1. EXECUTIVE SUMMARY

In January 1997, Stibnite Mine, Incorporated (SMI), Hecla Mining Company (Hecla), and the Mobil Corporation (Mobil), collectively known as the Stibnite Site Characterization Voluntary Consent Order Respondents (or Stibnite Group), signed a Voluntary Consent Order (VCO) with the Idaho Department of Health and Welfare Division of Environmental Quality (IDEQ) to perform a Site Characterization and risk evaluation of the Stibnite Site. The primary objectives of the Site Characterization were to identify chemical or physical impacts to surface water, groundwater, and soil that are attributable to historic mining and milling or recent gold mining activities within the Stibnite Site; to identify, if possible, the sources of the impacts; and to provide data adequate for human health and ecological risk assessment.

This document is the Site Characterization Report. It describes the results of the 1997 and 1999 Site Characterization field investigations, which included sampling and analysis of surface water, groundwater, seeps and springs, surface soil, sediment, and benthic macroinvertebrates; aquatic habitat characterization; and terrestrial and riparian habitat characterization. Additional sampling of groundwater, surface water, sediment, benthic macroinvertebrates, and fish was conducted by the United States Department of Agriculture Forest Service (Forest Service) and IDEQ. The report also includes relevant findings from previous investigations and complete chemical analytical results from past and current sampling programs.

The Site Characterization was performed in accordance with the VCO requirements as specified in the VCO Exhibit B, Stibnite Area Site Characterization Scope of Work, with the IDEQ-approved Stibnite Area Site Characterization Field Sampling and Mapping Work Plan (Work Plan) (Stibnite Group, 1997), and with the Final Scoping Document, Additional Site Characterization (Stibnite Group, 1999a) and the Field Sampling and Mapping Work Plan Addendum (Stibnite Group, 1999b). The work was performed in a manner consistent with the U.S. Environmental Protection Agency (USEPA) guidance for remedial investigations under the Comprehensive Environmental Response, Compensation, and Liability Act and with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (USEPA, 1990).

1.1 BACKGROUND

The Stibnite Site is part of a mining area located along the East Fork of the South Fork of the Salmon River (EFSFSR), 14 miles southeast of Yellow Pine, Idaho (Figure 1-1). For purposes of the Site Characterization, the Stibnite Site boundaries have been defined as shown in the Stibnite Site Areas of Investigation (Figure 1-2). The southern boundary of the Site is about one-half mile above the Meadow Creek Diversion Channel; the northern boundary is one-quarter mile below the confluence of Sugar Creek and the EFSFSR. Tributaries to the EFSFSR within the Site boundaries include Meadow Creek, Blowout Creek, Garnet Creek, Fiddle Creek, Midnight Creek, Hennessey Creek, Sugar Creek, and West End Creek (Figure 1-2).

A large ring-fault system, which cuts through the granitic rocks and Precambrian rock of the region, contains gold, silver, mercury, antimony, and tungsten deposits. These deposits had significant tonnages of oxidized gold ore overlying sulfide mineralization. Iron, antimony, mercury, and arsenic sulfides constitute the sulfide mineralization. The Meadow Creek Fault Zone, West End Fault Zone, and Garnet Creek Fault Zone are three of the major highly mineralized zones within the Site (Plate 2).

Mining and mineral processing, primarily of gold, antimony, and tungsten, have occurred at the Site intermittently since the early 1900s. Major historic mining operations included (1) the Meadow Creek Mine and ore processing facilities in the Meadow Creek Valley, which were operated between 1919 and 1927 by the Meadow Creek Silver Mines Company and between 1928 and 1938 by the Yellow Pine Company; (2) the Yellow Pine Mine underground workings and open pit on the EFSFSR, operated primarily by the Bradley Mining Company between 1937 and 1952; and (3) the West End mining area, which was mined between 1982 and 1990 by various entities including Canadian Superior Mining Company (a dissolved former subsidiary of Mobil), Twin River Developments (TRD), Pioneer Metals Corporation, and Barrier Reef, Inc. More recently, SMI, a subsidiary of Dakota Mining Corporation, mined gold in the West End area and Garnet Creek between 1991 and 1997, and Hecla mined oxide gold ore from the Homestake ore body between 1988 and 1992. SMI ceased mining operations in 1997 and declared bankruptcy in 1999. Currently, both the Hecla and SMI operations are undergoing reclamation and closure activities.

Until 1952, the majority of ore processing occurred in the Meadow Creek Valley, at the site of the Meadow Creek Mine. Processing facilities operated by the Bradley Mining Company included a mill, flotation plant, and a smelter (operated intermittently between 1949 and 1952, and again briefly from 1956 to 1957).

During operation of the Meadow Creek Mine and Yellow Pine Mine, mine tailing was disposed in impoundments throughout the Meadow Creek Valley floor. The tailing deposits in Meadow Creek are referred to as the Bradley tailing, after the operator of the Yellow Pine Mine. Initially, tailing was disposed in areas in lower Meadow Creek Valley adjacent to the processing facilities. A larger tailing impoundment was built near the end of World War II in upper Meadow Creek Valley above Blowout Creek. The creation of the tailing impoundment resulted in ponding of upper Meadow Creek behind the impoundment. In both the upper and lower valleys, Meadow Creek was diverted to provide room for the tailing deposits, but during winters the tailing was directly discharged to Meadow Creek. There are an estimated 3.7 to 4.2 million cubic yards of Bradley tailing in the upper tailing impoundment.

Between 1952 and 1978, the site was largely idle, and during this time the upper and lower Meadow Creek diversions failed, allowing the creek to erode through tailing. The Forest Service has estimated that 10,000 tons of tailing washed into Meadow Creek at a rate of 500 tons per year.

Between 1982 and 1984, mining of low-grade oxide gold ore was undertaken in the West End area by Canadian Superior and TRD. On/off leach pads and associated cyanidation processing facilities were constructed near the site of the former Meadow Creek Mine and Bradley processing facilities. Canadian Superior and TRD, in accordance with the Record of Decision and operating permit issued by the Forest Service, used neutralized ore from the leach pads to encapsulate the Bradley tailing impoundment and to prevent erosion of the fine-grained Bradley tailing into Meadow Creek. In addition, Canadian Superior reconstructed the Meadow Creek Diversion Channel around the Bradley tailing impoundment, built a keyway (earthen dam) at the base of the tailing impoundment to add structural stability and prevent mass failure of the tailing, realigned lower Meadow Creek, and covered the tailing in the lower Meadow Creek Valley with waste rock and other materials. The goal of these projects was to decrease the sediment load to Meadow Creek from the historic Bradley tailing deposits.

The on/off leach pads and neutralized ore disposal area at the Bradley tailing impoundment were later used by Pioneer Metals (1985–1990) and SMI (1991–1997), who continued to mine ore from various pits in the

West End area, as well as from Garnet Creek Pit. In 1997, the Bradley tailing impoundment/neutralized ore (BT/NO) disposal area covered about 76 acres in the upper Meadow Creek Valley.

Hecla mined oxide gold ore from the Homestake Pit between 1988 and 1992, first using the Pioneer leach pads for gold extraction (in 1988) and then constructing a permanent heap to the west of the Pioneer pads and on top of the old Bradley milling facilities. The heap was finished in 1991. The heap leach operation is now undergoing closure.

In 1995, SMI entered into an Administrative Order on Consent (AOC) with USEPA to stabilize the BT/NO disposal area and improve water quality in Meadow Creek. Activities conducted in 1996 and 1997 included redirecting discharge from, and draining, the Meadow Creek Pond that lay behind the tailing impoundment, and beginning construction of a new diversion channel to minimize contact of stream flow with the Bradley tailing. SMI ceased mining at the site at the end of the 1997 season due to economic considerations. SMI did not complete the AOC work and EPA terminated the AOC in December 1997.

In May 1998, a new AOC was signed between Mobil Oil Corporation, USEPA, and the Forest Service to stabilize and reclaim the BT/NO disposal area. The goals of the Bradley Tailing Diversion and Reclamation Project were to minimize surface water contamination of Meadow Creek by: (a) constructing a barrier to the migration of particulates; (b) stabilizing the Meadow Creek Channel; (c) stabilizing exposed tailing; and (d) reducing infiltration into the tailing. The project included constructing a new 4,575-foot-long Meadow Creek on the south side of the BT/NO disposal area, building a new drainage channel on the north side, lining the old Meadow Creek diversion channel to reduce seepage, closing the pond and covering about 5 acres of exposed tailing at the upper end of the BT/NO disposal area, regrading and revegetating the 100-acre BT/NO disposal area, revegetating the banks of the diversion channel, and installing voluntary stream restoration features such as channel pools and large boulders. The construction work was completed in 1998, and revegetation continued in 1999. Long-term water quality monitoring is continuing.

