2009 Trails BMP Retrofit Monitoring Report

USDA Forest Service
Lake Tahoe Basin Management Unit

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Appendix A: Trails Monitoring WQRAP Protocol

I. Introduction

Trails have been identified as a potential source of sediment input to surface water. This may be exacerbated by increased public use and the length of time since best management practices (BMPs) were initially implemented or maintained. Furthermore, unauthorized trails have a far greater potential than managed trails to contribute sediment to surface water. The LTBMU's Trails Access and Travel Management Plan (ATM, June 2009**),** includes a comprehensive trails relocation, maintenance and decommissioning program which improves BMPs on managed forest trails and decommissions unauthorized trails in order to prevent eroded sediment from reaching stream channels and improve the recreational experience. BMPs are designed to reduce or eliminate soil movement, and hydrologically disconnect trails from adjacent waterbodies.

In the summers of 1999, 2000, and 2001, an inventory of all trails within the Basin was performed to determine the potential risk of Basin trails to adversely affect water quality as part of the analysis performed for the ATM. Basin wide, existing trails total approximately 484 miles. Each trail was evaluated to determine whether it should remain as a National Forest System Trail (system trail), or be adopted and managed as a system trail, or be removed from the system. A *system trail* is a trail managed and maintained by the Forest Service (currently totaling 320 miles). A *unauthorized trail*, sometimes called a user-created trail, is any trail on National Forest System Lands that is not managed and maintained by the Forest Service (currently totaling 164 miles). For planning purposes the Basin was divided into nine geographical areas or "transportationsheds" based on recreational uses and water quality concerns. The Access and Travel Management Plan (ATM) prioritized these transportationsheds on the basis of resource risks.

II. Methodology

The primary objective of trails monitoring is to evaluate the impacts of trail treatment measures by determining the change of risk to water quality before and after implementation of work. Comparisons will determine if selected techniques and methods are effective at reducing potential sediment transport. These determinations should influence and/or enhance decision making relative to trails adaptive management.

The Water Quality Risk Assessment Program (WQRAP) was initially developed to assess LTBMU roads in 1998 (Derig et al, 1999). This protocol was used as part of the comprehensive *Forest Roads BMP Upgrade Monitoring Report (Briebart, Harris and Norman, 2007).* A modified version of WQRAP was developed by LTBMU engineers and hydrologists to identify and evaluate chronic erosion features (CEF) and stream crossings (SC) on system trails. Techniques such as GPS, mapping, flagging and photo points are used to accurately relocate CEFs and stream crossings identified in pre-project monitoring, in order to facilitate creation of an accurate and comparable pre- and post-project data set. This protocol is presented in Appendix-A.

WQRAP evaluations are based on standardized physical attributes which, depending on their relative magnitude, pose a greater or lesser risk to water quality from erosion and sediment transport. WQRAP assessment forms designate a range of empirical risk values for each attribute (see Table 1, in Appendix A). The attribute scores are summed for each CEF or stream crossing. These scores are normalized to produce a percent ranking score, zero being the least risk and one hundred the highest. The scores are then divided into a low (0-32%), medium (33-66%) and high (67-100%) risk category

Pre-project monitoring was performed on all trails in the transportationshed. Post-project monitoring sites were determined by evaluating the results of the pre-project monitoring. Trail segments that were determined to be of the highest risk to water quality from pre project monitoring were selected to identify a representative sample of trail segments for post project monitoring. Choosing which trail segments to evaluate for post-project monitoring was also based on map review in order to identify connectivity to water bodies and degree of slope, and input from project managers.

Pre-project runoff and erosion modeling was performed in 2005 for specific North Shore trail locations having visible erosion problems, as part of the NEPA process for the North Shore Trail ATM (Breibart, 2005). Modeling was conducted with the Water Erosion Prediction Project (WEPP) model to estimate erosion rates and potential sediment transport to streams from five high risk trail segments, and to evaluate the effectiveness of various design criteria in reducing erosion and sediment yield. The result of these analysis is presented in the specialist report (Breibart, 2005) and the North Shore Trails ATM Plan EA (ESA, 2007), and summarized in the results section below.

