Battle Creek Watershed Based Plan

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Prepared by:

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Funding for this project has been provided in full or in part through an agreement (No. D1513502) with the California State Water Resources Control Board. The contents of this document do not necessarily reflect the views and policies of the California State Water Resources Control Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

SECTION 1.0 – INTRODUCTION

The Battle Creek watershed hosts spawning, rearing and migratory habitats for threatened and endangered salmonid species. Major changes to the Battle Creek watershed and its stream environments have occurred since the early settlers in the mid-19th century. Large hydroelectric projects have created fish passage issues since the 1960's, and even-age timber harvest has increased markedly since the year 2000. The Ponderosa Fire of 2012 and the first three years post-fire (2013-2015 water years) represents one of the largest recent disturbances to the watershed and a source of sediment pollution to the streams of Battle Creek. This wildfire is likely to represent the new normal for wildfire size and severity.

Efforts to understand the needs of threatened and endangered salmonid species have occurred amidst rapid changes to the landscape. As part of a Federal Energy Regulatory Commission's process for re-licensing a large-scale hydroelectric project, restoration efforts are underway to mitigate problems related to salmonid migration, spawning, and rearing (see https://www.usbr.gov/mp/battlecreek/). However, concerns about overall land use within the basin have prompted closer look into non-point sources of sediment pollution as part of this restoration effort.

Stakeholders in the BC watershed include land owners, water users, conservation groups, and state and federal regulators. These stakeholders' interests are diverse, complicated, and often compete with one another. However, many stakeholders have expressed a willingness to collaborate to address the watershed-wide non-point sources of sediment pollution in Battle Creek. This document describes a plan to reduce sediment inputs to streams within the BC watershed. This plan includes a framework for organizing and prioritizing land management projects and provides guidance for landowners on how they can achieve sediment load reduction goals.

1.1 WBP Goals

The overall goal of the Watershed Based Plan (WBP) is to develop a collaborative and flexible strategy for protecting areas of the watershed that contribute to pristine waters of Battle Creek relative to its beneficial uses and restore areas of the watershed that have been negatively impacted by controllable sources of pollution. The collaborators include the stakeholders of Battle Creek who meet regularly to coordinate stream and watershed restoration projects. A strategic approach will address problems in a systematic manner that ensures resources are utilized efficiently, are focused on highest priority areas, and these resources are optimized to assist landowners' needs. The WBP must be flexible due to the various nature of the watershed with respect to natural resource interests, restoration efforts, land ownership and management, and natural or man-made disturbances (fire, flood, etc.).

1.2 WBP Design

This plan is a first step in in a greater strategy to prioritize and track sediment delivery assessments and sediment reduction implementation projects within Battle Creek Watershed. This plan aims to utilize adaptive management of priorities through monitoring considering key indicators, and includes input from stakeholders and land owners. To best achieve this strategy, this document, or plan, provides an overview of sediment reduction needs and describes how to prioritize and track through time sediment reduction assessments and implementations. Tracking these projects through time requires a system that can be easily updated, incorporates various information sources, and can adapt to sudden changes in the basin, such as wildfire or flooding events. Given these needs, it was determined that an online, geospatially-oriented tool is the most appropriate method to achieve the goals of a "living document" , the basic structure and needs of which is described in this document. The online data platform will be established on the Sacramento River Watershed Program (SRWP) portal to:

1. Host the WBP documentation and provide a clearinghouse for information useful to stakeholders
2. Track a prioritized list of watershed improvement projects, including efforts that are past, currently in planning, or are underway. Provide annual web-based updates on work plan actions, milestones, and monitoring results to determine effectiveness.
3. Align existing and future assessments and implementations with EPA's 9-elements to expedite grant writing processes aimed at EPA's section 319 (and other) funding, and
4. Adaptively prioritize projects in response to future major climate-driven events (e.g. fires and extreme precipitation).

1.3 Nine Minimum Elements of an EPA Watershed Based Plan (WBP)

The Battle Creek Watershed Based Plan utilizes the U.S. Environmental Protection Agency's nine minimum elements planning framework (USEPA 2008, 2013) for the identification of threats to beneficial uses of waterways within the Battle Creek watershed. In addition to the primary focus on controllable sediment sources, the Watershed Based establishes the foundation and process to achieve the desired outcome of sound watershed health and resilience, economic sustainability, and maintenance of beneficial uses. The nine critical elements for the development of effective watershed based plans are described in Table 1 and provides sections of this document where these elements are addressed.

Table 1. The nine critical elements for effective watershed based plans (USEPA 2013) and the sections within this document where they are addressed.

1. Identify causes and sources of pollution (Section 3)
2. Estimate pollutant loading into the watershed and the expected load reductions (Section 4)
3. Describe management measures that will achieve load reductions and targeted critical areas (Section 5)
4. Estimate amounts of technical and financial assistance and the relevant authorities needed to implement the plan (Section 9)
5. Develop an information/education component (Section 6)
6. Develop a project schedule (Section 5)
7. Describe the interim, measurable milestones (Section 5)
8. Identify indicators to measure progress (Section 7)
9. Develop a monitoring component (Section 7)

1.4 Background

The land uses and stakeholders within the Battle Creek watershed are diverse and reflect a wide variety of management goals relative to the land and water resources of the watershed. The watershed supports viticulture, timber production, hydropower, ranching, fish hatcheries, and recreation. The watershed is also the focus of restoration efforts to re-introduce threatened /endangered salmonid species in decline due to lack of access to historic habitat due to unpassable dams on the main stem Sacramento River. The watershed also supports commercial fish hatchery mitigation for Central Valley Project Improvement Act (CVPIA) impacts due to the same lack of access to historic habitat.

In 2012, the Battle Creek watershed experienced a 27,000 acre wildfire within the forested mid elevations and widespread salvage logging of burned timberlands was performed. In the 2015 water year (WY), an atmospheric river precipitation event initiated extensive erosion within the burn area resulting in significant sediment delivery to the stream network. Impacts to landowners, downstream stakeholders, and beneficial uses of water resources were widespread though there was uncertainty over whether these effects were controllable through land-use management or uncontrollable due to natural disturbance processes of the wildfire.

In light of these sediment impacts and uncertainties the Battle Creek Watershed Conservancy (Conservancy) partnered with the Central Valley Water Board and the State Water Board in 2016 through funding from the Timber Regulation and Forest Restoration Grant Program to develop the Watershed Based Plan (WBP) for Battle Creek. The WBP Project includes three elements: a watershed assessment focused on sediment sources and influencing factors (Terraqua 2018); a WBP that addresses the nine EPA planning elements (this document); and the implementation of a demonstration project focused on sediment source reductions on native surface roads.

The WBP Project is guided by an MOU signed by the Conservancy and the Central Valley Water Board in November 2016 (BCWC/CVWB 2016). In light of the numerous stakeholders and their varied perspectives and goals, the MOU established several mutually understood principles that guided the development of the WBP (BCWC/CVWB 2016):

1. "MOU Partners are committed to investigating water quality and stream sediment in a scientifically rigorous, data driven manner, and using watershed assessment results to guide WBP development and implementation."
2. "MOU Partners are committed to engaging the local community in the science driven management of the watershed in which they live, maintain relationships with private landowners that offer access to assessment and monitoring sites, and foster long-term acceptance of the Restoration Project by the local community."
3. "MOU Partners are committed to working collaboratively with public/private landowners to address controllable sources of degradation where they are identified through the assessment/planning process, and withhold enforcement action where collaboration can yield effective results."
4. "MOU Partners are committed to using WBP implementation as an opportunity to improve water quality and critical salmonid habitat rather than initiating a 303d listing once the assessment and WBP development activities are completed." Note: the initiation of a 303d listing for an impaired waterbody is not under the control of either MOU partner. The CA State Water Resources Control Board periodically reviews water quality data to determine the need for impaired status. Also note that this MOU is not a legally binding agreement.

The success of the WBP is dependent upon stakeholder participation. As an initial step in the WBP process, watershed stakeholders were identified and their participation in the WBP was encouraged through participation in a Technical Advisory Committee (TAC). Stakeholders were primarily identified through their ongoing participation in the Greater Battle Creek Watershed Working Group. Table 2 identifies the Battle Creek Watershed stakeholders participating in the TAC process.

Table 2. Battle Creek watershed stakeholders participating in the WBP Technical Advisory Committee.

Battle Creek Watershed Conservancy	U.S. Fish and Wildlife Service
Central Valley Water Board	Lassen Volcanic National Park
Sierra Pacific Industries	Resource Conservation District, Tehama Co.
Battle Creek Alliance	Resource Conservation District, Shasta Co.
University of California, Riverside	US Forest Service, Lassen National Forest
Pacific Gas and Electric	California Department of Fish and Wildlife

1.5 Map of the Battle Creek Watershed

The Battle Creek watershed encompasses approximately 369 square miles in northern California, split between Shasta and Tehama Counties. The watershed drains from the western slopes of Mount Lassen to the Sacramento River near the town of Cottonwood. The drainage area is consists of twelve HUC 12 sub-watersheds (Figure 1; Table 3).

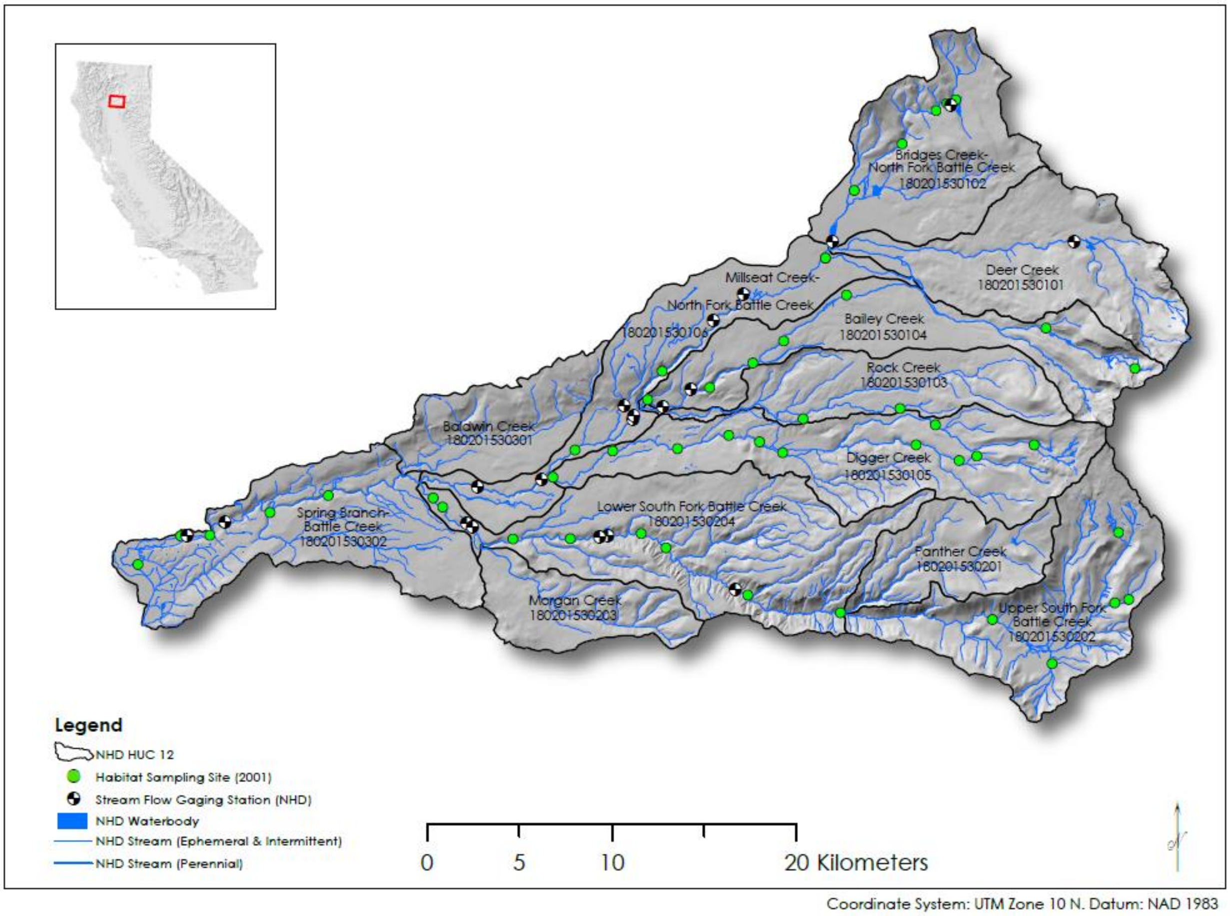

Figure 1 . Map of the Battle Creek watershed and the twelve HUC 12 hydrologic units (sub-watersheds).

Table 3. HUC 12 hydrologic units within the Battle Creek watershed.

HUC 12 Name	HUC 12 ID Number
Bridges Creek-North Fork Battle Creek	180201530102
Millseat Creek-North Fork Battle Creek	180201530106
Panther Creek	180201530201
Upper South Fork Battle Creek	180201530202
Spring Branch-Battle Creek	180201530302
Digger Creek	180201530105
Deer Creek	180201530101
Morgan Creek	180201530203
Baldwin Creek	180201530301
Lower South Fork Battle Creek	180201530204
Rock Creek	180201530103
Bailey Creek	180201530104

SECTION 2.0 – DESCRIPTION OF THE WATERSHED

2.1 Land Use and Ownership

The Battle Creek watershed is sparsely populated with the largest town of Manton having a population of just 347 (USCB 2010; Terraqua 2018). Land use within the Battle Creek watershed is varied and significant for the local and regional economy. Land use as a percentage of total watershed area is approximately: 35% private timberlands; 20% private ranchlands; 27% National Forest lands; 10% National Park lands; 5% viticulture, and <5% dense residential development. The cold-water resources of the watershed also support recreational fishing opportunities, and federal, state, and private fish hatcheries that contribute to commercial and recreational fisheries throughout the state. The distribution of land uses largely follows the dominant vegetation communities which change with elevation. Private ranch lands dominate the lower elevation grasslands and blue oak woodlands, and private timberlands in the conifer /mixed conifer zones across the mid elevations.

Approximately 60% of the watershed is privately owned and 40% is publicly owned by federal, state, or not-for-profit agencies. The largest private landowner is Sierra Pacific Industries (SPI) which actively manages their mid-elevation acreage for commercial timber production representing approximately 35% of the watershed. The largest public ownership is the U.S. Forest Service representing approximately 27% of the watershed area (Terraqua 2018) which is distributed across higher forested elevations often adjoining SPI lands.

2.2 Hydrology

The Battle Creek watershed is characterized as a Mediterranean climate with the majority of precipitation in the form of rain, and snow in upper elevations, occurring during October through May. Precipitation typically peaks in December and January, and the months of June through September see very little precipitation. Stream flows in Battle Creek largely follow the timing and magnitude of precipitation (Terraqua 2018). Due to the volcanic geology, many natural springs are present in the watershed which provide base flows through the summer months that are typically colder than other watersheds in the region. These cold spring flows provide critical habitat and a unique restoration opportunity for populations of Chinook salmon and steelhead listed under state and federal endangered species acts (NMFS 2014). The hydrology of the watershed is also modified by the extensive hydropower infrastructure of Pacific Gas and Electric which includes diversion dams, canals, ditches, flumes, and pipelines (Terraqua 2018). The Battle Creek Salmon and Steelhead Restoration Project being implemented in the watershed is a collaborative multi-stakeholder effort to modify or remove barriers to allow for fish migration to historic habitats and provide sufficient stream flows to meet their life history needs.

2.3 Geology

The geology of the Battle Creek watershed is predominantly underlain by extrusive volcanic deposits from the Pliocene and Holocene ages and include a variety of volcanic deposits including andesite, rhyolite, basalt, dacite, and pyroclast (Terraqua 2018; Figure 2). Mt. Lassen, the highest peak in the watershed at 10,457 feet in elevation, is a volcanic dome. Additionally, there are small glacial and a variety of sedimentary deposits in the watershed. The various geologic formations have soils that vary in their erosion potential and some, such as rhyolite, have much higher erosion or soil redistribution potential when perturbed by wildfire or land use such as timber harvest practices (Terraqua 2018).

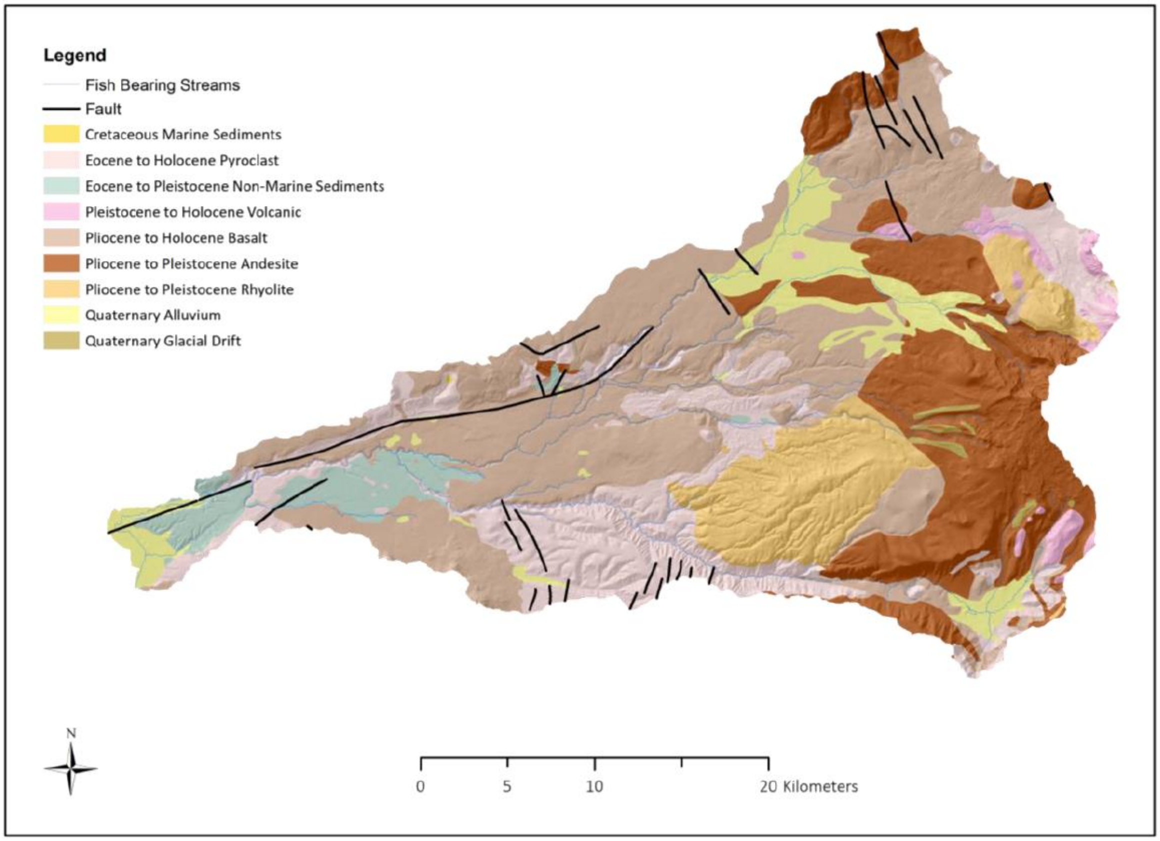

Figure 2. Geologic map of the Battle Creek watershed (*from* Terraqua 2018).

