crossing	Inlet of culvert is 90% plugged with rocks and woody debris. Diversion potential.	Clean inlet and install trash rack. Install critical dip.

Route ID: 31N09
Drainage: Upper East Fork of Hayfork Creek, Upper Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.426 -1.578	Gully	Multiple connected gully segments.	Improve existing cross-drains and install new rolling dips more frequently within the segment. Armor dips and outlet. Spot rock as needed.

Route ID: 29N07
Drainage: Halls City Creek – Wilson Creek, Upper Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
2.187	Stream Crossing	Culvert may be undersized; fill loss at inlet indicates. Diversion potential	Evaluate crossing design. Upgrade if needed and add critical dip.

Additional Features of Concern

Feature Type	Mile Marker	Route ID	Problem	Recommendations
Stream Crossing	0.373	32N13	Inlet completely buried, some fill loss at outlet, intermittent stream	Clear Inlet. Add armored critical dip. Add rip rap at fill loss.
Stream Crossing	1.201	30N04A	Large woody debris blocks inlet. Upstream erosion compromises capacity.	Install trash rack or increase maintenance.

Section 8 Lower Hayfork Creek

8.1 Introduction

The Lower Hayfork watershed is approximately 142,015 acres in size and is located to the west of the Upper Hayfork watershed, within the southern portion of the Klamath River basin. The Lower Hayfork watershed begins in Hayfork Valley, west of Hayfork in Trinity County and extends to the confluence with South Fork of the Trinity River in Hyampom Valley. Hayfork Creek is wide and flat in the Hayfork Valley; it steepens as it flows northwest into a narrow gorge, before emerging in the Hyampom Valley and joining the South Fork Trinity River.

The landscape consists mainly of steep slopes, with valleys and flatter terrain intermixed. The elevations range between 6,300 feet at Hayfork Bally and 1,250 feet in Hyampom. The majority of the vegetation in the watershed consists of early to late-seral Douglas fir forest. Other types of vegetation found within the watershed include mixed conifer, white fir, and jeffrey pines, with small patches of gray pine. The landscape has been affected by wildfires and the timber industry (U.S. Forest Service 1996).

Similar to the Upper Hayfork watershed, the climate is Mediterranean-like, with hot dry summers and moderately wet winters. Precipitation is highly seasonal, and most of it falls between October and April. Most of the watershed is in a transition zone between the rain zone and snow zone. Average annual precipitation in the Lower Hayfork watershed ranges from 40 inches at Hyampom to 60 inches in the mountains (U.S. Forest Service 1996).

8.2 Overview

For this effort, five subwatersheds (HUC 6) and 19 drainages (HUC 7) were delineated for the purposes of the SSI and RAP efforts. Table 8-1 characterizes the hierarchy for the five subwatersheds, Corral Creek, Grassy Flat-Miners Creek, Rusch Creek-Little Creek, Salt Creek-Hayfork Creek (Salt Creek), Tule Creek-Hayfork Creek (Tule Creek), included in the SSI and RAP risk analysis. Figure 8-1 illustrates the location of these subwatersheds, drainages and the respective road segments. As shown in Figure 8-1 and Table 8-1, the 2012 SSI was conducted in all five subwatersheds.

As shown in Table 8-1, the project GIS data indicates there are 790.6 miles of road in the watershed and a road density of 3.6 miles of road per square mile of watershed. The Tule Creek subwatershed has the smallest drainage area and least road mileage, but the highest road density with 105.9 miles of road and 4.5 miles of road per square mile. The Salt Creek subwatershed has the largest drainage area and greatest road mileage and the second highest road density in the watershed, with 242.4 miles of road and 4.2 miles of road per square mile. The Grassy Flat-Miners Creek subwatershed has the lowest road density in the Lower Hayfork Creek watershed, with 2.6 miles of road per square mile.

Table 8-1. Lower Hayfork Creek Watershed Characteristics

Subwatersheds (HUC 6)	Drainage Area (mi^2)	Total Road Length (mi)	Road Density (mi/mi^2)	Past SSI Road Miles	2012 SSI Road Miles	Total SSI Road Miles
Corral Creek	36.1	108.9	3.0	10.6	69.6	80.2
Grassy Flat-Miners Creek	54.6	140.0	2.6	0.0	60.7	60.7
Rusch Creek-Little Creek	50.2	193.4	3.9	6.1	64.9	71.0
Salt Creek-Hayfork Creek	57.6	242.4	4.2	44.2	103.9	148.1
Tule Creek-Hayfork Creek	23.3	105.9	4.5	23.0	39.5	62.5
Watershed Totals	221.9	790.6	3.6	83.9	338.7	422.6

Many of the roads were originally constructed for mining purposes and later expanded for the timber industry. Poor road construction and placement has led to road failures and sediment issues in streams. Many of these problems areas have been corrected over time, however there are still issues with road maintenance and sediment inputs to nearby streams (U.S. Forest Service 1996).

Hydrology

There are numerous perennial streams in the watershed including more than a dozen large tributaries to Lower Hayfork Creek. Corral Creek is the largest tributary, while other notable sized tributaries include Bear Creek, Olsen Creek, Grassy Flat Creek, Big Canyon and Dinner Gulch (U.S. Forest Service 1996). Approximately 29 percent of the 1,129 miles of streams in the watershed are perennial in nature and approximately 23 percent are identified as fish bearing streams. The Rusch Creek-Little Creek subwatershed has the greatest percentage of perennial stream with 38.8 percent perennial and the Tule Creek-Hayfork Creek subwatershed has the greatest percentage of fish bearing streams. while the Salt Creek-Hayfork Creek subwatershed has the lowest percentage of perennial streams and lowest percentage of fish bearing streams, with 20.6 percent and 19.3 percent respectively (Table 8-2).

The Lower Hayfork Creek watershed has a relatively high stream density, with 5.1 miles of stream per square mile. As shown in Table 8-2, the Rusch Creek subwatershed has the highest density of streams, with 5.6 miles of stream per square mile, while Ditch Gulch-Salt Creek subwatershed has the lowest density of streams, with 4.3 miles of streams per square mile.

Stream channel conditions and characteristics vary throughout the watershed due to differences in soils and geology. In the higher elevations of the watershed, streams are steeper, and often confined by bedrock. Sediment is generated from the channels as a result of downcutting as well as input to the channels from adjacent uplands and either stored in, or transported through the channel network. Mass wasting and other erosional processes contribute sediment to the channel network throughout the watershed. In the lower elevations of the watershed, stream channels are wider, with gentle gradients that more alluvial in nature (U.S. Forest Service 1996).

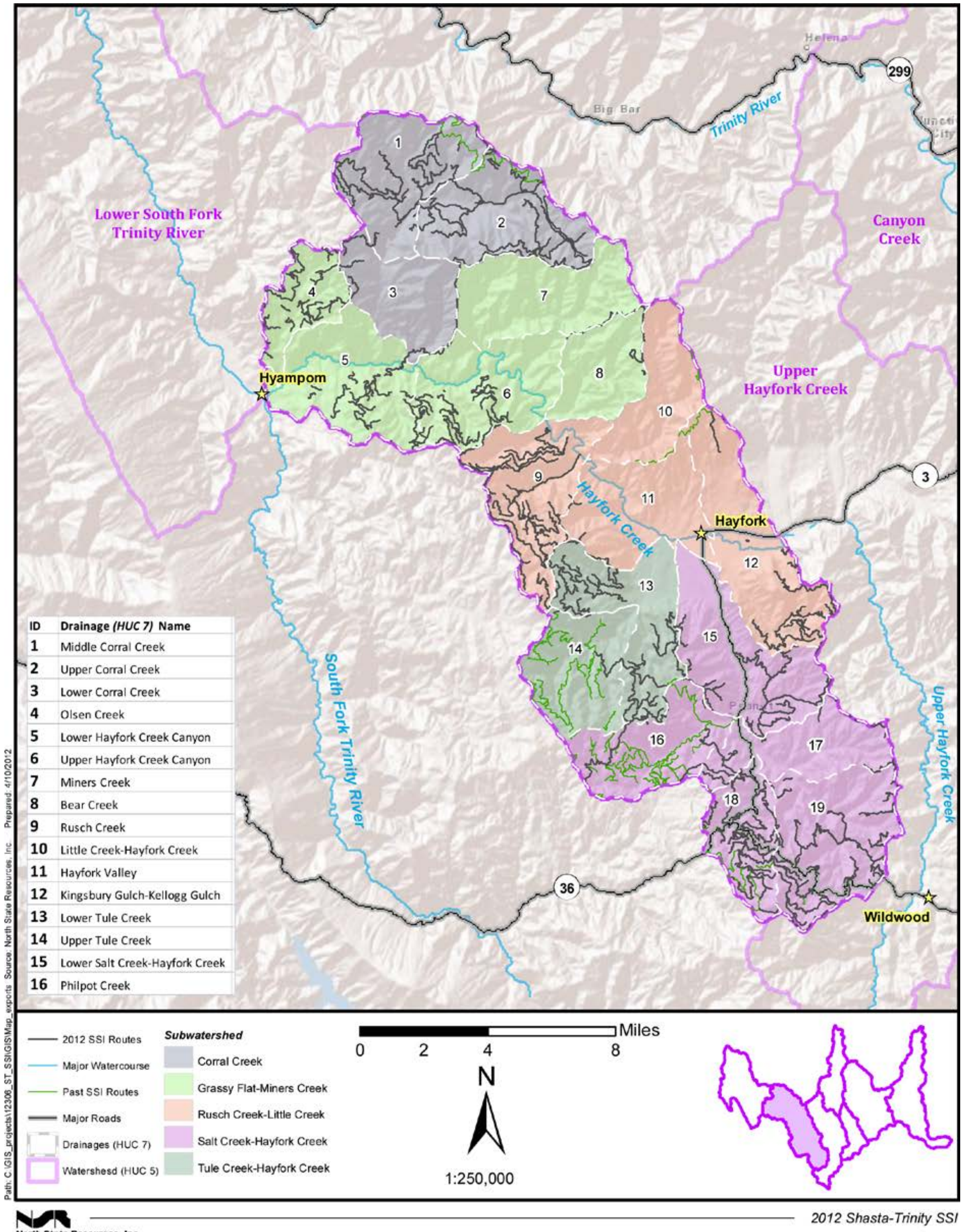


Figure 8-1. Lower Hayfork Creek Watershed Location

Table 8-2. Lower Hayfork Creek Watershed Streams Densities and Fish Bearing Lengths

Subwatersheds (HUC 6)	Stream Length (mi)	Stream Density (mi/ (mi^2))	Miles of Perennial Stream	Perennial Streams as % of Total Miles	Miles of Fish-Bearing Streams	Fish-Bearing Streams as % of Total Miles
Corral Creek	175.5	4.9	40.4	23.0%	40.4	23.0%
Grassy Flat-Miners Creek	257.8	4.7	75.5	29.3%	64.7	25.1%
Rusch Creek-Little Creek	279.2	5.6	108.4	38.8%	61.7	22.1%
Salt Creek-Hayfork Creek	298.7	5.2	61.4	20.6%	57.6	19.3%
Tule Creek-Hayfork Creek	118.0	5.1	39.9	33.8%	31.1	26.3%
Watershed Totals	**1,129.3**	**5.1**	**325.6**	**28.8%**	**255.5**	**22.6%**

Water Quality

The South Fork Trinity River, including tributaries such as Hayfork Creek is included on California's CWA Section 303(d) list as water quality limited due to sediment (Environmental Protection Agency 1998). The sediment impairment resulted in non-attainment of designated beneficial uses, primarily the cold water fishery. A total minimum daily load (TMDL) for sediment, with numeric targets, was prepared for the South Fork Trinity River and Hayfork Creek in 1998. The water quality objectives addressed in the TMDL include settleable material and sediment (Environmental Protection Agency 1998). The dominant source of sediment delivery in the Hayfork Creek sub-basin (includes Lower Hayfork Creek watershed) is bank erosion processes followed by surface erosion processes. Road-related sources, such as mass wasting, surface erosion, and washouts and gullies account for approximately 25 percent of the sediment delivery in the Hayfork sub-basin (Environmental Protection Agency 1998).

The 303(d) listing for the South Fork Trinity River and Hayfork Creek was updated to include temperature impairment in 1998, but to date a TMDL has not been developed (Environmental Protection Agency 1998). A number of monitoring efforts have documented high water temperatures during low-flow conditions in the summer months in the lower reaches of Hayfork Creek. Water temperatures in excess of 70 degrees Fahrenheit are typical and temperatures have reached 85 degrees Fahrenheit (U.S. Forest Service 1996). High water temperatures are a limiting factor to anadromous and resident fish in the Lower Hayfork Creek. Elevated water temperatures are likely a result of water diversions, loss of riparian vegetation, natural conditions, and excess sedimentation.

Aquatic and Riparian Habitat

Steelhead trout, rainbow trout and chinook salmon occur within the Lower Hayfork Creek watershed. Habitat is present, however, fish abundance in Lower Hayfork Creek is very low, due to poor habitat conditions. Summer steelhead and chinook sightings are sporadic in the mainstem of the Lower Hayfork Creek. Sediment accumulation, elevated water temperatures and low flows contribute to the degraded habitat. As stated in the previous section, high water temperatures and low flows are the factors limiting fish production. While, Lower Hayfork Creek is considered poor fish habitat, the tributaries have been rated as good habitat, with resident rainbow trout and anadromous steelhead populations in most tributaries (U.S. Forest Service 1996).

Various monitoring efforts are conducted to assess the habitat conditions of Lower Hayfork Creek. Stream Conditions Inventories (SCI) and redd surveys are conducted intermittently, while stream temperature and abiotic conditions are monitored actively (Chilcote 2012).

As shown in Table 8-2, the STNF GIS data indicates that approximately 255.5 miles of stream or 23 percent of the streams in the watershed are fish bearing streams. In general, most of the perennial and, to varying degrees intermittent streams provide some degree of habitat for aquatic and riparian dependent organisms (flora and fauna). Approximately 25 percent of the streams in the Grassy Flat-Miner Creek subwatershed are fish bearing, which is the highest amongst the subwatersheds.

Geology

A majority of the Lower Hayfork Creek watershed is underlain by metasediments, metavolcanics, and serpentinized deposits of the Eastern and Western Hayfork Terranes and the Rattlesnake Creek Terrane of the Western Paleozoic and Triassic Geologic Belt of the Klamath Mountains Province (Table 8-3). Dioritic rock from the Wildwood Pluton occupies large areas in the Dubakella Creek and East Hayfork Creek subwatershed, located in the southern portion of the watershed. Non-marine sandstone and conglomerate underlies alluvial fill at various locations throughout the Hayfork Valley (Strand 1977, Wagner & Saucedo 1983).

Table 8-3. Lower Hayfork Creek Watershed Prominent Geologic Units and Rock Types

Geologic Unit	Percent of Watershed		Dominant Rock Type(s)
Western Paleozoic and Triassic Belt	65%		
Eastern Hayfork Terrane		4%	argillite, breccia, volcaniclastics
Western Hayfork Terrane		27%	metavolcaniclastic; tuff & breccia
Rattlesnake Creek Terrane		34%	diamictite, metavolcanics, serpentine
Plutonic Rock	27%		
Ironside Mountain Pluton		25%	diorite, tonalite
Miocene Sedimentary Rock	7%		non-marine sandstone & conglomerate

Approximately 44 percent of the Lower Hayfork Creek watershed contains very high and high potential areas for soil erosion (Figure 8-2). Most of these soils are in proximity to the Ironside Mountain Pluton. In addition, 27 percent of the watershed is covered by sensitive landforms; mostly steep-sloped intrusive rocks, inner gorge terrain, and dormant landslides that occur in the northern half of the watershed.

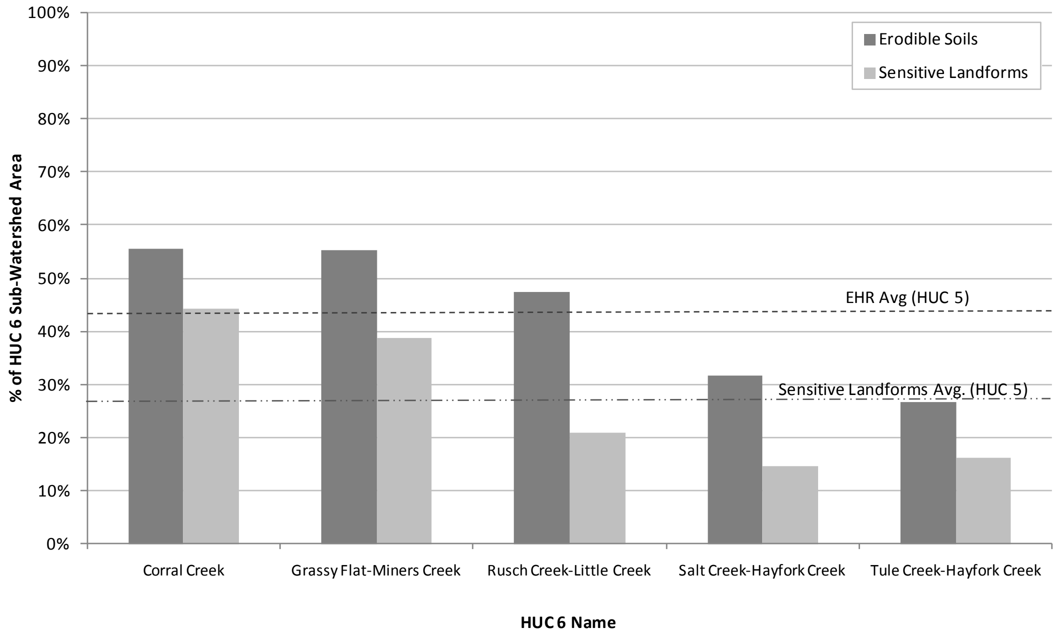


Figure 8-2. Area of Lower Hayfork Creek Subwatersheds Occupied by Erodible Soils and Sensitive Landforms

8.3 SSI Results

As described in Section 1, roads in the Lower Hayfork Creek watershed were inventoried during multiple field seasons. In total, approximately 422.6 miles of road were inventoried in the watershed. As part of the 2012 SSI, NSR inventoried 338.7 miles of road in the watershed during the 2011 and 2012 field seasons. The following discussion focuses on the 2012 SSI data set. The data acquired during the 2012 SSI was in addition to SSI data provided by the STNF, including information acquired by NSR and other entities over the past several years under various types of contracts and agreements. The cumulative SSI data set is presented following the 2012 SSI discussion.

2012 SSI Results

The objective of the 2012 SSI was to document the condition of existing road-related infrastructure and identify existing and potential erosion and sediment producing features located over 338.7 miles of road in the Lower Hayfork Creek watershed (Figure 8-1 and Appendices E & F). Inventoried features were prioritized based on their potential for sediment production and delivery to the hydrologic network. This section focuses on the inventoried and prioritized features included in the 2012 SSI. The results are presented at both the subwatershed (HUC 6) and drainage scales (HUC 7).

Inventoried Features

The 2012 SSI identified and characterized 5,899 features; 31.9 miles of gully, 45.4 miles of ditch segments; 421 stream crossings; 72 erosion features; 1,312 hydrologically connected cross-drain sites; 4,002 non-hydrologically connected cross-drains; and 92 springs (Table 8-4 and Appendices E & F).

