Report of Waste Discharge

Elk River Watershed

Humboldt County, CA

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1.0 Introduction

This report comprises an Application/Report of Waste Discharge for sediment discharges from timber harvesting activity conducted by Humboldt Redwood Company, LLC, in the Elk River watershed which drains to Humboldt Bay in Humboldt County.

California Water Code section 13260 requires that persons discharging or proposing to discharge waste that could affect the quality of waters of the State shall file a Report of Waste Discharge (ROWD).

Humboldt Redwood Company (HRC) is currently operating under the Watershed-wide Waste Discharge Requirements established by California Regional Water Quality Control Board North Coast Region Order no. R1-2006-0039. These watershed-wide WDRs were established in 2006 at the request of the previous landowner, the Pacific Lumber Company (PALCO). These WDRs were subsequently amended by Order No. R1-2008-0100, to reflect the 2008 change in ownership from PALCO to HRC. HRC also currently operates in this watershed under two sediment-related Cleanup and Abatement Orders (CAOs) established by the NCRWQCB. Both Order R1- 2004-0028 (South Fork Elk River) and Order R1-2006-0055 (North Fork Elk River) were also inherited from the previous landowner.

The intention of this ROWD is to provide information necessary to replace the existing WDRs (inherited from PALCO) with new WDRs that reflect current management and watershed conditions. As has been discussed with the NCRWQCB, remaining necessary requirements for erosion control from the two CAOs are proposed for incorporation in the new WDRs, allowing for termination of the CAOs as separate Board orders and more efficient management of related monitoring and reporting. As such, this ROWD provides a comprehensive sediment management strategy for the purposes of control, prevention, trends and effectiveness monitoring, and associated reporting.

An assessment of watershed response to past and more recent management activities, along with updated watershed trends, is provided in the recently completed Elk River Watershed Analysis Re-visit (HRC 2014), which is provided as a companion report to this ROWD and referenced herein where applicable. This report includes a comprehensive sediment source budget covering the years 2001 through 2011, and provides detailed discussion of watershed trends relative to mass wasting and surface erosion, water temperature, canopy cover, large wood recruitment, in-stream sediment, substrate, and wood, and pool frequency and quality. Periodic watershed assessment synthesis is a requirement of the landowner's HCP and a cornerstone of its adaptive management process as findings can trigger changes in forestry prescriptions and/or monitoring goals, hypotheses, and design.

The NCRWQCB has indicated an interest in the drafting of new Watershed-Wide Waste Discharge Requirements in coordination with completion of its Upper Elk River TMDL. The strategies for sediment prevention and control presented in this ROWD are intended to address the Total Maximum Daily Load (TMDL) targets identified by the NCRWQCB, and provide the basis for an effective TMDL implementation plan.

1.1 *Site Description*

1.1.1 **Site Location**

Elk River is located in coastal northern California, draining into Humboldt Bay just south of the town of Eureka, within Humboldt County (Map 1). Elk River's legal description at the mouth to Humboldt Bay is T04N R01W S04 and is comprised of five (5) sub-basins delineated under CalWater V2.2 planning watersheds as Lower Elk River (1110.000402), Lower North Fork Elk River (1110.000201), Upper North Fork Elk River (1110.000202), Lower South Fork Elk River (1110.000302), and Upper South Fork Elk River (1110.000301)

1.1.2 **Facility Defined**

The Elk River Watershed encompasses approximately 33,700 acres (52.7 mi^2). The watershed contains two major forks, the North and South forks. The watershed area for North Fork and South Fork are about 14,336 acres (22.4 mi^2) and 13,120 acres (20.5 $mi^{2)}$, respectively, with the remaining 6,244 acres (9.7 mi2) draining directly into the Elk River mainstem below the North Fork-South Fork confluence. The "Facility" covered by this WDR application includes only those lands owned and managed by HRC and rights-of-ways over roads on lands owned by others, totaling approximately 22,200 acres. HRC lands account for approximately 66% of the watershed; 98% of the North Fork Elk basin, 50% of the South Fork basin, and a small section of the mainstem region near the confluence. Other ownerships within the watershed include the Headwaters Forest Reserve managed by Bureau of Land Management, Green Diamond Resource Company, City of Eureka, and mixed private residential and agricultural ownership.

HRC's forest lands are managed consistent with zoning for growing conifer and hardwood trees for the production of saw logs, chip logs, and other renewable forest products such as bio-fuel, split products, firewood, and burls. Eight hundred and two (802) acres of HRC's ownership in the watershed are managed primarily as a Marbled Murrelet habitat reserve pursuant HRC's multi-species Habitat Conservation Plan (HCP). HRC maintains an approximate 210 mile road network throughout the 'facility'; approximately six (6) road miles per square mile.

Detailed information regarding topography, hydrology, geology, vegetation, climate, and storm history can be found in Section 2.0 of the Elk River/Salmon Creek Watershed Analysis Report (HRC 2014). A map of HRC's ownership in the watershed is provided (Map 2).

2.0 Site Use and Regulation

HRC land use within the watershed is consistent with timber production zoning (TPZ) and is predominantly devoted to timber production.

2.1 *Regulatory Agencies and Permitting Requirements*

Agencies with regulatory oversight of timber harvest and related activities in the watershed are as follows:

- California Department of Forestry and Fire Protection
- North Coast Regional Water Quality Control Board
- California Department of Fish and Wildlife (CDFW)
- California Geological Survey
- North Coast Air Quality Management District
- County Agriculture Commissioner
- U.S. Fish and Wildlife Service
- NOAA Fisheries

Agencies that own and manage land within the watershed include:

- California Department of Fish and Wildlife (Elk River State Wildlife Area)
- Federal lands co-managed by BLM and CDFW (Headwaters Forest Reserve)
- California Department of Transportation (Hwy 101)
- City of Eureka (City of Eureka Elk River Wildlife Area)

2.1.1 **CEQA Requirements**

Adoption of new watershed-wide waste discharge requirements by the NCRWQCB will require compliance with the California Environmental Quality Act (CEQA).

2.1.2 **Timber Harvesting Permitting**

The CEQA Lead Agency for timber harvesting operations is the California Department of Forestry and Fire Protection (CAL-FIRE). The Secretary of Resources has certified that regulation of timber harvesting operations by CAL-FIRE under the Z'Berg-Nejedly Forest Practice Act is exempt from CEQA requirements to prepare an Environmental Impact Report (EIR) or Negative Declaration. A Timber Harvesting Plan (THP) that is approved by CAL-FIRE is considered a functional Equivalent of an EIR under CEQA. Multi-agency interdisciplinary review teams are established by the CAL-FIRE Director to review plans and assist in the evaluation of proposed timber operations and their effects on the environment. In addition to CAL-FIRE, the following state agencies often participate in plan review: the North Coast Regional Water Quality Control Board, California Department of Fish and Wildlife, and the Department of Conservation Division of Mines and Geology.

As noted, NCRWQCB staff review Timber Harvest Plans as a formal 'Review Team' member, participate in pre-harvest inspections, and submit comments and recommendations to CAL-FIRE to address concerns over potential adverse effects to water quality and related beneficial uses. California Water Code (CWC) section 13260 and related sections also provide Regional Water Boards with additional jurisdiction over forestry activities that could affect the quality and beneficial uses of waters of the state.

2.1.3 **Stream Alteration Permits**

Any activity proposed by HRC that may significantly alter the streambed or bank of any stream must first be issued a permit by the California Department of Fish and Wildlife pursuant Fish and Game Code §1600 et seq. Such activities may include new or reconstructed stream crossings, stream restoration, or water drafting. HRC has obtained a Master Agreement for Timber Operation (MATO) throughout the ownership which provides for a programmatic permitting process for certain stream crossing activities based upon a commitment of adherence to established standards (MATO No. 1600-2009-0279-R1).

2.1.4 **Habitat Conservation Plan**

All of HRC ownership in the Elk River watershed is covered by a multi-species state and federal Habitat Conservation Plan approved in 1999. The state and federal Incidental Take Permits (ITP) issued for aquatic species including Chinook salmon, Coho salmon, steelhead trout, southern torrent salamander, tailed-frog, red-legged frog, foothill-yellow legged frog, and the northwestern pond turtle are most relevant to protection of the Beneficial Uses of Elk River. The management measures for water quality protection of the HCP were the subject of the federal Environmental Impact Statement and state Environmental Impact Report which led to the issuance of the ITPs in conformance with the state and federal Endangered Species Acts.

A 'cornerstone' program of the HCP is Watershed Analysis, in which HRC's approximate 209,000 acre ownership is divided into eight primary watersheds for focused inventory and investigation of

conditions and processes related to mass wasting, surface erosion, riparian function, stream channel, and aquatic habitat. The first Watershed Analysis conducted for the Elk River/Salmon Creek (ERSC) Watershed Analysis Unit (WAU) involved several years of study culminating in a final report released in 2005. Forest management prescriptions (Appendix A) pertaining to slope stability and riparian forest protection were developed and formally established in consultation with multiple state and federal agencies including NMFS, USFWS, CDFW, and CGS, as a result of this process. NCRWQCB staff participated intermittently in the initial watershed analysis as well.

The 2014 *Elk River/Salmon Creek Watershed Analysis Re-Visit* report (HRC 2014) analyzes the effectiveness of these forestry prescriptions to date, along with watershed trends affecting aquatic habitat conditions and of vital importance to HCP covered species. A primary purpose of this report is to assess the effectiveness of the current ERSC forestry prescriptions in meeting the HCP Aquatic Conservation Plan goal 'to maintain or achieve, over time, a properly functioning aquatic habitat condition'. As such, this report is an important supporting document to this ROWD relevant to understanding the effects of contemporary forestry practices on beneficial uses of waters of the state.

Another important element of the HCP is its Road Auditing and Inspection Program patterned after the U.S. Forest Service Best Management Practice Evaluation Program (BMPEP). This program evaluates the effectiveness of road treatment in minimizing sediment delivery to streams. The program has been in effect since 2006 and the most recent annual technical report was produced in 2012 (Sullivan, Simpson 2012).

2.2 ***Beneficial Uses***

The Water Quality Control Plan for the North Coast Region (Basin Plan) lists the existing and potential Beneficial Uses of Water quality within the Elk River drainage:

- Municipal and Domestic Supply (MUN)
- Agricultural Supply (AGR)
- Industrial Service Supply (IND)
- Industrial Process Supply (PRO, potential)
- Groundwater Recharge (GWR)
- Freshwater Replenishment (FRSH)
- Navigation (NAV)

- Power Generation (POW, potential)
- Water Contact Recreation (REC-1)
- Non-Contact Water Recreation (REC-2)
- Commercial and Sport Fishing (COMM)
- Cold Freshwater Habitat (COLD)
- Wildlife Habitat (WILD)
- Rare, Threatened and Endangered Species (RARE)
- Migration of Aquatic Organisms (MIGR)
- Spawning, Reproduction and/or Early Development (SPWN)
- Estuarine Habitat (EST, applies only to estuarine portion of the waterbody)
- Aquaculture (AQUA, potential)

The extent to which these various beneficial uses actually apply to Elk River varies. Residents throughout the basin have historically used surface water for domestic and agricultural water supplies. HRC's ownership in the upper Elk River watershed contains approximately 34 miles of fish-bearing Class I stream habitat supporting Coho and Chinook salmon, and steelhead and cutthroat trout.

Citing logging-related effects on the drinking water beneficial use, the Regional Water Board ordered PALCO, the previous landowner, to restore domestic and agricultural water use or provide alternative water systems to effected residences along North Fork Elk River (Order No. 98-100). This CAO remains in effect. HRC currently provides drinking water service to twelve residents, while seeking final resolution and termination of the CAO.

The Elk River watershed was listed in 1998 as impaired under Section 303(d) of the federal Clean Water Act on the basis of excessive sedimentation/siltation. Potential Water quality problems cited under the listing include: sedimentation, threat of sedimentation, impaired irrigation water quality, impaired domestic supply water quality, impaired spawning habitat, increased rate and depth of flooding due to sediment, and property damage.

Once listed, the United States Environmental Protection Agency (EPA) requires states to establish a Total Maximum Daily Load (TMDL). The NCRWQCB has been working on the development of the TMDL and is currently in the draft stage.

The state implements TMDL limits through permits, waivers, and orders. HRC current conducts its forestry management activities, including timber harvest, pursuant to the following orders currently in effect for its ownership in the Elk River Watershed:

NCRWQCB Order No. R1-2006-0039 (Elk River Watershed-Wide Waste Discharge Requirements)

NCRWQCB Order No. R1-2008-0071 (Elk River and Freshwater Creek WDR-related Monitoring and Reporting Program Requirements)

NCRWQCB Order No. R1- 2004-0028 (South Fork Elk River Clean Up and Abatement Order)

NCRWQCB Order No. R1-2006-0055 (North Fork Elk River Clean Up and Abatement Order)

3.0 Land Use and Site History

Major land uses in the watershed are forestry, agricultural/residential, and power line right-of-way. Rural land use primarily includes pasturing and there are residential homes along the lower reaches of the mainstem and North Fork and South Fork branches. Forest management is the primary land use on HRC lands consistent with timber production zoning (TPZ).

Timbered areas in the watershed including HRC's ownership have been actively logged since the 1860's. Characterization of early harvest history is provided in reports produced by PWA (1998), Hart Crowser (2005), and HRC (2014). An extensive road system has been developed over the last one hundred plus years. Constructed to varying standards over time, much of the logging road system on HRC's ownership has been upgraded or decommissioned to HCP storm-proofed standards over the last fifteen years.

During much of the pre-Forest Practice Rules historical period, high impact activities were conducted with little to no regard for erosion control or conservation of riparian forest function. California Forest Practice Rules have guided forest management practices to minimize impacts of activities on water quality and sedimentation since 1974. Updates to these rules during the past 40 years have continually improved protections related to road construction, wet weather use, and maintenance practices and riparian management as scientific understanding of linkage to aquatic habitat conditions and processes has increased. The HRC (formerly PALCO) HCP has further

strengthened conservation measures, guided specifically by studies of environmental conditions found on HCP covered lands. Figure 3-1 provides photographs illustrating typical logging practices during various eras.

