Mendocino National Forest

Phosphorus Reduction and TMDL compliance in the Clear Lake Watershed

In response to an email on May 19, 2016 from Holly Grover

Southern and southwestern sections of the Mendocino National Forest lie in the watershed of Clear Lake, regulated by the Central Valley Water Quality Control Board (CVWQCB) and under a TMDL for nutrients, in particular, Phosphorus. This short report was required by the CVWQCB to inform their required reporting due next year. This report is in response to an email from Holly Grover, on staff with the CVWQCB, requesting the information below. The email states that a written request would be forth coming, but this has not been seen by the Forest at this time. Nevertheless, we are responding in a timely manner.

Primarily Forest lands in the Clear Lake watershed lie in the Middle Creek drainage that joins Clear Lake at Upper Lake. Most other areas in the southern Mendocino are in the watershed of the North Fork of Cache Creek.

In the Mendocino National Forest within the watershed of Clear Lake there have been a number of actions to improve water quality in relationship to sediments and sedimentation in recent years. Activities that create or have the potential to create sedimentation on the Forest and mitigation, repair and restoration actions include:

- Recreational OHV use: This is an on-going program with active management funded via state grants. Work includes active trail maintenance and trail improvements to reduce erosion and sedimentation.
- Fires: There have been no major fires in the Clear Lake Watershed in recent years. There has been small scale prescribed burning in many locations, particularly along roads and ridges, to reduce the risk of catastrophic, severe fire in the watershed.
- Roads and road construction: The Forest has not expanded the road network in the watershed of Clear Lake and Middle Creek in recent years. The Middle Creek Roads Project (undertaken with the County Resource Conservation District) hydrologically disconnected 42 miles of roads from area streams and channels, significantly reducing sedimentation. With the lack of fires, road construction and timber harvest projects in the Clear Lake watershed, existing Forest roads are likely the largest source of anthropogenic sedimentation from Forest Service lands.
- Vegetation Projects: There have been no large scale timber sales, sanitation projects nor significant thinning work in the watershed in many years. Much of the watershed is low elevation lands dominated by brush and not timber.
- Range: There are several grazing allotments in the Clear Lake Watershed on the Forest. These are actively managed and monitored and there are range improvement projects every year.

- BMP and BMP EP: For the few projects that have taken place, Best Management Practices have been used and these have been checked by BMP Evaluations for implementation and effectiveness.

Below are specific responses to questions posed to the Forest in the email from Holly Grover. We hope you find the answers to be sufficient and appropriate.

Question: What types of management measures is your agency implementing and what are the effects of those management measures on phosphorus reduction? These can be reported as erosion control measures, given phosphorus binds to soil.

The Forest has undertaken significant actions to reduce sedimentation (as a proxy for phosphorus) in the Clear Lake watershed including Middle Creek.

One key aspect of reduced sedimentation lies with reduced project activities on the Forest over the last two decades. Timber sales are now few and far between and none are planned for the Middle Creek watershed at this time. Timber harvest drove road construction, so now we are no longer building new roads. There have been no recent road construction projects in the area and none are planned. It is hoped that this long-term management change promotes improved water quality in the Clear Lake basin. This change has not been quantified for sediment reduction.

Specific work to improve conditions includes the Middle Creek Roads project undertaken with funds from an EPA grant and in close cooperation with the Lake County Resource Conservation District. This work took place on 42 miles of Forest road, nearly all of the roads in the Middle Creek watershed on the Forest. This work involves hydrologically disconnecting roads from the local stream and channel network. This is done by removing inboard ditches and culverts and outsloping road surfaces along with the installation of many rolling dips to move water off of road surfaces quickly and with minimal erosion. Please see the accompanying report on the project work by the Upper Lake and Covelo District Hydrologist, Hilda Kwan, which concludes via WEPP modeling that the project resulted in a 50% reduction in sedimentation from Forest roads in the watershed

The Forest has also undertaken several projects to reduce sedimentation from OHV activities. This includes closing both established and illegal trails that were steep and eroding in the watershed and also adding rock to channel crossings to harden the crossing and preclude erosion. Sediment reduction was 100% in closed areas within a few seasons due to natural revegetation. Although, these failed trails represent a small part of the total OHV system and so the overall reduction in sedimentation for the system is much lower. Details of the OHV monitoring and repair projects have been provided to the Board in the past in the Forest's annual reports and are also available from the Forest.

