

Star-Hope Preliminary Assessment Report

Custer County
State of Idaho



Department of Environmental Quality

December 2006

Submitted to:
U. S. Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, WA 98101

Star-Hope
Preliminary Assessment Report
December 2006

Table of Contents

List of Acronyms	v
Section 1. Introduction	1
1.1 Overview	1
Section 2. Site Description, Operational History, and Waste Characteristics	5
2.1 Current and Potential Future Land Uses	5
2.2 Wildlife and Wetlands	5
2.3 Individual Site Overviews and Waste Characteristics	8
2.3.1 Adit 1	8
2.3.2 Star Hope Mine	11
2.3.3 Gamebet Mine	27
Section 3. Pathway and Environmental Hazard Assessment	33
3.1 Ground Water	33
3.2 Surface Water	36
3.3 Soil Exposure and Air	38
Section 4. Summary and Conclusions	41
4.1 Presence of Wetlands	41
4.2 Impact on Water Quality	41
4.3 Potential Exposure for Wildlife and Vegetation	41
4.4 Potential Exposure for Humans.....	41
References	43
Appendix A: Sampling Locations Photo Log	45
Appendix B: Analytical Data	49
Report Index	51

List of Figures

Figure 1. Location of the Star Hope Mine area within the State of Idaho	2
Figure 2. Topographic overview of the Copper Basin Area	3
Figure 3. Aerial photograph of the Copper Basin Area (at the same scale as Figure 2).	4
Figure 4. Four mile radius for the Star Hope and Gamebet Mine sites.	6
Figure 5. One-mile radius setting for the Star Hope and Gamebet Mine sites.	7
Figure 6. Aerial view of Adit 1.....	10
Figure 7. Aerial photograph of the Star Hope Mine.	14
Figure 8. Site sketch of the Star Hope Mine, including environmental sample locations.....	15
Figure 9. Small-scale sketch of the main adit area of the Star Hope Mine.....	16
Figure 10. Aerial photograph with site sketch of the Gamebet Mine.	27
Figure 11. Basic Geology in the Star Hope Mining Area.....	34
Figure 12. Basic Lithology of the Star Hope Mining Area.....	35

Star-Hope
Preliminary Assessment Report
December 2006

Figure 13. Surface water 15-mile Target Distance Limit from the Preliminary Assessment Sites.37
Figure 14. Sensitive species identified in the vicinity of the Preliminary Assessment sites.39

List of Photographs

Photo 1. View of Adit 1 taken from the landing facing east.9
Photo 2. Ore Bin, located in the tailings/waste rock pile at the main Star Hope adit. Photo is taken from the north end of the tailings facing south..... 18
Photo 3. Ore bin located in the waste rock taken from the northwest tip of the pile facing southeast, showing the difference between the waste rock located on the right side of the picture, and the tailings, which are located on the left side of the picture. 19
Photo 4. Main adit at the Star Hope Mine, facing southwest, looking directly at adit.....21
Photo 5. Top of the waste rock pile from the adit facing north. Photo shows the adit discharge flow, where approximately a third of the flow is going down the road toward the southeast, while the other two-thirds heads north along the east side of the waste rock pile. 22
Photo 6. Upper adit of the Star Hope Mine, facing east. 26
Photo 7. Upper adit area of the Star Hope Mine, facing north..... 26
Photo 8. View from the waste rock pile at the lower adit of the Gamebet Mine, facing southwest, with the waste rock seen in foreground and Star Hope Creek visible in the background. 29
Photo 9. Gamebet Adit, facing east..... 31
Photo 10. Stream Sediment and Surface Water Sample number 1A-PPE, located on Star Hope Lake Outlet down gradient of the tailings, waste rock and adit flow of the Star Hope Mine. 45
Photo 11. Adit surface water sample number AW1A from the Star Hope Mine Adit outflow. 45
Photo 12. Stream sediment and surface water samples at location 2A upstream of the Star Hope Mine on Star Hope Lake Outlet..... 45
Photo 13. Star Hope Creek down gradient surface water sample at location SHDG. 45
Photo 14. Tailings sediment sample taken from the tailings located at the Main adit of the Star Hope Mine..... 46
Photo 15. Star Hope Creek up gradient surface water sample at location SHUG..... 46
Photo 16. Gamebet Mine adit outflow surface water sampling point (AW4)..... 47

List of Tables

Table 1. August 2, 2006 total soils analysis data from the tailings pile at Star Hope Mine..... 17
Table 2. August 2, 2006 total soils analysis data of stream sediment samples taken up and down gradient of the tailings pile at Star Hope Creek..... 20
Table 3. Surface Water Sample Results from the Main Adit Discharge at the Star Hope Mine. 23
Table 4. Surface Water Sample Results from up- and down-gradient of the main adit and waste rock piles on the Star Hope Lake Outlet. 24
Table 5. Star Hope Creek surface water sampling results from up- and down-gradient of the Star Hope Lake Outlet confluence..... 25
Table 6. Sample Results from the adit discharge at the Gamebet Mine. 30

List of Acronyms

Acronym	Definition
303 (d)	Section of the Clean Water Act in Idaho
ATV	All Terrain Vehicle (a.k.a. four-wheeler)
bgs	below ground surface
DEQ	Idaho Department of Environmental Quality
EPA	United States Environmental Protection Agency
gpm	gallons per minute
PA	Preliminary Assessment
ppm	parts per million
TDL	Target Distance Limit
TMDL	Total Maximum Daily Loads
USBM	United States Bureau of Mines
USFS	United States Forest Service
USGS	US Geological Survey

This page intentionally left blank for correct double-sided printing

Section 1. Introduction

This document presents the results of the preliminary assessments (PA) in the Star Hope Creek drainage. The Department of Environmental Quality (DEQ) was contracted by Region 10 of the United States Environmental Protection Agency (EPA) to provide technical support for completion of preliminary assessments at various mines within the Copper Basin Mining District in Custer County, Idaho.

DEQ often receives complaints or information about sites that may be contaminated with hazardous waste. These sites can include abandoned mines, rural airfields that have served as bases for aerial spraying, old landfills, illegal dumps, and abandoned industrial facilities that have known or suspected releases.

In February 2002, DEQ initiated a *Preliminary Assessment Program* to evaluate and prioritize assessment of such potentially contaminated sites. Due to accessibility and funding considerations, priority is given to sites where potential contamination poses the most substantial threat to human health or the environment.

For additional information about the Preliminary Assessment Program, see the following:

http://www.deq.idaho.gov/waste/prog_issues/mining/pa_program.cfm

1.1 Overview

The Copper Basin Mining District is located in the southern part of Custer County, along the border with Blaine County. Although there are multiple historic mining sites within the district, this preliminary assessment primarily addresses two sites within the Star Hope Creek sub-watershed, including the *Star Hope Group* and the *Gamebet Claim Group*. An unnamed mine adit, dubbed Adit 1, located about a mile up Star Hope Creek from the Star Hope Mine was also assessed.

The area is remote, with few private property sites. The general location of the Star Hope and Gamebet Claim mines is identified in Figure 1. The closest town to these mining sites is the city of Mackay, which is approximately 22 miles by air or 58 miles by road. Figure 4 and Figure 5 show the topography within four-mile and one-mile radii around the sites, respectively.

A U.S. Forest Service (USFS)-developed campground exists within a four-mile radius of both of the sites assessed. This campground, located on the Copper Basin Loop road, has two wells, which supply potable water to the campground. Dozens of undeveloped dispersed campsites are also located in proximity to the mine sites.

The Copper Basin Loop road is a gravel road accessible to all vehicle types, but Forest Road 508, which connects the Star Hope Campground to the Gamebet and Star Hope mines, is strictly a four-wheel drive road.

Star-Hope
Preliminary Assessment Report
December 2006

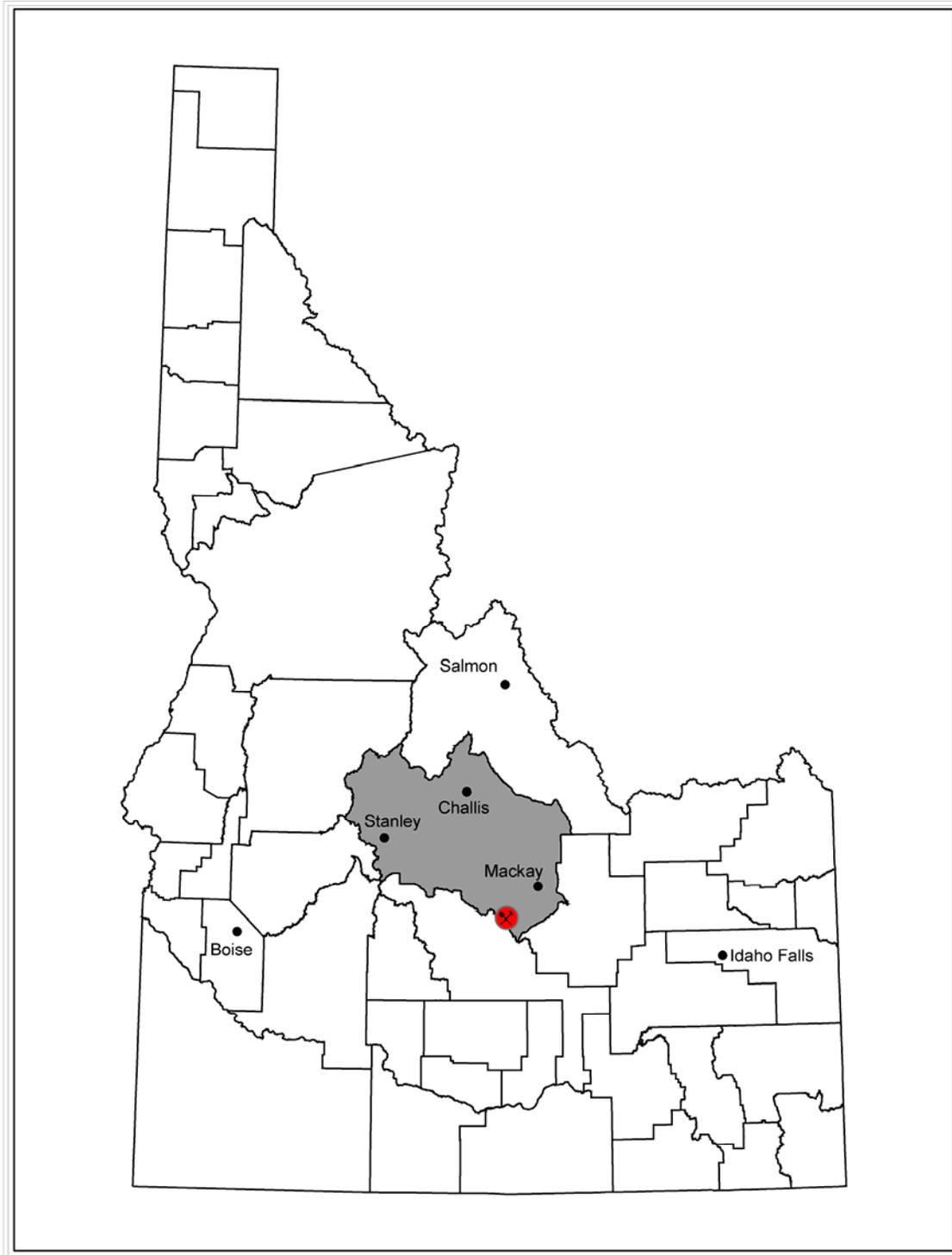


Figure 1. Location of the Star Hope Mine area within the State of Idaho.