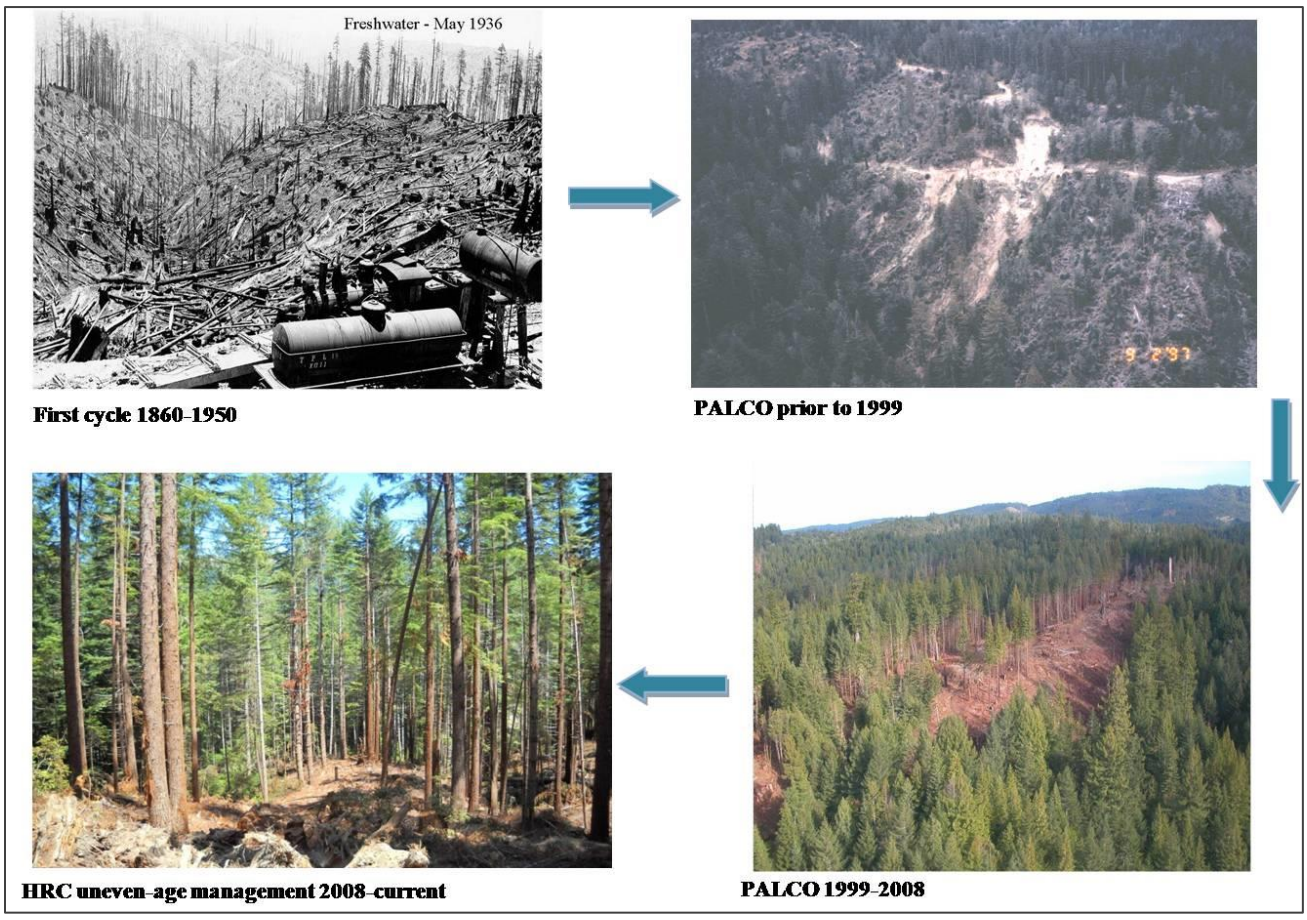


Figure 3-1. Photographs illustrating forest silvicultural practices history in Elk River and Freshwater Creek

3.1.1 Historic Land Use and Harvest History

Since the beginning of European settlement of the Humboldt Bay region in the 1850s, the condition and function of Elk River and its flood plain (including coastal marsh habitat) have been influenced by land use (farming, ranching, and timber), and urbanization and infrastructure encroachment (roads, bridges, and houses). Levees and dikes were constructed to create and maintain valley bottomlands suitable for farming and ranching, and roads and railroads built to access these

enterprises, regions further to the south, and early timber operations. As a result, much of the pre-existing wetlands and coastal marsh habitat have been converted to drier farmlands.

Stabilization of the bay mouth by constructing jetties off of the north and south spits circa 1890 hardened the entrance of the bay and resulted in the eroding away of much of what is referred to as Buhne Point (now the community of King Salmon). Sediments eroded from Buhne Point subsequently deposited at the mouth of Elk River causing the channel to turn north and lengthen prior to entering the bay. A recently completed longitudinal profile of Elk River found the river to reach sea level nearly four miles upstream of its entrance into Humboldt Bay, meaning a zero percent channel gradient exists along this final reach (Northern Hydrology, 2013).

Timber harvest began near the bottom of the watershed, downstream of what is now HRC's ownership, in the 1860's with animal-powered oxen log skidding, progressing upstream over time, using 'steam donkeys' and railroad logging into the 1920's. The first railroad tracks for timber access were laid in the 1880s and expanded over time into the 1930's; the construction of which required substantial hillslope alteration (excavation and fill) in order to establish low gradient railways on which log trains could run reasonably safely. Historic timber operations directly affected channel conditions and water quality in several ways including use of smaller channels as skid roads for log transport and the larger mainstem channels as the original means by which to transport logs to Humboldt Bay for milling (Figure 3-2).

Figure 3-2. Logs stacked in Elk River in 1892, waiting for a winter freshet to carry them downstream. Seth Buck Collection.

The Humboldt Times newspaper reported routine use of man-made dams throughout the 1870s to create early winter season floods by which loggers drove millions of board feet of old growth logs down the river to the bay. *Falk's Claim*, authored by John Humboldt Gates (1983), describes the process:

> *At that time the only way to move logs was by oxen and mule teams, so the loggers felled only trees which were nearest the river, then cut them into shorter sections with hand saws which measured from 6 to 24 feet in length. The woodsmen usually left behind the lower 20 feet of the tree because these logs were too big to handle. All the work was done in the summer months, so that by fall the river bed was loaded with the sectioned trees. A dam was then constructed downriver of the waiting logs, and as the autumn rains descended, the water level rose until these logs floated freely. The next phase of the operation (and the one that made living downstream somewhat troublesome) was to blow the dam up with high explosives. This sent a flash flood of water and*

> *huge timbers cascading down the river. Many of the logs made it all the way down the valley and into the bay, where they were lashed together and towed to the D.R. Jones mill. Quite a few logs, however, ran aground or became tangled in snarls of debris. Jones then sent crews back up river to free the ones that were easily accessible. Those that were too deeply imbedded were not salvaged. As the rains continued to pour throughout the winter, more debris floated downstream and formed log jams around these embedded snags, which eventually blocked the river and sent it over the banks into the farmlands of the lower valley. This went on for several years before complaints from the farmers forced an end to the flash –flood method of log delivery. (P.14-15)*

The first mill in the upper watershed was established along the South Fork Elk River in 1884. Early tractor and diesel powered high-lead cable logging was introduced to the watershed in the 1940's. Following a decrease in harvest activity in the 1970s through mid 1980s, harvest activity began to increase in the late 1980s and into the 1990s as second growth timber stands reached commercial age and redwood lumber prices soared. High-lead and skyline cable yarding methods, along with tractors were used to selectively harvest residual old-growth and larger second growth. Clearcut logging was also used to a lesser extent during this time period, primarily in the North Fork.

Management of the river and its lower floodplains was a common practice throughout much of the County's history and there are many anecdotal accounts by residents, ranchers, and County managers of the necessity for stream clearing for flood management purposes (PALCO 2005). In the 1970s and 1980s, reaches of the river were cleared of the abundance of large wood/log jams believed to be a limiting factor to fisheries by the California Department of Fish and Game. These log jams also contributed to channel roughness and reduced channel carrying capacity, and consequently contributed to flooding.

More recently, recognition that fish habitat benefits from fairly high loading of large wood resulted in an end to the practice of state sponsored stream cleaning. These benefits include sorting gravels, trapping sediment, creating pools, and providing for insect fall and cover. The subsequent listing of the Coho salmon (1997), Chinook salmon (1999), and steelhead (2000) as threatened further affected the extent to which, and how, stream channel conditions and riparian vegetation is managed. The current mostly 'hands-off' approach to in-channel management has led to an increasing trend in woody debris loading, riparian vegetative growth, and consequently, increased channel roughness, downstream of HRC's ownership where the stream gradient is <0.2% (HRC 2014).

3.1.2 **Contemporary Land Use and Harvest History (1999-2012)**

Timber harvest operations in Elk River changed significantly following implementation of the PALCO HCP in 1999, and again with the change of ownership from PALCO to HRC in August of 2008. From 2001 through July of 2008, PALCO used primarily even-age silviculture in harvesting mainly second

growth redwood and Douglas fir. Clearcut unit size and environmental impacts were reduced by HCP conservation measures restricting harvest adjacent watercourses and on unstable areas. HCP wet weather road use limitations, new road construction standards, and requirements for "storm-proofing" and road system monitoring were implemented. After July 2008, with the transition in ownership from PALCO to HRC, timber harvesting was converted to primarily uneven-aged selection silviculture practices. HRC immediately ended the silvicultural application of traditional clearcutting, minimized the use of herbicides, and implemented an old growth tree retention policy.

Harvest rates in terms of acres logged annually over this period are presented in Figure 3-3.

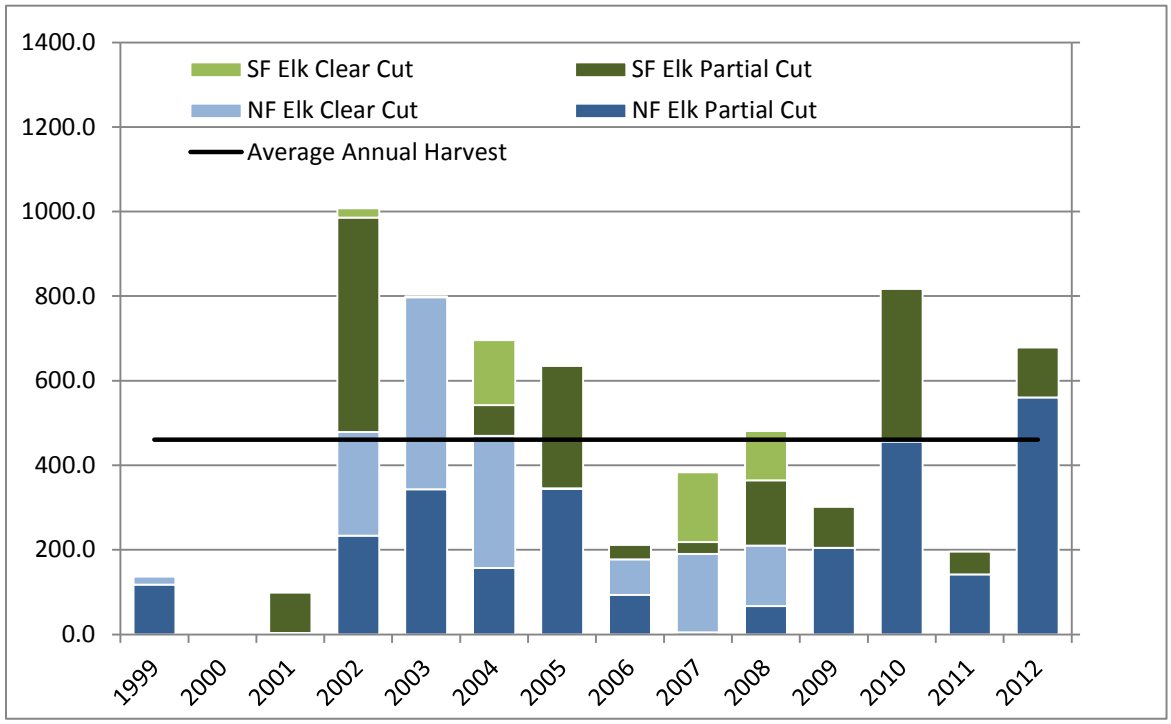


Figure 3-3. North and South Fork Elk River Harvest Rates; 1999-2012

The Elk River haul road system on HRC ownership was constructed over nearly a century long period using a variety of construction standards. A focused watershed-wide effort to control active and potential sediment delivery from the road system began in 1997, initiated with a comprehensive sediment source investigation and sediment reduction plan conducted by Pacific Watershed Associates (PWA 1998), and augmented with subsequent surveys. Implementation of road system upgrading and storm-proofing as part of HRC's HCP has resulted in the removal or prevention of delivery of an estimated 334,700 cubic yards of sediment to stream channels on HCP

covered lands as of end of year 2014. Two hundred and six (206) miles of the approximate 260 mile road system has been *storm-proofed* to HCP standards including 50 miles of road decommissioning and closure (Map 3). Further discussion of road system use and management including scheduling for completing remaining storm-proofing is provided in Sections 5.0 and 6.0 of this ROWD.

4.0 Forest Management Plan

Sediment delivery from forestry activities typically originates from two primary sources – roads and harvest areas – with amount of delivery dependent upon specific management practices, road system conditions, geology and soil, proximity to watercourse, climatic events, and other environmental factors.

The **Management Plan** described herein, details silviculture and Best Management Practices (BMPs) designed to control hillslope erosion, prevent and minimize sediment delivery, and result in no significant increase in peak flows over and above those which occur naturally in response to extended or otherwise significant precipitation events.

In general these measures focus on minimizing disturbance of streamside banks and riparian areas, identification and avoidance of activities on unstable or otherwise potential landslide prone areas, and BMPs for road system management, use, and maintenance. In addition to implementation of prevention and minimization measures at the project level, cumulative effects of sediment delivery are further addressed by landscape planning that describe the extent and location of harvest (acres disturbed; effect on canopy cover) watershed-wide, over a planning horizon of 20 years, and importantly, through the remediation of pre-existing legacy conditions most commonly related to historic road and landing construction.

In addition to this ROWD, information regarding the effectiveness of these strategies can also be found in the companion Elk River Watershed Analysis Re-Visit Report (2014).

4.1 *Silviculture and Logging Methods*

Due to a combination of climate and nutrient rich soil conditions, Elk River is very productive in terms of forest cover and regeneration. Since August 2008, timber stands found on HRC's ownership in the watershed have been managed using **uneven-aged single-tree and small group selection silviculture**. Selection is anticipated to continue to be the primary harvesting silviculture method applied over the 20 year planning horizon.

Variable Retention may be used in some instances as an alternative silviculture to address certain stand conditions, such as high levels of whitewood or hardwood species, animal damage, or general poor form and vigor due to past logging history. Variable Retention may also be used to achieve specific biological objectives such as increased prey-production for the endangered Northern Spotted Owl.

Other silvicultural methods that may be applied infrequently include **Rehabilitation of Understocked Areas, Seed Tree Removal,** and **Sanitation Salvage.** Rehabilitation of Understocked Areas could potentially be applied in the upper North Fork drainage where tanoak is most common. In some unique instances, Seed Tree Removal may be applied to removed scattered pre-dominant trees provided a thrifty stand of trees exists surrounding these scattered older trees, however use of this silviculture is expect to seldom occur over the 20 year planning horizon. Sanitation-Salvage may be used to respond to unforeseen acts of nature (i.e. outbreak of disease, wide spread insect attack, wildfire, wind, flood, etc.) which could result in substantial loss of timber value without appropriate action.

HRC does not use even-age clearcut logging methods nor harvest large Old Growth trees.

Logging (yarding) methods will be selected based on suitability to terrain. High-lead and full suspension **cable yarding** will continue to be the most common yarding method used in the watershed, typically applied to slopes >35-40 percent. **Ground-based** tractor, rubber tired skidder, or shovel logging operations will be constrained to slopes ≤ 40 percent with limited exception. Ground-based skid trails will continue to be minimized to the lowest number necessary to remove felled timber, and slashed packed per RPF instruction and/or specific THP requirement. Designated skid trails used within riparian management or equipment exclusion zones will be slash packed. Slash-packing of skid trails minimizes potential for surface erosion and sediment delivery following use prior to the re-vegetation. Figure 4-1 illustrates the practice of slash packing skid trails. Map 4 shows the location of slopes less than and greater than 40 percent, inferring where each yarding method will typically be used.

Figure 4-1 Slash packed tractor skid trail

Helicopter yarding, if used at all, will be done so sparingly and only as necessary to access areas where topography and/or slope stability prevents conventional yarding access (e.g. no existing road access; new road construction not advisable) or where topography otherwise prevents use of more conventional yarding means (e.g. blind leads, poor deflection, etc.).

Minimal harvesting will occur within Class I and II **Riparian Management Zones (RMZs)**. No harvesting will occur within 50 feet of a Class I watercourse or within 30 feet of a Class II watercourse. No harvesting will occur on **unstable slopes** leading to watercourses, unless approved as a result of consultation with a professional geologist.

Timber harvest is guided by enforceable forestry prescriptions developed and monitored for effectiveness per HRC's Aquatic HCP Watershed Analysis program and all THPs must be reviewed and approved per California's Forest Practice Rules requirements.

4.2 *Landscape Planning*

The HRC landscape planning process integrates forest inventory (forest stand conditions), watershed condition (informed by watershed analysis), and fisheries and wildlife conservation objectives (established by the HCP, ESA, CESA, and landowner directive) with the planning and scheduling of long term sustainable timber harvest in order to achieve HRC's overall landscape objectives. These objectives include:

- Maintaining and restoring forest productivity
- Maintaining and restoring watershed function related to water quality and healthy aquatic habitats
- Protecting ecological structure on multiple scales
- Achieving conversion to uneven-age stand structures from the mostly even-age stand structure currently existing
- Where appropriate, returning hardwood-dominated stands to a historical conifer-dominated condition
- Sustainable, predictable, cost-effective timber production with increasing yield over time as inventory grows

Annual harvest allowance is determined by the landscape plan. Elk River is one of thirteen designated *Sustainability Units* (SU) on HRC's approximate 209,000 acre ownership. The Elk River SU is made up of *management blocks* within which timber harvesting is scheduled over a twenty year period, in five year increments. The decision as to which blocks are to be managed during any five year period is dependent upon stand conditions (i.e. stocking, age, species composition), erosion control priorities (e.g. sediment source inventory), and a desire to disperse harvest activities throughout the SU so that concentrated temporal impacts on wildlife and watershed resources is avoided. Management blocks are assigned designated harvest periods with the 20 year planning horizon such that harvest area is limited to no more than 25-30 percent of the overall SU within any five year time period, and typically much less. Within each management block, wildlife and fisheries conservation measures (e.g. critical habitat for Marbled Murrelet, Northern Spotted Owl and other species of concern; riparian forest management; slope stability) along with stand conditions and forestry objectives dictate actual harvest locations and prescriptions.