Table 8-4. 2012 Inventoried Features for Lower Hayfork Creek Subwatersheds (HUC 6) and Drainages (HUC 7)

Subwatersheds (HUC 6) Drainages (HUC 7)	Road Miles	Gully Miles	Ditch Miles	Stream Crossings	Erosion Features	Connected Cross-Drains	Non-Connected Cross-Drains	Springs
Corral Creek	69.6	4.2	13.4	108	10	317	657	10
Lower Corral Ck.	5.6	0.3	0.0	4	0	14	107	0
Middle Corral Ck.	27.8	1.9	5.8	41	6	129	243	3
Upper Corral Ck.	36.2	2.0	7.6	63	4	174	307	7
Grassy Flat-Miners Creek	60.7	5.5	6.6	46	8	155	845	19
Bear Ck.	3.7	0.6	0.0	0	4	2	40	0
Lower Hayfork Creek Canyon	15.1	1.8	0.4	16	3	82	250	4
Miners Ck.	2.5	0.2	0.0	0	0	0	2	0
Olsen Ck.	17.8	1.0	5.4	22	0	38	221	4
Upper Hayfork Creek Canyon	21.5	1.9	0.8	8	1	33	332	11
Rusch Creek-Little Creek	64.9	5.2	5.2	75	14	263	754	19
Hayfork Valley	2.5	0.4	0.0	0	0	3	21	0
Kingsbury Gulch-Kellogg Gulch	18.9	2.7	0.4	24	8	96	214	3
Little Ck.-Hayfork Ck.	0.1	0	0.0	0	0	0	1	0
Rusch Ck.	43.5	2.1	4.8	51	6	164	518	16
Salt Creek-Hayfork Creek	103.9	14.7	11.2	134	30	459	1301	32
Ditch Gulch-Salt Ck.	30.9	5.6	3.0	56	10	152	418	16
Lower Salt Creek-Hayfork Creek	19.9	1.6	2.3	16	9	128	226	0
Philpot Ck.	7.4	1.2	3.7	10	5	36	79	1
Salt Gulch-Salt Ck.	8.8	2.4	0.3	9	2	33	96	0
Upper Salt Ck.-Hayfork Ck.	36.9	3.8	1.9	43	4	110	482	15
Tule Creek-Hayfork Creek	39.5	2.3	8.9	58	10	118	445	12
Lower Tule Ck.	37.0	2.2	7.9	56	10	105	422	10
Upper Tule Ck.	2.5	0.1	1.0	2	0	13	23	2
Watershed Totals	**338.7**	**31.9**	**45.4**	**421**	**72**	**1312**	**4002**	**92**

The Salt Creek subwatershed had the greatest number of inventoried features, greatest gully mileage, and second greatest ditch mileage; with 1,956 inventoried features, 14.7 miles of gully and 11.2 miles of ditch (Table 8-4). Accordingly, the Salt Creek subwatershed contained the greatest road mileage inventoried in the 2012 SSI (103.9 miles). At the opposite end, the Tule Creek subwatershed had the least number of inventoried features (643 features), and the lowest road mileage inventoried in the 2012 SSI (39.5 miles).

The proportion of inventoried features in each subwatershed is equal to the proportion of road miles inventoried in the 2012 SSI in each subwatershed. For example, approximately 33 percent of the total inventoried features were located in the Salt Creek subwatershed and approximately 31 percent of the total 2012 inventoried mileage was in the Salt Creek subwatershed; approximately 11 percent of the total inventoried features were located in the Tule Creek subwatershed and approximately 12 percent of the total 2012 mileage was inventoried in the Tule Creek subwatershed. This is consistently observed in each of the five subwatersheds.

However, the proportion of inventoried ditch and gully miles in each subwatershed is not consistent with the proportion of road miles inventoried in the 2012 SSI in each subwatershed. For example, approximately 46 percent of the total inventoried gully and 25 percent of the total inventoried ditch miles were located in the Salt Creek subwatershed compared to approximately 31 percent of the total 2012 inventoried mileage was in the Salt Creek subwatershed.

Feature Analysis/Risk Analysis

As described in Section 2, risk ranking matrices were created to identify features that currently do, or potentially could deliver elevated levels of sediment to nearby streams or waterbodies. The number of high risk features and the proportion by subwatershed are listed in Table 8-5. The accompanying GIS project is organized to extract the type and location of features by risk rating at multiple scales. The density of high risk features types for each subwatershed and drainage is shown in Figure 8-3.

As illustrated in Table 8-5, the 2012 SSI identified the following high risk features: 19.5 gully miles, 13.7 ditch miles, 165 stream crossings, 27 erosion sites, 179 connected cross-drains with CMP, and 29 spring sites. A total of 400 features or 35 percent of the total 2012 Lower Hayfork SSI features (excluding non-connected cross-drains and connected cross-drains without CMP) are characterized as high risk in the Lower Hayfork Creek watershed.

The Salt Creek subwatershed contained the greatest number of high risk features and gully miles, with a total of 129 features and 9.2 miles of gully considered high risk. The Grassy Flat-Miners Creek subwatershed had the lowest number of high risk features, but the second highest mileage of high risk gully, with 38 features and 3.3 miles of ditch.

When compared to the total number of high risk features and total road miles inventoried in the SSI, the proportion of these features within each subwatershed is relatively consistent with the proportion of roads inventoried within the subwatershed. For example, the Salt Creek subwatershed contains approximately 31 percent of the road miles inventoried within the watershed and it also contains 32 percent of the total number of high risk features. This is observed in each subwatershed, except for the Grassy-Flat Miners Creek subwatershed, where the percentage of high risk features is lower than the percentage of inventoried miles.

As expected, the proportion of high risk gullies and ditches is not consistent with the proportion of roads inventoried within the subwatershed. For example, the Corral Creek subwatershed contains approximately 21 percent of the 2012 road miles inventoried within the watershed and it contains 13 percent of the total high risk gullies and 40 percent of the total high risk ditches.

Table 8-5. High Risk Features for Lower Hayfork Creek Subwatersheds (HUC 6) and Drainages (HUC 7)

Subwatersheds (HUC 6) Drainages (HUC 7)	Gully Miles	Ditch Miles	Stream Crossings	Erosion Features	Connected Cross-Drain w/CMP	Springs
Corral Creek	2.5 (60%)	5.5 (41%)	47 (44%)	2 (20%)	50 (31%)	3 (30%)
Lower Corral Ck.	0.1 (25%)	0.0 (0%)	0 (0%)	0 (0%)	1 (13%)	0 (0%)
Middle Corral Ck.	1.4 (74%)	2.9 (49%)	26 (63%)	2 (67%)	39 (59%)	0 (0%)
Upper Corral Ck.	1.1 (53)	2.7 (35%)	21 (33%)	0 (0%)	10 (12)	3 (43%)
Grassy Flat-Miners Creek	3.3 (60%)	0.5 (7%)	17 (40%)	0 (0%)	13 (22%)	8 (42%)
Bear Ck.	0.6 (100%)	0.0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Lower Hayfork Canyon Ck.	1.0 (57%)	0.2 (39%)	2 (13%)	0 (0%)	0 (0%)	2 (50%)
Miners Ck.	0.2 (81%)	0.0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Olsen Ck.	0.4 (36%)	0.3 (5%)	12 (54%)	0 (0%)	8 (40%)	2 (50%)
Upper Hayfork Creek Canyon	1.1 (59%)	0.1 (9%)	3 (38%)	0 (0%)	5 (31%)	4 (36%)
Rusch Creek-Little Creek	2.9 (53%)	1.6 (30%)	23 (31%)	8 (57%)	37 (35%)	5 (26%)
Hayfork Valley	0.1 (32%)	0.0 (0%)	0 (0%)	0 (0%)	1 (100%)	0 (0%)
Kingsbury Gulch-Kellogg Gulch	1.8 (68%)	0.1 (35%)	13 (54%)	6 (75%)	15 (60%)	0 (0%)
Little Ck.-Hayfork Ck.	0.0 (0%)	0.0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Rusch Ck.	0.9 (62%)	1.5 (30%)	10 (20%)	2 (33%)	21 (26%)	5 (31%)
Salt Creek-Hayfork Creek	9.2 (73%)	4.3 (38%)	53 (40%)	14 (47%)	53 (32%)	9 (28%)
Ditch Gulch-Salt Ck.	4.1 (39%)	0.9 (29%)	26 (46%)	1 (10%)	12 (24%)	2 (13%)
Lower Salt Ck.-Hayfork Ck.	0.6 (81%)	1.4 (62%)	3 (19%)	7 (78%)	12 (19%)	0 (0%)
Philpot Ck.	0.0 (0%)	1.2 (31%)	4 (40%)	4 (80%)	16 (70%)	0 (0%)
Salt Gulch-Salt Ck.	1.4 (60%)	0.1 (33%)	2 (22%)	1 (50%)	4 (36%)	0 (0%)
Upper Salt Ck.-Hayfork Ck.	2.0 (53%)	0.8 (40%)	18 (42%)	1 (25%)	9 (50%)	7 (47%)
Tule Creek-Hayfork Creek	1.6 (70%)	1.8 (20%)	25 (43%)	3 (30%)	26 (42%)	4 (33%)
Lower Tule Ck.	1.6 (73%)	1.5 (19%)	25 (45%)	3 (30%)	22 (39%)	2 (20%)
Upper Tule Ck.	0.0 (0%)	0.3 (27%)	0 (0%)	0 (0%)	4 (67%)	2 (100%)
Watershed Totals	**19.5 (61%)**	**13.7 (30%)**	**165 (39%)**	**27 (38%)**	**179 (33%)**	**29 (32%)**

Note: Values in parenthesis represent percentage of watershed feature totals.

Figure 8-3 illustrates the variability in the number and type of high risk features per mile of inventoried road by subwatershed. Hydrologically connected cross-drains with CMP are the most frequent high risk feature in the Lower Hayfork Creek watershed and in all subwatersheds, except the

Grassy Flat-Miners Creek subwatershed. High risk stream crossings are as nearly common as the connected cross drains with CMP, with a watershed average with nearly one high risk stream crossing per mile of inventoried road. High risk erosion features and springs are much less common, however there were also less erosion features and springs inventoried in the watershed. There is an average of 0.06 miles of high risk gully per mile of inventoried road and 0.04 miles of ditch per mile of inventoried in the watershed (Figure 8-3).

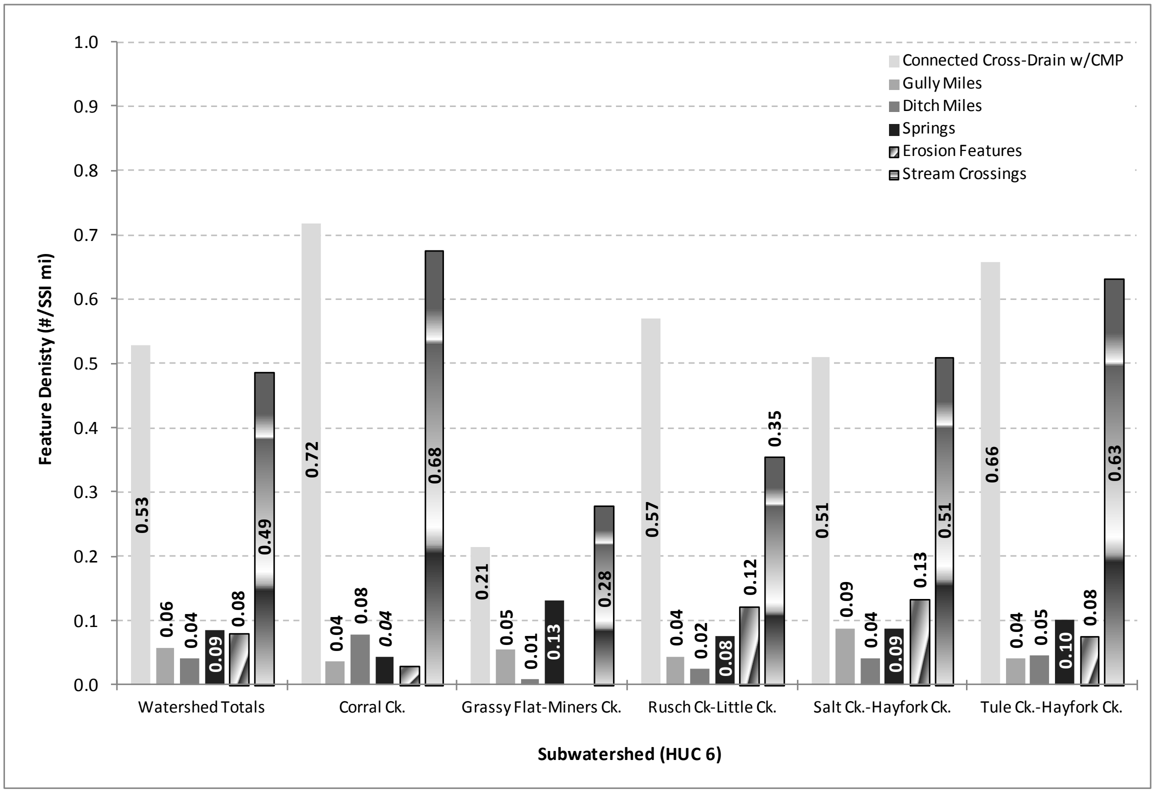


Figure 8-3. Density of High Risk Features for Lower Hayfork Creek Subwatersheds
Note: Gullies and ditch densities reported as miles of feature per mile of SSI road.

Cumulative SSI Data

Prior to conducting the 2012 SSI effort, the STNF acquired SSI data in four of the subwatersheds, Corral Creek, Rusch Creek-Little Creek, Salt Creek, and Tule Creek subwatersheds, over the course of several field seasons. Table 8-6 illustrates the total road miles inventoried relative to the cumulative number and type features that have been documented through various SSI efforts in the Lower Hayfork Creek watershed, by subwatershed/drainage.

The following discussion is based on cumulative SSI efforts conducted for the STNF on approximately 53 percent of all roads within the Lower Hayfork Creek watershed. Of 422.6 miles of inventoried roads in the Lower Hayfork Creek watershed, 83.9 miles were inventoried prior to the 2012 SSI. Cumulatively, the SSI data set documents the occurrence of 78 erosion sites and 2,052 hydrologically connected features, which includes stream crossings and connected cross-drains (Table 8-6). Six hundred and twenty-seven of these features were stream crossings, of which 35 percent were identified as high risk sites. These include crossings that were unable to or were in danger of not being able to adequately convey peak flow events at the site. Thirty-four percent of the total stream crossings were identified with diversion potential, and 10 percent were undersized pipes. Field indicators of undersized pipe were evidence of overtopping; substantially plugged features, poor structural integrity (i.e. holes, separated, etc.), poor positioning, or a significant loss of fill at the inlet.

Table 8-6. Lower Hayfork Creek Watershed Cumulative SSI Data

				Stream Crossings			
Subwatersheds (HUC 6) Drainages (HUC 7)	**Total SSI Miles**	**Erosion Features**	**Connected Features[1]**	**Total**	**High Risk**	**Diversion Potential**	**FEUP[2]**
Corral Ck.	80.2	10	481	122	55	49	7
Lower Corral Ck.	5.6	0	18	4	0	0	0
Middle Corral Ck.	33.5	6	183	49	33	28	2
Upper Corral Ck.	41.2	4	280	69	22	21	5
Grassy Flat-Miners Ck.	60.6	8	201	46	17	16	3
Bear Ck.	3.7	4	2	0	0	0	0
Lower Hayfork Canyon Ck.	15.1	3	98	16	2	1	1
Miners Ck.	2.5	0	0	0	0	0	0
Olsen Ck.	17.8	0	60	22	12	11	2
Upper Hayfork Ck. Canyon	21.5	1	41	8	3	4	0
Rusch Ck.-Little Ck.	71.1	14	346	82	23	22	1
Hayfork Valley	3.3	0	4	1	0	0	0
Kingsbury Gulch-Kellogg Gulch	20.6	8	125	29	13	11	0
Little Ck.-Hayfork Ck.	3.7	0	2	1	0	0	0
Rusch Ck.	43.5	6	215	51	10	11	1
Salt Ck.-Hayfork Ck.	148.1	34	756	244	82	78	38
Ditch Gulch-Salt Ck.	37.8	10	237	71	27	16	6
Lower Salt Ck.-Hayfork Ck.	20.2	9	144	16	3	4	2
Philpot Ck.	41.1	8	164	92	30	46	23
Salt Gulch-Salt Ck.	9.8	3	44	11	4	3	2
Upper Salt Ck.-Hayfork Ck.	39.1	4	167	54	18	9	5
Tule Ck.-Hayfork Ck.	62.5	12	268	133	42	51	13
Lower Tule Ck.	37.9	10	161	56	25	13	6
Upper Tule Ck.	24.6	2	107	77	17	38	7
Watershed Totals	**422.6**	**78**	**2052**	**627**	**219**	**216**	**62**

[1]Includes all stream crossings and Connected Cross-Drains; indicator of hydrologic connectivity of roads
[2]Field Evidence of Undersized Pipe (FEUP); see methods for explanation.

Similar to the 2012 SSI, the majority of the roads inventoried in previous efforts were in the Salt Creek subwatershed, with over 148 total miles inventoried. The Salt Creek subwatershed also has the most road miles (244.6) and the second highest road density in the Lower Hayfork Creek; 4.2 miles of road per square mile. Cumulatively, the Salt Creek subwatershed has the highest number of inventoried features; 34 erosion features, 756 hydrologically connected features, and 244 stream crossings (Table 8-6). Of the 158 stream crossings, about a third were characterized as high risk and identified with diversion potential. The density of these features was relatively similar to the watershed average (Figure 8-4).

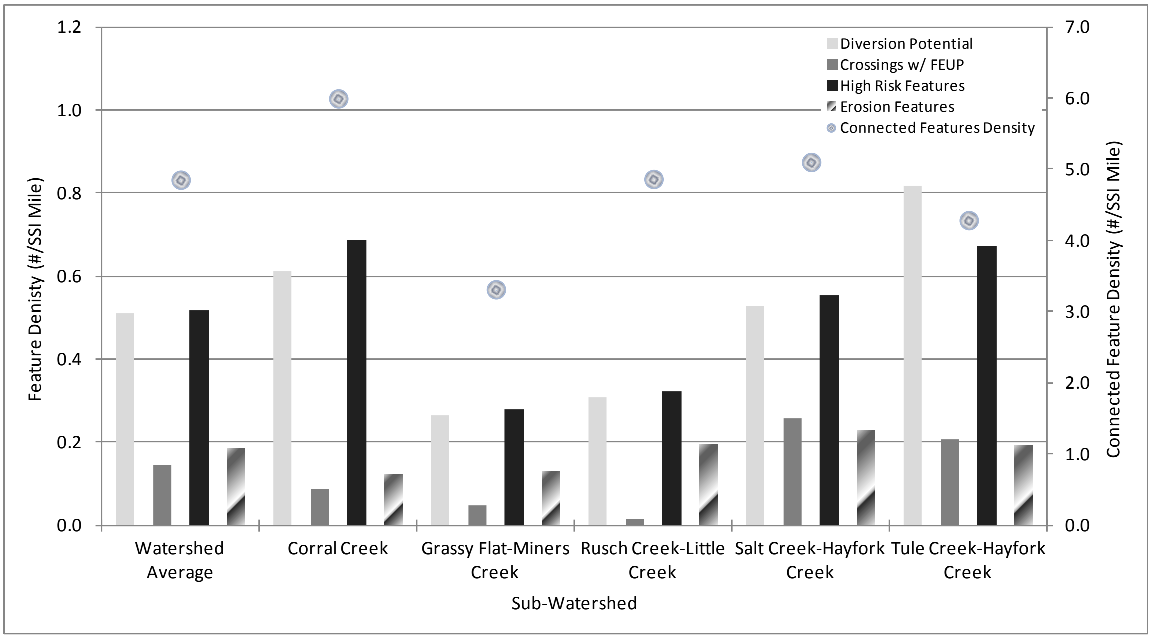


Figure 8-4. Density per Mile of SSI Road of Selected Features for Lower Hayfork Creek Subwatershed

Approximately 74 percent of the total roads (80.2 miles) in the Corral Creek subwatershed were included in the cumulative SSI data set. This data set represents the second highest mileage inventoried for any of the subwatersheds in Lower Hayfork Creek with 80.2 miles of inventoried road. The cumulative SSI data set contains 481 connected features, of which 122 are stream crossings. Ten erosion features were in Corral Creek subwatershed; all were identified during the 2012 SSI effort. As shown in Figure 8-4, the density of erosion features is lower than the watershed average and all other subwatersheds. However, this subwatershed has the most connected features and high risk features per road mile relative to other subwatersheds.

The density of erosion features and connected features in the Rusch Creek-Little Creek subwatershed was similar to the watershed average. However the density of stream crossings with field evidence of undersized pipe, stream crossings with diversion potential, and high risk stream crossings was lower than the watershed average. Approximately 37 percent of the total roads (71.1 miles) in the Rusch Creek-Little Creek subwatershed were included in the SSI cumulative data set.