2.4 Vegetation Characteristics

The vegetative land cover in the Battle Creek watershed can be generally characterized as: grasslands and blue oak woodlands at lower elevations; pine forests and mixed chaparral at mid-elevations; and mixed conifer and mixed chaparral at upper elevations (Heiman and Knecht 2010; Figure 3). Terraqua (2018) analyzed Landsat imagery for changes in land cover, or vegetative structure, between 1985 and 2017. Cover classes were based upon the 1992 National Land Cover Dataset, which are based on the Anderson Land Cover Classification System (Anderson 1976). The most significant changes during this time period have been an increase in shrubland and herbaceous cover and a decrease in forest cover (Terraqua 2018). Changes in vegetative structure due to both widespread logging of private commercial timberlands since 2000 and the Ponderosa wildfire of 2012 are evident upon inspection of Landsat imagery maps (Figures 4 and 5). Recent clearcuts are initially identified as herbaceous and then convert to shrublands after a few years, not yet having the conifer height to be classified as a forest type (Figure 4). The Ponderosa Fire and subsequent salvage logging resulted in a similar succession of vegetative structure. A large portion of the burn area (northern half) that was classified as forest pre-fire (2011) was largely converted to herbaceous by 2014, and shrubland by 2017 (Figure 4).

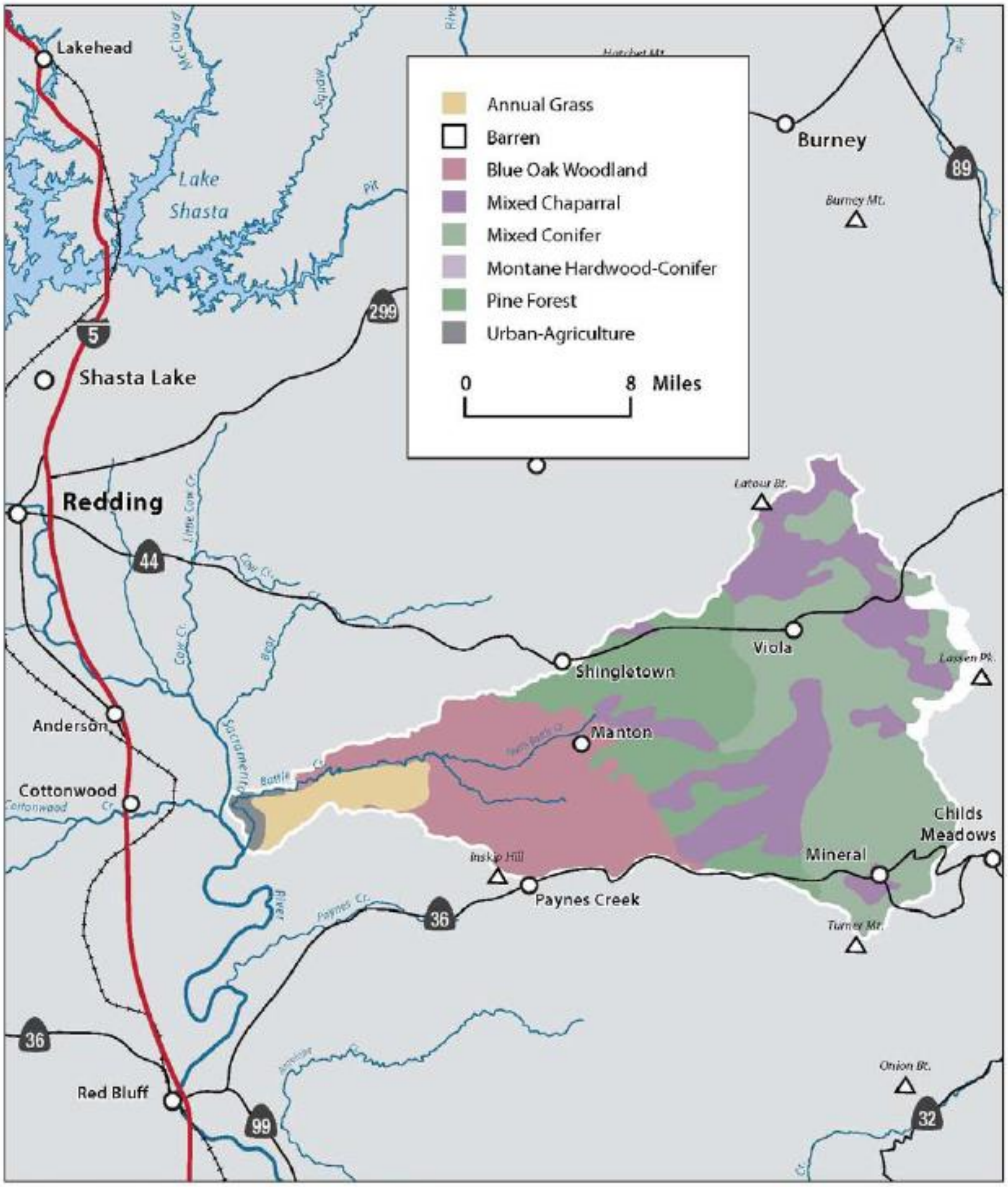

Figure 3. The distribution of vegetation communities in the Battle Creek watershed (*from* Heiman and Knecht 2010).

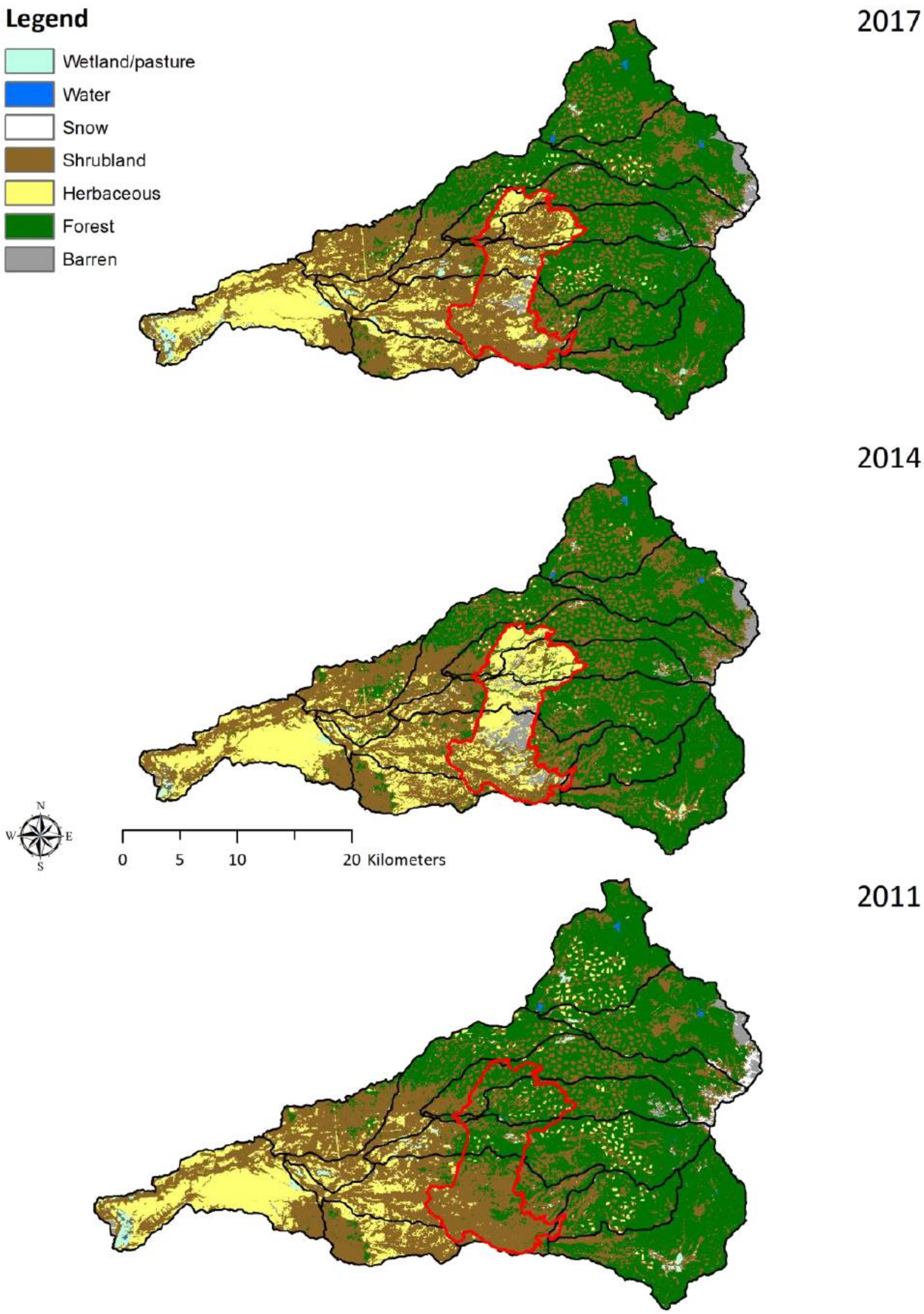

Figure 4. Change in Battle Creek land cover from 2011 to 2017 as derived from Landsat change detection (*from* Terraqua 2018).

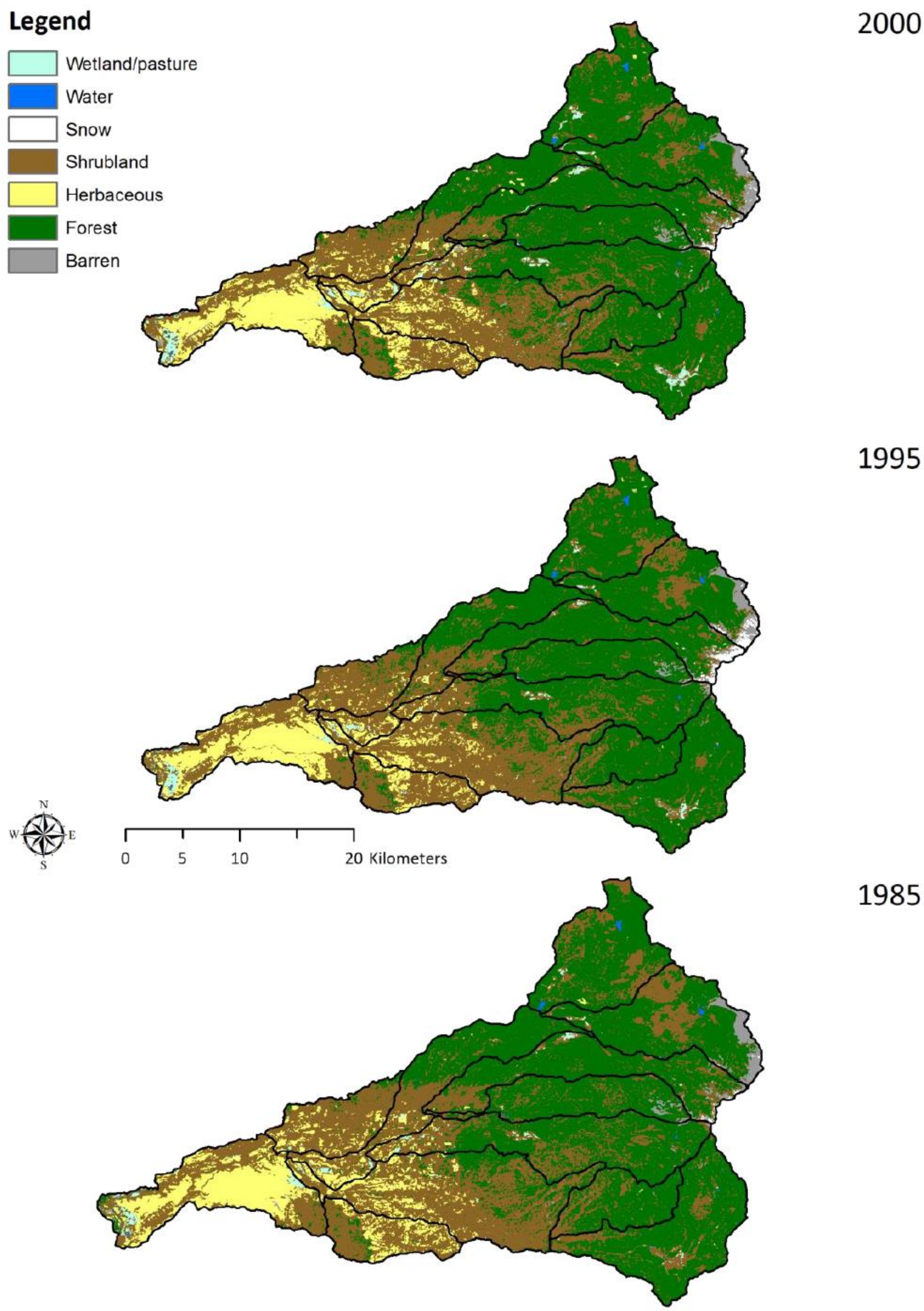

Figure 5 . Change in Battle Creek land cover between 1985 and 2000 as derived from Landsat change detection (*from* Terraqua 2018).

SECTION 3.0 – BENEFICIAL USES AND SEDIMENT STRESSES (EPA Element #1)

3.1 Waterbody Use Designations and Water Quality Criteria

The fifth edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin Basins was adopted by the Central Valley Water Board in May 2018 (CVWB 2018). The Basin Plan designates the beneficial uses to be protected, establishes water quality objectives to protect those uses, and identifies a program of implementation for achieving the objectives for waters within the region. The beneficial uses of Battle Creek identified in the Basin Plan include: agricultural irrigation, agricultural stock watering, hydroelectric power, contact and non-contact recreation, and cold water migration, spawning and habitat for anadromous salmonids (Table 4). Beneficial uses of any specifically identified water body generally apply to all of its tributaries.

Table 4. Beneficial uses identified in the Basin Plan for the Battle Creek watershed (CVWB 2018).

Category	Existing and Potential (p) Beneficial Uses
Agriculture Supply	Irrigation; Stock Watering
Industry	Hydropower Generation
Recreation	Water Contact Recreation; Canoeing And Rafting; Other Noncontact Recreation
Fresh Water Habitat	Warm Freshwater Habitat; Cold Freshwater Habitat
Migration of Aquatic Organisms	Cold Freshwater Habitat
Spawning, Reproduction, and/or Early Development	Warm Freshwater Habitat; Cold Freshwater Habitat
Wildlife Habitat	Wildlife Habitat
Commercial and Sport Fishing	Sport Fishing (p)
Aquaculture	Aquaculture (p)
Municipal and Domestic Supply	Domestic Supply (p)
Rare, Threatened, or Endangered Species	Threatened, or Endangered Species (p)

The Basin Plan prohibits the direct discharge of wastes such as sediment into intrastate waters. Water quality objectives for inland waters relative to sediment, turbidity and temperature effects on beneficial uses are described as follows (CVWB 2018):

- "The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses."
- "Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases in turbidity attributable to controllable water quality factors

shall not exceed the following limits:" Exceedance limits typically range from 10% to 20% above natural turbidity.
- "At no time or place shall the temperature of [designated] COLD or WARM intrastate waters be increased more than 5°F above natural receiving water temperature."

3.2 Sediment Stresses on Beneficial Uses

Sediment loading to waterways has been an ongoing concern in the Battle Creek watershed over the past 20 years. Fish-bearing streams throughout the Battle Creek watershed were assessed in 2001 through 2004 including an analysis of sediment source factors. Fine sediment levels were generally higher than what is favorable for salmonid production and levels observed in unmanaged USFS reference watersheds but were similar to other managed watersheds on USFS lands in California (Terraqua 2004). Elevated sediment levels were hypothesized to be predominately the result of increased erosion associated with precipitation and flooding events during the winter of 1996-97 as there were only weak correlations between stream condition and land use attributes such as road density, road stream crossing frequency and forest cover (Terraqua 2004). Repeat sampling of a subset of long-term stream monitoring sites in 2006 suggested channels were improving in condition relative to benthic macroinvertebrates metrics and percent surface fines (< 2 mm) at long-term monitoring sites (Terraqua 2008a, Tussing 2019).

In 2011, in response to concerns over the potential sediment impacts of clearcut harvesting practices and the rate of harvest on private lands, a state interagency Battle Creek Task Force was formed to perform a rapid assessment of sediment delivery from these practices (Beck et. al. 2011). While no significant direct water quality impact was observed related to clear cutting practices, impacts were observed relative to public and privately managed roads that did not meet Best Management Practices (BMP) standards. Examples of such substandard road features include: substandard design or maintenance practices resulting in roads with poor drainage or roads that had been placed too near watercourses (e.g. 30-50 feet; Beck et. al. 2011). Sediment delivery from road segments that adhered to BMP standards was generally low or unobservable (Beck et. al. 2011).