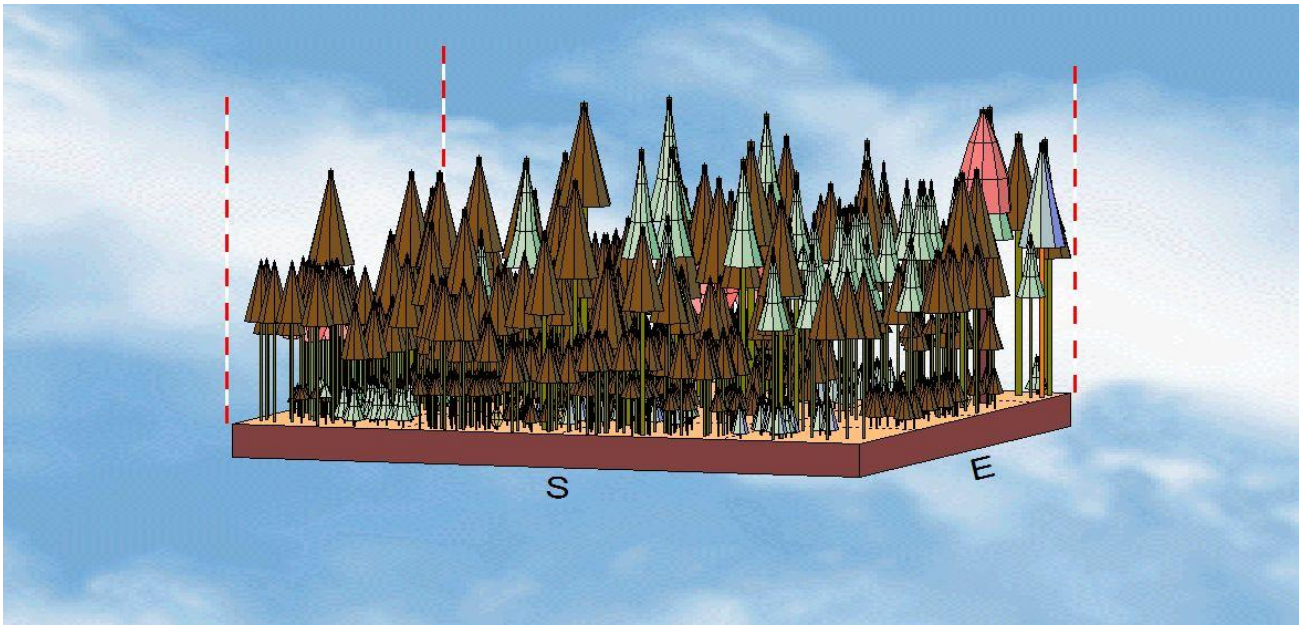
The landscape planning process facilitates predicting and communicating expected trends in harvest, growth, canopy cover, and standing inventory, and associated distribution and amount of forest wildlife habitat types across the landscape over time. This information is often forecast in designated five year planning periods.

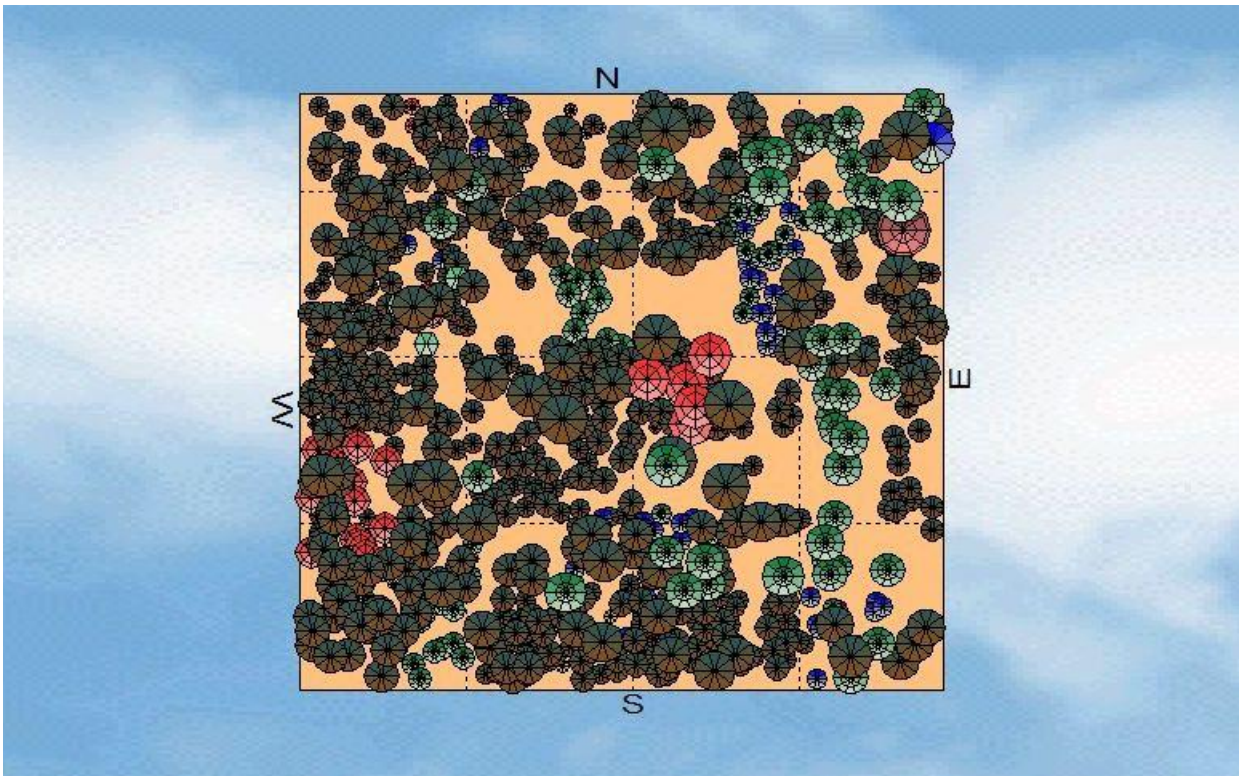
Forest landscape planning incorporates a number of modeling tools and components, including a Geographic Information System (GIS), forest resource inventory data, forest growth and yield models, watershed-analysis based sensitivity constraints, and software that can be used to manage data and analyze various alternatives and choices. One specific such tool is the Forest and Stand

Evaluation Environment (FORSEE) program, an inventory, growth, and yield model, used by HRC to predict and analyze future forest conditions over time under specific management scenarios and environmental constraints.

Forest canopy, a particular forest parameter of interest relative to concerns over harvest effect on storm-triggered peak flows, is one of numerous forest characteristics FORSEE can model. FORSEE models watershed-wide and individual sub-basin canopy condition over time by internally growing and harvesting a 'tree list' (i.e., a list of the trees in each field inventory plot within a stand or strata together with their characteristics -species, dbh, height, live crown ratio, defect, and trees/acre represented by that tree based on the inventory sampling design). The initial characteristics of those trees are as *measured* in the field. The tree list is then modified over time as the trees are grown (dbh, height and live crown ratio increase at a modeled rate), die via harvest or natural mortality (trees/acre are reduced), and are regenerated via sprouting, seeding or planting (small trees are added to the tree list).

Tree crown canopy is estimated for each tree in the list using geometric crown shape models applied to the species, dbh, height and crown length of each tree; and then using the crown area per tree and the trees/acre represented by each tree, the crown canopy area/acre for all trees in a stand or strata is calculated. In our well-stocked redwood forests the crown canopy area can and typically does sum to a number larger than 1.0 (100%), representing the real-world situation of crowns from different trees - usually trees of different sizes overtopping one another, but sometimes of similar size with intermingled crowns - overlapping with one another, so that a point on the ground has crowns from multiple trees directly above it intercepting rainfall.





The Landscape Planning process has been used to model a 20 year sustainable, *non-declining* harvest scenario for the Elk River watershed which increases both standing timber inventory and yield over time. Map 5 shows management blocks along with timing and location for where harvest is currently planned to occur over the 20 year horizon. Figure 4-2 presents HRC's Elk River modeled sustainable harvest (Alt 21) in terms of acres and corresponding overlapping canopy cover at the end of each period assuming 100 percent selection/group selection harvest over the 20 year horizon. Clearcut Equivalent Acres (CEA) also shown assuming current regulatory assumption of 1.0 selective harvest acre = 0.5 CEA. This represents the maximum acres HRC plans to harvest within each five year period over the 20 year horizon pursuant its landscape plan.

Figure 4-2 HRC Elk River Landscape Planning Sustainable Yield (Alt. 21)

HRC Elk River Ownership	Period 1 2015-19	Period 2 2020-24	Period 3 2025-29	Period 4 2030-34
Total Harvest Acres for 5 Year Period	3,125	2,772	2,794	3,196
Average Annual Harvest Acres	625 (312.5)	555 (277.5)	560 (280)	640 (320)
End of Period Watershed-Wide Overlapping Canopy Cover (%)	1.33	1.32	1.31	1.32

(###) = Clearcut Equivalent Acres

Figure 4-3 below shows the modeled 'Alternative 21' harvest distribution across all Elk River sub-basins in which HRC has a substantial ownership.

Fig. 4-3 HRC Elk River Landscape Planning Sustainable Yield (Alt. 21) by Sub-basin

Sub-Basin	Total Acres	HRC Ownership	Acres Harvested by 5-Year Period				
			2010-2014 (Actual)	Period 1	Period 2	Period 3	Period 4
Bridge Creek Elk	1,420.9	1,419.8 (99%)	98.2	65.4	49.1	274.0	
Browns	574.0	573.8 (100%)	201.2				267.0
Clapp Gulch	654.1	581.3 (88%)		20.8	168.5	17.2	226.2
Dunlap	423.8	411.4 (97%)	201.2			10.7	147.5
Lake Creek	1,362.4	1,362.4 (100%)	579.4		81.5	113.1	463.1
Lower NF	1,578.7	1,309.8 (83%)	141.0	63.4		169.9	427.0
Lower SF	1,840.3	1,138.0 (61%)	178.6	145.8	548.5		198.1
Mainstem Elk	5,564.0	319.9 (5%)		241.7			56.9
McCloud Creek	1,521.0	209.6 (13%)		46.3	76.2		
McWhinney	810.1	810.1(100%)	93.5		125.2	56.8	
North Branch NF	2,560.6	2,560.6 (100%)	12.6	1,099.8	218.4	364.6	
North Fork Elk	2,795.1	2,795.1(100%)		415.1	999.7	229.0	
Railroad Gulch	762.0	714.0 (93%)		133.6		290.3	
South Branch NF	1,224.9	1,224.9 (100%)	120.1	238.1		640.3	142.3
South Fork Elk	5,140.2	3,626.8 (70%)	583.5	197.5	369.6	627.8	194.6
Tom Gulch	1,605.9	1,188.6 (74%)	189.7	212.1	86.1		715.6
Upper NF	1,644.2	1,644.2 (100%)	248.5	245.2	48.8		217.5
TOTAL	**31,482.6**	**21,890.3**	**2,647.5**	**3,124.7**	**2,771.6**	**2,793.6**	**3,195.9**

Figure 4-4 below shows the average overlapping crown canopy for each 5 year period resulting from the modeled harvest presented in Figure 4-3. Overlapping canopy conditions presented below are considered a conservative or minimum projection, assuming retention of 75 sq. ft. Basal Area per acre post-harvest. Actual post-harvest basal area conditions will vary, typically ranging from 75 – 200 sq. ft. per acre depending upon pre-harvest stand condition and other physical and biological management considerations and requirements (e.g. RMZ, MWAC, NSO).

Fig. 4-4 Average Overlapping Crown Canopy by 5-year Period resulting from Alt 21 Sustained Yield

	Average Overlapping Crown Canopy Percent by 5-year Period				
SUB-BASINS	**Begin Per1**	**Begin Per2**	**Begin Per3**	**Begin Per4**	**End Per5**
Bridge Creek Elk	1.092	1.197	1.269	1.175	1.294
Browns	0.928	1.062	1.166	1.218	0.985
Clapp Gulch	1.359	1.444	1.298	1.378	1.128
Dunlap	0.904	1.042	1.140	1.168	1.049
Lake Creek	1.216	1.332	1.367	1.361	1.183
Lower NF	1.226	1.266	1.378	1.317	1.148
Lower SF	1.436	1.490	1.076	1.327	1.389
Mainstem Elk	1.407	1.056	1.286	1.437	1.378
McCloud Creek	1.227	1.233	0.987	1.224	1.394
McWhinney	1.160	1.289	1.238	1.284	1.403
North Branch NF	1.597	1.357	1.449	1.433	1.586

North Fork Elk	1.483	1.484	1.218	1.301	1.450
Railroad Gulch	1.304	1.306	1.420	1.116	1.263
South Branch NF	1.524	1.530	1.674	1.213	1.266
South Fork Elk	1.189	1.277	1.278	1.228	1.328
Tom Gulch	1.389	1.371	1.413	1.521	1.075
Upper NF	1.316	1.234	1.347	1.387	1.386
WATERSHED-WIDE	**1.322**	**1.330**	**1.322**	**1.309**	**1.320**

4.3 ***Hydrologic Effect of Forest Management***

Peak flow is the maximum discharge of stream flow (volume/rate) following a measureable precipitation causing a change in stream flow. Changes in instantaneous stream peak flows resulting from timber operations have been studied for more than 50 years in the Pacific Northwest (Cafferata and Reid, 2013). Significantly elevated peak flows can increase the frequency and magnitude of downstream overbank flooding, increase channel scouring, bank erosion, and sediment transport, and trigger changes in channel morphology.

Research conducted at Caspar Creek (Jackson State Demonstration Forest) investigated the effect of timber harvesting on peakflows in a north coast California watershed where like Elk River, hydrologic input is primarily rainfall (fall through spring), rain on snow events are rare, and where redwood and Douglas fir forest canopy play an important role in moderating hillslope infiltration.

Several key findings regarding the influence of logging on peak flows at Caspar Creek include:

- The largest percentage increases for peak flows after timber harvest are seen for small storms in the fall, when logged and unlogged watersheds are expected to show the greatest difference in soil moisture levels (Ziemer 1981, Ziemer 1998b, Lewis et al. 2001)
- In winter, when differences in soil moisture levels between logged and unlogged areas are minimal, peak flows increase after clearcutting due primarily to reduced interception loss after logging, and secondarily due to reduced winter transpiration (Reid and Lewis 2007, Reid 2012)

- Peak flow responses in clearcut sub-watersheds neared pre-treatment levels about 10 years after logging (Keppeler 2008)
- Increases in peak flow are related to antecedent wetness, proportion of basin logged (canopy removal), storm size, and time after logging (Lewis et al. 2001, Rice et al. 2001)

While storm driven channel scouring events (2 year and greater return interval) are a natural process, necessary in the development and maintenance of functional aquatic habitat, there is concern in the Elk River watershed that any significant increase in these peak flows resulting from timber harvest activities may contribute to suspended sediment loads, channel filling, and flooding downstream, adversely effecting landowners living on the flood plains adjacent Elk River, including domestic water supplies, property damage, and safe ingress and egress to these properties during flood events.

To minimize potential for significant logging related increases in both discharge and sediment yield, the California Department of Forestry and Fire Protection established (2002) an interim annual watershed-wide harvest rate of 600 clearcut equivalent acres (CEA) per year for the then PALCO ownership using a regression equation to predict peak flow changes. This equation was developed by John Munn (CAL-FIRE, now retired) from data obtained in the North Fork of Caspar Creek. Using this CEA approach, a clearcut acre is worth 1.0 acre, while an acre harvested selectively with its retention of mature trees and canopy and thus lesser effect on evapotranspiration, is valued at 0.5 CEAs.

