

North Canyon Watershed Assessment

Lake Tahoe Nevada State Park

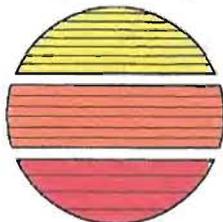
March 2002



Prepared For:

Nevada Tahoe Resource Team
Division of State Lands
333 S. Carson Meadow #44
Carson City, Nevada 89701

Prepared By:



ENGINEERING ✧ PLANNING ✧ RESOURCE MANAGEMENT

RESOURCE CONCEPTS, INC.

340 N. Minnesota St. • Carson City, NV 89703-4152 • (775) 883-1600 • Fax: (775) 883-1656
212 Elks Point Rd, Suite 41 • Zephyr Cove, NV 89448 • (775) 588-7500 • Fax: (775) 589-6333

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EXECUTIVE SUMMARY

The Nevada Tahoe Resource Team (NTRT) initiated this project to assess watershed conditions in the North Canyon Watershed within the Lake Tahoe State Park boundary. The project area encompassed approximately five square miles, and four subwatersheds identified as: Upper North Canyon, Spooner Creek, Lower North Canyon, and North Canyon below State Route 28. North Canyon Creek supports a residential fishery.

A basemap prepared from existing aerial photographs included a surveyed control line. Fifty control points were surveyed with GPS units, monumented with steel nails, and staked with wooden lathe and flagging along the Marlette Trail Road. The stakes served as reference points for verifying locations on the aerial photographs during the field reconnaissance. Coordinates for areas identified for treatment were added to the basemaps included with this report.

Resource Concepts, Inc (RCI) developed the project approach in cooperation with the NTRT. The field reconnaissance was conducted during the fall after leaf drop for better visibility of the stream channels, substrates, and banks. The initial reconnaissance identified general Rosgen stream types to provide an overview of the geomorphology, hydrology, soils, vegetation, and previous impacts to the canyons and meadows that predominate the landscape. Areas observed during the initial reconnaissance with potential stream function problems were identified for further evaluation.

Proper Functioning Condition analysis was used to evaluate the interactions between stream hydrology, vegetation, and erosion and determine the current functional status of individual stream reaches. Hydrologic analyses of each subwatershed area were completed to quantify various measures of high flow conditions.

Review of historical information including the archaeological report and the decreed water rights provided critical information necessary to interpret the channel adjustments observed in the field. During the Comstock era water was diverted from Upper North Canyon from the Secret Harbor watershed to the Lower North Canyon watershed for downstream irrigation and log fluming activities.

While no evidence of weirs for water diversion were observed in the field, the effects of the additional diverted flows to the lower North Canyon watershed were evident. Increased channel entrenchment, gullies, and sediment deposits were observed in the Lower North Canyon watershed that were not seen above the confluence with Secret Harbor.

Flows from upper North Canyon are currently conveyed to Secret Harbor, and have been for quite some time. As far as all records show, this is the original Secret Harbor watershed alignment prior to the Comstock era. North Canyon Creek actually originates below the divide for the Secret Harbor watershed and is fed by surface springs and seeps. Several tributary drainages flow into North Canyon with cumulatively increasing flows downstream.

Under the present conditions, the majority of the lower North Canyon stream channel is in proper functioning condition. It is predominantly well vegetated and stable. The channel shows evidence of past instability and subsequent healing under the reduced flow conditions that currently prevail. However, several small headcuts throughout the channel present potential risks for degradation of meadows in the lower North Canyon watershed.

Recommendations for treatment of the functional-at risk areas and other projects recommended to restore riparian functions have been developed and prioritized by RCI and the NTRT. However, the most important recommendation addresses the need to restore the hydrologic divide between the Secret Harbor watershed (including Upper North Canyon) and the Lower North Canyon watershed to assure that peak flows do not exceed the reestablished channel morphology and initiate a repeated episode of down cutting and excessive erosion.

1.0 Introduction

The North Canyon Watershed Stream Assessment project was initiated by the State of Nevada, Department of Conservation and Natural Resources, Nevada Tahoe Resource Team (NTRT). Resource Concepts, Inc. (RCI) was retained by the NTRT to conduct a field-based stream assessment focused on identifying excessive erosion and sediment generation occurring along the road and stream channels in the Lake Tahoe Nevada State Park, Spooner Unit.

The objective of this project was to inventory, map, describe, and prioritize stream restoration projects within portions of the North Canyon and Secret Harbor watersheds that lie within the Lake Tahoe Nevada State Park boundary. Through meetings and discussions with the NTRT the restoration objective was further defined as restoring "Proper Functioning Condition." A stream channel is in proper functioning condition when adequate vegetation, landform, or large woody debris is present to:

- Dissipate stream energy associated with high water flow, thereby reducing erosion and improving water quality;
- Filter sediment, capture bedload, and aid floodplain development;
- Improve flood-water retention and groundwater recharge;
- Develop root masses that stabilize streambanks against cutting action;
- Develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and
- Support greater biodiversity. (USDI 1998).

2.0 Background

Lake Tahoe State Park is located east of Lake Tahoe in Carson City and Douglas County, Nevada (see Figure 1). The topography is mountainous with occasional meadow openings along the main drainage channels. Elevations range from 5,300 feet at the confluence with Slaughterhouse Canyon to 9,200 feet at Snow Valley Peak.

The watershed is primarily characterized as mixed coniferous forest, dominated by Jeffrey pine (*Pinus jeffreyi*). A good diversity of understory shrub species including snow brush (*Ceanothus velutinus*), squaw carpet (*Ceanothus prostrates*), snowberry (*Symphoricarpos* sp.) and chinquapin (*Canstanopsis* sp.) occur throughout the forested areas. Aspen stands (*Populus tremuloides*) are primarily associated with tributary drainages and include associations with lodgepole pine (*Pinus contorta*), willow (*Salix* sp.), alder (*Alnus tenuifolia*), currant (*Ribes* sp.), thimbleberry (*Rubus pariflorus*), horsemint (*Agastache* sp.), horsetail (*Equisetum* sp.), false hellebore (*Veratrum californicum*), and delphinium (*Delphinium* sp.). Meadows are generally densely covered with a diversity of species including redtop (*Agrostis* sp.), sedges (*Carex* sp.), wiregrass (*Juncus balticus*), dock (*Rumex* sp.), *Sidalcea* sp., and other herbaceous species.

The project area encompasses portions of four separate subwatersheds as shown in Figure 2. Upper North Canyon, Lower North Canyon, and Spooner Lake are each similar in size: Upper North Canyon 1.5 square miles, Lower North Canyon 1.4 square miles, and Spooner Lake 1.1 square miles. North Canyon subwatershed below State Route 28 (SR28) is approximately 0.7 square miles, totaling approximately five

square miles for the entire project area. The main stream channel is 5.2 miles long. The North Canyon watershed ultimately drains into lake Tahoe by way of Secret Harbor Creek and Slaughterhouse Canyon Creek.

2.1 Historical Uses

During the Comstock era, the water resources of North Canyon and Marlette Basin were exceedingly valuable and were key to successful wood and water transport by Carson Tahoe Lumber and Fluming Company, the largest lumber and fluming company that operated within the Tahoe basin. A complex network of flumes, dams, reservoirs, and ditches changed the hydrological character and natural drainage patterns of North Canyon and adjoining watersheds.

There were several significant changes to the North Canyon watershed. The first occurred as early as 1866 when water from the Secret Harbor watershed was diverted into the North Canyon watershed. The headwaters of North Canyon Creek occur near a low divide near Secret Harbor Creek. A cut was created to capture the Secret Harbor flows and increased the North Canyon watershed from 2.5 square miles to 4 square miles, a 60 percent increase.

The second, less significant modification occurred in the 1940s when a dam was built to enlarge the irrigation reservoir and create Spooner Lake. The watershed feeding Spooner Lake comprises approximately 1.1 square miles, just over 25 percent of the North Canyon watershed above SR28. NDOW rebuilt the dam in the 1980s to create a recreational fishery. The dam is operated to release water in the fall for access to cross country ski trails in the winter. Water is released in the spring to maintain the lake level at a negotiated elevation to avoid flooding of cultural areas. Water releases from Spooner Lake flow through a constructed irrigation ditch along the south side of Spooner Meadow.

A thorough description of anthropogenic disturbances within the North Canyon and Marlette Basin is provided in a recent archaeological report prepared for the NTRT (Lindstrom, 2000).

2.2 Water Rights

The waters of North Canyon Creek and Secret Harbor Creek were decreed by Federal District Court in 1930 among the users of record at the time to Fulstone, The Glenbrook Company, and The Bliss Company, each with a priority of 1872. Important reference was made in the decree to a dam located in the W $\frac{1}{2}$ of the SE $\frac{1}{4}$ of Section 25, T15N, R18E to divert flows for Fulstone and The Glenbrook Company.

Fulstone was granted one-half of Secret Harbor Creek, not to exceed 15 cubic feet per second (cfs) from October 15 to May 1 of the following year. The Fulstone allocation was allowed to be diverted into the North Canyon Creek channel with the right to use the direct flow, and/or impound or store water in a reservoir situated in Section 1, T14N R18E MDM (Spooner Lake) for irrigation of agricultural lands in and around Spooner Meadow.

Fulstone was also adjudicated all the waters of North Canyon Creek and its tributaries flowing into the North Canyon Channel, all the waters of Spooner or Spooner Meadows Creek, and all the waters of Spooner Springs.

The Glenbrook Company was given the right to one-quarter of the flow of Secret Harbor Creek, not to exceed 7.5 cfs from October 15 to May 1 of the following year. These waters were also allowed to be diverted to the North Canyon Creek channel, and could be stored in a reservoir situated in the NE $\frac{1}{4}$ of Sec 25 T15N R18E, stored in a reservoir in the SE $\frac{1}{4}$ of Sec 25 T15N R18E, or could be used directly.

The Bliss Company was granted the remaining flow in Secret Harbor Creek which was not diverted to the North Canyon channel and was allowed to be stored in a reservoir situated in the SW $\frac{1}{4}$ of the SE $\frac{1}{4}$ and the SE $\frac{1}{4}$ of the SW $\frac{1}{4}$ of Section 26, T15N, R18E and/or in a reservoir in the SE $\frac{1}{4}$ of the SE $\frac{1}{4}$ of Sec. 23 T15N R18E, and/or in a reservoir situated in the NW $\frac{1}{4}$ of the NE $\frac{1}{4}$ of Sec 26, T15N R18E.

The Glenbrook Company and The Bliss Company were ordered to install and maintain a box and a weir near the dam to measure and divert permitted water to North Canyon Creek.

The Fulstone property and water rights are now under the management of the Nevada Division of State Parks. The U.S. Forest Service currently owns the Bliss Company property, and 59 percent of the Glenbrook property. The remaining 41 percent of the Glenbrook property remains in Glenbrook ownership.

The decreed water right dated July 2, 1930 for Secret Harbor Creek and North Canyon Creek is included as Appendix A.

2.3 Fisheries

The TRPA Threshold Carrying Capacity Study identified North Canyon Creek as a residential fishery (TRPA 1982, Appendix D). No spawning migration occurs between Lake Tahoe and North Canyon Creek. As a residential fishery it was rated as being in excellent condition in 1982 and 1996. Suggestions for further improving fishery condition included:

- Improving substrate
- Improving channel morphology
- Improving shade canopy
- Improving bank and channel stability

In August 2000 TRPA conducted a field investigation of North Canyon Creek to identify Environmental Improvement Needs. An excerpt from that report pertaining to this project area included the following observations:

- Within the Spooner Meadow reach there is little riparian cover other than overhanging grasses and the substrate is composed of almost entirely of sands.
- Just below the confluence with Secret Harbor Creek there are two very old log dams that should be removed to prevent further erosion problems.

3.0 Methods

The condition assessment, interpretation of data, and project prioritization for the North Canyon watershed evaluation was a collaborative process between the NTRT and RCI Watershed Team. Specialists directly involved with the project are identified in Appendix B.

