NATURAL RESOURCES

INACTIVE AND ABANDONED MINE LANDS—
Great Excelsior Mine, Mount Baker Mining District, Whatcom County, Washington

by Fritz E. Wolff,
Donald T. McKay, Jr.,
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Matthew I. Brookshier

WASHINGTON
DIVISION OF GEOLOGY
AND EARTH RESOURCES
Open File Report 2004-5
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site location

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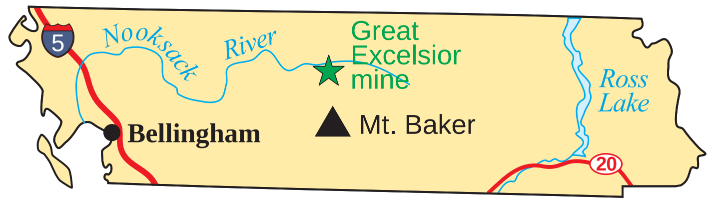
Contents

FIGURES

TABLES



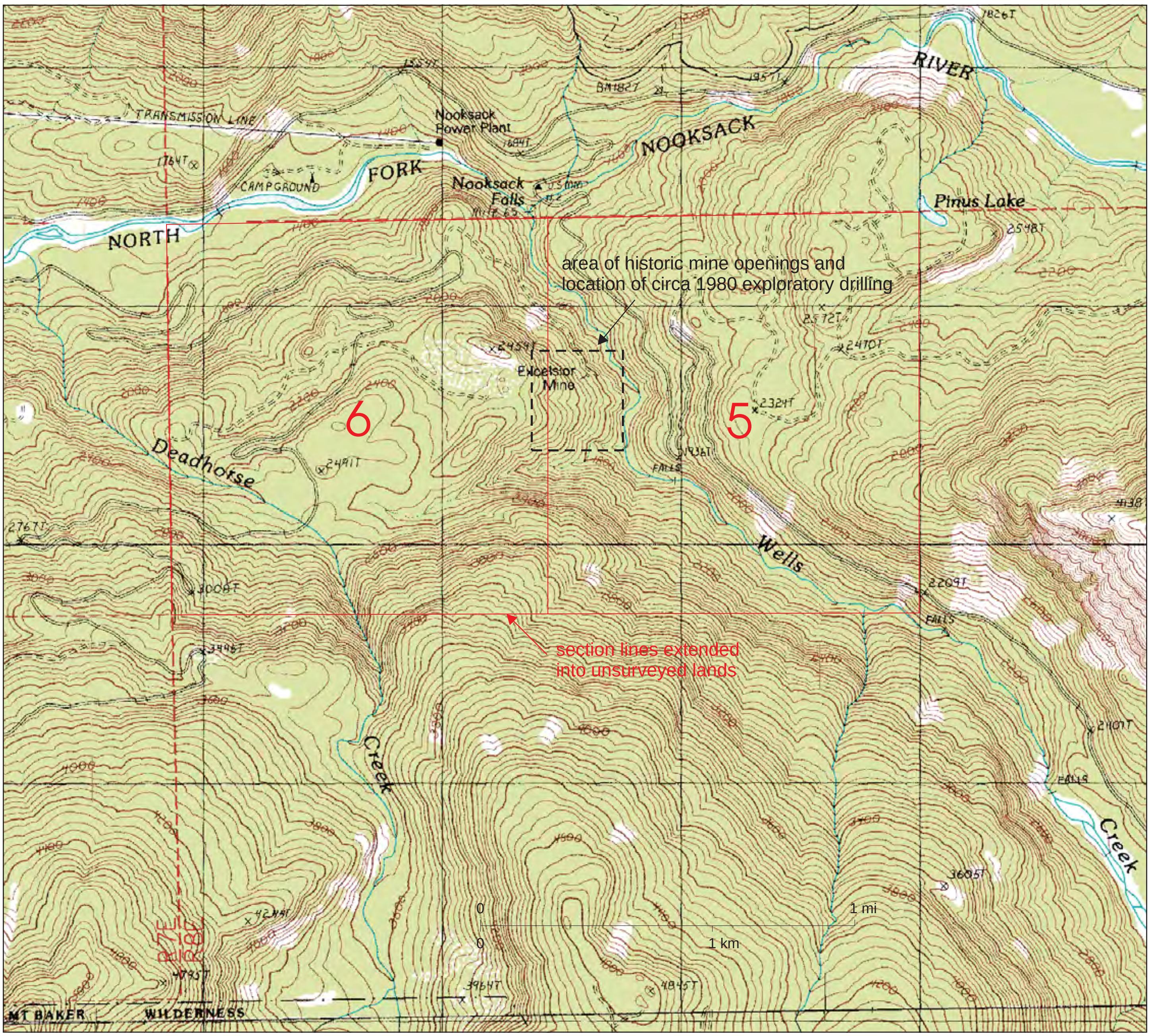


Figure 1. Map showing general location of the Great Excelsior mine in Whatcom County *(top)* and a site map of the mine.