In 2006 as part of current WWDRs, the NCRWQCB adopted a separate upper limit on harvesting in the North Fork Elk River watershed of 264 CEA. This acreage allowance also originated from peak flow calculations from Caspar Creek studies used to determine the modeled maximum harvest-related canopy cover removal that could occur on then PALCO timberlands in the North Fork Elk River while still allowing for a reduction in timber management effect on small storm peak flows downstream, specifically near the junction of Elk River Road and Wrigley Road. NCRWQCB staff found through use of the model that this CEA annual harvest amount result in a significant reduction of effect on peak flow from 10 percent down to 7 percent above background over a ten year period, as previously harvested stands regenerated (CRWQCB North Coast Region, Resolution No. R1-2006-0038). No peak flow related harvest limit was established for the South Fork watershed as nuisance flooding in this tributary was not as well documented and the model found the timber management effect on increase in recurrence interval streamflow to be less than 5 percent to begin with.

While the applicability and precision of the Casper Creek Model to predict harvest effect on peak flows in the Elk River watershed is scientifically debated (Dhakal, A., Sullivan K., 2006); these limitations on harvest acres were established primarily in light of evidence from Caspar Creek studies indicating that extensive canopy removal across a watershed or sub-basin, over a short time period (≤ 5-10 years), must occur to generate logging related adverse peak flow effects. This is why

it is important to model HRC's 20 year landscape timber harvest forest management plan relative to current and future canopy cover conditions, both watershed-wide and at an individual sub-basin scale. The results of modeling the upper limit of the HRC 20 year harvest plan using FORSEE indicate substantial canopy cover, as can be found in the watershed today, will be maintained over this 20 year horizon (Figures 4-2 and 4-4).

Addressed within the FORESEE model is the potential for increase in peak flow resulting from young, relatively open stands (less than 15 year old) originating from even-aged management that occurred on the ownership prior to 2009. Figure 4-5 derived from current forest inventory and harvest history, shows the percentage of ownership occupied by regenerating stands of timber less than 15 years of age. As can be seen in this figure, the most recent peak in forest hydrologic immaturity occurred in 2005-06 and forest hydrologic immaturity has been steadily declining since as these stands age and increase in canopy height and closure, and clearcutting is ended on the ownership. Likewise, Figure 4-6 shows a forest with maturing age classes in the absence of clearcut silviculture. Development of forest canopy in these younger stands, as well as in-growth of canopy in more recently and future selectively harvested stands, combined with the landscape plan which limits HRC harvest to an average of less than 2 percent of the Elk River watershed annually (and less than 3 percent of HRC's 22,200 acre ownership) over the next twenty years, using primarily selective harvest, minimizes potential for significant peak flow increases based on our current understanding of forestry-related hydrologic effect.

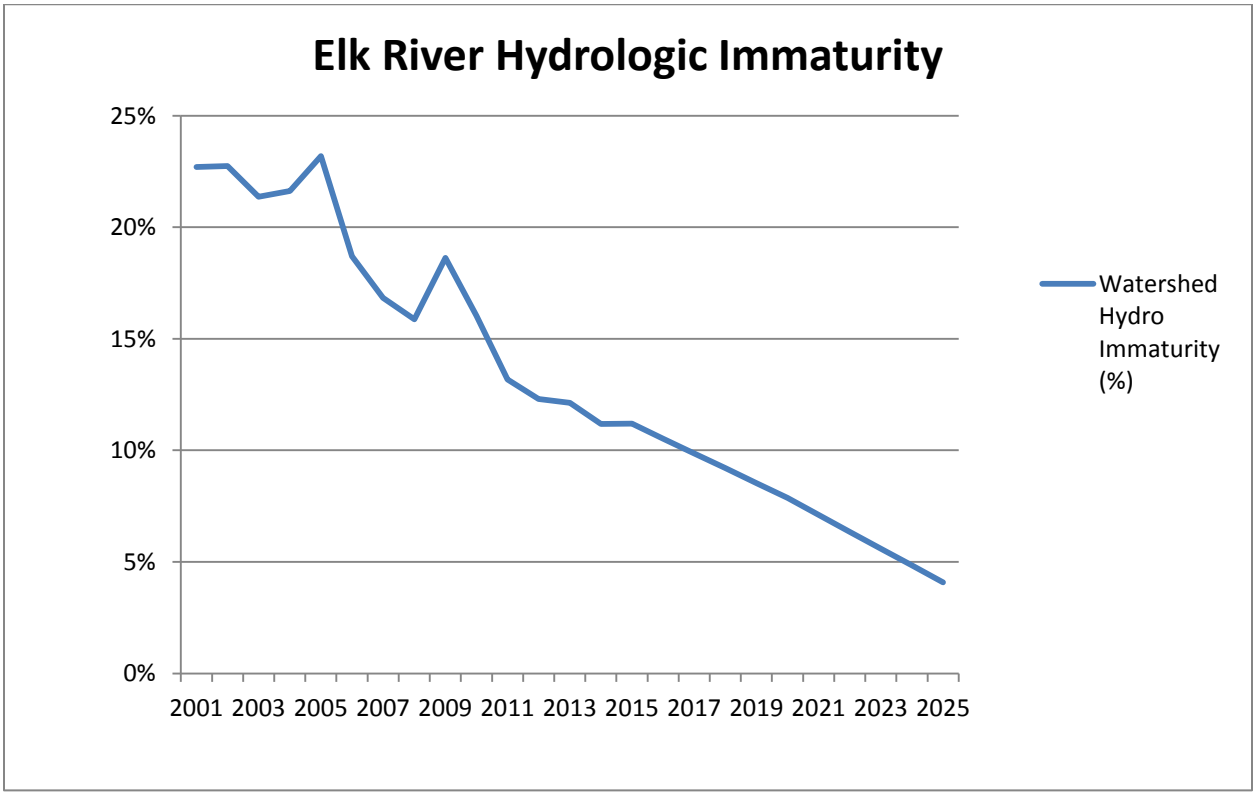
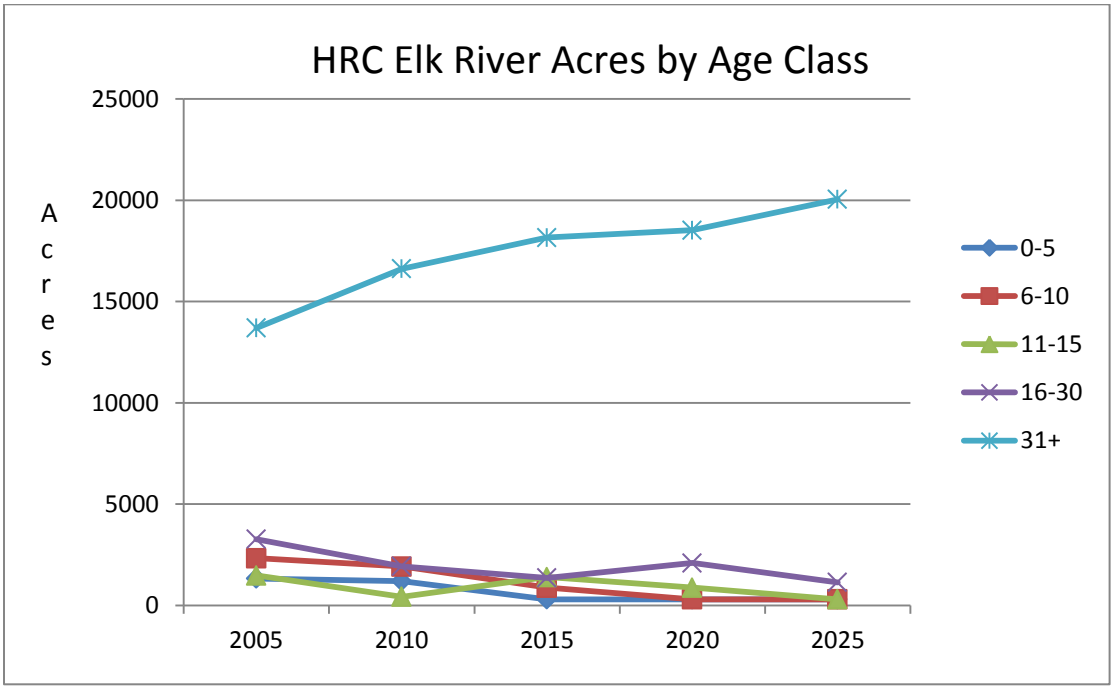


Fig 4-5 Elk River Hydrologic Maturity (% of ownership occupied by timber stands less than 15 years of age)

Fig 4-6 HRC Elk River Acres by Age Class over time



Peak Flow calculations based on Appendix A of Cafferata and Reid (2013) have also been used on several occasions to assess *individual* THP effects at the smaller, local sub-basin scale (THP 1-11-054HUM; THP 1-12-110HUM; and THP 1-14-039HUM). The purpose of these analyses was to assess potential for significant increases in peak flow in lower order stream channels relative to stream channel erosion processes.

In all cases evaluated, increases to peak flow during 2-yr Return Interval events have been less than 7 percent of what would otherwise occur with no project, when antecedent soil moisture is moderate to wet. In most cases the predicted increase from timber harvest ranged from <1 to <5 percent. This modeling takes in to account the cumulative effect of prior harvest (canopy removal) within the drainage area being analyzed. This overall minimal hydrologic effect on peak flow is a result of both landscape constraints on harvest since year 2000, recovery of hydrologic maturity occurring over time (figures 4-6 and 4-7) and the use of uneven-age selection silviculture since 2008 which conserves and promotes canopy cover, including overlapping cover.

An example of selective harvest and the in-growth of forest canopy conditions following harvest is illustrated in Figures 4-8, 4-9, and 4-10, which show canopy conditions pre and post harvest of an actual Elk River THP (THP 06-202; Unit 9). These ortho-photographs were taken prior to harvest, eight months post harvest, and again 2.8 years post harvest.

Figure 4-8 (left). Bridgehead THP Unit 9 2007 Ortho-photograph;

Figure 4-9. (lower left corner) Bridgehead THP Unit 9 2010 Ortho-

Figure 4-10. (below) Bridgehead THP Unit 9 2012 ortho-photograph;

Also important in minimizing concentration of storm runoff and associated potential peak flow effect are the following THP measures:

- Appropriate logging methods minimizing ground disturbance and compaction
- Retention of all in- and near stream large woody debris
- HCP Riparian Management and Equipment Exclusion Zones conservation measures
- Hydrologic disconnection of road system (HCP road storm-proofing)

These measures are presented in greater detail in Section 5.0.

5.0 Sediment Delivery Prevention and Minimization

5.1 *HCP Watershed Analysis Prescriptions (ERSC 2005)*

All timber operations in the Elk River watershed are subject to the Elk River and Salmon Creek Watershed Analysis Prescriptions. Current ERSC prescriptions relative to hillslope and riparian management are provided in Appendix A.

These enforceable forestry prescriptions were established as part of the HCP Watershed Analysis process (HCP 6.3.2) in collaboration with state and federal HCP signatory wildlife agencies including

CDF&G, NOAA Fisheries, and USFWS. The prescriptions prevent or minimize sediment delivery to streams and maintain and restore riparian forests for the benefit of shade canopy and large woody debris recruitment through restrictions and/or specific requirements for timber harvest and road construction/re-construction activities in riparian areas, steep streamside slopes, and unstable areas.

Some key elements of the prescriptions include:

1. **50' no-harvest zones adjacent Class I and 30' no harvest adjacent to class II watercourses, with licensed geologic review and additional harvest restrictions applicable up to 400 feet slope distance from the watercourse, dependent upon watercourse classification and slope condition (e.g. >50% slope) [*sediment; temperature; LWD recruitment*];**

2. **Licensed geologic assessment required for proposed harvest on inner gorges, headwall swales, high hazard features or earthworks [*sediment, LWD recruitment*]; THP Geologic Review;**

3. **No timber harvest or road construction/re-construction on unstable areas (e.g. inner gorge, headwall swale, earthflow, debris slide slope) and/or slopes >60% without on-site licensed geologic assessment including due consideration of risk to downslope aquatic habitat [*sediment*];**

4. **Ground-based equipment exclusion zones (EEZ) and prohibition on removal of pre-existing large down wood adjacent to watercourses [*sediment, LWD recruitment*]:**

    a. **Class I watercourses – minimum 150 feet**

    b. **Class II watercourses – minimum 75 feet**

    c. **Class III watercourses – minimum 50 feet or hydrologic divide**

5.2 *Additional Measures to Minimize Surface Erosion in Riparian Areas*

As part of the enforceable measures for control of sediment from roads and other sources detailed in Appendix B, ***HCP section 6.3.3.8*** describes specific environmental conditions relative to exposed soils in riparian areas that *require* application of effective erosion control measures and the timing within which application must occur.

5.3 *Additional Measures to Minimize Streamside Landslide and Bank Erosion*

As noted above, harvest limitations relative to minimizing streamside landslides and bank erosion include the establishment of no cut buffers along Class I and II watercourses and equipment exclusion zones (EEZs) for Class I, II, and III watercourses.

HRC's uneven-age selective harvest silvicultural policies minimize harvest disturbance adjacent Class III watercourses and HCP prescriptions prevent harvest of Class III channel trees and harvest on unstable slopes immediately adjacent the channel. As a result, moderate to high canopy retention typically occurs within the EEZ of Class III watercourses.

No salvage or harvest of down wood is permitted from within stream channels or RMZs and EEZs, further ensuring minimum disturbance along stream banks and adjacent streamside slopes in association with harvest activities.

The combined effectiveness of these measures to minimize streamside landslide and bank erosion is discussed in Section 6.1.1.

5.4 *SENSITIVE BEDROCK TERRAIN*

Elk River/ Little Salmon River WAU watershed analysis identified the Hookton Formation as being the geologic unit with the highest landslide frequency (0.041 SLS/acre/~50 years). Slopes underlain by Quaternary terrace and the Hookton deposits were also found to have a higher *shallow road-related landslide* rate compared to the other rock types found in the watershed. Consequently, because of the week nature of this material Hookton deposits are referred to in the watershed revisit report as "soft" and can be susceptible to a variety of geologic hazards.

Hookton sediments are described by Kilbourne (1985) as "well-to-poorly sorted, gently folded, un-indurated marine to non-marine sand, gravel, and silt." These sandy mid to Late Pleistocene deposits are generally limited to the following WAU sub-basins:

- Clapp,
- Lower South Fork,
- McCloud,
- Tom Gulch, and
- Railroad Gulch

The initial analysis stated that the largest sediment volumes originated from those basins in which Hookton deposits were the dominate bedrock type. Although the Elk River/ Little

Salmon River WAU revisit reported that the landslide annual delivery rates are down (2001-2011) the geologic hazards associated with Hookton sediment still exists.

Due to the sensitivity of the Hookton Formation sediments it was deemed prudent to establish specific protective measures for slopes within the 5 sub-basins that are underlain by Hookton Formation sediments. The intent of the mitigation proposed below is to reduce the influence timber operation can have on the stability of slopes/ soils in these areas and the subsequent delivery of sediment to down slope watercourses.

- Slopes with gradients equal to or greater than 50% and within 300 feet of a Class I or II watercourses shall be field reviewed by a state license professional geologist.
- Retention of a minimum of 150 square feet of basal area (of any commercial species) per acre shall be required on headwall swales that envelope Class III watercourse source areas as identified in THP geologic reports.
    - Headwall swales are steep areas of concave, convergent topography (inversed 'tear-drop') found at the head of, and connect linearly to, low order Class III and II watercourses. These drainage features should not be confused with other hill slopes concavity such as small zero order draws, bodies of large landslides, tree throw depression, or low-gradient hollows.
- Maintain a minimum of 100 square feet of conifer basal area on unstable slopes identified in THP geologic reports as potential point of sediment delivery.
- No timber will be marked for harvest within 10 feet of a Class III watercourse unless associated with a stump clump. Removal of timber associated with road construction, re-construction, or decommissioning may be harvested.
- All new road construction alignments shall be reviewed by a state licensed geologist. Findings will be documented in a CGS Note 45 compliant report.
- Road surfaces sloped at 10% or greater that contour across Hookton deposits will be storm proofed in accordance with a high or extreme erosion hazard rating. Ratings will be determined by the project forester in conjunction with project geologist.
- Haul road water bar outlets within 150 feet of a downslope Class I or II watercourse will be rock armored or slash packed with sound woody debris.
- All temporary road surfaces within Class I, II and IIIs RMZ shall be slash packed at the completion of operations with sound woody debris or equivalent type material. A walking or quad trail may be kept open on the inside (upslope) edge of the road facilitating safe access if desired.
- All skid trail surfaces within 50 feet of a watercourse shall be slash packed with sound woody debris or equivalent type material.

