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November 12, 2007
File No. 74407.02

Mr. Todd Wees
Homewood Mountain Resorts, LLC
P.O. Box 165
Homewood, California 96141

**SUBJECT: Stream Channel and Baseline Surface Water Assessment**
**Homewood Mountain Resort**
**Homewood, California**

Dear Mr. Wees:

Kleinfelder, Inc. has completed a stream channel and baseline surface water assessment for the stream systems on the Homewood Mountain Resort (HMR) property including stream classification, channel condition assessment, and baseline surface water sampling. The baseline surface water sampling included an evaluation of data collected between 1992 and 2006 in accordance with Monitoring and Reporting Program No. 95-86A1. Enclosed are three copies of this report, which signifies the completion of the scope of work, described in our proposal dated October 9, 2006.

We appreciate the opportunity to provide our environmental consulting services to Homewood Mountain Resort, LLC. Should you have any questions regarding this report or wish to discuss the conclusions and recommendations provided, please contact us at 775-689-7800.

Sincerely,

**KLEINFELDER WEST, INC.**

Terri L. Barnett
Biologist

/for

Melissa Sherman
Environmental Scientist

REGISTERED CERTIFIED ENGINEERING GEOLOGIST
DAVID J. HERZOG
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David J. Herzog, RG, CEG
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cc: Gary Midkiff- Midkiff and Associates, Inc.
Jason Drew- Nichols Consulting Engineers
Juan Larrigue- Design Workshop
Michael Hogan- Integrated Environmental Restoration Services

# STREAM CHANNEL AND BASELINE SURFACE WATER ASSESSMENT HOMEWOOD MOUNTAIN RESORT HOMEWOOD, CALIFORNIA

**November 12, 2007**

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# 1.0 INTRODUCTION

## 1.1 PURPOSE AND OBJECTIVES

The purpose of this stream channel and baseline surface water assessment is to describe the character and current conditions of both water quality and stream channels within three watersheds on the Homewood Mountain Resort (HMR) property in Homewood, California. This data will be considered the baseline condition against which water quality improvements can be measured.

## 1.2 SCOPE OF WORK

As described in our proposal dated October 9, 2006, Kleinfelder has completed the following scope of work (Tasks 1-5):

Task 1 – Data Compilation and Site Reconnaissance

Task 1 included research and data compilation along with a site reconnaissance to verify the extent of the watersheds and associated drainages. Kleinfelder located sixteen surface water sampling locations representative of the watersheds on or adjacent to HMR property.

Task 2 - Channel Classification

The stream courses were classified according to the California Forest Practice Rules based on their beneficial use. The streams were also classified using two different systems, Rosgen Level II and Montgomery-Buffington, based on geomorphic characteristics.

Task 3 - Channel Condition Assessment

The channel conditions were classified as good, fair, and poor based on condition of the banks and slopes surrounding the stream course.

Task 4 - Baseline Surface Water Sampling

In October 2006, March 2007, May 2007, and September 2007 Kleinfelder conducted surface water sampling at the locations identified in Task 1. Water samples were collected and sent to the laboratory for analysis. Physical parameters were measured in the field, which included flow measurement.

Task 5 - Reporting

This report documents the findings of the assessment including methodologies used for data collection during the field activities, mapped drainage channels, tabulated channel characteristics and conditions, surface water flows, and water quality data.

## 1.3 PREVIOUS WORK

Placer County contracted Entrix, Inc. and Lumos and Associates to conduct an assessment of the watersheds in the Homewood area for the purposes of identifying erosion control problems and opportunities for watershed and water quality improvements in these watersheds (Entrix, 2006 and Lumos and Associates, 2006). This assessment included an evaluation of the lower portions of the three major drainages present on the HMR property; Madden Creek, Ellis Creek, and Quail Lake Creek. This assessment was completed as part of the Homewood Erosion Control Project (ECP), which is denoted by the Tahoe Regional Planning Agency (TRPA) as Environmental Improvement Program (EIP) Project No. 725.

This assessment formed the basis for the additional evaluation that Kleinfelder has completed. Kleinfelder used this existing data and expanded upon the data to include the upper limits and headwaters of the subject watersheds associated with the HMR property.

HMR has been conducting surface water sampling from 1992 to 2007 in accordance with Monitoring and Reporting Program No. 95-86A1. Kleinfelder tabulated, graphed, and provided an assessment of these data.

## 1.4 STUDY AREA

Watersheds within the HMR property and surrounding areas have been delineated by TRPA. The assessment area includes portions of Madden Creek Watershed, Ellis Creek Watershed and Quail Lake Creek Watershed. The boundaries of the study area represent the HMR property lines; however, data collected downstream and outside of the HMR property by Entrix has been incorporated into this assessment for reference. All surface water sample locations are within or adjacent to HMR property boundaries and are placed to assess water quality where the stream enters HMR property and where the stream exits the HMR property.

# 2.0 SETTING

## 2.1 PROJECT LOCATION AND DESCRIPTION

The HMR ski area is located on the west shore of Lake Tahoe in Placer County in the town of Homewood, California. The property is located approximately 19 miles north of South Lake Tahoe and 5 miles south of Tahoe City along Highway 89. The property lies within portions of Sections 1, 2, 10, 11, and 12 of Township 14 North and Range 16 East. Elevations on the property range from approximately 6,300 feet to 7,880 feet above mean sea level (msl).

The property is used as an active ski resort with unpaved access roads, four major chair lifts, two lodge areas, and paved parking lots. The majority of the property is forested with mixed conifer stands with a shrub understory. Areas along the creeks were vegetated with mountain alder, dogwood, various willows and other riparian species. The ski runs were vegetated with grasses, forbs and low growing shrubs. In general, the soils present on the HMR property are classified as gravelly and stony sandy loams.

## 2.2 PHYSIOGRAPHY AND CLIMATE

Lake Tahoe is located along the border of California and Nevada. About one-third of the basin is in Nevada and two-thirds is in California. The basin is bounded by the Sierra Nevada to the west and the Carson Range to the east. The Lake Tahoe Basin was formed by geologic block faulting about 2 to 3 million years ago. The down-dropping of the Lake Tahoe Basin and the uplifting of the adjacent mountains resulted in dramatic topographic relief in the region. Mountain peaks rise to more than 10,000 feet msl. The surface of Lake Tahoe has an average elevation of about 6,225 feet msl (USGS, 2004).

The climate in the Lake Tahoe Basin is typically very dry with low humidity. The sun shines an average 75 percent or 274 days each year, but snow can fall during any month. At lake level, the area receives an average of 125 inches of snow annually. Higher elevations can receive an average of 300 to 500 inches annually.

Lumos and Associates compiled available precipitation (rainfall) data from the Spatial Climate Analysis program at Oregon State University, which determines annual precipitation based on location and elevation. Data was collected for the years from 1955 through 2004, which provided a yearly estimate of precipitation, which covered both dry and wet years for the Tahoe Basin and therefore represents a true average of annual precipitation. The calculated average produced 33.5 inches per year for the lower elevations and 37.5 inches per year for the upper watershed. The mean annual precipitation data generated from this study is summarized in Table 10 of the Homewood ECP document (Lumos and Associates, 2006) and has been included as Appendix A for reference.

## 2.3 WATERSHEDS

The entire HMR property is located within the Homewood ECP project planning area that was assessed by Placer County, Lumos and Associates, and Entrix. According to the watershed map developed by Lumos and Associates, there are three major watersheds within the HMR property including Madden Creek, Ellis Creek, and Quail Lake Creek. In addition, Intervening Zones C and D and numerous sub-watersheds are within the boundaries of the HMR property. These major watershed components are described further below. Appendix B contains copies of a watershed map prepared by Entrix.