Approximately 59 percent of the roads (62.5 miles) in the Tule Creek subwatershed were included in the cumulative SSI efforts; 12 erosion features and 268 connected features were documented (Table

8-6). Nearly half of the connected features were stream crossings (133 stream crossings) Of the stream crossings, 42 were considered high risk, 51 had diversion potential, and 13 had field evidence of undersized pipes (Table 8-6). Overall, the density of high risk stream crossings was greater than the average density for the Lower Hayfork Creek watershed.

The least mileage was inventoried in Grassy Flat-Miners Creek subwatershed (60.6 miles), with a total of 60.6 miles included. No previous SSI data was acquired for this subwatershed; all data is a result of the 2012 SSI effort. As shown in Figure 8-4, roads within the Grassy Flat-Miners Creek subwatershed had the least connected features per road mile relative to other subwatersheds. The stream crossings identified with diversion potential, at high risk and as undersized pipes were lower than watershed average. The number of erosion features per mile of road was also slightly lower than the watershed average. All features were identified in the 2012 SSI, as no roads were included from previous efforts.

8.4 Aquatic and Riparian Resources RAP Risk Analysis

The main focus of the RAP risk analysis was to identify road segments that could pose a moderate to high risk to aquatic and riparian resources. Three resources, including, water quality, hydrologic processes, aquatic and riparian habitat are analyzed in the following discussion. The RAP risk analysis is presented at both the HUC 7 drainage and road segment scales.

Aquatic and Riparian Resources Total RAP Risk Score per Drainage

The total Aquatic and Riparian Resources RAP risk score (total RAP risk score) for road segments within each of the 19 drainages (HUC 7) that constitute the Lower Hayfork Creek watershed are discussed in this section. The total RAP risk score is the average of the individual water quality, hydrologic processes, and aquatic and riparian habitat scores. As described in Section 2.4, the key questions specific to the three resources, and the associated criteria required to answer these questions have been developed in accordance with the STNF RAP protocol (Shasta-Trinity National Forest 2011) in order to rate the road segments at the drainage scale.

The RAP risk scores for water quality, hydrologic processes, aquatic and riparian habitat, including the total scores for each road and drainage are listed in Appendix D. Figure 8-5 illustrates the total miles of road per drainage and the associated total RAP risk score. This Figure displays the relative risk per drainage for the various sections of roads included in the RAP analysis. A key point in this discussion is that the RAP analysis focused on the 2012 SSI data set due to inconsistencies in previous SSI data sets.

The Aquatic and Riparian RAP effort indicates that less than six percent of the roads (19.8 miles) in the Lower Hayfork Creek subwatershed were scored as high risk to aquatic and riparian resources. There are road segments rated as high risk in each subwatershed, except for the Grassy-Flat Miners Creek subwatershed. The largest proportion of roads rated high risk were located in the Corral Creek subwatershed, and more specifically within the Upper Corral Creek drainage. The Upper Corral Creek drainage contained the greatest mileage rated high risk, with 5.8 miles or 16 percent (Figure 8-5).

Approximately 16 percent of the roads (55.9 miles) included in the 2012 SSI in the Lower Hayfork Creek watershed scored as moderate-high to aquatic and riparian resources. The majority of roads that scored moderate-high risk were located in the Salt Creek subwatershed; 21.7 of the 103.9 miles of roads included in the SSI within the subwatershed scored moderate-high. The Corral Creek subwatershed ranked second with 14.9 miles scored moderate-high. However both subwatersheds, Salt Creek and Corral Creek, had nearly the same percentage (21% and 22%, respectively) of 2012 inventoried roads that scored moderate-high to aquatic and riparian resources. The Grassy Flat-Miners Creek and Tule Creek subwatersheds had the least mileage that scored moderate-high, with only 4.1 miles and 4.5 miles, respectively (Figure 8-5).

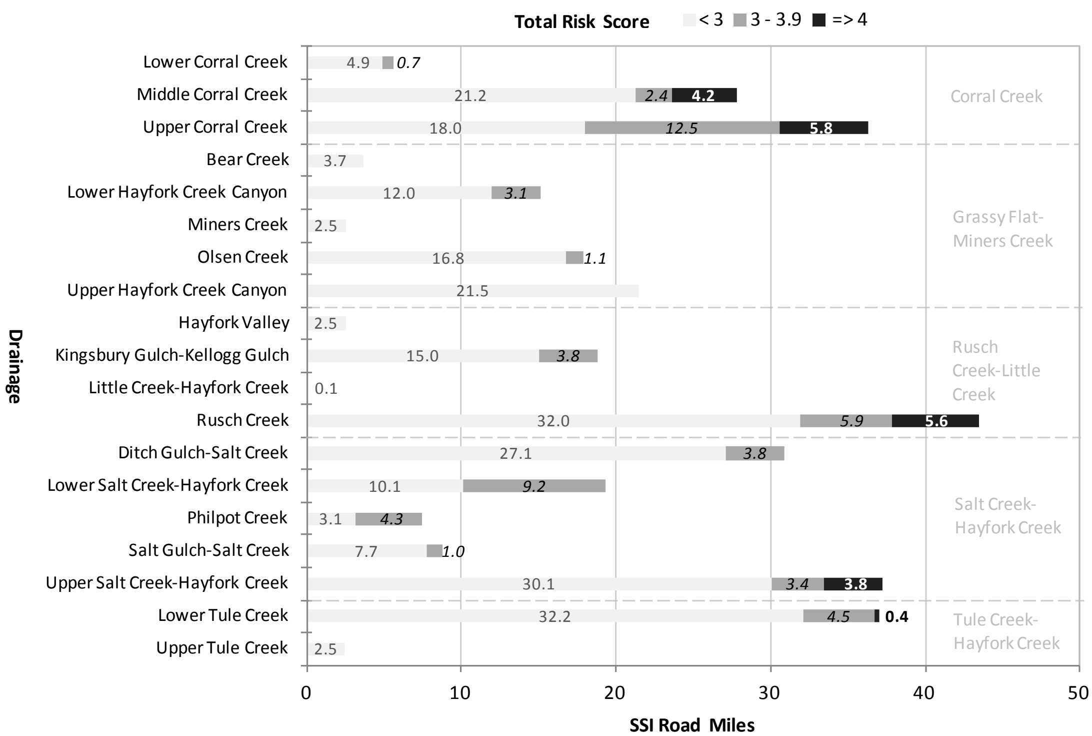


Figure 8-5. Aquatic and Riparian Resources RAP Total Risk Score for Lower Hayfork Creek Watershed Drainages

As shown in Figure 8-5, the Upper Corral Creek drainage had the greatest mileage with scores of 3.0 or above in the RAP analysis. Approximately half of the inventoried mileage within the Upper Corral Creek drainage was considered moderate-high to high risk to aquatic and riparian resources. The Rusch Creek drainage had the second highest mileage with RAP scores over three, with 11.5 miles of road scored moderate-high to high. However, this only represents 26 percent of the total mileage inventoried in the Rusch Creek drainage compared to 50 percent in the Upper Corral Creek drainage.

Overall, 77 percent of the roads included in the 2012 SSI within the Lower Hayfork Creek watershed had scores less than three (low-moderate risk). Based on the assumptions used for the RAP analysis, this suggest that a large number of the roads pose a low to moderate risk of affecting aquatic and riparian resources. Within the Bear Creek, Miners Creek, Upper Hayfork Creek Canyon, Hayfork

Valley, Little Creek-Hayfork Creek, and Upper Tule Creek drainages, all the roads included in the 2012 SSI scored less than three.

Moderate-High to High Risk Road Segments

Table 8-7 lists those road segments by drainage included in the 2012 SSI that scored 3.0 or above in the RAP risk analysis. Based on this analysis, these road segments have a moderate-high to high risk of affecting water quality, hydrologic processes, and aquatic and riparian habitats. In total, eight road segments or approximately 19.8 miles of road scored high risk and 53 road segments scored moderate-high risk. Figures 8-6a, 8-6b, and 8-6c illustrate the location of the moderate-high to high risk roads segments in the Lower Hayfork Creek watershed.

As shown in Table 8-7, the score for water quality is generally the highest of the three scores. Forty-one of the 61 road segments (84%) score high risk to water quality (scores equal to or above 4.0). This suggests that many of the moderate-high and high risk road segments are hydrologically connected and intersect areas prone to erosion. Evaluation of previous RAP risk analysis indicates that the large number of stream crossings and/or the road segments that are in close proximity to aquatic and riparian habitat provide a direct pathway for transport and delivery of sediment to water bodies in the Lower Hayfork Creek watershed. For example, Road 32N11 scored high risk to water quality; it parallels Rusch Creek for a few miles offering numerous direct pathways for transport and delivery of sediment and other materials to Rusch Creek (Figure 8-6b). Additionally, the slopes surrounding the road are steep in nature, which can contribute to erosion issues (Figure 8-6b)

Table 8-7 indicates that all road segments with one exception scored 3.8 for hydrologic processes; Road 30N18 scored 2.4. This analysis indicates that all moderate-high to high risk road segments pose a similar risk to hydrologic processes throughout the Lower Hayfork Creek watershed. These roads may potentially affect the routing of water by intercepting and diverting flows from their natural path. This is also an indication that where a portion of the road prism intersects the riparian or aquatic habitat, the location and nature of the road prism may constrict the channel, isolate floodplains, and/or constrain channel migration.

Table 8-7. Lower Hayfork Creek Watershed Routes with Total RAP Risk Scores of 3.0 and Greater

			Resource Risk Scores			
Route ID	**Drainage Name**	**Miles**	**Aquatic, Riparian**	**Hydrologic Process**	**Water Quality**	**Total Risk**
4N47	Upper Corral Creek	4.642	4.4	3.8	4.4	4.2
4N45	Upper Corral Creek	0.738	4.2	3.8	4.5	4.2
31N08A	Lower Tule Creek	0.347	3.8	3.8	4.7	4.1
30N19	Upper Salt Creek-Hayfork Creek	3.773	4.2	3.8	4.2	4.0
4N09	Middle Corral Creek	3.643	4.1	3.8	4.2	4.0
32N11	Rusch Creek	5.613	3.8	3.8	4.4	4.0
4N18_2	Middle Corral Creek	0.544	4.0	3.8	4.1	4.0
33N20A	Upper Corral Creek	0.399	3.6	3.8	4.5	4.0

Table 8-7. Lower Hayfork Creek Watershed Routes with Total RAP Risk Scores of 3.0 and Greater

			Resource Risk Scores			
Route ID	Drainage Name	Miles	Aquatic, Riparian	Hydrologic Process	Water Quality	Total Risk
31N42	Lower Salt Creek-Hayfork Creek	3.006	3.9	3.8	4.2	3.9
3N46	Lower Hayfork Creek Canyon	1.801	3.6	3.8	4.4	3.9
U30N18D	Upper Salt Creek-Hayfork Creek	0.105	3.3	3.8	4.7	3.9
U36TRI04	Ditch Gulch-Salt Creek	0.046	3.3	3.8	4.7	3.9
4N28	Middle Corral Creek	0.955	3.6	3.8	4.3	3.9
31N42A	Kingsbury Gulch-Kellogg Gulch	0.396	3.3	3.8	4.6	3.9
3N08	Rusch Creek	3.455	3.8	3.8	4.1	3.9
3N40	Olsen Creek	0.786	3.8	3.8	4.1	3.9
30N36	Ditch Gulch-Salt Creek	2.043	3.6	3.8	4.3	3.9
3N20A	Lower Hayfork Creek Canyon	0.981	3.6	3.8	4.3	3.9
4N47A	Upper Corral Creek	0.476	3.5	3.8	4.4	3.9
31N32	Philpot Creek	3.746	3.8	3.8	4.0	3.8
4N47E	Upper Corral Creek	1.467	3.6	3.8	4.1	3.8
31N22	Kingsbury Gulch-Kellogg Gulch	2.613	3.4	3.8	4.3	3.8
4N18	Middle Corral Creek	0.808	3.3	3.8	4.4	3.8
4N35	Upper Corral Creek	1.549	3.5	3.8	4.1	3.8
31N66D	Rusch Creek	1.673	3.3	3.8	4.3	3.8
4N06	Upper Corral Creek	0.639	3.3	3.8	4.3	3.8
31N66B	Lower Tule Creek	1.824	3.4	3.8	4.1	3.8
4N29	Upper Corral Creek	6.140	3.4	3.8	4.1	3.8
3N46	Lower Corral Creek	0.728	3.4	3.8	4.1	3.8
31N08	Lower Tule Creek	2.697	3.4	3.8	4.1	3.7
3N05A	Olsen Creek	0.322	3.5	3.8	3.9	3.7
2N28A	Rusch Creek	0.174	3.3	3.8	4.1	3.7
U4N05D	Middle Corral Creek	0.302	3.3	3.8	4.1	3.7
30N18C	Upper Salt Creek-Hayfork Creek	0.405	3.3	3.8	4.0	3.7
4N37	Upper Corral Creek	1.599	3.3	3.8	4.0	3.7
30N52	Lower Salt Creek-Hayfork Creek	2.185	3.3	3.8	4.0	3.7
32N11D	Rusch Creek	0.602	3.3	3.8	4.0	3.7
30N16Y	Ditch Gulch-Salt Creek	0.697	3.3	3.8	3.9	3.7
33N20	Upper Corral Creek	0.647	3.3	3.8	3.9	3.7
4N05GHST1	Middle Corral Creek	0.014	3.3	3.8	3.9	3.7

Table 8-7. Lower Hayfork Creek Watershed Routes with Total RAP Risk Scores of 3.0 and Greater

			Resource Risk Scores			
Route ID	Drainage Name	Miles	Aquatic, Riparian	Hydrologic Process	Water Quality	Total Risk
31N19	Lower Salt Creek-Hayfork Creek	3.027	3.3	3.8	3.9	3.6
30N51	Lower Salt Creek-Hayfork Creek	0.552	3.3	3.8	3.9	3.6
30N40	Upper Salt Creek-Hayfork Creek	0.083	3.3	3.8	3.8	3.6
4N05	Upper Corral Creek	0.020	3.3	3.8	3.8	3.6
3N08H	Lower Tule Creek	0.000	3.3	3.8	3.8	3.6
3N28	Lower Hayfork Creek Canyon	0.349	2.0	3.8	5.0	3.6
U31N22A	Kingsbury Gulch-Kellogg Gulch	0.019	3.3	3.8	3.7	3.6
30N49	Philpot Creek	0.557	3.3	3.8	3.7	3.6
31N48C	Lower Salt Creek-Hayfork Creek	0.412	3.3	3.8	3.7	3.6
31N17	Kingsbury Gulch-Kellogg Gulch	0.819	1.9	3.8	4.2	3.3
U36TRI06	Ditch Gulch-Salt Creek	0.023	1.3	3.8	4.7	3.2
U30N08	Ditch Gulch-Salt Creek	0.213	1.3	3.8	4.4	3.2
29N55A	Ditch Gulch-Salt Creek	0.599	1.3	3.8	4.3	3.1
4N49B	Middle Corral Creek	0.300	1.3	3.8	3.9	3.0
30N18	Upper Salt Creek-Hayfork Creek	2.795	3.3	2.4	3.2	3.0
U30N14B	Upper Salt Creek-Hayfork Creek	0.019	1.3	3.8	3.8	3.0
30N51A	Salt Gulch-Salt Creek	0.105	1.3	3.8	3.8	3.0
U36TRI03B	Ditch Gulch-Salt Creek	0.043	1.3	3.8	3.8	3.0
U30N07AD	Ditch Gulch-Salt Creek	0.102	1.3	3.8	3.8	3.0
U30N07A	Ditch Gulch-Salt Creek	0.044	1.3	3.8	3.8	3.0
31N64	Salt Gulch-Salt Creek	0.908	1.3	3.8	3.8	3.0

The road segment scores for aquatic and riparian habitat has a wider range of values relative to water quality and hydrologic processes, with scores from 1.3 to 4.4. These scores correlate the risk to aquatic and riparian habitat relative to the individual road segments with respect to affects on the functions and values of aquatic and riparian habitat, including attributes such as connectivity and flow. Road 4N47, within the Upper Corral Creek drainage had the highest aquatic and riparian risk score (4.4) of all analyzed road segments in the Lower Hayfork Creek watershed. This road is located in the Corral bottom and crosses Corral Creek and other small tributaries for over 4 miles (Figure 8-6a). The high is score is a result of the road's proximity to fish bearing streams and perennial streams, high number of aquatic organism barriers and stream crossings.

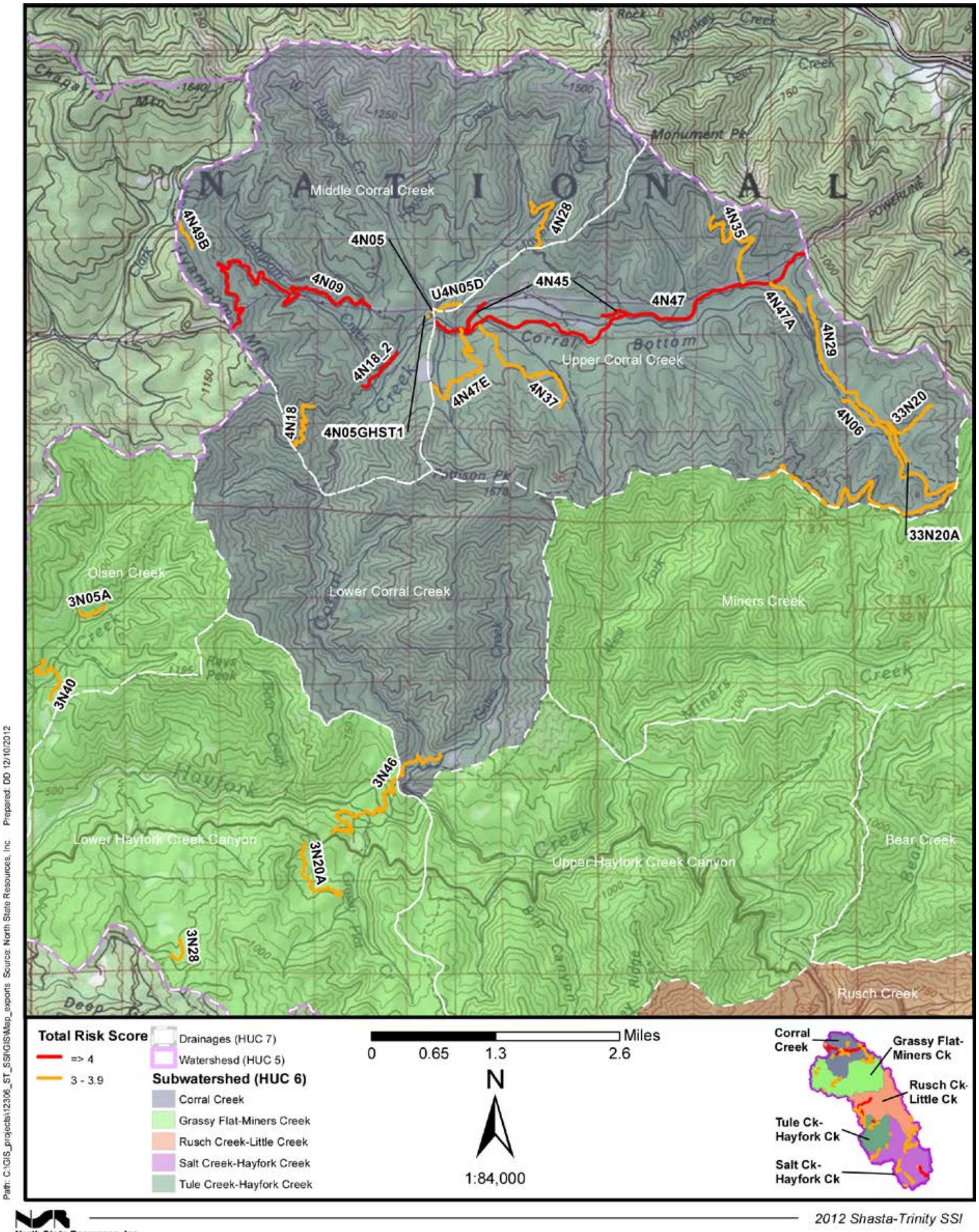


Figure 8-6a. Location of Moderate-High to High Risk Roads Segments in the Lower Hayfork Watershed