In August 2012, the Ponderosa Fire burned 27,600 acres at mid-elevations within the Battle Creek watershed, a large proportion being private timberlands. Subsequent salvage logging and reforestation took place on private timberlands where feasible. Post-fire salvage logging is often on a scale equal to that of the fire, which can be much larger than the typical timber harvest plan (THP) size in California (20 to 40 acre maximum). Post-fire emergency documents from CAL FIRE allow harvest within the fire region in compliance with current California Forest Practice Rules and Regulations. While these areas are also exempt from restocking standards, it should be noted that the overwhelming majority of the Ponderosa Fire on small private and private industrial timberlands was replanted at great investment within a three (3) year period. Additionally, herbicide use for reforestation, which targets the temporal suppression of non-conifer vegetative regrowth can increase soil exposure to erosive forces of rainfall. Within the

Ponderosa Fire, reforestation operations commonly involved the placement of severed stems perpendicular to the slope and contour tilling of the soil to increase infiltration and reduce concentrated runoff.

Within the first two winters post-fire, increased rates of debris flows were initiated primarily in Digger Creek and Lower South Fork Battle Creek (Terraqua 2018). However, the most severe sediment inputs to perennial stream channels are observed in the third winter post-fire (2015 WY) which brought high intensity rainfall and flooding to the Battle Creek watershed due to atmospheric river events. This wildfire event and these subsequent sediment-related impacts initiated a suite of stream monitoring, assessment, and planning efforts including the current watershed assessment (Terraqua 2018) and this planning document.

Observations in the 2015 water year indicated that fish habitat and water quality was affected by high sediment loads. There was evidence that anadromous habitats on the South Fork had experienced an increase in sediment deposition and the loss of important pool habitats (USFWS 2015a) that provide over-summer holding opportunities for spring run Chinook salmon. This prompted the installation of a barrier weir at the mouth of the South Fork to prevent the entrance of anadromous salmonids reliant on pool habitats. Additionally, fish survival at the Coleman National Fish Hatchery, on the main stem of Battle Creek, was being affected by high suspended sediment concentrations in late October of 2014 prior to the catastrophic atmospheric river events later in the 2015 water year (USFWS 2015b).

In the 2015 water year some road segments experienced catastrophic failures, especially in the Lower South Fork Battle Creek (CVWB 2015). Much of Ponderosa Way, a mid-slope native surface road on the Northern slope of the Lower South Fork, is currently impassable due to extensive crossing failures. This section of Ponderosa Way was in relatively poor condition pre-fire, with undersized culverts, and poor drainage due to inboard ditches and few ditch relief culverts (PWA 2017). Sediment contributions from Ponderosa Way to the stream network were also influenced by upslope processes including debris flows from burned areas, rill erosion from bare slopes, and fluvial instream transport (PWA 2017). Henkle et. al. (2016) found that the northern slope of the South Fork watershed is highly susceptible to surface erosion, and has areas of high landslide potential. Much of the burned area on this northern slope is underlain by highly erosive rhyolite soils (Figure 2). Rhyolite has much higher erosion or soil redistribution potential when perturbed by wildfire or logging practices (Terraqua 2018). In the 2015 water year, the South Fork stream channel had transported 88% of the total combined sediment load of the North and South Forks combined (Henkle et. al. 2016).

As the Ponderosa wildfire occurred in the mid-elevations of the watershed across the Lower South Fork and North Fork tributaries of Digger and Rock Creeks, many downstream beneficial uses were stressed by the high post-fire sediment loads carried by the stream networks (Table 5).

Table 5. Recent post-fire stresses on beneficial uses within the Battle Creek watershed.

Category	Beneficial Use	Stressed By
Agriculture Supply	Irrigation	Suspended Sediment Load
Industry	Hydropower Generation	Suspended Sediment Load
Fresh Water Habitat	Cold Freshwater Habitat	Suspended Sediment Load
Migration of Aquatic Organisms	Cold Freshwater Habitat	Suspended Sediment Load
Spawning, Reproduction, and/or Early Development	Cold Freshwater Habitat	Suspended Sediment Load
Commercial and Sport Fishing	Sport Fishing (p)	Suspended Sediment Load
Aquaculture	Aquaculture (p)	Suspended Sediment Load
Municipal and Domestic Supply	Domestic Supply (p)	Suspended Sediment Load
Rare, Threatened, or Endangered Species	Threatened, or Endangered Species (p)	Suspended Sediment Load

(p) are potential beneficial uses are effected activities within the watershed though not technically identified in the Basin Plan as existing beneficial uses.

More recent information on the post-fire condition of the stream channels relative to fish habitat, water quality, physical channel integrity, and percent fine sediment indicates that channels are recovering from 2015 water year high sediment loads. Stream surveys in summer of 2017 found that large amounts of fine sediments have been significantly reduced. The holding and spawning areas in the lower reach of South Fork of Battle Creek that were previously described as unsuitable for spring-run Chinook had recovered to the point of being suitable and the barrier weir was no longer necessary (USFWS 2017). Biological diversity in this reach had increased both in terms of fish diversity, abundance and age classes present, as well as the observable recolonization of cobble substrates by benthic macroinvertebrates (USFWS 2017). Although significant reductions in fine sediments were observed, deposits of fine sediments remained in this reach indicating it has not fully recovered from the effects of sedimentation subsequent to the Ponderosa Fire (USFWS 2017). Additionally, a large plume of fine sediments is being mobilized downstream into the mainstem of Battle Creek (USFWS 2017) filling in pools and covering spawning habitat in the lower river (USFWS 2019).

Stream condition monitoring in fall of 2017, implementing the California Surface Water Ambient Monitoring Program (SWAMP) protocol, tells a similar story in trends of stream condition. While the most significant impacts of the 2015 water year were not captured by stream condition surveys, SWAMP surveys in the fall of 2017 indicate that all major Battle Creek sub-watersheds were in a “likely intact” condition with the exception of the mainstem of Battle Creek which ranked as “likely altered”, though represented by a single sample reach. Based upon the 24 probabilistic sites sampled in 2017, the watershed as a whole was in better condition relative to the California Stream Condition Index (CSCI 1.05) than it was in 2001 (CSCI 0.88, n = 43), though not statistically different from CSCI values in 2006 (CSCI 0.99, n=50; Tussing 2019). Physical habitat condition results relative to the SWAMP Index of

Physical Integrity (IPI) indicate that the watershed as a whole and all sub-watersheds were in "likely intact" condition (Tussing 2019). However, the one sample site on the mainstem Battle Creek exhibited the highest percent surface fines and cobble embeddedness values observed across the 24 sites sampled which were at or exceeding thresholds thought to impact the benthic macroinvertebrate community (Tussing 2019).

3.3 Controllable Sources of Sediment

Unpaved roads are commonly the primary controllable sediment source in rural settings. These sources represent both chronic pollution, occurring at every significant rainfall event, and episodic pollution where watercourse crossings fail and fine sediment is transported downstream. Post-fire land management practices may also play a significant role in sediment production and delivery to streams in the watershed (PWA 2017; Lewis et. al. 2018). Although the exact proportion of controllable or uncontrollable sediment inputs resulting from large wildfires is unclear, it is clear that the effects of large wildfires, very-large storms following fires, and land disturbances resulting from post-fire logging potentially pose a threat to water quality. This section describes the impacts from unpaved roads and land management practices related to large wildfires as controllable sediment sources.

3.3.1 Unpaved Roads

Unpaved road sediment delivery for the entire Battle Creek watershed was assessed using the GRAIP-Lite analysis tool (Terraqua 2018). GRAIP-Lite sediment delivery values are model based estimates and can vary from the actual sediment delivered from a road segment. Additionally, GRAIP-Lite doesn't include sediment inputs from gullying and landslides caused by roads or fill failures, so should be considered a low estimate of road related sediment delivery. At the watershed scale, approximately 17% of the road network sediment produced is delivered to streams (Terraqua 2018). Estimates of both road sediment delivery and road density through GRAIP-Lite modelling vary considerably across the HUC 12 catchments that comprise Battle Creek with nearly 40% of sediment delivery explained by road density (Figure 6). Digger Creek (N.F. tributary) and the Lower South Fork have the highest estimated rates of sediment delivery while Millseat Creek and Rock Creek, both on the Nork Fork, have the highest road density (Figure 6). However, when viewed spatially at the scale of micro-catchments (average size of 0.23 km^2) the greatest sediment delivery contributions are spread throughout the mid to upper elevations (Figure 7).

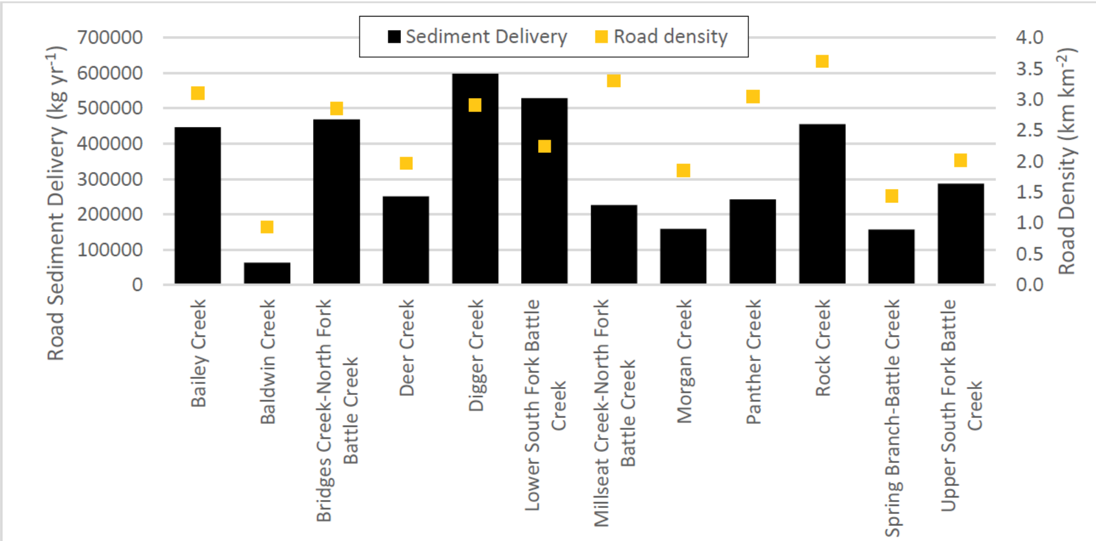

Figure 6. Unpaved road sediment delivery estimates and road density in each of the HUC 12 sub watersheds (Terraqua 2018).

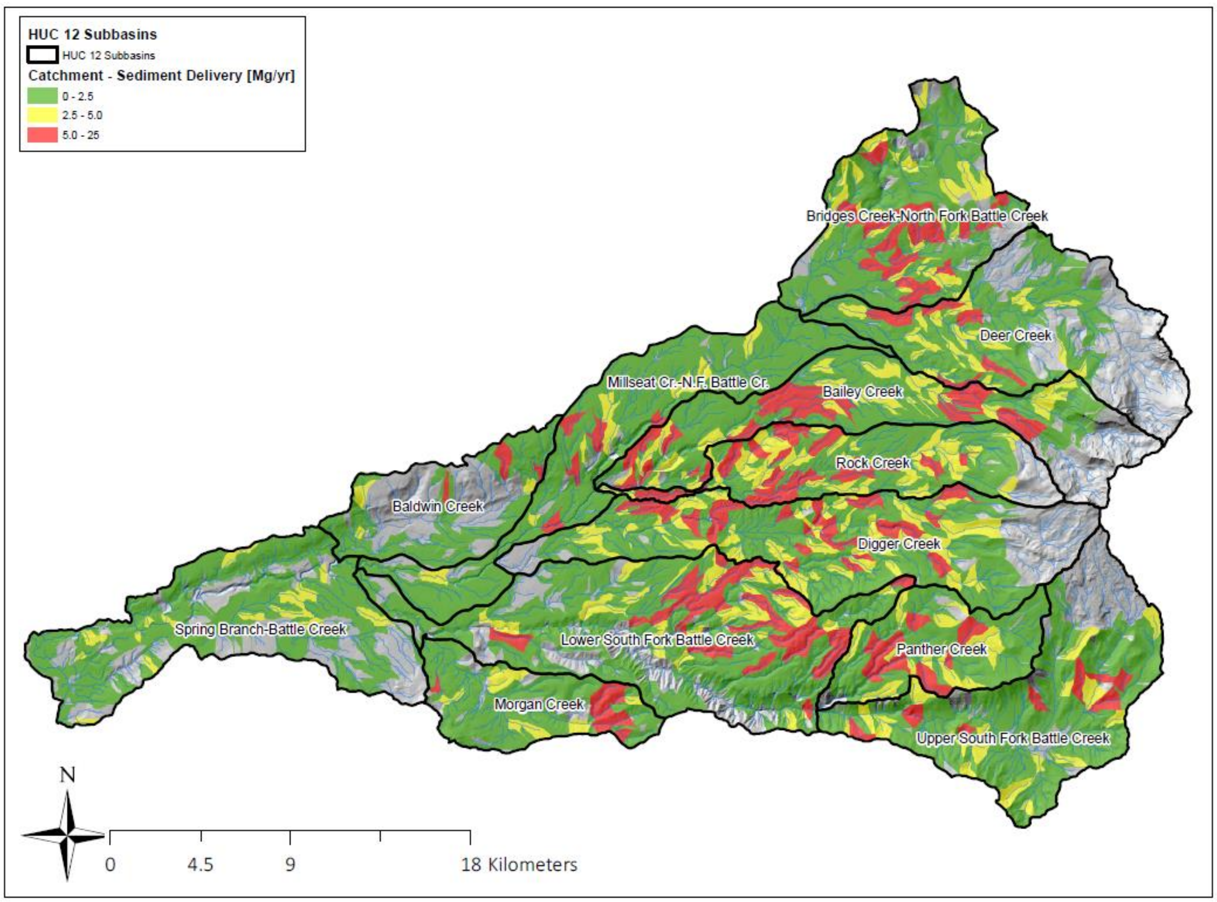

Figure 7. Road sediment delivery per GRAIP-Lite micro-catchment in units of Mg/yr (Terraqua 2018).

From upslope investigation of existing and potential road related sediment sources in the Lower South Fork sub-watershed PWA (2018) found that that the most significant sources were in the burn area along the inner gorges and stream side hillslopes. While the main haul roads in this area were in good condition meeting current best management practices, many of the secondary native surface haul roads used during salvage logging were not up to current standards by concentrating runoff, often being gullied or heavily rilled, and discharging to stream channels (PWA 2018).

3.3.2 Vegetation Management

Wildfire has the potential to exert sediment related stresses to watercourses through the interaction of fire severity, soil erosion potential, landslide risk and the routing and delivery of sediment by the unpaved road network. While wildfire is not considered a controllable sediment source, there are management measures that can be implemented to reduce wildfire risk and severity, and promote landscapes that are resilient to wildfire disturbance. Forest structure plays an important role in the spreading of wildfire. Extensive fire research shows that four factors working together result in large, high-severity wildfires. These are: weather (including wind and very low humidity); terrain characteristics; lack of moisture in both soil and fuels; and, an abundance of fuels (combustible grasses, chaparral, or forest materials). Of these factors, only fuel abundance is controllable by human influence (USDA 2003). Wildfires are trending toward larger sizes and greater severity (Collins et. al. 2019). Both Goode et. al. (2012) and Gould et. al. (2016) predict that with climate change bringing larger wildfires with higher severity, sediment yields will increase and negatively impact beneficial uses of water. Given this trend, the immediate need to increase the magnitude of fuels reduction projects on both private and public lands in Battle Creek is apparent.

3.3.3 Post-fire Management

Substantial changes to the landscape following high-intensity fires can leave the ground surface susceptible to accelerated erosion. Post-fire logging and associated road building, has the greatest potential to increase erosion impacts where ground-based yarding occurs especially on steep slopes and sensitive soils (McIvar and Starr, 2000). There is evidence that in some cases salvage logging, and erosion control treatments (e.g. contour sub-soiling), when implemented within the first two years post-fire can substantially reduce the amount of sediment generated at sites when compared to burned sites with no salvage logging disturbance (James and Krumland 2018). However, these results cannot be assumed to be effective when applied to geologies that have greater sensitivity to disturbance (wildfire, logging) or greater slopes than those upon which the studies are based.

Turbidity levels within streams draining areas burned in the Ponderosa wildfire and subsequently salvage logged in the Battle Creek watershed generally increased across the three year post-fire period (Lewis et. al. 2018). An analysis of turbidity data from 2009 to 2015 at 13 locations across all major tributaries indicated that sites draining areas with the highest road densities and the most harvesting and had the highest turbidity before the fire and throughout the monitoring period (Lewis et. al. 2018). Associations with harvesting are partly confounded with wildfire and road density as both of these factors appear to have affected turbidity levels (Lewis et. al. 2018). However, after accounting for road effects, turbidity remained strongly associated with harvesting (Lewis et. al. 2018).

The Battle Creek watershed is comprised of a wide variety of geologic formations (Figure 2). These formations vary in their erosion and landslide potential, and their response to disturbance from wildfire and logging (Terraqua 2018). Results from Terraqua's (2108) study of erosion rates (soil redistribution) for various geologies and disturbance types performed for this planning effort, indicate that rhyolitic soils have the highest erosion rates in the watershed when disturbed by wildfire or logging. Sites that experienced both wildfire and logging had even higher average erosion rates. Rhyolitic soils within the Ponderosa fire footprint are confined to Northern slopes of the South Fork Battle Creek watershed (lower South Fork and Panther Creek HUC 12's) and the Digger Creek watershed. Terraqua (2018) concluded that wildfire, wildfire prevention measures (fire lines) timber harvest activities, and roads have all contributed to the initiation of landslides in recent years. Within the Ponderosa fire footprint, 14 debris flows were identified (33% of watershed total landslides) as contributing sediment to South Fork Battle Creek, 10 of which originated in rhyolite soils that had been subject to salvage logging.

Given the post-fire sediment impacts to the South Fork of Battle Creek and the results of sediment source investigations, it is unwarranted to assume the results of James and Krumland (2018) would apply to the Battle Creek watershed as a whole. The study was based on soils in the lower Rock Creek drainage that are half as erosive that of rhyolite (See figure 26, Terraqua 2018). Swale treatment sites exposed to experimental combinations of salvage logging, contour sub-soiling, and biomass removal had average centerline slopes of 19% (average side slopes of 21%).