### Madden Creek

Madden Creek Watershed (H9) has an area of approximately 2.5 square miles. The headwaters begin at Ellis Peak at an elevation of about 8,700 feet msl, flow over three miles and discharge into McKinney Bay of Lake Tahoe. Lake Louise is the only lake in this watershed and is located at approximately 7,700 feet msl. The HMR property covers the majority of the lower portion of the watershed, but US Forest Service Land is located adjacent to the north side of the drainage.

### Ellis Creek

Ellis Creek Watershed (H40) has an area of approximately 1.3 square miles, the majority of which is located on the HMR property except for the residential areas down stream. The headwaters begin at Knee Ridge, flow over two miles and discharge into McKinney Bay of Lake Tahoe.

### Quail Lake Creek

The Quail Lake Creek Watershed (H64) has an area of approximately 1.7 square miles, but only 1/3 of the total watershed area is located on the HMR property. The headwaters flow from an elevation of 8,400 feet msl at Knee Ridge and discharge into McKinney Bay of Lake Tahoe near Lagoon Road. Quail Lake is located in the lower half of the watershed and therefore less than half of the runoff from this watershed actually flows through this lake. The abandoned Noonchester Gold Mine is located south and upgradient of Quail Lake, which may have the potential to impact water quality downgradient in the watershed.

Intervening Zone C

This zone is located between the Quail Lake Creek Watershed and the Ellis Creek Watershed.

Intervening Zone D

This zone is located between the Ellis Creek Watershed and the Madden Creek Watershed and encompasses a larger unnamed drainage channel that was incorporated into this assessment.

## 2.4 WATER RIGHTS

Kleinfelder queried the California Regional Water Quality Control Board's water rights database for points of diversion (POD) located on the HMR property. Six points of diversion were found and described below:

**A020487** – This POD is located on Madden Creek at the downstream property line near Trout Street Bridge. No additional information is provided in the database.

**A018934** – This POD is located at the Lake Louise outfall to Madden Creek. The water is diverted for domestic purposes by Homewood Mountain Resort.

**A011449** – This POD is located in the upper portion of Ellis Creek. The water is diverted for both mining and domestic uses by the U.S. Forest Service.

**A027988 01**– This POD is located near the Quail Lake outfall to Quail Lake Creek. Quail Lake Water Company is the permit holder and the water is diverted for municipal use.

**A027988 02** – This POD is located approximately mid-stream on Ellis Creek. Quail Lake Water Company is the permit holder and the water is diverted for municipal use.

**S006462** – This POD is located on the lakeshore between Madden Creek and Ellis Creek. Homewood Mountain Resort is the permit holder and the water is diverted from Lake Tahoe.

These water rights may be outdated or no longer applicable. Additional information regarding the PODs and a map showing their locations is included in Appendix C for reference.

# 3.0 METHODS

## 3.1 OVERVIEW OF STUDY APPROACH

In October and November 2006, Kleinfelder scientists conducted the field studies of the watersheds on the HMR property and collected baseline surface water samples. In 2005, Entrix had completed a geomorphic and channel condition assessment of portions of Madden Creek (River Mile [RM] 0.0 to 1.0), Ellis Creek (RM 0.0 to RM 0.7) and Quail Lake Creek (RM 0.0 to RM 0.9). Kleinfelder continued the assessment of these drainages along with an unnamed drainage (Unnamed Creek) located between Madden Creek and Ellis Creek. Kleinfelder assessed Madden Creek from RM 1.0 to RM 2.08 up to Lake Louise. Ellis Creek was assessed from RM 0.7 to RM 1.89. Kleinfelder assessed the final segment of Quail Lake Creek from RM 0.9 to RM 0.97 where the drainage starts at Quail Lake. Unnamed Creek was assessed from the lower property line of HMR to the start of the creek, RM 0.0 to RM 0.7.

Figure 1 illustrates the stream segments assessed by both Entrix and Kleinfelder and the surface water sample locations.

## 3.2 CHANNEL CLASSIFICATION

### California Practice Rules

After all creeks and drainage channels were mapped, the stream courses were classified according to the California Forest Practice Rules into four stream classes based on their beneficial uses.

- Class I streams provide domestic water supplies and habitat that supports fish on a seasonal or perennial basis.
- Class II streams are valued for their water-quality influence on perennial and seasonal fish and other aquatic life.
- Class III streams are capable of sediment transport to Class I and II streams under normal high flow conditions and area valued for their influence on water quality.
- Class IV streams are human-made watercourses designed for domestic, agricultural, hydroelectric, or other beneficial uses.

Rosgen Stream Classification

Kleinfelder conducted a Rosgen Level II stream classification which is based on characteristics of the channel cross-section, longitudinal profile, and planform features as measured and computed from collected field data.

The following geomorphic parameters were measured in the field and calculated:

- *Entrenchment Ratio* – the degree of vertical containment of a river channel. This is calculated by dividing the width of the flood prone area by bankfull width.
- *Width-Depth Ratio* – the shape of the channel cross-section. This is calculated by dividing the bankfull width by the mean bankfull depth.
- *Dominant Channel Materials* – the most prevalent of the six major bed material types including bedrock, boulders, cobbles, gravel, sand, or silt/clay.
- *Slope* – slope of the water surface averaged for 20-30 channel widths. Due to the steep slopes in the project area, this was measured using a clinometer and a topographic map.
- *Sinuosity* – characterization of channel planform. This is calculated by dividing the stream length by the valley length. This was estimated from field observations and topographic maps.

Based on these measurements and assessments, Kleinfelder inputted the numbers into a stream classification worksheet and using the Rosgen stream type charts and classification key assessed the stream type. Stream types are given a letter (A-G) depending on the number of channels, entrenchment ratio, width/depth ratio, and sinuosity. The stream type is then amended with a number (1-6), which represents the dominant type of channel material and then a lower case letter (a-c) depending on the slope range.

One discrepancy noted during this classification was that a large portion of the stream segments analyzed had poorly entrenched channels but high stream gradients and low sinuosity and, therefore, did not fall into clearly defined Rosgen stream types. The poor entrenchment indicates an E or C type channel, but neither of these channel types occurs on gradients greater than 4 percent, and these channels have moderate to high sinuosity.

The Rosgen classification for all the streams on the HMR property is shown in Figure 2 and summarized in Tables 1 through 4. A further detailed description of the Rosgen Classification System, stream types, and classification keys are included in Appendix D for reference.

Montgomery-Buffington Stream Classification

Kleinfelder classified the bed form of the streams using the Montgomery-Buffington criteria (Montgomery-Buffington, 1997). This method is determined by visual observation and no measurements or quantitative analysis is required for classification. The Montgomery-Buffington classification is based on bed morphology and described seven types of channels. The seven types of channels are grouped into three basic types of channels: colluvial, alluvial, and bedrock. Alluvial channels are further defined as: dune-ripple, pool-riffle, plane-bed, step-pool, and cascade.

The following channel types were applied to the steam segments on the HMR property:

- *Colluvial* - these channels are small headwater streams that flow over colluvial valley fill and exhibit weak or ephemeral fluvial transport. They are typically very steep (>10%), and exhibit variable bedforms. Colluvial channels have none to very limited floodplain development. None of the streams observed in this study are classified as colluvial.

- *Bedrock* – these streams can be defined as channels where a substantial proportion of the boundary is exposed bedrock or is covered by an alluvial venner that is largely mobilized during high flows such that the underlying bedrock geometry influences patterns of hydraulic and sediment movement. Bedrock channels are non-adjustable, typically confined and have a steep to moderate gradient with little to no floodplain development. The bedform may be variable in bedrock channels. Bedrock channels are present within a few stream reaches in the study area.

- *Alluvial* – these streams are defined as channels that can erode, transport and deposit sediments, such that they are self-forming and self-maintained. Alluvial channels are found over a relatively wide range of slopes, from low to high gradients, and may have narrow to very wide floodplains. The majority of the stream reaches classified in the study area represent a type of an alluvial channel or a transition stage between two alluvial stream types.