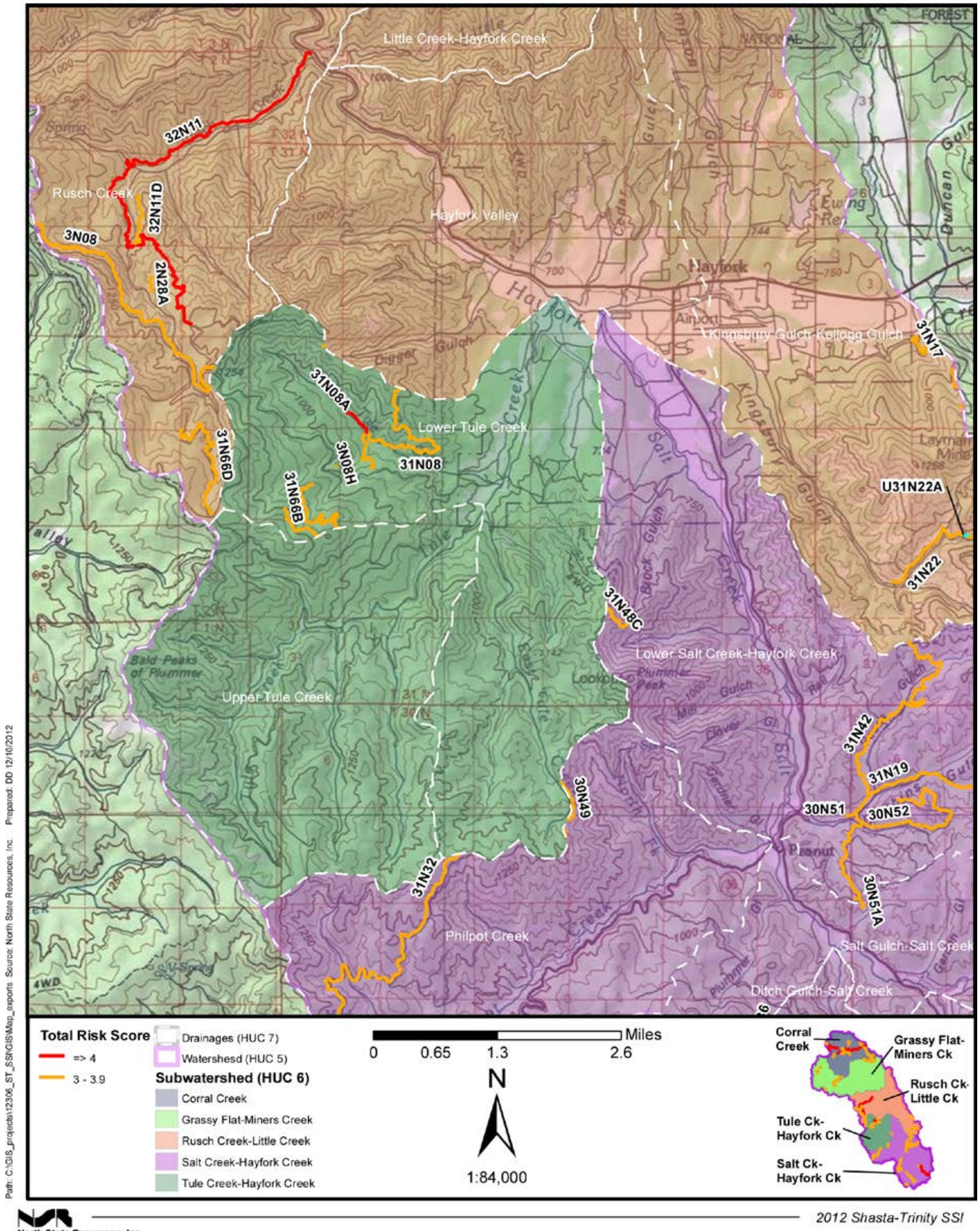


Figure 8-6b. Location of Moderate-High to High Risk Roads Segments in the Lower Hayfork Watershed

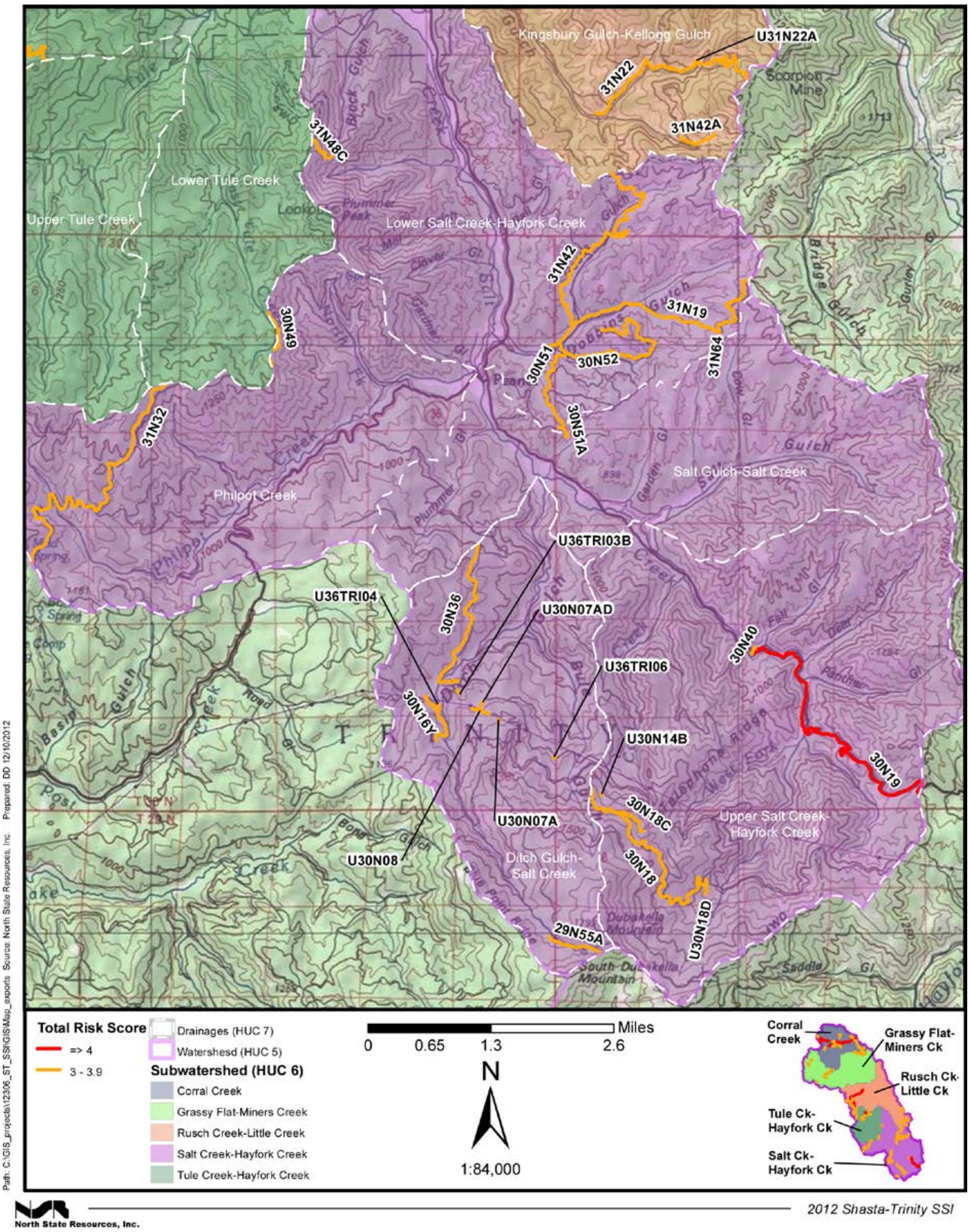


Figure 8-6c. Location of Moderate-High to High Risk Roads Segments in the Lower Hayfork Watershed

8.5 Recommendations

Moderate-High and High Risk Road Segments General Recommendations

Table 8-8 provides general recommendations for routes in the Lower Hayfork Creek watershed with a total RAP risk score of 3.0 or greater. Four different recommendations are presented, including: maintain, upgrade, decommission, and evaluate. Maintain includes activities such as cleaning out inlets and outlets of culverts and cross-drain with culverts, cleaning rolling dips and ditches, and spot-grading. Also included in this category are roads that have been decommissioned or abandoned and do not have significant erosion issues; maintain indicates that they should retain their current route status. Upgrading roads includes renovation of existing features, construction of new features, large-scale grading and placement of aggregate, combined with normal maintenance activities. Decommissioning the road includes either full road obliteration or a temporary road decommission. Evaluate includes routes that were not inventoried because they could not be located or were inaccessible due to land ownership. This recommendation suggests that USFS remove non-existent routes from database and evaluate legal access to roads that were inaccessible due to land ownership. The recommendations are based on the RAP risk score, the density and condition of the features in the 2012 SSI data set, and the road-related hydrologic connectivity to the stream network.

Table 8-8. General Recommendations for Moderate-High to High Risk Routes in the Lower Hayfork Creek Watershed

Route ID	Drainage Name	Miles	Total Risk	General Recommendation
4N47	Upper Corral Creek	4.642	4.2	Upgrade
4N45	Upper Corral Creek	0.738	4.2	Maintain
31N08A	Lower Tule Creek	0.347	4.1	Maintain
30N19	Upper Salt Creek-Hayfork Creek	3.773	4.0	Upgrade
4N09	Middle Corral Creek	3.643	4.0	Upgrade
32N11	Rusch Creek	5.613	4.0	Upgrade
4N18_2	Middle Corral Creek	0.544	4.0	Upgrade
33N20A	Upper Corral Creek	0.399	4.0	Maintain
31N42	Lower Salt Creek-Hayfork Creek	3.006	3.9	Maintain
3N46	Lower Hayfork Creek Canyon	1.801	3.9	Upgrade
U30N18D	Upper Salt Creek-Hayfork Creek	0.105	3.9	Maintain
U36TRI04	Ditch Gulch-Salt Creek	0.046	3.9	Maintain or Decommission
4N28	Middle Corral Creek	0.955	3.9	Maintain
31N42A	Kingsbury Gulch-Kellogg Gulch	0.396	3.9	Maintain
3N08	Rusch Creek	3.455	3.9	Maintain
3N40	Olsen Creek	0.786	3.9	Maintain
30N36	Ditch Gulch-Salt Creek	2.043	3.9	Upgrade
3N20A	Lower Hayfork Creek Canyon	0.981	3.9	Maintain

Table 8-8. General Recommendations for Moderate-High to High Risk Routes in the Lower Hayfork Creek Watershed

Route ID	Drainage Name	Miles	Total Risk	General Recommendation
4N47A	Upper Corral Creek	0.476	3.9	Decommission or Maintain
31N32	Philpot Creek	3.746	3.8	Upgrade
4N47E	Upper Corral Creek	1.467	3.8	Maintain
31N22	Kingsbury Gulch-Kellogg Gulch	2.613	3.8	Upgrade
4N18	Middle Corral Creek	0.808	3.8	Maintain
4N35	Upper Corral Creek	1.549	3.8	Upgrade
31N66D	Rusch Creek	1.673	3.8	Maintain
4N06	Upper Corral Creek	0.639	3.8	Maintain or Decommission
31N66B	Lower Tule Creek	1.824	3.8	Upgrade
4N29	Upper Corral Creek	6.140	3.8	Maintain
3N46	Lower Corral Creek	0.728	3.8	Maintain
31N08	Lower Tule Creek	2.697	3.7	Upgrade
3N05A	Olsen Creek	0.322	3.7	Maintain
2N28A	Rusch Creek	0.174	3.7	Upgrade
U4N05D	Middle Corral Creek	0.302	3.7	Upgrade
30N18C	Upper Salt Creek-Hayfork Creek	0.405	3.7	Maintain
4N37	Upper Corral Creek	1.599	3.7	Maintain
30N52	Lower Salt Creek-Hayfork Creek	2.185	3.7	Upgrade
32N11D	Rusch Creek	0.602	3.7	Maintain
30N16Y	Ditch Gulch-Salt Creek	0.697	3.7	Maintain
33N20	Upper Corral Creek	0.647	3.7	Maintain
4N05GHST1	Middle Corral Creek	0.014	3.7	Decommission
31N19	Lower Salt Creek-Hayfork Creek	3.027	3.6	Upgrade
30N51	Lower Salt Creek-Hayfork Creek	0.552	3.6	Maintain
30N40	Upper Salt Creek-Hayfork Creek	0.083	3.6	Maintain
4N05	Upper Corral Creek	0.020	3.6	Maintain
3N08H	Lower Tule Creek	0.000	3.6	Evaluate
3N28	Lower Hayfork Creek Canyon	0.349	3.6	Maintain
U31N22A	Kingsbury Gulch-Kellogg Gulch	0.019	3.6	Maintain
30N49	Philpot Creek	0.557	3.6	Maintain
31N48C	Lower Salt Creek-Hayfork Creek	0.412	3.6	Maintain
31N17	Kingsbury Gulch-Kellogg Gulch	0.819	3.3	Maintain

Table 8-8. General Recommendations for Moderate-High to High Risk Routes in the Lower Hayfork Creek Watershed

Route ID	Drainage Name	Miles	Total Risk	General Recommendation
U36TRI06	Ditch Gulch-Salt Creek	0.023	3.2	Maintain
U30N08	Ditch Gulch-Salt Creek	0.213	3.2	Maintain
29N55A	Ditch Gulch-Salt Creek	0.599	3.1	Decommission or Upgrade
4N49B	Middle Corral Creek	0.300	3.0	Maintain
30N18	Upper Salt Creek-Hayfork Creek	2.795	3.0	Upgrade
U30N14B	Upper Salt Creek-Hayfork Creek	0.019	3.0	Maintain
30N51A	Salt Gulch-Salt Creek	0.105	3.0	Maintain
U36TRI03B	Ditch Gulch-Salt Creek	0.043	3.0	Maintain
U30N07AD	Ditch Gulch-Salt Creek	0.102	3.0	Maintain
U30N07A	Ditch Gulch-Salt Creek	0.044	3.0	Maintain
31N64	Salt Gulch-Salt Creek	0.908	3.0	Maintain or Decommission

Specific Recommendations to Upgrade Roads

Specific recommendations are listed below for the roads listed under ‘upgrade’ in Table 8-8 and for ten additional road segments. The recommendations focus on the sections of each road that either contained a high density of high risk features or individual features that could be treated to help decrease their impacts to water resources. Locations are denoted by Route ID, mile marker, and drainage. The feature type and associated problem are also included, along with recommendations for upgrades.

Route ID: 31N64
Drainage: Salt Gulch-Salt Creek
Location: Mile Marker 0.001 – 1.2793, Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.001 -0.78	Cross-Drains	Route exists in erodible soils and is gullied to varying degrees. Existing cross-drains are ineffective.	Reshape existing cross-drains and add additional cross-drains at regular intervals to disperse road surface runoff.
0.218-0.375	Erosion Feature (Gully)	Deep gully forms in route surface. Feature is not connected but will continue to increase in size.	Grade road and install cross-drain and regular intervals appropriate for slope grade and soils.
0.78-1.284	Route Surface	Route surface has no engineered drainage structures and is eroding. Route alignment is parallel to an intermittent stream and in close proximity. Route does not lead to a specific feature.	Consider decommissioning road between MM 0.78-1.284 or at least planting vegetation and abandoning. Route could remain open above MM 0.78 for fire protection and could be connected to road TC1483 if connectivity is required.

Route ID: 30N18
Drainage: Upper Salt Creek-Hayfork Creek
Location: Mile Marker 0.086 – 1.284, Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.086-0.144	Gully	Route surface gully forms from a combination of surface runoff and spring flow then bypasses a partially functioning dip, forming a gully. Gully not connected but if gully is unmitigated it may flow into lower section of road that is connected to a ephemeral stream	Reconstruct dip at MM 0.149 and install additional dips downgrade as needed to disperse runoff. Upgrade spring at MM 0.1.59 to promote drainage off of the route surface.
0.146	Cross-Drain CMP	Partially plugged inlet with diversion potential may promote gully formation if overtopping occurs.	Clean inlet and install critical dip.
0.439	Stream Crossing CMP	Ephemeral crossing fill eroding downstream, partially plugged with woody debris, and high diversion potential. Crossing 200 feet from perennial stream.	Add rip-rap at outlet to prevent future scour and install critical dip to prevent diversion to perennial stream.
0.517	Stream Crossing CMP	Perennial stream crossing has fill loss on upstream side and has moderate diversion potential to perennial stream.	Reinforce upstream fill to limit future erosion and install critical dip to prevent diversion to perennial stream.
0.555	Stream Crossing CMP	Ephemeral stream crossing has moderate diversion potential to perennial stream.	Install critical dip to prevent diversion to perennial stream.
0.704	Connected Cross-drain	Dip connected to swale (300 ft from perennial) > 75% full with sediment. Diverts gully flow.	Clear sediment.
0.706-0.738	Gully	High erosion potential route surface gully connected to swale.	Install additional rolling dips to disperse surface runoff.
0.749	Cross-Drain	Heavy scour of rolling dip due to route surface gully.	Reshape dip and armor.
0.752-0.797	Erosion Feature (Gully)	Route surface gully with high erosion potential caused by concentrated surface flow. Gully is not currently connected to stream network, but has potential to connect with swale (via another gully) if unmitigated.	Grade road segment and add armored rolling dips as necessary for soil type and road grade.
0.851	Stream Crossing CMP	Some erosion of upstream crossing fill and aggraded channel suggests that this may be the flow source for the road gully (MM 0.752-0.797) but no clear evidence of overtopping.	Develop armored cross-drain to mitigate potential diversion potential.
1.844-2.146	Stream Crossings CMP	Multiple stream crossings have partially-plugged or slightly crushed inlets, but all are functioning. Several have diversion potential.	Clean inlets and install critical dips where appropriate. This segment has high connectivity so this measure is privative maintenance.

Route ID: 30N18 *(Continued)*
Drainage: Upper Salt Creek-Hayfork Creek
Location: Mile Marker 0.086 – 1.284, Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
2.702-2.793	Gully	Runoff from 30N18B causes surface gully, but gully persist due to partially functioning cross-drains at MM 2.752 and MM 2.793. Gullies aren't connected to stream network, but will continue to erode if no treated.	Install rolling dip on 30N18B near intersection to keep runoff off 30N18. Clean and reshape dips at MM 2.752 and MM 2.793. Install additional cross-drains as required by road grade.

Route ID: 29N55A
Drainage: Ditch Gulch-Salt Creek
Location: Mile Marker 0.001 – 0.575, Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.001-0.113	Erosion Feature (Gully)	Highly erodible road surface gully caused by road surface runoff. Some flow is diverted to a swale at a cross-drain (MM 0.03) the remaining flow persists and continues down on to the 29N55.	Grade road segment. Reconstruct and armor rolling dip at MM 0.03 and MM 0.113. Install additional armored rolling dips as required for road grade and soil type.
0.234-0.332	Gully	Significant road gully directly connected to an intermittent stream. Gully caused by ruts, concentrated road runoff, a partially functional cross-drain at MM 0.301, and spring flow at MM 0.271.	Grade road segment and install rolling dips at intervals as required for road grade and soil type. Construct rolling dip downgrade of spring (MM 0.271). Construct trench with aggregate (French-drain) to drain road prism.
0.489-0.565	Erosion Feature (Gully)	Significant road gully directly connected to an ephemeral stream. Road gully is functioning as an ephemeral streambed.	Grade road segment and install rolling dips at intervals as required for road grade and soil type. Remove large downed tree.
0.0001-0.575	Route Surface	To remain open for vehicle access, the entire route will need to be graded and armored cross-drains will need to be installed at frequent intervals. This route provides access to Dubakella Mountain summit, but U29N55A also provides access. Recommend only one access route.	Consider decommissioning this route and improving U2955A for access to Dubakella Mountain Summit.

Route ID: 2N28A
Drainage: Rusch Creek
Location: Mile Marker 0.169 , Clear Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.169	Erosion Feature (Stream Bank Erosion)	Ephemeral/Intermittent stream cutting though existing road prism due to lack of engineered structure. Crossing directly connected to Rusch Creek approximately 150 feet downslope.	Construct armored drainage structure (Ford or wide rolling dip) with rip-rap at the outlet.