Inactive and Abandoned Mine Lands—Great Excelsior Mine, Mount Baker Mining District, Whatcom County, Washington

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INTRODUCTION

The Washington State Department of Natural Resources (DNR), Division of Geology and Earth Resources (DGER) is building a database and geographic information system (GIS) coverage of major mines in the state. Site characterization was initiated in 1999 (Norman, 2000). Work is funded through interagency grants from the U.S. Forest Service, Region 6. Other agencies sharing in the project are the U.S. Forest Service (USFS), U.S. Bureau of Land Management (BLM), the U.S. Environmental Protection Agency (EPA), and the Washington Department of Ecology (DOE).

Over 3800 mineral properties have been located in the state during the last 100 years (Huntting, 1956). Many are undeveloped prospects of little economic importance. Therefore, in considering the population to include in the Inactive and Abandoned Mine Lands (IAML) inventory, we have identified approximately 60 sites that meet one of the following criteria: (a) more than 2000 feet of underground development, (b) more than 10,000 tons of production, (c) location of a known mill site or smelter. This subset of sites includes only metal mines no longer in operation.

We have chosen to use the term *inactive* in the project's title in addition to the term *abandoned* because it more precisely describes the land-use situation regarding mining and avoids any political or legal implications of surrendering an interest to a property that may re-open with changes in economics, technology, or commodity importance.

The IAML database focuses on physical characteristics and hazards (openings, structures, materials, and waste) and water-related issues (acid mine drainage and/or metals transport). Accurate location, current ownership, and land status information are also included. Acquisition of this information is a critical first step in any systematic approach to determine if remedial or reclamation activities are warranted at a particular mine. Open-File Reports (OFRs), such as this one, provide documentation on mines or groups of mines within specific mining districts or counties. The IAML database may be viewed with assistance from DGER personnel. IAML OFRs are posted online at http://www.wa.gov/dnr/htdocs/ger/iaml.

SUMMARY

Historically, the Great Excelsior (Excelsior) mine (Fig. 1) was one of Washington's better known but problematic gold producers due to the presence of microscopic precious metal values and related milling problems. For all practical purposes, mining and milling operations terminated in 1917. The property is located 6 miles east of the town of Glacier, on the west side of Wells Creek near its confluence with the Nooksack River. The mine openings lie on Mt. Baker–Snoqualmie National Forest land in NW¼ of sec. 5, T39N R8E; unsurveyed (Fig. 1). This area is about one mile north of the Mt. Baker Wilderness boundary.

As explained below, the previous underground mining activity took place in a very restricted part of a large-scale epithermal volcanogenic sulfide deposit. Changes in the economics of mining and milling large-tonnage, low-grade ore deposits created a number of serious exploration efforts in the period from 1972 to 1993. This latter day exploration work included subsurface drilling and geophysical surveys that extended the known disseminated gold-silver mineralization into sec. 6, T39N R8E (Robertson and McGregor, 1988). This work determined that the deposit's most abundant precious metal was silver, not gold. Exploration drilling took place on an approximately 45-acre tract bounded on the north by the mine workings and on the south by the east fork of Deadhorse Creek. DGER personnel visited the site on 7 August 2002. DOE and DGER personnel took Wells Creek water samples above and below the mine area in October of 2002 and June of 2003. The field observations reported below pertain only to the area of the original "President" group of nine claims, now obsolete, and related underground operations.

Several events taking place after 1975 significantly affected the course of development at the Excelsior mine property. In 1980 the market price of silver spiked to a historic high of $48 per ounce, only to return to $5 per ounce eighteen months later. Additionally, in 1983 gold struck a historic high of $600 per ounce, but retreated to approximately $300 per ounce a short time later. A nesting northern spotted owl was found near the mine in June 1986 by WDFW biologists. The spotted owl was given a "threatened species" designation in June of 1990 by the U.S. Department of Fish and Wildlife. The former exploratory drilling sites and mine openings now lie within a spotted owl management circle, an administrative area that carries certain constraints as to permissible activities. Congress authorized establishment of the Mt. Baker Wilderness area in 1984, the northern boundary of which lies approximately one mile south of the Excelsior mine.