- *Cascade* – these channels have the steepest slopes (>6.5%) with large particle size relative to flow depth.

- *Step-pool* – these channels have relatively steep slopes (3%-6.5%) with relatively large particle size often with bedrock exposures. This bedform is organized into a series of channel spanning accumulations that form a series of steps separating pools.

- *Plane-bed* – these channels have moderate slopes (1.5%-3%). The bedform is considered featureless often typified by glides, riffles and rapids. Cobble-gravel bed material is the typical particle size.

- *Pool-riffle* – these channels have low to moderate slopes (<1.5%). The bedform is organized into laterally oscillating sequence of bars, pools, and riffles.

- *Dune-ripple* – these channels are unconfined, low gradient channels with sandy bed material. None of the stream reaches in the study area are classified as dune-ripple.

The Montgomery-Buffington classification for all the streams on the HMR property is shown in Figure 3 and summarized in Tables 1 through 4. The diagnostic features of each channel type are included for reference in Appendix E.

## 3.3 CHANNEL CONDITION ASSESSMENT

Kleinfelder classified channel conditions as good, fair, and poor. Good conditions are present where banks exhibited erosion only on outcurves, at obstructions, and infrequently in other areas. Fair conditions are present where channels were eroded intermittently in locations not explained by stable fluvial processes. Poor conditions include extensive and continuous erosion on one or both banks.

Entrix used the Stream Condition Inventory (SCI) protocol to assess the stability of stream banks. The SCI method rates bank stability as Stable, Vulnerable and Unstable. The methodology is based on an inventory checklist that considers the amount of vegetative cover, presence of boulders and other coarse bank material, bank angle, and other indicators of bank stability. Stable banks have no instability factors and greater than 75 percent cover (cover includes vegetation, large rock, downed wood, or erosion resistant soil types with clay or conglomerate). Unstable banks have less than 75 percent cover and at least one instability indicator. Vulnerable banks have greater than

75 percent cover, but at least one instability indicator. Instability indicators include mass movement, slumping, fracturing, undercut banks, or significant lengths of bank erosion.

## 3.4 SURFACE WATER SAMPLING AND MONITORING

Kleinfelder conducted surface water sampling activities in October 2006, March 2007, May 2007, and September 2007. As shown in Tables 5 and 6, several sampling stations either did not have flow (NF) or were not accessible in March 2007 (NA). Kleinfelder collected water samples from the remaining locations for laboratory analysis and physical and chemical parameters in the field. The results of the sampling and monitoring activities are summarized in Tables 5 and 6.

### Sampling Protocol

Kleinfelder scientists, using a pair of new, nitrile gloves at each sampling location, performed all sampling. Surface water samples were collected in laboratory-supplied containers for the analytes identified in Table 5 in accordance with the identified EPA Methods. Sample containers were stored in the sample cooler prior to sample collection. The sample containers were placed directly in the surface water stream and the upstream water flowed into the containers. To prevent preservative dilution, the sample containers were not overfilled. Care was taken not to disturb bank or bed-load sediment during sampling. If entry into the stream of water was required, the sample was collected upstream of this location. Samples were labeled, placed in an iced cooler and transported to the laboratory under chain-of –custody protocol. The samples were sent to Western Environmental Testing Laboratory (Wet Lab) of Sparks, Nevada for analysis.

### Field Measurements

Temperature, pH and conductivity readings of the water were collected using a Hanna Oakton-Lon 10 Series field meter. Dissolved oxygen was collected using an YSI, model 55 DO meter. Flow was calculated for all the sample points that had a velocity of more than 0.3 feet per second and a depth of greater than 1 inch. Flow was calculated by using the equation Flow (Q) = Velocity (V) x Area (A). Area was measured by taking various depth measurements of the water in a stream cross-section and a width measurement of the wetted area. Therefore area was calculated using the equation Area (A) = mean depth (D) x width of the wetted perimeter (W). Velocity was measured using a velocity meter (Global Water FP 101), which calculates the average velocity of the stream when placed at several points along the cross-section of the stream. The data collected in the field is summarized in Table 6.

### 3.4.1 Permit Compliance Sampling

The Homewood Mountain Resort is required to have a monitoring and reporting program (Program No. 95-86A1) by the Regional Board. A copy of this document is included for reference in Appendix H. This program includes the following components: water quality monitoring of the ski area, erosion control inspections of the ski area, parking lot monitoring, an annual work plan, and snow conditions chemicals monitoring. All the sampling data is stored in the Regional Board's files. The following is an overview of the monitoring program:

Six monitoring stations have been established of which five are consistent with the locations that Kleinfelder collected baseline water samples.

**Stations**

Station M-1 – Madden Creek, immediately downstream of the outfall from Lake Louise (Kleinfelder sample location SW-9).

Station M-2 – Madden Creek, immediately downstream of the point where the creek exits the property (Kleinfelder sample location SW-2).

Station E-1 – Ellis Creek, immediately downstream of the point where the creek enters the property (Kleinfelder sample location SW-10).

Station E-2 – Ellis Creek, immediately downstream of the point where the creek exits the property (Kleinfelder sample location SW-14).

Station P-1– North Parking Lot, at the outlet drain pipe (Kleinfelder sample location SW-1).

Station P-2 – South Parking Lot, at the drop inlet on the south side of the parking lot.

**Frequency**

- During spring snowmelt period (April-June) sample weekly between 1pm-5pm.
- Other periods of year, samples collected during each significant rainfall event, which causes observed flow at each monitoring station. If possible between the first four hours of runoff.

### Constituents and Measurements

- Volumetric Flowrate measurement
- Turbidity
- Total Non-filterable Residue (Total Suspended Solids)
- Total Nitrogen
- Total Phosphorus

### Report Submittal

Quarterly Water Quality Monitoring reports are due to the Regional Board on July 15, October 15.

# 4.0 RESULTS

## 4.1 MADDEN CREEK

### 4.1.1 Channel Classification

Kleinfelder performed a field survey of Madden Creek from RM 1.0 to RM 2.1. Entrix performed a survey of Madden Creek from RM 0.0 to RM 1.0. The stream segments that are present on the HMR property extend from RM 0.2 located at the Trout Street Bridge to RM 2.1 at Lake Louise. The following is a description of the whole stream, which summarizes the findings of both Entrix and Kleinfelder.

Channel gradients are moderately high, about four percent between Lake Tahoe and just above Highway 89 (RM 0.0 to RM 0.1). The majority of the Madden Creek is typified by extremely high gradients ranging from ten percent to over 20 percent upstream to Lake Louise. There is a portion of the steam, between RM 1.4 and RM 1.8, where multiple drainages confluence into the main channel and where the river valley widens and flattens out. The slopes are less than ten percent in this reach and, therefore, the stream has greater sinuosity and larger expanse of riparian vegetation.

A summary of all the classification methods for all the stream segments of Madden Creek assessed is included in Table 1.

California Practice Rules

Madden Creek from RM 0.0 to RM 1.5 can be classified as a Class I stream due to the presence of fish habitat and observed fish during the assessment. Although Madden Creek originates at Lake Louise, the section of the creek, from RM 0.0 to RM 1.5, represents the main channel that captures the majority of the water from the upper watershed. A major tributary along with smaller tributaries enter Madden Creek at approximately RM 1.56 and therefore anything above this location in the creek is considered Class II and Class III.

Madden Creek was inventoried by USFS in August 1994 for fish habitat. Based on the USFS information, it appears that most of Madden Creek may provide better potential habitat for adult trout than the other streams in this assessment due to its greater proportion of pools and their greater depth. It has been noted that the lower portion of

Madden Creek, off the HMR property, does not provide good fish habitat due to the alteration of the streambed for flood control.

