Kensington Project
Lower Slate Lake Tailings Storage Facility
Ecological Monitoring Plan

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Introduction

The Kensington Project is an underground gold mine, located approximately 45 air miles north of Juneau, Alaska. When the mine begins production, tailings will be conveyed as slurry from the processing area through a pipeline and deposited underwater in the Lower Slate Lake tailings storage facility (TSF). A dam at the outflow of Lower Slate Lake will be constructed in stages. At closure, the flooded area in the basin will have increased from the existing 20 acre lake to 56 acres.

The Slate Lakes drainage includes Upper Slate Lake and Lower Slate Lake (Figure 1). Outflow from Upper Slate Lake drains to Lower Slate Lake via Mid-Lake Slate Creek. Lower Slate Lake drains to East Fork Slate Creek. The first permanent barrier to upstream migration of anadromous fish is near the confluence of East Fork Slate Creek and West Fork Slate Creek, which join to form Slate Creek.

Occurrence of fish and wildlife species in the Slate Lakes basin is summarized in the FSEIS (USFS 2004). Dolly Varden and threespine stickleback are the only fish species that occur in the Slate Lakes basin above the barrier to anadromous fish. An estimated 1,000 Dolly Varden reside in Lower Slate Lake. Sightings of wildlife or their sign within the Slate Lakes basin include moose, black bear, Canada geese, ducks, red squirrels, beaver cuttings, bald eagles, boreal toads, and river otter. A lack of prey, including Sitka black-tailed deer, is suspected to limit use of the Slate Lakes area by gray wolves.

The TSF was designed to contain the environmental impact of tailings placement to within the boundaries of the facility. The effectiveness of the TSF in this regard will be monitored through the NPDES monitoring program and portions of this TSF ecological monitoring plan.

After the operation, the TSF will be restored as a productive lake. The original lake bed and surrounding terrestrial habitat will be covered with tailings. However, as the lake level is raised to its final elevation after cessation of tailings deposition, approximately 11 acres of native soil will be flooded but not overlain by tailings. It is expected that this

native soil will be quickly colonized by a productive benthic community that will support fish populations as has been documented in hydroelectric and other man-made impoundments. This 11-acre area will be equal to the area of productive sediment in the existing lake (9 acres are not productive due to low light penetration and low oxygen concentrations).

Furthermore, evidence has supported the conclusion that the tailings should be habitable to some degree for at least some species immediately after deposition (EVS 1999, Kline and Stekoll 2000, AScI 2000a, 2000b). Tailings may even become colonized as rapidly as in native sediment, as they did in a marine experiment (Kline and Stekoll 2000), although any colonization in tailings assures that the overall benthic productivity of the TSF will exceed that in the existing lake.

While slower colonization in tailings relative to submerged native soil would not jeopardize the reclamation goal (see below), it could be interpreted as indicating that the tailings may be less suitable for some species. Experimentation will be conducted to separate potential causes of reduced habitability of tailings. The most likely limiting factors would be lack of organic matter or residual process water. Both of these potential stressors will be alleviated over time. A tiered, experimental approach to evaluate colonization of tailings is included in this TSF ecological monitoring plan.

It should not be assumed that benthic colonization will be the rate limiting factor in restoring a sustainable population of Dolly Varden in the TSF. The resource agencies will decide whether or not to import Dolly Varden from outside of the Slate Lakes basin or rely on natural reintroduction from Upper Slate Lake through Mid-Lake Slate Creek. The agencies may decide to maintain a supply of Dolly Varden to East Fork Slate Creek below the TSF until sufficient numbers begin to exit the TSF via the spillway. It is possible that natural reintroduction of Dolly Varden will lag behind establishment of a sufficient prey base. These are some of the questions that this TSF ecological monitoring plan is designed to answer. The final plan for Dolly Varden will be based on monitoring results and submitted to the USFS in the final reclamation plan for USFS and State approval two years before closure.

TSF Reclamation Goal

The reclamation goals for the TSF include:

1) Establish a self-sustaining ecosystem that includes:

a) Rooted aquatic plants that are comparable in aerial coverage to that in the existing Lower Slate Lake;

b) Dolly Varden that are comparable in abundance to that in the existing Lower Slate Lake.

2) Meet water quality standards in the TSF, in any discharge, and in any seepage below the tailings dam.