Pre-project WEPP modeling was conducted in 2009 for most of the East Shore Beaches Trails, as part of the LTBMU trails monitoring program.

III. Results

Trails monitoring in the 2009 included the North Shore (post-project) and East Shore Beaches (pre-project) trails. Post-project monitoring of East Shore Beaches is scheduled to be performed in the summer of 2010, soon after spring runoff.

North Shore Trails

The North Shore transportationshed encompasses an area of approximately 14,234 acres. The trail system was relatively unplanned and did not meet Forest Service Standards defined by the Forest Service Trail Handbook and the Standard Specifications for the Construction and Maintenance of Trails. The area includes both system and non-system trails that receive a mix of motorized, mechanized, and non-mechanized uses. Pre-project trails monitoring totaled 61.0 miles, of which 33.2 miles were system trails and 37.8 miles were unauthorized trails. The total system trail mileage after

decommissioning, relocating and adopting non-system trails will total approximately 54.3 miles.

Pre-project WEPP analysis was performed on a selected sample of 5.8 miles of trail. Of these, only 3 short segments (on trail 17E46.3, totaling 1,638 feet) predicted sediment delivery to streams greater than 88 lbs/year. The values for these three segments were 160, 236, and 939 lbs/yr. Post project modeling was not conducted on any specific North Shore trail segment, however WEPP modeling was used as part of the NEPA analysis to evaluate the effectiveness of various design criteria on reducing rates of erosion and sediment yield from a typical trail segment at stream crossings. This analysis predicted substantial reductions from the types of improvements implemented in the project, which included reducing slope, reducing connected trail length, and increasing buffer distances to streams. These types of improvements resulted in a 99% reduction in predicted sediment yield.

Pre-project monitoring was completed in 2006. Post-project monitoring started in 2009, following the first season of implementation in 2008**. Implementation continued in 2009, and is scheduled to be completed by August, 2010.**

A total of 8.7 miles of trail were identified for post project monitoring based on an evaluation of pre-project data and identification of those segments that posed the greatest risk. This 8.7 miles of trail, rated moderate to high risk, contained a combined total of 41 Chronic Erosion Features (CEFs) and 1 Stream Crossing (SC).

Only 1.7 miles of these trails were treated in 2008, so these were the only trail segments monitored in 2009. Trail upgrades included decommissioning, increasing the number of drainage features to reduce connected length, armoring of the trails surface, and reducing gradient to <10% where possible. These results are presented below.

16N52 (0.7 miles)
16N52A is a road to trail conversion, located off Highway 267 near Brockway Summit. The first several hundred feet of 16N52A is part of the original trail. It then becomes a new trail which follows contour to connect with trail 16N97A. The decommissioned section of trail is now covered with aggregate material.

The pre-project risk assessment identified 7 CEFs on the old trail included 4-low, 2-moderate and 1-high risk score. Post-project monitoring observed no CEFs or connectivity to an SEZ. Water quality risk dropped from a pre-project average of 35% to a post-project average of 0%.

19E00 (0.5 miles)
This trail is part of the Tahoe Rim Trail (TRT) near Watson Creek. None of the 3 CEFs identified during pre-project monitoring now exist. Trail connectivity to the SEZ remains direct. Water quality risk dropped from a pre-project average of 30% to a post-project average of 0% for this trail.

16N75.2 (0.5 miles)
This is a road to trail conversion. Of the 5 CEFs identified during pre-project monitoring 2 CEFs continue to pose moderate and low risk and 3 no longer exist. This trail segment received the only post-project SC evaluation (ephemeral) for North Shore trails. The SC had 0 feet of connected length (topographically level). The water quality risk score decreased from a high (99%) to low (0%). This decrease is due primarily to an abundant increase in vegetation adjacent to the trail and channel. Over all water quality risk dropped from a pre-project average of 56% to a post-project average of 17% for this trail.