3.1 Mapping

The basemap for this project was developed from digital color aerial photographs provided by the NTRT. The aerial coverage for the project area was not flown to a particular scale as no ground control was used to rectify the photo. USGS 7.5' topographic maps were used to identify watershed boundaries and analyze hydrology for North Canyon, Secret Harbor, and Spooner Creeks. However, photographic distortion did not allow for complete correlation between the aerial photographs and the existing USGS topographic maps.

Fifty control points were surveyed with GPS units, monumented with steel nails, and staked with wooden lathe and flagging along the Marlette Lake Road. The stakes served as reference points for verifying locations on the aerial photographs during the field reconnaissance, and were used to bring the uncontrolled aerial photographs into a standardized coordinate system. Aerial photos were enlarged to a scale of 1" = 200' for use in the field. Potential treatment areas identified during the field analyses were documented with GPS coordinates and marked on the aerial photos. All lathe and flagging were removed from the project area at the end of the field season. The controlled baseline is documented and can be reestablished for use on future projects.

The aerial photographs were adjusted to correlate with the Nevada State Plane coordinate system and converted to ARCVIEW files that are included with this report and described in APPENDIX C. The ARCVIEW files include coordinates for the control points, coordinates for the project areas, descriptions of the project areas, descriptions of treatment recommendations and alternatives, and project ranking priority. ARCVIEW maps are included in Appendix F.

3.2 Watershed Assessment

The field reconnaissance and channel evaluations were conducted in September and October. Observations of the stream were scheduled during the fall period to facilitate observation of the channel and banks during and after leaf drop when foliage cover was reduced. General Rosgen stream types were identified during the initial field reconnaissance to provide an overview of the geomorphology, hydrology, soils, vegetation, and previous impacts to the canyons and meadows that predominated the landscape. A general description of the Rosgen Stream Classification System is included as Appendix G. Bank failures, head-cuts, channel incisement, lateral cutting, and hydraulic control structures were mapped on aerial photos and GPS points were recorded at potential functional problem areas.

The potential problem areas identified during the initial reconnaissance were evaluated according to procedures developed by land management specialists to evaluate the interactions between stream hydrology, vegetation, and erosion and determine the current functional status of individual stream reaches.¹ Analysis of Proper Functioning Condition focused entirely on the current status or condition of the riparian vegetation, woody debris, stream energy dissipation, and floodplain functions. Through these procedures, areas of excessive erosion, sedimentation, lack of adequate vegetation, noxious weeds, and active entrenchment, incision, and head-cuts are classified as "functional-at-risk" or "nonfunctional."

The RCI Watershed Team worked collaboratively to make the appropriate interpretations of the PFC field indicators on a site-specific basis.

3.3 Hydrologic Analysis.

Hydrology calculations for North Canyon Creek were developed for several different scenarios taking into account man-made features that can alter the contributing watershed area. Peak flow predictions helped in evaluation of the stream by:

- Providing a "bankfull flow" estimate to assist with interpretation of channel dimensions, and,
- Illustrating how human factors could contribute to instability of the stream channel both historically and in the future.

¹ A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas RIPARIAN MANAGEMENT TECHNICAL REPORT TR 1737-15 1998 was developed by a working team of riparian scientists from the US Forest Service, the Natural Resources Conservation District, and the Bureau of Land Management.

Contributing Area. The North Canyon Creek watershed has been divided into four separate areas for hydrologic evaluation. The drainage areas were determined by utilizing the USGS Glenbrook and Marlette Quadrangles, 7.5 minute topographic series.

- Upper North Canyon Creek (1.5 sq. miles) – The north end of the channel and watershed up-gradient of the fork to Secret Harbor Creek. Though this watershed presently drains to Secret Harbor Creek, historically it was diverted at this point to Spooner Meadow and Slaughterhouse Canyon for irrigation. The diversion routinely operated from October to May.
- Lower North Canyon Creek (1.4 sq. miles) – The channel and watershed from the fork at Secret Harbor Creek to the lower end of Spooner Meadow near SR28.
- Spooner Lake (1.1 sq. miles) – The contributing watershed up-gradient of the dam at Spooner Lake. Water is released at the dam in the spring and fall to maintain certain water level elevations. The lake and dam have been present since the Comstock era.
- North Canyon Creek below SR28 (0.6 sq. miles) – The watershed down-gradient of Spooner Meadow and SR28 to the State Park Boundary. The park boundary is just up-gradient of Prey Meadow and the confluence with Slaughterhouse Creek.

The watersheds are typically steep with 20 to 40 percent slopes and wooded, except through Spooner Meadow where slopes are 2 to 5 percent and vegetation is typically composed of grasses and herbaceous species. The watersheds are almost entirely undeveloped except for SR28 and the unpaved roads accessing Marlette and Spooner Lakes.

Calculations. A combination of methods for generating peak flow values was used in evaluating the North Canyon Creek watershed. This included regional regression equations developed by the USGS from stream gauging data in two studies and comparison to local stream gauging data. The NRCS TR55 method was not used because it predicted excessively high flows that did not correspond well to either regional or local peak flow data.

The USGS has published regional regression equations for calculating peak flows at various return intervals for ungauged watersheds. These equations are developed from statistical analysis of stream gauging data from various regions. Both regions evaluated in the USGS publications overlap the North Canyon Creek watershed area.²

The referenced regional regression equations utilize similar, but slightly different definitions for the variables specific to the ungauged watershed to be evaluated. The regional regression methods were used to predict peak flow information for various recurrence intervals: 2, 25, 50 and 100 years. Bankfull discharge used to evaluate channel geometry approximates the 1.5 year recurrence interval (Rosgen, 1996). Typically the 1.5 year return interval was assumed to be 2/3 of the 2-year peak flow event.

Results were then compared to local gage data reported in both USGS studies and recently published stream flow data for Glenbrook Creek (USGS, WRIR 02-4030, 2002). The results for the Eastern Sierra Region corresponded more realistically to gage data from local streams and was therefore selected for presentation. The equation, basin characteristic variables, and coefficients are presented in Table 1.

² *Sierra Region, Magnitude and Frequency of Floods in California* USGS, WRI 77-21, 1977.

Methods for Estimating Magnitude and Frequency of Floods in the Southwestern United States. USGS Region 5. OPF Report 93-419, 1994.

Table 1. Basin characteristics and variables used in the hydrology regression analyses for the North Canyon Watershed Assessment project.

Equation for Eastern Sierras Region 5: $Q = kA^a(E/1000)^b[(L-28)/10]^c$					
Basin Characteristic Variables:					
<ul style="list-style-type: none"> • Peak Discharge, Q (cfs) • Drainage Area, A (sq. mi.) - Total upstream area • Mean Basin Elevation, E (ft.) - Average of evenly spaced grid point elevations, using minimum of twenty points per basin. • Latitude, L (decimal degrees) 					
Coefficients:					
Recurrence Interval (yr.)	k	a	b	c	Average Std. Error %
2	0.0333	0.853	2.68	4.1	135
5	2.424	0.823	1.01	4.1	101
10	28.0	0.826	0	4.3	84
25	426	0.812	-1.10	4.3	87
50	2030	0.798	-1.71	4.4	91
100	7000	0.782	-2.18	4.6	95

3.4 Treatment Recommendations

The initial concepts for bio-technical treatment of problem areas were formulated in the field during the site assessment with input from the entire Watershed Team. Treatment recommendations were further developed with input from the NTRT. The Team focused on biotechnical treatments that complimented the natural appearing landscape and ecological context. In some cases alternative treatment recommendations were presented that represented a range of restoration potential.

3.5 Project Prioritization

Each of the projects recommended for treatment as a result of the field assessment were evaluated to prioritize their overall beneficial potential. Five project ranking criteria were developed to prioritize the recommended projects and in some cases project alternatives. The criteria developed by RCI were presented to the NTRT and revised to directly reflect current and future objectives. The evaluation process was developed as a quantitative system whereby the projects receiving the overall highest score would represent the highest priorities for implementation. The project ranking criteria are described in Table 2.

Table 2. Project prioritization framework for the North Canyon Watershed Assessment Project.

Project Ranking Criteria	Score	Description of Score
Timeframe of Measurable Results.	1	The effects of implementing the project may not be realized in the immediate future.
	2	The effects of implementing the project are foreseeable but not immediate.
	3	The effects of implementing the project will be realized right away.
Effects on Lake Tahoe water quality.	1	The project will have little or no effect on water quality in Lake Tahoe.
	2	The project will have some effect on water quality in Lake Tahoe.
	3	The project will have a significant effect on water quality in Lake Tahoe.
Ratio of accessibility and environmental impact to benefits of the project	1	The disturbance associated with doing the project more than offsets the benefit from doing the project, primarily due to accessibility.
	2	Some disturbance will be associated with doing the project, but the benefits out-weigh the impact.
	3	The project is readily accessible and the disturbance will be minor.
Likelihood to restore proper functioning condition (PFC).	1	The result of the project does little to further PFC.
	2	The result of the project achieves some aspects of PFC restoration.
	3	The result of the project is consistent with restoring PFC.
Potential to improve or enhance fishery.	1	The result of the project has little or no affect on fisheries.
	2	The project will enhance habitat OR remove an obstruction to migration.
	3	The project will enhance habitat AND remove an obstruction to migration.

4.0 Results

4.1 General Stream Reconnaissance

North Canyon Creek within the project area extends from the State Park boundary by Prey Meadow to the Marlette Lake access road at the north end of the Park. At the downstream, west park boundary the stream enters Prey Meadow transitioning from a 'B' stream type up-gradient to an 'E' stream type down-gradient. The channel at the boundary is entrenched but stabilized with herbaceous vegetation and willow. Above the meadow the valley and stream slopes steepen and vegetation transitions from herbaceous vegetation cover to woody riparian species and conifers. The 'B' stream type is somewhat entrenched with minor bank erosion and numerous small drops over logs and boulders. The stream channel and bank have accumulated woody debris.

The stream gradient continues to increase toward SR 28 becoming an 'A' stream type. Large granitic boulders and bedrock outcrop typify the 'A' stream type. The boulder and outcrop features are laterally extensive and continue up the sides of the canyon. These geologic features create relatively abrupt waterfalls and the water disappears under the boulders in some locations. There is a small meadow immediately upstream of the boulders with a very short stretch of meadow and 'E' stream type with aspen and willow overstory and a well vegetated grassy channel. The channel gradient then increases and resumes an 'A' channel as it nears SR28. This reach is heavily wooded with conifers.

At SR28 the channel parallels the road both above and below the highway. There are two culverts; one under the highway and one parallel to the highway on the upstream side. The channel on the upstream side of SR28 is low gradient and well vegetated with herbaceous plants. Down-gradient from SR28 the highway embankment binds one side of the channel. The stream is 10 to 20 feet from the edge of road.

As the stream crosses the lower end of Spooner Meadow it is an entrenched, well stabilized historic gully with an 'E' stream type reestablished in the bottom. The channel is well vegetated with herbaceous meadow species. Near the middle of the meadow the entrenchment becomes more pronounced and the top edge of the north bank becomes sparsely vegetated for widths of one to five feet. The channel and remaining meadow remain well vegetated. The area shows evidence of a small in-stream headcut and small lateral headcuts where water diverted through irrigation ditches reenters the main channel (Treatment Areas 1 and 2).

The confluence with the Spooner watershed occurs toward the upper end of Spooner Meadow. An eroding irrigation ditch on the south side directs water from Spooner Lake toward the middle meadow (Treatment Area 3).

A second irrigation ditch along the northwest edge of the meadow spreads water across the eastern half of Spooner Meadow. Multiple overflow channels lead to various marshes in the lower meadow. This irrigation ditch is very well vegetated with willow and provides additional structural habitat diversity on the edge of the coniferous uplands. The uppermost end of Spooner Meadow is characterized by widespread sediment deposition. The area is sparsely revegetated and is characteristic of a dry meadow lacking surface soil moisture throughout the duration of the growing season.

As the irrigation ditch intersects the natural stream channel, there is a short reach of eroding bank below a stabilized headcut (Treatment Area 4). The entrenched channel is densely matted with willow. A headcut is stabilized with a dense willow root mass across the channel.