5.5 ***Roads***

The road system on HRC's ownership in the upper Elk River watershed is necessary to facilitate commercial operations consistent with timber production zoning including activities such as log hauling, forestry, watershed and wildlife surveys, and reforestation. Road surfaces, stream

crossings, inboard ditches, cutbanks, and fillslopes are all recognized as potential sediment sources. HRC forest management and the HRC HCP focus significant effort in the prevention and minimization of sediment delivery from roads including construction and reconstruction of roads and stream crossings to storm-proofed standards, limitations on use during the wet weather season, a standardized inspection routine, and timely attention to maintenance needs. Legacy abandoned, often streamside, logging roads no longer required for harvesting (e.g. due to transition from tractor to cable yarding) or other forestry purposes (e.g. wildlife surveys, monitoring, etc.) are decommissioned or abandoned.

Implementation of road system upgrading and storm-proofing as part of HRC's HCP has resulted in the removal or prevention of delivery of an estimated 334,700 cubic yards of sediment to stream channels on HCP covered lands as of end of year 2014. Two hundred and six (206) miles of the approximate 260 mile road system has been *storm-proofed* to HCP standards including 50 miles of road decommissioning and closure (Map 3). Storm-proofed roads (HCP 6.3.3.9) are designed, constructed, monitored, and maintained, to minimize the delivery of fine sediment from roads and drainage facilities to streams, particularly during larger magnitude, infrequent storms and floods.

The existing road system provides access to HRC's managed forest and new road construction will continue to be limited to short spur roads necessary to facilitate logging operations. Details regarding specific road construction are provided and available for review through the THP process and annual work plans. Systematic HCP measures in place to prevent and minimize sediment delivery from the road system can be found in HCP section 6.3.3 and are summarized as follows:

5.5.1 Control of Sediment from Roads

Section 6.3.3 of the HRC HCP establishes measures for control of sediment from roads and other sources. A brief synopsis of each relevant HCP section is provided in this section with full HCP sediment control measures provided in Appendix B. Additional details regarding road maintenance and road inspection activities can be found in Section 6.2.

5.5.1.1 Road Construction, Reconstruction, and Upgrades

HCP section 6.3.3.3 describes standards and guidelines for road construction, reconstruction, and upgrades. These measures are intended to prevent and minimize sediment delivery during and subsequent these activities.

5.5.1.2 Road Maintenance

HCP section 6.3.3.4 describes measures to be taken to prevent or minimize sediment delivery related with road maintenance activities.

5.5.1.3 Road Inspections

HCP section 6.3.3.5 outlines road inspection requirements to be conducted to insure roads maintenance needs are identified on an annual basis and in response to large storm events.

5.5.1.4 Wet Weather Road Use Restrictions

HCP section 6.3.3.6 describes conditions under which various types of road use – from log hauling to light vehicle use - is permitted during the wet weather period (October 15 – May 1). Roads are required to meet and be maintained to a specific 'permanent' standard designed to minimize sediment delivery if log hauling is to occur during dry periods of the wet weather period.

5.6 *Geologic Review (Landslide Hazard Evaluation)*

HRC uses a multivariate approach for evaluating landslide hazards relative to proposed land use activities within the Elk River watershed. Data generated from both qualitative and quantitative approaches are assessed.

As part of THP planning, a review of watershed analysis and other available pertinent technical data including landslide inventories, regional geomorphic maps, and stereoscopic aerial photographs are conducted to denote potential high risk slopes. The *ERSC Hillslope Management Check List* is used to identify regions susceptible to landslide processes as a site-specific requirement of the Elk River Salmon Creek Watershed Analysis prescriptions (Appendix A). A shallow landslide potential map developed using the process-driven landslide model SHALSTAB (Montgomery and Dietrick, 1994) is also evaluated.

SHALSTAB theory is based on the observation that shallow landslides tend to occur on steep, convergent slopes where surface/subsurface flow is concentrated and soil pore pressures are increased. This model assumes that although site-specific properties control the size and the moment when shallow landslides are triggered, the main controlling factor defining slide location is topography. This is a relatively simplistic approach and provides a snapshot of spacial prediction of landslide susceptibility applicable to the Elk River watershed. SHALSTAB has a tendency to over-predict landslide potential; therefore field verification is often necessary.

Following the evaluation of this technical data, a ground based investigation may be conducted, as warranted, to further examine mapped landforms and features previously unobserved as well as to determine the relation of mass wasting events (if present) to past land use activities. This investigation also includes the collection of general landslide attributes for use in the comprehensive watershed-wide landslide inventory.

A report containing pertinent data, conclusions, and remedial treatment recommendations is developed when site conditions, land use activities, and watershed analysis prescriptions warrant. This report is signed by a state licensed professional geologist (P.G.) and prepared in general conformance with California Geologic Survey (CGS) Note 45 guidelines. Hazard reduction measures prescribed in the report are developed in association with a state license professional forester (RPF) and follow procedures detailed in the ERSC Watershed Analysis.

Appendix C-2 provides a sample (final product) of the Landslide Evaluation process as applied during THP development and submitted with each HRC THP in Elk River.

5.7 *California Forest Practice Rules and Dept. of Fish and Wildlife Code 1600*

The following California Forest Practice Rule (FPR) requirements and restrictions on timber operations are designed to prevent and/or minimize adverse effects to watershed and water quality values including those potentially resulting from sediment delivery and removal of streamside riparian canopy. These rules are enforced by CAL-FIRE.

Reference	Description	Citation
FPR	Erosion Hazard Rating	912.5
FPR	Cumulative Impact Assessment	912.9
FPR	Post Harvest Stocking	913
FPR	Tractor Ops Limitations	914.2 (f)
FPR	Site Preparation Addendum	915
FPR	Servicing of Logging Equipment	914.5
FPR	Waterbreaks	914.6

FPR	Winter Ops	914.7
FPR	Tractor Crossings	914.8
FPR	Watercourse and Lake Protection	916
FPR	Domestic Water Supply Protection	916.10
FPR	Logging Practices	921.5
FPR	Logging Roads and Landings	923 et. Seq.
FPR	Road Maintenance Period	923.4
FPR	LTO Requirements	1022.1

A timber harvesting plan prepared by a registered professional forester must be approved by California Department of Forestry prior to conducting timber operations. The plan is subject to multi-disciplinary state and federal review as well as review by the public prior to approval. Site specific recommendations for the protection of water quality and related beneficial uses may be made and incorporated into the THP during this review process.

In addition, pursuant DFW Code 1600, formal agreements must be reviewed and approved by the California Department of Fish and Wildlife prior to lake or streambed alteration which includes the construction and/or removal of stream crossings where such activities may substantially alter the bed, bank or channel of a watercourse. Site-specific DFW recommendations for the benefit of water quality and related beneficial uses may be made and incorporated into these agreements.

5.8 *Effectiveness of Sedimentation Prevention and Minimization Strategies*

In addition to routine inspection of active operations by licensed foresters, and required monitoring and reporting associated with existing WDRs, CAOs, FPRs, and HCP, numerous studies have been undertaken to evaluate the effectiveness of the various sediment prevention and minimization measures described in Section 5.0. These studies are summarized in the Elk River

Watershed Analysis Revisit Report (HRC 2014), and have been previously provided to the NCRWQCB.

Mass Wasting-related Sediment Delivery

SHN Consulting Engineers and Geologists, 2013. Streamside Landslide and Bank Erosion Survey, Summer 2012, Elk River, Humboldt County, California

Oswald, J. 2012. Landslide Inventories for the 2003, and 2006, 2010 Storm Seasons, Elk River, Humboldt Co.

Road-related Sediment Delivery

Sullivan, K., N. Simpson, 2012. Effectiveness of Forest Road Construction Practices in Preventing Sediment Delivery. Technical Report, Humboldt Redwood Company, Scotia, CA. 99 pp.

Sullivan, K., A.S. Dhakal, M.J. Kunz, M. Medlin, A. Griffith, R. Rossen, and K. Williams. 2011. Sediment Production from Forest Roads on Humboldt Redwood Company Lands: Study of erosion rates and potential delivery to streams. Technical Report, Humboldt Redwood Company, Scotia, CA. 108 pp.

Sediment-related Water Quality

Klein, R.D., J. Lewis, M.S. Buffleben. 2012. Logging and turbidity in the coastal watersheds of

Northern California. *Geomorphology* 139-140: 136-144

Sullivan, K., Manthorne, D., Rossen, R., Bohrmann, T., Griffith, A. 2012. Trends in Sediment-Related Water Quality after a Decade of Forest Management Implementing an Aquatic Habitat Conservation Plan. Technical Report, Humboldt Redwood Company, Scotia, CA. 140 pp.

Fisheries Stream Habitat

Humboldt Redwood Company. September 2015. *2014 Aquatic Trends Monitoring Report*, Scotia, CA.

6.0 Managing Sediment Source Inventories

6.1 *Methods for Maintaining Complete and Current Inventory of Landslide-related Sediment Sources*

HRC maintains a complete and current inventory of landslide-related sediment sources through several means including periodic aerial photograph assessment, helicopter fly-overs, and on-ground field inspection and reporting. The purpose of these assessments is to locate and characterize new or re-activated landslides which deliver sediment to streams, and if management related, determine if sediment delivery mitigation options exist (i.e. bio-remediation, drainage alteration, armoring, excavation, etc.), and if any changes in practices are warranted (adaptive management). Some of these landslide surveys are conducted periodically as an HCP requirement including WA re-visitation air photo and streamside landslide/bank erosion assessments, storm and earthquake-triggered forensic landslide investigation, annual and/or storm-triggered road inspection program (ARIP). Others are currently required by the NCRWQCB as part of existing WWDR requirements including annual 'Tier 2' unit field inspections, currently accomplished by a helicopter fly-over of the watershed including all Tier 2 harvest units, in April of each year, and THP Erosion Control Plan (ECP) inspections. Geologic investigations conducted during THP development are also another source for maintaining a thorough and current landslide inventory.

The most recent ***watershed-wide comprehensive air photo landslide inventory*** was ***conducted by a Certified Engineering Geologist*** in 2012 (Oswald 2012). This inventory used 2003, 2006 and 2010 air photo interpretation to identify and characterize new and/or active landslides in the Elk River watershed. Methods used during this landslide inventory are described in the report and the Elk River Watershed Analysis Revisit. Future inventories of this nature will be conducted using similar methodologies consistent with guidelines presented in California Geological Survey Note 52, Guidelines for Preparing Geologic Reports for Regional-Scale Environmental and Resource Management Planning (2001); and will occur at 10 year intervals in conjunction with the next HCP required watershed analysis re-visitation.

Streamside landslides are periodically inventoried ***using field survey methods conducted under licensed geologist supervision***. These sources are important elements in the development of refined sediment budgets, as these smaller features are typically not apparent on aerial photography because of the generally dense riparian canopy cover and smaller size. Twenty-six (26) miles of combined Class I, II, and III watercourses were field surveyed for evidence of streamside landslides and significant bank erosion in 2012. A description, along with results, of this investigative study can be found in the HRC Watershed Analysis Re-visit Report, including a 2012 report prepared by SHN Consulting Engineers and Geologists who supervised this effort. A similar streamside landslide inventory will be conducted again in 8-10 years in conjunction with the next HCP required watershed analysis re-visitation. The effect of forest management on the processes of small streamside landsliding and bank erosion is of significant interest to NCRWQCB and HRC

staff, and is therefore also a key area of study in an ongoing THP scale effectiveness monitoring projects discussed in section 8.0 of this ROWD.

Focused watershed-wide reconnaissance level investigations for mass wasting events utilizing established protocols (WOP-08) ***following triggering events*** in or near the Elk River watershed, defined as (1) greater than 3 inches of rainfall within 24 hours; (2) a significant earthquake. Determining if an earthquake is a "triggering event" is based upon earthquake magnitude and distance of epicenter from the watershed referencing Figure 2, Graph A of Keefer (1984). Depending upon magnitude of event and other planning considerations HRC may opt for helicopter reconnaissance in conducting these investigations in addition to ground based surveys.

New active or potential sediment sources, including from landslides, are identified through implementation of an ***Annual Road Inspection Program (ARIP)*** (HCP 6.3.3.5.1). This program requires that all accessible roads be inspected following a triggering event, or at least once annually between April 1 and October 15, to ensure that drainage structures and facilities are intact and fully functional, and to identify any active or imminent road-related failures of the road prism, cutbanks, or fills which may have occurred during the previous winter and are active or potential sediment delivery sources.

In addition to the measures described above, THPs enrolled in the current WWDR program also contain individual Erosion Control Plans (ECPs) which include a specified inspection regime for THP units and appurtenant roads. *This ROWD proposes replacing individual THP ECPs with watershed-wide active THP monitoring and reporting requirements; specifically:*

- **Active THP Watershed Wide Waste Discharge Requirements** – HRC will conduct and document the following annual inspection requirements of the THP project area including appurtenant roads and harvest units where timber operations are or have been active.

    a. **Prior to October 16th –** to ensure erosion control measures are in place

    b. **Storm-triggered Inspection(s) October 16th through April 1st –** Storm-triggered inspections >3 inches/24 hours as measured at a centrally located rain gauge in the upper Elk River watershed) to provide opportunity for emergency prevention and response in imminent failure situations

    c. **Post April 1st –** THP Project Area Inspection including all appurtenant roads to document any discharges resulting from the preceding winter period and to schedule any required road maintenance or other mitigation. No post April 1st inspection is required if a storm-triggered inspection has been conducted, and no significant rainfall event (>3"/24 hours) or greater than 10 inches of total rainfall has subsequently occurred since the date the storm-triggered inspection was initiated.

In all instances, significant discharges in potential violation of the Basin Plan will continue to be reported to the NCRWQCB upon discovery within 48 hours.

Information regarding discovered new or reactivated landslides is recorded in a centralized database.

Collectively, these measures, in addition to routine on-ground reporting consisting of HRC staff (i.e. forestry, physical sciences, wildlife) contacting the HRC Geology Department in the event a new or recently active landslide is observed during the course of daily duties (i.e. THP and road inspections, wildlife surveys, aquatics monitoring, THP layout and logging supervision), provide for the maintenance of a complete and current landslide inventory.

6.1.1 **Current Inventory, Source Remediation, and Discussion**

The current landslide inventory is provided as Appendix C. Landslide remediation is addressed in notification of discharges sent to NCRWQCB staff. Potential erosion control measures may include, but are not limited to: re-vegetation (e.g. tree planting, seeding, willow waddles), excavation, drainage modification, and buttressing or armoring of unstable areas. In many instances landslides are not easily remediated and treatment is infeasible, therefore avoidance and prevention relative to management activities is essential.

Results from the most recent air photo interpreted watershed-wide landslide inventory of HRC's Elk River ownership can be found in a 2012 report prepared by Oswald Geologic. The results of this inventory are discussed in Oswald's report and in further detail in the Elk River WA Re-Visit Report (HRC 2014, Section 4.1.2). Landslide activity was investigated, mapped, and described throughout the Elk River drainage, including specifically for 2003, 2006 and 2010 storm seasons. Aerial photographs were utilized to make estimates of sediment production and delivery to watercourses for each storm season, and landslide attributes were analyzed to quantify associations with geomorphic and management criteria. The 2003 and 2006 storm seasons were significant when compared with historical precipitation data, set several records for seasonal and monthly totals, and are considered landslide-triggering events because of the widespread landsliding experienced across Humboldt County and the north coast region during these winters. The 2010 storm season was the third most significant water year recorded in the decade of study, with an annual precipitation total above the ten year average.