Rosgen Classification

The following is a description of the Rosgen geomorphic characteristics of either individual stream segments or longer reaches that have been grouped into stream types beginning with the most downstream section of the stream. Figure 2 illustrates the classification of the stream segments assessed on Madden Creek.

**RM 0.0 – RM 0.05**: This section has been altered by bank protection and rip-rap which has narrowed the channel, encroaching into the bankfull channel width. This is a highly entrenched, moderate gradient, low-width-depth ratio **G2/G3** channel type that is dominated by both boulders and cobbles.

**RM 0.15 – RM 0.2**: Upstream from the bike path to the Trout Avenue bridge, the channel is steep, highly entrenched, with a low width-depth ratio and boulder dominated **A2** stream type.

**RM 0.2 – RM 0.9**: Upstream from the Trout Avenue bridge the channel is very steep, highly entrenched, with a low width-depth ratio. RM 0.2 to RM 0.7 is dominated by boulders and is an **A2a+** stream type and RM 0.7 to RM 0.9 is a bedrock channel type and therefore an **A1a+.**

**RM 0.9 – RM 1.0**: This segment of the stream has a moderately entrenched channel with a mix of boulders, cobbles, and gravel dominating the bed material and is classified as **B1/B2/B3** stream type.

**RM 1.0 – RM 1.2**: This reach of Madden Creek is slightly entrenched, with a low width depth ratio, but has moderate gradient and low sinuosity. The bed materials are co-dominated by boulders and cobbles and, therefore, this stream type meets the basic criteria for a **C2/C3** stream type.

**RM 1.2 – RM 1.3**: This section of the stream has exposed bedrock in some areas but otherwise is dominated by boulders. A moderate entrenchment ratio, width/depth ratio and slope classify this segment as a **B1a/B2a** stream type.

**RM 1.3 – RM 1.8**: This segment of Madden Creek does not cleanly fall into Rosgen steam types due to the conflicting entrenchment ratios and high gradients. Based on the low entrenchment ratios these areas fall into the **C/E** stream types, but have gradients greater than 4% and have low sinuosity. Cobbles and gravel dominate the bed material.

**RM 1.8 – RM 1.9**: A moderate entrenchment ratio, width/depth ratio and slope classify this segment as a **B2a/B3a** stream type with boulders and cobbles dominating the bed material.

**RM 1.9 – RM 2.08**: A weir structure spills water from Lake Louise into Madden Creek and the area where the headwaters is located is in a broader valley area so the entrenchment ratio is low and due to the controlled flow in this initial upgradient reach, the width/depth ratio is low. The bed material gets larger in size the further the channel is from Lake Louise and, therefore, there are areas dominated by gravel, cobble and boulders, which indicate a **C2b/C3b/C4b**. The segment between RM 1.9 and RM 2.0 has a gradient higher than 4 percent, but a lower gradient between Lake Louise and RM 2.0.

Montgomery-Buffington

Almost all the identified channel types in the lower half of Madden Creek (Bedrock, Cascade, and Step-Pool) are considered to be high-energy stream segments, with a high sediment supply and corresponding high bedload sediment transport rates. The upper half of Madden Creek is within a wider valley area and various tributaries confluence into the lower, high-energy channel. The majority of the upper creek is typified by step-pool channel types, but intermixed with a lower energy plane-bed channel type. The gradients are relatively lower in the upper half of Madden Creek, but some short segments still exhibit very high gradients. Most of the sediment delivered to Madden Creek is derived from mass wasting of very steep, unstable channel banks as noted near RM 1.3.

Figure 3 illustrates the various Montgomery-Buffington stream types within Madden Creek.

### 4.1.2 Channel Condition Assessment

According to Entrix, approximately 60 percent of the portion of the stream they assessed (RM 0.0 – RM 1.0) was rated as Unstable, with Vulnerable and Stable rating each comprising 20 percent of the channel length. Conditions vary between RM 1.0 and RM 1.5 with good channel conditions between RM 1.0 to 1.2 and very poor conditions between RM 1.3 and RM 1.4. The poor conditions observed included steep unvegetated banks with unstable soils. In the upper reach of Madden Creek, between Lake Louise and RM 1.5, the channel is in very good condition with only minor bank erosion in very limited areas. This section is located upgradient of the various confluences of the tributaries in the watershed.

Undercut banks were observed in the lower reach below the Trout Avenue bridge (RM 0.0 to RM 0.2), between RM 1.4 and RM 1.5, and between and RM 1.2 and RM 1.3. Mass wasting sites were observed in various locations along the stream including RM 0.2, RM 0.9, and RM 1.3. The mass wasting sources contribute a substantial volume of sediment directly to the channel. The surface water sample results confirm the loading of the stream in these locations.

Figure 4 identifies the stream segments with varying channel conditions.

## 4.2 ELLIS CREEK

### 4.2.1 Channel Classification

Kleinfelder performed a field survey of Ellis Creek from RM 0.7 to RM 1.89. Entrix performed a survey of Ellis Creek from RM 0.0 to RM 0.7. The stream segments that are present on the HMR property approximately extend from RM 0.2 located at the HMR south lodge on Tahoe Ski Bowl Way to RM 1.89. The following is a description of the whole stream, which summarizes the findings of both Entrix and Kleinfelder.

Channel gradients are approximately four percent in the lowest reach between Lake Tahoe and Ski Bowl Way and then range from 12 percent to 27 percent upstream to the headwaters where the gradient flattens to less than one percent.

A summary of all the classification methods for all the stream segments of Ellis Creek assessed is included in Table 2.

#### California Practice Rules

Ellis Creek, from RM 0.0 to RM 1.1, can be classified as a Class I stream due to the presence of fish habitat and observed fish during the assessment. The upper reaches of the stream are considered Class III stream type due to the very steep gradient, lack of substantial pool depths, and lengths and source of headwaters.

Ellis Creek was inventoried by USFS in August 1994 for fish habitat. Based on the USFS information, it appears that Ellis Creek provides limited habitat for adult trout lifestages, but there is substantial suitable spawning habitat. High gradients between RM 0.3 and RM 0.7, and RM 1.1 and RM 1.4 may act as natural barriers for migration in low flow years.

Rosgen Classification

The following is a description of the Rosgen geomorphic characteristics of either individual stream segments or longer reaches that have been grouped into stream types beginning with the most downstream section of the stream. Figure 2 illustrates the classification of the stream segments assessed on Ellis Creek.

**RM 0.0 – RM 0.1**
The most downstream reach of Ellis Creek is a moderate gradient, highly entrenched, low width-depth ratio, **G4/G5** channel type. Gravels and sand to smaller coarse particles are the co-dominant bed material size.

**RM 0.1 – RM 0.2**
This portion of the stream is poorly entrenched, moderate width-depth ratio, **E4b/E5b** channel type with a gravel/sand substrate. The channel is moderately sinuous and exhibits a pool-riffle type bedform with bars. This is the only segment along Ellis Creek with a floodplain although the floodplain is very narrow (less than 5 feet) and discontinuous alternately bordering both sides of the channel.

**RM 0.2 – RM 0.25**
Upstream from Tahoe Ski Bowl Way, there is a short section of **A2/A3/A4** channel type.

**RM 0.25 – RM 0.7**
This reach of Ellis Creek is very steep, highly entrenched, low width-depth ratio, and boulder dominated **A2a+** stream type. Bedrock exposures, visible in short sections, are indicative of the high transport capacity of the A2a+ channel type.

**RM 0.7 – RM 1.0**
This segment of Ellis Creek does not cleanly fall into Rosgen steam types due to the conflicting entrenchment ratios and high gradients. Based on the low entrenchment ratios these areas fall into the **E4** stream types, but have gradients greater than 4% and have low sinuosity. Cobbles and gravel dominate the bed material.

**RM 1.0 – RM 1.1**
This section of Ellis Creek is slightly entrenched, has low width-depth ratio, but moderately high gradient. Large boulders dominate the bed material in this **C2b** channel type.