Historic mining-related activities have also resulted in alterations to stream configuration and habitat. These alterations include the Yellow Pine Pit or Glory Hole, a pit lake created in 1955 when the flow of the EFSFSR was no longer diverted around the Yellow Pine Pit; Bradley waste rock dumps along the EFSFSR above and below the Glory Hole; the BT/NO disposal area; Meadow Creek channel diversions; and debris and tailing deposits resulting from the catastrophic failure of the dam on Blowout Creek in 1965.

1.2 INVESTIGATION PROGRAM

For the Site Characterization investigation, the Site was divided into three areas based on geography and operational history. The area boundaries are shown on Figure 1-2. Site features are shown on Plate 1 and Figure 3-1. Area 1 is the Meadow Creek Valley beginning about one-half mile upstream of the new Meadow Creek Diversion Channel and extending down to the confluence with the EFSFSR. Area 2 is the EFSFSR from the eastern Site boundary to the confluence with Midnight Creek. Area 3, referred to as the Glory Hole, includes the EFSFSR from Midnight Creek to the northern site boundary as well as the lower reaches of Sugar Creek.

The Site Characterization focused primarily on the following potential sources of chemical or physical stressors:

Area 1: Meadow Creek Valley

- Historic Meadow Creek Mine
- Historic Meadow Creek Mine processing facilities (now dismantled and removed or buried)
- Historic Bradley tailing impoundments and deposits in Meadow Creek Valley
- Meadow Creek Mine hillside behind the historic Bradley facilities
- Neutralized ore at neutralized ore disposal area
- Waste rock in valley floor
- SMI leach pads and cyanide plant
- Hecla heap leach operations
- Smelter stack ruins above the historic Bradley facilities

Area 2: EFSFSR

- Historic Bradley tailing below confluence with Meadow Creek
- Former Primary and Secondary Camps
- Garnet Creek Pit
- Defense Materials Exploration Administration (DMEA) dump

Area 3: Glory Hole

- Historic Yellow Pine Mine (Glory Hole)
- Historic Bradley waste rock dumps on the EFSFSR above and below the Glory Hole and on Sugar Creek
- West End, Homestake, and Midnight Pits
- Historic Bradley Tunnel Outlet (BTO) on Sugar Creek

Primary chemical stressors of concern are metals (especially antimony and arsenic) and weak acid dissociable (WAD) cyanide. Chloride and nitrates/nitrites have also been associated with mineral processing and mining activities. Primary physical stressors of concern are sediment release to surface water.

Environmental samples were collected and analyzed in accordance with procedures outlined in the Site Characterization Field Sampling Plan and Quality Assurance Project Plan, which are part of the 1997 Work Plan, and corresponding addenda in the 1999 Work Plan Addendum. Chemical analytical data collected under the VCO underwent data quality review using guidance from the USEPA Contract Laboratory Program (CLP) Functional Guidelines. In addition, usability of historic data and compliance monitoring data in Site Characterization was confirmed based on split sample evaluation and review of laboratory certification and quality assurance programs.

1.3 SURFACE WATER SAMPLING

Three rounds of surface water sampling were performed in 1997 and four rounds were performed in 1999 for the Site Characterization. In 1997, 29 stations were sampled on June 28–July 8, August 21, and October 28–31. Two storm events were also sampled in 1997, one by the Forest Service and one by the Stibnite Group. In 1999, 24 stations were sampled on June 10–12, June 22–25, July 16–18, and September 15–25. Plate 1 and Figure 3-1 show the surface water sampling stations. Flow measurements from 1999 were used to calculate metals loadings to support source identification.

Many of the surface water sampling stations also were sampled under other monitoring programs conducted by SMI, Hecla, Mobil, and IDEQ. Tables showing all of the surface water data for the Site from 1996, 1997, and 1999 are included in Appendix B and are reported in tables accompanying Section 8.1, Surface Water Sampling.

Surface water quality was evaluated by comparing chemical analytical results from the 1996, 1997, and 1999 sampling with Idaho and USEPA water quality criteria, adjusted, if necessary, for an estimated average site-specific hardness of 50 milligrams per liter (mg/L). Results for antimony were compared with proposed USEPA water quality criteria. Criteria for most metals are based on dissolved concentrations, with the exception of aluminum, antimony, iron, mercury, and selenium. The water quality criteria used are listed in Table 8.1-1 of this report.

Antimony, arsenic, mercury, and WAD cyanide levels are most indicative of impacts attributable to historic or recent mining activities. Other trace metals were either detected much less frequently or not at all, or occurred in comparable levels at reference stations. Aluminum, for example, was frequently detected at all stations, including reference locations, at levels above the USEPA freshwater quality criterion of 87 μg/L. Elevated levels of antimony and arsenic occurred in Meadow Creek and the EFSFSR prior to the start of recent mining activities in 1982, as indicated in the Environmental Background Report and Final Environmental Impact Statement (JMM, 1979; 1981) and surface water data for the period 1978 to 1981 in Appendix B.

In 1997, individual sample results at all main stream stations on Meadow Creek and the EFSFSR ranged from 4 to 135 μg/L for total antimony and 7.3 to 101 μg/L for dissolved arsenic. The arsenic concentrations were all below the USEPA chronic water quality criterion for the protection of freshwater aquatic life of 150 μg/L dissolved arsenic. The 1997 mean concentrations ranged from 28 to 74 μg/L for total antimony and from 43 to 99 μg/L for total arsenic.

In 1999, following implementation of the Bradley Tailing Diversion and Reclamation Project, concentrations of antimony and arsenic at each Meadow Creek and EFSFSR station were one-third to two-thirds lower than 1997 levels. Mean concentrations ranged from 7 to 26 μg/L for total antimony and from 32 to 60 μg/L for total arsenic. The greatest improvement was seen at Stations 322, 319, and 313 on Meadow Creek and the EFSFSR below Meadow Creek. For example, at Station 322 below the Meadow Creek Diversion Channel and the BT/NO disposal area, total antimony and dissolved arsenic decreased by 85 percent and 50 percent, respectively, between 1997 and 1999. All sample results for dissolved arsenic (<7 to 96 μg/L) were below the USEPA criterion of 150 μg/L dissolved arsenic. Additionally, all but two

results for total antimony, which ranged from <5.3 to 35 µg/L, were below the USEPA proposed freshwater quality criterion of 30 µg/L.

Surface water concentrations of antimony and arsenic were highest at Meadow Creek Stations MC-2B and 319 (below the historic Bradley features and tailing deposits in lower Meadow Creek Valley); in the EFSFSR at Station 308 below the Glory Hole and Northwest Bradley waste rock dump; and in Midnight Creek Station 321.

Total antimony concentrations were higher in sample UW-1 from the Upgradient Wetland above the BT/NO disposal area (69 µg/L), at Station KW-1 below the Keyway (up to 127 µg/L), and at Station BTO (Bailey Tunnel Outlet) (up to 280 µg/L) than in the main streams immediately downstream. Flows at these locations were very low, and the small loading from these sources does not result in significant effects on stream water quality. For example, the antimony concentrations at the discharge from the Upgradient Wetland (Station MC-1A) and at Station 368 (downstream of KW-1) are comparable in quality (i.e., lower than the proposed chronic criterion of 30 µg/L) with that at the upgradient Meadow Creek reference Station 320.

- Dissolved mercury was not detected above its USEPA chronic criterion of 0.77 µg/L in any Stibnite Site sample collected in 1999. However, 13 samples site-wide had detected concentrations of total mercury (>0.042 µg/L) that were greater than the Idaho chronic criterion of 0.012 µg/L. Concentrations of mercury were consistently elevated throughout Sugar Creek (9 of 13 results for total mercury at 0.047 to 0.39 µg/L) due to sources upstream of the Site. Total mercury results from 1997 were similar to those in 1999 with scattered detections of mercury in Meadow Creek and EFSFSR but frequent detections in Sugar Creek.