Star-Hope
Preliminary Assessment Report
December 2006

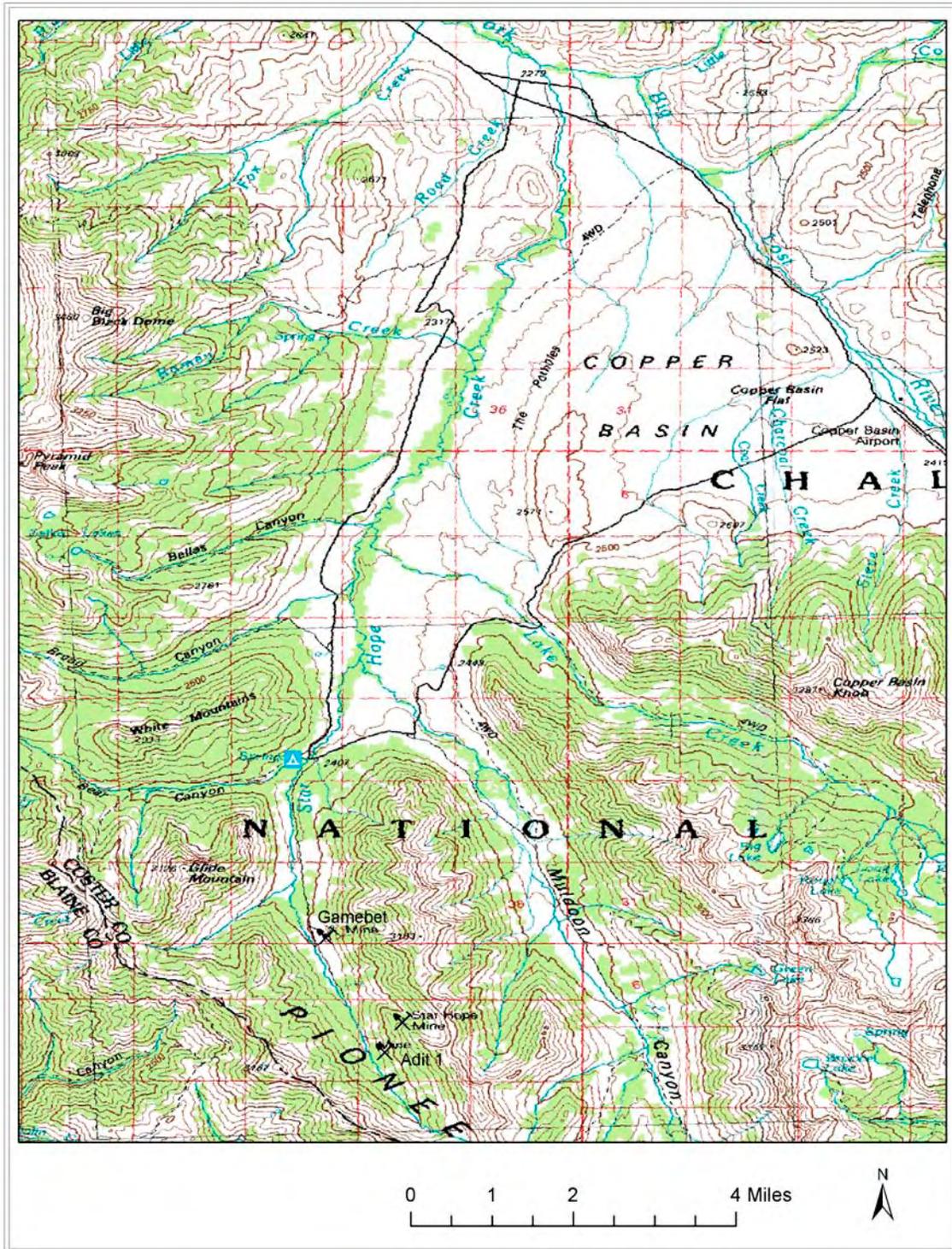


Figure 2. Topographic overview of the Copper Basin Area.



Figure 3. Aerial photograph of the Copper Basin Area (at the same scale as Figure 2).

Section 2. Site Description, Operational History, and Waste Characteristics

Physical characteristics of Adit 1, the Star Hope Group, and the Gamebet Claim Group mine sites are presented in the following, along with the mines' operational histories and characteristics of the waste that remains.

2.1 Current and Potential Future Land Uses

Current land uses in the area (Figure 4 and Figure 5 show features within four-mile and one-mile radii of the sites) are identified by the USFS as biking, camping, fishing, hiking, backpacking, horseback riding, picnicking, scenic driving, wildlife viewing, and off-road vehicle touring (USFS 2006). The Starhope Campground is accessible from the Copper Basin Loop road by all vehicle types and is a developed campground with restrooms and potable water.

During fieldwork conducted for this report, DEQ site inspectors observed visitors camping, fishing, scenic driving, and utilizing off road vehicles for recreation in the area.

Future land use could potentially include some seasonal homes on the private parcels of property in the sub-basin; however, due to the remoteness and access issues at the Star Hope mine, it seems unlikely for this to occur in the near future.

2.2 Wildlife and Wetlands

Wildlife seen during fieldwork included deer, cougar, antelope, and brook trout; bear sign was also seen.

Fish presence/absence studies have confirmed both brook trout (*Salvelinus fontinalis*) and sculpin (*Cottus*) present in Star Hope Creek. In the Big Lost River watershed above the reservoir there have also been whitefish (*Prosopium*), rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*) and westslope cutthroat (*Oncorhynchus clarki lewisi*) presence confirmed.

Official wetland surveys for the area could not be found, but aerial photographs and direct observation seem to indicate that the Star Hope Creek valley contains interspersed wetland areas.

Star-Hope
Preliminary Assessment Report
December 2006

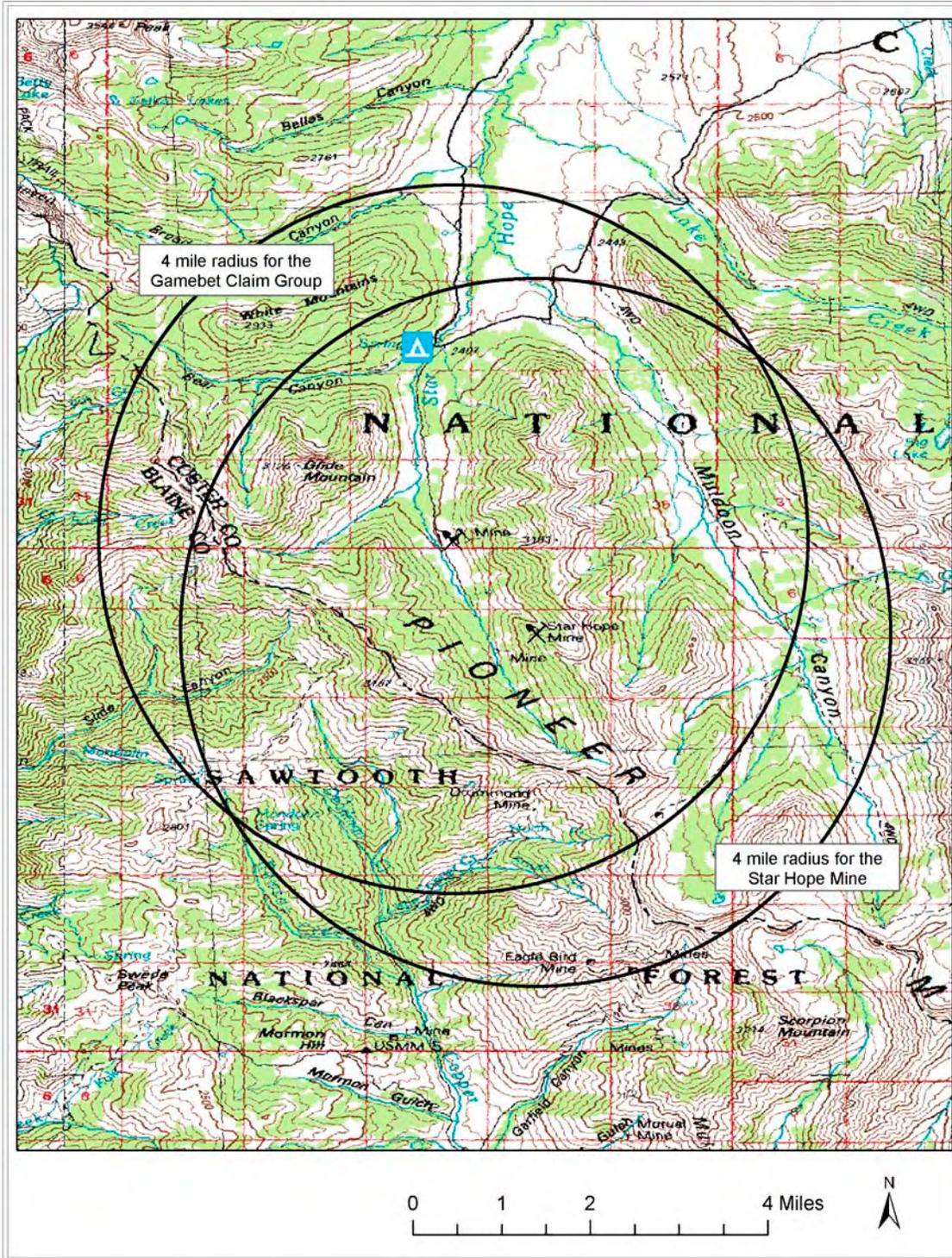


Figure 4. Four mile radius for the Star Hope and Gamebet Mine sites.