Operational consideration and erosion control efforts designed to reduce sediment impacts were implemented across all private timberlands which conducted salvage logging. While much of the Ponderosa Fire burned on Industrial timberland, not all logging applications were equal. Required BMP's were applied on the entire area salvage logged and, in some cases, additional measures were implemented to reduce sediment impacts. The results from the BMP efforts demonstrated that sediment impacts continued to occur throughout the salvaged landscape. Continual research is recommended for future salvage logging plan development that considers BMP development, soil erosion rates, landslide potential and the unpaved road network.

SECTION 4.0 - SEDIMENT REDUCTION PRIORITIES AND GOALS (EPA Element #2)

4.1. Sediment Load Reduction Priorities

Existing road networks and watercourse crossings represent both sediment delivery problems that occur during every significant rainstorm and those that occur episodically. Post-fire management can only occur after a large fire and fuel hazard reduction projects are useful only as a preventative measure. Fire-related priorities are different because fires threaten life and property in addition to sediment loading, and the timing of their need is not controllable, as opposed to road sediment delivery projects. Therefore these priorities are laid out separately in this document and may be considered as parallel priorities.

The importance of the watershed to regional anadromous salmonid recovery warrants mention, even though the prioritization of sediment reduction projects is not based on beneficial uses for Battle Creek. NOAA (2005) identifies the critical habitats within Battle Creek for Central Valley spring run Chinook salmon and steelhead ESU's and the primary constituent elements essential for their conservation including:

> "(1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
> (2) Freshwater rearing sites with:
>> (i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
>> (ii) Water quality and forage supporting juvenile development; and
>> (iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
>
> (3) Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival."

The various funding entities of sediment source reduction projects often self-prioritize the benefits to at-risk anadromous salmonid habitats, and because of this, the following provides general guidance on priority HUC 12 watersheds within the greater Battle Creek watershed relative to these critical habitats. While extent of critical habitats for winter run Chinook salmon, targeted for re-introduction, have not been identified they are included here assuming that their habitat use would approximate that of spring run Chinook salmon. The HUC 12 watersheds that comprise the North Fork are of the highest priority for restoration priorities of anadromous salmonids because these waters support habitat for endangered winter run Chinook salmon, threatened spring run Chinook salmon, and steelhead trout (Table 6). Winter run Chinook salmon spawning and early life history rearing habitat is found exclusively in the Millseat Creek-

N.F. Battle Creek HUC 12 watershed. Natural barriers prevent access of all anadromous salmonid stocks upstream of this waterbody. The five HUC 12 waterbodies that drain directly into the Millseat Creek HUC 12 can influence the quality of these habitats for these at-risk salmonids.

Table 6. Anticipated post-restoration presence of anadromous salmonid habitats for at-risk threatened (T) and endangered (E) species / stocks in Battle Creek HUC 12 watersheds.

		Anadromous Salmonid Habitat			Anadromous Salmonid Stocks		
Tributary / Region	Catchment HUC 12	Holding	Spawning	Rearing	Winter run Chinook (E)	Spring run Chinook (T)	Steelhead Trout (T)
North Fork	Millseat Creek-N.F. Battle Creek	X	X	X	X	X	X
South Fork	Lower South Fork Battle Creek	X	X	X		X	X
	Upper South Fork Battle Creek 1	X	X	X		X	X
	Panther Creek 1		X	X			X
Mainstem Tributaries	Baldwin Creek		X	X			X
	Morgan Creek		X	X			X

1. There is uncertainty as to the accessibility of anadromous salmonid habitat in Upper South Fork Battle Creek below Angel Falls.

The HUC 12 watersheds that comprise the South Fork are also significant for the recovery of threatened stocks including spring run Chinook salmon and steelhead trout (Table 6). The Lower South Fork Battle Creek HUC 12 captures the majority of this over-summer adult holding, spawning, and juvenile rearing habitat. Three upstream HUC 12 waterbodies drain directly to Lower South Fork Battle Creek. Additionally, the Spring Branch Battle Creek HUC 12 that captures the mainstem of Battle Creek provides seasonal opportunities for juvenile rearing and adult and juvenile migration.

4.1.1 Unpaved Roads

Sediment load reduction priorities for unpaved roads are identified as areas of highest estimated sediment delivery. These estimates are from the GRAIP-Lite simulation results (Terraqua, 2018) of road sediment delivery to watercourses and summarized over very small catchment areas, or "micro-catchments". Low, moderate and high priority micro-catchments are identified as having 0-5, 5-10, and 10-250 Mg/yr/km^2 sediment delivery respectively (Green, Yellow and Red polygons, Figure 8). The average size of micro-catchments is 0.23 km^2 with the number of micro-catchments in low, moderate and high priority categories being 1,991 (47%), 496 (12%) and 468 (11%) respectively. Micro-catchments with zero estimated road sediment delivery are 1,244 (30%). Additional analysis for areas in which to focus sediment reduction projects from the unpaved road network are identified as drain points that exceed 0.5 Mg/yr and are within 250 meters apart (grey circles, Figure 8). While the estimates from the GRAIP-Lite analysis are hypothetical, and require detailed, field-verified quantifications of sediment delivery, it does provides an estimate of relative sediment delivery across micro-catchments that comprise the entire watershed in an objective manner to establish priorities regardless of land ownership patterns. Additionally, model based GRAIP-Lite results do not estimate the potential risk of episodic sediment delivery from such mechanisms as road crossing failures. Prioritizing episodic sediment delivery from stream crossings is not possible because it requires an understanding of likelihood of failure (culvert size or surface erodibility) and the volume of fill at risk, both of which are not attainable via the techniques used for the watershed-scale evaluation.

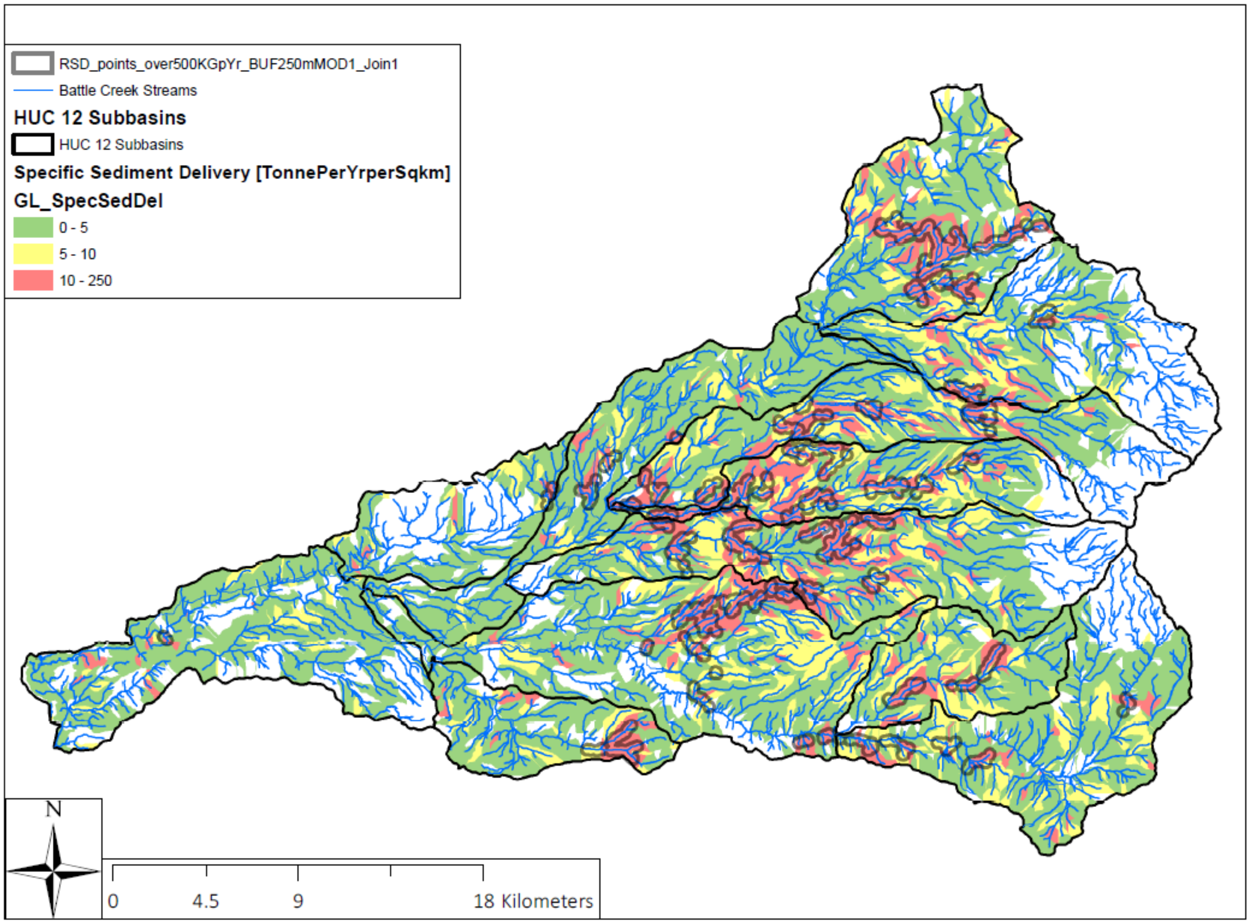

Figure 8. Prioritization of modeled road sediment delivery for micro-catchments (Mg/yr/km^2) and the location of road drain points that exceed sediment delivery of 0.5 Mg/yr. (Terraqua 2018).

The micro-catchments and major drain points identified in Figure 8 identify the priorities for implementation of site-specific road assessments and sediment reduction plans. Micro-catchments that exceed sediment contributions of 10 Mg/yr/km^2 (red polygons) and mapped delivery points that exceed 0.5 Mg/yr. (grey circles) are hypothesized to have the highest potential to deliver sediment to the stream network of Battle Creek. It is anticipated that the scale of road assessment areas will be at least an order of magnitude greater than those of micro-catchments, and that the priority areas will be grouped by proximity, road connectivity and ownership considerations (see Section 5 Management Measures). Sediment reduction plans will establish high, moderate and low immediacy rankings for both chronic and episodic sediment delivery sources identified. Appendix B provides an example of the prioritization of chronic and episodic sediment delivery sources identified in a recent road assessment in the South Fork Battle Creek watershed (PWA 2018) that is consistent with nine element planning guidelines.

4.1.2 Vegetation Management

This plan recommends the consideration of the combined factors of soil erodibility, landslide potential, and chronic road sediment delivery when prioritizing fire prevention/fuels reduction projects in the Battle Creek. The decision support tool developed by Terraqua (2018) uses these factors to highlight areas of the basin that are of higher erosion risk, and can be used as a tool by managers to focus fuels reduction projects (Figure 9). Of course, planning fuels reduction projects involves many more important factors than sediment issues, such as life and property values, however sediment load reductions can add to such decisions, or be used once fuels projects have adequately addressed these more important values.

The Community Wildfire Prevention & Mitigation Report (CAL FIRE 2019) identifies the HWY 44 Fuels Reduction Project as its top priority. This project is a 1,112-acre shaded fuel break near Shingletown, CA, and is roughly 23 miles long. This fuel break project lies partially within the Battle Creek Watershed and will add a vital piece of fuel reduction along the northern border of Battle Creek Watershed that compliments existing fuel breaks completed within the Battle creek Watershed. Subsequent fuels reduction projects within Battle Creek Watershed could also use connectivity to other fuel break projects as a guide for land managers in creating a network of interconnected fuel breaks throughout the watershed. In 2017, the USFS, CAL FIRE, National Fish and Wildlife Foundation, and industrial timberland owners entered into a Memorandum of Understanding (MOU) to collaborate together to coordinate wildfire risk reduction measures as an example of how the government and private sector can work together to address important safety and environmental issues. Planning of changes in silvicultural prescription to increase fire resiliency could also be aided using the decision support tool (Figure 9) to protect both communities and wildlife.

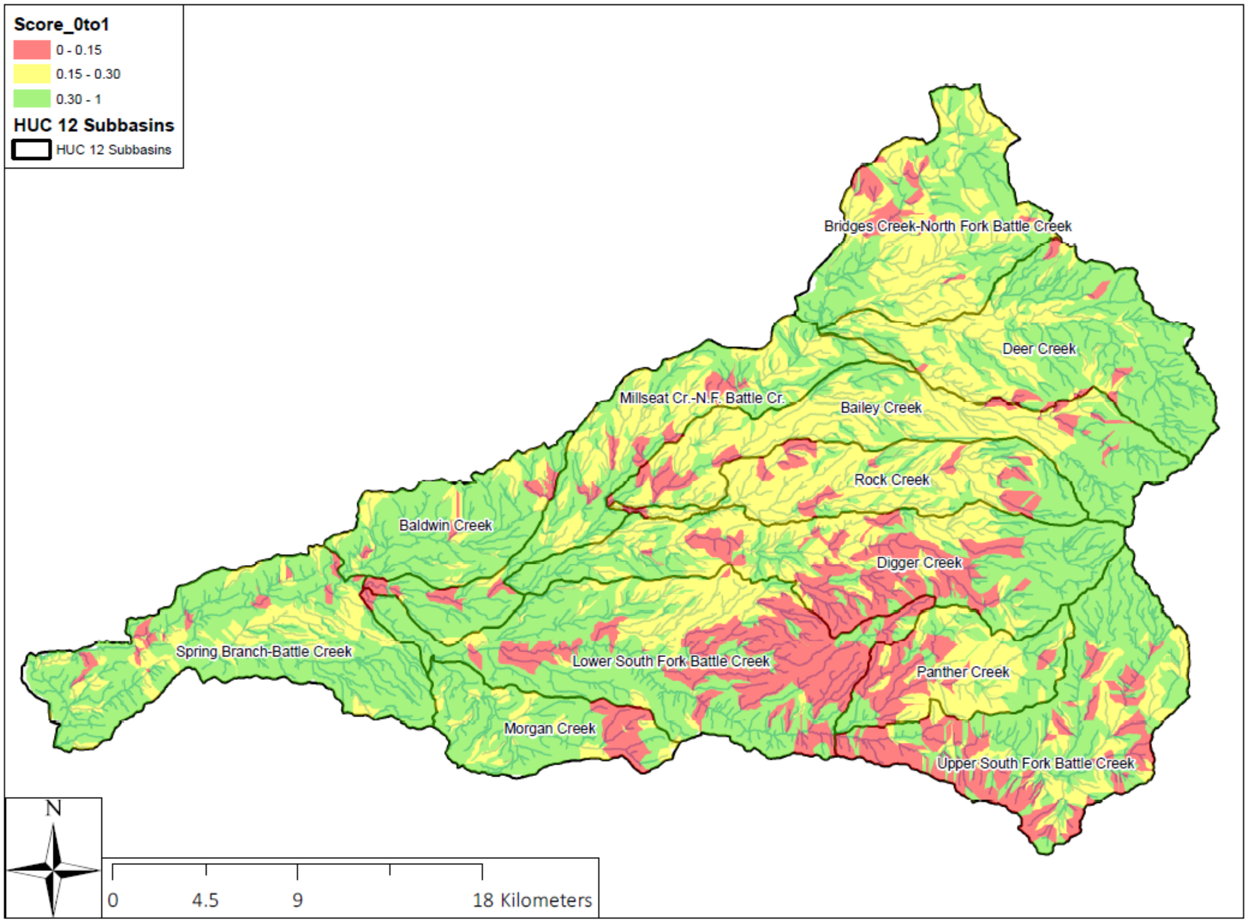

Figure 9. Decision support tool results incorporating specific road sediment delivery, landslide potential, and soil redistribution potential (Terraqua 2018).

4.1.3 Post-fire Management

When the next wildfire occurs in Battle Creek watershed, the decision support tool (Figure 9; Terraqua, 2018) could be used as a guide to assess sensitive areas as a salvage logging operations area developed. The tool was developed generally for the basin and any areas already sensitive to erosion would be amplified under post-fire condition. Areas within the Upper and Lower South Fork Battle Creek HUC12, Panther Creek HUC12 and Digger Creek HUC12 (Figure 9, red polygons) indicate the highest relative sensitivity to combined factors of erodibility, landslide potential, and chronic road sediment delivery. This represents the top 15% of the risk category. Additionally, the eastern portion of Morgan Creek, the northern portion of Bridges Creek/North Fork Battle Creek show small, yet concentrated areas of high sensitivity. It should be noted that the areas shown in yellow on the DST figure indicate the top 15% to 30% of risk categories, which covers much of the timber production zone within Battle Creek.

4.2. Sediment Load Reduction Goals

Establishing quantitative sediment load reductions goals is challenging given the lack of a rigorous sediment budget for the watershed and the difficulty in quantifying sediment savings from fire resilience/ fuels reduction efforts that may lessen the severity of wildfire. Additionally, the vegetation management portion of controllable sediment sources is largely a placeholder in this planning document as there were no dedicated assessment efforts to quantify fuels loadings, model fire behavior, or analyze the distribution of existing fuel breaks for potential gaps. When the vegetation management strategy is complete, goals in terms of acres of fuels reduction treatment or miles of fuel break will be possible. In the future, the addition and refinement of goals will be captured and tracked with the online planning tool (data portal).

Sediment reduction goals presented here focus on the unpaved road network within the Battle Creek watershed. The high priority micro-catchments (Figure 8, red polygons), drain points and contributing road segments, establish interim goals for sediment reductions from chronic road sources and goals for the implementation of detailed road assessments. Sediment reduction goals in terms of reducing chronic unpaved road sediment delivery as estimated by the GRAIP-Lite model, represent a 49% reduction (1,912 Mg/yr) by addressing 11% of micro-catchments in the Battle Creek watershed (Table 7). Estimated chronic sediment reductions in the North Fork, South Fork and Mainstem of Battle Creek are 55%, 41%, and 27% respectively (Table 7). These goals assume that priority road networks can be treated to attain near 100% disconnection from the stream network. These sediment reduction goals are interim by necessity because assessments of priority unpaved road networks will result in more accurate estimates of sediment delivery from both chronic and episodic sources and the estimates of sediment savings for priority treatments.

Table 7. GRAIP-Lite modeled estimates of annual sediment delivery from unpaved road segments within priority micro-catchments.