In brief, Oswald mapped 126 landslides that occurred from 2001 to 2010. Approximately 60% (75) of these landslides delivered to a watercourse with an average 12.5% of measured displaced

sediment volume delivery. This accounts for 23,131 cubic yards of delivered sediment with an estimated decade rate of 85.9 tons per square mile per year. In comparison, estimate of sediment delivery from landslides for the years 1988-2001 was significantly higher at 460 tons per square mile per year (HartCrowser 2004).

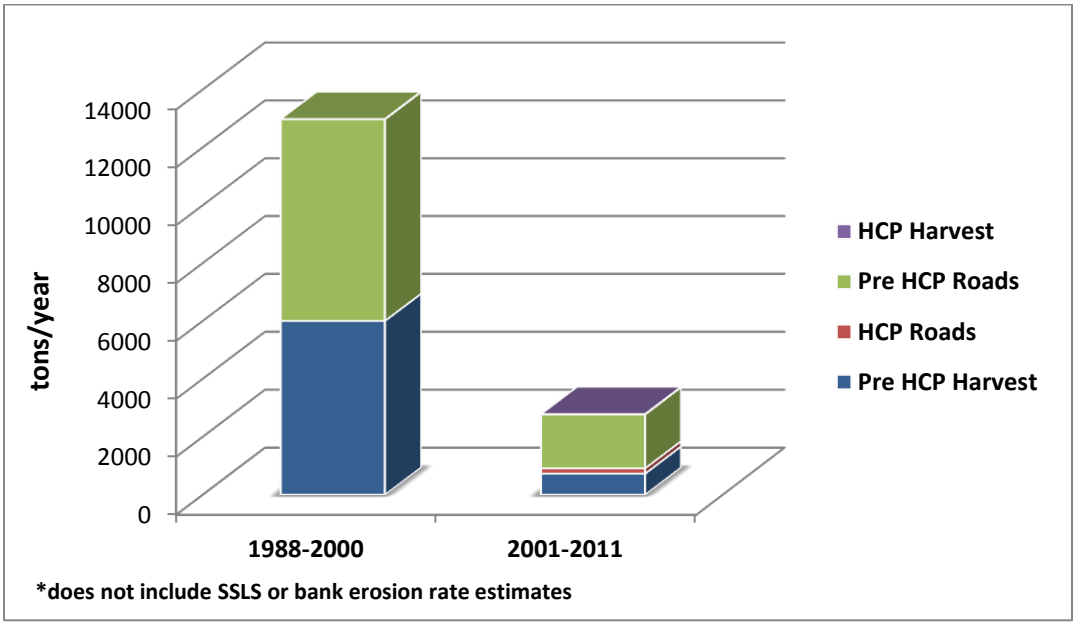


Figure 6-1. Elk River HRC HCP area estimated hillslope landslide sediment delivery from management-associated sources 1988-2000 vs. 2001-2011

The total sediment delivered from landslides during the 2003 and 2006 storm seasons alone made up about 97% of the estimated decade total. Over half of the delivery to Class I watercourses from 2001 to 2010 came from one very large reactivated landslide in the lower South Fork Elk River sub-basin. This landslide (LS 716) delivered an estimated 7,911 yds^3 of sediment, which accounted for about 95% of the total LS delivered sediment to Class I watercourses for the entire 2006 storm season.

Including LS 716, approximately 61% (N=30) of landslide volume was associated with non-stormproofed active and abandoned roads, whereas five to six percent (N=9-13) of the total sediment delivery was associated with storm-proofed roads. Oswald identified two landslides possibly associated with post HCP timber harvest activities. Both units were harvested in 2003 utilizing clearcut silviculture, and the landslides were identified on the 2003 aerial photo series.

One unit was logged via helicopter and the other by cable. LS263, delivering an air photo estimated two (2) yd^3 of sediment, was located within an area of the THP excluded from harvest operations (i.e. no harvest) as a result of pre-harvest THP geologic review. The second HCP harvest-associated landslide (LS167) is estimated to have delivered seven (7) yd^3 and originated from a harvested area. Combined these two landslides delivered an estimated nine (9) yd^3 (0.004 % of total volume from hillslope landslides).

'Background' mass wasting, defined as landsliding in areas with no harvest activity over the last 15-30 years was limited to 12 landslides delivering an estimated 2,057 yds^3. With most of the HRC's ownership in the watershed having experienced some type of harvest over the last 25 years, this approximate nine percent of the total landslide delivery is roughly proportionate to area of harvest versus non-harvest.

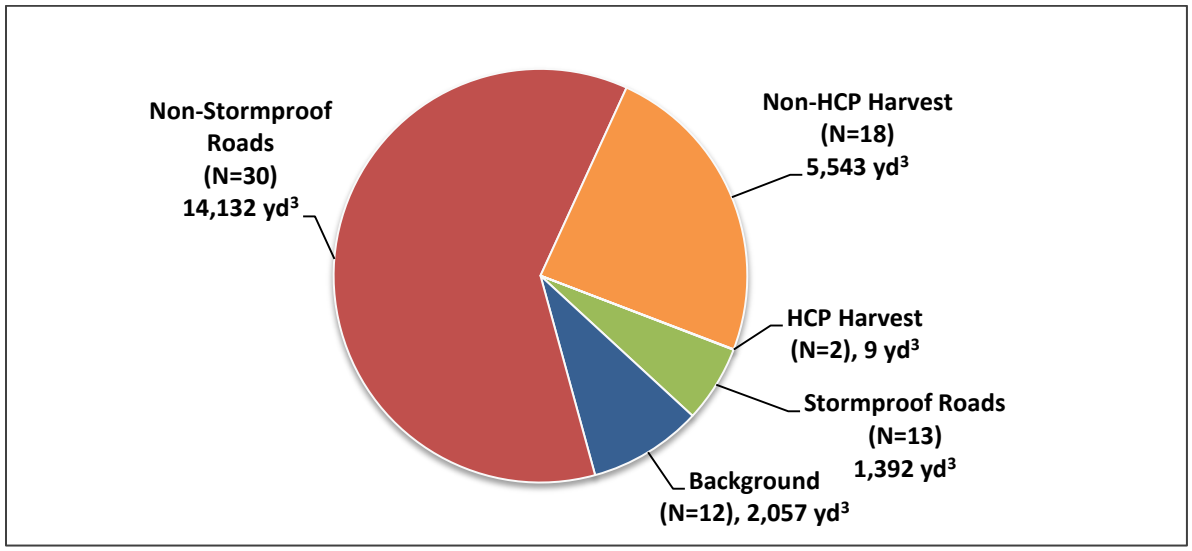
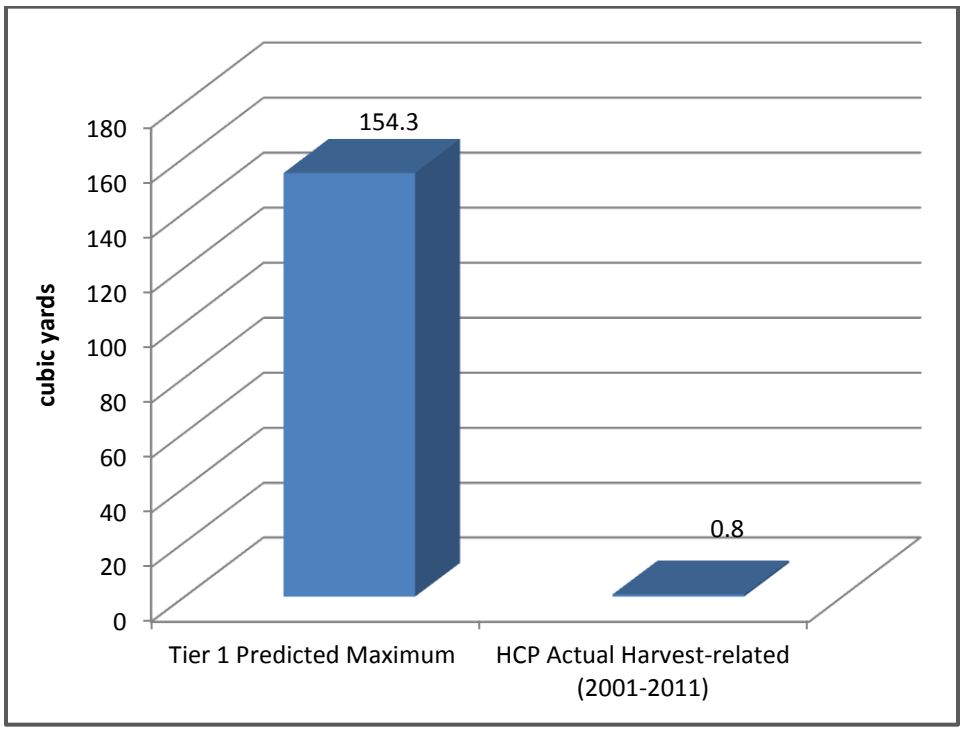


Figure 6-2. Elk River HRC HCP area watershed landslide inventory sediment source volume delivered; 2001 - 2011

In addition to periodic air photo analysis, monitoring and reporting requirements required by WDR Order No. R1-2006-0039 requires annual field inspections of harvested areas and road systems to evaluate the effectiveness of HRC's forest practices. HRC typically employs a helicopter each spring to fly over the watershed and specifically harvest areas in search of any slope failures which may have occurred during the past winter. In addition to the pilot, two spotters are used including a geologist. Results from these efforts confirm negligible open-slope (non-road related) landslide activity associated with HCP harvest operations.

These findings indicate a high degree of success in achieving harvest related landslide control objectives established by the current Elk River WDR (Order No. R1-2006-0039). This WDR relied upon an empirical model to set harvest acre limitations based on predicted annual sediment delivery from harvest related landsliding. Based on assumptions used in the model, it was predicted that a maximum annual harvest rate of 378 non-high hazard acres (tier 1) would result in 154.4 cubic yards per year of sediment delivery to watercourses from new harvest related landslides. *The actual total delivery of sediment since 2001 from HCP harvest related landslides was an air photo estimated approximate 9 cubic yards (0.81 cuy/year); less than one percent (0.52%) of what was predicted by NCRWQCB when establishing Order No. R1-2006-0039 (Figure 6-3).*

Figure 6-3. Annual Sediment Delivery from Landslides (HRC HCP Covered Elk River lands) compared to NCRWQCB Projected Sediment Delivery from New Harvest-Related Landslides



Twenty-six (26) miles of combined Class I, II, and III watercourses were field surveyed in 2012 for evidence of streamside landslides and significant bank erosion (SHN 2012). These sources are important elements in the development of refined sediment budgets, as these smaller features are typically not apparent on aerial photography because of the generally dense riparian canopy cover and smaller size. A description, along with results, of this investigative study can be found in the ERSC WA Revisit Report along with the 2012 report prepared by SHN Consulting Engineers and Geologists.

Survey results indicate low rates of streamside mass wasting relative to other studied watersheds within the HRC ownership (Upper Eel 2007, Bear River 2008, Mattole 2012). Field surveys identified approximately 6,500 cubic yards of sediment delivery from nearly 26 miles of stream length. Because Elk River is a coastal watershed with moderate topographic relief, stream valleys tend to have broad cross-sections with wide valley bottoms. As such, stream impingement on valley sidewalls is infrequent and undercutting is rare. This condition is in contrast to steeper, more deeply incised stream valleys found elsewhere on the property (e.g. Bear River, Mattole, Eel River tributaries).

Causal mechanisms related to recent management were virtually non-existent as no apparent interaction between streamside slopes and upslope management was observed during any survey. In every stream segment surveyed, a broad, intact riparian zone was present to buffer the stream from adjacent management areas. Surveys found streamside landsliding and bank erosion to be occurring independently of recent management with primary causal mechanisms most frequently related to unstable geology and natural flow deflection. Remnants from historic operations including in-channel cut old growth logs, root wads attached to stumps, and instabilities associated with historic skid trails were observed and reported as additional causal mechanisms responsible for approximately 25% of the observed streamside delivery.

6.2 *Methods for Maintaining Complete and Current Inventory of Controllable Road-Related Sediment Sources*

HRC maintains a complete and current road-related sediment source inventory for roads under its control. In the Elk River watershed, this inventory was initiated with a base-line 1998 Pacific Watershed Associates (PWA) watershed-wide inventory of roads controlled by the previous landowner (PALCO).

New active or potential sediment sources are identified through implementation of an **Annual Road Inspection Program (ARIP)** (HCP 6.3.3.5.1). This program requires that all accessible roads be inspected for maintenance needs at least once annually between April 1 and October 15 to ensure that drainage structures and facilities are intact and fully functional, and to identify any active or

imminent road-related failures of the road prism, cutbanks, or fills which may have occurred during the previous winter and are active or potential sediment delivery sources. Maintenance needs addressing new or potential sources are then required to be performed prior to October 15 the year of discovery (HCP 6.3.3.4.1).

Road inspections conducted throughout the year, in coordination with or addition to the ARIP, include:

- **Storm-triggered Road Inspections** (HCP 6.3.3.5.2) - All accessible roads are inspected as soon as conditions permit following any storm event that generates 3 inches or more of precipitation in a 24-hour period, as measured at the Scotia rain gauge. HRC proposes to establish a centrally located rain gauge within its Elk River ownership and use this as the WWDR inspection trigger requirement (3"/24 hours). Road maintenance sites that are discovered are either addressed immediately, when feasible and significant delivery is active or imminent, or added to the database and scheduled for repair.

- **Timber Harvest Plan - Roads** appurtenant to planned timber harvest operations are reviewed during individual Timber Harvest Plan (THP) development to determine if roadwork is required to achieve or maintain an 'upgraded' or 'storm-proofed' standard (HCP 6.3.3.9). The appurtenant road system and logging roads within harvest units are then subsequently monitored throughout the active life of the plan.

- **Best Management Practices Effectiveness Program (BMPEP) –** HRC forestry staff inspects all completed stream crossing related roadwork to ensure HCP stormproofing and DFW MATO standards are correctly implemented and that each work site has been properly treated for erosion control in advance of the wet weather season. In coordination with ARIP and Storm-Triggered Inspections, these newly treated sites are specifically inspected for sediment prevention and minimization performance following the first winter. Accessible sites then continue to be monitored over time per the ARIP and Storm-Trigger Inspection requirements.

- **Active THP Watershed Wide Waste Discharge Requirements** – HRC will conduct and document the following annual inspection requirements of the THP project area including appurtenant roads and harvest units where timber operations are or have been active.

    - **Prior to October 16th –** to ensure erosion control measures are in place

    - **Storm-triggered Inspection(s) October 16th through April 1st** – Storm-triggered inspections >3 inches/24 hours as measured at a centrally located rain gauge in the upper Elk River watershed) to provide opportunity for emergency prevention and response in imminent failure situations

- **Post April 1st –** THP Project Area Inspection including all appurtenant roads to document any discharges resulting from the preceding winter period and to schedule any required road maintenance or other mitigation. No post April 1st inspection is required if a storm-triggered inspection has been conducted, and no significant rainfall event (>3"/24 hours) or greater than 10 inches of total rainfall has subsequently occurred since the date the storm-triggered inspection was initiated.

Significant discharges in potential violation of the Basin Plan will continue to be reported to the NCRWQCB upon discovery within 48 hours.

Information regarding discovered maintenance sites, including new or developing sediment sources, is recorded in a centralized Roads Database. These records are maintained for the purpose of describing necessary maintenance work to be performed, scheduling of work, inspection monitoring, and maintenance history. The database is updated with completion dates as individual sites are treated.

The HRC Roads Department is contacted immediately in instances where significant active delivery or preventive imminent failure is discovered so that control measures can be enacted as soon as environmental conditions permit.

Controllable sediment discharge sources identified by ARIP, Storm-Triggered Inspections, and Active THP inspections are typically scheduled and treated within one year of discovery during the drier months of the year (May – November). Additional non-scheduled routine minor maintenance (i.e. shaping of road surface, cleaning of inboard ditches and culvert inlets, maintenance of energy dissipation/downspouts, and roadside brush maintenance) may occur as needed in response to road inspection results and management directive.

Collectively, these measures provide routine inspection and maintenance of the road system and a current road-related sediment source database from which to prioritize, schedule, implement, and monitor road-related sediment source remediation.