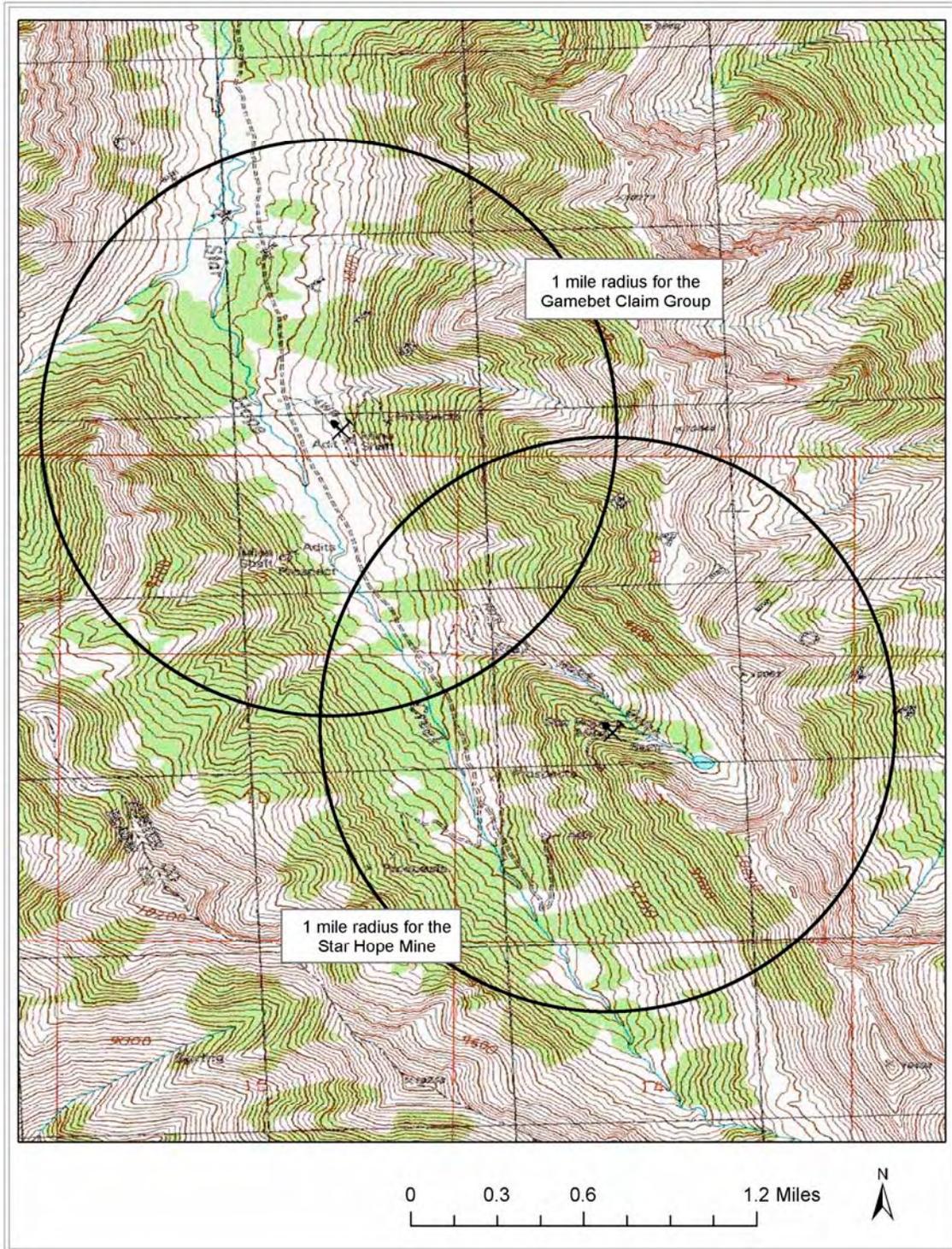


Figure 5. One-mile radius setting for the Star Hope and Gamebet Mine sites.

2.3 Individual Site Overviews and Waste Characteristics

Overview descriptions, ownership, operational histories, and waste characteristics for the mine sites are discussed in the following, beginning with the unnamed adit dubbed *Adit 1*, and followed by the Star Hope Mine and the Gamebet Mine.

2.3.1 Adit 1

Located a little over a mile up Star Hope Creek from the Star Hope Mine, this unnamed, inactive adit (Photo 1) is located on the east side of the creek, on USFS property, and is accessible by high-clearance four-wheel drive vehicles. Adit 1 was originally thought by the inspectors to be associated with the Star Hope Mine, but further historical and geologic investigation seems to indicate a correlation with the adjacent workings of the Bent Pine Tree Group, which is located on the west side of Star Hope Creek.

2.3.1.1 *Ownership and History*

The Bent Pine Tree Group, also known as Bent Pine Tree No. 10, lies immediately west of Adit 1 on the west side of Star Hope Creek. Located at latitude (DD) 43.6878 and longitude -113.9358, the mine is situated on an unpatented claim. The current owner of the property is the USFS, Challis National Forest.

Historical information relating to dates of operation and production for Adit 1 could not be found. Data presented by Tucheck and Ridenour (1981) identified three open adits, one caved adit, and one small prospect pit. The recognized ore zone appeared as contact alteration zones, nearly 1.5 meters thick in a limestone host rock adjacent to porphyry dikes. Five samples were collected:

... four samples across zones; average trace gold, 7 grams silver per metric ton, 0.08 percent copper, 0.08 percent lead, and 0.09 percent zinc. Grab sample of iron-oxide-stained porphyry; trace gold, 17 grams silver per metric ton, 1.9 percent copper, 3.36 percent lead, and 2.6 percent zinc”

(Tucheck and Ridenour, 1991, p.290)

Based upon the strike of the porphyry dikes and their likely projection toward the east side of Star Hope Creek, it appears the miners were seeking to locate additional alteration zones with the driving of Adit 1. Although this adit was caved and little mineralized rock was visible on the dump, the lithology appears to correlate more closely with the Bent Pine Tree Group than with the Star Hope mine.



Photo 1. View of Adit 1 taken from the landing facing east.

A small landing built with waste rock had been placed in front of the adit. This landing and disturbed area measures approximately 15,800 square feet (.36 acres), contains 4,105 cubic yards of material, and is located approximately 722 feet above Star Hope Creek. The adit had no discharge during the inspection, and there were no morphological indicators that the adit has typically discharged any water.

An aerial view of Adit 1 is shown in Figure 6.

Star-Hope
Preliminary Assessment Report
December 2006



Figure 6. Aerial view of Adit 1.

2.3.2 Star Hope Mine

Located on the Star Hope Lake outlet, above the confluence with Star Hope Creek, this inactive mining site contains two identified adits--the main adit and the upper adit--each with an associated waste rock pile, and the remnants of a historic jig mill. The site is accessible by ATV or foot.

The main adit area is located in the Star Hope Lake outlet drainage area, which flows into Star Hope Creek, while the upper adit area is in the drainage area above Star Hope Creek just to the south of the main adit. An aerial photograph and full site sketch can be viewed in Figure 7 and Figure 8, respectively. Figure 9 provides a sketch of the main adit area.

2.3.2.1 *Ownership and History*

According to Umpleby (1917), the Star Hope Mine was probably the first mineral location identified within the Copper Basin and “is said to have produced \$50,000 from rich lead-silver ores during the decade that ended about 1890” (p. 105). The workings extended approximately 1,500 feet, with several short tunnels on five levels, the long main tunnel, and a 70° inclined shaft from the upper adit to the main adit level (Lewis, personal communication, 2006). “The ore was concentrated for shipment with two hand jigs” (Umpleby, 1917, p. 105).

The mine was located in the early 1880s by the Lewis family. On October 19, 1891, the Star of Hope claim was patented to Isaac I. Lewis. According to Kenneth E. Lewis (2006), the patented mining property remained within the family, passing from Isaac to his son, Horace, and then to Isaac’s grandson, George J. Lewis. When George died, the mine passed to his sister, Gertrude. From the estate of their great-aunt Gertrude, Mr. Lewis and his brother, Donald W. Lewis, inherited a majority stake in the mine, though a minor fraction was also willed to the Episcopal Diocese of Boise.

In 1954 the Lewis brothers began working on the property. A road was constructed from Forest Road 508 to the main adit and the upper adit. According to Mr. Lewis (ibid), most of their activities involved the partial refurbishing of the workings, detailed underground mapping (five levels), assaying of ore (argentite and galena) and assessment of ore reserves.

Mr. Lewis estimated the ore reserves at \$1,000,000. These projected reserves encouraged the Lewis brothers to apply for a contract with the Defense Minerals Exploration Program (DMEA). Following an assessment by the program’s geologists (DMEA-3889), the Star Hope mine application was denied in 1955. Further exploration activities ceased, and the mine resumed its inactive status.

2.3.2.2 *Geology*

Star Hope Creek exposes the Copper Basin thrust plate of the Copper Basin Formation, one member of which had been delineated as “a middle limestone unit equivalent to the Upper Mississippian Drummond Mine Limestone of Paull and others (1972)” (Dover, p.39):

Drummond Mine Limestone Member is composed of mainly gray, yellow-brown-weathering, slabby to platy, silty micritic limestone, but varies from silty limestone to calcareous siltstone. Locally the limestone is silicified and (or) recrystallized. Dark and light color banding is prominent where dark argillaceous laminations or thin interbeds are present. The middle and upper parts of the limestone contain more argillaceous beds than the lower part.

(ibid).

Rocks in the vicinity of the mine are carbonaceous argillite and quartzite with thin interbeds of limestone intruded by rhyolite and granitic dikes. The sedimentary strata are folded and crumpled and generally strike northwest and dip northeast.

(Tuchek & Ridenour, 1981, p.288-89)

Dikes and other small hypabyssal intrusive bodies are scattered through the Copper Basin area; the dikes tend to occupy well-developed fracture sets, particularly those trending northeast and east.

(ibid, p. 50)

Swarms of fine-grained silicic dikes and quartz porphyry dikes cut both structural plates (Glide Mountain and Copper Basin) of the Copper Basin Formation on the ridges between Star Hope Creek and Little Wood River, and are associated with locally intense alteration.

(ibid, p. 51)

Lewis (2006) mapped granitic dikes through the underground workings of the Star Hope mine. Umpleby (1917) suggested the rocks near the mine “comprise a series of rather intensely metamorphosed bluish-gray fine-grained quartzites and dark-blue siliceous limestones cut by dikes of granite and rhyolite porphyry” (p. 105).

2.3.2.3 *Ore Deposits*

According to Umpleby (1917), the lead-silver veins of the Star Hope “seem to be replacement deposits along a sheared or fissured zone in fine-grained quartzite” (p. 104). Umpleby examined waste rock dumps and noted “partly oxidized galena scattered irregularly through medium-grained bluish-white quartz. A little smithsonite and considerable iron oxide suggests the presence of sphalerite and pyrite in the primary ore. The workings were inaccessible at the time of visit, but from the composition of the dumps it is probable that the vein is inclosed in the fine-grained quartzite” (ibid, p.105).

Mr. Lewis (2006) indicated the ore zones lie within the quartzite, but adjacent to granitic dikes. He noted the ore primarily contained argentite and galena. Simons (1981) noted “the highest molybdenum content of any rock sampled was 300 ppm, in a fault breccia at the Star Hope mine” (p.127).