Route ID: 31N19
Drainage: Lower Salt Creek-Hayfork Creek
Location: Mile Marker 0.195 – 2.972, Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.195	Connected CMP Cross-drain	Cross-drain is partially plugged, has evidence of overtopping, and has diversion potential to a hydrologically connected ditch. Structure is connected to perennial stream.	Clear inlet and install critical dip to prevent future road diversion.
0.195-1.362	Drainage Structures with CMP (Stream Crossings & Cross-Drains)	This segment is highly connected to the stream network and most structures have varying degrees of diversion potential.	Install a critical dip at each drainage structure to prevent diversion in case of potential flow diversion.
2.031,2.062, 2.169, 2.22, 2.559, 2.66, 2.775, 2.804, 2.972	Cross-Drains	This section of road has numerous cross-drains to divert surface runoff and prevent route surface erosion. The listed cross-drains are non-functional, partially-functioning, or are eroding road fill at the outlet.	Reshape or reconstruct cross-drains to prevent erosion of the route surface. Install rip-rap or OSD at outlets as needed to prevent erosion of road fill. This recommendation is intended to be preventative maintenance and to maintain vehicle access.
2.835	Erosion Feature (Gully)	Route surface gully forms and drains off the road prism causing erosion.	Install rolling dip and armor outlet to prevent fill erosion. Feature not connected. The recommended action is for preventative maintenance.
2.972	Erosion Feature (Gully)	Route surface gully forms and drains off the road prism causing erosion.	Install rolling dip and armor outlet to prevent fill erosion. . Feature not connected. The recommended action is for preventative maintenance.

Route ID: U4N05D
Drainage: Middle Corral Creek
Location: Mile Marker 0.001 – 0.195, Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.001-0.195	Erosion Feature (Gully)	Highly erodible gully that is 1,000 feet long and connected to Corral Creek. Gully forms due to two non-functioning cross-drains and lack of additional road drainage features.	Grade road segment. Repair existing rolling dips. Install frequent rolling dips or road drainage structures to dissipate road surface runoff.
0.001-0.195	Gully	Highly erodible gully forms due to four non-functioning cross-drains. Gully is not connected but compromises access and has potential to erode further.	Grade road segment. Repair existing rolling dips. Install frequent rolling dips or road drainage structures to dissipate road surface runoff.

Route ID: 30N52
Drainage: Lower Salt Creek-Hayfork Creek
Location: Mile Marker 0.171 – 1.148, Clear Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.171	Connected Cross-Drain CMP	Structure has diversion potential to road that could connect with existing route surface gully that is connected to intermittent stream.	Install critical dip.
0.195	Connected Cross-Drain	Cross-drain erodes road fill at outlet and is connected to an intermittent stream.	Install OSD or rip-rap at outlet to mitigate further erosion of road fill.
0.201	Erosion Feature (Gully)	Route surface gully connected to intermittent stream. Gully caused by lack of road drainage. A large berm exists on the outer edge or road; almost a through-cut.	Demolish berm and remove material from site. Grade road segment and out slope if possible. Install rolling dip(s) with outlet protection.
0.221-0.25	Gully	Route surface gully is connected to intermittent stream. Concentrated road runoff forms gully.	Install rolling dips with outlet protection.
0.262	Connected Cross-Drain CMP	Structure has diversion potential to road that could connect with existing route surface gully that is connected to intermittent stream.	Install critical dip.
0.437-0.48	Gully	Route surface gully is connected to intermittent stream. Concentrated road runoff forms gully.	Install rolling dips with outlet protection.
0.497	Connected Cross-Drain CMP	Structure has diversion potential to road that could connect with existing route surface gully that is connected to intermittent stream.	Install critical dip.
0.713-0.816	Gully	Route surface gully is connected to intermittent stream. Concentrated road runoff forms gully due to lack of cross drains.	Install critical dips at CMP cross-drains (MM 0.745 and MM 0.783) and reshape the cross drain at MM 0.8.
1.026	Cross-Drain CMP	Structure has diversion potential and is partially plugged at inlet. Field data indicates no connectivity, but air photo indicates intermittent/ephemeral stream 100 feet from structure.	Clean inlet and install critical dip.
1.028-1.148	Gully	Concentrated road runoff forms gully due to three non-functioning cross-drains (MM 1.036, MM 1.074, MM1.1). Field data indicates no connectivity, but air photo indicates intermittent/ephemeral stream 100 feet from the road.	Reshape existing dips and related infrastructure. Install additional dip between MM 1.1 and MM 1.148.

Route ID: 31N08
Drainage: Lower Tule Creek
Location: Mile Marker 0.305 – 1.894, Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.11	Connected Cross-Drain CMP	Inlet and outlet partially plugged by road fill.	Clear inlet & outlet.
0.178	Connected Cross-Drain	Feature storage nearly full because of high volume of road runoff. Direct delivery of sediment to perennial stream.	Clean and shape dip. Install rolling dips upgrade to dissipate road runoff. Armor outlets with rip-rap to prevent road fill erosion.
0.305	Gully	Runoff from 31N08E delivers sediment to route and continues to a perennial fork of Tule Creek.	Repair existing cross-drains on 31N08E (MM 0.001-0.292) and install additional dip near the intersection.
0.338-0.827	Route Surface	Existing cross-drains are scoured and road surface eroded near diversion point.	Install additional rolling dips, repair and armor existing structures.
0.9241-0.961	Gully	Gullies form in ruts. Ponds at cross-drain (MM 0.924) and erodes outlet. Flow continues through road on slope below and is connected to West Tule Creek.	Repair and armor existing rolling dip (MM 0.924). Grade gully segment and install additional armored rolling dip.
1.152	Cross-Drain CMP	Inlet aggraded from road gully deposition of sediment. Feature conveys swale but most flow is from route gully.	Clean Inlet.
1.1522-1.204	Gully	Small road gullies deposit sediment at a CMP cross-drain inlet.	Install rolling dips upgrade to dissipate surface flow.
1.204	Erosion Feature (Gully)	Unauthorized OHV trail directly up a swale. Mechanical action deposits sediment on road. Not much concentrated flow.	Place boulders to deter further use and to retain sediment.
1.532-1.6	Gully	Route surface gully forms due to non-functioning cross-drain. Connected to swale.	Reconstruct and armor existing cross-drain (MM1.579) and install additional cross-drain down grade.
1.7839-1.825	Gully	Route surface gully forms and connected to swale.	Reconstruct and armor existing cross-drain (MM1.784).
1.841-1.894	Erosion Feature (Gully)	A series of gullies from in the road fillslope due to runoff from road surface gully. If not mitigated, could eventually compromise access. Feature is connected to swale.	Construct armored rolling dips at current outlets of road surface gully. Install additional rolling dips upgrade as requires for grade and soil type.

Route ID: 31N66B
Drainage: Lower Tule Creek
Location: Mile Marker 1.14 – 1.6992, Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
1.14	Stream Crossing CMP	Inlet and outlet of ephemeral stream crossing partially plugged.	Clean inlet
1.265	Stream Crossing CMP	Inlet of ephemeral stream crossing partially plugged.	Clean inlet.
1.64	Stream Crossing CMP	Inlet of perennial stream crossing partially plugged by sediment lobe from hillslope debris at inlet; restricts flow through CMP. Large sediment slug at outlet; flow goes subsurface.	Clean inlet of CMP. Consider clearing outlet as to not restrict flow through CMP.
1.6992	Stream Crossing CMP	Fillslope erosion on downstream side of road prism deposited sediment lobe at outlet. Fillslope still eroding and somewhat unstable. Spring flow at crossing and connects to perennial stream. Some transport of sediment.	Install large rip-rap at base of fillslope near outlet to provide support. Establish vegetation on fillslope to decrease further erosion.

Route ID: 4N35
Drainage: Upper Corral Creek
Location: Mile Marker 1.2, Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
1.2	Stream Crossing (CMP)	Ephemeral stream crossing that is partially-plugged and has evidence of overtopping. CMP is rusted through and does not convey all streamflow and fill is eroding on the downstream side.	Resize and replace CMP.

Route ID: 31N22
Drainage: Kingsbury Gulch-Kellogg Gulch
Location: Mile Marker 0.164 – 1.97 , Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.164 – 0.661	Connected Cross-Drains	Cross-drains are connected to perennial stream and most have diminished capacity or functionality.	Reshape, reconstruct, and armor as necessary..
0.704	Stream Crossing Ford	Low-water ford of intermittent stream. Ford conveys some stream flow but most flow is diverted onto road and flows 240 feet to cross-drain at MM 0.661.	Install CMP and critical dip at crossing or improve ford to prevent diversion.
1.21	Stream Crossing Ford	Low-water ford of intermittent stream. Ford conveys some stream flow but most flow is diverted onto road and flows 100 feet to cross-drain at MM 1.163.	Install CMP and critical dip at crossing or improve ford to prevent diversion.

Route ID: 31N22 *(Continued)*
Drainage: Kingsbury Gulch-Kellogg Gulch
Location: Mile Marker 0.164 – 1.97 , Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
1.238	Stream Crossing Ford	Low-water ford of intermittent stream. Ford conveys some stream flow but most flow is diverted onto road and flows 100 feet perennial stream	Install CMP and critical dip at crossing or improve ford to prevent diversion.
1.503-1.583	Gully	Route surface gully connected to intermittent stream. Gully forms from concentrated road runoff.	Install 2-3 rolling dips.
1.617-1.669	Gully	Route surface gully connected to intermittent stream. Gully forms from concentrated road runoff.	Install 2 rolling dips.
1.6981-1.711	Gully	Route surface gully connected to intermittent stream. Gully forms from concentrated road runoff.	Repair rolling dip at MM 1.709 and install one additional rolling dip.
1.937	Erosion Feature (Gully)	Road surface runoff drains off of road and erodes fill and hillslope below. Connected to swale.	Develop existing outlet as armored rolling dip and install an additional dip up grade.
1.97	Stream Crossing Ford	Intermittent low-water ford badly eroded.	Reconstruct ford and install critical dip or install CMP with critical dip.

Route ID: 30N36
Drainage: Ditch Gulch-Salt Creek
Location: Mile Marker 0.12 – 1.023, Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.12-0.197	Gully	Route surface gully forms due lack of route drainage. Gully connected to perennial stream.	Install rolling dips on route segment. Install critical dip at connected cross-drain CMP (MM 0.182) to also serve as cross-drain for drainage.
0.879	Connected Cross-Drain	Dip partially-functioning; flattened and breached.	Repair dip.
0.89	Stream Crossing CMP	Downstream fillslope erosion due to route surface gully draining at crossing. Moderate diversion potential. Ephemeral streamflow.	Add rip rap to fillslope gully for stability and to prevent further erosion. Install rolling dips to upgrade route segment with gully (MM 0.891-1.023)
0.891-1.023	Gully	Route surface gully drains at ephemeral crossing and erodes fill.	Install rolling dips at appropriate intervals for road grade and soils. Install rolling dip near crossing to divert flow away from crossing. Clean plugged ditch (MM 0.895-0.954) to mitigate potential for diversion to route.

Route ID: 31N32
Drainage: Philpot Creek
Location: Mile Marker 4.013 – 6.243, Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
4.013	Connected Cross-Drain CMP	Inlet partially plugged with rocky bedload site has high diversion potential to perennial stream.	Clean inlet and install critical dip.
4.046	Connected Cross-Drain CMP	Structure drains swale but has high diversion potential to perennial stream at cross-drain at MM 4.013.	Install critical dip to prevent diversion to perennial stream.
4.157	Cross-Drain CMP	Partially plugged CMP with diversion potential to plugged ditch or cross-drain CMP that is connected to swale.	Clear inlet and install critical dip.
4.171-4.216	Ditch	Plugged ditch connected to swale.	Clean ditch to prevent diversion to road.
4.615-4.703	Ditch	Plugged ditch connected to intermittent stream through a connected cross-drain CMP (MM 4.708) that has high diversion potential to intermittent stream.	Clean ditch to prevent diversion to road; would flow to intermittent stream crossing.
4.667	Erosion Feature (Gully)	Route surface runoff and possibly diverted ditch flow drain off the route surface and form gully in highly erodible fillslope and hillslope below.	Develop existing drain point into a rolling dip and armor outlet and gully cavity with rip-rap to prevent future erosion.
4.708	Connected Cross-Drain CMP	Structure has high diversion potential directly to intermittent stream	Install critical dip.
4.74	Connected Cross-Drain	Non-functional dip that would drain existing route surface gully if functional.	Rehabilitate existing structure.
5.035	Connected Cross-Drain CMP	Structure is partially plugged and high diversion potential directly to perennial stream crossing (MM 4.963). Structure drains ditch.	Clean inlet and install critical dip to prevent diversion to perennial stream.
5.229, 5.307,	Connected Cross-Drains CMP	Both structures are functional, have bedload restricting inlet flow, and have diversion potential to perennial stream crossing. Structures drain ditch.	Clear inlets and install critical dips. Critical dips would also act as route surface drainage structures.
5.14-5.334	Ditch	Ditch is plugged and connected to perennial stream.	Clear ditch to prevent diversion to route.
5.458	Erosion Feature (Gully)	Gully forms in fillslope and hillside below road prism and is connected to perennial stream. Flow for feature comes from route surface gully (MM 5.459-5.516).	Develop existing drain point into a rolling dip and armor outlet and gully cavity with rip-rap to prevent future erosion. Also, install dips on route surface to disperse up route surface gully.
5.563	Erosion Feature (Gully)	Gully forms in fillslope and hillside below road prism and is connected to perennial stream. Flow for feature comes from route surface gully.	Develop existing drain point into a rolling dip and armor outlet and gully cavity with rip-rap to prevent future erosion. Also, install dips on route disperse route surface gully.

Route ID: 31N32 *(Continued)*
Drainage: Philpot Creek
Location: Mile Marker 4.013 – 6.243, Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
5.575	Connected Cross-Drain CMP	Inlet partially-plugged with rocks. Structure drains ditch and has high diversion potential to perennial stream.	Clear Inlet and install critical dip.
5.681-5.756	Erosion Feature (Gully)	Route surface gully exits road at MM 5.681 and forms a gully in fillslope and hillslope; connects to Intermittent/ephemeral stream.	Develop existing drain point into a rolling dip and armor outlet and gully cavity with rip-rap to prevent future erosion. Also, install dips on route disperse route surface gully.
5.781-5.866	Erosion Feature (Gully)	Route surface gully exits road at MM 5.781. OSD undercut and persists in fillslope and hillslope; connects to Intermittent/ephemeral stream.	Develop existing drain point into a rolling dip and armor outlet and gully cavity with rip-rap to prevent future erosion. Also, install dips on route disperse route surface gully
5.872- 6.241	Gully	Two non-connected route surface gullies form in this segment. If surface gully flow persists, could become connected and compromise access.	Install critical dips at Cross-Drain CMP's (MM 5.951, 6.025, 6.123) to disperse surface flow and mitigate diversion potential. Install rolling dips as necessary for grade and soil type.
4.013-6.243	Ditches	High density of ditch drainage on this segment with high connectivity. Segments of the ditches are plugged. Evaluate and clean ditches	Evaluate and clean ditches when conducting upgrade or maintenance activity.

Route ID: 3N46
Drainage: Ditch Gulch-Salt Creek
Location: Mile Marker 1.224 – 1.387, Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
1.224-1.31	Gully	Route surface gully forms due to lack of drainage. Gully connected to Hayfork Creek. Gully is highly erodible.	Install rolling dips with erosion protection on outlet. Repair dip at MM 1.31
1.359-1.387	Gully	Route surface gully has direct delivery to Hayfork Creek.	Install rolling dips with erosion protection on outlet. Possibly add aggregate top road surface.

Route ID: 4N18_2
Drainage: Middle Corral Creek
Location: Mile Marker 0.411 – 0.524, Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.411	Stream Crossing CMP	Inlet and outlet are more than 50% plugged with bedload (fine gravel). Inlet poorly aligned with large sediment lobe. Inlet headwalls armored with Sackcrete. CMP likely undersized.	Clean inlet and outlet. Evaluate CMP size. Potentially install rocked critical dip to accommodate flow in case of failure.
0.422-0.524	Gully	Route surface gully forms due to non-functioning cross-drain and lack of road drainage. Gully connected to Hyampom Creek.	Repair existing rolling dip and install additional rolling dips to provide surface runoff drainage.

Route ID: 32N11
Drainage: Rusch Creek
Location: Mile Marker 0.971 – 0., Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.971	Connected Cross-Drain	Structure drains ephemeral drainage. Eroding road fill and actively moving sediment.	Install CMP or develop as an armored ford.
2.052-2.133	Gully	Two route surface gullies form due to lack of drainage. Both gullies drain at cross-drains and scour feature and outlet. Gullies not connected (350 feet to Rusch creek), but have high erosion potential.	Armor outlets of existing cross-drains. Install an additional cross drain on each gully segment.
2.581	Stream Crossing CMP	Intermittent stream crossing has diversion potential to perennial stream crossing.	Install critical dip.
4.22	Erosion Feature (Gully)	Road runoff drains off the side of road and forms a gully in road fill. Gully connected to Rusch Creek	Install dip on road upgrade of feature to divert some flow from the feature. Armor outlet of feature to disperse scour action of remaining flow.
4.436-4.41	Gully	Route surface gully directly connected to Rusch Creek.	Install rolling dip with armored outlet and/or add aggregate to route surface.
5.48 – 5.681	Gully	Route surface gully forms due to lack of drainage structure. Connected to Hayfork Creek.	Install multiple rolling dips with armoring at outlet and/or add aggregate to route surface.

Route ID: 30N19
Drainage: Upper Salt Creek-Hayfork Creek
Location: Mile Marker 0.293 – 3.224., Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.293-0.323	Gully	Route gully forms from concentrated surface runoff. Gully directly connected to perennial stream.	Install multiple rolling dips on segment to disperse road runoff.
0.363-0.395	Gully	Route gully forms from concentrated surface runoff. Gully connected to perennial stream.	Install rolling dip on segment to disperse road runoff.
1.312-1.356	Gully	Route gully forms from concentrated surface runoff and spring flow. Gully connected to Salt Creek.	Repair existing dip (MM 1.311) and install additional dip near spring.
1.373	Spring	Spring flow creates gully in route and contributes to route surface gully down grade.	Construct dip to drain spring flow.
1.42	Connected Cross-Drain	Dip aggraded and is directly connected to Slat Creek.	Clear aggregates and reshape structure.
1.512-1.534	Gully	Route gully forms from concentrated surface runoff. Gully connected to perennial stream.	Install rolling dip on segment to disperse road runoff.
1.567-1.87	Gullies	Multiple non-connected gully segments form on this segment of road. Failure of existing cross-drain may cause smaller segments to join; increasing erosion potential.	Maintain existing cross-drains and grade road as necessary. Install additional dips and spot rock as necessary.
3.089, 3.115	Connected Cross-Drains	Cross-drains erode fillslope at outlet.	Add OSD to prevent erosion of road fill.
3.116-3.224	Gully	Route gully forms from concentrated surface runoff. Gully connected to perennial stream.	Install critical dips at existing CMP cross-drains. Critical dips sever as route drainage and to prevent diversion potential.

Route ID: 4N09
Drainage: Middle Corral Creek
Location: Mile Marker 0.113 – 1.011., Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.113	Stream Crossing CMP	Alder growing at CMP inlet. Reduces conveyance capacity. Sediment lobe at inlet. Perennial stream.	Remove alder.
0.138-0.201	Gully	Route surface gully connected to perennial stream.	Repair dip at MM 0.18 and install additional rolling dip on section.
0.231-0.275	Ditch	Ditch erodes hillslope and part of route. Active sediment transport and deposition. Ditch connected to ephemeral stream at CMP cross-drain	Clear ditch and add grade control (small rip-rap) structures to stabilize grade and provide temporary storage.
0.25	Erosion Feature (Gully)	Route surface is heavily rutted and compacted due to lack of drainage.	Install drainage structure (dip) to drain surface. Add aggregate to route surface.

Route ID: 4N09 *(Continued)*
Drainage: Middle Corral Creek
Location: Mile Marker 0.113 – 1.011., Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.401-0.46	Gully	Multiple gullies form in ruts and are connected to ephemeral stream. Ruts caused by driving on surface when saturated. Soils are very erodible.	Install rolling dip to divert surface flow. Add coarse aggregate to route surface.
1.011	Stream Crossing (Bridge)	Fillslope for bridge eroding. Old CMP in stream.	Add rip-rap to fill slope to stabilize and to minimize erosion.