Overall, surface water quality in the Meadow Creek and EFSFSR improved substantially between 1997 and 1999, following implementation of the Bradley Tailing Diversion and Reclamation Project. For example,

- At Meadow Creek Station 322 below the new Diversion Channel and Keyway Wetland, total antimony concentrations were reduced by 85 percent and arsenic by 50 percent in 1999 compared with 1997.
- At all stations on the main stems of Meadow Creek and the EFSFSR, average 1999 concentrations of total antimony and arsenic were one-third to two-thirds lower than in 1997.
- Individual results for arsenic in 1999 were below Idaho and USEPA chronic water quality criteria for protection of freshwater aquatic. All but a few results for total antimony (maximum = 35 µg/L) were below the USEPA proposed criterion of 30 µg/L. When detected (infrequently), mercury concentrations exceeded the Idaho numeric criterion of 0.012 µg/L (total mercury) but were lower than the USEPA criterion of 0.77 µg/L (dissolved mercury).
- WAD cyanide concentrations greater than the chronic criterion were reported in a few Meadow Creek samples in 1997 (4 of 53 samples). In 1999, all reported results were estimated values less than 3 µg/L or were non-detectable. The chronic water quality criterion for WAD cyanide is 5.2 µg/L.

Loadings were calculated for total antimony, dissolved arsenic, and sulfate based on 1999 surface water quality data and flow rate measurements (see Tables 8.1-19 and 8.1-20 and Figures 8.1-21 through 8.1-23). The principal increases in loading were seen in lower Meadow Creek, the Glory Hole, and the EFSFSR between Stations 308 and 314 (especially sulfate). Evaluation of all environmental data suggest that the

chief sources of loading are historic Bradley tailing deposits throughout lower Meadow Creek Valley, natural mineralization at and near the Glory Hole, and a variety of sources, including the Bradley waste rock dumps, Hennessey Creek, and Sugar Creek below Station 308. However, despite the increases in loadings of antimony, arsenic, and sulfate, only total antimony (31-35 μg/L) exceeded any criteria (30 μg/L; proposed USEPA chronic criterion) in Meadow Creek or the EFSFSR.

1.4 GROUNDWATER SAMPLING

The groundwater investigation for the Site Characterization focused on Meadow Creek Valley because this is the area where the mill and smelter operations and recent heap leach operations are most likely to have impacted the groundwater quality. In Area 1, 27 monitoring wells were sampled for the 1997 investigation and most were resampled in 1999; of these, 10 are located in the BT/NO disposal area and 17 are in the area of the Hecla and former SMI processing facilities. Limited groundwater characterization was also performed in other portions of the Stibnite Site: in Area 2, eight wells along the EFSFSR were sampled in 1997, including wells in the Primary and Secondary Camps; and in Area 3, three wells were sampled in 1997, one in the West End Creek drainage and two in the Midnight Creek drainage.

In 1997, three rounds of groundwater sampling were performed at each well, and over 100 samples were collected and analyzed. In 1997, SMI and Hecla also collected groundwater samples as part of their routine compliance monitoring programs. The results from the routine groundwater monitoring performed in 1997 were consistent with the results of the 1997 Site Characterization monitoring. In 1999, two rounds of sampling were performed at selected wells in lower Meadow Creek Valley, coincident with Hecla's quarterly compliance monitoring in June and September. Analytical data from the VCO site characterization, compliance monitoring, as well as previous monitoring results (primarily from the period 1994 to 1996) are included in Appendix B of this report. Monitoring well locations are shown on Plate 1 and on Plate 4 (wells in Areas 1 and 2).

To readily identify areas with potential mining-related impacts to groundwater, sample results were compared to Area-specific screening levels based on reference wells that were upgradient of mining-related disturbances in the Meadow Creek watershed (Area 1), the EFSFSR (Area 2), and in the Midnight Creek drainage (Area 3). This evaluation focused on dissolved trace metals and selected anions as the most appropriate constituents for identifying potential impacts on groundwater quality from mining activities.

Consistent with the findings of the surface water investigation, arsenic and antimony were the chief constituents that were associated with groundwater that is impacted by historic Bradley tailing in the Meadow Creek area. The static water levels that were measured in 1997 and 1999 indicated that the groundwater table rose high enough to contact the bottom of the historic tailing throughout most of the Meadow Creek Valley (see Figure 8.2-3).

Bradley tailing material is present both in the BT/NO disposal area in upper Meadow Creek Valley and throughout the lower portion of Meadow Creek Valley, where it has been covered with several feet of waste rock, alluvial fill, and neutralized ore material. Dissolved arsenic levels over 12,000 μg/L and dissolved antimony over 1,000 μg/L were associated with wells screened totally or partially in tailing or just beneath tailing (CW-2B, GAI-MW-4, MW-1B, HEC-1, and HEC-3C). Concentration ranges for dissolved antimony and arsenic for different portions of the Site are listed below.

- BT/NO disposal area (Table 8.2-7): dissolved antimony (2 to 1,160 μg/L), dissolved arsenic (3 to 12,700 μg/L);
- Lower Meadow Creek Valley (Table 8.2-8): dissolved antimony (3 to 3,070 μg/L), dissolved arsenic (7 to 13,800 μg/L);
- EFSFSR (Area 2) (Table 8.2-9): dissolved antimony (2 to 138 μg/L), dissolved arsenic (4 to 266 μg/L);
- West End and Midnight Creek watersheds (Area 3) (Table 8.2-11): dissolved antimony (10 to 39 μg/L), dissolved arsenic (76 to 154 μg/L).

High levels of dissolved arsenic (up to about 1,000 μg/L) were also found in groundwater near the highly mineralized Meadow Creek Fault Zone, as evidenced by samples from well UG-2 (above the SMI leach pads) and spring SPMC-5, which emerges at the surface expression of the Meadow Creek Fault Zone near the Meadow Creek Mine adits.

Mercury was rarely detected in filtered groundwater samples, but mercury was detected in unfiltered samples. Total mercury concentrations ranged from 0.2 to 76.5 μg/L in wells in Area 1 (Meadow Creek Valley, including the BT/NO disposal area), 0.2 to 8.2 μg/L in wells in Area 2 (along the EFSFSR), and 0.2 to 11.4 μg/L in wells in the West End Creek and Midnight Creek drainages in Area 3.

Little or no impact on groundwater quality from mining activities was seen in samples from eight monitoring wells along the EFSFSR between Meadow Creek and Midnight Creek (Table 8.2-9) and three wells in the West End Creek drainage and in the Midnight Creek drainage (Table 8.2-11). Metals levels in groundwater were consistent with natural mineralization, based on comparison to levels in surface water in West End Creek prior to mining activity in the West End Area, and with concentrations in an upgradient reference well (MW96-3) in the Midnight Creek drainage (see Tables 8.2-9 through 8.2-12). One possible exception is well LA-2, near the EFSFSR and the Thunder Mountain Road, where concentrations of dissolved arsenic levels (200 μg/L) were somewhat elevated above reference levels, possibly due to impacts from tailing that was deposited in this area during the Bradley operations.

In conclusion, the greatest impacts to groundwater quality, represented by elevated concentrations of dissolved antimony and arsenic, are seen primarily in areas in upper and lower Meadow Creek Valley where the Bradley tailing is saturated or intermittently in contact with the water table, although natural mineralization and neutralized ore may also contribute to constituent levels in groundwater.

Groundwater quality appears to affect surface water quality in lower Meadow Creek, as indicated by increased concentrations and loading of arsenic and antimony between surface water stations MC-2A, MC-2B and 319 (see Section 8.1 and accompanying figures). Nevertheless, 1999 concentrations of dissolved arsenic were below the USEPA freshwater quality criterion of 150 μg/L at all surface water stations in the main streams of Meadow Creek and the EFSFSR, and only two results for total antimony (maximum = 35 μg/L) exceeded the USEPA proposed criterion of 30 μg/L.

1.5 SEEPS AND SPRINGS SAMPLING

In 1997, 16 seeps were sampled, most of them located on the hillside above Meadow Creek, in lower Meadow Creek Valley, and near the Glory Hole. In 1999, 11 seeps near the Glory Hole and Bradley waste

rock dumps and seep SPMC-8 in lower Meadow Creek Valley were sampled. Locations of seeps and springs are shown on Plate 1.

Results from the seep and spring sampling in the Meadow Creek Valley (shown in Table 8.3-1) are consistent with the findings of the groundwater investigation, namely, antimony and arsenic concentrations are highest in seeps and springs in contact with Bradley tailing, but relatively high levels can also be seen in water in highly mineralized zones such as the Meadow Creek Fault Zone. For example, three springs that emerge from areas with Bradley tailing deposits in the lower Meadow Creek Valley had maximum concentrations of dissolved antimony and arsenic of over 2,000 μg/L, and spring SPMC-5 at the Meadow Creek Fault Zone had the highest concentrations of dissolved arsenic (443 to 2,600 μg/L) of the springs not influenced by Bradley tailing.