6.2.1 Current Road Inventory, Prioritization Strategy, and Source Remediation

Implementation of road system upgrading and storm-proofing as part of HRC's HCP has resulted in the removal or prevention of delivery of an estimated 334,700 cubic yards of sediment to stream channels on HCP covered lands as of end of year 2014. Two hundred and six (206) miles of the approximate 260 mile road system has been *storm-proofed* to HCP standards including 50 miles of road decommissioning and closure (Map 3). Storm-proofed roads (HCP 6.3.3.9) are designed, constructed, and maintained, to minimize the delivery of fine sediment from roads and drainage facilities to streams, particularly during larger magnitude, infrequent storms and floods.

Per HCP requirements (§6.3.3.2), and formal order from the NCRWQCB (Cleanup and Abatement Orders R1- 2004-0028 and R1-2006-0055), HRC (as had its predecessor, PALCO) prioritized

remediation of the worst sites first, i.e., those most likely to fail or deliver the greatest volume of sediment to waters, and specifically to fish-bearing streams.

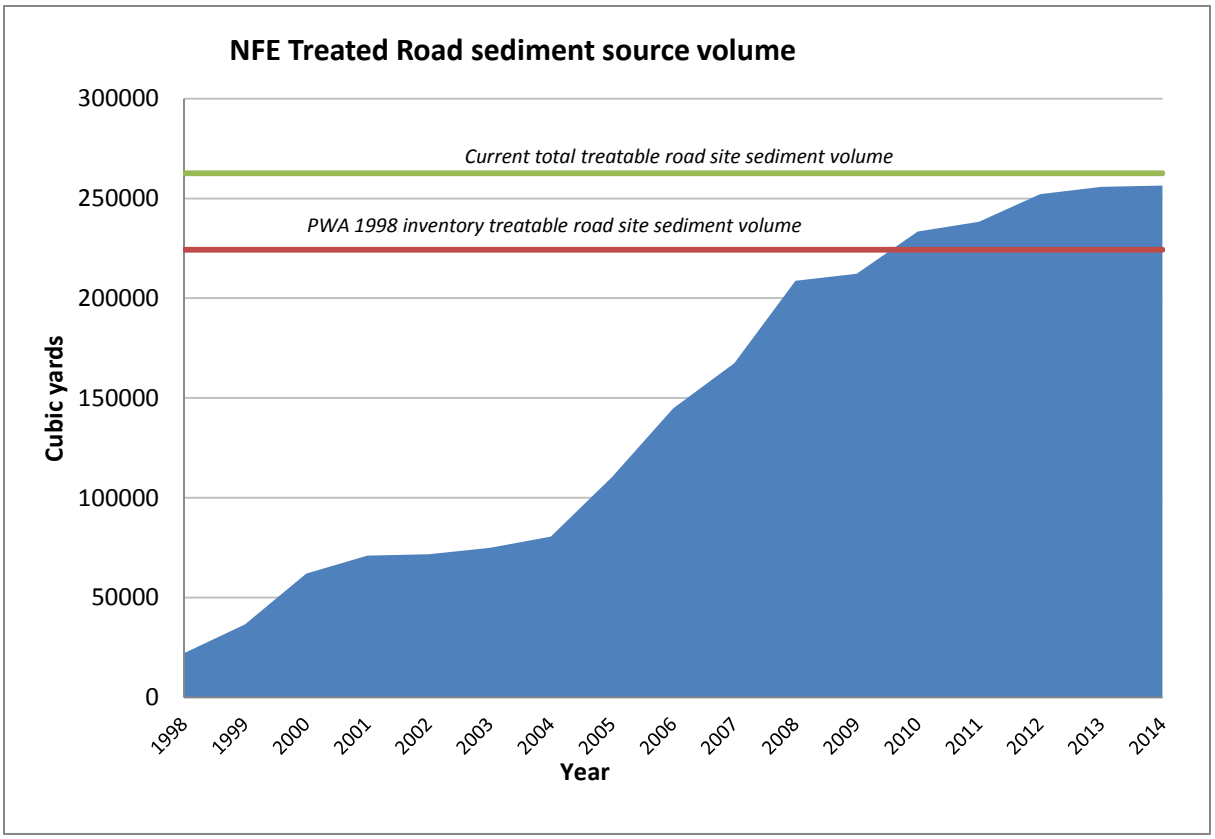
Master treatment schedules for both the North Fork and South Fork/Main Stem Elk River addressing this sediment source inventory were submitted to the NCRWQCB in 2007 as required pursuant Clean Up and Abatement Orders R1-2006-0055 and R1-2004-0028. These schedules set a treatment goal of 80% of the top 100 sites with the greatest potential for sediment related adverse environmental impact by 2011.

This requirement to treat the top 80 sites by 2011 was met and a revised master treatment schedule for each CAO was subsequently submitted in 2012 as required to schedule treatment of the remaining sediment sources in the watershed. This Master Treatment Schedule is updated and currently submitted annually as an appendix to these CAO Annual Work Plans.

Moving forward with the adoption of a new WWDR, these Master Treatment Schedules will be combined as one schedule for all of HRC's Elk River ownership, and updated and reported annually as part of the WWDR Annual Road Work Plan. The current Master Treatment Schedule is provided in Appendix D.

Figure 6-4 and Figure 6-5 present the progress of sediment source remediation in the NF Elk and SF Elk watersheds from 1997 through 2014. The volumes presented in these figures are for completed road sites and do not include off-road sources or road sites designated for "no treatment." A "No treatment" designation is provided for sites where environmental disturbance related to accessing and treating the site is likely to have a greater adverse impact on watershed values (e.g. sediment, temperature, habitat) than the potential benefits gained by treatment.

Figure 6-4. North Fork Elk River HRC HCP area road-related sediment delivery volume controlled 1998-2012



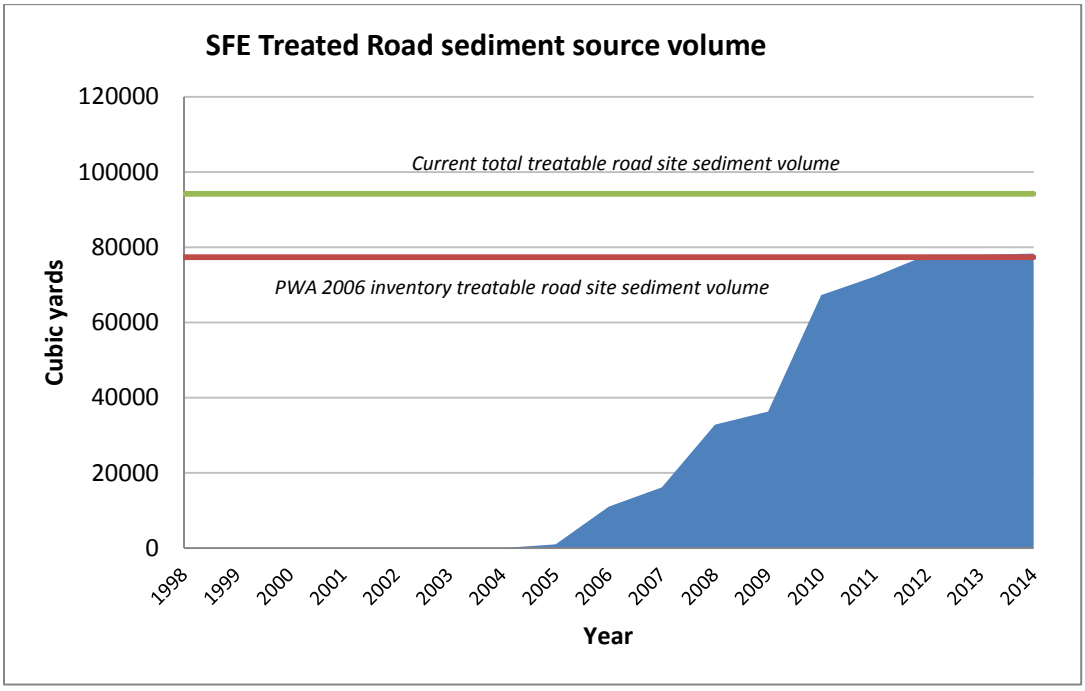


Figure 6-5. South Fork Elk River HRC HCP area road-related sediment delivery volume controlled 1998-2012

There are currently 112 potential treat sites remaining in the inventory (Appendix D) with an estimated potential delivery of 22,086 cubic yards scheduled for treatment (pending final on-site field evaluation) by end of year 2017. These sites have received priority ranking based upon level of erosion activity, volume of potential delivery, and receiving watercourse classification. With some exception, the prioritization for treatment/control of individual sediment sources is based on a 'cluster' approach evaluation, in which active or potential sediment sources on individual roads are looked at cumulatively in order to prioritize treatment. Road segments with the greatest potential sediment delivery over the shortest period of time (highest cumulative ranking) are prioritized for treatment over road segments with less potential future sediment delivery. The exception to this strategy is in the event where individual sites pose a significant threat to human safety or water quality resources, in which instance these sites are moved up in priority regardless of the rest of the road condition in that vicinity.

Moving forward with the adoption of a new WWDR, the Master Treatment Schedule will be updated and reported annually as a distinct component of the WWDR Annual Road Work Plan.

New controllable sediment discharge sources identified by ARIP, Storm-triggered, or THP inspections are typically scheduled and treated within one year of discovery during the drier months of the year (May – November) pursuant to HCP requirements (HCP Section 6.3.3.4.1).

Additional non-scheduled routine minor maintenance (i.e. shaping of road surface, cleaning of inboard ditches and culvert inlets, maintenance of energy dissipation/downspouts, and roadside brush maintenance) may occur as needed in response to road inspection results and management needs.

6.3 *Skid Trails and other off-Road (non-landslide) Logging Related Sediment Sources*

Contemporary sediment delivery from surface erosion caused by logging-related ground disturbance (i.e. skid roads, cable-yarding corridors, and site preparation activities including broadcast burning) is minimal due to HCP and FPR mitigation measures. Ground-based skid trails will continue to be minimized to the lowest number necessary to remove felled timber. The practice of slash-packing tractor skid trails within riparian management and equipment exclusion zones, and as otherwise directed by the project supervising RPF or required in the THP further minimizes potential for surface erosion and sediment delivery following use prior to re-vegetation.

However, historical 19th and 20th century logging operations in Elk River, as in other coastal watersheds, did cause significant alteration of stream channel conditions. First with animals, primarily oxen teams, and then with steam and subsequently diesel powered equipment, it was common to yard logs in stream channels. Many channels were partially or completely filled with soil and debris during this pre-Forest Practice Rules period, either through the in-channel yarding, or through the construction of non-culverted skid trail crossings (PWA 1999).

PWA (1997) concluded that mechanically filled stream channels represent a limited but persistent source of post-harvest erosion in areas tractor yarded between 1954 and 1997. More recently tractor-yarded areas (1980's through the 1990's) had discrete tractor-constructed stream crossings, but did not show evidence of in-channel yarding, as was visible in the earlier photos.

6.3.1 **Maintaining a Current Inventory of Controllable Skid Trails and other off-Road (non-landslide) Logging Related Sediment Sources**

Initial compliance with Cleanup and Abatement Orders (CAOs) No. R1- 2004-0028 (South Fork Elk River), and R1-2006-0055 (North Fork Elk River) required off-road surveys of large tracks of land known to have experienced significant ground based logging operations, in addition to inventories conducted during individual THP development. This was deemed necessary by NCRWQCB staff to

expedite an understanding of the cumulative significance of this sediment source as well as control of discovered controllable sources. As a result, over 12,300 acres of HRC's Elk River ownership has been surveyed since 2007 and 143 potentially controllable off-road surface erosion sites identified. Through end of year 2014 sixty-nine (69) of these sites have been treated for a sediment savings of an estimated 5,788 yds3. Seventy-four sites (16,367 yds3 potential delivery) remain as potential treat sites pending further evaluation. The inventory is consulted as part of each THP development so that known sites in the area, along with any additional discoveries, can be evaluated, and if deemed controllable, treated as part of THP active operations. Current Inventory is provided as Appendix E.

However, in consultation with NCRWQCB staff, it has been found that the vast majority of sites encountered during these focused surveys (>85%) are non-controllable, with greater potential environmental damage resulting from disturbance caused by treating, outweighing the potential benefit of treatment. Recognizing the limited feasibility in treating many of these historic skid trail and other historic logging related sources which have often re-vegetated and to varying extent, stabilized, HRC and the NCRWQCB have transitioned to the following strategy:

> Surveys for pre-existing, legacy sources are conducted annually in coordination with the planning of other projects. These projects include THP layout, in which areas within and surrounding future harvest units will be surveyed; and road decommissioning projects, in which areas surrounding planned road decommissioning will be surveyed to avoid orphaning controllable sediment sources by removing potential access roads. Watershed Operating Protocol (WOP) 56 is used to search for all sediment sources, including skid trail associated sources such as stream crossings, mechanically filled channels and landings.

Surveys associated with THP will continue to have results documented within the ECP of each THP including the following information for each identified site:

- A treatment identification (ID) number and location on a scaled map
- The volume of sediment to be treated
- Treatment immediacy
- A detailed description of the selected treatment plan, including all erosion control measures to be implemented
- A detailed time schedule for treatment activities

This information along with the current status of these sources will also be maintained centrally in HRC's sediment source database.

Determination as to whether a site can be controlled or not will adhere to the decision tree process described in WOP 56. This decision tree evaluates variables including current and potential delivery relative to access and disturbance involved with treatment to determine feasibility and appropriateness of control (Figure 6-6). As this is ultimately a judgment call, inspectors must have experience and training in assessing the significance of sediment sources and in the range and effectiveness of available treatment options (hand work, bio-remediation, and heavy equipment) including heavy equipment capabilities and limitations.

Introduction: To ensure treatment of sites results in a reduction of sediment, HRC has developed a decision tree to help guide staff in deciding where an active treatment at a site would be beneficial. HRC has learned that treatment of a site can increase short term sediment production and in some cases long term production. As such, HRC has incorporated a decision
tree that aids in the determination of which sites are highly effective to treat and those that are not.

Decision tree for road and off road sediment source site treatment

A1. A road or skid trail sediment source will be used in the future ……..…..…….... TREAT
A2. A road or skid trail sediment source will not be used in the future..…….. Go to B1

B1. Amount of ground disturbance created by heavy equipment access is greater than sediment saved from site remediaton. Ground disturbance is more problematic in the Hookton and Wildcat formations ..... NO TREAT
B2. Amount of ground disturbance created by heavy equipment access is less than sediment saved from site remediation. Ground disturbance is less problematic in the Yager and Franciscan formations.… ….. Go to C1

C1. Treatment may destabilize the adjacent hillslope…… NO TREAT
C2. Treatment may not alter the adjacent hillslope ……..…..……. Go to D1

D1. Competent geology (ie. Yager, Franciscan) where stable/natural channel bed can be found …..…… Go to E1
D2. Incompetent geology (ie. Hookton, Wildcat) where stable/natural channel bed is not defined……..…. Go to H1

E1. Site has already delivered most (>75%) of the volume originally stored in the site…….…..……. NO TREAT
E2. Site has not delivered most (>75%) of the volume originally stored in the site…….……Go to F1

F1. Fill is relatively stable with second growth trees present and little evidence of active erosion……..…..… NO TREAT
F2. Fill is unstable with evidence of active erosion…….…. Go to G1

G1. The site is associated with low stream power……..…….. NO TREAT
G2. The site is associated with moderate to high stream power..…….....**.....** TREAT

H1. Highly aggraded Class I downstream receptors (NF Elk River) ……...…… Go to I1
H2. Non-aggraded downstream receptors ……..…… Go to E1

I1. The immediate upstream and downstream stream channel is filled in with sediment and debris……..… NO TREAT
I2. The immediate upstream and downstream stream channel is not filled in with sediment and debris ……..… Go to E1

Note: It should also be noted that site treatment can range from using the site as is over the life of the THP to a full scale excavation and pull back. Site treatment also depends on a variety of condtional factors as well, and will be covered in another decision tree in the near future.