Route ID: 4N47
Drainage: Upper Salt Creek-Hayfork Creek
Location: Mile Marker 0.002 – 4.658., Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.7831	Stream Crossing CMP	Inlet of ephemeral crossing completely buried by sediment (possible slide upstream of inlet).	Clear inlet.
0.996	Erosion Feature (Gully)	Route surface gully from TC445 connects to ditch on 4N47. Ditch has some connectivity with a perennial stream.	Repair berm on TC445 and add additional cross-drains.
1.2671	Erosion Feature (Gully)	Fillslope eroding from surface runoff. Compromising chip surface.	Add rip-rap to gully to prevent further erosion of fill.
2.244	Stream Crossing CMP	Ephemeral stream crossing. Multiple stream crossings on roads above structure. Head cut on channel above inlet. Scour underneath base of CMP; evidence that not all flow goes through pipe.	Upgrade inlet to prevent further scour under CMP.
2.244	Stream Crossing CMP	Perennial stream crossing. CMP has small hole at inlet and some flow conveyed through it.	Upgrade inlet to seal hole and prevent flow from saturating road fill.
2.361-2.44	Ditch	Evidence of sediment deposition near perennial stream.	Install grade control structures in ditch for temporary sediment storage.
2.503	Cross-Drain CMP	CMP is 40% full with sediment throughout and diversion potential.	Evaluate CMP size and grade.
2.664	Stream Crossing CMP	Inlet of ephemeral crossing partially plugged with bedload. Crossing has evidence of overtopping.	Clear inlet and evaluate CMP size.
2.764	Stream Crossing CMP	Upstream fillslope of perennial crossing eroding from surface runoff from 4N30.	Install cross-drain on 4N30 to limit runoff to crossing. Add rip rap to crossing fillslope for stability.
3.0681-3.253	Ditch	Ditch is plugged and diverts onto road and damages asphalt.	Clear ditch.

Route ID: 4N47 *(Continued)*
Drainage: Upper Salt Creek-Hayfork Creek
Location: Mile Marker 0.002 – 4.658., Lower Hayfork Creek Watershed

Mile Marker	Feature Type	Problem	Recommendation
3.325-3.408	Ditch	Ditch is plugged and diverts onto road and damages asphalt.	Clear ditch.
3.905-3.99	Ditch	Ditch is plugged and deposits sediment in riparian reserve; only connected at high flow.	Clear ditch.
3.98	Connected Cross-Drain	Critical dip and OSD partially filled with aggregates. Connected to perennial stream.	Clear aggregates and OSD.
4.289	Stream Crossing CMP	Perennial stream crossing has heavy vegetation growth and dead wood at inlet. High plug potential.	Clear vegetation at inlet to prevent plugging.
4.4281	Stream Crossing CMP	Inlet has sediment accumulation reducing capacity by 35%. Ephemeral stream.	Clear inlet basin.
0.0002-4.658	Ditches	Route surface drainage relies heavily on ditch drainage. When ditches become plugged, they divert onto to route and erode asphalt surface.	Evaluate ditches for cleaning when conducting any work.

Additional Features

Feature Type	Mile Marker	Route ID	Problem	Recommendations
Erosion Feature (Debris Flow)	0.333	30N27	Recent landslide above route slid on route and restricts road width. Not connected.	Remove slide material. Add boulders to toe for shear strength.
Erosion Feature (Gully) & Stream Crossing CMP	0.655-0.675	30N07	Crossing failure. Road prism completely obliterated. Huge gully formed in channel. Big failure.	Remove existing road fill and rehabilitate channel back to stable grade. Decommission road past crossing. Ephemeral channel but large sediment source; high priority.
Erosion Feature (Gully)	0.134	31N39	Highly eroded route surface gully that compromises access.	Grade road and install frequent armored rolling dips. Add aggregate to route surface.
Stream Crossing CMP	1.576	30N26	Inlet plugged, headwall eroded, evidence of overtopping, and diversion potential.	Clear inlet, reinforce fillslope, and clear inlet. May need to be replaced. High failure potential.
Stream Crossing CMP	7.801	4N47	Debris flow buried inlet. Subsequent flow scoured out deposits. Plug potential very high.	Clear inlet and debris from slide.
Stream Crossing Ford	0.136	30N45A	Site developed as cross-drain but actually ephemeral stream crossing. Significant erosion of road fill from ephemeral flow.	Develop crossing as an armored ford or install CMP for drainage.
Stream Crossing Ford	0.263	30N24	Significant fill loss at intermittent crossing.	Install CMP.
Connected Cross-Drain CMP	8.8211	4N47	Inlet completely buried by debris flow. All flow diverts to road or ditch and connects to swale/ephemeral.	Clear debris from inlet.
Spring	2.636	3N01	Long gully created by heavy spring flow. Flow enters ditch and then breaches ditch at Cross-Drain CMP (MM 2.679). Connected to Intermittent stream.	Install perforated CMP at near spring source. Repair ditch and clean cross-drain inlet.
Gully	4.661-4.929	33N68	Long highly erodible gully that forms two erosion features. Not connected but compromises route access.	Install frequent cross-drains with armored outlets.
Gully	0.01-0.696	3N22E	3,600-foot gully or poorly constructed outboard ditch. Not connected to stream network.	Install cross drains for drainage or improve ditch.

Section 9 Lower South Fork Trinity

9.1 9.1 Introduction

The Lower South Fork Trinity Watershed is approximately 49,267 acres in size and is part of the larger, encompassing South Fork Trinity River Sub-Basin and Klamath Basin. The South Fork Trinity River is the largest undammed river in California (U.S. Environmental Protection Agency 1998). It flows steeply from its headwaters in the North Yolla Bolly Mountains northwest towards the Hyampom Valley, where it meets up with Hayfork Creek. From this confluence, it flows at a moderate gradient in a confined canyon, towards the Trinity River and then to the Klamath River. The watershed includes tributaries that drain directly into the Lower South Fork Trinity River from the confluence with Hayfork Creek, downstream to the mainstem Trinity River.

The watershed varies from rugged ridges and mountains to foothills to the Hyampom valley floor. The upper section of the watershed is located in the Hyampom Valley and consists of farmlands, with short steep tributaries running off the ridges. Downstream of Hyampom Valley, the Lower South Fork Trinity River steepens and runs through a confined canyon. Ridge top elevations range between 5,000 and 6,000 feet along the western edge of the watershed. The Lower South Fork Trinity River drops approximately 800 feet from the confluence with Hayfork Creek to the confluence with the mainstem Trinity River; from approximately 1250 feet to 450 feet. The vegetation in the mountainous areas of the watershed is dominated by the Klamath Mixed Conifer, while Montane Chaparral and Mixed Chaparral vegetation occur at all elevations in the watershed, and Annual grasslands and pastures occur in the valley floors (Farber 1998).

The watershed lies within the Klamath Mountain range, where the climatic conditions are characterized by warm, dry summer, and cool, wet winters. The majority of the precipitation falls between October and April. Temperatures and precipitation vary greatly in the watershed with the elevation differences. Average annual precipitation amounts in the watershed range from 45 inches in the lower elevations near the South Fork Trinity River to 85 inches in the mountains (Natural Resources Conservation Service, 1998).

9.2 Overview

For this effort, five subwatersheds (HUC 6) and seven drainages (HUC 7)[3] were delineated for the purposes of the SSI and RAP efforts. Table 9-1 characterizes the hierarchy for the five subwatersheds, including, Eltapom, Grouse Creek, Hyampom, Lower South Fork Trinity River, and Madden Creek. Figure 9-1 illustrates the location of these subwatersheds, drainages and the respective road segments. As shown in Figure 9-1 and Table 9-1, the 2012 SSI focused on the Eltapom Creek subwatershed, with less effort in Hyampom subwatershed and minimal effort in the Grouse Creek and Lower South Fork Trinity River subwatersheds, and no effort Madden Creek subwatershed.

[3] Seven drainages were delineated within the STNF; drainages outside of the STNF were not delineated.

Table 9-1. Lower South Fork Trinity River Watershed Characteristics

Subwatersheds (HUC 6)	Drainage Area (mi^2)	Total Road Length (mi)	Road Density (mi/mi^2)	Past SSI Road Miles	2012 SSI Road Miles	Total SSI Road Miles
Eltapom Creek	19.7	69.5	3.5	9.1	45.2	53.3
Grouse Creek	56.7	48.1	0.8	0.0	1.5	1.5
Hyampom	57.3	200.7	3.5	1.2	4.5	5.7
Lower South Fork Trinity River	45.0	103.6	2.3	0.0	1	1
Madden Creek	23.2	4.5	0.2	0.0	0.0	0
Watershed Totals	**201.8**	**426.4**	**2.1**	**9.3**	**52.2**	**61.5**

As shown in Table 9-1, the project GIS data indicates there are 201.8 miles of road in the watershed and a road density of 2.1 miles of road per square mile of watershed. The majority of SSI miles were located in Hyampom subwatershed, with about 25 percent as many in the Eltapom Creek subwatershed. Only one mile of road was inventoried in the Lower South Fork Trinity River subwatershed and 1.5 miles in the Grouse Creek subwatershed.

The Hyampom subwatershed has nearly 3 times the road mileage as Eltapom Creek, with 200.7 miles, compared to 69.5 miles. However, both Eltapom Creek and Hyampom subwatershed have a road density of 3.5 miles of road per square mile. Both of these subwatersheds have much higher road densities than the remaining three subwatersheds within the Lower South Fork Trinity River watershed.

Hydrology

The watershed contains approximately 844.1 miles of stream channels with a stream density of 4.2 miles per square mile (Table 9-2). Approximately 28 percent of the streams are perennial in nature; Grouse Creek and Madden Creek are some of the largest perennial streams in terms of drainage area.

Hyampom is the largest subwatershed within the Lower South Fork Trinity River watershed, it has the most stream miles and the highest stream density; 239.2 miles of stream with a density of 4.2 miles of stream per square mile (Table 9-2). Approximately 40 percent of the streams in this subwatershed are perennial in nature. There are five drainages nested within the Hyampom subwatershed, including, Grapevine, Big Slide Creek, Big Creek, Hyampom Valley, and Pelletreau Creek (Figure 9-1).

Eltapom Creek subwatershed is the smallest subwatershed in the Lower South Fork Trinity River watershed; there are approximately 72.3 miles of stream with a stream density of 3.7 miles of stream per square mile (Table 9-2). Similar to Hyampom Creek subwatershed, approximately 41 percent of the streams are perennial in nature. There are two drainages nested within the Eltapom Creek subwatershed, including, Lower and Upper Eltapom Creek (Figure 9-1).

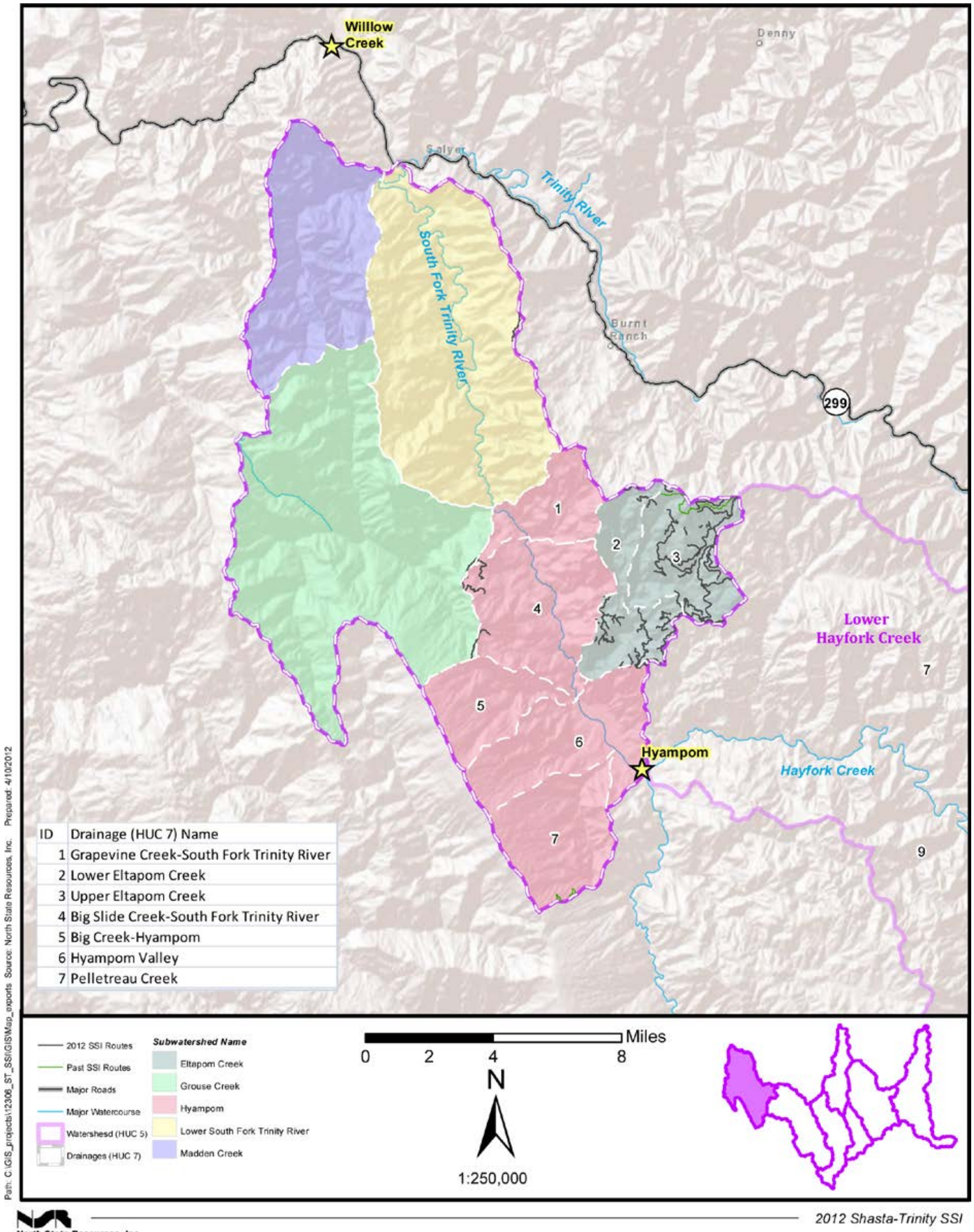


Figure 9-1. Lower South Fork Trinity River Watershed Location

Table 9-2. Lower South Fork Trinity River Watershed Streams Densities and Fish Bearing Lengths

Subwatersheds (HUC 6)	Stream Length (mi)	Stream Density (mi/ (mi^2))	Miles of Perennial Stream	Perennial Streams as % of Total Miles	Miles of Fish-Bearing Streams	Fish-Bearing Streams as % of Total Miles
Eltapom Creek	72.3	3.7	29.4	40.7%	29.0	40.2%
Grouse Creek	227.7	4.0	54.1	23.8%	53.8	23.6%
Hyampom	239.2	4.2	96.6	40.4%	89.9	37.6%
Lower South Fork Trinity River	199.1	4.4	32.8	16.5%	32.3	16.2%
Madden Creek	105.8	4.6	22.9	21.6%	22.9	21.6%
Watershed Totals	844.1	4.2	235.8	27.9%	228.0	27.0%

Water Quality

The South Fork Trinity River, including tributaries such as Hayfork Creek is included on California's CWA Section 303(d) list as water quality limited due to sediment (Environmental Protection Agency 1998). The sediment impairment resulted in non-attainment of designated beneficial uses, primarily the cold water fishery. A total minimum daily load (TMDL) for sediment, with numeric targets, was prepared for the South Fork Trinity River and Hayfork Creek in 1998. The water quality objectives addressed in the TMDL include settleable material and sediment (Environmental Protection Agency 1998). The Lower South Fork Trinity River sub-basin has a much higher estimated sediment delivery rate (per-unit-area basis) than the Upper South Fork Trinity River and Hayfork Creek sub-basins; nearly twice the rate of the Upper South Fork and nearly seven times the rate for the Hayfork Creek sub-basin. The high sediment delivery rate is mainly due to the highly erodible geology in four of the five subwatersheds in the Lower South Fork Trinity River subwatershed. The dominant source of sediment delivery in the Lower South Fork Trinity River sub-basin is mass wasting from non-management sources (e.g. natural landslides) followed by mass wasting from roads (Environmental Protection Agency 1998).

The 303(d) listing for the South Fork Trinity River and Hayfork Creek was updated to include temperature impairment in 1998, but to date a TMDL has not been developed (Environmental Protection Agency 1998). A number of monitoring efforts have documented that high water temperatures occur during low-flow conditions in the Lower South Fork Trinity River, likely as a result of water diversions, loss of riparian vegetation, natural conditions, and excess sedimentation.

Aquatic and Riparian Habitat

The South Fork Trinity was once a major producer of Coho salmon, spring and fall Chinook salmon, and steelhead. Historically, large numbers of anadromous fish used to spawn in the South Fork Trinity River and its tributaries, however, natural and anthropogenic disturbances have reduced spawning habitat substantially. The December 1964 flood triggered mass wasting events, which resulted in negative channel altercations, including, sedimentation, filling in of rearing pools, and channel aggradation. In addition to the flood events, surface erosion from poor land use practices, specifically improperly designed and maintained roads and timber harvest have accelerated erosion.

Sediment and high water temperatures have negatively impacted the anadromous fish habitat. There are signs of habitat improvement, including increases in the Chinook salmon spawning run (Environmental Protection Agency 1998).

Steelhead, chinook, and potential coho habitat is present in the Lower South Fork Trinity River watershed. Annual surveys are conducted to identify spatial distribution and abundance trends in holding and spawning adult fish (Chilcote 2012). Steelhead are found in the tributaries of the Hyampom Valley, Hayfork Creek drainages and the East Fork of the South Fork Trinity River. Spring Chinook utilize the South Fork Trinity River upstream of Grouse Creek to the confluence with the East Fork, while Fall Chinook are observed from the mouth to the Hyampom Gorge. Coho are rarely observed but have been found in the lower to middle South Fork Trinity River (Environmental Protection Agency 1998). The Southern Oregon Northern California Coastal Coho salmon have been listed as threatened under the Endangered Species Act.

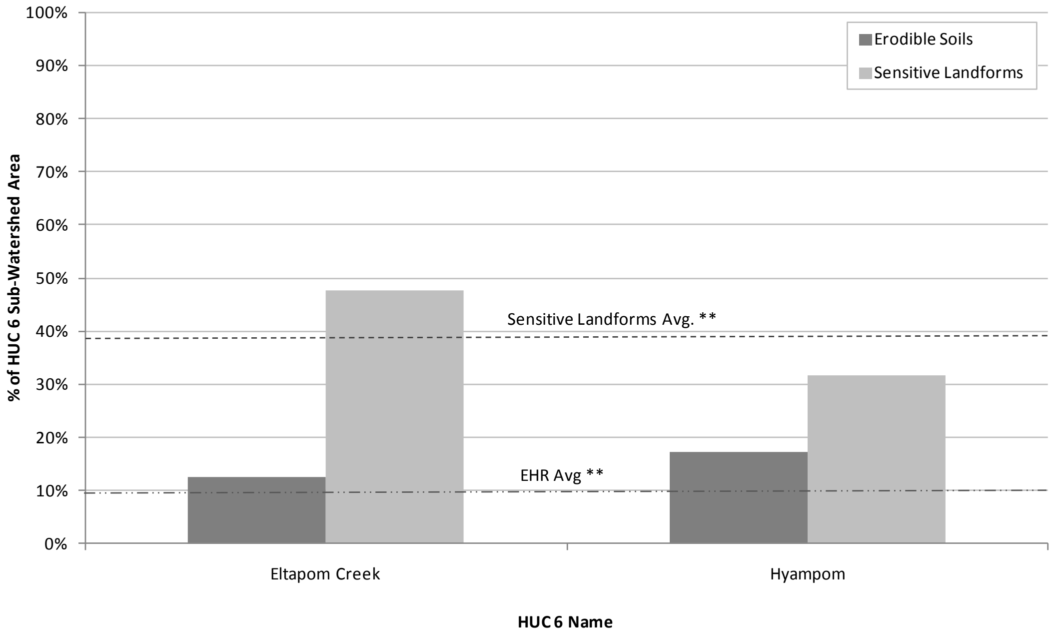
Geology

The geologic belts of the Klamath Mountains within the Lower South Fork Trinity River watershed are aligned roughly northwest to southeast with the South Fork Mountain Thrust, which roughly divides the watershed into halves. The eastern half includes STNF lands. The diamictite and serpentine of the Rattlesnake Terrane occupy an overwhelming majority of the eastern half of the watershed (Table 9-3). Most units of the Franciscan Complex, Western Klamath Belt, and plutonic rocks occur in the western half of the watershed.