Trace metals other than antimony and arsenic (i.e., cadmium, chromium, copper, lead, nickel, selenium, silver, and zinc) were detected sporadically or not at all in filtered samples; these metals are not indicative of mining-related impacts to shallow groundwater or seeps.

Seeps and springs in Bradley tailing-impacted areas of the Meadow Creek Valley may transport dissolved or suspended constituents to surface water in Meadow Creek. However, flow rates are low in comparison to stream volume, and many springs are intermittent. Therefore, in themselves the seeps and springs are not likely to be significant sources of constituent loading to Meadow Creek.

Water quality was similar in many springs near the Meadow Creek Fault Zone and at the Glory Hole, Homestake Pit, and Garnet Creek. Water in these springs does not flow through mine waste material but rather through native ore bodies. Water quality in these springs was therefore concluded to be characteristic of mineralized zones. For example, concentrations of dissolved antimony (7 to 261 μg/L), arsenic (9 to 278 μg/L), and other trace metals are fairly similar in springs SPMC-4, SPMC-7, and SPMC-10 in the Meadow Creek Valley, SPEF-3 and SPGC-1 in the middle portion of the EFSFSR, and SPGH-1 through SPGH-9 at the Glory Hole.

Only two seeps were identified that flow through mine waste rock: SPNW-1 and SPNW-2 at the base of northwest Bradley waste rock dump above the EFSFSR, about 150 feet downstream from the bridge at the main access road. Samples from these seep areas had somewhat higher levels of dissolved antimony (202 to 257 μg/L) and arsenic (231 to 647 μg/L) than seeps SPGH-1 through SPGH-9 at the Glory Hole.

Sulfate levels were variable, ranging from 4 to 136 mg/L in the 1999 samples. The pH levels in all seeps ranged from 6.3 to 8.1, with most occurring between 7 and 8. Therefore, acid leachate is not characteristic of seeps in the Stibnite mining area.

1.6 SURFACE SOIL SAMPLING

The surface soil sampling program focused on the following areas of potential concern:

- Meadow Creek Mine hillside behind the former Bradley smelter;
- Smelter stack ruins on the Meadow Creek Mine hillside;
- Wetlands in upper and lower Meadow Creek Valley;

- Meadow Creek Valley soils, which may contain Bradley tailing, neutralized ore, and waste rock;
- BT/NO disposal area;
- Former Primary and Secondary Camps;
- DMEA dump; and
- Historic Bradley waste rock dumps along the EFSFSR above and below the Glory Hole and above Sugar Creek.

During the 1997 Site Characterization, 52 site samples were collected from six areas affected by mining activities and 21 reference samples were collected from mineralized and non-mineralized zones in upgradient areas away from the direct influence of mining activities. In 1999, 46 samples were collected at the Bradley waste rock dumps and in wetlands. At each sample location, the surface cover, terrain, physical features, soil type, and characteristics were recorded in field notes. The 1997 sample locations are shown on Plate 7. The 1997 and 1999 sample locations in Meadow Creek Valley and at the Bradley waste rock dumps are shown on Figures 8.4-1 and 8.4-2. Results are shown in Tables 8.4-2 through 8.4-14.

The areas targeted for soil sampling were characterized by higher concentrations of arsenic, antimony, and mercury than occurred in reference samples from non-mining areas. For example, mean arsenic concentrations ranged from about 1200 mg/kg to 4300 mg/kg in the Bradley waste rock dumps, Bradley tailing, neutralized ore, and soil near the smelter stack ruins. Mean arsenic levels were lower (273 to 717 mg/kg) in Meadow Creek Valley, Meadow Creek Mine hillside, and Meadow Creek wetlands, where surficial materials include both mineralized and non-mineralized materials.

Mean antimony levels were highest (790 to 1400 mg/kg) in Bradley tailing samples from the BT/NO disposal area and lower Meadow Creek Valley. Mean antimony levels were much lower (54 to 124 mg/kg) in neutralized ore, the former camps, and soil at the smelter stack ruins. Mean antimony levels were variable in the Bradley waste rock dumps, ranging between 1 and 329 mg/kg, depending on the dump area sampled.

Mean mercury levels were between 0.2 and 2 mg/kg in all areas sampled, except the DMEA dump (mean mercury = 6 mg/kg) and soil at the smelter stack ruins (mean mercury = 126 mg/kg).

Analytes other than antimony, arsenic, and mercury generally occurred in concentrations comparable to concentrations in reference samples. The few exceptions include relatively higher concentrations of chloride, chromium, copper, lead, and nickel in tailing samples at the BT/NO disposal area and some tailing-affected samples in lower Meadow Creek Valley.

Most soils (except for the historic Bradley waste rock dump samples) were alkaline compared to the reference value of 100 mg/kg $CaCO_3$. The pH levels were slightly alkaline (8 to 9) for some samples from the neutralized ore in the BT/NO disposal area. The pH levels were relatively low (3.5 to 5.5) in most of the Bradley waste rock dump samples. The pH in samples from other areas was generally near 7.

The Meadow Creek Mine hillside behind the former Bradley smelter site was sampled to evaluate possible impacts from deposition of past smelter emissions. The Meadow Creek Fault Zone passes through the Meadow Creek Mine hillside and parts of the hillside are disturbed by past exploration and mining activities. Average concentrations of antimony (7.5 mg/kg) and arsenic (386 mg/kg) from sample locations

on the Meadow Creek Mine hillside are comparable to the concentrations in samples from the mineralized reference stations in upper Midnight Creek in Area 3 (average antimony = 6.5 mg/kg; average arsenic = 200 mg/kg). The highest levels of arsenic (378 to 1460 mg/kg) and mercury (0.39 to 1.13 mg/kg) were observed in 4 of 12 samples (MCM-2, -3, -5, and -6), with the maximums occurring in sample MCM-5, located at the surface expression of the Meadow Creek fault zone. The variation in metal concentrations on the hillside is likely to be a function of several factors, primarily the surface expression of fault zones within the granitic colluvial soils, mine exploration disturbances, and possibly deposition of smelter emissions, although smelter impacts, if present, are not readily discernible from the existing data.

Wetland soil sample locations were well-vegetated with expected species, even where tailing was present, with the exception of one location in remnant tailing above the BT/NO disposal area where vegetation has not yet re-established itself after the 1998 regrading of the BT/NO disposal area.

All the Bradley waste rock dumps appear to be comprised of similar material and no significant differences in chemical composition were noted (although antimony levels were variable). Samples from gullies, and the field mapping of soil types and erosional features, did not suggest that different types of materials would be subject to future erosion. The dumps are typically barren or sparsely vegetated, with a high fraction of cobble and boulders. The pH at the dumps was relatively low (between 3.5 and 5.5) compared to most other areas at the site (pH typically between 5.8 and 9).

Special areas targeted in the 1999 investigation were the DMEA dump and smelter stack remains, including ash. The DMEA dump samples contained the highest levels of arsenic (up to 9460 mg/kg) and ash-impacted soil near the concrete base of the smelter stack contained the highest levels of mercury (up to 471 mg/kg) and among the highest arsenic levels (up to 3750 mg/kg) observed in soil sampling at the Stibnite site.

In summary, nearly all areas sampled in the soil investigation had average concentrations of antimony, arsenic, and mercury in excess of levels in non-mining areas. This is not unexpected because areas were targeted for sampling that were known or suspected of containing Bradley tailing, waste rock, neutralized ore, or native ore. These materials derive from highly mineralized native rock in the Stibnite mining area.

1.7 AQUATIC SAMPLING AND HABITAT CHARACTERIZATION

Physical habitat was characterized at 10 aquatic stations as part of the 1997 Site Characterization. Two additional stations (MC-1C in the new Meadow Creek Diversion Channel and EF-7 in the EFSFSR below the Glory Hole) were characterized in 1999. In addition, the Forest Service and IDEQ sampled sediment and benthic macroinvertebrates (for community and chemical analysis) at 8 to 10 stations in 1996 and 1997, and the Forest Service, with assistance from the Stibnite Group, collected fish for chemical analysis at five stations in 1997. Benthic macroinvertebrates were collected by IDEQ and the Forest Service from 12 stations in 1999. As described previously, surface water quality samples were collected from 29 stream stations in 1997 and from 24 stations in 1999.

The purposes of the aquatic characterization were to document aquatic habitat condition in Meadow Creek, EFSFSR, and Sugar Creek; to identify chemical or physical impacts from mining activities that result in impaired aquatic habitat; and to collect data to support ecological risk assessment.