Tributary / Region	**Watersheds HUC 12**	**Number of Priority Micro-catchments (GL_SpecSed >10 Mg/yr/km^2)**	**Percent of Total Micro-catchments within Watersheds**	**Road Sediment Delivery from Priority Micro-catchments (Mg/yr)**	**Percent of Total Road Sediment Delivery within Watersheds**
North Fork	Millseat Creek-N.F. BC	18	6%	69	30%
	Deer Creek	33	8%	101	40%
	Bridges Creek-N.F. BC	59	16%	301	64%
	Bailey Creek	55	15%	246	55%
	Rock Creek	59	24%	274	60%
	Digger Creek	94	20%	355	59%
	Totals	**318**	**14%**	**1346**	**55%**
South Fork	Lower South Fork BC	61	12%	243	0.461
	Upper South Fork BC	31	7%	75	0.262
	Panther Creek	19	11%	102	0.419
	Morgan Creek	20	12%	85	0.529
	Total	**131**	**10%**	**505**	**41%**
Mainstem	Baldwin Cr	6	3%	22	35%
	Spring-Branch	13	3%	38	24%
	Total	**19**	**3%**	**60**	**27%**
Battle Creek Watershed Totals		**468**	**11%**	**1912**	**49%**

SECTION 5.0 –DESCRIPTION OF NONPOINT SOURCE MANAGEMENT MEASURES NEEDED (EPA Elements #3, #6, #7)

This section describes the management measures needed to reduce sediment threats to water quality, a description of the implementation schedule and project milestones. The management measures include road sediment reduction projects that include road assessments and implementation projects, and fuels reduction projects.

5.1. Management Measures Needed to Reduce Sediment Threats

5.1.1 Unpaved Roads

Minimizing sediment delivery from prioritized drain points and associated road segments will require: 1) additional field validation of modeled GRAIP-Lite results through assessments of priority road segments; 2) the development of prioritized sediment reduction plans for assessed areas; and 3) the implementation of a variety of road related management measures that will address both chronic and episodic sources of sediment delivery. This section identifies both the ongoing efforts to evaluate and treat road related sediment delivery within the context of prioritized micro-catchments and drain points, and identifies new project areas to address the remaining prioritized areas. The suite of management measures needed to accomplish sediment source reduction goals are described, as well as the guiding documents that describe current best management practices applicable by land ownership.

Two ongoing road assessments implemented by two Resource Conservation Districts (RCD) capture several priority drain points in the Lower South Fork Battle Creek (RCD, Tehama County) and Rock Creek (RCD, Shasta County) HUC 12 watersheds (Figure 10). Both of these projects focus on a main unpaved county road artery and road spurs on private lands. These assessments will result in specific road related work plans consistent with the nine element planning guidance (e.g. Appendix A).

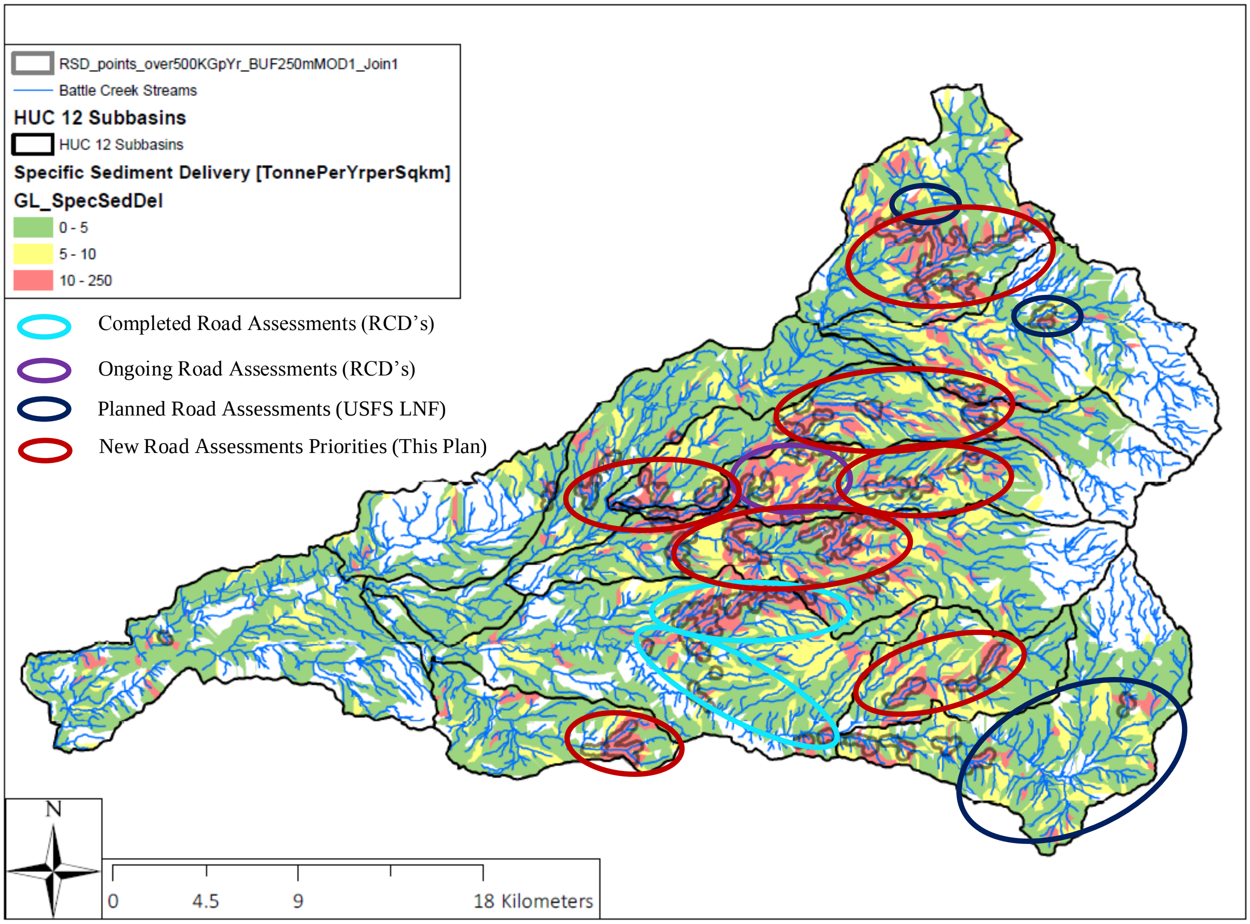

Figure 10. Priority Micro-catchments and drain points, land ownership, road assessment projects in progress, and priority road assessments for implementation.

Additionally, Lassen National Forest (LNF) is implementing the Southwest Lassen Watershed Improvement Project which is focused on reducing chronic and potential sediment sources being routed from roads to streams and improvements to road crossings to accommodate bedload, stormflow and aquatic organism passage (LNF 2018). Improvement and/or rehabilitation activities are categorized into two different treatment area types: National Forest Transportation System (NFTS) road and stream intersections; and, non-NFTS routes on National Forest System lands. The maximum extent of the disturbance for NFTS road / stream intersection activities are:

on the road prism, up to 500 feet in each direction from the crossing structure with a 60 feet total width; and, in the stream channel, up to 200 feet in each direction and a width of ten feet beyond the bankfull elevation (100 feet maximum).

NFTS road / stream intersection treatments may include the following management measures:

1. Road/Stream Crossing Reconstruction Activities
2. Drainage Structure Maintenance
3. Armoring
4. Drainage Structure Installation
5. Surfacing
6. Road Prism Shaping
7. Rolling Dip
8. Diversion Prevention Dips (DPDs)
9. Cut or Fill Slope Stabilization

The maximum extent of the disturbance for activities on non-NFTS routes are: on the route prism, up to 100 feet total maximum width; and, in the stream channel, up to 200 feet in each direction and a width of ten feet beyond the bankfull elevation (100 feet maximum).

Non-NFTS route sites may be rehabilitated using one or more of the following decommissioning strategies:

1. Culvert/Road-Fill Removal and Channel Restoration
2. Non-Drivable Waterbar Installation
3. Boulder or Log Installation
4. Re-establishing Vegetation
5. Recontouring Route Prism
6. Decompacting Route Surface

Several of the stream crossings that LNF has identified for evaluation and treatment are also identified within this current WBP effort as high priority drain points with modeled sediment delivery exceeding 0.5 Mg/yr (Figure 10). The landscape-scale NEPA permitting for this project is anticipated to be completed in October 2019.

Most of the remaining micro-catchment and drain point priorities occur on private commercial timberlands or other smaller private ownerships. As the largest landowner in the watershed, the mid-elevation commercial timberlands of Sierra Pacific Industries (SPI) encompass a large proportion of high priority sites (Figures 10, 11).

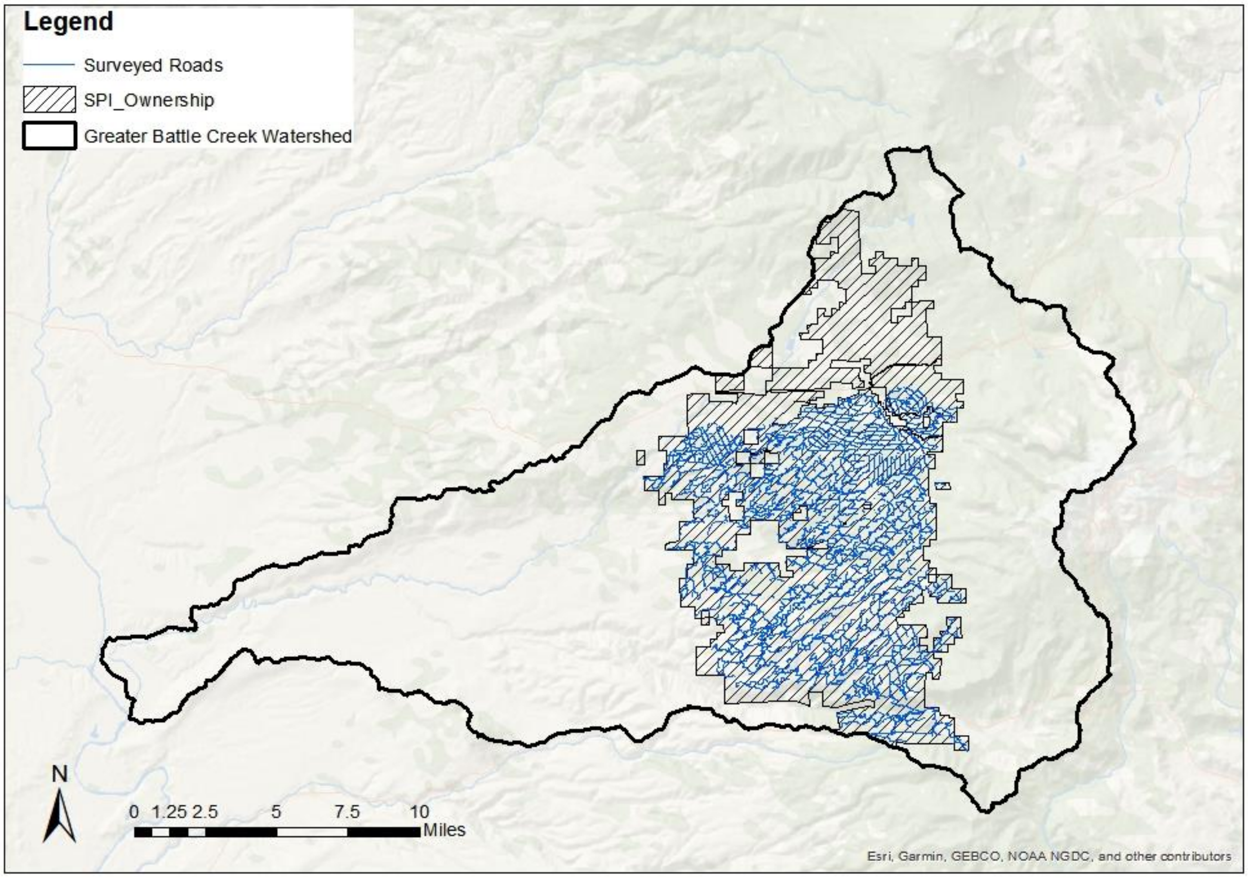

Figure 11. Extent of roads surveyed for sediment delivery across Sierra Pacific Industries ownership. Road segments inventoried have been prioritized for treatment as maintenance workstations or to be included in future THP road projects. (jpeg file courtesy of Sierra Pacific Industries).

A recently completed and published road inventory and erosion assessment (Benda et.al. 2019) was performed by the Research and Monitoring Department of Sierra Pacific Industries (SPI) in collaboration with Terrain Works. This study inventoried the Bailey, Digger, and Rock Creek Watershed road networks within the Greater Battle Creek Watershed on a 135 km^2 or 52 sq. mi. of SPI's forestlands. The field road network inventory took detailed information on 9,647 road segments with added engineered drains across the three sub-basins. This field data was then used to populate and run the ROAD EROSION AND DELIVERY INDEX MODEL (READI) that provides a direct estimate of hydrologic connectivity between road and stream networks by calculating the road length contributing water and sediment to streams. As reported in the Journal of American Water Resources, (Benda et al. 2019) the READI model assesses current road network conditions within SPI lands in the Greater Battle Creek Watershed and identifies specific locations to optimize and prioritize future road improvements. Additionally, READI provides guidance on locations where new drain placements can be installed to reduce road erosion and sediment delivery to streams. The road network inventories and READI model estimated where the largest achievable sediment delivery reductions can occur on areas where inventory and model results are available. SPI can combine these results with mitigation costs and specific water resource concerns to determine the best strategy for reducing site-specific sediment delivery.

Road assessments to be performed on suites of related high priority sites throughout the watershed will also refine sediment source reduction priorities, sediment savings estimates, and management measures to be implemented. A variety on management measures will be required to effectively treat priority drain points to reduce both chronic sediment inputs from the unpaved road network and to mitigate the threat of episodic failure of road crossings and road fill (Table 8). Best management practices (BMP) guidance for management measures often varies by land ownership. Guiding documentation for the implementation of management measures for specific ownership types is provided in Table 9. However, regardless of land ownership both Weaver et. al. (2015) and CAL FIRE (2017) provide excellent guidance regarding best practices for unpaved rural roads.

Table 8. The suite of management measures that road assessments of priority micro-catchment and drain points may identify for implementation.

Unpaved Road Feature	Management Measure	Goal
Stream / Drainage Crossings	Crossing Upgrades	Passes 100 year flood flows, wood, and sediment
Other Drain Points	Drain Point Upgrades	100% Disconnected from stream network, erosion resistant
Road Segments Contributing to Crossings	Outsloping Rolling Dips Ditch Relief	100% Disconnected from stream network
	Rocking / Hardening	Erosion resistance
	Road Reconstruction	Road placement away from watercourses
	Road Abandonment / Decommissioning	Stabilize sediment at risk of chronic and/or episodic delivery

Table 9. Best management practices guidance by land ownership.

Land / Easement Ownership	Best Management Practices Guidance
Public, National Forestlands (USFS)	Water Quality Management for Forest System Lands in California, Best Management Practices (USDA 2011a)
	National Best Management Practices for Water Quality Management on National Forest System Lands – Volume 1 (USDA 2012)
	Soil and Water Conservation Handbook (USDA 2011b)
Public, Shasta and Tehama Counties	Public Rural Road Standards
	Handbook for Forest, Ranch & Rural Roads (Weaver et. al. 2015)
Private Commercial Timberlands	California Forest Practice Rules (CAL FIRE 2018)
	California Forest Practice Rules, Road Rules Package (CAL FIRE 2013)
	Designing Watercourse Crossings for Passage of 100-Year Flood Flows, Wood, and Sediment (CAL FIRE 2017)
Other Private	Handbook for Forest, Ranch & Rural Roads (Weaver et. al. 2015)

5.1.2 Vegetation Management

The decision support tool (Terraqua 2018) will be helpful for identifying priority areas for pre-fire planning and treatments (e.g. fuels reductions, fuel breaks) for areas that have high sediment generation potential. Future efforts will also be necessary to incorporate additional wildfire risk attributes (e.g. fuels loadings) into this planning framework and will help to identify and prioritize the suite of management measures to best promote wildfire resilience and reduce burn severity and size.

Several fuel break projects have been successfully implemented within Battle Creek. However, bare and open fuel breaks maintained on erodible soils have caused erosion in Battle Creek (PWA 2018). Use of fuel breaks on a landscape scale in strategic locations such as ridgetops, near cities and along roads can be efficient and cost effective at fighting wildfire (USDA 2003). However, the concept of a shaded fuel break where effective ground cover (both canopy and herbaceous cover) exceeds 50% would offer improved protection for erosion (USDA 2012), while providing vertical discontinuity in fuels. Shaded fuel breaks near roads offer additional advantages of accessibility and horizontal fuel discontinuity.

Battle Creek Watershed has a wide variety of private and federal landowners within its boundary. The concept of fuel breaks is just one type of vegetation project that can be implemented within the watershed to improve and reduce fuels. Strategies to develop a comprehensive vegetation reduction program between Federal, State, County and private land ownership will be a key component to accomplishing this. The upper elevations of Battle Creek are owned primarily by the USFS while the mid elevations are mostly owned by industrial private timber companies and the lower elevations are owned by ranchers and farmers including some other agriculture uses. Mixed into all of this are several Wildland Urban Interfaces (WUI's).

Working with the various landowners and using the decision support tool to help identify and prioritize pre-fire planning, new vegetation management projects should be designed, developed and planned. Landowners can choose the best vegetation treatment that fits their management objective and reduces fuels while addressing the greater issues within the Battle Creek Watershed.

5.1.3 Post-fire Management

Managing post-fire landscapes poses substantial challenges, as land managers are forced to choose between resource recovery and resource protection. The capital needed to recover from the loss of investment, and investments into reforestation can come from post-fire salvage logging. The best practices for salvage logging have yet to be uniformly accepted. However, numerous studies suggest that ground-based yarding systems used on steeper slopes or erodible soils can have deleterious effects of sediment on receiving waters. Watercourse crossings may become undersized post-fire because of the changes to the runoff characteristics of the basin upstream. Increased effective ground cover (dead and live) to levels above 50% has been found to be protective of soil erosion from raindrop impact. The most effective way to achieve ground cover would be reducing the broadcast application and timing of post-salvage herbicides. The application of herbicides has been a widely debated topic and continuous studies focusing on potential impacts of increased sediment transport and impacts to waters should be studied further. Results of those studies can be used to develop effective management tools to effectively manage and reduce non-point sources throughout the Battle Creek Watershed. .