After the final water level is reached in the TSF, reclamation will be dominated by natural processes. Water quality, rooted aquatic plants and Dolly Varden will be used to assess the status of reclamation because:

- they are reflective of a diverse and productive lake;
- they are readily quantifiable;
- the annual and within-season variability of aquatic plans and Dolly Varden populations are low once they are established;
- they are a direct food source for wildlife;
- they are indicative of high water quality and productive benthic and water column habitat.

Other ecosystem components that will be monitored are not well suited for use in assessing the status of reclamation. For example, the benthic invertebrate community in the submerged native soil and tailings in the TSF after closure may differ from Lower Slate Lake baseline data and the Upper Slate Lake community while the process of species succession progresses. This would be irrelevant to the reclamation goal,

however, if Dolly Varden were to become established in the TSF despite taxonomic differences in the benthic invertebrate assemblage.

Objectives

This TSF ecological monitoring plan is not intended to replace the NPDES monitoring requirements that address the physical, chemical, and toxicological characteristics of discharge from the TSF. This TSF ecological monitoring plan was designed to:

1) Address the effectiveness of the TSF in containing the environmental impacts of the operation to within the TSF by demonstrating that the tailings are suitable for recolonization, do not have the potential for adverse metal transfer to waterfowl or other wildlife, and will not cause water quality exceedances, including any ADEC approved variations to the water quality standards after closure.

2) Provide information to be used for refining the following aspects of the reclamation plan;

    a) an appropriate Dolly Varden restocking plan;

    b) the optimal final TSF water level and depth to optimize lake productivity;

    c) incorporation of wildlife habitat features, and

    d) determine the habitability of the tailings and appropriate methods of capping or amendments, if necessary.

3) Confirm progress towards achieving the TSF reclamation goal.

Monitoring Components (summarized in Table 1)

Baseline

Baseline conditions have been documented in Lower Slate Lake and are summarized in the FSEIS (USFS 2004). These data, in addition to data collected from Upper Slate Lake

and Spectacle Lake during operation and after closure will serve as a reference when interpreting monitoring data. The only exception is that aerial coverage of rooted aquatic plants has not been quantified in Lower Slate Lake, Upper Slate Lake, and Spectacle Lake. This task will be conducted prior to construction. Additional details on this task are provided below in the *Aquatic Plants* section.

Water Quality

During operations water quality will be monitored via the NPDES approved outfall from the TSF. At closure of the facility, water quality within the TSF will be monitored to assess progress toward achieving the reclamation goals. Water quality will be monitored during late August and late winter at mid-depth, and near the tailings surface for the first three years after closure. Sampling will coincide with dissolved oxygen profiling (see Table 1). Samples will be analyzed for Al, NH_4, As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, NO_3, pH, Se, Ag, SO_4, TDS, and Zn.

Tailings Geochemistry

Samples of tailings will be collected annually and analyzed for the same metals as in the ecological risk assessment The samples will be digested with nitric acid (USEPA 3050) and then analyzed using ICP-MS (USEPA 6020).

Quarterly samples of tailings will be collected during operations and analyzed for modified ABA and metal mobility analysis. Samples will be tested using the meteoric water mobility procedure and analyzed for Al, NH_4, As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, NO3, pH, Se, Ag, SO_4, TDS, and Zn.

Tailings Habitability

An *in situ*, tiered approach will be used to assess tailings habitability. For the first experiment, tailings will be collected from three locations within the TSF using a benthic grab sampling device. These samples will represent tailings immediately upon cessation of milling activities. The three samples will be individually sieved and any invertebrates will be removed.

Recently submerged native soil will also be collected from three locations around the perimeter of the TSF. The three samples will be individually sieved and any invertebrates, vegetation, stones, or sticks will be removed.

To represent tailings after the process of consolidation has ceased to influence the composition of interstitial water in the surface layer of tailings, three additional tailings samples will be collected. These samples will be suspended in Upper Slate Lake water (10 parts water to 1 part tailings) and allowed to settle for 24 hours. The overlying water will be decanted and the settled tailings will be used for the experiment. The interstitial water in these rinsed tailings will be comprised of lake water. This will be a conservative approach because by the time consolidation is nearing completion in much of the TSF, organic matter will have settled on the tailings and pioneer species will have begun to naturalize the surface layer of tailings and irrigate them with overlying lake water.