Figure 6-6. HRC Sediment Site Decision Tree

7.0 Forestry Operations Monitoring and Reporting

An effective and efficient form of monitoring and reporting necessary to demonstrate compliance with watershed-wide waste discharge requirements is proposed as follows. Planned timber operations will be identified in an annual **Timber Management Plan** (TMP) submitted at the start of the year. The Timber Management Plan may be amended throughout the year as necessary to reflect changes in planning. Timber harvest activities not reported in the TMP shall not commence until the TMP is amended. Individual THPs will incorporate all required measures of the WWDR, HCP, and Forest Practice Rules and will as a matter of state law been subject to the Forest Practice Rules THP review process including multi-agency review.

An annual **Road Work Plan** will be provided in the spring of each year identifying the planned location and description of new road construction, reconstruction, and road-related erosion control activities including upgrading, storm-proofing, and decommissioning. This planning activity is conducted for all HCP-covered lands property-wide the first quarter of each year and information specific to Elk River will be provided to the NCRWQCB by April 15th of each year. The Road Work Plan will provide the best available forecast and scheduling of road work to be completed for the subject year; however variation in actual roadwork conducted may occur due to various factors. An accurate accounting of work completed and explanation for any significant deviation will be provided in an annual end of the year **Forest Management Summary Report**.

Additional non-scheduled routine minor maintenance (i.e. shaping of road surface, cleaning of inboard ditches and culvert inlets, maintenance of energy dissipation/downspouts, and roadside brush maintenance) may occur as needed in response to road inspection results and management directive, and is not subject to annual road work plan reporting requirements.

A **Forest Management Summary Report** will be provided at the end of each year detailing the activities conducted during the past year, including timber and road system management, any off-road erosion control, and any riparian or in-stream restoration activities.

Discharges in potential violation of the Basin Plan will be reported to the NCRWQCB within 48 hours of the time of discovery.

7.1 *Annual Reporting*

7.1.1 Timber Management Plan

- List of THPs, units, and acres scheduled for management (harvest) in the subject year including silviculture and logging methods

7.1.2 Road Work Plan

- Location and description of planned new road construction or re-construction
- Locations and description of planned road-related erosion control activities (upgrading, storm-proofing, and decommissioning)

7.1.3 Forest Management Summary Report

- List of THPs, units, and acres harvested in the year prior (subject year of the report)
- Location and description of new road construction or re-construction activities implemented in the past year
- Location and description of road-related erosion control activities including upgrading, storm-proofing, and decommissioning. Any significant deviation from the Annual Road Work Plan will be noted and explained.
- Results from required WWDR THP road and harvest unit inspections including summary of any Notice of Discharges reported to the NCRWQCB from the previous year
- Location and description of any off-road erosion control activities conducted during the past year (e.g. skid trail and/or landslide remediation)
- Description of any riparian or in-stream restoration activities conducted during the past year

8.0 Watershed Trends and Effectiveness Monitoring and Reporting

HRC monitors a number of water quality and aquatic habitat parameters in the upper Elk River in order to understand trends and potential linkage to management activities. In addition, HRC also currently has three effectiveness monitoring projects ongoing in Elk River evaluating Best Management Practice (BMP) sediment prevention and minimization measures. Nearly all of these monitoring and study activities were developed or refined in consultation with HCP wildlife agencies and/or the NCRWQCB and are implemented to meet current HCP and NCRWQCB requirements.

Unlike *effectiveness* monitoring, *trend* monitoring is not specifically intended to evaluate specific management practices. Trend monitoring results may, over time, corroborate the findings of effectiveness monitoring, but are also strongly influenced and constrained by inherent watershed conditions and processes, apart from management, including drainage area, geology and geomorphology, topography, vegetation, and climate. Due to improvements in timber harvest practices required by the California Forest practice Rules and Humboldt Redwood Company's (HRC) HCP, recovery of aquatic habitat, where currently impaired, is expected to occur over time to the extent provided for by inherent watershed conditions. HRC's ATM program is designed to test this hypothesis, as well as inform the scientific community as to the likely range of inherent conditions, as it tracks watershed trends over time.

A brief introduction to this monitoring program is provided here, recognizing additional discussion will likely be had during the development of any WWDR Monitoring and Reporting Plan. A location map of ATM and Hydrology Monitoring stations is provided (Map 6).

8.1 ***Aquatic Trends Habitat Monitoring***

Long-term monitoring of fish-bearing (Class I) streams was initiated with adoption of the Habitat Conservation Plan (HCP) in 1999 with the goal to collect data to determine if salmonid habitat conditions across the property meet, or are trending towards Aquatic Properly Functioning Condition (APFC). The Pacific Lumber Company had an ongoing stream monitoring program when the HCP was adopted in 1999, and many of the existing sites were included in the newly created Aquatic Trends Monitoring (ATM) program. Representative stream reaches included in the ATM program were chosen for a variety of factors that included access, distribution, gradient, percentage of HCP coverage in the watershed, and watershed interest. Over the years, some sites have been added, some removed, and some moved from their initial location to a nearby location in a specific sub-watershed to better meet sampling objectives. The basic design of this monitoring program is to repeatedly measure habitat characteristics of stream reaches within the portion of watersheds most utilized by anadromous salmon (≤4% gradient).

Class I ATM stations (stream reaches) have been monitored on various schedules in Elk River over the last decade ranging from habitat measurements taken every year to every third year. Habitat values assessed include streambed substrate, pools, large woody debris, forest canopy over and adjacent to the stream, and water temperature. Cross-section stream channel area is also measured. Each ATM site is a stream reach that is at least 30 channel widths long. Summer time stream temperature (Maximum Weekly Average Temperature) is measured at each site annually. Snorkel surveys for determining fish presence and relative abundance are also conducted at each ATM location. Information from the ATM program is summarized and presented in several report formats including the Annual Class I ATM Report, Watershed Analysis Reports produced approximately every ten years, and other periodic reports (*Stream Temperature Trends and Current Canopy Measurement, 2001-2012*; *2012 Fisheries Monitoring*).

An overview of the current HCP ATM Program approved by the HCP Wildlife Agencies, including elements specific to Elk River, are provided as Appendix F. ATM sites are monitored at three year intervals with the exception of temperature and biological which occur annually. Additional information regarding program design and protocols can be found in the Annual Class I ATM Report.

8.2 *Hydrology Trends and Effectiveness Monitoring*

Stage-discharge, turbidity, and suspended sediment data has been collected at a total of 16 different locations in Elk River since 2003 with 12 of these stations having a monitoring record of six years or more (HRC 2014, Section 6.4). This has provided a robust dataset for analysis of turbidity and suspended sediment throughout the watershed (Sullivan 2012). There are currently 10 stations being monitored annually in Elk River throughout the wet weather season including eight trend monitoring stations, and two additional stations involved with an HCP effectiveness study discussed in Section 7.3. Hydrology Monitoring Reports are currently provided the NCRWQCB on an annual basis.

HRC believes several adjustments are needed to improve the current hydrology trends monitoring program including the restarting of monitoring at station 522 (Corrigan Creek), the relocation of hydrology station 534 (Little South Fork Elk River), and suspending monitoring at stations 509 (off-property, mainstem Elk River) and 533 (Tom's Gulch).

Station 522 (Corrigan Creek) monitors water quality from 100% HCP covered lands with active operations, and is one of three sub-basins extensively studied by the NCRWQCB over the last decade. Station 509 is located off-property on the Elk River mainstem and is situated on a physically deteriorating and increasingly unsafe bridge, has nearby HRC monitored stations located above it on both the North and South Fork Elk, has been repeatedly vandalized, and has water quality reflective of ownerships and land uses other than HRCs. The current location of station 534 in the BLM managed Headwaters Forest is difficult to access and manage for both data collection and quality assurance, and the small contributing drainage area to the station significantly limits the natural variation of inherent watershed conditions and processes reflected in the recorded water quality data. Moving station 534 downstream closer to the confluence with the South Fork Elk River will roughly triple the contributing drainage area, increase natural variability in contributing landscape terrain, and importantly provide greater ease of access for both maintenance/quality control and data collection. Maintaining a monitoring station in the Little South Fork Elk River sub-basin, where forest management is minimal under BLM control and old-growth forest conditions exist, is considered important as one point of water quality base-line reference. Similarly, station 533 (Tom Gulch) is difficult to access and the channel is subject to significant change throughout the winter making relationships highly variable and causing sensors to be occasionally buried. The long periods of record available for all stations monitored over the last ten plus years has provided sufficient stage-discharge, turbidity, and SSC characterization of these sub-basins to shed light on existing variability, conditions, and trends.

Figure 8-1 presents active and inactive water quality monitoring locations in the watershed.

Table 8-1. HRC Recommended Hydrology Monitoring Stations for HY 2015-2024.

Location	Station ID	Basin Area (km^2)	Basin Area (mi^2)	Monitoring Record	Proposed Status (next 10-year period)
Mainstem Elk River (metal Bridge)	509	111.53	43.06	2003-2014	Inactive
S. Fork Elk River	510	50.25	19.40	2003-2014	Active
N. Fork Elk River	511	56.82	21.94	2003-2014	Active
N. Fork Elk River	532	35.03	13.53	2005-2014	Active
Clapp Gulch (mainstem trib)	543	2.28	0.88	2013	Inactive
Railroad Gulch (SF trib)	514	3.01	1.16	2013.00	Inactive
Bridge Creek (NF Trib)	517	5.71	2.20	2003-2014	Active
S. Branch N. Fork Elk River	519	4.90	1.89	2004-2012	Inactive
Corrigan Creek (SF Trib)	522	4.33	1.67	2003-2012	Active
S. Fork Elk Mainstem (below 520)	183	19.49	7.53	2003-2011	Inactive
S. Fork Elk Mainstem (above 520)	188	16.12	6.23	2003-2014	Active
Tom's Gulch (SF Trib)	533	6.45	2.49	2006-2014	Inactive
Little S. Fork Elk (headwaters)	534	3.03	1.17	2004-2014	Active[1]
Doe Creek tributary (NF Trib)	550	0.14	0.05	2006-2012	Inactive

Railroad Gulch - East Branch	683	1.46	0.56	2014	Active[2]
Railroad Gulch - West Branch	684	1.28	0.49	2014	Active[2]

[1] Propose moving station 534 downstream and establishing new station number

[2] Active through completion of McCloud Shaw THP Effectiveness Monitoring Project (2014-2019)

8.3 *Sediment Prevention and Minimization Effectiveness Studies*

There is currently three forestry effectiveness monitoring studies active on HRC's ownership in Elk River. These include slope stability monitoring of harvested areas, implementation and effectiveness evaluation of water quality related road construction practices, and a focused THP scale paired watershed study.

8.3.1 **Slope Stability Monitoring of Harvested Areas**

HRC routinely monitors its managed forest in Elk River for evidence of new or re-activated landslide occurrence. Current Elk River WDRs require an annual investigation of harvested hillslopes following the winter season. This is regularly accomplished by placing a licensed geologist in a helicopter and flying over the watershed at a low elevation. Information from this fly-over relative to managed areas, and in particular WDR 'Tier 2' harvested areas, is communicated to the NCRWQCB on an annual basis. Periodic orthographic aerial photographs are also taken by a contractor every three to five years and subsequently interpreted under the supervision of a licensed geologist to determine hillslope response to forest management activities. The results of these air photo interpretations are analyzed as part of watershed analysis to evaluate the effectiveness of the HRC's slope stability conservation and mass wasting avoidance strategy as presented in individual enforceable WA-based forestry prescriptions.

8.3.2 **Effectiveness of Road Construction Practices in Preventing Sediment Delivery**

The "storm-proofed" design standard on HRC HCP covered lands for new construction, reconstruction, or closing roads, attempts to construct a road condition that can weather all storms including large magnitude, infrequent events (defined as the 100-year storm) without damage to water crossings and with minimum sediment delivery. Many characteristics of a road determine its potential to deliver sediment to streams. Roads built before adoption of the HCP often fail to have

some or all of these qualities. Since 1999, PALCO and HRC have constructed, reconstructed or closed roads according to the stormproofing specifications.

Road inspections and maintenance ensure that roads remain at this high standard. HRC has implemented a road auditing and inspection program to track performance and evaluate effectiveness of road projects in meeting low impact goals. HRC's road monitoring program is patterned after the U.S. Forest Service Best Management Practice Evaluation Program (BMPEP) as required by HCP §6.3.5.1.3. This monitoring program has also been developed in cooperation with the North Coast Regional Water Quality Control Board for confirming that sediment sources are controlled in the Elk River and Freshwater Creek watersheds. A similar approach was used by the California Department of Forestry in evaluating the effectiveness of the Forest Practice Regulations (Cafferata and Munn, 2002; Board of Forestry 2006).

8.3.3 **Railroad Gulch Best Management Practices Evaluation Study**

This study is designed to evaluate the effectiveness of HRC's Habitat Conservation Plan (HCP), the California Forest Practice Rules, and Elk River Watershed Analysis-derived prescriptions in minimizing sediment delivery to watercourses in response to timber harvest activities, through the integration of compliance and effectiveness monitoring. HRC's HCP requires monitoring to evaluate the effectiveness of timber harvest prescriptions in preventing the delivery of management-related sediment to watercourses. Monitoring requirements include implementation of a Best Management Practices Evaluation Program (BMPEP) (HCP §6.3.5.1.3) and In-stream Effectiveness Program (HCP §6.3.5.2). This study is being conducted at the scale of a single Timber Harvesting Plan (THP), 1-12-110HUM (McCloud Shaw).

The objective of this project is to collect and evaluate specific sediment production, storage, and delivery data to test the effectiveness of HCP prescriptions in limiting sediment production and delivery from potential sources (roads, landslides, bank erosion, upslope stream channel head-cutting, and harvest unit surface erosion) as it relates to land management. The study presents eight (8) hypotheses that are intended to test whether THP-related HCP and Watershed Analysis harvest prescriptions are effective at minimizing the impact that land management has on the delivery rate of fine sediment to Railroad Gulch. Hypothesis subjects include overall THP effectiveness relating to mass wasting, stream channel erosion, and road-related sediment delivery.

The project plan was prepared by HRC geologists and hydrologists and reviewed by HRC foresters. Independent third party review was conducted by Dr. Lee MacDonald (Colorado State University). The Project Manager is Dr. Andrew Stubblefield (Humboldt State University).

9.0 Watershed Restoration and Enhancement

Elk River has long been recognized as providing critical spawning and rearing habitat for Coho and Chinook salmon, Steelhead, and residential trout. In-stream restoration and enhancement work consisting primarily of loading the stream with large wood engineered to stay in place and provide increased aquatic habitat complexity including pool development, sediment sorting, shelter and refuge has been implemented in the upper watershed since the 1990s. Significant changes in riparian forest management affecting aquatic habitat function have been in place since 1999 including the establishment of no-harvest riparian corridors, retention of largest trees, and restrictions on shade canopy removal and use of ground-based equipment adjacent watercourses.

HRC has recently completed design, and acquired permitting for a COHO Help Act project in the North Fork Elk River involving the installation of two large wood features comprised of approximately 29 individual pieces; a project determined by NMFS, NCRWCB, and DFW to be a beneficial to endangered salmonids. Specifically, design goals are to increase frequency and depth of pools, provide velocity refuge during peak winter flows, sort and collect spawning gravels, and provide complex cover for juvenile salmonids. Implementation of this project is scheduled for this year (2015).

In addition to on-property conservation, restoration, and enhancement activities, HRC is also partnering with the NCRWQCB, other agencies, and NGOs to address chronic downstream health and safety concerns relative to water quality and domestic water supply, and winter storm flooding, including both financial and in-kind contributions to both the Elk River Recovery Assessment and Stewardship Projects.

10.0 References

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11.0 Maps

Map 1 - General Location

Map 2 – Site Map (HRC Elk River Ownership)

Map 3 – Road Conditions

Map 4 – Topographic Slope Class (LIDAR)

Map 5 – Landscape Plan (20 Year Horizon)

Map 6 – Watershed Monitoring Overview

12.0 List of Appendices

Appendix A	Elk River Salmon Creek Watershed Analysis Prescriptions
Appendix B	HCP Section 6.3.3
Appendix C	Landslide Inventory
Appendix C-2	Sample - THP Specific Mass Wasting Avoidance Analysis
Appendix D	Road Inventory and Master Treatment Schedule
Appendix E	Off-Road Surface Erosion Inventory
Appendix F	Aquatic Trends Monitoring Program