2.3.2.4 *Production*

Simons (1981) made the following observation about production:

The Star Hope mine is estimated to have produced about \$50,000 during the 1880s (Umpleby, 1917, p.105); if most of this amount is attributable to silver, then at the same

ratio of silver to lead and the same average price of silver, about 1,660,000 lb (750,000 kg) of lead may have been produced

(p.122)

Simons further noted that “at an average price of \$0.60 per oz for silver” the Star Hope may have produced 83,000 oz of silver (p.133).

2.3.2.5 *Previous Geological Reports*

In addition, to annual reports generated by the Idaho Inspector of Mines (1901-1974), Umpleby first described the ore deposits in the Copper Basin district in 1917, from field work conducted in 1912. Later reports, which included the Copper Basin, were published by Nelson and Ross in 1969 and Dover, Simons, Tucheck, et al. in 1981.

Star-Hope
Preliminary Assessment Report
December 2006



Figure 7. Aerial photograph of the Star Hope Mine.

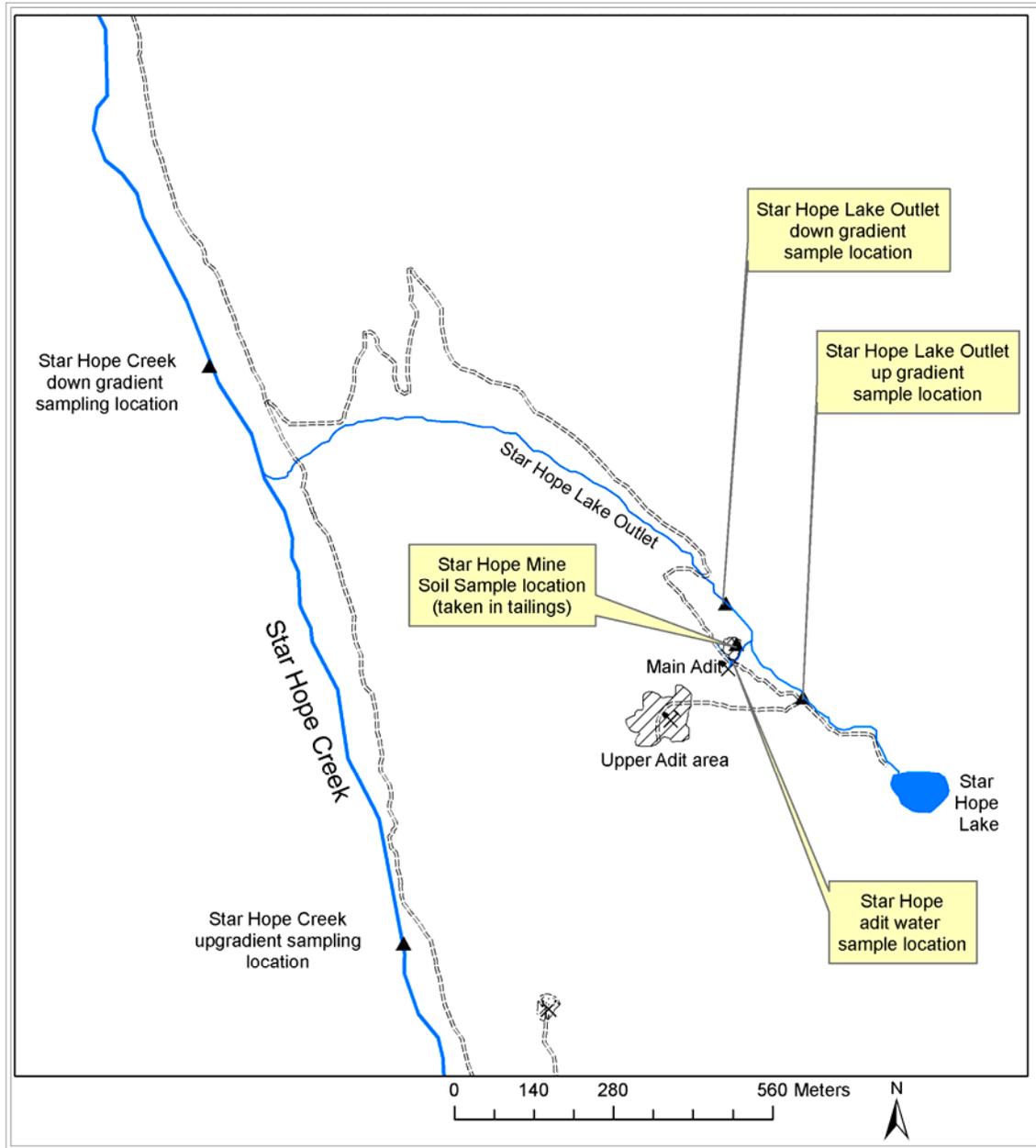


Figure 8. Site sketch of the Star Hope Mine, including environmental sample locations.

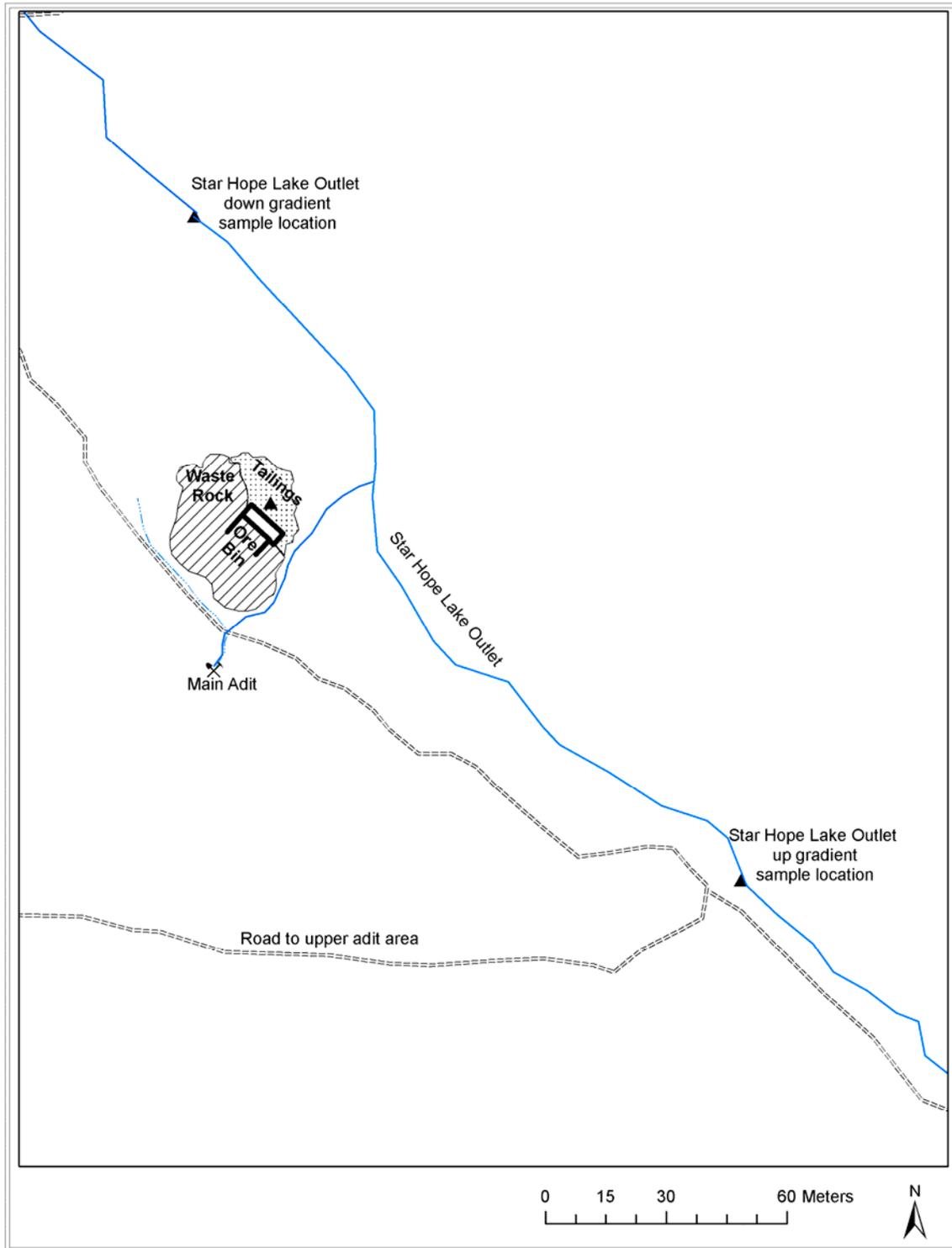


Figure 9. Small-scale sketch of the main adit area of the Star Hope Mine.

2.3.2.6 *Soil and Sediment Analysis*

The main adit area comprises an adit with flow, a waste rock pile, the remains of an ore bin (Photo 2 and Photo 3), and what appears to be a small-scale mill with some remnant tailings. Figure 9 depicts this main adit area in closer detail.

The entire pile at the main adit is approximately 0.25 acres in area, approximately a third of which is tailings. There is an estimated 8,900 cubic yards of waste rock and 180 cubic yards of tailings within this pile. The majority of the tailings is piled below the ore bin and extends down the slope as a veneer.

A soil sample was collected from the tailings pile at the main adit (Figure 8) and analyzed for total metals of the identified constituents of concern. The results are presented in Table 1. This sample, a composite of material between 2-8 inches in depth, indicates elevated levels of silver, arsenic, cadmium, copper, iron, mercury, lead, selenium, and zinc which exceeded the Idaho Default Target Levels (IDTLs) under the Idaho Risk Evaluation Model (REM).

Table 1. August 2, 2006 total soils analysis data from the tailings pile at Star Hope Mine.

Chemical of Concern	Result (mg/kg)	Idaho Initial Default Target Levels under REM (mg/kg)
Manganese	152	223
Silver	567	0.189
Aluminum	1620	--
Arsenic	72.8	0.391
Barium	136	896
Beryllium	0.28	1.63
Cadmium	12.7	1.35
Chromium	1.8	2130
Copper	3380	921
Iron	18000	5.76
Mercury	0.313	0.00509
Nickel	9.4	59.1
Lead	90800	49.6
Selenium	337	2.03
Zinc	1590	886



Photo 2. Ore Bin, located in the tailings/waste rock pile at the main Star Hope adit. Photo is taken from the north end of the tailings facing south.



Photo 3. Ore bin located in the waste rock taken from the northwest tip of the pile facing southeast, showing the difference between the waste rock located on the right side of the picture, and the tailings, which are located on the left side of the picture.

Stream sediment samples were taken, both up- and down-gradient, of the tailings pile in the Star Hope Lake Outlet. The State of Idaho does not currently have specific stream sediment criteria, so the data collected (Table 2) is presented in as a comparison between the up-gradient and down-gradient locations to determine if an impact from the tails has been made in the creek. Any chemical of concern seen at a concentration three times higher in concentration below the tails as compared to above the tails is considered to be a significant impact in this evaluation.