Best Management Practices and the evaluation of their implementation and effectiveness has been on-going in the watershed for decades on Forest land for all project activities including

Range, Timber, Roads and Recreation. Up until 2015 the evaluations were managed at the Forest Service Regional level. Now BMP evaluations are done nationally under national standards and protocols. The number of evaluations completed in the watershed each year has varied from three to none. Both national and regional evaluations scored highly in recent years with less than 10% showing any problems or issues. Effectiveness scores are slightly higher than implementation scores.

Range allotments in the Middle Creek watershed are monitored for compliance and throughout the seasons for vegetation, riparian, channel and wetland impacts at a variety of locations. When problems are encountered, issues are remediated, such as in 2015 when issues at a wetland on the Elk Mountain allotment led to new fencing and infrastructure. Range monitoring reports, forms, letters and project information can be provided to the Water Board.

Question: Is your agency achieving the 40% phosphorus loading reduction required by the TMDL load and waste load allocations? If not, please estimate how much of a phosphorus reduction your agency is achieving with the management measures, describe any additional management measures that can be implemented to meet the 40% reduction requirement, and describe your agency's plans to implement additional management measures.

Yes, the Mendocino National Forest is meeting its mandate to reduce sedimentation 40% in the Clear Lake Watershed. To summarize, we have had one large action (the Middle Creek roads project) with a quantified reduction in sediment output and numerous small projects without a quantified calculation and also a historic change that has greatly reduced ground disturbing activity.

Thus, the 40%+ reduction has been accomplished through: 1) 50% reduction in sedimentation from our road network, by far our largest source of sediments. This alone likely meets the 40% reduction target. 2) Work to reduce sedimentation problems on OHV trails and grazing allotments, 3) a lack of large fires; 4) Best Management Practices and their evaluation; 5) a lack of ground disturbing projects.

To summarize, the Forest has taken numerous actions to reduce erosion in the watershed, in particular a large roads project. And the Forest has not undertaken very few new actions in recent years on projects likely to generate sediment and or increase erosion, such as timber harvests, new road construction, etc.

Hydrologic Monitoring Report

Prepared by Hilda Kwan, Hydrologist, Upper Lake Ranger District

8/26/2014

Background

Roads can be a significant source of non-point pollution to watersheds. Forest Service roads were originally designed for hauling timber off National Forest lands. These roads were routinely maintained with profits through timber sales. With the decline of the timber industry and reduced federally appropriated dollars, road maintenance activities have been less frequent, resulting in poor drainage, culvert failures, and increased sediment load to aquatic systems.

The USFS conducted a road survey in 2009 on native surface roads in the Middle Creek watershed. The survey documented road segments that were hydrologically connected, culvert blockage, and number and volume of rills. The results were used to prioritize 42 miles of road for treatment due to their potential for contributing sediment to Middle Creek and Clear Lake. These water bodies are 303(d)-listed for nutrients and mercury; which can be transported as part of, or attached to, fine sediments (i.e. fine sands, silts, and clays).

This project "storm proofed" approximately 42 miles of road mentioned above. The intent of storm proofing is to reduce the miles of road hydrologically connected to the Middle Creek stream network and make them less susceptible to failure and subsequent sediment delivery during average and above average size storms. Storm proofing activities included cleaning out culvert entrances, outsloping of the road surface, installing rolling dips, and installing critical dips where necessary.

Several types of monitoring were implemented for the Middle Creek Storm Proofing Project to analyze the effectiveness of the project. This report will detail two of these monitoring activities; WEPP:ROAD and Hydrologic Connectivity. Comparisons are made between pre project and post implementation. Further comparison will be made in 2015 for 1-year post project when additional data is collected.