**RM 1.1 – RM 1.3**
This reach of Ellis Creek is very steep, highly entrenched, low width-depth ratio, and boulder dominated **A2a+** stream type. Bedrock exposures, visible in short sections, are indicative of the high transport capacity of the A2a+ channel type.

**RM 1.3 – RM 1.6**
A moderate entrenchment ratio, width/depth ratio and slope classify this segment as a **B2a/B3a** stream type with boulders and cobbles dominating the bed material.

**RM 1.6 – RM 1.89**
This segment is representative of the headwaters of Ellis Creek. A large wet meadow with areas of emergent wetland is present at the base of the slopes of Knee Ridge. The low entrenchment ratio, low width to depth ratio, and sinuosity characteristics classify this segment as an E stream type with the graduating decreasing stream bed particle sizes the further up the stream segments. Therefore, stream types E3b, E4b, E5b, and E6b, were observed in the upper reaches of Ellis Creek.

Montgomery-Buffington

Similar to Madden Creek, the upstream reaches of Ellis Creek are typical of steep transport channel type (Step-pool/Cascade) and closer to the lake the channel is a response type (Plane-bed/Pool Riffle). The uppermost reaches near the headwaters are a response type stream with limited supply characteristics (Step-Pool/Plane-bed). At about Tahoe Ski Bowl Way, the gradient is more moderate, with pool-riffle and plane-bed channel types. These are response type channels and are more likely to adjust their channel dimensions or planform in response to change in the flow or sediment regime.

Figure 3 illustrates the various Montgomery-Buffington stream types within Ellis Creek.

### 4.2.2 Channel Condition Assessment

According to Entrix, approximately half (48 percent) of the portion of the stream they assessed (RM 0.0 – RM 0.7) was rated as Unstable. Bank instability between RM 0.3

and 0.68 appears to be due to mass wasting sites along a steep gradient. Stable and vulnerable banks were in similar proportions, 29 percent and 23 percent, respectively. In the lower 0.2 mile of the channel, undercutting was observed. Kleinfelder observed some erosion and undercut banks near RM 1.15, otherwise the portion of the stream assessed (0.7 – 1.89) had good channel conditions with substantial vegetation cover and no major erosional features.

Figure 4 identifies the stream segments with varying channel conditions.

## 4.3 QUAIL LAKE CREEK

### 4.3.1 Channel Classification

Kleinfelder performed a field survey of Quail Lake Creek from RM 0.9 to RM 0.97. Entrix performed a survey of Quail Lake Creek from RM 0.0 to 0.9. The stream segments that are present on the HMR property approximately extend from RM 0.6 to RM 0.97 at Quail Lake. The following is a description of the whole stream, which summarizes the findings of both Entrix and Kleinfelder.

The channel gradient is moderately high, 4.5 percent, between RM 0.0 to RM 0.2. The majority of Quail Lake Creek has a steeper gradient of approximately nine percent between RM 0.2 and RM 0.9, except for the very steep segment between RM 0.9 and RM 0.97 which has slope of 28 percent.

A summary of all the classification methods for all the stream segments of Quail Lake Creek assessed is included in Table 3.

#### California Practice Rules

The lower portions (RM 0.0 – RM 0.3) of Quail Lake Creek have potential spawning habitat for fish and, therefore, is considered a Class I stream type. An intermediate area of the creek (RM 0.3 – RM 0.5) may provide some habitat on a seasonal basis depending on the amount of annual precipitation and can be considered a Class II stream. The upper half of Quail Lake Creek is considered a Class III stream. The upper portion of Quail Lake Creek is predominantly very steep step-pool bedform, which would act as a natural barrier for fish migration. In addition, the upper portion of this creek (RM 0.5 – RM 0.97) does not have water year-round.

Rosgen Classification

The following is a description of the Rosgen geomorphic characteristics of either individual stream segments or longer reaches that have been grouped into stream types beginning with the most downstream section of the stream. Figure 2 illustrates the classification of the stream segments assessed on Quail Lake Creek.

**RM 0.0 – RM 0.3**
This lower most reach is moderately entrenched, moderate width-depth ratio **B2/B3** channel type that is boulder to cobble dominated.

**RM 0.3 – RM 0.5**
This reach is a single-thread **B2** stream type with a cobble and gravel as the dominant bed materials.

**RM 0.5 – RM 0.7**
This section of Quail Lake Creek has at least three split channels of which all are distinct and well separated by vegetated areas. This area was poorly entrenched but had high stream gradients and did not fall clearly into defined Rosgen classifications. Based on the low entrenchment ratios these areas fall into the **C/E** stream types, but have gradients greater than 4% and have low sinuosity. Gravels dominate the bed material.

**RM 0.7 – RM 0.9**
This reach of Quail Lake Creek is very steep, highly entrenched and is identified as an **A2a+/A3a+** stream type. Boulders and cobbles dominate the bed material and the lack of finer material and steep grade indicate that this stream segment is a transport channel type that rapidly delivers sediment to the downstream reaches.

**RM 0.9 – RM 0.97**
This uppermost section of the channel, which meets Quail Lake, also has a steep gradient and is highly entrenched, but is dominated by cobbles and gravels and is an **A3/A4** stream type. A large pool is present where the flume structure that drains Quail Lake flows into this channel.

Montgomery-Buffington

The lower reaches (RM 0.0 – RM 0.7) of Quail Lake Creek are classified as an intermediate step-pool/plane bed type and have characteristics of both transport and response stream types. The upper portion of the stream (RM 0.7 – RM 0.97) is a higher gradient cascade/step-pool channel. This transport channel type rapidly delivers sediments to the downstream reaches. Figure 3 illustrates the various Montgomery-Buffington stream types within Quail Lake Creek.

### 4.3.2 Channel Condition Assessment

The majority of the stream banks along Quail Lake Creek were rated Stable by Entrix and in good condition by Kleinfelder. However, the lower reach of this stream (RM 0.0 – RM 0.32) had banks considered Vulnerable based on episodic soil movement as a result of a flood or a shift in the course of the stream. Overall, the stream banks had very good coverage of both vegetation and large material and no major erosional features were present. The HMR property does not operate any ski runs prone to disturbance in close proximity to this stream.

Figure 4 identifies the stream segments with varying channel conditions.

## 4.4 UNNAMED CREEK

### 4.4.1 Channel Classification

Kleinfelder performed a field survey of Unnamed Creek from RM 0.0 to RM 0.7 which is entirely on the HMR property. The lower segments of this channel, extending from Tahoe Ski Bowl Way to Lake Tahoe, were not assessed because they were outside of HMR property.

A summary of all the classification methods for all the stream segments along Unnamed Creek assessed is included in Table 4.

California Practice Rules

The entire length of this stream on the HMR property is classified as a Class III stream. It does not provide perennial or seasonal fish habitat and is capable of transporting sediment to Lake Tahoe and potentially Ellis Creek. No water was observed in this channel during the assessment, but based on the geomorphic features present and observed storm flow by HMR staff; this stream conducts high volumes of water during large storm events and captures snow melt water from Intervening Zone D.

Rosgen Classification

The following is a description of the Rosgen geomorphic characteristics of either individual stream segments or longer reaches that have been grouped into stream types beginning with the most downstream section of the stream. Figure 2 illustrates the classification of the stream segments assessed on Unnamed Creek.

**RM 0.0 – RM 0.1**
This lower reach of this stream is located at the northern termination of Tahoe Ski Bowl Way. The gradient is rather flat and the flood plain widens to include a small side channel to the north with sparse vegetation between the two channels. Based on the low entrenchment, low width-depth ratio; this is an **E3** stream type.

**RM 0.1 – RM 0.2**
This reach is moderately entrenched, moderate width-depth ratio **B2a/B3a** channel type that is boulder to cobble dominated.