The decision support tool (Figure 9; Terraqua 2018) identifies high risk areas with high sediment generation potential that can inform post-fire management activities (e.g. herbicide treatments, heavy equipment use). Salvage logging in post-fire areas of the Battle Creek watershed should also consider the following practices and or recommendations that can help reduce erosion and routing of sediment to stream networks:

1. Areas that have been determined to have high or extreme Erosion Hazard Rating (EHR) should be evaluated for increased BMPs.
   - Maintain >50% ground cover prior to herbicide application.
   - Limit broadcast herbicide application and or circle spray.
   - Require water break spacing to a standard higher than state requirements. (i.e. high EHR treated as extreme).
   - Reduce skid trail stacking and water break connectivity.
2. Temporarily remove watercourse crossings that have failure potential and disconnect secondary roads from the drainage network. Post-fire runoff is often 10-100 times greater than non-burned runoff responses.

3. Minimize or eliminate new road construction during salvage operations. Use temporary roads when feasible.
4. Reduce ground-based yarding on high and extreme EHR areas by identifying (mapping) appropriate skid trail pattern.
5. Increase ground cover. Use herbicides within sensitive areas of the burn via circle-spray or "hack & squirt" methods instead of broadcast applications.
6. If sediment reduction mitigations includes sub-soiling, ensure operations can maintain a contour design.

5.2. Implementation Schedule and Milestones

The implementation schedule for short-term management measures calls for the implementation of all prioritized work plans for the three ongoing road assessment projects by 2022 (Table 10). The implementation schedule for long-term management measures calls for the completion all road assessments and sediment reduction plans for priority areas within the 1st five years (2024) and implementation of all prioritized work plans within ten years (2029, Table 10). A list of interim attainable milestones for the suite of management measures over the 10 year project window is also provided (Table 10).

Table 10. Schedule for implementation and milestones for priority unpaved road sediment source reduction management measures.

Short-Term Management Measures	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Implementation of Priority Road Treatments: Ponderosa Way Road Project	X	X	X							
Implementation of Priority Road Treatments: Rock Creek Road Project	X	X	X							
Implementation of Priority Road Treatments: Southwest Lassen Watershed Improvement Project	X	X	X							
Long-Term Management Measures										
Implement Road Assessments for High Priority Micro-catchments and Road Networks	X	X	X	X	X					
Develop Prioritized Road Sediment Reduction Workplans	X	X	X	X	X					
Implementation of Priority Road Treatments for Chronic and Episodic Sediment Delivery	X	X	X	X	X	X	X	X	X	X
Milestones										
Implementation of Priority Road Treatments: Ponderosa Way Road Project		50%	100%							
Implementation of Priority Road Treatments: Rock Creek Road Project		50%	100%							
Implementation of Priority Road Treatments: Southwest Lassen Watershed Improvement Project		50%	100%							
WBP Road Assessments and Workplans Completed		25%	50%	75%	100%					
Implementation of WBP Priority Road Treatments Completed				25%		50%		75%		100%

SECTION 6.0 –EDUCATION AND OUTREACH (EPA Element #5)

The WBP education and outreach strategy is designed to encourage public and stakeholder support and participation in the development and implementation of management measures (Table 11). The ongoing participation of private landowners will be crucial to the successful implementation of this plan as the majority of prioritized treatment areas for unpaved roads occur on private lands. Sediment source reduction plans for road assessment areas should be developed in collaboration with private landowners to meet both the needs of landowners for specific road segments and sediment source reduction goals. The goals and objectives of the education and outreach strategy include those that are informational, educational and that promote participation in the WBP project (Table 11).

Table 11. Goals and objectives for the education and outreach strategy.

Element	Goals	Objectives
Information	Understanding of the WBP strategy, process, and status by landowners and stakeholders	Outreach to the public and landowners through informational and progress reporting meetings
		Project updates at bi-monthly meetings of watershed stakeholders (Battle Creek Working Group)
		Online data portal to host WBP documentation and information useful to stakeholders.
Education	Understanding of current BMP's for management measures by private landowners	Host periodic educational workshops on road BMP's, fuels reduction projects, fire prevention, and pesticide use that can denude soils or impact receiving waters.
		Online data portal to host educational BMP materials relevant to the project.
Participation	Promote landowner and stakeholders participation in the project	Encourage continued technical participation of stakeholders through annual TAC meetings to review short-term priorities and project progress.
		Online data portal to host informational materials that identify short-term priorities and project progress.
		Outreach to affected landowners to promote participation in road assessments, the development of sediment source reduction plans, and fuels reduction projects.

SECTION 7.0 – CRITERIA AND MONITORING TO DETERMINE SUCCESS (EPA Elements #8, #9)

7.1. Sediment Load Reduction

Interim goals established in Section 4.1 include the reduction of chronic unpaved road sediment delivery (as estimated by the GRAIP-Lite model) by approximately 50% by assessing and treating priority drain points and contributing road segments in approximately 10% of micro-catchments within the Battle Creek watershed. Criteria for measuring incremental progress and determining success of sediment load reduction efforts can be characterized as the percentage of the number of assessed and treated high priority micro-catchments, drain points and contributing road segments. It will also be beneficial to track and report the volumetric sediment savings from reductions in chronic and episodic sediment sources over time. However, measuring success in terms of volumetric reductions are problematic as there is not an established maximum allowable loading goal against which to measure success. Once detailed road assessments and prioritized sediment reduction plans are completed for high priority micro-catchments, it would be feasible and worthwhile to measure implementation success against the sediment source reduction treatments recommended in the plans and their associated sediment savings estimates.

The progress of sediment load reduction related activities will be monitored for consistency with the schedules for management measures and milestones (Table 10) by annual reporting of the following criteria on the online data portal:

- Percent of priority road treatments implemented for established efforts:
    - Ponderosa Way Road Project
    - Rock Creek Road Project
    - Southwest Lassen Watershed Improvement Project.
- Percent of road assessments and sediment reduction plans completed for high priority micro-catchments and related road networks.
- Percent of priority road treatments implemented: WBP Projects.
- Sediment Savings for all implemented road related treatments (chronic and episodic).

7.2 Biologic and Physical Condition of Streams

Several biological and physical stream condition monitoring metrics will be useful for establishing WBP stream condition criteria and measuring project success. These include: statewide multi-metric indices for evaluating impacts to beneficial uses such as the California Stream Condition Index (CSCI) and Index of Physical Habitat Integrity (IPI); and attributes of critical habitats for at-risk anadromous salmonid stocks (Table 12). Several metrics are recommended for monitoring that can track trends in critical habitat quality for specific life stages of anadromous salmonids and to understand how fine sediment may be affecting them. The frequency of pool habitats and the amount fine sediment deposition within them provides a means of monitoring the quality of spring run Chinook holding habitat. Characterizing the particle size composition and percentage of fine sediment within riffle habitats used for spawning provides a means to monitor the quality of winter and spring run Chinook spawning habitats (Table 12).

Table 12. Biological and physical stream condition metrics, criteria and methods for measuring WBP success.

Metric	Criteria	Stream Attribute	Monitoring Methods
CA Stream Condition Index (CSCI)	Greater than 0.92 for all HUC 12's	Water Quality	SWAMP: Benthic Macroinvertebrates
Index of Physical Habitat Integrity (IPI)	Greater than 0.94 for all HUC 12's	Physical Stream Habitat Quality	SWAMP: Structure, Cover, Substrate, Diversity
Pool to Riffle Ratios / Pool Frequency	No long-term declining trends (5 year)	Anadromous Salmonid Holding Habitat Availability	SWAMP: Macro-Habitat Types
Residual Pool Volumes / Depths	No long-term declining trends (5 year)	Anadromous Salmonid Holding Habitat Quality; Measure of Fine Sediment Deposition in Pools	V-Star Methods
Particle Size / Percent Fines in Spawning Habitats	No long-term declining trends (5 year)	Anadromous Salmonid Spawning Habitat Quality	McNeil Core Sample Methods

This plan is promoting stream networks that are resilient and have the ability to recover relatively quickly after natural disturbance, rather than exhibiting marginal conditions for extended periods due to chronic controllable sources of sediment. To measure project success and effectiveness, stream condition criteria will be evaluated in terms of both threshold quality values, and trends in metric values over a 5-year time period to account for inter-annual variability due to natural disturbance events. Criteria for CSCI and IPI multi-metric indices have been established for streams statewide, with “likely intact” values being greater than or equal to 0.92 and 0.94 respectively (Tussing 2019; Table 12).

Probabilistic stream condition monitoring sites (50) across all fish bearing stream in the watershed were established in 2001 (Terraqua 2004) and have been periodically revisited through 2017 (Terraqua 2008a, Tussing 2019). These long-term monitoring sites will continue to be used to evaluate CSCI, IPI, and pool frequency. Monitoring sites for characterizing residual pool volumes and depths, and the quality of spawning habitats should be performed within the actual stream habitats being used by, or restored for, at-risk salmonids. This may require the establishment of additional monitoring sites to effectively evaluate these metrics over time.

Securing funding for the long-term monitoring of water quality and physical habitat condition in Battle Creek has been a challenge in the past. As the recommended V-Star and McNeil core sampling methods are labor intensive, less intensive rapid assessment methods could be considered for implementation if long-term funding is limited. Several sediment related metrics can be generated from SWAMP physical habitat data collection including, percent fines (stream bed surface), and percent embeddedness of cobble substrates. Other rapid assessment methods could additionally be implemented at SWAMP monitoring sites to capture the depth and volume of pool habitats, and estimates of surface fines (fines grid) in pool tail outs (AREMP protocol), or visual assessment of the particle size distribution in spawning habitats (e.g. Bottaro and Earley 2018).

Given the multi-stakeholder nature of the watershed based plan, it is important that measures of project success adhere to strict quality assurance / quality control (QA/QC) standards for data collection, processing and assessment. Quality assurance project plans (QAPP's) are the preferred means to establish and document standardized QA/QC methods being employed.

7.3 Provisions for Progress Review and Plan Revision

Annual or biannual review of the planning effort at TAC meetings, or other oversight body comprised of Battle Creek Working Group stakeholders, will provide the vehicle for:

- Reviewing project progress relative to the assessment and implementation needs
- Assessment and monitoring results
- Planning and implementation schedules and priorities for the coming year
- Making any necessary plan revisions

The online data portal will host current information for all of the above review related topics. The online data portal will also facilitate the ability to revise plan priorities quickly in the event of major changes in the watershed that could have significant effects on sediment production and delivery (e.g. wildfire).

SECTION 8.0 – OUTSTANDING INFORMATION / ASSESSMENT NEEDS

The WBP approach outlined by USEPA (2008, 2013) and described in Section 1.2 outlines all the minimum elements needed to apply for grant funding through the 319h funding for impaired water bodies. Most sediment load reduction projects would occur at a scale of a HUC12 subwatershed or smaller because of the costs associated with such projects, and Battle Creek is comprised of twelve HUC12 subwatersheds. Even though this WBP attempts to meet the needs of a nine element plan, and is structured to do so, the level of detail needed to identify all major pollutants, assess pollutant load reductions, and plan remedies at the project-scale in Battle Creek were ultimately beyond the scope of this WBP. This tool can act as a link between the watershed-wide needs, and those that are site- or project-specific. Nonetheless, project-scale detailed sediment load reduction assessments will need to be conducted to meet EPA's nine minimum elements of a watershed plan.

Several significant data gaps and assessment needs still exist that limit comprehensive watershed planning and management within the Battle Creek watershed. These include: a sediment budget informed by a longer record of suspended sediment data; stream temperature studies relative to those needed by threatened or endangered salmonid species; a wildfire risk reduction strategy relative to sediment source impacts; and, an evaluation the degree to which the cumulative effects of pesticide use from various sources throughout the watershed may be affecting Battle Creek water quality.

The California State Water Resources Control Board funded an assessment of Battle Creek hydrology and sediment which collected data in the 2015 water year (Henkle et. al. 2016). This study found that the lack of available suspended sediment data prohibits the assessment of Battle Creek sediment impacts with any degree of certainty using traditional methods. Excerpt from Henkle et. al. (2016):

> "There is insufficient data at this time to conduct state-of-the-art analyses that go beyond central tendency to explain how climatic, hydrological, and land cover / land use factors control the variation of sediment flux about the expectation – something that has been demonstrated for other watersheds for which longer term suspended sediment data have been collected. A comprehensive monitoring plan is recommended to include a multiscalar approach to suspended sediment monitoring at gages targeting both North Fork Battle Creek (NFBC) and South Fork Battle Creek (SFBC) above, within, and below the perimeter of the Ponderosa wildfire, as well as Mainstem Battle Creek."

Henkle et. al. (2016) recommend permanent turbidity monitoring stations be installed on the Mainstem, North Fork, and South Fork of Battle Creek and that suspended sediment grab samples be collected for sediment rating curve development. This would enable the evaluation of how sediment transport responds to the magnitude and duration of precipitation, how weather patterns are affecting fluvial processes and the development of a sediment budget for the watershed (Henkle et. al. 2016).

The Battle Creek also needs a more comprehensive wildfire strategy that can assess and incorporate fuel loadings, wildfire behavior, and sediment delivery risks at the watershed scale in order to prioritize and implement a suite of prioritized fuels reduction, stand structure, and fuel break implementation projects to reduce wildfire risks to watershed resources.

The role and possible impacts of undocumented pesticide use throughout the watershed from illegal marijuana grows is poorly understood relative to potential effects on Battle Creek streams. It is recommended that a focused study on the issue of illegal marijuana grows in the Greater Battle Creek Watershed be conducted. The study should include information as to the pesticides commonly found in these sites and their potential harmful effects to public health, fish, wildlife species and beneficial uses of water within the watershed.

Lastly, the role and cumulative effect of the use of industrial chemicals such as pesticides and fertilizers throughout the watershed from a variety of sources is poorly documented and understood relative to potential effects on Battle Creek streams. It is recommended that a focused study of water quality relative to chemical concentrations be conducted to establish baselines and determine if this potential pollutant source warrants further investigation or is currently at levels that are inconsequential to public health and beneficial uses within the watershed.

SECTION 9.0 – PLAN IMPLEMENTATION ASSISTANCE (EPA Element #4)

9.1 - Technical Assistance

The development of the WBP has drawn upon the technical assistance from a wide variety of public and private land management agencies and entities, resource conservation districts, state and federal resource management agencies, regulatory agencies, and educational institutions through participation in a technical advisory committee (Table 2). The continued participation of WBP TAC members and select state agencies involved in the permitting process (e.g., CVWB, CAL FIRE, CDFW, etc.) are anticipated to provide much of the technical oversight required for project implementation. However, dedicating technical staff to perform sediment source assessments and reduction plans, and the implementation of management measures will require additional technical assistance. Additionally, a WBP coordinator will be necessary to coordinate elements of the plan including: education and outreach; liaison with small private landowners for WBP participation, development of proposals for plan assessments and implementation; advisory committee meetings; and to track plan performance in terms of the implementation schedule, milestones, and success criteria.

9.2 - Financial Assistance and Funding Sources

Possible funding sources for the various task categories required for WBP implementation are identified in Table 13. However, at this time, annual or total task costs and the financial assistance needed for implementation cannot be estimated with confidence. Cost estimates for detailed road assessments will be generated once participating landowners are identified (project scope). Cost estimated for implementation efforts will be generated when road assessments can provide the specific type and amount of road treatments necessary to reduce chronic and episodic sediment sources.

Financial assistance for future work in this watershed planning effort will be most critical for landowners who do not have the resources available to plan, assess, and implement sediment reduction efforts. Many of the industrial landowners are required to implement sediment reduction BMPs as part their permitting processes and are typically paid for under normal operating expenses. This mechanism is effective and has resulted in many instances of unpaved road improvements and BMP compliance in the watershed. The remaining landowners that do not have an economic benefit of economic revenue of land management and that would choose to participate in sediment reduction efforts represent a higher need for financial assistance.

Table 13. Potential funding sources for WBP implementation.

Task / Category	Possible Sources of Funding
Project Management/ Coordination, Education/ Outreach, Grant Funding Proposals, Load Reduction Monitoring	CA Dept. of Conservation Watershed Coordinators Grant; The Nature Conservancy
Web Based Data Portal / Platform	CA Prop 1 Timber Funds
Road Assessments and Sediment Reduction Plans	USEPA 319h; CA Prop 1 Watershed Restoration Grant Program; CA Fisheries Restoration Grant Program
Permitting: CEQA	USEPA 319h; CA Prop 1 Watershed Restoration Grant Program; CA Fisheries Restoration Grant Program
Implementation of Management Measures	USEPA 319h; CA Prop 1 Watershed Restoration Grant Program; CA Fisheries Restoration Grant Program
Stream Condition / Habitat Monitoring	USEPA 319h; CA Prop 1 Watershed Restoration Grant Program; CA Fisheries Restoration Grant Program

SECTION 10.0 – SUMMARY AND PATH FORWARD

The land uses and stakeholders within the Battle Creek watershed are diverse and reflect a wide variety of management objectives of land and water resources in the watershed. The watershed supports viticulture, timber production, hydropower, ranching, fish hatcheries, and recreation. Declining populations of threatened and endangered salmonid species in Battle Creek is the focus of restoration efforts to re-introduce these species and improve their access to lost habitat from hydroelectric projects. Also of concern are impacts to these habitats from pollutants such as the use of industrial and illegal chemicals, sediment, and temperature, the latter two from sources that are natural, land management related, or a combination of both. The goal of this WBP is to develop a strategy for protecting areas of the watershed that contribute to pristine waters of Battle Creek and restore areas of the watershed that have been negatively impacted by controllable sources of pollution. The success of the WBP is dependent upon stakeholder participation, which is currently organized through the Greater Battle Creek Watershed Working Group and associated Technical Advisory Committees.