The nine samples (3 soil, 3 freshly deposited tailings, 3 rinsed tailings) will be placed in polyethylene trays and placed several feet underwater in the littoral zone of Upper Slate Lake after ice-out during the first spring of operation. The trays will be retrieved during the following fall and sieved to remove macroinvertebrates, which will be identified and enumerated. The design of subsequent experiments will depend on the results of each preceding experiment. Any experiments conducted after the first experiment will include sufficient replication to allow statistically powerful comparisons.

Dolly Varden in Mid-Lake Slate Creek

Dolly Varden in Mid-Lake Slate Creek will be captured and released below the TSF dam from the beginning of construction of the TSF until confirmation that suitable conditions for Dolly Varden are present in the TSF. These Dolly Varden will be measured for length, weighed, searched for abnormalities, and scanned for tags from baseline studies. By relocating migrants, subtleties of timing and life stage relating to downstream movement will be preserved. The information that will be gained on numbers, seasonality, and sizes of Dolly Varden migrants will be directly applicable to the final plan for reintroduction of Dolly Varden to the TSF.

Dolly Varden in Mid-Lake Slate Creek will be captured upstream of the water diversion structure. Generally, a method that does not require screening of the entire stream, such as minnow traps, will be used to capture Dolly Varden. Monitoring during the early years of operation may reveal seasonality that could reduce or eliminate the need to trap and transplant during certain periods of the year, particularly if 100% capture success is not required. Any decision to modify capture systems will be reviewed and approved the State and USFS.

Dolly Varden in the TSF and Upper Slate Lake

If all Dolly Varden are transported around the TSF when construction begins until after closure, and assuming that little or no successful reproduction occurs in Lower Slate Lake, it can be expected that the Dolly Varden population in the TSF will steadily decline and reach zero before closure due to natural mortality alone.

The Dolly Varden population that will be present when the operation begins provides an opportunity to predict how quickly the population can be restored after closure. By the end of the second or third year of operation, the entire original lake bottom is likely to be covered by tailings and the area of newly submerged native soil will be less than the area that will be submerged after closure. As such, if reductions in Dolly Varden numbers during the early years of operation can be attributed to natural attrition, it will demonstrate that Dolly Varden can survive under conditions that are more challenging than the conditions that will exist at closure. If by chance this occurs, then reintroduction of Dolly Varden immediately after cessation of tailings discharge or during the final years of operation would be worthy of consideration. If the population declines more rapidly than would be expected through natural attrition, the monitoring effort may still contribute to determining a schedule for reintroducing Dolly Varden after closure.

The number of Dolly Varden in the TSF will be estimated using mark and recapture sampling after the first year of operation and again in year 3 and 5 of operations. Captured Dolly Varden will be processed as described above (see *Dolly Varden in Mid-Lake Slate Creek)* and released back to the TSF. To provide a reference, the same surveys will be conducted concurrently in Upper Slate Lake. The need for and timing of

Dolly Varden surveys in the TSF will be based on the findings of preceding surveys and as approved by the State and USFS.

Dolly Varden Reproduction

Prior to 2004, it was not known when or where Dolly Varden in the Slate Lakes basin were spawning. Stream habitat that was accessible from Lower Slate Lake did not appear to provide suitable gravels for spawning. A small number of suspected redds were observed in littoral gravels of Lower Slate Lake during 2003 and 2004. However, no eggs were found in the redds and interstitial oxygen concentrations were low. This indicated that attempts to spawn in Lower Slate Lake were not contributing to the population. During 2004, minnow traps were set in the north inlet to Upper Slate Lake (North Upper Slate Creek, Figure 1) for the first time. Numerous Dolly Varden parr were captured. Parr are young-of-the-year fish that have vertical markings on their sides. This finding, compared to a near absence of parr captured anywhere else in the Slate Lakes basin, provided strong evidence that this single stream was the dominant source of Dolly Varden for Upper Slate Lake and Lower Slate Lake. This interpretation is supported by the finding of abundant, well-sorted gravels in North Upper Slate Creek and the near absence of spawning habitat elsewhere in the basin.