**RM 0.2 – RM 0.3**
The section of Unnamed Creek is very steep, highly entrenched, and has a low width-depth ratio. Boulders are dominant along with bedrock exposures, which are indicative of the high transport capacity of the **A1a+/A2a+** channel type.

**RM 0.3 – RM 0.6**
A moderate entrenchment ratio and width/depth ratios classify this segment as a **B1a/B2a/B3a** stream type with boulders and cobbles dominating the bed material and areas of exposed bedrock between RM 0.5 and RM 0.6. Areas of mass wasting and unstable slopes were observed in this reach and the high gradient will effectively transport sediment to the lower reaches.

**RM 0.6 – RM 0.7**
The stream channel is first evident in this upper portion of the watershed and is very shallow in depth and does not support riparian vegetation. Based on the low entrenchment ratios this area falls into the **E4/E5** stream types, but have gradients greater than 4%. Gravel and sand dominate the bed material.

Montgomery-Buffington

The majority of the Unnamed Creek has Step-Pool features with steeper areas showing cascade features and bedrock exposures. The gradient of the stream is lower in the most downgradient and upgradient reaches, which have led to a Plane-bed bedform.

This stream is a transport stream type that delivers sediment to the lowest reach, which acts as a response type stream.

4.4.2 Channel Condition Assessment

The Unnamed Creek had banks in good condition with the exception of the banks between RM 0.4 and RM 0.6, where the banks had little or no vegetation along the steep slopes of this area. In a few small segments in this area, both banks had erosional features such as slope failure, undercut banks, loose soil, and exposed tree roots.

Four dirt roads cross this creek and various measures have been taken to control the creek in these areas, including culverts, hay bales, and riprap material. Despite these controls, the channel condition downstream from each of the road crossings exhibits erosional features and debris.

Figure 4 identifies the stream segments with varying channel conditions.

## 4.5 SURFACE WATER SAMPLING

### 4.5.1 Baseline Surface Water Sampling

Kleinfelder conducted surface water sampling activities in October 2006, March 2007, May 2007, and September 2007. One of the objectives of this sampling is to determine and track changes in water quality as it enters the HMR property and compare it to the water as it leaves HMR property. The following sections describes the initial results and trends noted, but this data should be considered baseline and preliminary and continued sampling events will lend to a clearer understanding of the water quality conditions associated with the HMR property.

The following table outlines the relationship of the sample location to the HMR property lines. The locations of these samples are shown on Figure 1.

| Stream Name | Upstream Sample | Midstream Sample | Downstream Sample |
|---|---|---|---|
| Madden Creek | SW-9 | SW-15 | SW-2 |
| Ellis Creek | SW-10 | SW-8, SW-7 | SW-14 |
| Quail Lake Creek | SW-3 | -- | SW-6 |
| Tributaries to Quail Lake | -- | -- | SW-4, SW-5 |

Western Environmental Testing Labs of Sparks, Nevada analyzed the samples from HMR. Water quality objectives (WQO) used in this comparative analysis are from the California Regional Water Quality Control Board's (Regional Board) *Basin Plan* for the Lahontan Region and more specifically for the Tahoe Basin. Within this document, certain water bodies within the Lake Tahoe Hydrologic Unit had specific water quality objectives. Madden Creek was included in this list for the following constituents: total dissolved solids (TDS), chloride, total nitrogen, total phosphorus, and iron.

The Regional Board also issued Board Order R6T-2005-0007, entitled *Updated Waste Discharge Requirements and National Pollutant Discharge Elimination System for Permit No. CAG616002 for Discharges of Storm Water Runoff Associated with Construction Activity Involving Land Disturbance in the Lake Tahoe Hydrologic Unit*. This document sets maximum concentration levels for discharge into surface waters for the following additional analyzed constituents: turbidity and grease and oil.

The following sections summarize the results for each constituent analyzed and whether any preliminary trend in the data was present.

Chloride

Chloride concentrations in all of the October, 2006 samples analyzed exceeded the WQO of 0.1 milligrams per liter (mg/L) with a maximum concentration of 2.6 mg/L in a tributary to Quail Lake (SW-5). Chloride concentrations also exceeded the WQO in one sample in March, May, and September at different locations.

Possible anthropogenic sources of chloride are septic waste, wastewater treatment plant effluent, industrial waste, animal waste, fertilizer, road salting for de-icing of roadways, and produced water from oilfield operations. Possible natural sources of chloride are precipitation and geologic units containing chloride. These natural chloride sources could possibly be located upstream at great distances or near the surface-water sampling sites. Due to the consistent levels and still relatively low concentrations of chloride in the water samples, it appears that the source of chloride is from natural sources.

Nitrogen

Kleinfelder analyzed the surface water samples for nitrite nitrogen, nitrate nitrogen, total kjeldahl nitrogen, and total nitrogen (TN) to separate potential anthropogenic sources from natural sources. Both nitrate nitrogen and nitrite nitrogen are typically derived from fertilizers, wastewater disposal/septic systems, sewage treatment system outfalls, sewage treatment bypass outfalls, and domestic pet excreta. Total kjeldahl nitrogen is the sum of organic nitrogen and ammonia, which is typically derived from sewer and manure discharges into a water body. TN is the sum of inorganic and organic nitrogen. The organic-nitrogen components of total nitrogen are typically derived from soil, plant and animal material. The inorganic sources are most commonly fertilizers. Based on the low levels of nitrite, nitrate, and total kjeldahl nitrogen, it appears that the source of nitrogen detected in small quantities in the samples is from a natural source such as atmospheric loading, soil, or plant and animal material.

Multiple samples exceed the WQO of 0.18 mg/L for TN. The two highest TN results, 1.3 and 1.1 mg/L (SW-5 and SW-6) were collected near Quail Lake where fish and other aquatic life are abundant along with a greater surface area of water to fix nitrogen from the atmosphere.

Total Phosphorus

Phosphorus originates from a variety of sources, many of which are related to human activities. Major sources include human and animal wastes, soil erosion, detergents, septic systems and runoff from farmland or lawns. Total phosphorus (TP) includes soluble phosphorus and the phosphorus in plant and animal fragments suspended in surface water.

A few samples during each quarter had concentrations that were equal to or exceeded the WQO of 0.015 mg/L with the highest concentration of 0.077 mg/L in a tributary to Quail Lake (SW-5). These concentrations are considered low and are not at levels to cause impairment of the stream or lake.

Sulfate

Only five water samples (SW-4, SW-5, SW-6) had detectable levels of sulfate over the laboratory detection limit of 1.0 mg/L, which is also the WQO. These locations are all within the Quail Lake Creek watershed. Sampling location SW-4, which ranged in concentration from 7.3 to 11 mg/L, is downstream of Noonchester Mine. This detection may represent a naturally occurring concentration derived from the geologic formation in this area or may be from mine outwash. Sulfate minerals are common in areas mined for gold and are an indicator chemical for ore deposits. Further sampling and a field investigation of the condition of the mine, may clarify the source of this concentration.

Total Dissolved Solids

Total dissolved solids (TDS) comprise inorganic salts and small amounts of organic matter that are dissolved in water. Total dissolved solids in surface water originate from natural sources, sewage, urban and agricultural runoff, industrial wastewater and in snowy climates from deicing salts. Eight sample locations exceeded the WQO objective of 60 mg/L. Two sample locations (SW-14 and SW-16), which were collected from Ellis Creek at the culvert near the south lodge and at the south parking lot BMP location had a concentration notably over the objective at 100, 110, and 130 mg/L, respectively. Due to the deicing of the parking lots and interaction of the surface water in these locations with anthropogenic activities, this concentration may be higher than background levels.