This version of the Watershed Based Plan represents a first step at identifying areas that warrant more detailed assessments and provides a basis and justification for choosing these areas. This plan outlines management strategies that can be applied to help minimize sediment inputs related to land use and disturbance and highlights the importance to protect natural resources from the effects of large, catastrophic wildfires. This plan also outlines the uncertainties that remain with respect to many possible sources of pollution including industrial and illegal use of chemicals and stream temperature.

Given the short time needed for natural disturbances to shift the needs and strategies of all the stakeholders in the watershed, as well as ongoing development of BMPs, the strategy outlined in this WBP may need to be revised. This process is intended to be iterative with each successive iteration drawing on past versions and contemporary information, insights, and resources to steer the strategy toward the overall goals of improving watershed health.

A complete watershed plan, with respect to EPA's nine-element process, is based on the framework of a TMDL implementation plan. This process requires catchment-wide identification of; pollution sources, pollutant loading to receiving waters, projects that can reduce the pollutant loads, as well as the expected amount of achievable pollutant load reductions. In addition, this process calls for pollutant load reductions specific to these projects including implementation project scheduling, performance monitoring, project success measures and milestones. The scale of the Battle Creek watershed is large relative to these needs, and without the technical foundation equivalent to that provided by a formal TMDL process, meeting all these elements at the watershed scale proved to be beyond the scope of this project. Additional site-specific assessments will be necessary to meet all these elements.

Despite the additional assessment needs to more fully address EPA's nine elements of a watershed plan, this WBP provides a tool that allows landowners and land managers to focus their efforts on areas of the watershed that are of higher risk relative to other areas, and sets up a framework to track and update specific projects. Future sediment pollution reduction work (assessment and implementation projects) within Battle Creek can refer to the WBP contents to identify priority areas and justify the need for the projects. This WBP provides a link between watershed-scale needs and project-specific assessment needs and will likely streamline grant proposal processes to obtain funding for sediment reduction projects. In addition, information from this WBP will be available through the online portal through which project updates and plan revisions can be tracked.

The success of maintaining high-quality water, restoring impacted or potentially impaired waters, and protecting the beneficial uses of this water will require the collaboration of all stakeholders of Battle Creek Watershed, including private landowners, power companies, state and federal land managers, conservation and non-profit organizations, as well as state and federal natural resource regulators. Stakeholder participation to achieve these goals is voluntary, however the existing organizations and working groups demonstrate the potential to achieve this goal. Each stakeholder will need to assess their needs and concerns and be prepared to work collaboratively with other stakeholders to achieve the goals of the WBP. Technical and financial resources of each stakeholder need to be leveraged with those from state and federal sources to maximize the success of this plan.

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APPENDIX A. –ROAD ASSESSMENT AND SEDIMENT REDUCTION PLAN OUTPUT EXAMPLE

The below tables from the recent Ponderosa Way Road Assessment and Sediment Reduction Plan Project (PWA 2017) provides an example of the desired output from focused road assessment and sediment reduction planning for unpaved road networks within priority Battle Creek micro-catchments. This Ponderosa Way project is in the Lower South Fork Battle Creek HUC 12, and is being implemented by the Resource Conservation District Tehama County with funding from the Proposition 1 Timber Fund Grants Program.

Table 2. Site specific sediment delivery sites and hydrologically connected road segments recommended for treatment to reduce sediment delivery on a total of 22.1 miles of road, Ponderosa Way Road Assessment and Sediment Reduction Plan Project, Tehama County, California.

Site type	Road erosion assessment sites identified (#)	Sites recommended for treatment (#)	Hydrologically connected road segments treated (mi)
Stream crossings	85	81	8.64
Ditch relief culverts	8	8	0.90
Discharge points for road drainage	8	8	0.83
Fill failures	6	6	0.00
Springs	3	3	0.14
Hillslope gully	1	1	0.06
Total	**111**	**107**	**10.57**

Table 3. Estimated future sediment delivery for erosion sites and road surfaces recommended for treatment, Ponderosa Way Road Assessment and Sediment Reduction Plan Project, Tehama County, California.

Sediment sources	Estimated sediment savings (yd^3)	Percent of total
1. Episodic sediment delivery from road related erosion sites (indeterminate time period)		
Stream crossings	8,730	90%
Ditch relief culverts	167	2%
Discharge point for road drainage	160	2%
Fill failures	626	6%
Springs	13	< 1%
Hillslope gully	10	< 1%
Total episodic sediment delivery	**9,706**	**100%**
2. Chronic sediment delivery from road surface erosion (estimated for a 10 yr period)[a]		
Total chronic sediment delivery	**5,980**	**100%**

[a] Sediment delivery is calculated for a 10 yr period using field-measured road, ditch, and cutbank contributing areas and 1 of 10 empirical values for road surface lowering and cutbank retreat rates based on field observations and analyses by PWA staff.

Table 4. Treatment immediacy ratings for sediment delivery sites and associated lengths of hydrologically connected road, Ponderosa Way Road Assessment and Sediment Reduction Plan Project, Tehama County, California.

Treatment immediacy	Sites and hydrologically connected road lengths proposed for treatment				Estimated future sediment delivery from inventoried erosion sites[b]		Estimated future sediment delivery from road, ditch, and cutbank surfaces[c]	
	Upgrade sites	**Road length (ft)[a]**	**Decommission sites**	**Road length (ft)[a]**	**Volume (yd^3)**	**Relative percentage**	**Volume (yd^3)**	**Relative percentage**
High	2 stream crossings	920	11 stream crossings, 1 ditch relief culvert	10,099	3,352	*34%*	1,259	*21%*
High-moderate	6 stream crossings, 1 hillslope gully	5,215	7 stream crossings	4,867	1,281	*13%*	1,165	*20%*
Moderate	17 stream crossings, 3 ditch relief culverts, 1 spring	13,103	13 stream crossings, 4 fill failures, 2 discharge points, 1 spring	7,602	3,549	*36%*	2,046	*34%*
Moderate-low	5 stream crossings, 3 ditch relief culverts, 1 discharge point	7,056	13 stream crossings, 1 ditch relief culvert, 4 discharge points	5,062	1,037	*11%*	1,337	*22%*
Low	2 stream crossings, 1 fill failure, 1 spring	255	5 stream crossings, 1 fill failure, 1 discharge point	1,629	487	*5%*	173	*3%*
Total	**43 upgrade sites[e]**	**26,549**	**64 decommission sites[f]**	**29,259**	**9,706**	**100%**	**5,980**	**100%**

[a] *Road length* refers to hydrologically connected road reaches adjacent to recommended treatment sites.
[b] Episodic sediment delivery for road related sites (indeterminate time period).
[c] Chronic sediment delivery from adjacent hydrologically connected roads and cutbanks (estimated for a 10 yr period).
[e] Upgrade sites (43 total): 32 stream crossings, 6 ditch relief culverts, 2 springs, 1 discharge point, 1 fill failure, 1 hillslope gully.
[f] Decommission sites (64 total): 49 stream crossings, 7 discharge points, 5 fill failures, 2 ditch relief culverts, 1 spring.

APPENDIX B. – RESPONSE TO TAC AND EPA COMMENTS

The Battle Creek Watershed Based Plan (WBP) followed EPA's nine element planning framework with reference to other short-form format WBP plans. While this WBP makes important contributions related to its focus on sediment related processes and treatment priorities, it lacks: finer scale details; a broader scope of stakeholder participation; and, the identification and treatment of the full range of stakeholder concerns. EPA (Region 9) reviewed this WBP document and concluded that it is a good start but is not as comprehensive as a WBP should be. In recognizing the validity of this feedback, we (authors) believe that a more comprehensive watershed based planning process is necessary but will require additional efforts in the future to attain.

In light of this context, Appendix B captures comments on the 4/15/19 draft Battle Creek WBP document from both the TAC and EPA. It is hoped that this appendix will also provide a placeholder for outstanding items that should be addressed in future efforts and plan revisions that strive to make this plan more comprehensive and with sufficient detail to meet EPA nine element standards. It should be noted that while the TAC meeting (4/17/19) to walk through the draft WBP document was well attended (9 of 12 TAC stakeholders), we received written comments from only two TAC stakeholders. TAC review period was approximately four weeks (4/15/19 through 5/10/19), and we accepted all comments received including two sets of comments received on 5/14/19.

Table 1. Response to comments on the 4/15/19 draft Battle Creek Watershed Based Plan.

Section / Topic	Entity	Comment	Response / Status	#
	TAC Meeting 4/17/19	1. Give more thought to how we will describe the process of prioritization for other landowners that have different prioritization methods (e.g. LNF, SPI), and once additional data, or road surveys come.	Incorporated.	1
	TAC Meeting 4/17/19	2. Clarify that LNF roads project is focused on stream crossing and NEPA (completed Aug 2019) will extend 500 feet in both directions on road surface and 200 feet upstream and downstream.	Incorporated.	2
SECTION 9.0 – PLAN IMPLEMENTATION ASSISTANCE	TAC Meeting 4/17/19	3. Revise Table 13 to a similar format as table 10, similar to a capital expenditure table.	Table 13 was revised. Due to uncertainties in the scope of implementation, monetary estimates were removed. Potential funding sources expanded.	3
	TAC Meeting 4/17/19	4. Link critical habitat for salmonids in BC to primary constituent elements (PCE's).	Incorporated the identification of PCE's within the watershed. Would also be beneficial to map PCE's (e.g. spawning, holding, rearing locations), barriers, ladders, etc. at the HUC 12 scale.	4
	TAC Meeting 4/17/19	5. Maybe link or package projects of various types for funding (e.g. shaded fuel breaks and roads projects).	Will consider and explore this as an option when packaging projects and drafting proposals.	5
	TAC Meeting 4/17/19	6. Consider linking detailed road assessments and implementation actions into one project for grant funding.	Will consider this for proposal development.	6
	TAC Meeting 4/17/19	7. Don't discount lower elevation fire prevention efforts (e.g. shrublands).	We concur that the wildfire management strategy should be developed at the watershed scale to capture low elevation shrublands.	7
	TAC Meeting 4/17/19	8. Consider implementing a rapid road survey to ground truth high priority road related sites.	Could provide the basis for developing funding proposals for detailed road assessment, permitting and implementation efforts.	8
Section 5.0 –Nonpoint Source Management Measures - Page 23	USFS, LNF, 5/8/19	Clarify the parameters of the WIP project that the Forest Service is in the process of completing. I will send you the DRAFT appendix that talks about the work areas, as well as Integrated Design Features associated with the WIP project later today. We do not anticipate these will change. The only thing that might change as the Forest wraps up this NEPA is the sites (some may be thrown out over Archaeology concerns).	Materials were reviewed and descriptions of work areas and management measures were incorporated.	9
Section 5.0 –Nonpoint Source Management Measures - Page 23	USFS, LNF, 5/8/19	On page 23, the discussion of our project should be modified slightly, Change "programmatic" to "landscape-scale". (note: because the locations are site-specific, it's not considered programmatic) Also, please change the expected completion date to October 2019 (we're waiting for completion of archeological surveys).	Incorporated.	10
Introduction – Page 1	SPI 5/14/19	James, C.E. and Krumland, B., 2018 – Forest Science post-fire erosion study demonstrates salvage logging reducing sediment deliveries. Beck, B.W. et. al. 2011 A rapid Assessment from timber harvest – Environmental Science and Technology show no sediment delivery related to timber management activities Suggested Replacement: "The Ponderosa Fire of 2012 represents one of the largest recent disturbances to the watershed and a source of sediment pollution…"	Both references were incorporated in the document. Sentence modified considering the suggested replacement.	11

Section / Topic	Entity	Comment	Response / Status	#
Vegetation Characteristics – Page 7	SPI 5/14/19	Suggested Addition: It should be noted that within the nationwide Anderson Land Cover Classification System utilized (Anderson 1976) that Shrubland includes areas covered by small young trees less then 16-feet in height – young tree species of the forest class. This can be a source of confusion wherein the regionally employed Guide to Wildlife Habitats of California defines Shrub habitats as the absence of, or less than 10% tree occupied (California Department of Forestry – 1988)	Incorporated reference to Anderson 1976. Existing verbiage identifies that young trees are classified as shrublands.	12
Sediment Stresses on Beneficial Uses – Page 11	SPI 5/14/19	Incorrect use of CFPR defined terminology… Suggested Replacement: Post-fire salvage logging is often on a scale equal to that of the fire, which can be much larger than the typical timber harvest plan (THP) size in California. Post-fire emergency documents from CAL Fire allow harvest within the fire region in compliance with current California Forest Practice Rules and Regulations. While these areas are also exempt from restocking standards, it should be noted that the overwhelming majority of the Ponderosa Fire on small private and private industrial timberlands was replanted at great investment within a three (3) year period. Additionally, herbicide use for reforestation, which targets the temporal suppression of non-conifer vegetative regrowth can increase soil exposure to erosive forces of rainfall. Within the Ponderosa Fire, reforestation operations commonly involved the placement of severed stems perpendicular to the slope and contour tilling of the soil to increase infiltration and reduce concentrated runoff.	Suggested replacement was incorporated largely as written. Acreage of THP size added.	13
Controllable Sources of Sediment – Page 14	SPI 5/14/19	Timberland Production Zone (TPZ) defines an area that has been officially zoned by the County to be devoted to and used for the purpose of growing and harvesting timber. Highest & Best Use. Suggested Replacement: Although the exact proportion of controllable or uncontrollable sediment inputs are unclear, it is clear that the effects of large wildfires within forestlands zoned by the County for the purpose of growing and harvesting timber (TPZ), potentially pose an equal or greater threat to water quality than those from roads.	Suggested comment was considered, and sentence paragraph revised, comparisons to threats from roads removed.	14

Section / Topic	Entity	Comment	Response / Status	#
Post-fire Management – Page 16	SPI 5/14/19	Suggested Replacement: Substantial changes to the landscape following high-intensity fires can leave the ground surface susceptible to accelerated erosion. Results from within the same mixed conifer forest type Poff (1989), Chou et al. (1994a, 1994b), and Olsen (2016) are consistent with the James and Krumland (2018) study performed on the Ponderosa Fire within the Greater Battle Creek Watershed and indicated that salvage logging does not increase sediment production on hillslopes where some or all of the salvage logging is completed within the first 2 water years post-fire. 16 McIver and Star (2000, p. 30) reviewed previous studies on salvage logging and discussed how the large among-unit variation reported in Chou et al. (1994a) made it “difficult to distinguish changes in sediment yields due to logging from those due to the fire itself.” The Chase (2006) results demonstrated similar findings to those of Chou et al. (1994a, 1994b) and for the same reasons that McIver and Star noted. McIver and McNeil (2006) implemented recommendations from McIver and Star (2000) in their study of the 1996 Summit Wildfire, Malheur National Forest, in northeastern Oregon. McIver and McNeil (2006) concluded that a combination of factors probably contributed to the relatively low levels of soil disturbance and sediment transport that resulted from the salvage logging performed in August 1997 prior to the second winter post-fire. Previous studies suggest that salvage logging impacts depend on stand structure; burn severity; post-fire weather; differences between slope classes for tractor, cable, or helicopter logging; soil composition; road network; and type of salvage logging (Potts et al. 1985; Chou et al.1994a, 1994b; McIver and Star 2000; McIver and McNeil 2006). McIver and Star (2000) reviewed many studies that reported a wide range of potential deleterious effects of post-fire salvage logging. However, those salvage logging activities began several years after a fire occurred, and the studies were not performed on industrial forestlands where regulations, timing, and practices differ.	Section was rewritten and suggested replacement considered. Findings of James and Krumland 2018 incorporated.	15
Wildfire Prevention / Silviculture – Page 19	SPI 5/14/19	Suggested Replacement: The Community Wildfire Prevention & Mitigation Report (Cal Fire 2019) identifies the HWY 44 Fuels Reduction Project as its top priority. This project is a 1,112-acre shaded fuel break near Shingletown, CA, and is roughly 23 miles long. This fuel break project lies partially within the Battle Creek Watershed and will add a vital piece of fuel reduction along the northern border of Battle Creek Watershed that compliments existing fuel breaks completed on commercial timberlands. Subsequent fuels reduction projects within Battle Creek Watershed could also use connectivity to other fuel break projects as a guide for land managers in creating a network of interconnected fuel breaks throughout the watershed. In 2017, the USFS, Cal Fire, National Fish and Wildlife Foundation, Sierra Pacific Industries and other industrial timberland owners entered into a Memorandum of Understanding (MOU) to collaborate together to coordinate wildfire risk reduction measures as an example of how the government and private sector can work together to address important safety and environmental issues. Planning of changes in silvicultural prescription to increase fire resiliency could also be aided using the decision support tool (Figure 8) to protect both communities and wildlife.	Suggested replacement was incorporated as written.	16