Results of the characterization indicate that physical stream habitat is impaired primarily in lower Meadow Creek Valley (Stations 368 and 319) and the EFSFSR above and below the bridge on the main access road to the site (including Station 308). The lower-quality habitat is primarily a function of sparse instream and riparian cover and, in a portion of Meadow Creek, increased percent surface fines. In addition, streambank condition is impaired along several reaches: some stretches of lower Meadow Creek with unstable tailing; portions of the EFSFSR with steep sparsely vegetated banks, specifically, 425 feet of streambank above the Glory Hole in the vicinity of Monday Camp and 800 feet of the west streambank of the EFSFSR above the main access road; and the lower reach of Sugar Creek where moderately stable banks and limited vegetation occur. The distribution of three key habitat factors (bank stability, riparian vegetation, and percent surface fines) is diagrammed in Figure 8.5-11.

Most of the EFSFSR above the Glory Hole (except for immediately upstream of the Glory Hole to just above Monday Camp) exhibited good-quality habitat, represented by good instream and riparian cover, a variety of riffle-run and pool habitats, and low to moderate percent surface fines. These stream segments also had unimpaired benthic community structure and relatively lower concentrations of key metals in sediment and fish tissue.

The EFSFSR below the Glory Hole (down to the bridge on the main access road) is of satisfactory quality in terms of a variety of instream habitat and substrate condition. However, the riparian habitat is poor to fair along much of this reach, due to limited vegetation on the scoured banks, which are comprised of alluvium and waste rock. Sediment concentrations of metals were similar at Station EF-7, below the Glory Hole, and at downstream Station 308, below the northwest Bradley waste rock dump. Both stations had sediment concentrations of arsenic, iron, and zinc that were higher than most other aquatic stations.

In Sugar Creek, physical aquatic habitat is generally unimpaired (stream banks are only moderately stable in the mid and upper sections), but site-wide maximum mercury concentrations were found in Sugar Creek surface water, sediments, benthic macroinvertebrate tissue, and whole body fish tissue. The mercury burden in Sugar Creek is from upgradient off-site sources.

The 1999 total bioassessment scores for benthic macroinvertebrates improved at 7 of the 10 stream stations that also were sampled in 1998 as shown in Figures 8.5-12 – 8.5-14. The total bioassessment scores prepared by ABA (2000; see Appendix I.4 of this report) for 1999 ranged from 71 to 81 percent at all Site stations with the exception of stations in new channels (Station MC-1C in the new Meadow Creek Diversion Channel) or in unstable substrates (Stations 369A/B immediately upstream of the Glory Hole). In 1998, total bioassessment scores ranged from 63 to 82 percent. The 1999 scores indicate moderate to high aquatic habitat complexity and biotic integrity. In view of the high elevation and cold water temperatures in the Site streams, most of the stations sampled in the EFSFSR watershed have the potential to score only in the 80- to 90-percent range for total bioassessment. Further, benthic macroinvertebrate community composition and densities did not change substantially between the upper reference stations and lower stations as the EFSFSR traverses the Stibnite Site. According to Wisseman of ABA (personal communication), mayfly abundance and taxa richness were very high in the 1999 Stibnite samples, and intolerant mayflies tend to be one of the groups most sensitive to metals.

1.8 GLORY HOLE CHARACTERIZATION

The Glory Hole investigation conducted in 1999 included bathymetry and velocity measurements, bank stability mapping, and sampling and analysis of surface water, seep water, sediment, and benthic macroinvertebrate community structure. The objectives of the study were to evaluate:

- The potential for mobilization of sediments during 2-year ("typical"), 100-year, and 500-year flow events and during seasonal turnover, if present;
- The potential risk to in-situ aquatic life posed by water and sediment in the Glory Hole;
- The potential for unacceptable risk to downstream aquatic receptors if Glory Hole sediments were to become resuspended; and
- Whether erosional features are significant sources of sediment loading to the Glory Hole and whether seeps contribute to exceedances of water quality criteria in the Glory Hole.

Details of the field investigations and analysis of Glory Hole data are presented in Sections 8.5.7 and 8.8.

Water in the Glory Hole was 44 feet deep at the deepest point (measured on July 13–16, 1999). The majority of the Glory Hole pool is over 20 feet deep, with a central area over 40 feet in depth occupying about 0.7 acres (Figure 8.5-4). Alluvial fans exist on the eastern and southern margins of the pool, the highwall of the Yellow Pine Pit is on the west side, and the Glory Hole outlet flows over a rocky shelf that controls water levels in the lake. Woody debris is a significant component of the bottom sediments.

Acoustic doppler velocity measurements show that current flows clockwise from the inlet toward the west wall of the Glory Hole, with a significant backcurrent or eddy flow in the eastern half of the pool. Most current is found in the upper 15 feet of water column, and the average current velocity on the bottom was estimated to be 0.05 feet per second.

Estimated bottom velocities occurring in the Glory Hole during the 2-year, the 100-year, and the 500-year flow events were below the permissible velocity threshold (i.e., the water velocity below which sediments will not be resuspended) for unconsolidated fine-grained sediments, 0.04 mm -- the average grain size of sediment in the Glory Hole (Figure 8.8-3). Therefore, there is a low potential for sediment resuspension during 2-year flow and 100-year flow, which is considered the maximum event of reasonable concern. Estimated bottom velocities during the 500-year event approached the permissible velocity limit; therefore, the potential for resuspension is considered to be low to moderate, to account for variability in the controlling conditions. Local sediment scour may occur if high flows are constricted near the outlet, or where bottom turbulence is created when inlet flows glance against the west high wall. However, widespread scour is not probable over the bottom of the Glory Hole, and deposition, rather than resuspension, will dominate even in high flow events.

Temperature profiles collected in July, August, and September, 1999 revealed thermal stratification in all three months. These results suggest that isothermal conditions may occur in the Glory Hole in the spring and fall. The duration of isothermal conditions, however, is expected to be combined with an expected inverse thermocline in winter of limited duration. Turnover would be possible during isothermal conditions, provided other factors such as high winds or substantially high inflow currents coincided with the isothermal conditions. The potential to resuspend sediment under these conditions is not known and

cannot be quantified. However, if turnover occurs, it is not expected to generate the bottom current velocities necessary for sediment resuspension.

Sediment and surface water do not appear to be toxic to the indigenous aquatic biota, based on evaluation of sediment quality, surface water quality, benthic macroinvertebrate community, and fish community.

Analytical results for six Glory Hole sediment samples, including the inlet shelf, (Table 8.5-21) were compared to a recently compiled consensus-based freshwater sediment screening values and other published values. The consensus-based values are termed threshold effect concentrations (TECs) -- concentrations below which adverse effects on benthic invertebrates are not expected and probable effect concentrations (PECs) -- concentrations above which adverse effects on benthic invertebrates are expected (MacDonald et al., 2000; Table 8.5-23). Additional sediment screening values from various sources were recently compiled by EVS (1998) and are shown in Table 8.5-22. The average sediment concentration of arsenic in the Glory Hole (452 mg/kg) was greater than the consensus-based PEC and all other screening values. The average concentrations of antimony (56 mg/kg) and mercury (0.98 mg/kg) were greater than some screening values, but all other sediment metals concentrations were less than most screening values.

Metal concentrations in sediments apparently are not significantly toxic to the benthic macroinvertebrate infauna based on the results from the benthic macroinvertebrate sample analyses which showed that benthic macroinvertebrate densities were high, and the number of taxa were typical for the soft sediment habitat (ABA, 1999).

Water samples were collected from two or three depths at three locations in the Glory Hole in July, August, and September, 1999. All metals results were lower than applicable water quality criteria for protection of freshwater aquatic life. However, five samples collected in September had antimony concentrations between 31 and 33 µg/L, slightly greater than the proposed USEPA chronic criterion of 30 µg/L.

Four stations (three replicates each) were sampled for benthic macroinvertebrates. The benthic macroinvertebrate community in the Glory Hole is dominated by pond or lentic water taxa, typically found in fine organic sediments in cool-water ponds and lakes in the Pacific Northwest, and the data cannot be compared with any stream invertebrate community data generated from streams in the area (ABA, 1999; Appendix I.3). Invertebrate densities were very high at Stations GH-1 and GH-3 (35,000-53,000/m^2), and extremely high at Station GH-4 (192,000/m^2). The numbers indicate a highly productive invertebrate community in the Glory Hole. In contrast to the other three Glory Hole stations, total invertebrate densities at Station GH-2 (287/m^2) were significantly lower. Factors contributing to the low abundance at Station GH-2 are unknown; however, Station GH-2 is the deepest Glory Hole Station at 43 feet compared to depths of 17 feet or less at GH-1, GH-3, and GH-4.