Upgrades to the remaining 7 miles of trail originally identified for post project monitoring will be completed in 2010. The water quality risk for these remaining segments ranges from 18% to 42%. Because of the low level of water quality risk present on these trails, and the degree of effectiveness documented from work conducted to date in this area, the LTBMU has decided to not conduct any more post project monitoring on trails with the North Shore Transportationshed. These trails will continue to be routinely surveyed by engineering staff to assess condition and maintenance needs, but will not be monitored by hydrology staff utilizing the WQRAP protocol.

East Shore Beaches Trails

Monitoring of East Shore Beaches trails was conducted on 6 trails totaling 4.5 miles, of which 1.5 miles are scheduled to be decommissioned. These trails are located on 1,170 acres between Skunk Harbor and Sand Harbor State Park, between Highway 28 and Lake Tahoe. Pre-project monitoring was performed early in the 2009 field season on all trails, identifying a total of 9 CEFs. Trail work was completed later the same season. Up-grades include trail armoring, installing additional drainage features, stairs, realignment and decommissioning. Post-project data is scheduled to be collected immediately after spring runoff in 2010. The following is a description of the 6 trails and associated pre-project WQRAP score and WEPP analysis.

18E22.3 (0.1 miles)
This short unauthorized "cut-off" trail is located in Slaughterhouse Canyon and connects the main trail to the meadow. It has long connected lengths between water bars and received a 72% (high risk) score. Pre-project WEPP average annual erosion and average annual sediment yield in is 804 lbs. and 54 lbs. respectively.

Slaughterhouse Canyon unauthorized trail (0.1 miles)
Slaughterhouse Canyon road (15N67) is an administrative use road and is generally closed to public vehicles. The road is frequently used by the public for access to the meadows and the lake shore, however parking is limited at the gated junction of this road with Hwy 28. Various parking spots are located along Hwy. 28. Most are at an inconvenient and/or hazardous walking distance along the Hwy. to the junction. As a result, an unauthorized trail has developed which provides a shortcut from the parking spots along the Hwy to the road below. It has not been determined as yet if this trail will become a system trail or be decommissioned. This high gradient trail has long connected lengths between water bars and received a 68% (high risk) score. Pre-project WEPP

average annual erosion and average annual sediment yield in is 244 lbs. and 41 lbs. respectively.

Secret Harbor Trail -18E27A (0.1 miles)
This trail connects the Secret Harbor parking area to the lake shore. Planned upgrades include realignment and erosion control measure to be determined by site specific conditions. This high gradient trail has long connected lengths between water bars and received a 96% (high risk) score. Pre-project WEPP average annual erosion and average annual sediment yield in is 433 lbs and 64 lbs respectively.

Chimney Beach Trail -18E27 (.5 miles)
Pre-project monitoring was performed on 1 trail CEF and 2 SCs for crossings of Marlette Creek (upper and lower). The trail segment to be realigned received a 75% (high risk) score.

The upper Marlette Creek crossing received a 17% (low risk) score while the lower crossing received a 68% (high risk) score. Pre-project WEPP average annual erosion and average annual sediment yield is 70 lbs. and 0.14 lbs. respectively.

Marlette Creek Trail -18E19 (3.5miles)
Pre-project monitoring was performed on one SC at Marlette Creek (large foot bridge) and one CEF on the trail section connected to the trailhead/parking area and is scheduled to be realigned. The Marlette Creek crossing received a 17% (low risk) score while the lower crossing received a 66% (moderate risk) score. The trail segment to be realigned received a 68% (high risk) score. Pre-project WEPP average annual erosion and average annual sediment yield is 261 lbs. and 36 lbs. respectively.