Nonetheless, to gain an understanding of the variability in recruitment of Dolly Varden to the basin from North Upper Slate Creek, minnow traps will be set in the stream at the same time that they are set for the lake population estimates described above. Potential Dolly Varden spawning habitat also occurs along the eastern shore of Upper Slate Lake, although lake spawning may not occur given the high quality spawning habitat in the north inlet to the lake. A biologist will walk along the eastern shore of Upper Slate Lake once per week from mid-July through mid-September to document any suspected redds or spawning behavior. If redds are discovered in Upper Slate Lake, baited minnow traps will be set along the eastern shore and in the north inlet to the lake to gain a better understanding of adult Dolly Varden distribution and use of the lake margins for spawning.

Threespine Sticklebacks

Sticklebacks are a major food source for Dolly Varden in Lower Slate Lake. Therefore, the rate of recovery of the Dolly Varden population may depend to a large degree on reestablishment of sticklebacks.

Large schools of threespine sticklebacks are common throughout the streams and littoral zones of the Slate Lakes basin. Their widespread distribution suggests that they will likely be present in the TSF throughout the operation and that no specific actions are necessary to restore threespine sticklebacks during reclamation. Because they are an important prey item for Dolly Varden, their abundance in the TSF will be monitored, compared to Upper Slate Lake, and factored into the Dolly Varden reintroduction plan. Seines or dip nets will be used to quantitatively sample threespine sticklebacks from the littoral zone of the TSF and Upper Slate Lake during each season that Dolly Varden population surveys are conducted.

Benthic Invertebrates

Benthic macroinvertebrates will be monitored in the TSF and Upper Slate Lake during each season that Dolly Varden population surveys are conducted. Sampling within the TSF will occur in tailings that have not had fresh deposition for a minimum of three months to the extent feasible. Quantitative grab samples will be collected and sieved. Taxa will be identified to the lowest practical level and enumerated. The sampling design for benthic macroinvertebrates will be adaptive, depending on conditions and the timing of water level changes. Additional sampling may be conducted later in the operation if previous monitoring suggests that it will provide information that will contribute to determining the appropriate timing of Dolly Varden reintroduction in the TSF.

Zooplankton

Zooplankton will be monitored in the TSF and Upper Slate Lake during each season that Dolly Varden population surveys are conducted. Plankton tows will be conducted to

provide quantitative data on taxonomic composition and abundance. These data will be used when interpreting data from Dolly Varden and threespine stickleback monitoring.

Aquatic Plants

A riparian and littoral survey was conducted on Lower Slate Lake during 2000 that included estimates of rooted plant coverage within select areas (Kline 2001). This survey did not fully quantify coverage for the entire lake and did not include species identification. A botanist will use appropriate methods to quantify aerial coverage of rooted aquatic vegetation in Lower Slate Lake, Upper Slate Lake, and Spectacle Lake during 2005. The survey of Lower Slate Lake will provide baseline data for assessment of progress toward the reclamation goals in the TSF after closure. The survey of the other two lakes will provide information that will be included when dissolved oxygen profile data are interpreted (see below).

Wildlife

Select personnel will be trained to identify and document wildlife and sign in the Slate Lakes basin during operation. Likely personnel will be those that transport Dolly Varden from Mid-Lake Slate Creek to East Fork Slate Creek. Noteworthy observations will include live animals, scat, tracks, fur, calls, feathers, bones, and other sign. Documentation will include date, time, location, weather conditions, habitat, measurements, photographs, and samples as appropriate. A database and collection of samples will be maintained.

Dissolved Oxygen

The final depth of the impoundment will be dictated, in part, by consideration of winterkill. Winterkill refers to a large-scale die-off of fish under ice due to low levels of dissolved oxygen. It occurs when bacterial decomposition of organic matter consumes oxygen at a time when oxygen input through primary production and surface aeration is restricted due to ice and snow cover. Winterkill is a function of many variables, including the duration of ice and snow cover, the depth of snow cover, the minimum oxygen tolerance threshold of resident fish, and the rate of oxygen depletion.

Attempts to identify predictors of winterkill susceptibility, such as mean water depth, seasonal stratification, total phosphorous, and chlorophyll *a* have revealed that generalizations can sometimes be made, but apply only to the region or lake type that was studied and cannot be extrapolated to all lakes. No predictive model was located that is likely to be applicable to the TSF.