Table 9-3. Lower South Fork Trinity River Watershed Prominent Geologic Units and Rock Types

Geologic Unit	Percent of Watershed		Dominant Rock Type(s)
Western Paleozoic and Triassic Belt	45%		
Rattlesnake Creek Terrane		44%	diamictite, serpentine
Franciscan Complex	24%		
Picket Peak Formation		13%	quartz mica schist
Yolla Bolly Formation/undifferentiated		9%	greywacke, metavolcanic blocks
Western Klamath Belt	24%		
Galice Formation		23%	slate, phyllite, metagreywacke
Plutonic Rock	7%		
Ironside Mtn. & Ammon Ridge Plutons		6%	diorite, tonalite

Only 10 percent of the Lower South Fork Trinity River watershed that has soil data contains very high and high potential areas for soil erosion (Figure 9-2). However, nearly 40 percent of the watershed is covered by sensitive landforms; mostly large active landslides and dormant landslide zones. Landslides are primary erosion agent in the eastern portion of the watershed. A western portion of the Lower South Fork Trinity River watershed is outside of STNF boundaries, and geomorphic and soils data is only available for the eastern portion.



**Average is for portion of watershed/sub-watershed with associated data (usually USFS lands).

Figure 9-2. Area of Lower South Fork Trinity River Subwatersheds Occupied by Erodible Soils and Sensitive Landforms

9.3 SSI Results

As described in Section 1, roads in Lower South Fork Trinity River watershed were inventoried during multiple field seasons. In total, approximately 61.5 miles of road were inventoried in the watershed. As part of the 2012 SSI, NSR inventoried 52.2 miles of road in the watershed during the 2011 and 2012 field seasons. The following discussion focuses on the 2012 SSI data set. The data acquired during the 2012 SSI was in addition to SSI data provided by the STNF, including information acquired by NSR and other entities over the past several years.. The cumulative SSI data set is presented following the 2012 SSI discussion.

2012 SSI Results

The objective of the 2012 SSI was to document the condition of existing road-related infrastructure and identify existing and potential erosion and sediment producing features located over 52.2 miles of road in the Lower South Fork Trinity River watershed (Figure 9-1 and Appendices E & F). Inventoried features were prioritized based on their potential for sediment production and delivery to the hydrologic network. This section focuses on the inventoried and prioritized features included in the 2012 SSI. The results are presented at both the subwatershed (HUC 6) and drainage scales (HUC 7).

Inventoried Features

The 2012 SSI identified and characterized 497 features; 0.4 miles of gully, 10.4 miles of ditch segments; 69 stream crossings; six erosion features; 78 hydrologically connected cross-drain sites; 349 non-hydrologically connected cross-drains; and one spring (Table 9-4 and Appendices E & F).

Table 9-4. 2012 SSI Inventoried Features for Lower South Fork Trinity River Subwatersheds (HUC 6) and Drainages (HUC 7)

Subwatersheds (HUC 6) Drainages (HUC 7)	Road Miles	Gully Miles	Ditch Miles	Stream Crossings	Erosion Features	Connected Cross-Drains	Non-Connected Cross-Drains	Springs
Eltapom Creek	45.2	0.4	9.8	64	6	72	282	1
Lower Eltapom Creek	16.7	0.0	2.9	15	4	27	100	0
Upper Eltapom Gulch	28.5	0.4	6.9	49	2	45	182	1
Grouse Creek	1.5	0.0	0.0	0	0	0	1	0
Hyampom	4.5	0.0	0.6	5	0	4	57	0
Big Creek-Hyampom	< 0.1	0.0	0.0	0	0	0	0	0
Big Slide Creek-South Fork Trinity River	3.6	0.0	0.3	5	0	3	50	0
Grapevine Creek-South Fork Trinity River	0.2	0.0	0.0	0	0	0	0	0
Hyampom Valley	0.7	0.0	0.3	0	0	1	7	0
Lower South Fork Trinity River	1.0	0.0	0.0	0	0	0	1	0
Watershed Totals	**52.2**	**0.4**	**10.4**	**69**	**6**	**78**	**343**	**1**

Note: The drainages included in the 2012 SSI are shown in Table 9-4; other drainages within the watershed are not listed.

Approximately 87 percent of the roads included in the 2012 SSI were located in two drainages within the Eltapom Creek subwatershed; Lower Eltapom Creek and Upper Eltapom Creek. Accordingly, the Eltapom Creek subwatershed contained the greatest number of features relative to the other subwatersheds. Of the total features identified in the 2012 SSI, 425 features or 86 percent of the total number occur within the Eltapom Creek subwatershed; with 146 features in Lower Eltapom drainage and 279 features in Upper Eltapom drainage (Table 9-4). The remaining 66 features were identified in the Hyampom subwatershed, with only 1 feature identified in each of the Grouse Creek and Lower South Fork Trinity River subwatersheds. However, only 4.5 road miles were inventoried in the Hyampom Creek subwatershed, 1.0 road mile was inventoried in the Lower South Fork Trinity River subwatersheds, and 1.5 road miles in the Grouse Creek subwatershed.

Feature Analysis/Risk Analysis

As described in Section 2, risk ranking matrices were created to identify features that currently do, or potentially could deliver elevated levels of sediment to nearby streams or waterbodies. The density of high risk features types for each subwatershed and drainage is shown in Figure 9-3. As illustrated in Table 9-5, the 2012 SSI identified the following high risk features: 0.0 gully miles, 3.5 ditch miles, 23 stream crossings, 1 erosion site, 54 connected cross-drains with CMP, and zero spring sites. A total of 78 features or 16 percent of the total 2012 SSI data set for the watershed (excluding non-connected cross-drains and connected cross-drains without CMP) are characterized as high risk in the watershed.

As anticipated, the Eltapom Creek subwatershed contained nearly all the high risk features (92%) and high risk ditch miles (94%) identified in the Lower South Fork Trinity River watershed. Of the total 50 high risk features within the Eltapom Creek subwatershed, 20 (40 percent) were located in the Lower Eltapom Creek drainage and 30 (60 percent) were located in the Upper Eltapom Creek drainage (Table 9-5). A total of four high risk features and 0.24 miles of high risk ditch were located in the Hyampom Creek subwatershed. No high risk features, ditch or gullies were identified in the Grouse Creek or Lower South Fork Trinity River subwatersheds.

Table 9-5. High Risk Features for Lower South Fork Trinity River Subwatersheds (HUC 6) and Drainages (HUC 7)

Subwatersheds (HUC 6) Drainages (HUC 7)	Gully Miles	Ditch Miles	Stream Crossings	Erosion Features	Connected Cross-Drain w/CMP	Springs
Eltapom Creek	0.0 (0%)	3.3 (34%)	22 (34%)	1 (17%)	50(82%)	0 (0%)
Lower Eltapom Creek	0.0 (0%)	0.8 (28%)	5 (33%)	1 (25%)	20 (87%)	0 (0%)
Upper Eltapom Creek	0.0 (0%)	2.5 (36%)	17 (35%)	0 (0%)	30 (79%)	0 (0%)
Grouse Creek	0.0 (0%)	0.0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Hyampom	0.0 (0%)	0.2 (41%)	1 (20%)	0 (0%)	4 (100%)	0 (0%)
Big Creek-Hyampom	0.0 (0%)	0.0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Big Slide Creek-South Fork Trinity River	0.0 (0%)	0.2 (71%)	1 (20%)	0 (0%)	3 (100%)	0 (0%)
Grapevine Creek-South Fork Trinity River	0.0 (0%)	0.0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Hyampom Valley	0.0 (0%)	0.04 (13%)	0 (0%)	0 (0%)	1 (100)	0 (0%)
Lower South Fork Trinity River	0.0 (0%)	0.0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Watershed Totals	**0.0 (0%)**	**3.5 (34%)**	**23 (33%)**	**1 (17%)**	**54 (83%)**	**0 (0%)**

Note: Values in parenthesis represent percentage of watershed feature totals.

Figure 9-3 illustrates the variability in the number and type of high risk features per mile of inventoried road by subwatershed. However, since the majority of the road miles were inventoried in the Eltapom Creek subwatershed and very few miles were inventoried in the Grouse Creek, Hyampom and Lower South Fork Trinity River subwatersheds, Figure 9-3 is not necessarily a fair comparison of the four subwatersheds or of the watershed average.

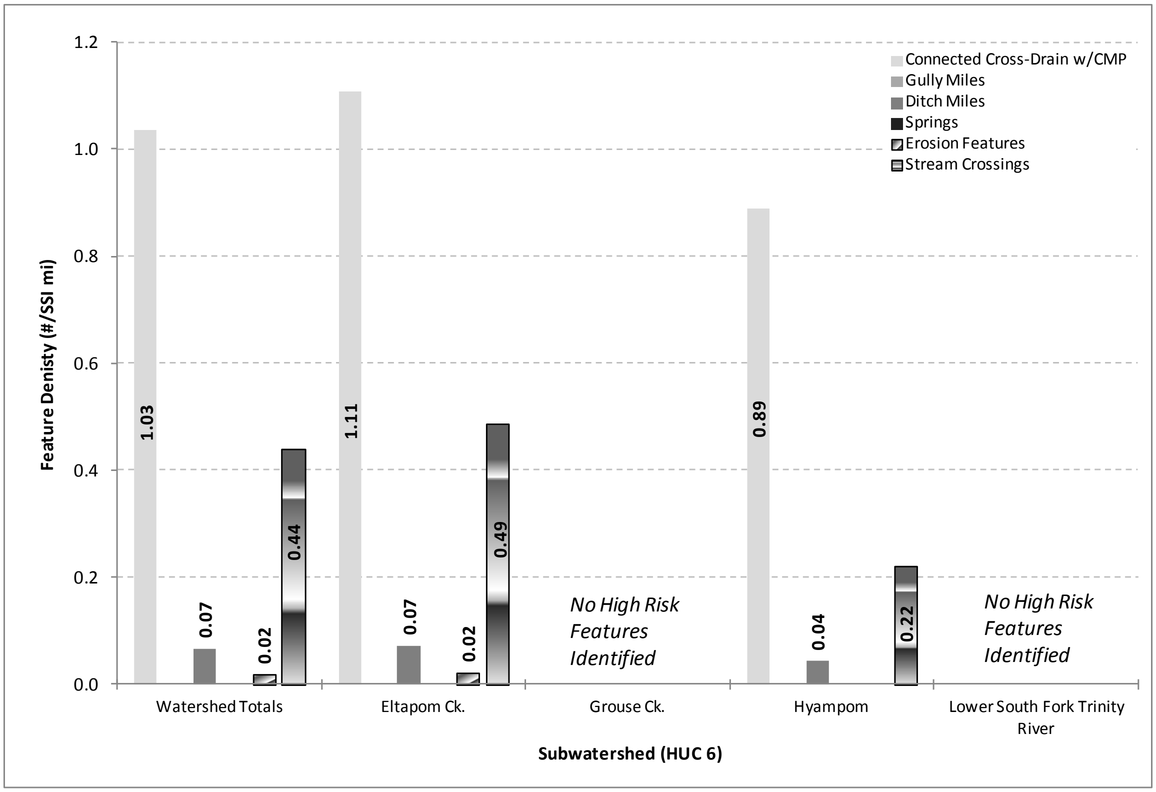


Figure 9-3. Density of High Risk Features for Lower South Fork Trinity River Subwatersheds

Note: Gullies and ditch densities reported as miles of feature per mile of SSI road.

Cumulative SSI Data

Prior to conducting the 2012 SSI effort, the STNF acquired SSI data in two of the subwatersheds; Eltapom Creek and Hyampom Creek. Table 9-6 illustrates the total road miles inventoried relative to the cumulative number and type features that have been documented through various SSI efforts in the Lower South Fork Trinity River watershed, by subwatershed/drainage.

The following discussion is based on cumulative SSI efforts conducted for the STNF on approximately 13 percent of all roads within the Lower South Fork Trinity River watershed. Of 61.5 miles of inventoried roads in the Lower South Fork Trinity River watershed, 9.3 miles were inventoried prior to the 2012 SSI. Cumulatively, the SSI data set documents the occurrence of 6 erosion sites and 151 hydrologically connected features, which includes stream crossings and connected cross-drains (see Table 9-6). Seventy-five of these features were stream crossings, of which one-third were identified as high risk sites. These include crossings that were unable to or were in danger of not being able to adequately convey peak flow events at the site. Sixty percent of the total stream crossings were identified with diversion potential, and seven percent were undersized pipes. Field indicators of undersized pipe were evidence of overtopping; substantially plugged features, poor structural integrity (i.e. holes, separated, etc.), poor positioning, or a significant loss of fill at the inlet.

Table 9-6. Lower South Fork Trinity River Watershed Cumulative SSI Data

Subwatersheds (HUC 6) Drainages (HUC 7)	Total SSI Miles	Erosion Features	Connected Features[1]	Stream Crossings			
				Total	High Risk	Diversion Potential	FEUP[2]
Eltapom Ck.	53.3	6	140	68	23	44	5
Lower Eltapom Ck.	16.7	4	42	15	5	9	1
Upper Eltapom Ck.	36.6	2	98	53	18	35	4
Grouse Ck.	1.5	0	0	0	0	0	0
Hyampom	5.7	0	11	7	1	1	0
Big Ck.-Hyampom	0.0	0	0	0	0	0	0
Big Slide Ck.-South Fork Trinity River	3.6	0	8	5	1	1	0
Grapevine Ck.-South Fork Trinity River	0.2	0	0	0	0	0	0
Hyampom Valley	0.7	0	1	0	0	0	0
Pelletreau Creek	1.2	0	2	2	0	0	0
Lower South Fork Trinity River	1.0	0	0	0	0	0	0
Watershed Totals	**61.5**	**6**	**151**	**75**	**24**	**45**	**5**

[1]Includes all stream crossings and Connected Cross-Drains; indicator of hydrologic connectivity of roads
[2]Field Evidence of Undersized Pipe (FEUP); see methods for explanation.

A total of 53.3 miles were inventoried in the Eltapom Creek subwatershed, of which 3.7 miles were inventoried prior to the 2012 SSI. The inventoried roads account for nearly 77 percent of the total roads within the Eltapom Creek subwatershed. Cumulatively, 146 features were identified in the subwatershed, including six erosion features and 140 connected features, of which 68 were stream crossings (Table 9-6). Approximately 40 percent of the stream crossing features were considered high risk, 65 percent had diversion potential and seven percent were considered undersized.

Less than three percent of the total roads in the Hyampom Creek subwatershed were included in the cumulative SSI data set. Within the 5.7 miles of inventoried road in the subwatershed, 11 connected features were identified, of which seven were stream crossings. One stream crossing was identified as high risk and one with diversion potential. No erosion features were identified in the Hyampom Creek subwatershed.

Figure 9-4 illustrates the variability in the number and type of selected feature per mile of inventoried road by subwatershed. No features were identified in Grouse Creek and Lower South Fork Trinity River subwatershed. The density of all features, including connected features, erosion features, high risk crossings, crossing with FEUP and crossings with diversion potential, is lower in the Hyampom Creek subwatershed than Eltapom Creek subwatershed. However, nearly 10 times more road miles were inventoried in the Eltapom Creek subwatershed than the Hyampom Creek subwatershed.

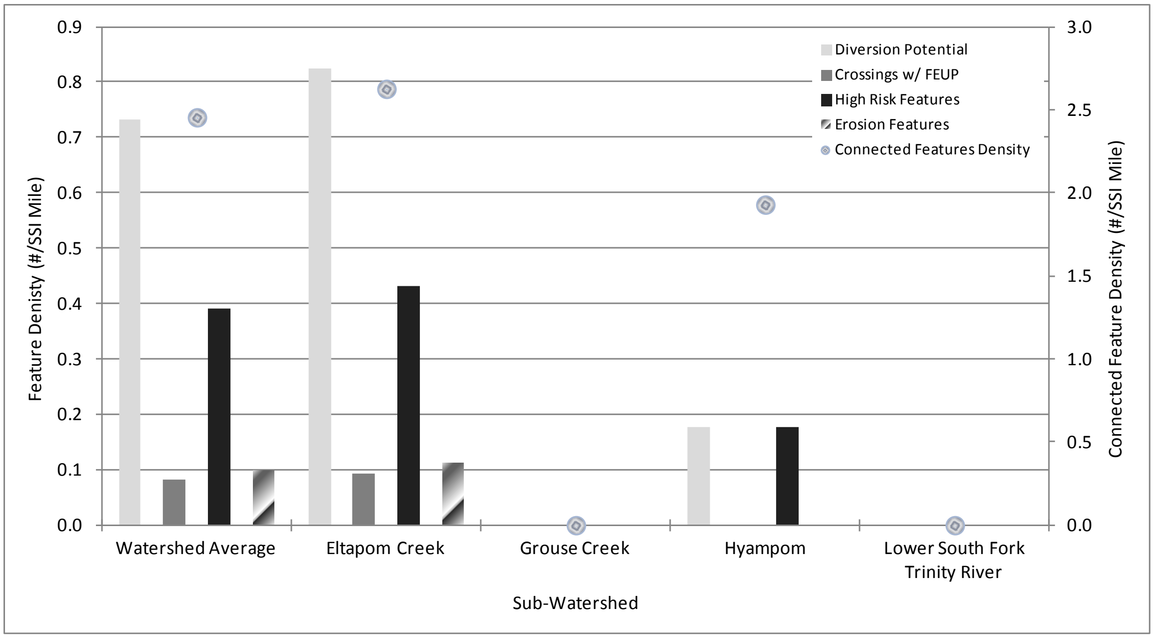


Figure 9-4. Density per Mile of SSI Road of Selected Features for Lower South Fork Trinity River Subwatershed

9.4 Aquatic and Riparian Resources RAP Risk Analysis

The main focus of the RAP risk analysis was to identify road segments that could pose a moderate to high risk to aquatic and riparian resources. Three resources, including, water quality, hydrologic processes, aquatic and riparian habitat are analyzed in the following discussion. The RAP risk analysis is presented at both the HUC 7 drainage and road segment scales.

Aquatic and Riparian Resources Total RAP Risk Score per Drainage

The total Aquatic and Riparian Resources RAP risk score (total RAP risk score) for road segments within six of the drainages (HUC 7) within the Lower South Fork Trinity River watershed are discussed in this section. The drainages within the Grouse Creek and Lower South Fork Trinity River subwatersheds were not delineated in the HUC7 GIS layer and therefore were not included in the RAP analysis. The RAP risk scores for water quality, hydrologic processes, aquatic and riparian habitat, including the total scores for each road and drainage are listed in Appendix D. Figure 9-5 illustrates the total miles of road per drainage and the associated total RAP risk score. This figure displays the relative risk per drainage for the various sections of roads included in the RAP analysis. A key point in this discussion is that the RAP analysis focused on the 2012 SSI data set due to inconsistencies in previous SSI data sets.

The Aquatic and Riparian RAP effort indicates that none of the roads included in the SSI 2012 data set is scored as high risk. Approximately 8.9 miles of road or 18 percent of the data set is scored as moderate-high risk to aquatic and riparian resources within the Lower South Fork Trinity River watershed (Figure 9-5).

As shown in Figure 9-5, nearly all of the roads that scored moderate-high were located in the Upper Eltapom Creek drainage, within the Eltapom Creek subwatershed. Only 0.1 miles of moderate-high risk road was located in the Lower Eltapom Creek drainage. Less 0.01 miles of moderate-high risk road were located in the Hyampom Creek subwatershed, within the Big Slide Creek drainage.