Turbidity

Only one location (SW-5) exceeded the WQO of 20 nephelometric turbidity units (NTU) at a concentration of 50 NTU in October, 2006. Natural sources of turbidity include land-derived sand, silt, clay, and organic particles dislodged by rainfall and carried by overland flow may cloud surface water systems. Additional suspended organic matter may result from natural in-stream detritus. Particulate matter may be re-suspended from the bottom sediments by changes in the speed or direction of the water current. Turbidity is often due to excessive phytoplankton production. Phytoplankton production is enhanced when nutrients are released from bottom sediments during seasonal turnovers and changes in water current. Sediment and nutrients contributed by anthropogenic activities can substantially increase turbidity beyond natural levels. Due to the overall results, turbidity within the stream systems is at excellent levels.

Iron

Iron is a naturally occurring mineral found in parent rock and other natural sources. Approximately 50% of the sample locations that had flow had concentrations exceeding the water quality objective of 0.015 mg/L. The exceeded concentrations ranged from 0.026 to 3.2 mg/L. Quail Lake outfall (SW-3) had a high concentration of iron (3.2 mg/L) for one sampling period and one parking lot sample had an iron concentration of 1.1 mg/L. A tributary to Quail Lake (SW-5) had an elevated iron concentration from 0.3 to 0.69 mg/L. All other samples that exceeded the WQO are considered low with a maximum concentration of 0.25 mg/Land should not impact water quality.

Temperature

Temperature in the water samples collected ranged from 1.2° Celsius (C) to 13.2° C. The variation in the temperature may be affected by the location of the sample, exposure to sun, time of year, and time of day, which the measurement was collected. Long term monitoring will show trends in temperature and whether significant changes are occurring.

pH

The pH levels of the samples ranged from 6.41 to 8.28. Most of the samples were at a pH of 7.5 or below, which is well within the acceptable range for fresh water. Long term monitoring will show trends in pH levels and whether changes toward more alkaline conditions are occurring.

Dissolved Oxygen

Dissolved oxygen (DO) is a measure of dissolved oxygen gas in water, much of which comes from the atmosphere. DO levels in the samples ranged from 6.30 (SW-2) to 11.64 (SW-2). All the samples had relatively high DO concentrations, which is good for the health of fish and other aquatic life.

Electrical Conductivity

Electrical conductivity (EC) estimates the amount of total dissolved salts, or the total amount of dissolved ions in the water. EC is controlled by geology (rock types), the size of the watershed, evaporation of water, urban and agricultural runoff, and other sources. EC concentrations ranged from 24.80 to 128.90 umhos per centimeter. Long-term monitoring will provide a larger set of data with which to calculate the mean annual EC. In the Tahoe Basin, the WQO is 100 umhos per centimeter for the mean annual EC. All but two samples met the WQO for Lake Tahoe.

Flow

Flow volume ranged from 0.004 cubic feet per second (CFS) to 33.69 CFS. Flow is a highly variable measurement dependent on seasonal fluctuations as well as precipitation levels. Long term monitoring will provide a larger data set which to analyze seasonal and annual trends in each stream.

Table 5 summarizes the laboratory analytical results from the surface water samples and Table 6 summarizes the sample parameters collected in the field. The laboratory reports and Chain-of-Custody documents are included in Appendix F.

### 4.5.2 Historical Surface Water Sampling

Surface water sampling at HMR began in February, 1989; however, it wasn't until June, 1995 when more consistent monitoring began. There are six historical sampling locations; two along Madden Creek (SW-9/M-1 and SW-2/M-2), two along Ellis Creek (SW-10/E-1 and SW-14/E-2); and two near the HMR parking lots (SW-16/P-1 and SW-1/P-2), as shown in Figure 1. The constituents tested included; total nitrogen (TN) total phosphorus (TP), turbidity, and total suspended solids (TSS).

Data for each sampling station are summarized in Figures 6 through 11. The following sections describe trends from an analysis of the historical data.

A downward trend is occurring with all constituents at sample location M-1 (Figure 6). Data prior to May, 1998 was variable with extremely high and low concentrations. After May, 1998 concentrations appeared to be lower and more consistent with TP and TN values near or below the WQO, and TSS and turbidity at consistent concentrations below the WQOs.

M-1 exceeded the WQO for TN and TP in May 1996 and from 1998 through 2002 and has been below the WQO for TN since 2002. The TP concentration has also been below the WQO since 2002 with the exception of one sample in 2005. The turbidity and TSS peaked in May 2006 along with TN and TP concentrations. Independent spikes also occurred with all constituents throughout the historical data.

TN ranged from 0.01 to 0.5 mg/L (WQO at 0.18 mg/L) with the highest concentrations occurring in May, 1996 and continuously from April 2001 until June 2001. Two more peaks occurred in May and June of 2002.

TP ranged in concentrations from 0.005 to 0.11 mg/L, with the WQO at 0.015 mg/L. The highest concentrations occurred before May, 1998 with a significant drop in TP concentrations after that date. Only four samples after May, 1998 exceeded the WQO for TP.

Turbidity had a few spikes, ranging from 0.1 to 3.4 NTU, all falling below the WQO of 20 NTU. TSS ranged from 0.5 to 28 mg/L, but without a WQO, it is difficult to determine if any spikes were significant.

M-2

The TN and TP concentrations exhibited a more stable pattern with lower concentrations after 2001 (Figure 7). Only a few samples exceeded the WQO after 2001. Turbidity fluctuated throughout the data, but remained below the WQO value. TSS also showed consistent concentrations starting in 2001.

Spikes where all four constituents were at higher concentrations occurred in June 1995, May 1996, May 2001, and May 2005. Independent spikes also occurred with all constituents throughout the historical data.

TN ranged from 0.01 to 7.3 mg/L, exceeding the WQO of 0.18 mg/L multiple times. The highest concentrations occurred in May 1996, June 1998, and May 2001.

TP concentrations ranged from 0.005 to 0.1 mg/L with a WQO of 0.018 mg/L. Most of the concentrations that exceeded the WQO occurred before June 2001 with TP concentrations only exceeding the WQO four times after June 2001.

Turbidity concentrations ranged from 0.05 to 6.2 NTU, well below the WQO of 20 NTU. TSS concentrations had a wide range at this location with a range from 0.1 to 48 mg/L. Again, without a WQO it is difficult to determine if 48 mg/L is a high concentration.

E-1

After May 2004, three of the constituent concentrations began to decrease (Figure 8). All TN and TP concentrations after May, 2004 fell below the WQO. Although turbidity was always below the WQO, its numbers also decreased. TSS, however, increased slightly from the years prior to 2004.

There were two sampling events in May, 1996 where a positive correlation was present between elevated concentrations of TN and TP as existed at Madden Creek. There were also spikes with turbidity and TSS during the same time, but nothing that exceeded the WQO. There was also another spike with TP, TN, TSS, and turbidity that occurred in May, 2002. There were also independent spikes with constituents at different times.

TN had many spikes in concentration that exceeded the WQO for Madden Creek. TN varied in range from 0.01 to 0.4 mg/L, with a WQO of 0.18 mg/L. The spikes in data were May, 1996, April, 1998 through June, 2001, and then again in May and June, 2002.

TP was above the WQO during half of the sampling periods. The largest concentration occurred in May, 1996 with a concentration of 0.36 mg/L with the WQO for TP at 0.15 mg/L. Another spike occurred in June and July 1995, August 1995, January 1996, April 1996, April and May 1997, May 1998, June 1998, July 1998, May 2002, and May 2004.

There were mild spikes with turbidity throughout the years, but none that exceeded the WQO. There were mild spikes with TSS, but without a WQO, it is difficult to determine if any spikes were significant.

E-2

After June 2004, TN and TP concentrations exhibited a downward trend with only one concentration of TN exceeding the WQO after 2004 (Figure 9). Turbidity and TSS, however, did not experience the same trend. This sampling location also had spikes in the data where elevated concentrations of all four constituents were present. These spikes occurred in May, 1996 as well as May, 2005. There were also other spikes in the data, but no other event where all four constituents spiked together.