Whale Beach -18E27.4 (.25 miles)
Pre-project monitoring was performed at one stream crossing (unnamed intermittent stream). This trail does not appear to receive frequent use and is being choked by thick vegetation. This crossing received a pre-project score of 57% (moderate risk). Pre-project WEPP modeling for Whale Beach was not conducted.

IV. Conclusions and Recommendations

Pre project monitoring indicates that overall the 61 miles of trails in the North Shore tranportationshed present a relatively low risk to water quality. The total trail network will be reduced to 54 miles once all upgrades and decommissioning is completed. For 1.7 miles of North Shore trails receiving post-project evaluation, risk to water quality dropped from a pre-project average of 40% (moderate risk) to a post-project average of 6% (low risk). Pre project WEPP modeling predicted very few trail segments had the potential to transport sediment to streams, and WEPP analysis of proposed improvement to trails predicted a > 90% reduction in sediment yield for a typical trail at a stream crossing.

Pre project monitoring of the 4.5 miles of trails accessing the East Shore Beaches Trails, indicate that all the trails present high to moderate risk to water quality based on WQRAP assessment, however the WEPP predictions of annual sediment yield from these segments range from between 64 to 0.14 lbs.

The following conclusions can be made at this time relative to water quality risk from trails. WEPP modeling indicates that even in the worst case scenarios the potential for sediment delivery from trails is quite low. This is not surprising considering the dispersed nature of trails, and relatively small foot print of trails (average width 5 to 3 feet). The post project WQRAP evaluations indicate that risk levels drop substantially with the implementation of trail upgrades. WEPP analysis predicts a greater than 90% reduction in sediment yields at stream crossings by decreasing trail slope, and increasing water diversions to reduce connected length.

For this reason it is recommended that the trails monitoring program only be continued for one more year, utilizing the WQRAP protocol. Post project implementation monitoring will be conducted on the East Shore Beaches trails soon after spring runoff in 2010, along with WEPP modeling using actual post project implementation data. An update to this report will be produced at the conclusion of that monitoring effort.

Future monitoring will then consist of routine trail condition surveys conducted by LTBMU engineering department staff. This routine surveying will not be reported, but rather used internally by engineering staff to assess and schedule trail maintenance needs. For the purposes of TMDL reporting, the metrics will consist of miles of trails upgraded and maintained on an annual basis. Based on the results of the data produced in this report our assumption is that once trails are upgraded, and maintained on a routine basis, we will have achieved maximum load reductions for this particular type of land use.

References

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Appendix A

Water Quality Risk Assessment Protocol for Trails
USDA Forest Service
Lake Tahoe Basin Management Unit
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Introduction

The Lake Tahoe Basin is renowned as a major recreational destination and visitor use continues to increase each year. Research has shown the trend of recreational use in conjunction with human disturbance has contributed to the decline of water quality. In order to address the water quality impacts associated with Forest Service recreational use and trails, the USDA Forest Service, Lake Tahoe Basin Management (LTBMU) implemented a Trail Access and Travel Management Plan (ATM). The Trail ATM incorporates a water quality risk analysis, which identifies trail routes with a low, medium or high risk to water quality. Ratings are derived from ranking field data that is collected during field inventories (methodologies described below). The results of the water quality risk analysis combined with sensitive wildlife and plant species analysis will provide the ecosystem management framework for planning and implementing the Trail ATM.

Methodologies

The trails water quality analysis involves mapping chronic erosion features, and stream crossings on US Forest Service/LTBMU system trails, using a standard global positioning system unit (GPS). Each feature is mapped described and rated with the attributes outlined below and recorded into the GPS data dictionary. This information will be downloaded into the LTBMU Geographic Information System Trail ATM database.

Water Quality Risk Analysis Attributes

1. **Trails**

User type: foot, non-motorized, or motorized. This is a determination of the predominant use of the trail. Foot indicates that the main use on the trail is pedestrian, non-motorized indicates mountain bike and/or horse traffic, and motorized includes any motorized activity.