A number of conclusions can be made regarding the Glory Hole benthic habitat and its macroinvertebrate community:

- Invertebrate taxa richness is low, but typical for fine organic (soft), lentic sediments.

- The very high invertebrate densities at Stations GH-1 and GH-3 (35,000-53,000 per square meter), and extremely high at Station GH-4 (192,000 per square meter) indicate a highly productive invertebrate community.

- The fauna collected indicate that dissolved oxygen levels in the surface sediments are moderate or better. Taxa associated with nearly anoxic or low dissolved oxygen conditions were not found in the samples collected at the four Glory Hole stations.

In 1999, a total of 229 bull trout were collected from the EFSFSR drainage in a population study sponsored by The Payette National Forest, Idaho Department of Fish and Game, and the University of Idaho. Over half (125) were caught in the Glory Hole. Steelhead/rainbow trout, cutthroat, and mountain whitefish also were noted in the Glory Hole. Given the water quality results in the Glory Hole and the abundant resident fish population, it was concluded that water quality in the Glory Hole does not pose an unacceptable risk to the resident aquatic biota.

Overall, the sediments and water quality in the Glory Hole do not appear to pose an unacceptable risk to the aquatic community in the Glory Hole, nor to the aquatic environment downstream of the Glory Hole. This conclusion is based on four principal reasons: 1) resuspension of sediments has only a low probability under the 2-year and 100-year flow events, 2) sediments in the Glory Hole are not toxic to the resident aquatic biota, 3) Glory Hole sediments, if resuspended, would be a small fraction of the total sediment load, most of which would come from streambeds upstream and downstream of the Glory Hole, and 4) any fine-grained sediments that were resuspended would remain in suspension until they encountered low stream velocities similar to those in the Glory Hole; i.e., they would be transported and mixed with other suspended particulate for a long distance downstream before final settling occurred.

Erosional areas and seeps were also evaluated as potential sources of metals loading to the Glory Hole. Although the Yellow Pine Pit contains areas of evident erosion, it does not have erosional features that are likely to deliver significant amounts of sediment directly to the Glory Hole lake. Steep and erosive areas mostly occur on the upper slopes of the Yellow Pine Pit. None connect directly to the water surface (Plate 12) but rather are separated from the aquatic habitat of the Glory Hole by more stable areas such as mine excavation terraces and alluvial fans. The shoreline of the Glory Hole lake is considered mostly stable, consisting of rock outcrop, wetlands, mostly stable alluvial fans and mine terraces on bedrock and moderately stable flat to gentle slopes. These areas are unlikely to contribute significant amounts of sediment. However, about 100 feet of shoreline on the southwest side is steep terrain that is only moderately stable.

Portions of the banks upstream of the Glory Hole and below Monday Camp have steep and erosive slopes with gully and sheetwash erosion. These slopes are a potential source of sediment loading to the EFSFSR above the Glory Hole. However, there is no evidence that the slopes are disintegrating or subject to mass wasting under common conditions. The EFSFSR banks themselves and the stream bed in this section are heavily armored with boulders and cobbles.

The seeps that emerge from the highwalls above the Glory Hole do not appear to contribute significantly to exceedances of water criteria in the Glory Hole, because water quality criteria were met for all constituents in all Glory Hole samples, except for some total antimony results (maximum = 33 μg/L) that slightly

exceeded the proposed USEPA criterion of 30 µg/L. All of the seeps at the Glory Hole flow through native ore bodies (including disturbed areas), and do not flow through mine waste rock. The seep water concentrations were consistent with the natural mineralization of ores in this reach of the EFSFSR, through which the seeps flow. Therefore, the seeps are likely to be one of several factors (including groundwater, surface runoff, and releases from bottom sediments) that contribute to the slight increase in concentrations and loading of antimony, arsenic, and some other constituents in the Glory Hole (Section 8.3.7).

1.9 UPLAND AND RIPARIAN HABITAT CHARACTERIZATION

Terrestrial studies conducted in 1997 and 1999 included characterization of soils, vegetation (habitat), and wildlife, and identification of rare or sensitive plant and animal species.

Many portions of the Stibnite Area have been affected to varying degrees by historic and recent mining activity. Some areas remain largely unvegetated and in poor condition; some have recovered to some extent, but remain in poor to fair condition; and some have recovered to good condition, where the differences between them and undisturbed areas are not apparent. Many of the areas with poor or fair condition were classified as such based on impacts attributable to physical disturbance from mine exploration and excavation, and flood scouring and deposition. The surrounding habitats not directly affected by mining activity are in good ecological condition.

In Area 1, most of the areas affected by mining are riparian habitats located in the valley bottom. About 15 acres of lower Meadow Creek Valley have historic tailing deposits on the soil surface, but nearly all of this area is good condition wetlands, meadow and forest, with the exception of about 1.1 acres of unvegetated tailing. About 360 feet (6 percent) of the right bank of lower Meadow Creek and 230 feet (4 percent) of the left bank are unstable and in tailing, and other discontinuous portions of streambank with tailing are currently stable but susceptible to erosion. In the vicinity of the confluence with Blowout Creek, Meadow Creek flows through alluvium deposited by the Blowout Creek dam failure, and there are some areas of bank instability in the alluvium. Most other portions of the valley bottom are permitted reclamation or operational areas. The hillside north of the Hecla and former SMI leach pads, Meadow Creek Mine area, and smelter stack area on the north side of the valley are also in poor to fair condition, associated with cuts and fills, steep slopes, erosion, and heavy big game use.

The DMEA dump in Area 2, which occupies less than 1 acre, provides poor habitat, largely because it is barren. Much of the valley slopes are undisturbed, but some areas along this reach of the EFSFSR are in poor to fair condition due to historic activities such as vegetation clearing for operational areas, cuts and fills, and erosion and deposition in riparian areas along the EFSFSR.

In Area 3, the Bradley waste rock dumps and Glory Hole occupy about 110 acres. Soils are mainly derived from mining, including mine excavations, mine waste rock, and reclaimed mine waste rock. Vegetation is sparse or absent in many areas, but reclaimed portions have varying amounts of vegetation cover. About 23 acres have erosive soils and 38.5 acres have moderately erosive soils. However, as noted previously, steep erosive slopes that are adjacent to the EFSFSR occur only along 800 feet of the west bank of the EFSFSR above the bridge at the main access road, along about 100 feet of shoreline on the southeast side of the Glory Hole, and along about 450 feet on the west bank of the EFSFSR between Midnight Creek and the

Glory Hole. In total, the steep erodible slopes immediately adjacent to the EFSFSR occupy about 15 percent of the shoreline from Midnight Creek to Station 314, including the Glory Hole perimeter.

The riparian habitat along the EFSFSR above and below the Bradley dumps and Glory Hole is in poor to fair condition because of past scouring and deposition.

Over 150 wildlife species (mammals, birds, reptiles and amphibians) are likely to occur at the Stibnite site. No threatened or endangered species are known or expected to occur, other than an experimental reintroduction population of gray wolf. Suitable habitat is present for nine sensitive (Watch list) animal species. No threatened, endangered, rare or sensitive plant species are known to occur at the Stibnite site, but some sensitive plant species could potentially be present within natural vegetation types.

1.10 CONCLUSIONS

The following conclusions can be drawn based on the previous summary of findings and current reclamation and remediation work being performed at the Site:

1. Surface water quality in the Meadow Creek and EFSFSR drainage improved substantially between 1997 and 1999 following implementation of the Bradley Tailing Diversion and Reclamation Project. This conclusion is based on significantly reduced levels of antimony and arsenic, the two constituents most characteristic of the site:
   - At Meadow Creek Station 322 (below the new Diversion Channel and below the Keyway Wetland), total antimony was reduced by 85 percent and arsenic by 50 percent in 1999 compared with 1997.
   - At all stations on the main stems of Meadow Creek and the EFSFSR, average concentrations of antimony and arsenic were one-third to two-thirds lower in 1999 compared to 1997.
   - Individual results for arsenic in 1999 were below Idaho and USEPA chronic water quality criteria for the protection of freshwater aquatic life. All but a few results for total antimony (maximum = 35 μg/L) were below the USEPA proposed criterion of 30 μg/L.