The down-gradient stream sediment location on the Star Hope Lake Outlet (Figure 8) is considered to be the Point of Potential Exposure (PPE). Another sample location is located up gradient of the entire site and is also identified in Figure 8. The total metals data from the tailings themselves, which are located approximately 27 yards up-slope from the Star Hope Lake Outlet is also presented in Table 2 to provide comparison information.

Table 2. August 2, 2006 total soils analysis data of stream sediment samples taken up and down gradient of the tailings pile at Star Hope Creek.

Chemical of Concern	Tailings	Star Hope Lake Outlet down gradient sample location	Star Hope Lake Outlet up gradient sample location	Screening Level¹
Manganese	152	3570	4,110	12,330
Silver	567	3.93	1.17	3.51
Aluminum	1,620	8,740	15,300	45,900
Arsenic	72.8	20	11	33
Barium	136	77.8	92.4	277.2
Beryllium	0.28	1.79	1.11	3.33
Cadmium	12.7	2.79	0.33	0.99
Chromium	1.8	26.3	24.5	73.5
Copper	3,380	273	39.3	117.9
Iron	18,000	18,400	20,400	61,200
Mercury	0.313	<0.033	<0.033	0.099
Nickel	9.4	55.7	37.4	1,12.2
Lead	90,800	1,730	77.3	231.9
Selenium	337	14	4	12
Zinc	1,590	526	185	555

1: This value was derived from multiplying the upgradient (2A) concentrations by a factor of 3 in order to give a site specific screening level to determine impact.

Based on this comparison data, constituents of concern, of which the waste rock at the main adit may be directly contributing to Star Hope Outlet Creek, include silver, cadmium, copper, lead and selenium. Zinc may also be considered a constituent of concern due to the elevated levels found, even though concentrations did not quite reach three times the up-gradient sample.

The main adit identified is located above the Star Hope Outlet Creek and had a steady discharge of approximately five gallons per minute during the site inspection on August 2, 2006 (Photo 4). As the water discharged from the adit, approximately a third of the flow followed the road toward the northwest, while the other two-thirds channeled directly northeast along the east side of the waste rock pile (Photo 5). This larger flow connected directly with the Star Hope Lake outlet.



Photo 4. Main adit at the Star Hope Mine, facing southwest, looking directly at adit.



Photo 5. Top of the waste rock pile from the adit facing north. Photo shows the adit discharge flow, where approximately a third of the flow is going down the road toward the southeast, while the other two-thirds heads north along the east side of the waste rock pile.

In-stream water column data was collected from the adit water as well as up gradient and down gradient sample locations on the Star Hope Lake Outlet (Figure 8). This data is presented in Table 3 and Table 4, in comparison to the State of Idaho water quality standards, which are based on the protection of aquatic life.

Star-Hope
Preliminary Assessment Report
December 2006

Table 3. Surface Water Sample Results from the Main Adit Discharge at the Star Hope Mine.

Constituent of Concern	Star Hope Adit Water Result (mg/l)	CMC ^{2,3} @ 117 mg/l	CCC ^{2,4} @ 117 mg/l
Hardness ¹	117	--	--
Silver	<0.005	0.00452	--
Aluminum	<0.03	--	--
Arsenic	<0.025	--	--
Barium	0.0336	--	--
Beryllium	<0.002	--	--
Cadmium	0.0276	0.00235	0.00116
Chromium	<0.006	--	--
Copper	0.0835	0.0197	0.013
Iron	<0.06	--	--
Mercury	<0.0002	0.0021	0.000012
Nickel	0.129	0.535	0.059
Lead	<0.0005	0.077	0.00298
Selenium	0.00674	0.02	0.005
Zinc	1.91	0.134	0.135
Field Parameters			
pH	7.14 std. units		
Specific Conductance	286 µ-siemen/cm		
Temperature	12.2 °C		

1 Hardness is calculated from calcium and magnesium concentrations

2 Both the CMC and CCC are State of Idaho Water Quality Standards as set forth by the Idaho Administrative Procedures Act (IDAPA) section 58.01.02.

3 CMC= Criterion Maximum Concentration is defined as the maximum instantaneous or one (1) hour average concentration and should adequately protect aquatic organisms from acute toxicity if not exceeded more than once every three (3) years. This is equivalent to "acute criteria."

4 CCC= Criterion Continuous Concentration is defined as the four (4) day average concentration of a toxic and should adequately protect aquatic organisms from chronic toxicity if not exceeded more than once every three (3) years. This is equivalent to "chronic criteria."

These analytical results (Table 3) show that the water coming from the adit does not meet Idaho water quality standards for cadmium, copper, nickel, selenium, and zinc. The adit water also indicates that there is a relatively high hardness value, which aids in buffering these metals to a certain extent.

Star-Hope
Preliminary Assessment Report
December 2006

Table 4. Surface Water Sample Results from up- and down-gradient of the main adit and waste rock piles on the Star Hope Lake Outlet.

Constituent of Concern	Star Hope Lake Outlet down gradient Result (mg/l)	Star Hope Lake Outlet up gradient Result (mg/l)	CMC ^{2,3} @ 25 mg/l	CCC ^{2,4} @ 25 mg/l
Hardness ¹	23.3	6.1	--	--
Silver	<0.005	<0.005	0.00032	--
Aluminum	<0.03	<0.03	--	--
Arsenic	<0.025	<0.025	--	--
Barium	0.0052	0.0022	--	--
Beryllium	<0.002	<0.002	--	--
Cadmium	0.00126	<0.0003	0.00052	0.0004
Chromium	<0.006	<0.006	--	--
Copper	<0.003	<0.003	0.0046	0.0035
Iron	<0.06	<0.06	--	--
Mercury	<0.0002	<0.0002	0.0021	1E-05
Nickel	<0.01	<0.01	0.145	0.016
Lead	0.00347	<0.0005	0.014	0.0005
Selenium	<0.005	<0.005	0.02	0.005
Zinc	0.102	<0.01	0.036	0.036
Field Parameters				
pH	7.21 std. units	7.11 std. units		
Specific Conductance	66.6 µ-siemens/cm	25.5 µ-siemens/cm		
Temperature	7.9 °C	12.2 °C		

1 Hardness is calculated from calcium and magnesium concentrations.

2 Both the CMC and CCC are State of Idaho Water Quality Standards as set forth by the Idaho Administrative Procedures Act (IDAPA) section 58.01.02.

3 CMC= Criterion Maximum Concentration is defined as the maximum instantaneous or one (1) hour average concentration and should adequately protect aquatic organisms from acute toxicity if not exceeded more than once every three (3) years. This is equivalent to "acute criteria."

4 CCC= Criterion Continuous Concentration is defined as the four (4) day average concentration of a toxic and should adequately protect aquatic organisms from chronic toxicity if not exceeded more than once every three (3) years. This is equivalent to "chronic criteria."

The up- and down-gradient samples on the Star Hope Lake Outlet (Table 4) indicate adit water is increasing the hardness in the stream. Concentrations of cadmium, lead, and zinc are all elevated at the down-gradient location, most likely caused by the adit water inflow. However, surface water quality samples collected down-gradient of the Star Hope Lake Outlet confluence indicate that any impacts from the mine do not extend to Star Hope Creek itself (Table 5).

Table 5. Star Hope Creek surface water sampling results from up- and down-gradient of the Star Hope Lake Outlet confluence.

COC	Star Hope Creek up gradient result (mg/l)	Star Hope Creek down gradient result (mg/l)	CMC ^{1,2} @ 79.1 mg/l	CCC ^{1,3} @ 79.1mg/l
Silver	<0.005	<0.005	2.31	--
Aluminum	<0.03	<0.03	--	--
Arsenic	<0.025	<0.025	--	--
Barium	0.0045	0.0045	--	--
Beryllium	<0.002	<0.002	--	--
Cadmium	<0.0003	<0.0003	0.0016	0.00087
Chromium	<0.006	<0.006	--	--
Copper	<0.003	<0.003	0.0136	0.0093
Iron	<0.06	<0.06	--	--
Mercury	<0.0002	<0.0002	0.0021	1.2E-05
Nickel	<0.01	<0.01	0.384	0.043
Lead	<0.0005	<0.0005	0.05	0.00195
Selenium	<0.005	<0.005	0.02	0.005
Zinc	<0.01	<0.01	0.096	0.097
Field Parameters				
Hardness ⁴	79.1 mg CaCO ₃ /L	86.8 mg CaCO ₃ /L		
pH	6.63 s.u.	8.29 s.u.		
specific conductance	178.5 us/cm	189.1 us/cm		
Temperature	9 degrees C	10.5 degrees C		

1 Both the CMC and CCC are State of Idaho Water Quality Standards as set forth by the Idaho Administrative Procedures Act (IDAPA) section 58.01.02.

2 CMC= Criterion Maximum Concentration is defined as the maximum instantaneous or one (1) hour average concentration and should adequately protect aquatic organisms from acute toxicity if not exceeded more than once every three (3) years. This is equivalent to "acute criteria."

3 CCC= Criterion Continuous Concentration is defined as the four (4) day average concentration of a toxic and should adequately protect aquatic organisms from chronic toxicity if not exceeded more than once every three (3) years. This is equivalent to "chronic criteria."

*Hardness is calculated from calcium and magnesium concentrations.

2.3.2.7 *Assessment of the Upper Adit*

Approximately 1.08 acres of exposed and disturbed waste rock lies at and below the upper adit location (Photo 6, Photo 7). Waste rock with an estimated volume of 100 cubic yards constitutes the adit landing and extends down the very steep slope below the lower road. Most of the waste rock volume appears as a veneer covering the slope.

There was no discharge from this location and morphological features suggest that the site does not flow seasonally. The waste rock is located approximately 1,755 feet up slope of Star Hope Creek.

Environmental samples were not taken from this location.



Photo 6. Upper adit of the Star Hope Mine, facing east.



Photo 7. Upper adit area of the Star Hope Mine, facing north.

2.3.3 Gamebet Mine

This inactive mining site is located on USFS property, approximately 2.3 miles south of the Star Hope Campground. The site consists of a lower adit, a raise, and some upper prospect workings. The adit is accessible by high clearance four-wheel drive vehicles, but the upper prospects are only accessible by foot (Figure 10).



Figure 10. Aerial photograph with site sketch of the Gamebet Mine.

2.3.3.1 *Ownership and History*

The Gamebet, which is also known as the Lambert Property, comprises several unpatented claims. Harold C. Lambert and others claimed the property, though dates of operation are unknown. Kiilsgaard (1997) noted that the operators had applied for a loan through the Office of Mineral Exploration (OME), but the application was denied in 1960. OME information was not available and further ownership history is unknown.