Above the headcut a well vegetated 'E' stream type traverses a small meadow. Beyond the meadow the stream courses through the canyon transitioning between 'A' and 'B' stream types with coniferous overstory. Aspen occupies several tributary corridors throughout the canyon area. The channel is stable throughout this reach. Although it is intermittently entrenched from past hydrologic events its current

condition includes dense riparian shrub root masses and accumulated woody debris throughout the majority of its distribution.

At the upper end of the canyon an abrupt transition occurs to a meadow. The transition point is distinctly marked by a precariously stable headcut at the lower end of the meadow. Dense overhanging grass sod covers buried woody debris suggesting a beaver or debris dam may have assisted in forming the meadow (TREATMENT AREA 8). Several productive springs support the meadow.

Above this meadow, the channel gradient again increases to a 'B' stream type with coniferous overstory. The channel is deeply entrenched (greater than 20 vertical feet) as it passes through a feature referred to as the "Grand Canyon." The stream channel in the bottom of the gully has widened and stabilized under reduced flow conditions that have prevailed over the last several decades. However, the upper cut slopes of the gully are bare or poorly vegetated. The top edge of the gully is an easily eroded vertical cut in sandy soils that continues to provide direct sediment input to the stream (Treatment Area 9).

Up-gradient of the Grand Canyon is a well vegetated meadow / marsh with dense herbaceous cover and well established willow clusters. At this time (and evidently for several decades past) there is no direct surface flow from the meadow to North Canyon Creek. The main channel from upper North Canyon Creek veers east and drains to Secret Harbor Creek. This is a very stable 'E' channel, transitioning to a very stable 'B' channel as it exits the state park.

Historically there was a structure at this meadow to divert water down to Lower North Canyon into Spooner Meadow and Slaughterhouse Canyon. Some remnants of an earthen dam and ponding area remain at this location but have not impounded water for many years. No evidence of a weir was found.

Above the meadow the stream transitions to steeper gradients and a long reach of 'A' / 'B' stream types. The channel is generally well vegetated with willows and alder.

The upper meadow at the north boundary of the project area is a good reference reach for the 'E' meadow stream type. The channel is deep, narrow, densely sodded and shaded with occasional clumps of willow, and has good access to its floodplain. The substrate is cobble and gravels as opposed to sand that typified the lower North Canyon areas.

4.2 Hydrology

The configuration of a stream channel and its floodplain are closely linked to seasonal peak flow, in addition to vegetation slope and many other factors. Rosgen identifies two measures of peak flow for hydrologic evaluations and stream classification. "Bankfull", the 1.5-year return interval, corresponds to the stream channel dimensions. The 25-year event corresponds to the floodplain width. The regression analysis for North Canyon watershed predicts the following flows per unit area over the entire watershed. (Values for specific watershed scenarios vary with mean elevation.)

- Bankfull: 6 cfs/sq. mile
- 25-year event: 60 cfs/sq. mile
- 100-year event: 100 cfs/sq. mile

In order to project peak flow estimates at various points on North Canyon Creek, two historical features must be considered that can alter the contributing watershed area and, consequently, effect stream hydrology:

- The diversion of Upper North Canyon Creek from the Secret harbor drainage to the Spooner Meadow / Slaughterhouse Canyon drainage, and
- Operation of the Spooner Lake Dam.

Presently, and for the past many years as well as prior to the Comstock era, the Upper North Canyon watershed has drained to Secret Harbor Creek and does not contribute flow to lower portions of North Canyon Creek. At Spooner Lake dam, water is routinely released during the spring to maintain a maximum water level elevation in Spooner Lake, however the dam significantly attenuates peak flows to lower portions of the Creek. Effectively, this makes the contributing watershed for peak flows to Lower North Canyon Creek 1.4 sq. miles at the bottom of Spooner Meadow and 2.0 sq. miles at the State park boundary above Prey Meadow. Peak flows are summarized in Table 3.

Table 3. Estimates of peak flows within the North Canyon Watershed for various flow regime scenarios.

	Effective Area (sq. mile)	Bankfull (cfs)	25-year Event (cfs)	100-year Event (cfs)
Peak discharge at fork to Secret Harbor Creek				
Upper North Canyon Creek only	1.5	13	94	165
Peak discharge at lower end of Spooner Meadow above SR28				
Lower North Canyon Creek (Approximate Present Condition)	1.4	10	98	189
Upper and Lower North Canyon Creek (Historic Diversion)	2.9	20	169	306
Spooner Lake and Lower North Canyon Creek (Natural Condition)	2.5	15	159	307
Spooner Lake, Upper and Lower North Canyon Creek	4.0	26	223	405
Peak discharge at State Park boundary above Prey Meadow				
Lower North Canyon Creek (Approximate Present Condition)	2.0	12	133	263
Upper and Lower North Canyon Creek (Historic Diversion)	3.5	23	198	363
Spooner Lake and Lower North Canyon Creek (Natural Condition)	3.1	18	192	373
Spooner Lake, Upper and Lower North Canyon Creek	4.6	28	253	465

The diversion from Upper North Canyon to Lower North Canyon almost doubles the contributing area and peak flow to Spooner Meadow.

4.3 Treatment Areas and Recommendations

The PFC analysis and the site reconnaissance resulted in identifying 11 treatment areas within the North Canyon project area. Two were identified as being functional-at-risk based on the occurrence of active headcuts or bank erosion, and two meadow areas were considered at-risk from headcuts. Treatment

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areas, locations, and recommendations are described below. The priority ratings for each treatment are included in Appendix D. Photographs of treatment areas are included in Appendix E. Locations of treatment areas and Control Points are shown on the maps in Appendix F.

Treatment Area 1 occurs in lower Spooner Meadow, approximately 1000 feet west of Control Point 4. This is a very linear reach of the channel where channel entrenchment becomes more pronounced. The top edge of the north bank becomes sparsely vegetated for widths of one to five feet and appears to be sediment deposits elevated well above the subirrigation capacity of the stream to support wetland floodplains. The loose soils are potentially subject to erosion and water quality impact under high flow conditions. Two treatment alternatives are presented for this area.

The first alternative consists of supplemental revegetation including seeding drought tolerant herbaceous species and planting deep-rooted willows. This alternative will require supplemental irrigation of plantings during the establishment period. The additional willow cover will contribute to improving the fishery condition in this reach by providing additional shading and moderate water temperature.

The second alternative includes modification of the existing high banks to recreate natural floodplain conditions in addition to revegetation treatment described above. This alternative requires some additional disturbance but results in additional stream function restoration.

Both treatment alternatives were ranked as medium priority.

Treatment Area 2 represents a small in-stream headcut and small lateral headcuts where water diverted through irrigation ditches reenters the main channel. Treatment area 2 is in the vicinity of Treatment area 1 and was also rated as functional-at-risk. Although the headcuts are not aggressively active at the present time they are vulnerable "weak links" in the meadow system. Any additional stream cutting would contribute more sediment loading to the existing heavily laden system and could interfere with proper meadow function. Two treatment alternatives are presented for this area.

The first alternative is to directly deal with the problem area and armor the headcuts with rock rip rap. Armoring should be properly installed with cutoff walls to prevent the stream from cutting a new channel around the armored drop. Revegetation should include willow plantings to fortify the banks with root mass and provide additional stream shading.

The second alternative is more of a long-term solution that could be installed in conjunction with the armoring described above. This alternative recommends the use of small check dams to trap sediments and raise the channel elevations to the top of the headcut. This approach requires a time-series of very low check dams monitored and maintained on a regular schedule over a long period of time to achieve the desired result without exposing the channel to lateral cutting.

Both treatment alternatives were ranked as medium priority.

Treatment Area 3 addresses the actively eroding irrigation channel that conveys flows from the Spooner Lake outlet. The recommendation is to remove the irrigation ditch by filling, regrading, and revegetating. Future flows from the Spooner Lake outlet would be directed to the existing, stable channel through existing culverts and into the marsh on the east side of Spooner Meadow.

Treatment Area 3 was rated as a high priority due to the active erosion condition and the ease of access to the treatment area.

Treatment Area 4 is the result of background information gathered during the course of this project and address the operation of the outlet structure at Spooner Lake dam. Water releases from the dam have been managed by state personnel with long term experience in the function of the reservoir. This recommendation includes development of an annual operations plan for managing the water level in Spooner Lake to regulate flow releases in a manner that will avoid coinciding with peak runoff periods. Some maintenance or retrofitting of the outlet gate is also required.

This project was ranked as high priority to assure that the flows released through the lower meadow do not exceed channel capacity and result in damaging flood conditions.

Treatment Area 5 is an actively eroding streambank at the confluence of the main stream channel and the constructed irrigation ditch in the upper area of Spooner Meadow. This is an active bank erosion area that is currently contributing additional sediments to the meadow system and was rated functional-at-risk. The recommended treatment for this area includes regrading the bank and providing permanent stabilization with bioengineered treatments for vegetation establishment and protection.

Treatment Area 6 is the culvert at the third road crossing on the Marlette Trail Road. This crossing is near the upper reach of the lower North Canyon subwatershed (below Secret Harbor Creek) and has minimal flow. Although this reach is not considered a fishery due to the prevalent low flow conditions at the headwaters of the subwatershed, the culvert is not suitable for fish passage. This area was identified for treatment due to the visual impacts of the culvert and its inconsistency with the rest of the state park. Two alternatives were recommended for this area.

The first alternative consists of cutting the downstream end of the culvert and adjusting the boulder armor to improve the finished look of the existing installation. This alternative was ranked as a low priority.

The second alternative was to reset the culvert to an improved alignment that would be compatible for fish passage should future conditions allow for the stream to support a fishery. This alternative was ranked as medium priority due to its potential for fishery improvement.

Treatment Area 7 occurs in a deeply incised segment of the channel, below the Grand Canyon. While the stream channel in the bottom of the gully is currently in proper functioning condition for the existing flow regime (with the entire upper North Canyon subwatershed conveyed to Secret Harbor), the steep upper slopes are bare at this point and actively sloughing additional sediment into the creek. The recommended treatment for this area includes slope protection with bioengineered woody debris and revegetation treatment.

This area was ranked as moderate priority.

Treatment Area 8 is a three-foot headcut located at the upper end of a canyon where an abrupt transition occurs to a meadow. The headcut is precariously stable with dense overhanging grass sod covering buried woody debris and some exposed, erosive soil. The active status of the headcut was undeterminable with one season of observation. However, if the headcut is actively progressing upstream, the meadow above the headcut is at-risk of dewatering and erosion. Three alternatives were proposed for this area.

The first alternative involves direct treatment of the headcut with rock armor and revegetation with native sod to prevent further headcutting.

The second alternative was to construct a new channel and divert stream flows around the headcut.

The third alternative was to monitor the headcut following each high runoff event to determine the actual stability of the headcut and choose the preferred treatment after further observations.

Each of these alternatives were ranked low priority primarily due to the difficulty for access to the treatment area and the undetermined status of the current stability of the headcut.

Treatment Area 9 addresses the steep gully slope on the east side of the "Grand Canyon". This area was undoubtedly the source of the existing sediment deposition that characterizes the substrate throughout the lower North Canyon watershed. The gully has continued to widen over the past decades and a stable channel has reestablished in the bottom that is adjusted to the current flow regime (with the entire upper North Canyon subwatershed conveyed to Secret Harbor). A wooden check dam exists in the

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bottom of the channel as evidence of a past attempt to stabilize the gully. The check dam is not functional as water flows under it. The steep, vertical gully walls continue to slough and add sediments to the stream system. The east slope is of particular concern due to its proximity to the Marlette Trail Road and potential public safety concerns. The top of the gully continues to become undercut and sloughs due to sandy soil and lack of vegetation for permanent stabilization. Two alternatives were recommended for this area to address this area. Both alternatives include removal of the wooden check dam.

The first alternative addresses the east slope of the gully. The west slope was not recommended for treatment due to access limitations and the additional disturbance that would occur within the park. The treatment includes regrading the gully cut slope to reduce the steepness and construct terraces that would promote vegetation establishment. Bioengineered stabilization treatments would provide long-term stability.

The second alternative is extensive and involves re-filling the gully to its original elevation and reconstructing the stream channel adjacent to the existing cut. This alternative would require extensive truck access and great expense.

Both of these alternatives were ranked medium priority.