Collection of oxygen profiles and related variables during operation in nearby lakes will allow determination of the site-specific relationship between variables that influence the potential for winterkill. While the reclamation plan emphasizes establishment of a broad littoral zone in the TSF, there may be a point where oxygen consumption resulting from decomposition of organic matter produced in the littoral zone would result in winterkill. Part of the final reclamation plan will be to identify a balance of shallow and deep water that will be appropriate for the TSF. Given some flexibility in setting the final depth of the TSF and the opportunity to collect site-specific data, winterkill should be considered a factor that can be designed out of the final reclamation plan.

Upper Slate Lake and Spectacle Lake will be monitored to gain an understanding of the site-specific factors that will influence the risk of winterkill in the TSF. To this end, dissolved oxygen and temperature profiles, chlorophyll *a* concentrations (a measure of primary productivity), outflow discharge, and aerial coverage of rooted aquatic plants (see above) will be documented. Surveys will be conducted during late summer and late in the following winter to explore relationships between the variables. It is anticipated that three years (2 seasons each) of monitoring will provide an adequate database. Additional water column profiling may also be conducted at the end of winters that are extreme with regard to the length of time that the lakes are covered by ice and snow.

Reporting and Data Review

Annual reports will be prepared by Coeur Alaska that summarize monitoring results and submitted to the ADNR and USFS by February 1 of the following year for review and comment. The results and comments by these resource agencies will be used to adapt monitoring plans and schedules, as appropriate, which will be submitted for State and USFS approval.

References

AScI Corporation. 2000a. Results of life-cycle *Chironomus tentans* habitability test with tailing sample from Utah and lake sediments from Alaska.

AScI Corporation. 2000b. Results of 42-day *Hyalella azteca* habitability tests with tailing sample from Dawson Metallurgical Laboratories, Utah and lake sediment samples from Lower Slate Lake, Alaska.

EVS Environment Consultants. 1999a. Kensington Project, Underwater Tailings Placement Studies: Tailings Habitability Testing.

Kline Environmental Research, LLC. 2001. Kensington Project, June 2000 Slate Creek Basin Survey, Data Report.

Kline, E. August 23, 2004. Technical memorandum to Rick Richins. Subject: Dolly Varden spawning location.

Kline, E.R and M.S. Stekoll. 2001. Colonization of mine tailings by marine invertebrates. *Marine Environmental Research* 51:13-37.

U.S. Forest Service. December 2004. Kensington Gold Project, Final Supplemental Environmental Impact Statement.

Table 1. Kensington TSF ecological monitoring plan summary.

Category	Monitoring Component	Applicable Objective	Estimated number of times that each monitoring component will take place							
			TSF		Upper Slate Lake		Spectacle Lake		Mid-Lake Slate Creek	
			Operation	Reclamation	Operation	Reclamation	Operation	Reclamation	Operation	Reclamation
Tailings	geochemistry	1,2d	Quarterly	none	none	none	none	none	none	none
	habitability	1, 2d	see text	see text	see text	none	none	none	none	none
Fisheries	Dolly Varden population size	2a, 3	3	3	3	3	none	none	none	none
	Dolly Varden condition	2a, 3	3	3	3	3	none	none	regularly	regularly
	Dolly Varden parr abundance	2a	3	3	3	3	none	none	regularly	regularly
	stickleback catch per unit effort	2a	3	3	3	3	none	none	regularly	regularly
Invertebrates	benthic population	2a	3	3	3	3	none	none	none	none
	zooplankton population	2a	3	3	3	3	none	none	none	none
Plants	rooted aquatic plant coverage	2b, 3	1 *	3	1 *	1	1 *	1	none	none
Wildlife	amphibians	2c	periodically	periodically	periodically	periodically	none	none	none	none
	other riparian or aquatic wildlife	2c	periodically	periodically	periodically	periodically	none	none	none	none
Water column	metals and ammonia	1, 3	none	6 (3 yr x 2 per yr)	none	none	none	none	none under this plan	none under this plan
	dissolved oxygen/temperature	2b	none	6 (3 yr x 2 per yr)	6 (3 yr x 2 per yr)	6 (3 yr x 2 per yr)	6 (3 yr x 2 per yr)	6 (3 yr x 2 per yr)	none	none
	phytoplankton chlorophyll a	2b	none	6 (3 yr x 2 per yr)	6 (3 yr x 2 per yr)	6 (3 yr x 2 per yr)	6 (3 yr x 2 per yr)	6 (3 yr x 2 per yr)	none	none

* To be conducted prior to construction.