2.3.3.2 *Geology*

The Gamebet mine has been mapped by the U.S. Geological Survey (USGS) to lie within the Glide Mountain plate of the Copper Basin Formation. “Rocks of the Glide Mountain plate represent a more western, carbonate poor and plant-rich, shallow marine to partly terrigenous depofacies of the Copper Basin Formation than do those of the Copper Basin plate” (Dover, 1981, p.41). The Glide Mountain plate shows “intense shearing, tight folding, and silicification ...but locally it contains slices and rolled blocks of structurally underlying rocks, including the lithologically distinctive Drummond Mine limestone Member” (ibid, p.65).

The Gamebet lies on the east side of Star Hope Creek, opposite and just northeast of the workings of the Mackinaw Group. Based upon sample analysis of adit drainage and study of waste rock from Gamebet’s dumps, it seems apparent that the lithology is comparable to the Mackinaw mine. Tucheck and Ridenour (1981) noted that the Mackinaw workings “are in a small wedge-shaped block of limestone on fault contact on the west and south with argillites, and mantled on the northeast with alluvium. The limestone beds have been contorted and fractured along bedding planes. The country rock generally trends northwest and dips moderately to the northeast” (p. 289).

Based upon the direction of ore zone dip from the Mackinaw and its likely projection toward the east side of Star Hope Creek, it appears the miners were seeking to locate the down-dip extension of the Mackinaw ore zone. Judging from the waste rock, the Gamebet adit was driven into argillite and quartzite, but reached limestone and aplitic rocks near its face. This limestone may be the continuation of the wedge-shaped block identified at the Mackinaw.

2.3.3.3 *Production*

Kiilsgaard (1997) identifies the Gamebet as a small copper skarn deposit, which produced 2,500 grams of silver and 2.2 metric tons of copper. The period(s) of production are unknown, but it appears as though the mine’s operation may have ceased following the loan denial by the OME in 1960.

2.3.3.4 *Workings*

The adit area consists of the adit, which was discharging during the site visit on August 2, 2006, its associated waste rock pile, and a raise. The raise is located about 90 feet upslope from the adit. Small boards and rocks, some with malachite staining, cover most of the opening, but safety issues may remain.

The waste rock dump (Photo 8), which measures approximately 286 square yards (.06 acres) in area and 1,612 cubic yards in volume, is located approximately 679 feet above Star Hope Creek. Vegetation was present in the waste rock material. The upper prospects cover an area of approximately 2,254 square yards (approximately 0.5 acres) and are located approximately 1,362 feet above Star Hope Creek.

An unnamed creek channel is located directly north of the site, but was dry during the inspection. None of the Gamebet Mine workings appear to be in this creek's drainage area.



Photo 8. View from the waste rock pile at the lower adit of the Gamebet Mine, facing southwest, with the waste rock seen in foreground and Star Hope Creek visible in the background.

2.3.3.5 *Water Analysis*

The Gamebet adit water (Photo 9) was sampled during the inspection at the site. This water infiltrated just below the waste rock pile and did not reach Star Hope Creek. Fluvial characteristics suggest that the outflow reaches Star Hope Creek during periods of high flow.

The data, presented in Table 6, shows that selenium is the only constituent sampled at a concentration greater than the State of Idaho chronic water quality standard.

Star-Hope
Preliminary Assessment Report
December 2006

Table 6. Sample Results from the adit discharge at the Gamebet Mine.

Constituent of Concern	Gamebet adit water sampling results (mg/l)	CMC ^{2,3} @ 86.4 mg/l	CCC ^{2,4} @ 86.4 mg/l
Hardness ¹	86.4	--	--
Silver	<0.005	0.00268	--
Aluminum	<0.03	--	--
Arsenic	<0.025	--	--
Barium	0.0048	--	--
Beryllium	<0.002	--	--
Cadmium	<0.0003	0.00175	0.00093
Chromium	<0.006	--	--
Copper	<0.003	0.0148	0.01
Iron	<0.06	--	--
Mercury	<0.0002	0.0021	0.000012
Nickel	<0.01	0.414	0.046
Lead	<0.0005	0.055	0.00215
Selenium	0.00847	0.02	0.005
Zinc	<0.01	0.104	0.104
Field Parameters			
pH	8.23 std. units.		
specific conductance	210 µ-siemen/cm		
Temperature	6.9 °C		

1 Hardness is calculated from calcium and magnesium concentrations.

2 Both the CMC and CCC are State of Idaho Water Quality Standards as set forth by the Idaho Administrative Procedures Act (IDAPA) section 58.01.02.

3 CMC= Criterion Maximum Concentration is defined as the maximum instantaneous or one (1) hour average concentration and should adequately protect aquatic organisms from acute toxicity if not exceeded more than once every three (3) years. This is equivalent to "acute criteria."

4 CCC= Criterion Continuous Concentration is defined as the four (4) day average concentration of a toxic and should adequately protect aquatic organisms from chronic toxicity if not exceeded more than once every three (3) years. This is equivalent to "chronic criteria."



Photo 9. Gamebet Adit, facing east.

This page intentionally left blank for correct double-sided printing.

Section 3. Pathway and Environmental Hazard Assessment

Assessment of pathway and environmental hazards addressed ground water, surface water, soil exposure, and air. These hazards are described in the following.

3.1 Ground Water

The Star Hope Campground is approximately 3.5 miles from the Star Hope Mine and 2.3 miles from the Gamebet Mine. This campground includes two wells, which are the only two wells within a four-mile radius of the Preliminary Assessment sites.

Due to the remoteness of the campground, and the limited use the campground receives, DEQ does not require drinking water sampling for metals from the campground wells. Therefore, no known data on metals in these wells is available.

Well driller reports (IDWR, 2006) show black coarse sand and black shale within the screened interval. This lithology indicates the wells were developed within the Glide Mountain Formation and suggests minimal buffering of the ground water from these clastic rocks.

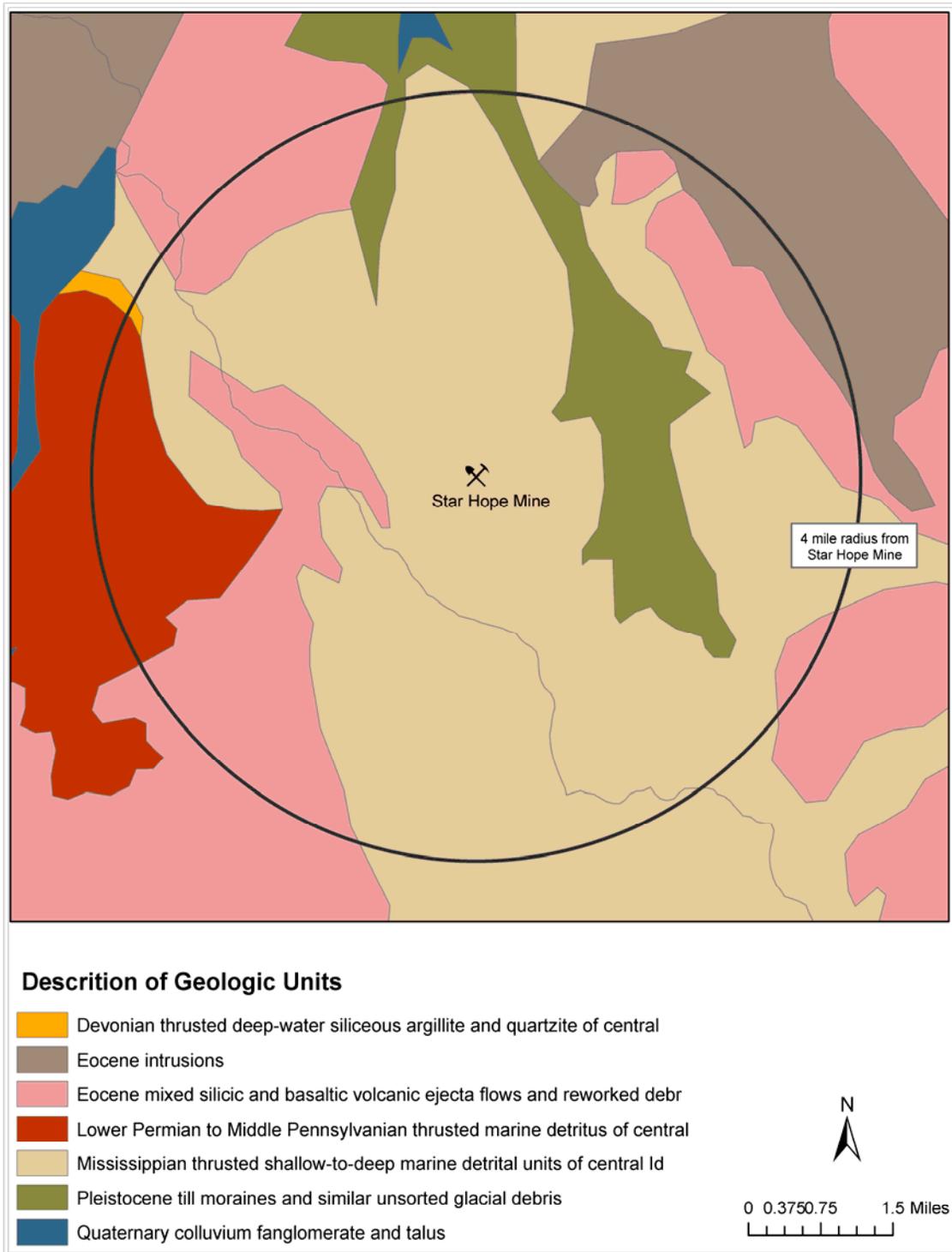


Figure 11. Basic Geology in the Star Hope Mining Area.