Treatment Area 10 addresses the need to permanently restore the hydrologic divide between Secret Harbor and North Canyon to the condition that prevailed prior to the Comstock era. This treatment involves only minor regrading to construct vegetated berms that would effectively assure that flows from the upper North Canyon subwatershed were permanently restored to their original conveyance channel to Lake Tahoe through Secret Harbor Creek. This treatment was ranked as a high priority to protect the lower North Canyon subwatershed from future degradation and restore natural watershed boundaries. The treatment area is also readily accessed from the Marlette Trail Road.

Treatment Area 10 was ranked as high priority.

Treatment Area 11 is the only treatment area that was rated functional-at-risk in the upper North Canyon subwatershed and the only upper watershed stream segment where significant channel incisement has occurred. An active 18-inch headcut and lateral bank cutting mark a short segment of the channel. Two treatment alternatives were proposed for this area.

The first alternative is direct treatment of the headcut with rock armor and revegetation. This alternative was ranked moderate priority due to its accessibility and its potential for immediate results.

The second alternative recommends regrading and reconstruction of the channel floodplain, and reconstruction of the channel to reestablish sinuosity. This alternative was ranked high priority because of the additional stream functions that could be reestablished in addition to the accessibility of the project area from the Marlette Trail Road and the immediate results that could be achieved.

5.0 Conclusions

Contrary to current mapping, the Upper North Canyon Watershed is currently (and was historically) part of the Secret Harbor watershed. North Canyon Creek actually originates and is fed by surface springs and seeps below the currently mapped confluence (Lower North Canyon subwatershed). The dominant factor affecting stream flow is snowmelt with peak flows generally occurring in June. Several tributary drainages flow into North Canyon increasing flows downstream.

Under the present conditions, the majority of the North Canyon stream channel is in proper functioning condition. It is predominantly well vegetated and stable. However, the channel shows evidence of past instability and subsequent healing that may be related to past logging practices during the Comstock era and man-altered hydrology for irrigation. This is particularly true for the Lower North Canyon subwatershed.

There is an enormous amount of sediment in the Lower North Canyon stream system as a result of massive erosion, primarily associated with the "Grand Canyon". Evidence of massive sediment transport and deposition was observed in the upper portion of Spooner Meadow. The diversion of waters from Secret Harbor to North Canyon may have helped to create the "Grand Canyon" and accelerated the rate of transport and quantity of eroded sediment into the meadow areas. Additional sediments continue to slowly move through the system and have been observed as sandy substrate throughout the channel.

It is unknown, but not likely that the bulk of these sediments will reach Lake Tahoe for a very long time (under the current climatic and hydrologic conditions whereby the upper North Canyon watershed is conveyed to Secret Harbor). Spooner meadow and Prey Meadow below the State Park provide extensive areas for sediment deposition to occur prior to flowing into Lake Tahoe.

Future operation of the Upper North Canyon Creek diversion and releases from Spooner Lake dam should be done in consideration of downstream flow rates. The State and the USFS still have water rights to divert Upper North Canyon Creek to the Spooner Meadow area as was done historically. The diversion almost doubles the contributing area and peak flow to Spooner Meadow. A future diversion of water to Lower North Canyon could potentially result in a new surge of channel scouring and sediment transport through the system.

Similarly, the peak flow hydrology can be greatly affected by release of water from Spooner Lake. Carefully planned operation of the dam can have a positive effect on the lower North Canyon watershed by attenuating peak flow as well as by reducing the downstream sediment load.

Although only minor impacts to the meadows were observed during the course of this project, existing headcuts at Treatment Areas 2 and 8 pose potential risks to the meadow systems. The meadows are serving critical functions by retrieving the existing sediment load from within the watershed system. It is critically important for the meadows to be maintained in healthy functional condition. Some consideration for annual biomass reduction should be given as a management action for meadow maintenance. Continual buildup of vegetation litter will eventually reduce species diversity and productivity.

The evidence of significant past erosion and channel scouring have been masked as the watershed heals from past altered hydrologic events. The channel healing that was observed appears to have occurred under the reduced flow conditions of the current hydrology. However persisting headcuts and occasional bank erosion are indicators of the potentially fragile state of the watershed.

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Figures

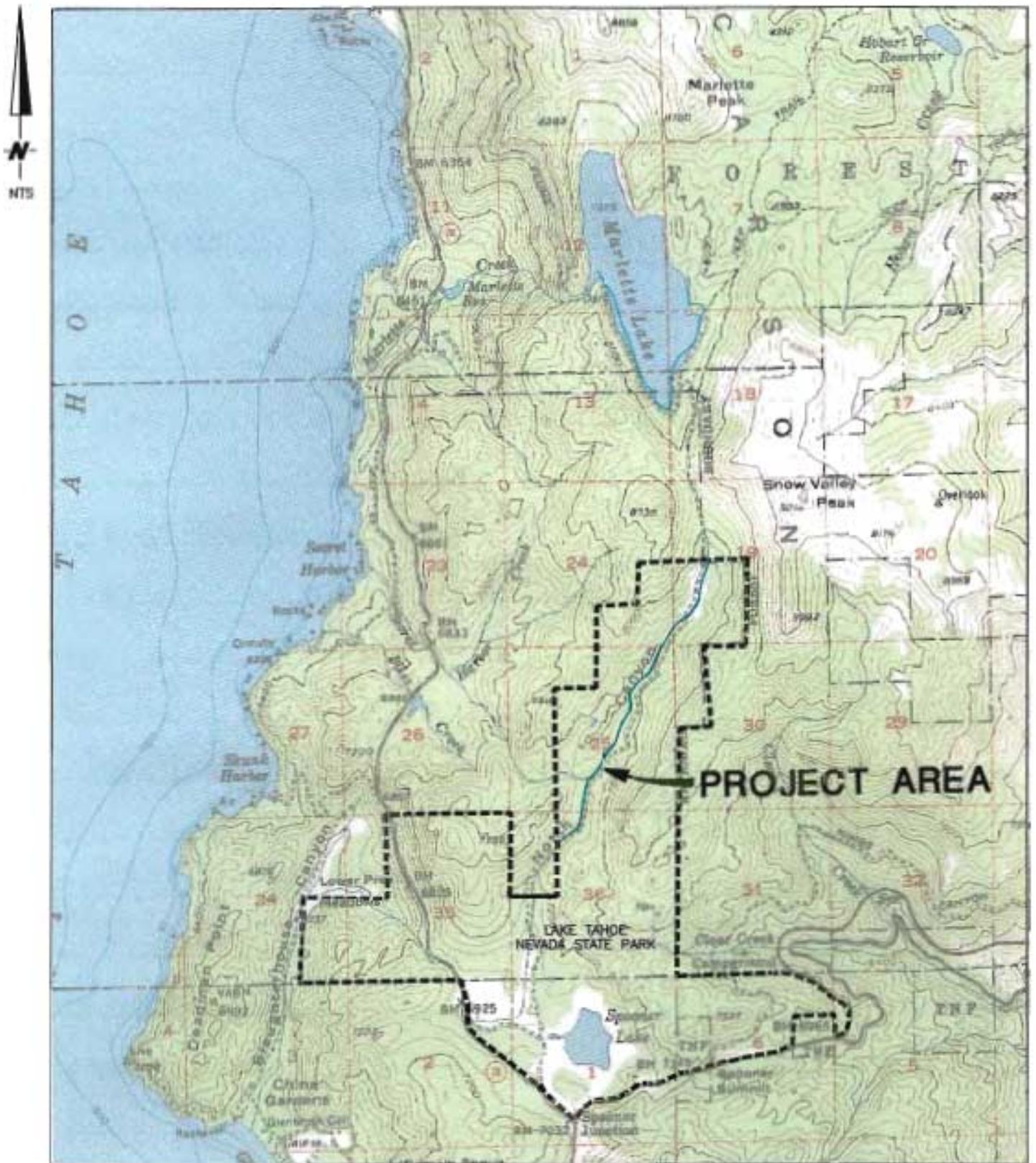


Figure 1
General Location of the North Canyon Project Area

Appendix A

*Water Right Decree
For
North Canyon and Secret Harbor Creeks*

1 Filed July 2^d, 1930. In Equity No. F-33
 2 W. H. Atterman, Clerk.
 3 By _____, Deputy.

4
 5 IN THE DISTRICT COURT OF THE UNITED STATES OF AMERICA IN AND
 6 FOR THE DISTRICT OF NEVADA.
 7 - - - - -

9 THE GLENBROOK COMPANY,)
 10 a corporation,)
 11)
 12) Plaintiff,)
 13 vs.)
 14 CHARLES FULSTONE, CARSON AND)
 15 TAHOE LUMBER AND FLUMING COMPANY,)
 16 a corporation, JOHN DOE, RICHARD)
 17 ROE and JANE DOE,)
 18)
 19) Defendants.)

JUDGMENT AND DECREE

18 This cause came on to be heard at this term, and was
 19 argued by counsel, and thereupon, on consideration thereof, it
 20 was ORDERED, ADJUDGED and DECREED as follows, viz:

21 I.

22 That the respective parties hereto, to-wit: the plain-
 23 tiff THE GLENBROOK COMPANY, a corporation, the defendants
 24 CHARLES L. FULSTONE and CLARA J. FULSTONE, and the defendants
 25 WALTER D. BLISS, WILLIAM S. BLISS and HOPE BLISS (collectively
 26 known as THE BLISS COMPANY), are hereby adjudged and decreed to
 27 be the owners of and to have the right to use in the relative
 28 amounts, and in the manner and for the specific uses and purposes
 29 hereinafter set forth, the waters of those certain streams and
 30 water courses arising in the mountains easterly from Lake Tahoe
 31 and within the State and District of Nevada, and flowing thence
 32 westerly over and through lands lying and being wholly within

1 the said State and District of Nevada into the said Lake Tahoe,
2 and which said streams are known as Secret Harbor Creek (sometimes
3 known as Nye Creek and sometimes known as Bliss Creek), including
4 all its tributaries, and North Canyon Creek (sometimes known as
5 Slaughter House Creek and sometimes known as Davis Creek, and
6 sometimes known as Pray's Creek), including all its tributaries
7 and expressly including its tributary known as Spooner Creek.

8 II.

9 That the defendants Charles L. Fulstone and Clara J.
10 Fulstone, or their grantors and predecessors in interest from
11 whom they derived title, have severally appropriated and bene-
12 ficially applied, and that the said Charles L. Fulstone and
13 Clara J. Fulstone have the right to use directly and/or to store
14 and/or impound one-half of the total flow of said Secret Harbor
15 Creek measured at the dam situated in the west half of the south-
16 east quarter of Section 25, Twp. 15 N. R. 18 E., M.D.M., and
17 not exceeding Fifteen (15) cubic feet per second of time continuous
18 flow from October fifteenth of each year to May first of the
19 succeeding year; that the said defendants may flow or direct said
20 portion of said waters of said creek, at said point of diversion,
21 into the channel of North Canyon Creek, and have the right to use
22 the direct flow, and/or to impound and/or store the said waters or
23 any portion thereof in a reservoir situated in Section 1, Twp.
24 14 N. R. 18 E., M.D.M., or at any other place, with a priority of
25 1872, and to utilize the waters so impounded and/or direct flow
26 for irrigation, fish propagation, resort purposes, domestic,
27 culinary and other beneficial purposes.

28 III.

29 That the plaintiff The Glenbrook Company, a corporation,
30 or its grantors and predecessors in interest from whom it derived
31 title, have severally appropriated and beneficially applied and
32 that the said The Glenbrook Company has the right to use directly

1 and/or store and/or impound one-quarter of the total flow of said
2 Secret Harbor Creek measured at the dam situated in the west half
3 of the southeast quarter of Section 25, Twp. 15 N. R. 18 E.,
4 M.D.M., and not exceeding Seven and one-half (7 1/2) cubic feet
5 per second of time continuous flow from October fifteenth of each
6 year to May first of the succeeding year; that the plaintiff may
7 flow or direct said portion of said waters of said Secret Harbor
8 Creek into the channel of North Canyon Creek, and have the right
9 to use the direct flow, and/or impound and/or store the said
10 waters or any portion thereof in a reservoir situated in the NE¹/₄
11 of Sec. 25, Twp. 15 N. R. 18 E., and/or in a reservoir situated
12 in the SE¹/₄ of Sec. 25, Twp. 15 N. R. 18 E., with a priority of
13 1872, and to utilize the waters so impounded and/or direct flow
14 for irrigation, fish propagation, resort purposes, domestic,
15 culinary and other beneficial purposes.