2. The 1999 total bioassessment scores improved at 7 of the 10 Stibnite stream stations (including reference stations) sampled in 1998. The total bioassessment scores in 1999 ranged from 71 to 81 percent at all Site stations with the exception of stations in new channels (Station MC-1C) or in unstable substrates (Stations 369A/B). These scores indicate moderate to high aquatic habitat complexity and biotic integrity. In view of the high elevation and cold water temperatures, most of the sites sampled in the EFSFSR watershed only have the potential to score in the 80- to 90-percent range for total bioassessment. Further, benthic macroinvertebrate community composition and densities did not change substantially between the upper and lower stations as the EFSFSR traverses the Stibnite Site. According to Wisseman (ABA; personal communication), taxa richness and mayfly abundance were very high in the 1999 Stibnite samples, and selected mayflies (i.e., intolerant taxa) tend to be one of the groups most sensitive to metals.

3. The Glory Hole aquatic habitat is not significantly impaired, based on environmental sampling and aquatic and riparian characterization performed in 1999:

- The sediments and water quality in the Glory Hole do not pose an unacceptable risk to the indigenous biota because there is a vigorous benthic community and abundant fish; with minor exceptions, water quality results were below relevant water quality criteria for the protection of freshwater aquatic life; and average sediment concentrations of metals other than arsenic meet most or all freshwater sediment quality guidelines.
- Most of the slopes around the Glory Hole are stable or moderately stable and are not expected to be significant sources of sediment to the Glory Hole; steep slopes susceptible to erosion occur along about 425 feet the EFSFSR above the Glory Hole, but there is no evidence of severe erosion.
- Seeps discharging into the Glory Hole flow through native mineralized zones, have low flows, and in themselves are not a significant source of loading to the Glory Hole.

4. The Glory Hole is primarily a sediment sink. The potential for sediment resuspension in the Glory Hole is low, as is the potential for adverse effects downstream were resuspension to occur:

   - The estimated bottom velocities under the 2-year and 100-year events are lower than the velocity required to resuspend unconsolidated fine-grained sediments and the average grain size sediment in the Glory Hole. The potential for resuspension is considered low to moderate under a 500-year flow event.
   - Although seasonal turnover could occur during isothermal conditions (expected to be of short duration), turnover is not expected to produce the bottom current velocities needed to suspend sediments.
   - The potential for significant adverse effects downstream is low because resuspension potential is low, in-place sediments do not appear to be toxic to the indigenous fauna, and velocities necessary to resuspend sediment would result in long-distance transport and dilution of fine-grained material prior to settling in a low-velocity environment.

5. Evidence of current impairment of aquatic or riparian habitat by historic mining activities occur primarily in Meadow Creek Valley and in portions of the EFSFSR above and below the bridge at the main access road and immediately upstream of the Glory Hole. Some of the highest quality aquatic habitat on the Stibnite Site is found in the EFSFSR between Meadow Creek and upstream of Monday Camp.

6. In Meadow Creek Valley:

   - Relative impairment of the physical aquatic in upper Meadow Creek (the Diversion Channel) and lower Meadow Creek is reflected in limited riparian vegetation, reduced instream cover, and increased percent surface fines in the substrate.
   - Bradley tailing deposits occur at or below the surface in most of lower Meadow Creek Valley (Plate 10). However, only small portions of the streambank are comprised of unstable tailing (these patches represent 4 to 6 percent of the length of lower Meadow Creek).
   - Surface water quality in lower Meadow Creek appears to be affected by groundwater because concentrations and loadings of antimony and arsenic increase, particularly between Stations 322 and MC-2B. These stations are downgradient of most of the historic Bradley facilities and are in an area of Bradley tailing deposits that are often in contact with the water table.

- In spite of elevated levels of antimony and arsenic in groundwater, arsenic concentrations in Meadow Creek surface water were below ambient water quality criteria, and all but two results for antimony were below the USEPA proposed criterion of 30 µg/L. Occasional detections of mercury were above the Idaho numeric criterion of 0.012 µg/L total mercury, but were below the USEPA criterion of 0.77 µg/L dissolved mercury.
- Wetlands and other valley bottom plant communities in Meadow Creek Valley are in good condition, although tailing is present to a greater or lesser degree in all three wetlands investigated. Wetland vegetation in tailing areas were largely indistinguishable from non-tailing areas.
- With one exception (Station MC-1C in the new Diversion Channel), the 1999 total benthic macroinvertebrate bioassessment scores at all Meadow Creek stations exceeded 70 percent of the maximum possible score (moderate biotic complexity/habitat integrity), and scores improved at Station 319 (mouth of Meadow Creek) between 1998 and 1999 (Figure 8.5-12). The long-term (1983-1999) trend at Station 319 is one of marked improvement – from a total bioassessment score of 22 percent in 1983 to 77 percent in 1999 (Appendix I.4).

7. In the EFSFSR below the Glory Hole:

- Satisfactory aquatic habitat in terms of the variety of instream habitat and substrate condition is present in the EFSFSR below the Glory Hole to the main access road. However, the riparian habitat is poor to fair along much of the reach, due to limited vegetation. Steep, erodible banks occur along about 800 feet of the west bank above the main access road.
- Below the main access road bridge, in the stream segment represented by Station 308, the EFSFSR flows through an open, apparently disturbed area below the Northwest Bradley waste rock dump. Substrate is primarily cobble and small boulders. Riparian cover is limited.
- Metals concentrations in surface water, sediment, and benthic macroinvertebrate tissue were somewhat higher in the EFSFSR below the Glory Hole (Stations EF-7 and 308) than in other portions of the EFSFSR. Never the less, 1999 levels of metals in surface water were below Idaho and USEPA water quality criteria; except for a few results for total antimony (up to 35 µg/L) slightly exceeded the USEPA proposed chronic criterion of 30 µg/L. Mercury was detected in this reach of the EFSFSR only below the confluence with Sugar Creek.
- Total benthic macroinvertebrate community bioassessment scores at the EFSFSR stations below the Glory Hole were 74 percent or greater (moderate to high biotic complexity/habitat integrity). The biological community at EFSFSR Station 314 reflects conditions at the most downgradient stream location on the Stibnite Site. It has a total bioassessment score of 81 percent (indicative of high habitat complexity/biotic integrity). Given the high mayfly abundance and taxa richness found in the benthic macroinvertebrate samples from Stations EF-7 and 308, it appears that any adverse effects from metals are minimal in the EFSFSR below the Glory Hole.

8. Mercury levels in surface water and sediment of Sugar Creek and the EFSFSR below Sugar Creek were substantially higher than elsewhere on site, due to off-site sources of mercury in the Sugar Creek watershed.

9. In groundwater, the highest concentrations of dissolved antimony (about 200 to 2000 µg/L) and arsenic (about 500 to 13,800 µg/L) are observed in samples collected within or in close proximity to saturated