<table>
<tr><th>Section / Topic</th><th>Entity</th><th>Comment</th><th>Response / Status</th><th>#</th></tr>
<tr><td>Sediment Load Reduction Goals – Pages 24 - 25</td><td>SPI 5/14/19</td><td>Suggested Replacement:
<table>
<tr><th>Study basin</th><th>Number of topographic drains[a] (per km)</th><th>Number of engineered drains[b] (per km)</th><th>Number of road segments, topographic drains only</th><th>Number of road segments with added engineered drains</th><th>Average road segment length, topographic drains (m)</th><th>Average road segment length, with added drains (m)</th></tr>
<tr><td>Bailey</td><td>574 (3.2)</td><td>1,773 (9.9)</td><td>998</td><td>2,733</td><td>159</td><td>58</td></tr>
<tr><td>Digger</td><td>931 (6.0)</td><td>2,004 (12.8)</td><td>1,768</td><td>3,658</td><td>86</td><td>44</td></tr>
<tr><td>Rock</td><td>780 (5.1)</td><td>1,954 (12.7)</td><td>1,410</td><td>3,256</td><td>112</td><td>49</td></tr>
<tr><td>Total</td><td>2,285</td><td>5,731</td><td>4,176</td><td>9647</td><td></td><td></td></tr>
</table>
A recently completed and published road inventory and erosion assessment (Benda et.al. 2019) was performed by the Research and Monitoring Department of Sierra Pacific Industries (SPI) in collaboration with Terrain Works. This study inventoried the Bailey, Digger, and Rock Creek Watershed road networks within the Greater Battle Creek Watershed on a 135 km2 or 52 sq./mi. of SPI's forestlands. The field road network inventory took detailed information on 9, 647 road segments with added engineered drains across the three sub-basins. This field data was then used to populate and run the ROAD EROSION AND DELIVERY INDEX MODEL (READI) that provides a direct estimate of hydrologic connectivity between road and stream networks by calculating the road length contributing water and sediment to streams. As reported in the Journal of American Water Resources, (Benda et al. 2019) the READI model assesses current road network conditions within SPI lands in the Greater Battle Creek Watershed and identifies specific locations to optimize and prioritize future road improvements. Additionally, READI provides guidance on locations where new drain placements can be installed to reduce road erosion and sediment delivery to streams. The road network inventories and READI model determined where the largest achievable sediment delivery reductions can occur on the SPI road network in the Greater Battle Creek Watershed. SPI can combine these results with mitigation costs and specific water resource concerns to determine the best strategy for reducing site-specific sediment delivery.</td><td>Did not incorporate the table, but the suggested replacement was incorporated as written, as well as the figure title.</td><td>17</td></tr>
<tr><td>Wildfire Prevention / Silviculture – Page 27</td><td>SPI 5/14/19</td><td>Untrue – Unsubstantiated – Not the case in the Ponderosa Fire
Suggested Replacement:
Young even-aged forest plantations and established fuelbreaks (often associated with roadways) were utilized extensively by Cal Fire during the 2012 Ponderosa Fire to control the spread of wildfire. Both established fuelbreaks and plantations share the opportunity to be cleared of vegetative fuels in a timely and efficient manner, allowing fire fighters and heavy equipment operators to work safely and get firelines established in front of the approaching wildfire. Land managers are working currently with the California State Board of Forestry to reduce current stocking standards to establish young forest plantations as a result of contemporary success in reforestation efforts and reducing the expense of future pre-commercial thinning activities, while reducing fuel loading. A variety of silvicultural systems exist for Federal, State and private forest managers to select the proper tool to decrease existing fuel loads while protecting of the beneficial uses of water, wildlife habitat and maintaining forest health. Management strategies that promote increased resilience to wildfire and maintain harvest volume for the production of commercial forest products should be supported.</td><td>Suggested replacement was considered. The section was rewritten and broadened to Vegetation Management throughout the watershed.</td><td>18</td></tr>
</table>

Section / Topic	Entity	Comment	Response / Status	#
Post-fire Management – Pages 27-28	SPI 5/14/19	Suggested Replacement: 1. Provide mitigation measures during post-fire salvage logging in high or extreme Erosion Hazard Rating (EHR) areas which are sensitive for exposed soils. 2. Temporarily remove watercourse crossings that have failure potential and disconnect secondary roads from the drainage network. Post-fire runoff is often 10-100 times greater than non-burned runoff responses. 3. Minimize new road construction during post-fire salvage operations, attempt to balance with existing road abandonment and/or surface rocked segments. 4. Consider employing contemporary Low Impact ground-based harvest machinery in high and extreme EHR areas that are additionally tetherable on steeper slopes. 5. Increase ground cover. Use herbicides within sensitive areas of the burn via circle-spray or "hack & squirt" methods instead of broadcast applications. 6. Employ Sub-soil tilling on the contour where possible to increase infiltration, break up potentially hydrophobic soil layer and reduce concentrated flows. 7. Lay sub-merchantable severed stems perpendicular to the slope to act as a flow energy dissipater 8. Minimize the use of waterbars on tractor roads and trails in post-fire harvest operations, favor the use of slash packing trails where feasible	Suggested replacements were considered and the list of management measures was revised.	19
Outstanding information / Assessment Needs – Page 33	SPI 5/14/19	Incorrect – Unsubstantiated – Misses the target Pesticide applications are regulated by the California Department of Pesticide Regulation (DPR) and enforced through the County Agriculture Commissioner. The process starts with a landowner or their representative securing a permit to apply pesticides on specified sites. The landowner then will apply the pesticide or hire a licensed Pest Control Business to do the application for them. A written pesticide recommendation from a licensed Pest Control Advisor (PCA) is required prior to application. After the application is complete a pesticide use report is required to be submitted within 10-days after the end of the month of application. This use report includes the site treated and details regarding the application such as rates and acres treated. These use reports are public record and available upon request from the County Agriculture Commissioner. For herbicides used in forest regeneration (reforestation) programs there is no application allowed directly to water. Buffer zones on stream courses further reduce the likelihood of herbicides entering the water and extensive water (grab) sampling confirms this. Suggested Replacement: Lastly, the role and possible impacts of undocumented pesticide use throughout the watershed from illegal marijuana grows is poorly understood relative to potential effects on Battle Creek streams. It is recommended that a focused study on the issue of illegal marijuana grows in the Greater Battle Creek Watershed be conducted. The study should include information as to the pesticides commonly found in these sites and their potential harmful effects to public health, fish, wildlife species and beneficial uses of water within the watershed.	Suggested replacement was edited and incorporated.	20
General Comment	EPA Region 9 5/14/19	1. The Draft WBP includes a good start on providing components to a watershed-based plan, presenting information on select sediment impairments and sources, with focus on loading from unpaved roads and managment of private timber lands. The Draft WBP should be amended to address other areas in the watershed and other water quality issues.	Concur. Will need to be addressed in future.	21

Section / Topic	Entity	Comment	Response / Status	#
General Comment	EPA Region 9 5/14/19	2. The document would benefit from an introduction providing an overview of key stakeholders, their issues of concern, and the collective goals and objectives of stakeholders. This would support efforts to identify and prioritize implementation efforts.	Concur. Will need to be addressed in future. Current planning effort focused on sediment, leaving the full range of stakeholder concerns unidentified.	22
General Comment	EPA Region 9 5/14/19	3. A summary of data needs and information gaps is encouraged, to clearly identify future efforts needed to advance the WBP development and implementation.	Concur. We have included a placeholder in Information gaps section for further plan development.	23
General Comment	EPA Region 9 5/14/19	4. An editorial review of the document is recommended, to make the document easier to read for someone not familiar with the area or the watershed issues (e.g., consolidate information corresponding to each WBP element, check use of terms for consistency such as Management Measures; verify referenced documents are included in the references list, etc).	Comment was incorporated in final.	24
Element A: Causes and Sources of Impairment, Recommended Future Updates	EPA Region 9 5/14/19	1. Provide additional description of the watershed for readers not familiar with the area: a. clarify references to Battle Creek versus Battle Creek watershed, and show the main stem, north and south forks of Battle Creek, and its tributaries on a figure. b. Provide an overview of land ownership categories and uses (e.g., USFS, private timber, residential, agriculture, etc) c. Show all areas and/or features mentioned in the text (e.g., reaches with channel stability concerns, gorges and steep streamside hill slopes (e.g., presented on page 12 for South Fork, or in Terraqua 2018); reaches supporting anadromous salmonids (page 17); the location of the Coleman National Fish Hatchery (see pgs 11 - 13); the extent of the Ponderosa wildfire; the locations of hydroelectric projects, fish passage barriers, fish hatcheries, the barrier weir, and road segment failures (e.g., Ponderosa Way).	Concur. Will need to be addressed in future update.	25
Element A: Causes and Sources of Impairment, Recommended Future Updates	EPA Region 9 5/14/19	2. Watershed-based plans (WBPs) provide an overview of issues in a watershed, and should include: pollutants identified in the state's current Integrated Report (listing of 303(d) and 305(b)) for all waterbody segments in the watershed, water quality concerns indicated from monitoring and modeling efforts, and potential point and nonpoint sources of those pollutants. Identify all segments listed in the Integrated Report; also address any other water quality concerns and potential impairments that may not be listed yet (e.g., temperature, turbidity and herbicides) and identify critical areas/reaches and temporal periods for those pollutants.	Concur. Will need to be addressed in future. No integrated report to draw from. No water quality concerns are listed yet. Outstanding needs to investigate other constituents identified.	26
Element A: Causes and Sources of Impairment, Recommended Future Updates	EPA Region 9 5/14/19	3. Identify the goals, managment objectives and targets for the watershed, and criteria to measure progress in achieving targets.	Established these to extend possible. Will need to be expanded and amended in the future with site specific sediment savings and addition of other stakeholder concerns.	27
Element A: Causes and Sources of Impairment, Recommended Future Updates	EPA Region 9 5/14/19	4. Describe all sources that need to be controlled (e.g., grazing, viticulture activities) including point and non-point sources; show where each source type is present in the watershed. Provide a map of roads throughout the watershed in the watershed characterization section (needed to support Section 3.3.1 implied conclusion that sediment delivery is linked to road density in the "mid to upper elevations").	All possible sources have not yet been identified and need to control them is not established. Will need to be addressed in future revision.	28

Section / Topic	Entity	Comment	Response / Status	#
Element A: Causes and Sources of Impairment, Recommended Future Updates	EPA Region 9 5/14/19	5. Summarize monitoring data characterizing causes and sources; show sampling locations on a figure, and identify impaired reaches. Text states 2017 SWAMP data shows reaches to be “likely altered” - please define this term (does it mean impaired?); similarly, clarify if CSCI data showed any reaches to be impaired and show locations (does Figure 1 show the 2006 CSCI locations?).	We refined our references to other documents and page numbers for this information in keeping with the short-form format. E.g. CSCI results are mapped in Appendix A of Tussing et al 2019. Short form WBP format do not identify sampling locations for all assessment activities.	29
Element A: Causes and Sources of Impairment, Recommended Future Updates	EPA Region 9 5/14/19	6. Describe models used to estimate pollutant loads and appropriate uses of the model results (e.g., what the model considered/addresses, gaps in model results, sources of data etc). For example, the title for Figure 8 implies the model evaluated landslide potential and soil redistribution potential. Say what other factors were assessed (e.g., road density data, road types, other land uses). Please confirm modeled sediment delivery units in Figure 5 and 6 (kg/yr versus mg/yr).	Sediment delivery units confirmed.	30
Element A: Causes and Sources of Impairment, Recommended Future Updates	EPA Region 9 5/14/19	7. The Draft WBP has provided modeled estimates of road sediment loads by HUC-12 (Table 7) and shows ranges by catchment (Figure 6); provide additional information to support statements of total combined sediment loads from the North and South Forks (Section 3.2). Provide quantified estimates of pollutant loads for each source category. Data should support statements of load correlation to land use attributes (e.g., road density and crossing frequency) and managment (BMPs on public vs. privately managed roads).	Concur. Will need to be addressed in future.	31
Element A: Causes and Sources of Impairment, Recommended Future Updates	EPA Region 9 5/14/19	8. Describe needed load reductions and any other goals to achieve the WBP goals, managment objectives and targets for the watershed.	Needed load reductions have not been established due to lack of a sediment budget. Will need to be addressed in future.	32
Element A: Causes and Sources of Impairment, Recommended Future Updates	EPA Region 9 5/14/19	9. To coordinate this WBP with other efforts in the watershed, describe other planning documents (e.g., FEMA Hazard Mitigation Planning, fire prevention and/or management plans, TMDLs, IRWMPs, Habitat Conservation Plans, stormwater plans, etc); include goal, milestones, and current and planned activities. As noted in Sections 4.1.3 and 5.1.1, there are ongoing road assessments, a Southwest Lases Watershed Improvement Project, and SPI’s recently implemented “READI” modeling approach for evaluating unpaved road erosion and stream sediment delivery from their road network).	This short-form WBP does not address many of these other planning efforts but could be added in a future revision. More detail was added regarding ongoing LNF and SPI efforts.	33
Element b. Expected load reductions, Recommended Future Updates	EPA Region 9 5/14/19	An estimate of the load reductions expected from management measures described under Element (c) below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time). Estimates should be provided at the same level as in item (a) above.	Table 7 provides expected load reduction for priority road treatments.	34

Section / Topic	Entity	Comment	Response / Status	#
Element c. Management Measures, Recommended Future Updates	EPA Region 9 5/14/19	1. Identify what load reductions are needed to achieve WBP goals (e.g., presented in a table by reach and parameter - sediments, turbidity, temperature, herbicides) for each constituent of concern and source. The plan should contain quantified estimates of current (and sometimes future) pollutant loads, and reductions needed by source category to achieve water quality goals; theses are needed to identify specific management measures, actions and locations to achieve load reductions and other targeted other benefits. Section 4 identifies some sources targeted for load reductions to support cold water habitat beneficial uses, including unpaved roads, wildfire prevention/silviculture and post-fire management, and also states "sediment reduction plans will establish high, moderate and low immediacy rankings for both chronic and episodic sediment delivery sources".	Incorporated the need to consider other potential constituents.	35
Element c. Management Measures, Recommended Future Updates	EPA Region 9 5/14/19	2. Clearly identify priority areas in which efforts are needed, and the MMs needed to address each source. California's Nonpoint Source Program Implementation Plan 2014-2020, Appendix A identifies MMs by sector (e.g., forestry operations, hydromodification). Prioritize the identified MMs to address sources and reduce pollutant loads, to inform coordinated and effective implementation.	Priority areas and MM's identified, however lack of information regarding some controllable sources limits our specificity. Will need future revision.	36
Element c. Management Measures, Recommended Future Updates	EPA Region 9 5/14/19	3. For each MM, identify for each source and area the MPs that could be implemented; provide load reduction estimates for MPs to help prioritize load reduction efforts. To address roads, Section 4.2 and Section 5, Table 8 identify some MMs / MPs. Table 9 identifies BMP guides for unpaved rural road, and Section 5 text named PWA (2015) and CAL FIRE (2017) (neither are included in Section 10. References). Wildfire Prevention planning and treatment priority areas and MM/MPs are yet to be identified.	Citations added.	37
Element c. Management Measures, Recommended Future Updates	EPA Region 9 5/14/19	4. Include MM/MPs associated with ongoing projects/areas, and the anticipate load reductions.	Added identification of MM's for some ongoing projects.	38
Element c. Management Measures, Recommended Future Updates	EPA Region 9 5/14/19	5. The Draft WBP states "the TAC for this watershed-based planning process decided against incorporating non-public proprietary data into assessment activities". Information on MMs and MPs can be summarized on a scale to protect business practices while still communicating needed, planned and accomplished progress.	Concur.	39
Element d. Estimate of technical and financial assistance needed, Recommended Future Updates	EPA Region 9 5/14/19	1. Identify specific technical assistance needed to advance and/or implement the WBP. Some information needs noted in the text include: a. Field validation of models results b. Identification of spatially explicit land ownership, areas of completed road assessments, prioritized treatments, and sediment source reduction estimates, in order to identify the spatial extent of outstanding road assessment; and prioritize implementation needs to determine how to best group them into projects and estimate the amount of financial assistance required (from Figure 9 title)	Section revised and expanded.	40
Element d. Estimate of technical and financial assistance needed, Recommended Future Updates	EPA Region 9 5/14/19	2. Both tasks and potential funding sources shown in Table 13 should be expanded. a. Provide specific proposed, implementation projects to meet the management measures listed for critical areas and identify the entities likely to be responsible for completing the suggested actions. Be clear if projects include planning and/or design needs, along with implementation. b. Provide cost estimates for proposed projects; identify potential funding sources (more than is currently identified.	Potential funding sources expanded. Cost estimates removed pending more detailed proposed project information.	41

Section / Topic	Entity	Comment	Response / Status	#
Element e. Information/education, Recommended Future Updates	EPA Region 9 5/14/19	Section 6 describes the Education and Outreach component. The section provides goals, with stakeholder groups, and objectives for each goal. The Education and Outreach should be expanded as the WBP is further developed to assure effective collaboration with stakeholders, funders, and the public.	Concur.	42
Element f. Schedule for implementation, Recommended Future Updates	EPA Region 9 5/14/19	Table 10 of the Draft WBP presents a start to an implementation schedule. • Three ongoing road assessment projects are identified and prioritized for completion by 2022. (The actual projects and their schedules are not presented.) • Three long-term "projects" identify next steps in developing the WBP and elements to address sediments from roads. Do the estimates for accomplishing milestones reflect actual project schedules to show realistic implementation progress? Future versions of the WBP should expand the implementation schedule to reflect projects to implement MMs/MPs for each reach and source, and how specific management measures relate to the necessary load reductions. Include an estimate for when WQOs will be achieved.	Concur. Added more detail on LNF management measures and scope of project. Will refine in future versions of the WBP.	43
Element g. Measurable milestones, Recommended Future Updates	EPA Region 9 5/14/19	This element focuses on managing progress implementing the WBP efforts, using milestones to track work and monitor progress. How to track projects as they are planned/started/completed should be addressed, with milestones for tracking the watershed plan implementation. Projects to be implemented could be summed by lead implementer, and/or identified on a map to coordinate projects by area or waterbody reach. The specific milestones and performance indicators should be quantifiable and measurable, to help determine progress towards attaining WQ Objectives.	Established in Section 5.	44
Element h. Success Criteria, Recommended Future Updates	EPA Region 9 5/14/19	Element h. A set of environmental or administrative criteria that will be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards – this criteria provides the basis for determining whether this watershed-based plan needs to be revised or whether the NPS TMDL needs to be revised.	Established in WBP Section 7. No NPS TMDL established for watershed.	45
Element i. Monitoring & evaluation, Recommended Future Updates	EPA Region 9 5/14/19	Using necessary load reductions for meeting WQOs, future WBP drafts should identify criteria (element h) to determine whether loading reductions are being achieved and to know when WQ targets are being met. Both interim and final indicators should be developed for each reach/pollutant combination, tied to specific MM's, and be quantifiable and measurable. Monitoring (element i) should be planned to to evaluate the effectiveness of implementation and assess progress seeing water quality improvements, on an appropriate schedule. Rapid assessment monitoring indicators are encouraged, especially for interim monitoring, to minimize the need expensive WQ modeling or monitoring. Include a review of progress in achieving load reductions and criteria, and use that information to periodically assess effectiveness of work done and revisit what future management measures are needed (adaptive management). The reviews should include an evaluation about whether the plan is achieving the interim and final targets and water quality goals, and what changes are needed to achieve the WBP goals.	Established in WBP Section 7. Added potential rapid assessment alternatives.	46