16 That the said The Glenbrook Company has the right to use
17 the waters so impounded for culinary, domestic, stock watering
18 purposes, resort purposes, fish propagation, irrigation and other
19 beneficial uses. That said water may be used on the following
20 described tracts and any thereof: 50 acres of land in Sections
21 3 and 10, Twp. 14 N. R. 18 E.

22 Provided that in the event The Glenbrook Company and/or
23 The Bliss Company divert and/or impound for storage purposes more
24 than 5 acre feet of water of Secret Harbor Creek above the measuring
25 weir at the "cut" provided for in Paragraph V. of this decree, then
26 such party or parties shall install and maintain another suitable
27 weir or measuring device to measure and divide the water in
28 accordance with the terms of this decree.

29 IV.

30 That the defendants Walter D. Bliss, William S. Bliss and
31 Hope Bliss (collectively known as The Bliss Company), or their
32 grantors and predecessors in interest from whom they derived title,

1 have severally appropriated and beneficially applied and that the
2 said Walter D. Bliss, William S. Bliss and Hope Bliss have the
3 right to use directly and/or store and/or impound one-quarter of
4 the total flow of said Secret Harbor Creek measured at the dam
5 situated in the west half of the southeast quarter of Section 25,
6 Twp. 15 N. R. 18 E., M.D.M., and not exceeding Seven and one-half
7 (7 1/2) feet per second of time continuous flow from October fifteen-
8 th of each year to May first of the succeeding year, and to all the
9 water flowing in the channel of Secret Harbor Creek below the
10 weir mentioned in Paragraph V. hereof; that the said defendants
11 Walter D. Bliss, William S. Bliss and Hope Bliss have the right
12 to use the direct flow and/or store and/or impound the said waters
13 or any portion thereof in a reservoir situated in the SW $\frac{1}{4}$ of the
14 SE $\frac{1}{4}$ and the SE $\frac{1}{4}$ of the SW $\frac{1}{4}$ of Sec. 26, Twp. 15 N. R. 18 E., and/or
15 in a reservoir situated in the SE $\frac{1}{4}$ of the SE $\frac{1}{4}$ of Sec. 23, Twp. 15
16 N. R. 18 E., and/or in a reservoir situated in the NW $\frac{1}{4}$ of the NE $\frac{1}{4}$
17 of Sec. 26, Twp. 15 N. R. 18 E., with a priority of 1872, and to
18 utilize the waters so impounded and/or direct flow for irrigation,
19 fish propagation, resort purposes, domestic, culinary and other
20 beneficial purposes.

21
22 That the said The Bliss Company has the right to use the
23 waters so impounded for culinary, domestic, stock watering purposes,
24 resort purposes, fish propagation, irrigation and other beneficial
25 uses. That said waters may be used on the following described
26 tracts and any thereof: 50 acres of land in Sections 14 and 23,
27 Twp. 15 N. R. 18 E.

28 V.

29 It is further ordered, adjudged and decreed that the
30 plaintiff The Glenbrook Company, and the defendants Walter D.
31 Bliss, William S. Bliss and Hope Bliss install and maintain a
32 box and weir at or near the said dam in the west half of the

ORDER OF THE COURT IN AND FOR THE COUNTY OF CLATSOP, OREGON, IN AND FOR THE DISTRICT COURT OF THE COUNTY OF CLATSOP, OREGON, IN AND FOR THE DISTRICT COURT OF THE COUNTY OF CLATSOP, OREGON.

3 1 southeast quarter of Section 25, Twp. 15 N. R. 18 E. suitable
2 and fitted to measure and divide the water there flowing in said
3 Secret Harbor Creek at all times and to divert any desired portion
4 thereof into the channel of North Canyon Creek while permitting
5 any desired portion thereof to flow on down the channel of said
6 Secret Harbor Creek.

7 VI.

8 It is further ordered, adjudged and decreed that the
9 defendants Charles L. Fulstone and Clara J. Fulstone install and
10 maintain a box and weir in the channel of North Canyon Creek at
11 a point to be by them selected above the present intake of what
12 is known as the upper Fray Ditch, situated in the NE $\frac{1}{4}$ of the SW $\frac{1}{4}$,
13 Sec. 35, Twp. 15 N: R. 18 E., and below the point where they return
14 to said stream all waste waters from irrigation and all waters
15 used for power purposes, and suitable and fitted to measure the
16 entire stream flow at such point.

17 VII.

18 It is further ordered, adjudged and decreed that the
19 defendants Charles L. Fulstone and Clara J. Fulstone, or their
20 grantors and predecessors in interest from whom they derived
21 title, at several and divers times, appropriated and beneficially
22 used and applied all the waters of North Canyon Creek (sometimes
23 called Slaughter House Creek and sometimes called Davis Creek,
24 and sometimes called Pray's Creek) and its tributaries flowing
25 in North Canyon channel above the weir mentioned in Paragraph VI.
26 hereof, and also all the waters of Spooner or Spooner Meadows
27 Creek, and all the waters of Spooner Springs, and also the portion
28 of the waters of Secret Harbor Creek hereinabove in Paragraph II.
29 set forth; and the said Charles L. Fulstone and Clara J. Fulstone
30 are the owners of said rights acquired by appropriation and
31 beneficial use and application in conformity with law and
32 custom relating thereto in and to said waters of said streams

1 and/or their tributaries, for the purpose of irrigation, domestic,
 2 fish propagation, resort purposes, culinary, stock watering and
 3 other beneficial purposes. That the said Charles L. Fulstone
 4 and Clara J. Fulstone are entitled to and have the right to use
 5 directly and/or store and/or impound one/half the waters of
 6 Secret Harbor Creek from October fifteenth of each year to
 7 May first of the succeeding year with the priority of 1872, as
 8 set forth in Paragraph II. hereinabove; that the water so im-
 9 ponded may be used for any of the several purposes hereinabove
 10 set forth, the irrigation to be upon any of the lands described
 11 hereinafter in this paragraph; that the said Charles L. Fulstone
 12 and Clara J. Fulstone are hereby adjudged and decreed to be the
 13 owners of the flow and use as aforesaid of the waters of Secret
 14 Harbor Creek, North Canyon Creek, Spooner Creek, Spooner Springs
 15 and of their and each of their tributaries as herein stated, with
 16 priorities and duty of water for irrigation and other purposes,
 17 as follows:

Priority	Meadow Ac.		Location	Source
1859	2.080	NE $\frac{1}{4}$ NW $\frac{1}{4}$	Sec. 36 T.15 N.R.18 E.	North Canyon Creek, Spooner Creek, and Secret Harbor Creek
"	4.096	NW $\frac{1}{4}$ SW $\frac{1}{4}$	" 36 T.15 N.R.18 E.	" " "
"	8.192	SW $\frac{1}{4}$ SW $\frac{1}{4}$	" 36 T.15 N.R.18 E.	" " "
"	10.752	SW $\frac{1}{4}$ SW $\frac{1}{4}$	" 36 T.15 N.R.18 E.	" " "
"	1.024	SE $\frac{1}{4}$ SE $\frac{1}{4}$	" 35 T.15 N.R.18 E.	" " "
"	11.712	SE $\frac{1}{4}$ SE $\frac{1}{4}$	" 35 T.15 N.R.18 E.	" " "
"	39.648	NE $\frac{1}{4}$ NE $\frac{1}{4}$	" 2 T.14 N.R.18 E.	" " "
"	4.848	NW $\frac{1}{4}$ NE $\frac{1}{4}$	" 2 T.14 N.R.18 E.	" " "
"	4.768	SE $\frac{1}{4}$ NE $\frac{1}{4}$	" 2 T.14 N.R.18 E.	" " "
"	17.536	NW $\frac{1}{4}$ NW $\frac{1}{4}$	" 1 T.14 N.R.18 E.	" " "
"	2.304	SW $\frac{1}{4}$ NW $\frac{1}{4}$	" 1 T.14 N.R.18 E.	" " "
"	0.208	SW $\frac{1}{4}$ NW $\frac{1}{4}$	" 1 T.14 N.R.18 E.	" " "
"	0.144	SW $\frac{1}{4}$ NW $\frac{1}{4}$	" 1 T.14 N.R.18 E.	" " "

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RECLAMATION DISTRICT NO. 16

Priority	Meadow Ac.	Location	Source
1859	13.984	NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 1 T.14 N.R.18 E.	North Canyon Creek, Spooner Creek, and Secret Harbor Creek
"	4.128	NW $\frac{1}{4}$ NE $\frac{1}{4}$ " 1 T.14 N.R.18 E.	" " "
"	27.026	SW $\frac{1}{4}$ NE $\frac{1}{4}$ " 1 T.14 N.R.18 E.	" " "
"	0.704	SE $\frac{1}{4}$ NE $\frac{1}{4}$ " 1 T.14 N.R.18 E.	" " "
"	31.712	SE $\frac{1}{4}$ NW $\frac{1}{4}$ " 1 T.14 N.R.18 E.	" " "
"	1.536	SW $\frac{1}{4}$ NW $\frac{1}{4}$ " 1 T.14 N.R.18 E.	" " "
"	3.488	NW $\frac{1}{4}$ SW $\frac{1}{4}$ " 1 T.14 N.R.18 E.	" " "
"	7.440	NE $\frac{1}{4}$ SW $\frac{1}{4}$ " 1 T.14 N.R.18 E.	" " "
"	13.376	NW $\frac{1}{4}$ SE $\frac{1}{4}$ " 1 T.14 N.R.18 E.	" " "
"	3.264	SW $\frac{1}{4}$ SW $\frac{1}{4}$ " 36 T.15 N.R.18 E.	" " "

Also the right to store and impound 750 acre feet of water annually with a priority of 1872 from Secret Harbor Creek and North Canyon Creek and their and each of their tributaries and also to store and impound 750 acre feet of water annually with a priority of 1868 from North Canyon Creek, and/or Spooner Creek, and their and each of their tributaries arising above the reservoir which is located in Section 1, Twp. 14 N. R. 18 E., with the right to use the said water so stored and impounded for any and all the purposes and uses enumerated, and any other beneficial use. That the right to store or impound waters of Secret Harbor Creek are limited to the period from October fifteenth of each year to May first of the succeeding year and limited to one-half of the flow of said Secret Harbor Creek during the said time and not to exceed Fifteen (15) cubic feet per second of time as provided in Paragraph II. of this decree.

That the said Charles L. Fulstone and Clara J. Fulstone have the right to use the waters so impounded for culinary, domestic, stock watering purposes, resort purposes, fish propagation, irrigation and other beneficial uses. That the said water may be

32

1 used on the following described tracts and any thereof:

2 $\frac{1}{2}$ of SE $\frac{1}{4}$, Sec. 35,
3 $\frac{1}{2}$ of SW $\frac{1}{4}$, Sec. 36,
4 SW $\frac{1}{4}$ of SE $\frac{1}{2}$, Sec. 36,
5 All being in Twp. 15 N. R. 18 E.,

6 NE $\frac{1}{4}$, Sec. 2,
7 NW $\frac{1}{4}$, Sec. 1,
8 N $\frac{1}{2}$ of SW $\frac{1}{4}$, Sec. 1,
9 W $\frac{1}{2}$ of NE $\frac{1}{4}$, Sec. 1,
10 NW $\frac{1}{4}$ of SE $\frac{1}{2}$, Sec. 1,
11 All being in Twp. 14 N. R. 18 E.