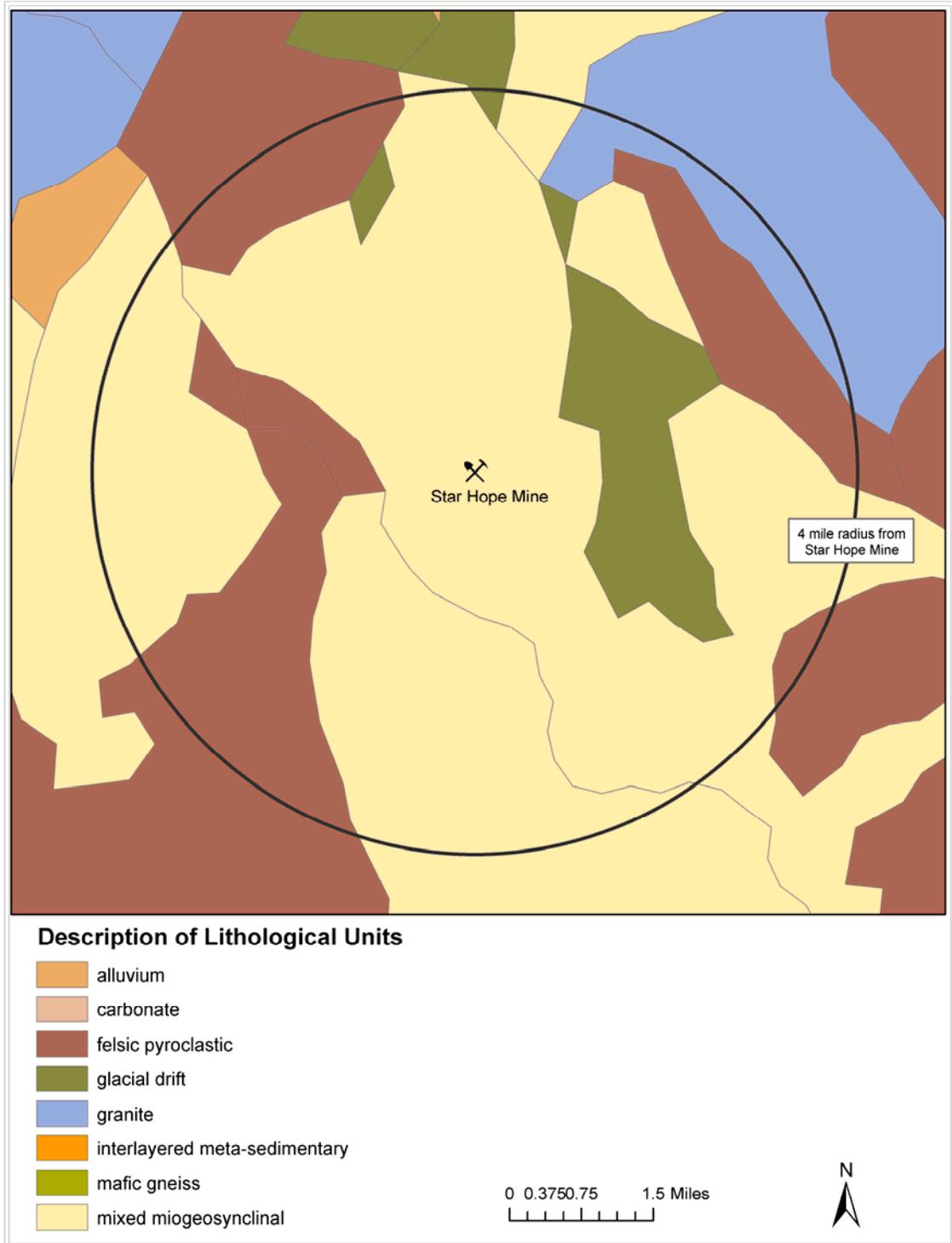


Figure 12. Basic Lithology of the Star Hope Mining Area.

3.2 Surface Water

Star Hope Creek, a tributary of the East Fork of the Big Lost River, is the most immediate stream that all three of the Preliminary Assessment sites could potentially impact. The main adit for the Star Hope Mine is located on the Star Hope Lake Outlet, which is a tributary to Star Hope Creek. The headwaters of Star Hope Creek are located approximately 1.5 miles upstream from Adit 1. From the headwaters, Star Hope Creek flows approximately 14.5 miles before its confluence with the East Fork of the Big Lost River. Muldoon Creek and Lake Creek, are the two main tributaries of Star Hope Creek.

Figure 13 depicts the drainage patterns of these creeks as well as the 15-mile downstream Target Distance Limit (TDL) located on the East Fork of the Big Lost River.

There are no surface water intakes for drinking water or any type of industry within the 15-mile TDL. One campground with two drinking water wells is located adjacent to Star Hope Creek as discussed in the Ground Water pathway section.

Based on field observations of the vegetation, hydrology, and topography in the Star Hope Creek drainage, it is believed that wetlands exist both above and below the Star Hope Campground. These wetlands begin near the confluence of Star Hope Lake Outlet and Star Hope Creek and are continuous to the campground. The topography and stream channel change at this location and wetlands from this point down to the confluence with the East Fork of the Big Lost River are interspersed. The distance from Adit 1 to the nearest downstream wetland is approximately 4,789 feet (0.9 mi), while the PPE of the Star Hope Mine is approximately 3,731 feet (0.7 mi) up-gradient of the wetlands. The Gamebet Mine is approximately 652 feet (0.12 mi) up-gradient of the wetland area.

Fish presence/absence studies compiled by the Idaho Department of Fish and Game have confirmed both brook trout (*Salvelinus fontinalis*) and Sculpin (*Cottus*) present in Star Hope Creek. In the Big Lost River watershed above the reservoir there have also been whitefish (*Prosopium*), rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*) and westslope cutthroat (*Oncorhynchus clarki lewisi*) presence confirmed.

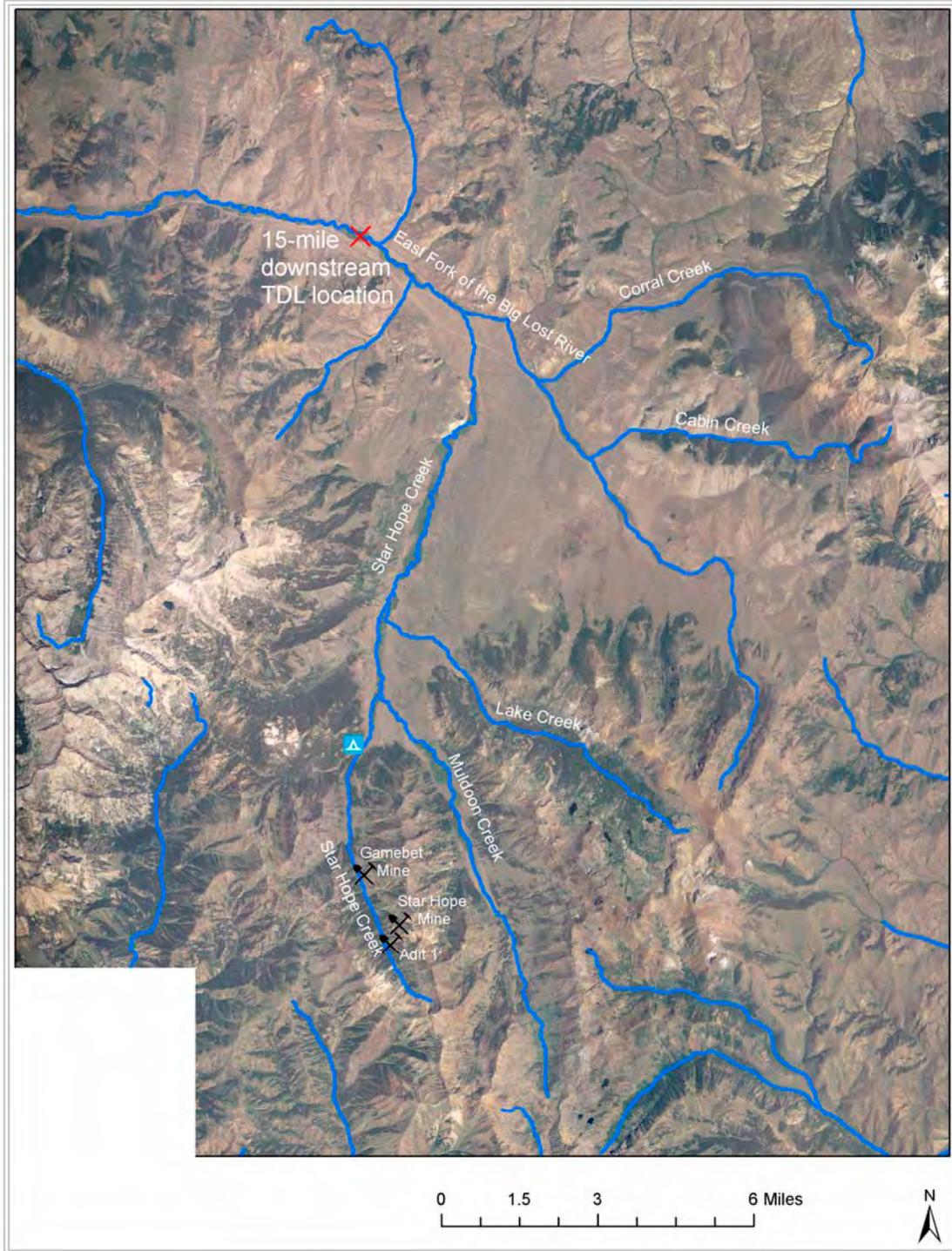


Figure 13. Surface water 15-mile Target Distance Limit from the Preliminary Assessment Sites.

3.3 Soil Exposure and Air

The waste rock and tailings volumes observed at all sites during these preliminary assessment investigations are considered too large to be mobilized by wind. These sites are remote, so the only exposure to humans would be through recreational use. There are no day-care centers, buildings, or populations of any kind within a four-mile radius of the site.

Potential exposure of waste rock and tailings soils to wildlife and vegetation from all of the Preliminary Assessment sites is present. During the investigation, several species sightings as well as wildlife signs were observed by the inspectors, including deer, elk, antelope, cougar, and bear. Small burrowing creatures were also observed living in the waste rock at the main Star Hope Mine adit. The entire drainage area of Star Hope Creek has been identified by the Nez Perce Tribe to be potential wolf habitat.

Sensitive species present within a four-mile radius of the Preliminary Assessment sites are presented in Figure 14. These include two plant species: mountain shasta sedge (*Carex stramineiformis*) was identified near Star Hope Creek between the Gamebet and Star Hope Mine, while wedgeleaf saxifrage (*Saxifraga adscendens var. oregonensis*) was located at the headwaters of Star Hope Creek up gradient of Adit 1.