WEPP:ROAD

The WEPP:ROAD model estimates sediment load leaving the road and entering the stream system. It accounts for road bed erosion, as well as cutbank, fillslope, and ditch erosion. The data needed to run the model includes a weather location (used to drive the stochastic weather generator) and physical properties of the road and soil. As a result of the project implementation, the typical physical properties that will change are the length of road segment contributing sediment, the road width, the road configuration (e.g. outsloped, insloped, etc) and occasionally the contributing segment slope.

For the purposes of this project, a field form was prepared to facilitate WEPP:ROAD model data collection. All field measurements were taken using standard instruments (i.e. tape measure, inclinometer, laser range finder). Soil texture were taken from published soil survey data and verified in the field using standard field methods for determining soil texture (i.e. the ribbon test).

The WEPP:ROAD form and analysis were completed prior to and after implementation of the project at randomly selected stream crossings and pour points. Using a GIS analysis of NHD streams and project roads, 127 stream crossings have been located along project roads (it must be noted that these points do not include all pour points such as rolling dip outlets and ditch relief culverts since these are not mapped features).

These points were assigned numerical numbers which were then used to randomly select 33 points for monitoring (30% of the crossings). Based on expected workload and manpower it was determined that 30% of the crossings could be analyzed and, along with the hydrologic connectivity data, would provide adequate representation of the project impacts. Statistically, 33 out of 127 would provide a +-11% margin of error within the 90% confidence level.

Input Parameters (pre-project)

For each road segment, soil type and road configuration was specified (in other words, insloped or not, ditched present or not, etc). Road configuration also included approach length, slope, and width. Fill length and slope along with buffer length and slope were included in the configuration. Soil texturing was performed in the field and a standardized soil type of ‘silt loam’ was determined for road surfaces. Lakeport, California was selected for climate data for simulation from the climate models provided by WEPP. A continuous simulation over a 30-year time horizon was performed.

Output Results

Pre-Project

The 33 surveyed points (30% of the crossings) were evaluated for its erosion potential in WEPP:ROAD (tons). Length of the approach was multiplied by width of the road for an area (acres). Averages of the *surveyed points* yield **24.7 tons/acre**.

Using the assumption of an 18-feet wide road for the 42-mile project, a total of **2263 tons/year** was calculated as total current erosion potential over the entire project.

Post Implementation

The same 38 points were revisited post-implementation and resurveyed between April through August 2014. Averages of the surveyed points yield **11.6 tons/acre**.

Using the assumption of an 18-feet wide road for the 42-mile project, a total of **1063 tons/year** was calculated as total current erosion potential over the entire project.

Conclusion

Post-implementation surveys reveal a drastic reduction in sediment delivery to the stream system. Reduction of erosion potential over the surveyed road area is over 50%. Most apparent changes noticeable in the field were shortened approach lengths and changes in slope due to installation of rolling dips.

Hydrologic Connectivity

The purpose of the hydrologic connectivity analysis is to determine what percent of the road network is directly connected to the stream system and delivering sediment without the filtering effect of a buffer strip. A reduction in percent hydrologic connectivity represents decreased sediment contribution from the roads and a return to a more "natural" drainage system. Road segments that are disconnected from the stream system return surface flow to subsurface flow by dispersing it onto a buffer strip where it can percolate back into the ground.

All project roads will be driven or walked and at each pour-point (e.g. rolling dip, over the side drain, ditch relief culvert, or stream crossing) evidence of sediment delivery to the stream system will be assessed. If the road is discharging onto a buffer area and no sediment delivery to a stream is observed, that road segment is classified as unconnected and no further data is collected at that site. If evidence of surface flow or sediment transport can be traced to the floodplain or stream bank, the road segment leading to that pour point is classified as connected. For connected segments, the length of road contributing runoff and sediment to that pour point is measured and recorded. The length is measured using a tape measure or laser range finder. All information is entered into a GPS data dictionary for geospatial display and analysis. A field form will be used as a backup in case satellite reception is poor (Appendix A). The length of road connected to the stream system divided by the overall road length will provide the percent of hydrologic connectivity.

The hydrologic connectivity assessment will be conducted prior to project implementation and then repeated after project implementation. The change in percent hydrologic connection will then be calculated.