12 VIII.

13 That the plaintiff The Glenbrook Company, or its grantors
14 and predecessors in interest from whom it derived title, at several
15 and divers times, appropriated and beneficially used and applied,
16 and that the said The Glenbrook Company has the right to use
17 directly and/or store and/or impound one-half of the total
18 flow of Secret Harbor Creek measured at the dam situated in the
19 west half of the southeast quarter of Section 25, Twp. 15 N. R.
20 16 E., M.D.M., and not exceeding Fifteen (15) cubic feet per second
21 of time continuous flow from the first day of May to the fifteenth
22 day of October of each year with the priority of 1872; and the
23 said The Glenbrook Company are the owners of said rights acquired
24 by appropriation and beneficial use and application in conformity
25 with law and custom relating thereto in and to said water of said
26 stream and/or its tributaries, for the purpose of irrigation,
27 domestic, fish propagation, resort purposes, culinary, stock
28 watering, storing, impounding, and other beneficial purposes.
29 That the said The Glenbrook Company is entitled to and has the
30 right to use directly and/or store and/or impound one-quarter of
31 the waters of Secret Harbor Creek from October fifteenth of each
32 year to May first of the succeeding year, with the priority of
33 1872, as set forth in Paragraph III. hereinabove, also to use and/or
34 impound all the waters of North Canyon Creek and its tributaries
35 flowing in the channel of said North Canyon Creek arising below
36 the weir mentioned in Paragraph VI. hereof after the rights of the

1 said Charles L. Fulstone and Clara J. Fulstone as herein described,
 2 including storage and reservoir rights and applications now
 3 pending in the office of the State Engineer of the State of Nevada,
 4 have been fully satisfied, with the priority of 1869; that the
 5 said waters so impounded may be used for any of the several purposes
 6 hereinabove set forth, the irrigation to be upon any of the lands
 7 described hereinafter in this paragraph; that the said The
 8 Glenbrook Company is hereby adjudged and decreed to be the owners
 9 of the flow and use as aforesaid of the waters of Secret Harbor
 10 Creek and of its tributaries as herein stated, with priorities and
 11 duty of water for irrigation and other purposes, as follows:

12	Prior- ity	Acre- age	Location	Point of Diver- sion	Channel
13					
14	1876	21.38	NW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec.35 T.15 N.R.18 E.	(NE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec.35 (NW $\frac{1}{4}$ SE $\frac{1}{4}$ " 25 (T.15 N.R.18 E.	No. Canyon Creek) Secret Harbor Creek
15					
16	1876	22.91	SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec.35 T.15 N.R.18 E.	" " "	" " "
17	1876	11.71	NE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec.34 T.15 N.R.18 E.	" " "	" " "
18					
19	1876	23.36	SE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec.34 T.15 N.R.18 E.	" " "	" " "
20	1876	4.63	NW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec.34 T.15 N.R.18 E.	(NW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec.34 (NW $\frac{1}{4}$ SE $\frac{1}{4}$ " 25 (T.15 N.R.18 E.	No. Canyon Creek) Secret Harbor Creek
21					
22	1876	3.52	SW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec.34 T.15 N.R.18 E.	" " "	" " "
23					
24	1869	4.41	SW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 3 T.14 N.R.18 E.	(SW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 3 (T.14 N.R.18 E. (NW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec.25 (T.15 N.R.18 E.	No. Canyon Creek) Secret Harbor Creek
25					
26	1869	9.70	NW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec.3 T.14 N.R.18 E.	" " "	" " "
27					
28	1869	13.22	NE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec.3 T.14 N.R.18 E.	" " "	" " "
29	1869	12.78	SE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 3 T.14 N.R.18 E.	" " "	" " "
30					
31	1869	13.44	SW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 3 T.14 N.R.18 E.	" " "	" " "
32	1869	5.95	NW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec.10 T.14 N.R.18 E.	" " "	" " "

1 Also the right to store and impound 100 acre feet of
2 water annually with a priority of 1872 from Secret Harbor Creek
3 and its and each of its tributaries in the or any of the res-
4 ervoires described in Paragraph III. hereof, with the right to use
5 the said water so stored and impounded for any and all the pur-
6 poses and uses enumerated, and any other beneficial use.

7 IX.

8 That the defendants Walter D. Bliss, William S. Bliss
9 and Hope Bliss have since the institution of this suit succeeded
10 to and are now the exclusive owners of any and all rights in the
11 said streams which were at the time of the institution of this
12 suit held, owned and possessed by the defendant Carson and Tahoe
13 Lumber and Fluming Company, a corporation.

14 That the said defendants Walter D. Bliss, William S. Bliss
15 and Hope Bliss, and their grantors and predecessors in interest
16 from whom they derived title, at several and divers times appro-
17 priated and beneficially used and applied, and that the said Walter
18 D. Bliss, William S. Bliss and Hope Bliss have the right to use
19 directly and/or store and/or impound one-half of the total flow of
20 Secret Harbor Creek measured at the dam situated in the west half
21 of the southeast quarter of Section 25, Twp. 15 N. R. 18 E.,
22 M.D.M., and not exceeding Fifteen (15) cubic feet per second of
23 time continuous flow from the first day of May to the fifteenth
24 day of October of each year, and all the waters of Secret Harbor
25 Creek and its tributaries at all times flowing in the channel of
26 Secret Harbor Creek below the weir in the west half of the south-
27 east quarter of Section 25, Twp. 15 N. R. 18 E., M.D.M., but
28 not exceeding a maximum of Fifteen (15) second feet; and that the
29 said Walter D. Bliss, William S. Bliss and Hope Bliss are the
30 owners of said rights acquired by appropriation and beneficial use
31 and application in conformity with law and custom relating thereto
32 in and to said waters of said stream and/or its tributaries, for

1 manner interfere with the diversion, use and enjoyment of the
2 waters of any of the other parties to this suit as set forth in
3 this decree, having due regard to the relative priorities therein
4 set forth, and each party is hereby enjoined and restrained from
5 ever taking, diverting, carrying away or otherwise using or claim-
6 ing any of the waters so allotted to them in any manner or at any
7 time in any manner or way as to in any way interfere with the
8 prior rights of other parties to this suit as the same are herein
9 set forth.

10 XIII.

11 Each of the parties above named is hereby adjudged to
12 be the owner of the flow and use of the several amounts of water
13 appropriated by them respectively, as above set forth from the
14 stream or streams as therein set forth, and are entitled to take,
15 divert and use the waters of the said streams or of any tributary
16 thereof as the case may be, without limit as to time, method,
17 application or use of any beneficial character whatsoever for
18 the irrigation of land, the watering of stock, domestic uses,
19 and other beneficial purposes, subject to and in accordance with
20 the priorities above set forth. Wherever two or more persons are
21 given a priority as of the same year and from the same stream,
22 such priorities shall be deemed to be identical in point of time
23 and equal in point of right with due regard to the amount hereby
24 allowed to each. Any of the said parties shall be entitled to
25 legally change the manner, means, place or purpose of use or the
26 point of diversion of the said waters or any thereof, so far as
27 they may do so without injury to the rights of other persons
28 hereto, and as the same are fixed hereby, and nothing herein
29 contained shall be deemed to in any way affect such right of
30 change of manner, means, place or purpose of use or diversion.

31 XIV.

32 It is further ordered and adjudged that each party hereto

THE COURT, having considered the evidence and the law, hereby orders that the defendant do and perform the things hereinbefore directed, and that he pay his or its costs.

1 pay his or its costs.

2 XV.

3 The duty of water for irrigation purposes, as herein
4 defined, is fixed at and determined to be an average flow of two
5 hundredths (0.02) of a cubic foot per second of time per acre of
6 land irrigated.

7 XVI.

8 The Court reserves jurisdiction to make further orders,
9 if any be needed, to carry this decree into effect.

10 Dated, *July 2nd*, 1930.

11
12
13 *Frank H. [Signature]*
14 DISTRICT JUDGE.

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Appendix B

Project Specialists

The RCI Watershed Team

Sheila Anderson	Wildlife Biologist, Range Ecologist, Certified Erosion Control Specialist, Specialized in Stream Restoration
George Mahe	Biotechnical Civil Engineer, Certified Erosion Control Specialist, Specialized in Stream Restoration Design
Chuck Saulisberry	Soil Scientist, Range Ecologist Specialized in Plant/Soil Correlations
Jill Sutherland	Environment Engineer, Hydrologist Specialized in Stream Hydrologic Functions
Lynn Zonge	Fluvial Geomorphologist, Hydrologist Specialized in Riparian Functional Analyses

Nevada Tahoe Resource Team

Tim Rochelle	Nevada Division of Forestry
Jenny Scanland	Nevada Division of Forestry (Formerly Nevada State Lands)
Shawn Espinoza	Nevada Division of Wildlife
Jay Howard	Nevada State Parks

Appendix C

Description of ARCVIEW Files

The North Canyon project resulted in a number of GIS layers. GPS points, in the Nevada State Plane Coordinate System zone west (datum NAD 83), were collected along the survey line. Treatment areas were created from GPS data and digitized from USGS Quad maps. Narrative descriptions of the treatment areas are linked to the project callout numbers and are shown in Table C-1. Aerial photos, provided by Nevada State Lands, were georeferenced to the GPS points for mapping purposes.

Table C-1. Treatment Area Recommendations and Priority Ranking for the North Canyon Watershed Project.

Treatment Number and	Field ID #	Treatment Description	Treatment Alternative 'A'	Treatment Alternative 'B'	Treatment Alternative 'C'
1		Lower meadow, approximately 1000' west of Control Point 4. Modified hydrologic conditions and sediment deposition resulted in high, dry banks, sparsely vegetated, and vulnerable to erosion under high flood flow conditions.	Revegetation including willow planting. Medium Priority	Modify banks to expand floodplain and revegetate. Medium Priority	
2	(M2)	Lower meadow, approximately 800' west of Control Point 4. Approximate 12-18" headcuts in lateral tributary channels intercepting the main channel from the north.	Armor with rock riprap and revegetate. Medium Priority	Raise channel elevation to top of headcut and armor. Medium Priority	
3	(M4)	Lower meadow, near Control Point 4. Actively eroding irrigation ditch. Ditch is not contributing to meadow function or maintenance.	Fill, regrade and revegetate. High Priority		
4		Spooner dam, east of Control Point 3. Regulate water releases to avoid coinciding with peak runoff periods.	Retrofit outflow gate and develop written operation plan. High Priority		
5	(M5)	Upper part of the lower meadow, near Control Point 9. Actively eroding outside stream bank.	Regrade bank and protect with bioengineered revegetation treatment. High Priority		
6		Culvert at road crossing #3, between Control Points 19 and 20. Culvert retrofit to improve visual quality. This stream reach is currently not a fishery.	Shorten downstream extension and adjust boulder armoring. Low Priority	Remove and reset culvert and boulder armor to remove fish passage obstruction. Medium Priority	
7	(N7)	Mid Canyon near Control Point 21. Active sloughing on sparsely vegetated, long steep slope. Ordinary high flow channel banks appear stable.	Slope protection with bioengineered woody debris treatment. Medium Priority		
8	(N8)	Mid Canyon, near Control Point 23. Three-foot headcut with dense overhanging sod and some exposed, erosive soil.	Construct new channel reach to redirect flow around headcut. Low priority	Construct rock drop to armor headcut and prevent further cutting. Low Priority	Monitor headcut to assess current status and trend. Low Priority
9	(N9)	"Grand Canyon" between Control Points 26 and 27. Deeply eroded gully with stable, functional stream channel in the bottom. East gully bank near the road (trail) is potential public safety concern.	Regrade bank to decrease slope, and construct terraces to promote revegetation. Medium Priority	Re-fill gully to original elevation and reconstruct stream channel. Medium Priority	

APPENDIX C:
North Canyon Watershed Assessment
Treatment Areas, Recommendations, Alternatives & Priority

Table C-1. Treatment Area Recommendations and Priority Ranking for the North Canyon Watershed Project.

10		Confluence of North Canyon and Secret Harbor; near Control Point 28. No recent flows have been diverted to North Canyon. Restore permanent hydrologic divide between North Canyon and Secret Harbor	Regrade berms and revegetate. High Priority		
11	(N10) (N11)	Upper watershed near Control Point 41. Recent depositional feature and channel adjustments. Approximate 18" headcut and lateral bank cutting.	Rock armor and revegetate. Medium Priority	Reconstruct floodplain, reestablish sinuosity, armor and revegetate. High Priority.	