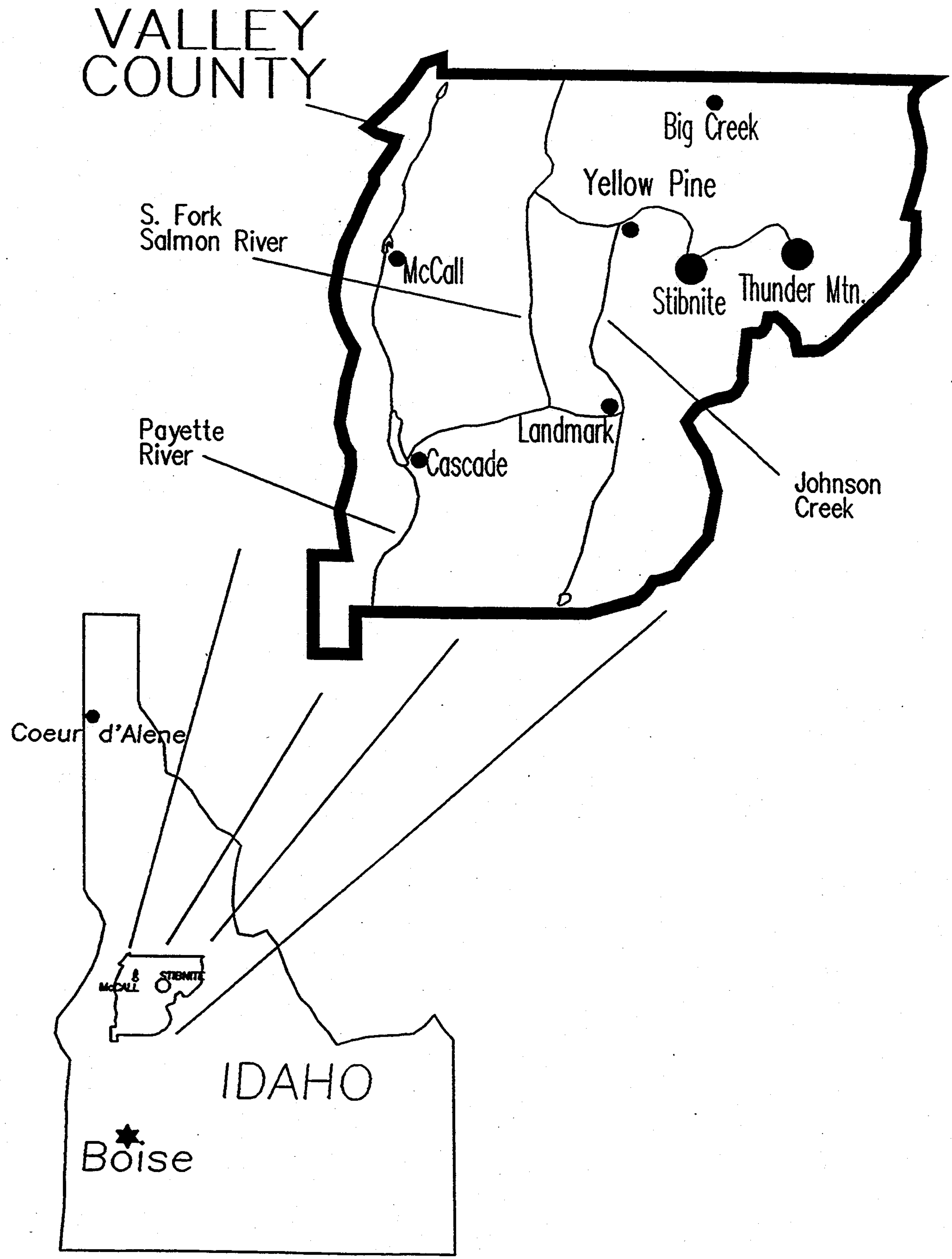
Bradley tailing. Lower levels elsewhere (e.g., about 20 to 50 μg/L dissolved antimony and about 30 to 150 μg/L dissolved arsenic) reflect the natural mineralization of ore bodies in the EFSFSR above and below the Glory Hole. However, concentrations over 1,000 μg/L dissolved arsenic were observed in groundwater and seeps on the Meadow Creek Mine hillside.

10. Concentrations in seep samples were consistent with the groundwater results, depending on sampling location. Sulfate concentrations above 100 mg/L were observed in several seeps in mineralized zones (Glory Hole, Meadow Creek Fault Zone) and near Bradley tailing. The pH levels in all seeps ranged from 6.3 to 8.1. Therefore, acidic seepage is not characteristic of the Stibnite mining area.

11. In soil, levels of antimony and arsenic were highest in native ores or material derived from the ores. Mean arsenic concentrations were about 1,350 mg/kg in samples at the Meadow Creek Fault zone, 1,200 mg/kg in Bradley tailing, 1,400 mg/kg in neutralized ore, and 1,900 mg/kg to 4,300 mg/kg in Bradley waste rock. Variation in arsenic and mercury levels in soil samples on the Meadow Creek Mine Hillside appear to be associated primarily with the proximity to the Meadow Creek Fault Zone and mine exploration areas; impacts from historic smelter emissions are not readily discernible from the data.

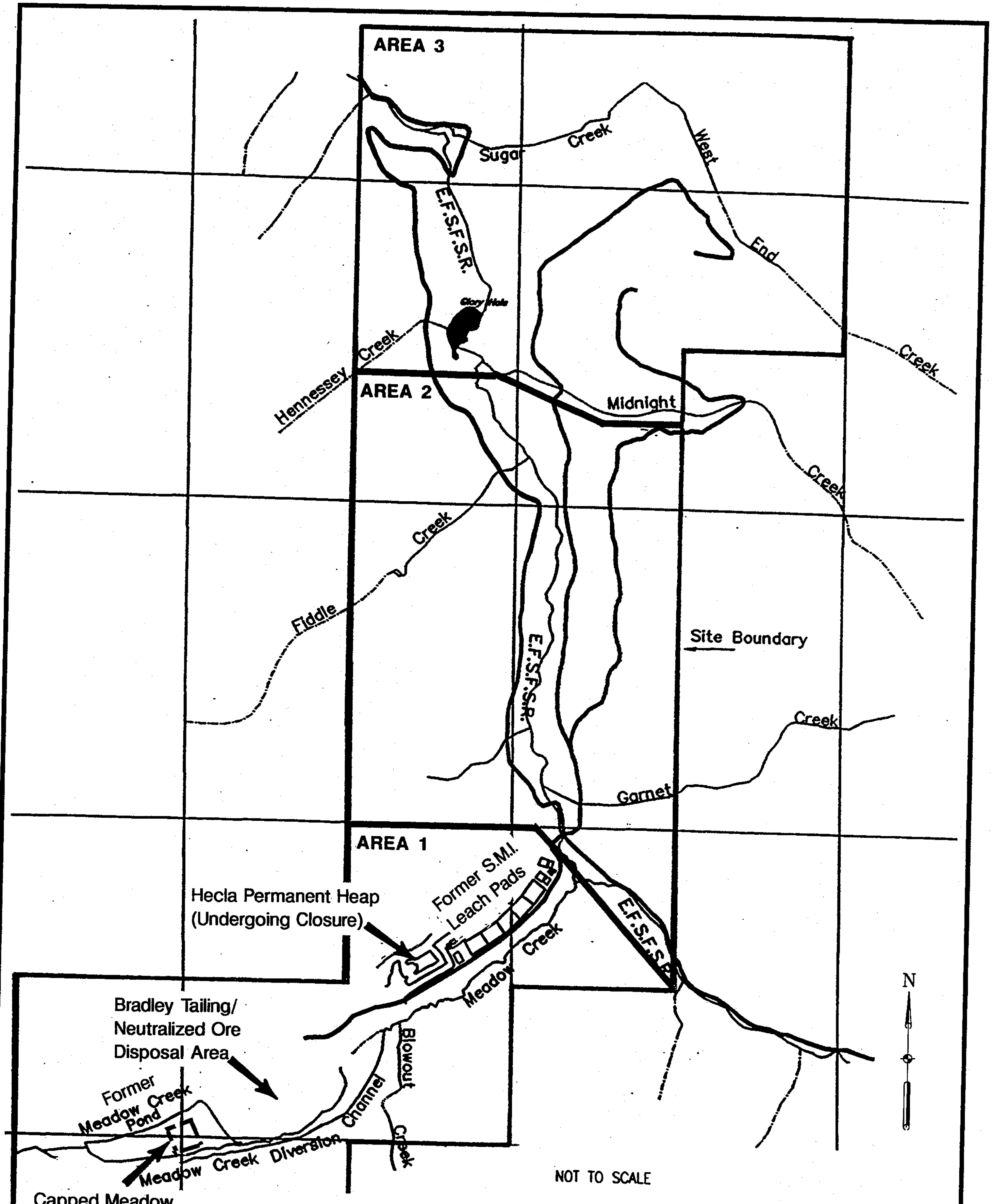
12. All the Bradley waste rock dumps appear to be of similar composition (although antimony and arsenic levels varied somewhat among the dumps). Much of the Bradley waste rock dumps and Glory Hole area is sparsely vegetated, and about 23 acres have steep slopes and evident erosional features. However, only portions of the steep erodible slopes are directly on the shoreline of the EFSFSR (800 feet of shoreline on the west bank above the main access road). The poor vegetation is likely due to the adverse physical characteristics of the substrate and a combination of high metals and low pH. Two seeps were identified at the Northwest Bradley waste rock dump in June 1999; these seeps had somewhat higher levels of dissolved antimony and arsenic than most seeps near the Glory Hole, but in themselves are not considered a significant source of loading to the EFSFSR.

The stabilization and reclamation activities that were conducted in 1998 by Mobil Oil Corporation at the BT/NO disposal area have contributed to an overall improvement in water quality in Meadow Creek and the EFSFSR over the 1997 and earlier conditions documented in this Site Characterization Report. Long-term improvements to terrestrial and riparian habitat and in water quality are also expected from current and planned SMI and Hecla reclamation activities. Now that mining has ceased at the site and reclamation activities are progressing to completion, sediment loading to the EFSFSR should continue to decline.



Job No. : 24343	FIGURE 1-1
Prepared by : C.R.P.	STIBNITE AREA LOCATION MAP
Date : 7/31/98	STIBNITE MINE

SAL-TB



Job No. : 24343	FIGURE 1-2
Prepared by : C.R.P.	STIBNITE SITE AREAS OF INVESTIGATION
Date : 3/13/00	STIBNITE MINE

SSAI-TB