Use: heavy, moderate, or light. This is an empirical determination of the amount of use a trail is receiving at the present time.

2. **Chronic Erosion Features (CEF)**

Connectivity: indirect or direct. This is a determination of whether or not an erosion feature is contributing sediment to a stream that is directly connected to Lake Tahoe.

Type: rilling, gully, slough, or mud hole. This distinguishes the erosion process responsible for each CEF. Rilling and gullying is the result of diverted water from the natural course causing an incision in the ground surface. Rilling has a cross-sectional area less than 2 square feet, where gullies are greater than 2 square feet. A slough is

defined as a wet or dry down slope movement of sediment on a large scale and a mud hole is defined as muddy, wet, and rutted, usually associated with a stream environment zone (SEZ).

CEF length. This describes the approximate length of the erosion feature in feet.

Photo name. This indicates the name of the photo that was taken at the particular CEF.

3. Stream Crossings

Type: bridge, culvert, hardened, tree, or native. This characterizes the kind of stream crossing present and if the current stream crossing is stabilized at the present time. A bridge may be defined as any elevated crossing. A culvert is defined as a metal, concrete, or rock tube that allows water to flow through it. The term ford is used to describe crossing where some protective measure has been taken, such as rock or paving stones Tree describes a crossing where a tree or downed wood has been placed to serve as a crossing. Native describes a crossing where the streambed is unprotected and restoration currently has not been implemented.

Stream type: ephemera, intermittent/perennial. An ephemeral stream is a low order stream that flows in response to direct snowmelt and rainfall. Intermittent/perennial streams are defined as streams that flow for periods of greater than one month or have year round discharge, respectively.

Condition: good, moderate, poor, or capture. This distinguishes the overall condition of the particular stream crossing. A good stream crossing is described as a crossing that is not eroding and all improvements are in good repair. The term moderate describes a stream crossing where there may be some erosion occurring but improvements are in good condition. If the condition of the stream crossing is poor, this indicates that the crossing is eroding, and any prior improvements are ineffective or need maintenance. The term capture indicates that the stream flow has diverted out of the channel and down the trail.

Connected length. This is the estimated length of the trail on both sides of the crossing that drains into the channel.

Photo name. This indicates the name of the photo that was taken at a particular stream crossing.

Each water quality analysis attribute was assigned an initial empirical value based on the magnitude of the water quality risk (table 1). The attribute scores are summed for each CEF and each stream crossing. These scores are normalized to produce a percent ranking analysis, zero being the least risk and one hundred the highest. The features are then divided into a low (0-32%), medium (33-66%) and high (67-100%) risk category

Table 1: Water Quality Risk Analysis Attributes

Chronic Erosional Features		
Connectivity	**(Maximum Score = 10)**	
	indirect	= 0
	direct	= 10
CEF Type	**(Maximum Score = 14)**	
	rilling	= 3.5
	mud hole	= 7
	gully	= 14
	slough	= 14
CEF Length	**(Maximum Score = 12)**	
	length < 21 feet	= 1.5
	length < 51 feet	= 3
	length < 81 feet	= 4.5
	length < 101 feet	= 6
	length < 151 feet	= 7.5
	length < 251 feet	= 9
	length < 501 feet	= 10.5
	length > or = 501 feet	= 12
Stream Crossing		
Stream Crossing Type	**(Maximum Score = 6)**	
	bridge	= 0
	culvert	= 2
	ford	= 2
	native	= 2
Stream Type	**(Maximum Score = 6)**	
	ephemeral	= 0
	perennial	= 6
Condition of Stream Crossing	**(Maximum Score = 12)**	
	good	= 0
	moderate	= 6
	poor	= 9
	capture/diversion	= 12
Length Connected	**(Maximum Score = 15)**	
	length = 0 feet	= 0
	length < 26 feet	= 3
	length < 51 feet	= 6
	length < 101 feet	= 9
	length < 201 feet	= 12
	length > or = 201 feet	= 15