Appendix D

Treatment Area Prioritization Matrix

Treatment Description (Number) ALTERNATIVE	Timeframe of Measurable Results /1	Effect on Lake Tahoe Water Quality /2	Ratio of Accessibility and Environmental Impact to Overall Benefit /3	Likelihood to Accomplish Restoring PFC /4	Potential to Preserve or Enhance Fishery /5	Total Score	RANK
Ditch removal in the lower meadow (3)	3	1	3	3	1	11	1 High
Restore hydrologic divide between North Canyon and Secret Harbor (10)	1	3	3	2	2	11	1 High
Bank stabilization (5)	3	1	2	3	2	11	1 High
Spooner Dam Outlet Retrofit and Management Plan (4)	3	2	3	1	2	11	1 High
Headcut and floodplain reestablishment (11) ALTERNATIVE B Reconstruct floodplain and sinuosity	3	1	1	3	3	11	1 High
Bank revegetation (1) ALTERNATIVE A Revegetate with willow	3	1	3	2	1	10	2 Medium
Headcut and floodplain reestablishment (11) ALTERNATIVE A Armor and Revegetate	3	1	2	2	1	9	3 Medium
Headcut stabilization (2) ALTERNATIVE A Rock rip-rap	3	1	2	1	2	9	3 Medium

Treatment Description (Number) ALTERNATIVE	Timeframe of Measurable Results ^{/1}	Effect on Lake Tahoe Water Quality ^{/2}	Ratio of Accessibility and Environmental Impact to Overall Benefit ^{/3}	Likelihood to Accomplish Restoring PFC ^{/4}	Potential to Preserve or Enhance Fishery ^{/5}	Total Score	RANK
Slope protection with woody debris and seeding below (7)	3	1	2	2	1	9	3 Medium
Bank revegetation (1) ALTERNATIVE B Regrade to reestablish floodplain	2	1	2	3	1	9	3 Medium
Retrofit culvert at road crossing #3 (6) ALTERNATIVE B – Reset to remove fishery obstruction	2	1	3	2	1	9	3 Medium
Head cut stabilization (2) ALTERNATIVE B Raise main channel elevation	2	1	2	2	2	9	3 Medium
Slope stabilization of "Grand Canyon" (9) ALTERNATIVE A Lay bank back terrace and revegetate	2	2	2	1	1	8	4 Medium
Slope stabilization of "Grand Canyon" (9) ALTERNATIVE B Fill gully and reconstruct stream	2	2	1	2	1	8	4 Medium
Retrofit culvert at road crossing #3 (6) ALTERNATIVE A Cut to shorten downstream	1	1	3	1	1	7	5 Low

Treatment Description (Number) ALTERNATIVE	Timeframe of Measurable Results /1	Effect on Lake Tahoe Water Quality /2	Ratio of Accessibility and Environmental Impact to Overall Benefit /3	Likelihood to Accomplish Restoring PFC /4	Potential to Preserve or Enhance Fishery /5	Total Score	RANK
Head cut stabilization (8) ALTERNATIVE A Re-route stream around headcut	2	1	1	2	1	7	5 Low
Head cut stabilization (8) ALTERNATIVE B Construct rock-armored drop	2	1	2	1	1	7	5 Low
Head cut stabilization (8) ALTERNATIVE C Monitor to assess current status	1	1	3	1	1	7	5 Low

1/ Timeframe of Measurable Results.	1	The effects of implementing the project may not be realized in the immediate future.
	2	The effects of implementing the project are foreseeable but not immediate.
	3	The effects of implementing the project will be realized right away.
2/ Effects on Lake Tahoe water quality.	1	The project will have little or no effect on water quality in Lake Tahoe.
	2	The project will have some effect on water quality in Lake Tahoe.
	3	The project will have a significant effect on water quality in Lake Tahoe.
3/ Ratio of accessibility and environmental impact to benefits of the project	1	The disturbance associated with doing the project more than offsets the benefit from doing the project, primarily due to accessibility.
	2	Some disturbance will be associated with doing the project, but the benefits outweigh the impact.
	3	The project is readily accessible and the disturbance will be minor.
4/ Likelihood to restore proper functioning condition (PFC).	1	The result of the project does little to further PFC.
	2	The result of the project achieves some aspects of PFC restoration.
	3	The result of the project is consistent with restoring PFC.
5/ Potential to improve or enhance fishery.	1	The result of the project has little or no affect on fisheries.
	2	The project will enhance habitat OR remove an obstruction to migration.
	3	The project will enhance habitat AND remove an obstruction to migration.

Appendix E
Project Photographs

TREATMENT AREA PHOTOGRAPHS



TREATMENT AREA 1
Sparsely vegetated banks.



TREATMENT AREA 2
Small lateral headcuts adjacent to an instream headcut.



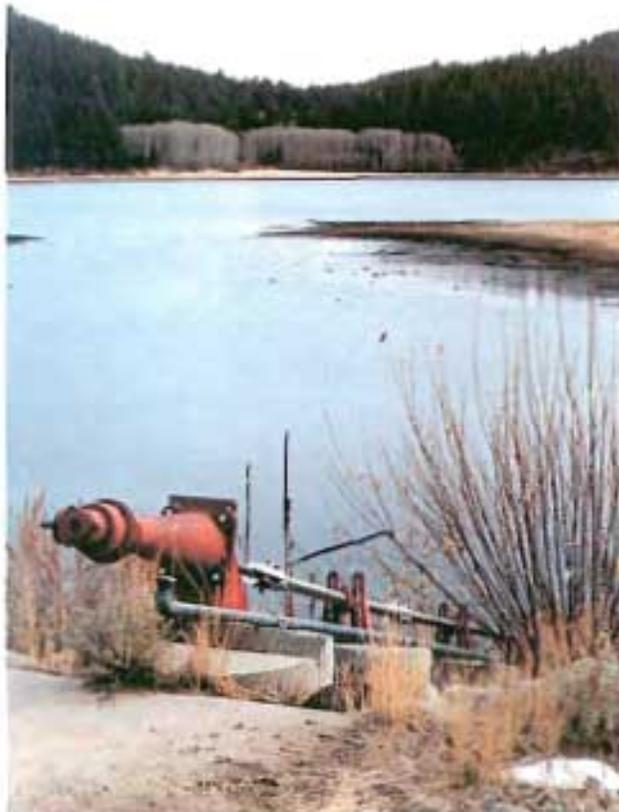
TREATMENT AREA 3
Actively eroding irrigation channel.



TREATMENT AREA 3
Actively eroding irrigation channel.



TREATMENT AREA 3
Flows should be redirected into the meadow.



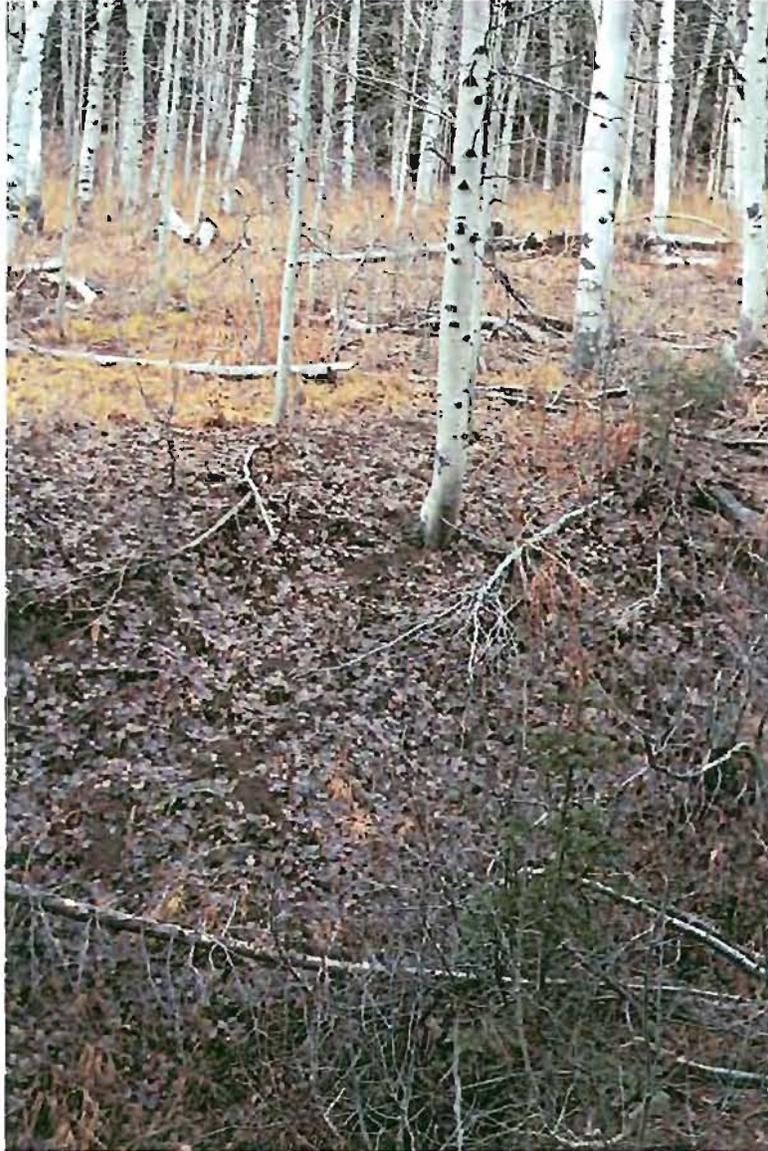
TREATMENT AREA 4
Outlet gate should be improved



TREATMENT AREA 5
Bank cutting.



TREATMENT AREA 6
The culvert at the third crossing is inconsistent with the State Park setting.



TREATMENT AREA 7
Sloughing slope in need of revegetation.



TREATMENT AREA 8

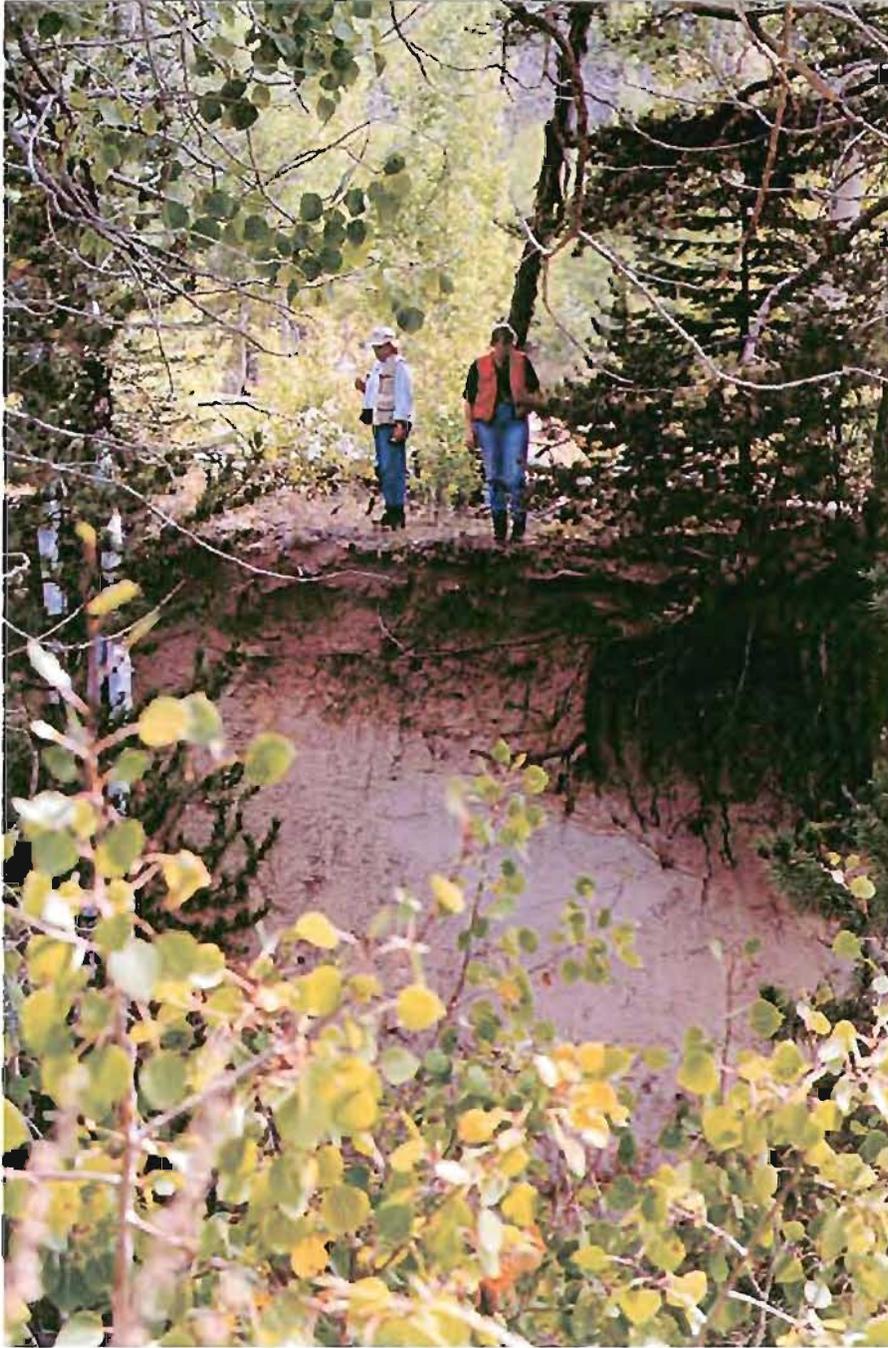
Large head cut at the lower end of a meadow.