Results

Pre-Project

Results from the hydrologic connectivity assessment show that over 55% of the surveyed roads are connected. The majority of these roads were connected by at least 50% individually (Table 1). There were no discernible differences in connectivity between ridge roads and foothill roads.

Table 1. Results of hydrologic connectivity assessment, pre implementation

Road Number	Connectivity (ft)	Surveyed Road Length (ft)	% connected
15N43	2734.4	4850.04	56.38
16N01	42526.18	84645.72	50.24
16N01c	868	3690.57	23.52
16N16	2206	5105.93	43.20
16N20(Lower Deer Valley Rd)	16555.6	21318.54	77.66
16N21	11640	31758.74	36.65
16N30	25681.2	34138.62	75.23
16N30A	2003	3197.7	62.64
16N36	3166	4999.89	63.32
16N37 (High Glade)	3582.6	5277.90	67.88
16N38	812	6945.53	11.69
16N81	4164	5775.25	72.10
17N11 (French Ridge)	1047.8	1048.00	99.98
17N28	3822	4023.00	95.00
Total	120808.78	216775.43	55.73

The connectivity assessments show that roads do not all have the same potential of sediment contribution. This may be due to different types of crossing structures and its condition, presence of energy dissipation, and other various factors.

Post- Implementation

Results from the post-implementation hydrologic connectivity assessment show that 9.95% of the surveyed roads are connected. No single road is connected by more than 25% (Table 2).

Table 2. Post Implementation connectivity survey

Road Number	Connectivity (ft)	Surveyed Road Length (ft)	% connected
16N21 (Pitney Ridge)	1188	31758.74	3.74
16N20 (Lower Deer Valley)	2409	21318.54	11.30
17N28 (Howard Mill)	864	4023.00	21.48
16N16	0	5105.93	0.00

15N43	278	4850.04	5.73
16N30	3201	34138.62	9.38
16N01	10698	84645.72	12.64
16N01C	200	3690.57	5.42
16N81	517	5775.25	8.95
16N30A	105	3197.70	3.28
16N37 (High Glade)	75	5277.90	1.42
16N36	1264	4999.89	25.28
17N11	88	1048.00	8.40
Total	20887	209829.90	9.95

1 Year Post- Project

Road Number	Connectivity (ft)	Surveyed Road Length (ft)	% connected
16N21 (Pitney Ridge)	1313	31758.74	4.13
16N20 (Lower Deer Valley)	2167	21318.54	10.16
17N28 (Howard Mill)	864	4023.00	21.48
16N16	100	5105.93	1.96
15N43	278	4850.04	5.73
16N30	3201	34138.62	9.38
16N01	11017	84645.72	13.02
16N01C	200	3690.57	5.42
16N81	517	5775.25	8.95
16N30A	105	3197.70	3.28
16N37 (High Glade)	75	5277.90	1.42
16N36	1330	4999.89	26.60
17N11	88	1048.00	8.40
Total	21255	209829.90	10.13

Conclusion

The hydrologic connectivity study pre and post implementation show a drastic reduction in hydrologic connectivity (Table 3). Hydrologic connectivity over the 42-mile project has been reduced by 80%.

Table 3. Comparison of hydrologic connectivity between pre and post implementation

Road Number	Pre-Project % connected	Post-Project % connected	1 year Post Project % connected
16N21 (Pitney Ridge)	36.65	3.74	4.13

16N20 (Lower Deer Valley)	77.66	11.30	10.16
17N28 (Howard Mill)	95.00	21.48	21.48
16N16	43.20	0.00	1.96
15N43	56.38	5.73	5.73
16N30	75.23	9.38	9.38
16N01	50.24	12.64	13.02
16N01C	23.52	5.42	5.42
16N81	72.10	8.95	8.95
16N30A	62.64	3.28	3.28
16N37 (High Glade)	67.88	1.42	1.42
16N36	63.32	25.28	26.60
17N11 (French Ridge)	99.98	8.40	8.40
Total	57.19	9.95	10.13

Monitoring Conclusion and Discussion

A reduction in connectivity through storm proofing methods decreased contributions of sediment into the stream system. 80% of total roads were disconnected leading to a potential sediment decrease from 2263 tons/year to 1063 tons/year (>50% reduction in sedimentation).