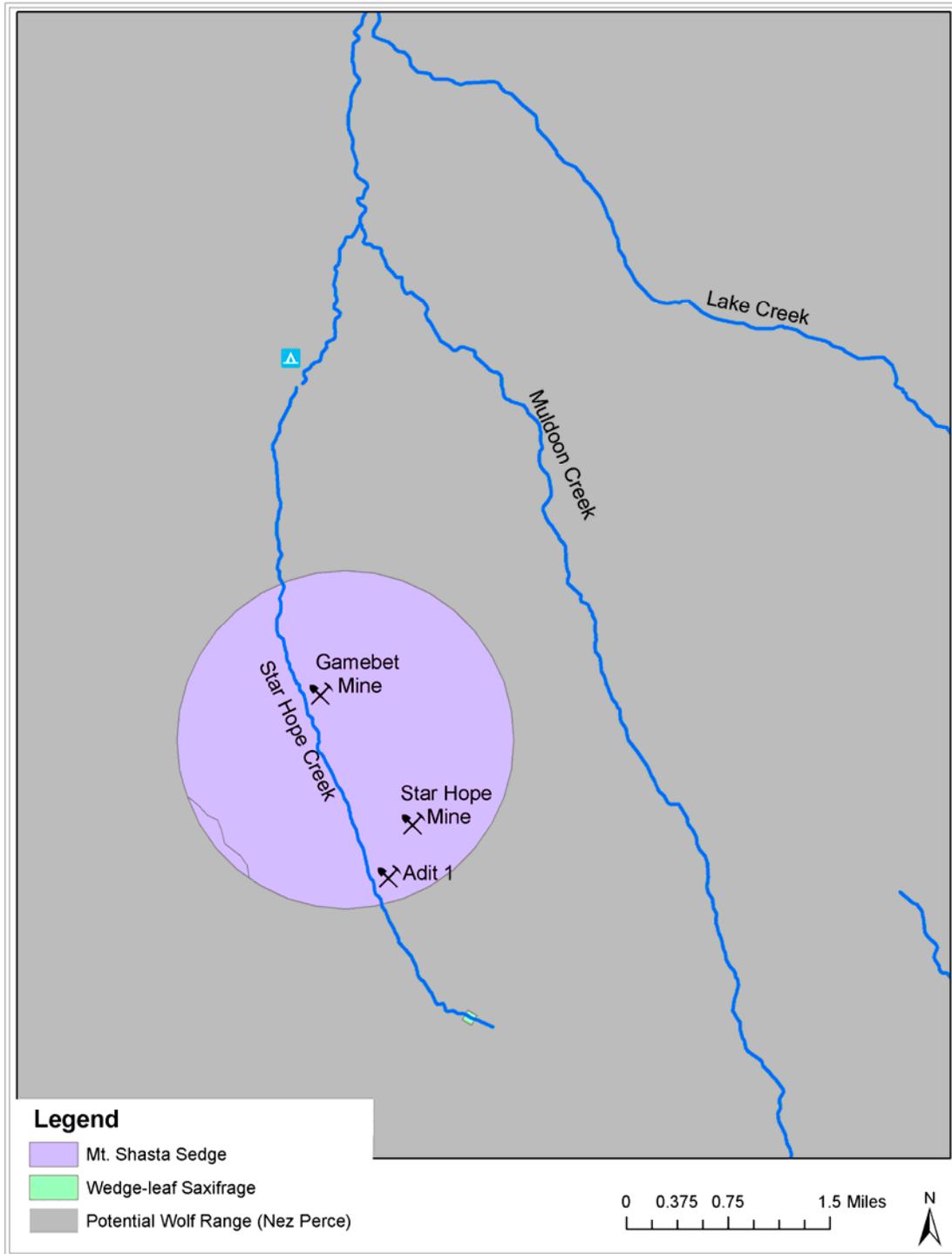


Figure 14. Sensitive species identified in the vicinity of the Preliminary Assessment sites.

This page intentionally left blank for correct doubled-sided printing.

Section 4. Summary and Conclusions

Adit 1, The Star Hope Mine, and the Gamebet Mine are located within the Star Hope Creek drainage in an area designated as the Copper Basin mining district. No history or production records relating to Adit 1 were found, but the Star Hope Mine was located in the early 1880s and produced more than \$50,000 from rich lead-silver ores during its earlier operations. The Gamebet's history and production records are limited, but minor silver and copper values were obtained.

4.1 Presence of Wetlands

Based on field observations of the vegetation, hydrology, and topography in the Star Hope Creek drainage, it is believed that wetlands exist both above and below the Star Hope Campground. These wetlands begin near the confluence of Star Hope Lake Outlet and Star Hope Creek and are continuous to the campground, after which they become interspersed.

4.2 Impact on Water Quality

The water quality data collected in these assessments indicates that although the Star Hope Mine appears to have an immediate impact on water quality in the Star Hope Lake Outlet, this impact is not shown in Star Hope Creek itself. The increased flow of the Star Hope Creek has most likely diluted the concentrations. Likewise, the Gamebet Mine adit flow data did not indicate a threat to surface water standards in Star Hope Creek.

Though the Gamebet claim group has been mapped by the USGS to exist within the Glide Mountain plate, its associated waste rock shows more carbonate-rich strata. The Star Hope and Adit 1 were similarly mapped within the Drummond Mine Limestone and appear to contain significant carbonates. Consequently, the adit discharges from the Gamebet and Star Hope appear to comparably buffer the associated metals.

4.3 Potential Exposure for Wildlife and Vegetation

Potential exposure of waste rock and tailings soils to wildlife and vegetation from all of the Preliminary Assessment sites is present. The armored and consolidated nature of waste rock piles and the relative coarseness of Star Hope's tailings seem to preclude aerial dispersion from the sites.

4.4 Potential Exposure for Humans

A USFS-developed campground exists within a four-mile radius of both of the sites assessed. This campground, located on the Copper Basin Loop road, has two wells that supply potable water to the campground. Due to the remoteness of the campground, well development within

the Glide Mountain plate strata, and the limited use the campground receives, potential receptors are expected to be minimal.

References

- Bureau of Land Management, 2006, *Land Patent Details* – BLM GLO Records.
<http://www.glorerecords.blm.gov/PatentSearch/Detail.asp?Accession=IDIDAA+046037&Index=1&QryID=41620.75&DetailTab=1>
- Department of Environmental Quality (DEQ), 2004, *Big Lost River Subbasin Assessment and TMDL*.http://www.deq.idaho.gov/water/data_reports/surface_water/tmdls/big_lost_river/big_lost_entire.pdf
- Dover, James H., 1981, Geology of the Boulder-Pioneer wilderness study area, Blaine and Custer Counties, Idaho. U.S. Geological Survey Bulletin 1497-A, pp.15-83.
- Idaho. Inspector of Mines. *Annual Report*. 1901-1974
- Idaho Department of Water Resources (IDWR), 2006.
<http://www.idwr.idaho.gov/water/well/search.htm>
- Kiislaard, T. H., 1997, Mining properties in Idaho that were involved in the DMA, DMEA, or OME mineral exploration programs, 1950-1974, USGS Open File Report 97-439, 34pp. [pubs.usgs.gov/of/1997/ofr97439/of97-439.pdf]
- Lewis, Kenneth E., 2006, Personal Communication.
- Nelson, W. H. and C. P. Ross, 1969, *Geology of the Mackay 30-Minute Quadrangle, Idaho*. U.S. Geological Survey, Open-file report.
- Simons, Frank S., 1981, A geological and geochemical evaluation of the mineral resources of the Boulder-Pioneer wilderness study area, Blaine and Custer Counties, Idaho. U.S. Geological Survey Bulletin 1497-C, pp. 181-292.
- Tuchek, Ernest T. & James Ridenour, 1981. Economic Appraisal of the Boulder-Pioneer wilderness study area, Blaine and Custer Counties, Idaho. U.S. Geological Survey Bulletin 1497-D, pp. 87-180.
- Umpleby, Joseph B., 1917, *Geology and ore deposits of the Mackay region, Idaho*. U.S. Geological Survey Prof. Paper 97, 129 p.
- USFS 2006, *Starhope Campground Information*
<http://www.publiclands.org/explore/site.php?search=YES&back=Search%20Results&id=2402>
- USGS, 2006, Mineral Resources Spatial Data.<http://mrdata.usgs.gov/website/MRData-US/viewer.htm>

This page intentionally left blank for correct double-sided printing.

Appendix A: Sampling Locations Photo Log



Photo 10. Stream Sediment and Surface Water Sample number 1A-PPE, located on Star Hope Lake Outlet down gradient of the tailings, waste rock and adit flow of the Star Hope Mine.



Photo 11. Adit surface water sample number AW1A from the Star Hope Mine Adit outflow.



Photo 12. Stream sediment and surface water samples at location 2A upstream of the Star Hope Mine on Star Hope Lake Outlet.

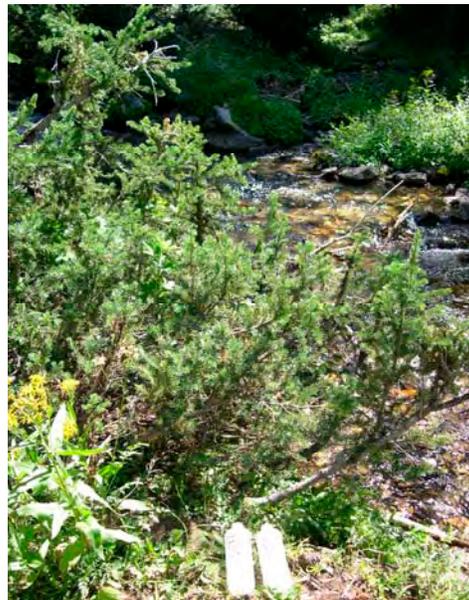


Photo 13. Star Hope Creek down gradient surface water sample at location SHDG.

Star-Hope
Preliminary Assessment Report
December 2006



Photo 14. Tailings sediment sample taken from the tailings located at the Main adit of the Star Hope Mine.



Photo 15. Star Hope Creek up gradient surface water sample at location SHUG.



Photo 16. Gamebet Mine adit outflow surface water sampling point (AW4).

This page intentionally left blank for correct double-sided printing.

Appendix B: Analytical Data

This page intentionally left blank for correct doubled-sided printing.

Report Index

Adit 1	5	land uses.....	5
arsenic	17	landfills	1
ATV	v	lead.....	8, 11, 12, 13, 17, 20, 24, 41
Bent Pine Tree Group	8	lead-silver veins	12
Big Lost River.....	5, 36, 43	Lewis family	11
black coarse sand	33	malachite.....	28
black shale.....	33	mercury	17
brook trout.....	5, 36	molybdenum	12
brown trout.....	5, 36	morphological indicators	9
cadmium.....	17, 20, 23, 24	mountain shasta sedge.....	38
Challis National Forest	8	Office of Mineral Exploration (OME).....	28
clastic rocks.....	33	ore bin	17
copper.....	8, 17, 20, 23, 28, 41	ownership.....	8, 28
Copper Basin Formation.....	11, 12, 28	Point of Potential Exposure (PPE).....	20
Defense Minerals Exploration Program		<i>Preliminary Assessment Program</i>	1
(DMEA)	11	rainbow trout.....	5, 36
Donald W. Lewis	11	sculpin	5
Drummond Mine Limestone.....	12, 41	selenium	17, 20, 23, 29
Episcopal Diocese of Boise	11	sensitive species	38
galena	11, 12	silver.....	8, 11, 12, 13, 17, 20, 28, 41
George J. Lewis	11	Star Hope Campground.....	1, 27, 33, 36, 41
Glide Mountain	28	Star Hope Lake iv, 11, 19, 20, 22, 24, 25, 36,	
Idaho Default Target Levels (IDTLs).....	17	41, 45	
Idaho Department of Fish and Game.....	36	Target Distance Limit (TDL).....	36
Idaho Inspector of Mines	13	U.S. Forest Service (USFS)	1
Idaho Risk Evaluation Model (REM).....	17	Upper Mississippian Drummond Mine	
illegal dumps.....	1	Limestone	11
iron	8, 12, 17	westslope cutthroat.....	5, 36
Kenneth E. Lewis.....	11	wetland area	36
Lambert Property	28	zinc.....	8, 17, 23, 24