This was the largest head cut located during the field reconnaissance.



TREATMENT AREA 9

The "Grand Canyon" area may pose a public safety issue.



TREATMENT AREA 9
Undercut bank in the "Grand Canyon" area.



TREATMENT AREA 10

The lowest point between the Secret Harbor watershed and the North Canyon watershed is between the photographer and the road. Access would be relatively easy to re-instate a more reliable hydrologic divide.



TREATMENT AREA 10

The mound in this photo may be remnants of the old diversion structure.



TREATMENT AREA 11
Raw bank adjacent to a headcut

**GENERAL WATERSHED
PHOTOGRAPHS**



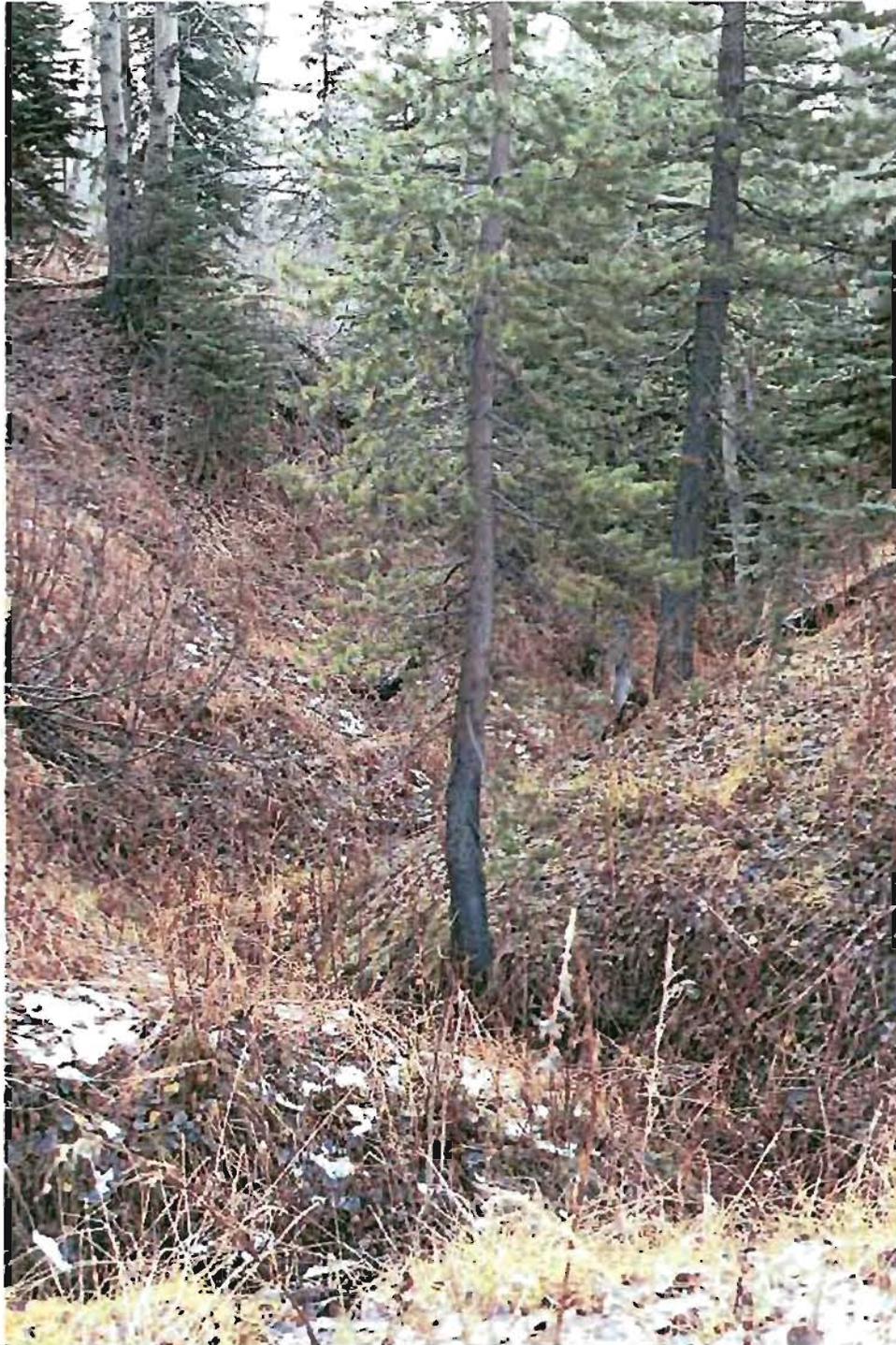
Spooner Meadow.



The creek through Spooner Meadow has recovered from an earlier period of down-cutting and entrenchment.



The 'A' and 'B' stream types in the canyon are very well vegetated with abundant woody debris.



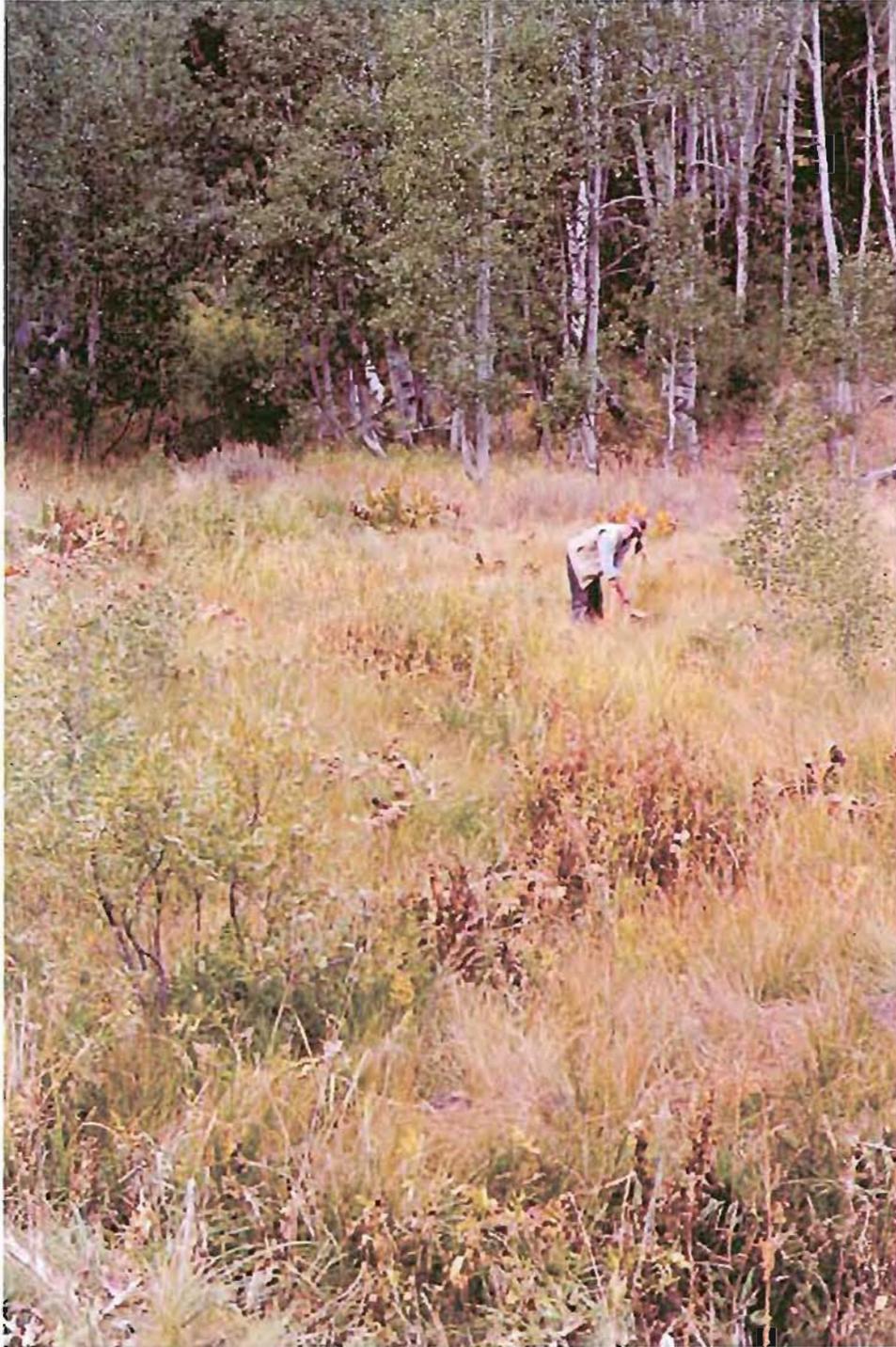
The Grand Canyon begins abruptly below the watershed divide between Secret Harbor and North Canyon watersheds.



Secret Harbor Creek is very well vegetated and stable.



Secret Harbor Creek transitions into a 'B' type stream and is very stable as it exits the State Park.



The meadow areas in the Upper North canyon Watershed are well vegetated and stable.



The stream through the Upper North Canyon Watershed is very healthy. The lower meadows most likely looked like this prior to anthropogenic influences.

Appendix F

Aerial Photograph- Maps



North Canyon Watershed Assessment

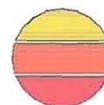
MAP 2
SECRET HARBOR



SCALE: 1" = 200'

0.1 0 0.1 0.2 Miles

NOTE: Photo is not ortho-rectified



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North Canyon Watershed Assessment

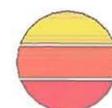
MAP 1
SPOONER MEADOW



SCALE: 1" = 200'



NOTE: Photo is not ortho-rectified



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North Canyon Watershed Assessment

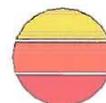
MAP 3
UPPER NORTH CANYON



SCALE: 1" = 200'



NOTE: Photo is not ortho-rectified



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Appendix G

Schematic Description of the Rosgen Stream Classification System

FIELD GUIDE FOR STREAM CLASSIFICATION

Stream TYPE →	Stream TYPE						D	DA	E	F	G
	A	B	C	D	DA	E					
1 Bedrock											
2 Boulder											
3 Cobble											
4 Gravel											
5 Sand											
6 Silt-Clay											
Entrenchmt	< 1.4	1.4 - 2.2	> 2.2	n/a	> 4.0	> 2.2	< 1.4	< 1.4	< 1.4	< 1.4	
WD Ratio	< 12	> 12	> 12	> 40	variable	< 12	> 12	> 12	> 12	> 12	
Sinuosity	1 - 1.2	> 1.2	> 1.2	n/a	variable	> 1.5	> 1.2	> 1.2	> 1.2	> 1.2	
Slope	.04-.099	.02-.039	< .02	< .04	< .005	< .02	< .02	< .02	< .02	.02-.039	

FIGURE 19. Primary delineative criteria for the major stream types.