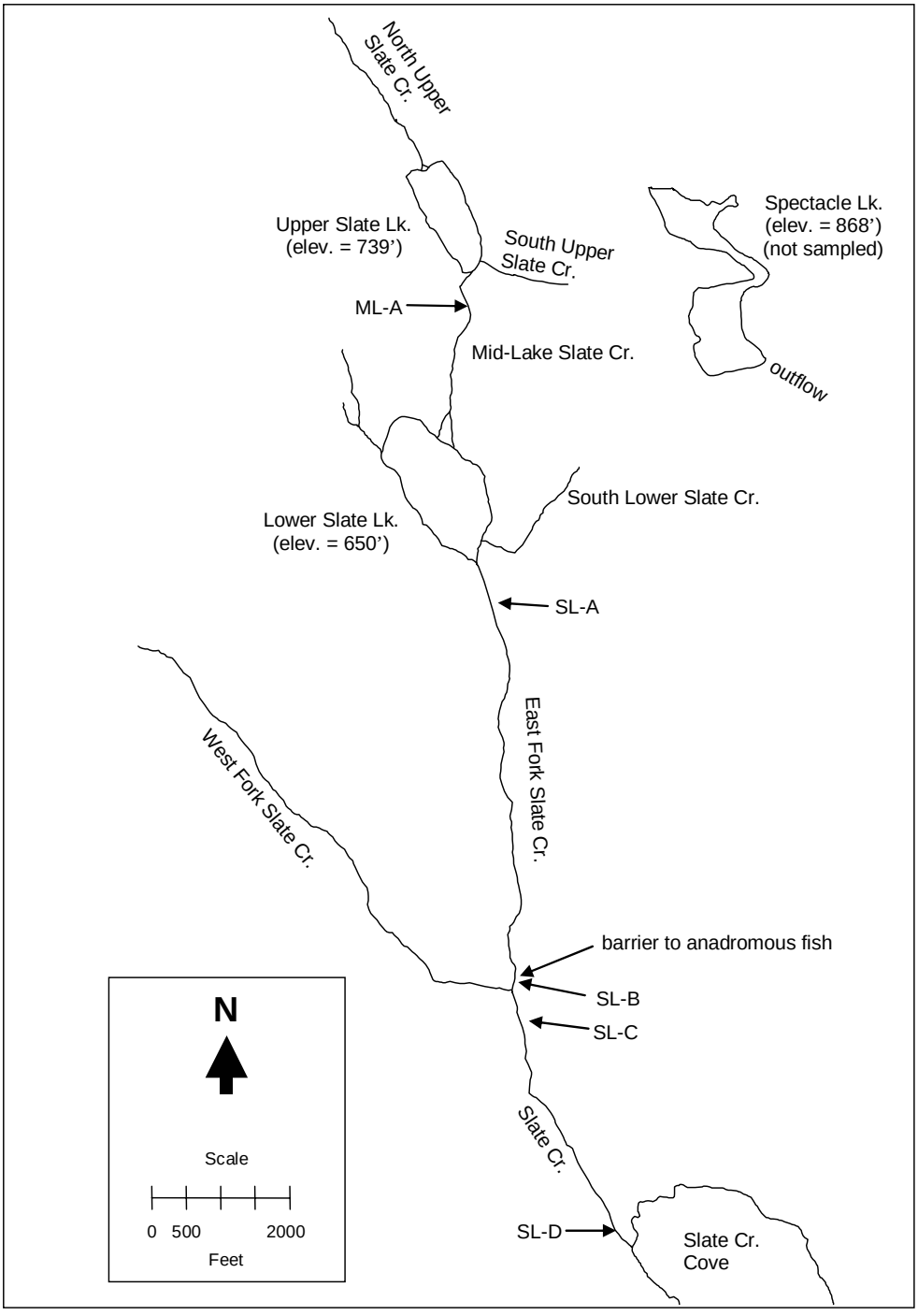

Figure 1. Sampling stations in the Slate Creek watershed.