TN ranged from 0.01 to 0.46 mg/L with the WQO at 0.18 mg/L. The higher levels of TN occurred during May 1996, May 2001, May and June 2002, and May 2005. TP levels ranged from 0.005 to 0.25 mg/L with the WQO at 0.015 mg/L.

TP levels exceeded the WQO for over half of the sampling events. The most significant peak occurred with the other constituents in May 2005.

Turbidity concentrations ranged from .05 to 6.5 NTU which all fell below the WQO of 20 NTU. There were mild spikes with TSS, but without a WQO, it is difficult to determine if any spikes were significant. TSS concentrations ranged from 0.5 to 180 mg/L which seems to be a large fluctuation, but again it is difficult to determine if these levels are significant or not

P-1

There was one sampling period in May 2004, where all constituents exceeded their WQO (Figure 10). Because there are such large gaps in the data collection at this location, very little information is available to detect any trends.

TN was at or above the WQO 25% of the time and ranged from 0.025 to 0.43 mg/L with the WQO at 0.015 mg/L.

All of the samples collected for TP exceeded the WQO of 0.015 mg/L with concentrations ranging from 0.06 to 0.88 mg/L.

Turbidity exceeded the WQO approximately 50% of the time and ranged from 0.1 to 120 NTU with the WQO at 20 NTU. TSS ranged from 1 to 374 mg/L and turbidity.

P-2

The start of a downward trend is becoming evident within the last three years among all constituents. For TN, concentrations began to decrease after April 2002, TP after May 2004, turbidity after May 2004 and TSS after May 2004.

There is also a gap in data collection between 1997 and 2001; therefore, detecting long term trends is difficult to establish (Figure 11). Like P-1, the sampling period showing all four constituents at high concentrations was in May, 2004.

TN exceeded the WQO from 2001 through 2004 and has been below the WQO since then. TN ranged from 0.01 to 1.0 mg/L with the WQO at 0.015 mg/L.

All but two of the samples collected for TP exceeded the WQO of 0.015 mg/L with concentrations ranging from 0.01 to 0.34 mg/L. TP concentrations decreased below the WQO in 2005 and 2006.

Turbidity has been below the WQO since 2004 ranging from 2.6 to 98 NTU with the WQO at 20 NTU. TSS ranged from 2.5 to 320 mg/L.

# 5.0 CONCLUSIONS AND RECOMMENDATIONS

## 5.1 RESTORATION POTENTIAL OPPORTUNITIES

Several restoration opportunities were identified on the HMR property. The following summarizes the opportunities in each of the streams located on the HMR property.

### Madden Creek

Various locations along Madden Creek were identified to have unstable banks and fair-poor channel conditions between RM 0.2 – RM 1.5. Revegetation and other measures improving slope stability in these areas may reduce sediment loading in Madden Creek.

### Ellis Creek

Various locations along Ellis Creek were identified to have unstable banks and fair-poor channel conditions. The majority of these areas are located between RM 0.2 and RM 0.7 and a smaller section between RM 1.1 and RM 1.2. Revegetation and other measures improving slope stability in these areas may reduce sediment loading in Ellis Creek. The culvert located at the south lodge under Tahoe Ski Bowl Way has been identified by Entrix as a potential area to improve fish passage. The culvert does not meet California Department of Fish and Game screening criteria and is a potential depth barrier at low flows.

### Quail Lake Creek

No restoration opportunities were identified along Quail Lake Creek within the HMR property.

### Unnamed Creek

The lowest portion of this stream within the HMR property is transected by two dirt roads adjacent to an area cleared of trees. This segment of the stream located between RM 0.0 and RM 0.2 would benefit from improving the riparian habitat along the creek. This would decrease sediment loading and provide a natural filter for sediment being transported to this reach from upgradient. By adding riparian vegetation to this section, the water quality would improve prior to exiting the HMR property. One of the source areas for sediment is the poor bank condition located between RM 0.4 and RM 0.6. Revegetation and bank stability measures which may include recountouring the slopes in this area would greatly reduce mass wasting and erosion in this area.

Figure 5 shows the locations of each of these areas along the stream courses and photographs of the areas identified for restoration are included in Appendix G.

## 5.2 SURFACE AND STORMWATER MONITORING

### Baseline Sampling

- Chloride: Chloride concentrations were generally below the WQO with the exception of the October, 2006 samples and three other samples.
- Nitrogen: Multiple samples exceed the WQO for TN. The two highest TN results were collected near Quail Lake.
- Phosphorus: A few samples during each quarter had concentrations that were equal to or exceeded the WQO with the highest concentration in a tributary to Quail Lake.
- Sulfate: Five water samples within the Quail Lake Creek watershed contained sulfate over the WQO. The highest concentrations were collected downstream of the Noonchester Mine.
- Total dissolved solids: Eight sample locations exceeded the WQO. Two sample locations from Ellis Creek at the culvert near the south lodge and at the south parking lot BMP location had the highest concentrations. Due to the deicing of the parking lots and interaction of the surface water in these locations with anthropogenic activities, this concentration may be higher than background levels.
- Turbidity: Only one sample exceeded the WQO.
- Iron: Approximately 50% of the sample locations that had flow had concentrations exceeding the WQO. Quail Lake outfall had a high concentration of iron and one parking lot sample had a moderate iron concentration. The other samples with elevated iron were within the Quail Lake watershed and may be related to the Noonchester Mine.

### Historical Sampling

- M-1: M-1 exceeded the WQO for TN and TP in May 1996 and from 1998 through 2002 and has been below the WQO for TN since 2002. The TP concentration has also been below the WQO since 2002 with the exception of one sample in 2005. The turbidity and TSS peaked in May 2006 along with TN and TP concentrations.

- M-2: The TN and TP concentrations exhibited a more stable pattern with lower concentrations after 2001. Only a few samples exceeded the WQO after 2001. Turbidity fluctuated throughout the data, but remained below the WQO value. TSS also showed consistent concentrations starting in 2001. Spikes where all four constituents were at higher concentrations occurred in June 1995, May 1996, May 2001, and May 2005.
- E-1: After May 2004, three of the constituent concentrations began to decrease. All TN and TP concentrations after May, 2004 fell below the WQO. Although turbidity was always below the WQO, its numbers also decreased. TSS, however, increased slightly from the years prior to 2004. Spikes occurred in May, 1996.
- E-2: After June 2004, TN and TP concentrations exhibited a downward trend with only one concentration of TN exceeding the WQO after 2004. Turbidity and TSS, however, did not experience the same trend. Spikes occurred in May, 1996 as well as May, 2005.
- P-1: There was one sampling period (May 2004) where all constituents exceeded their WQO. TN was at or above the WQO 25% of the time and TP exceeded the WQO in all sampling events. Turbidity exceeded the WQO approximately 50% of the time.
- P-2: The start of a downward trend is becoming evident within the last three years among all constituents. For TN, concentrations began to decrease after April 2002, TP after May 2004, turbidity after May 2004 and TSS after May 2004. The sampling period showing all four constituents above the WQO was in May, 2004. TN exceeded the WQO from 2001 through 2004 and has been below the WQO since then. TP exceeded the WQO for most sampling events but decreased below the WQO in 2005 and 2006. Turbidity has been below the WQO since 2004.

## 5.3 RECOMMENDATIONS

### Noonchester Mine

Kleinfelder recommends a field investigation to confirm the current status of the mine to determine whether surface water is flowing over tailings and mine waste which is transmitting residual constituents to the tributary to Quail Lake.

Quarterly Surface Water Sampling

Kleinfelder also recommends that surface water continue to be monitored at the six permit locations in accordance with Monitoring and Reporting Program No. 95-86A1.

# 6.0 REFERENCES


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