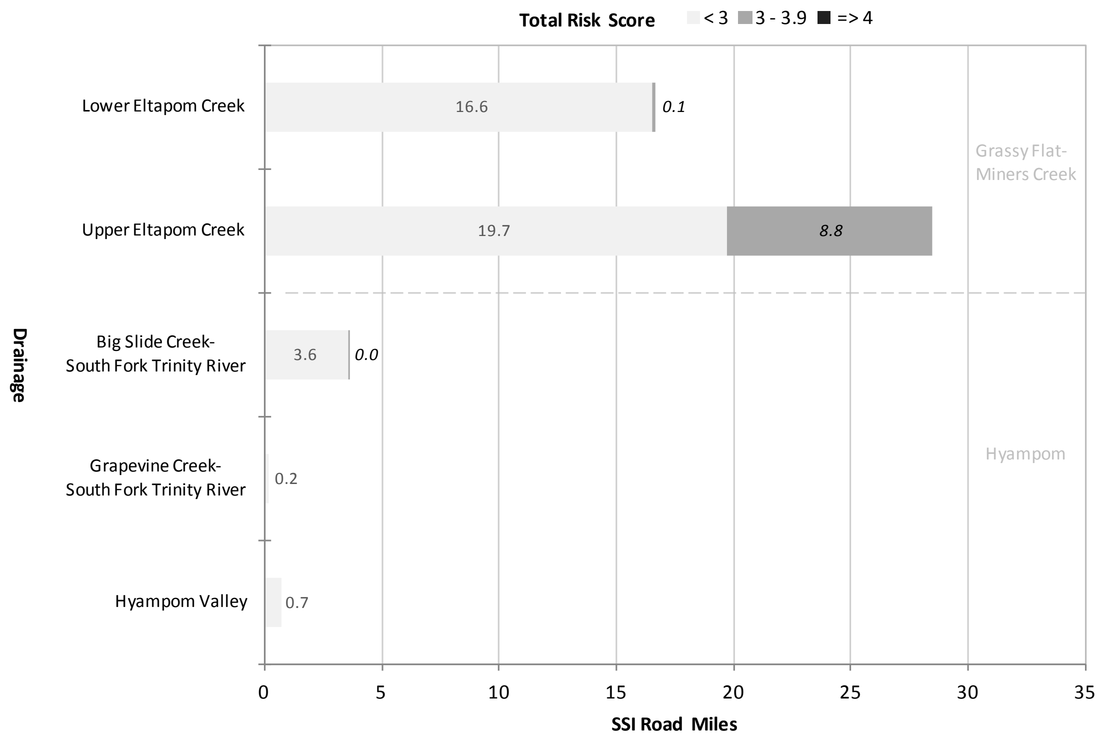


Figure 9-5. Aquatic and Riparian Resources RAP Total Risk Score for Lower South Fork Trinity River Watershed Drainages

Overall, 82 percent of the roads included in the 2012 SSI within the Lower South Fork Trinity River watershed had scores less than 3 (low-moderate risk). Based on the assumptions used for the RAP analysis, this suggest that a large number of the roads pose a low to moderate risk of affecting aquatic and riparian resources.

Moderate-High to High Risk Road Segments

Table 9-7 lists those road segments by drainage included in the 2012 SSI that scored 3.0 or above in the RAP risk analysis. Based on this analysis, these road segments have a moderate-high to high risk of affecting water quality, hydrologic processes, and aquatic and riparian habitats. In total, seven road segments or approximately 8.9 miles of road scored moderate-high risk and no road segments scored high risk. Figure 9-6 illustrates the location of the moderate-high risk roads segments in the Lower South Fork Trinity River watershed.

As shown in Table 9-7, the score for water quality is the highest of the three values for all seven road segments. Five of the seven road segments (98% of the road mileage) included in Table 9-7 have water quality scores equal to or above 4.0, and the remaining two have water quality scores equal to 3.9. This suggests that many of the moderate-high risk road segments are hydrologically connected and intersect areas prone to erosion. Evaluation of the road segments included in Table 9-7 indicate many of the road segments cross streams and are in close proximity to aquatic and riparian habitat which provide a direct pathway for transport and delivery of sediment to water bodies within the Lower South Fork Trinity River watershed. For example Road 5N60 and 4N41 traverse the hillside above Clark Creek and cross numerous drainages that flow into Eltapom Creek and Clark Creek (Figure 9-6).

Table 9-7. Lower South Fork Trinity River Watershed Routes with Total RAP Risk Scores of 3.0 and Greater

			Resource Risk Scores			
Route ID	Drainage Name	Miles	Aquatic, Riparian	Hydrologic Process	Water Quality	Total Risk
5N60	Upper Eltapom Creek	5.285	3.8	3.8	4.3	3.9
4N41	Upper Eltapom Creek	1.386	3.4	3.8	4.3	3.8
4N25D	Upper Eltapom Creek	0.510	3.3	3.8	4.1	3.7
4N34	Big Slide Creek-South Fork Trinity River	0.035	3.5	3.8	3.9	3.7
4N09	Upper Eltapom Creek	1.449	3.3	3.8	4.0	3.7
5N60H	Upper Eltapom Creek	0.127	3.3	3.8	3.9	3.6
4N34E	Lower Eltapom Creek	0.119	1.3	3.8	4.7	3.2

Table 9-7 indicates that all road segments scored 3.8 for hydrologic processes. This analysis indicates that all moderate-high risk road segments pose a similar risk to hydrologic processes throughout the Lower South Fork Trinity River watershed. These roads may potentially affect the routing of water by intercepting and diverting flows from their natural path. This is also an indication that the road alignment and fill may constrict the channel, isolate floodplains, and/or constrain channel migration.

The road segment scores for aquatic and riparian habitat is generally lower, with a wider range of values (1.3 to 3.8) relative to water quality and hydrologic processes. These scores correlate the risk to aquatic and riparian habitat relative to the individual road segments with respect to affects on the functions and values of aquatic and riparian habitat, including attributes such as connectivity and flow. Road 5N60 in the Upper Eltapom Creek drainage, has the highest aquatic and riparian habitat score and is 5.29 miles in length (Figure 9-6). The high scores is likely due to its proximity to Clark Creek, a fish bearing stream, and the numerous drainages that it crosses that flow into Eltapom Creek.

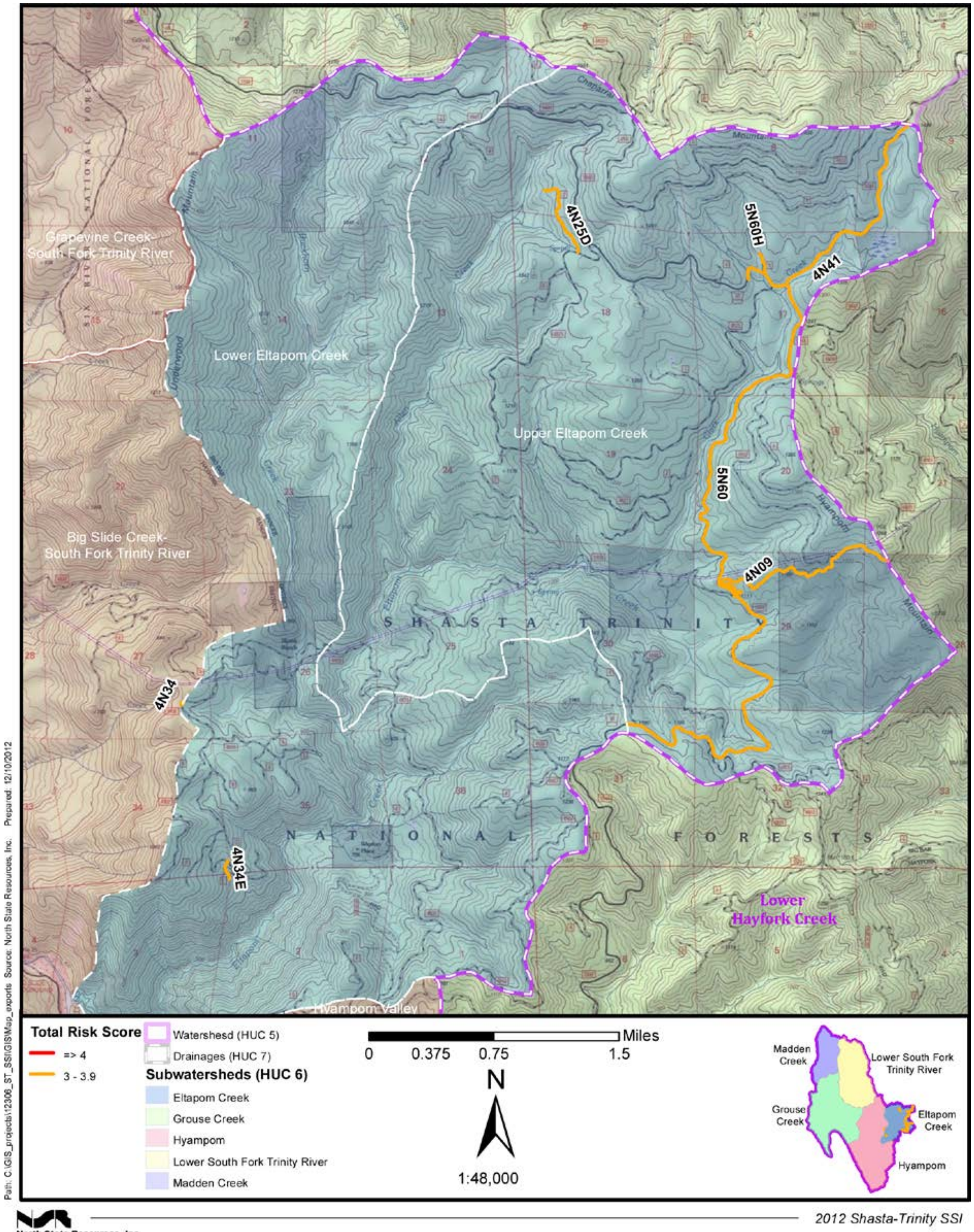


Figure 9-6. Location of Moderate-High to High Risk Roads Segments in the Lower South Fork Trinity River Watershed

9.5 Recommendations

Moderate-High and High Risk Road Segments General Recommendations

Table 3-8 provides general recommendations for routes in the Lower South Fork Trinity River watershed with a total RAP risk score of 3.0 and greater. Three different recommendation categories are presented in this section directed at maintaining, upgrading or decommissioning road segments with moderate-high and high risk scores. Maintain includes activities such as cleaning out inlets and outlets of culverts and cross-drain with culverts, cleaning rolling dips and ditches, and spot-grading. Upgrading roads includes renovation of existing features, construction of new features, large-scale grading and resurfacing all or part of a segment, combined with normal maintenance activities. Decommissioning roads includes either full road obliteration or a temporary road decommission (e.g., storm-proofing). The recommendations in this section are based on the RAP risk score in conjunction with SSI data such as road density and specific information on the type and number of features that could pose a risk to aquatic and riparian values.

Table 9-8. General Recommendations for Moderate-High to High Risk Routes in the Lower South Fork Trinity River Watershed

Route ID	Drainage Name	Miles	Total Risk	General Recommendation
5N60	Upper Eltapom Creek	5.285	3.9	Maintain & Upgrade
4N41	Upper Eltapom Creek	1.386	3.8	Upgrade
4N25D	Upper Eltapom Creek	0.510	3.7	Upgrade
4N34	Big Slide Creek-South Fork Trinity River	0.035	3.7	Maintain
4N09	Upper Eltapom Creek	1.464	3.7	Maintain
5N60H	Upper Eltapom Creek	0.127	3.6	Decommission
4N34E	Lower Eltapom Creek	0.119	3.2	Maintain

Specific Recommendations to Upgrade Roads

Specific recommendations are listed below for the roads listed under ‘upgrade’ in Table 9-8 and for three additional road segments. The recommendations focus on the sections of each road that either contained a high density of high risk features or individual features that could be treated to help decrease their impacts to water resources. Locations are denoted by Route ID, mile marker, and drainage. The feature type and associated problem are also included, along with recommendations for upgrades.

Route ID: 4N25D
Drainage: Upper Elatpom Creek
Location: Mile Marker 0.02-0.342, Lower South Fork Trinity River Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.02	Stream Crossing CMP	High diversion potential of spring and seasonal flow.	Install armored critical dip.
0.032 – 0.075	Ditch	Breached ditch. Drains spring and forms connected channel downslope. Moderate sediment deposition.	Repair and clean ditch.
0.0751	Connected Cross-Drain w/CMP	High diversion potential.	Install armored critical dip.
0.124, 0.175	Cross-Drain w/CMP	Two partially plugged/crushed CMP's with diversion potential. Although not connected, both are in proximity (350 ft) of perennial stream.	Clean inlets and install critical dips.

Route ID: 4N41
Drainage: Upper Elatpom Creek
Location: Mile Marker 0-01 -1.26, Lower South Fork Trinity River Watershed

Mile Marker	Feature Type	Problem	Recommendation
0.01	Connected Cross-Drain w/CMP	Partially plugged with moderate diversion potential. Feature within 100 feet of perennial stream	Clean inlet and install critical dip.
0.355	Cross-Drain w/CMP	Non-functioning plugged/crushed structure with diversion potential. Small channel not connected but in close proximity to stream network.	Clean inlet, replace dropped inlet lid , and install critical dip.
0.37	Stream Crossing CMP	Perennial stream crossing with moderate diversion potential.	Install armored critical dip.
0.40	Connected Cross-Drain w/CMP	High diversion potential feature that drains a spring-fed ditch. Ditch has moderate sediment deposition	Install armored critical dip.
0.401 – 0.445	Ditch	Ditch plugged and connected to perennial stream. Buried 8" drain outlet ties into dropped inlet CMP Cross-Drain at MM 0.40; may not be functional.	Clean ditch and evaluate effectiveness of sub-drain structure.
0.92, 1.2,1.34,1.4	Cross-Drain w/CMP	All structures have plugged/crushed inlets and diversion potential. Structures not connected but in proximity to stream network.	Clean Inlets and replace missing dropped inlet lids.
1.06	Stream Crossing CMP	Intermittent crossing with diversion potential in proximity to perennial stream.	Install critical dip.
1.26	Connected Cross-Drain w/CMP	High diversion potential. Structure drains spring to perennial stream.	Install critical dip.

Route ID: 5N60
Drainage: Upper Eltapom Creek
Location: Mile Marker 15.78 - 19.24, Lower South Fork Trinity River Watershed

Mile Marker	Feature Type	Problem	Recommendation
15.78	Connected Cross-Drain w/CMP	Structure has high diversion potential and is partially plugged. Connected to perennial stream.	Clean and excavate inlet basin
15.785-15.999	Ditch (multiple)	Ditches are plugged and connected to a perennial stream through cross-drains with CMP.	Clear and reconstruct ditches.
16.000	Connected Cross-Drain w/CMP	Dropped Inlet > 31% plugged. Structure connected to perennial stream.	Clear inlet and reconstruct ditch to minimize potential for sediment deposition.
16.085-16.085	Ditch (multiple)	Ditch is plugged and connected to a perennial stream through a cross-drain with CMP.	Clear and reconstruct ditches.
16.26	Stream Crossing CMP	Outlet buried with boulders and debris. May be issue at high flows. Perennial stream.	Remove boulders and debris to mitigate plug potential.
16.265-16.2999	Ditch	Ditch is plugged and connected to a perennial stream through a cross-drain with CMP.	Clear and reconstruct ditches.
16.305-16.3599	Ditch	Ditch is plugged from cutbank slough and connected to a perennial stream through a cross-drain with CMP.	Clear and reconstruct ditches.
16.36	Connected Cross-Drain w/CMP	Dropped Inlet > 31% plugged. Structure connected to perennial stream.	Clear inlet and reconstruct ditch to minimize potential for sediment deposition.
16.365-16.6199	Ditch	Ditch is plugged from cutbank slough . Ditch is not connected but heavy sediment deposition may cause plugging at cross-drains.	Clear and reconstruct ditches.
16.62	Cross-Drain w/CMP	Dropped Inlet partially plugged and missing lid. Sediment load from ditch compromises conveyance.	Clear inlet and replace 36” lid. Reconstruct ditch to minimize potential for sediment deposition.
16.78-16.7999	Ditch	Ditch is plugged and connected to an ephemeral stream through at a stream crossing.	Clear and reconstruct ditches.
16.805-16.9499	Ditch	Ditch is plugged and connected to an ephemeral stream through at a stream crossing.	Clear and reconstruct ditches.
17.11	Stream Crossing CMP	Inlet basin filled, sinkhole near inlet, outlet is buried and crushed. Ephemeral stream with diversion potential	Clear inlet basin and evaluate function of CMP.
17.35	Connected Cross-Drain w/CMP	Structure is not functioning and > 31% plugged. Drains swale and ditch.	Clear inlet of debris and upgrade structure inlet.

Route ID: 5N60 *(Continued)*
Drainage: Upper Eltapom Creek
Location: Mile Marker 15.78 - 19.24, Lower South Fork Trinity River Watershed

Mile Marker	Feature Type	Problem	Recommendation
17.3501-17.43	Ditch	Ditch is plugged and deposits moderate sediment in ditch. Ditch connected to a swale through at a cross-drain.	Clear and reconstruct ditches.
17.6	Cross-Drain w/CMP	Inlet 60% plugged and outlet 100% buried. Feature has diversion potential but not connected.	Clear inlet and outlet.
17.95, 18.06	Connected Cross-Drain w/CMP	Inlets > 31% plugged with bedload and both structures have high diversion potential. Structures drain ditch flow and swale flow.	Clear inlet and outlet.
17.9501-18.06	Ditch	Ditch is plugged and has moderate sediment deposition. Ditch is connected to swale.	Clear and reconstruct ditches.
18.3501 – 18.55	Ditch	Ditch is plugged and has moderate sediment deposition. Ditch is connected to a perennial stream at a stream crossing.	Clear ditch.
19.0201–19.145	Ditch	Ditch is plugged and has moderate sediment deposition. Ditch is connected to an ephemeral stream at a stream crossing.	Clear ditch.
19.24	Connected Cross-Drain w/CMP	Dropped inlet > 31% plugged with high diversion potential. Structure drains ditch flow and swale flow.	Clear inlet basin and inlet at ditch.

The ditches and features identified on this road segment may not present a large sediment source issue individually. However, the features are addressed because the cumulative effects of plugged ditches and plugged conveyance features, when coupled with the diversion potential of most conveyance structures, could present issues during large precipitation events.

Additional Features of Concern

Feature Type	Mile Marker	Route ID	Problem	Recommendations
Stream Crossing CMP	2.33	4N25	CMP has projecting inlet and is rusted through/weak. Grade is not consistent with intermittent channel grade.	Replace CMP at appropriate channel grade. Crossing to east is also a high risk site. Recommend this CMP upgraded with any activity at the stream crossing MM 2.35 and erosion feature MM 2.3301 to maximize sediment reduction efforts.
Erosion Feature (Gully)	2.3301	4N25	Stream flow from stream crossing (MM 2.35) flows across landing to stream below stream crossing (MM 2.33) and is head cutting slope above delivery point to stream.	Reconstruct both stream crossing features and reconstruct fill at landing; removing unnecessary fill and armoring as necessary.
Stream Crossing CMP	2.35	4N25	Heavily skidded and modified eroding channel above crossing causes flow to flow across landing at erosion feature (MM2.3301).	Reconstruct /rehabilitate entire crossing segment of road (stream crossing at MM 2.35, stream crossing at MM.2.33, and landing at MM 2.3301).
Stream Crossing CMP	1.07	4N48	Inlet of ephemeral crossing is 90% plugged with bedload.	Clear inlet and evaluate culvert size.
Stream Crossing CMP	1.67	4N48	Terminal Landing built in intermittent stream channel. Stream diverted 70 feet to CMP.	Decommission landing and rehabilitate stream channel.
Connected Cross-Drain w/CMP	2.25	4N25	Partially-functioning structure has evidence of overtopping and is > 31% plugged and has diversion potential. Structure conveys swale flow.	Clear inlet and evaluate culvert size. Site is located near other sites on 4N25. Combine with other activities to maximize sediment reduction efforts.
Connected Cross-Drain w/CMP	0.18	4N25B	Non-functioning structure that had evidence of overtopping and is > 31% plugged with bedload. Structure only conveys swale flow, but is a higher priority due to history of overtopping.	Clear inlet.

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