OWNERSHIP

In the late 1980s, approximately 100 unpatented claims surrounding the Great Excelsior mine were active and under exploration (Fig. 2). As of October 2003, all were classified "closed" except (WC #2, 3, 4, 6, and 7), held by Excelsior Mining Corporation, and a group on the east side of Wells Creek (Gold Porphyry #1–5) held under possessory title by private parties (BLM Land and Mineral Records LR2000 database, October 2003). Excelsior Mining made a patent application for the WC group claims in 1992 that has not been resolved as of the date of publication.

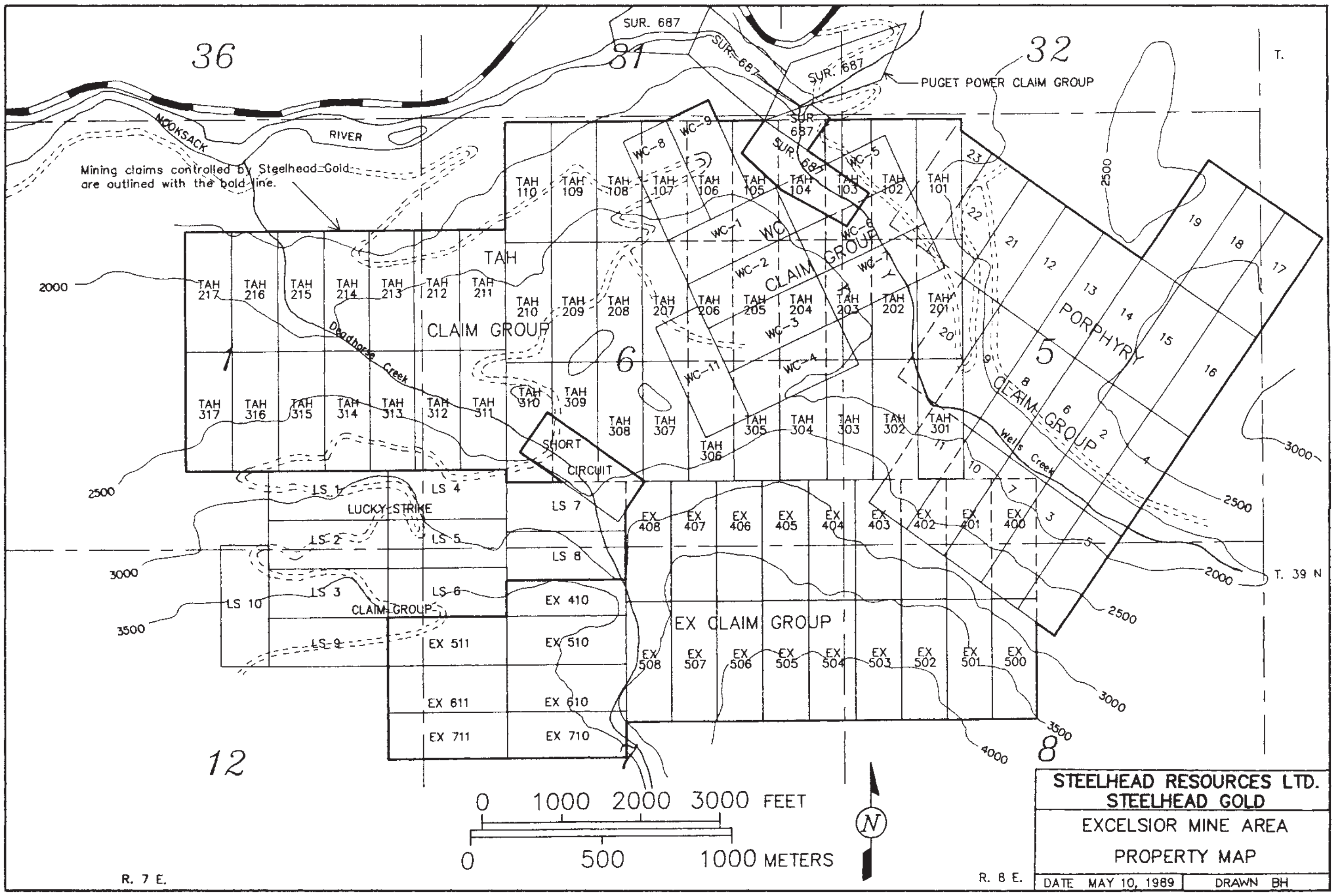

Figure 2. Excelsior mine area claims circa 1989. *(Courtesy of Steelhead Resources, Ltd.)*

HISTORY

W. H. Norton and others discovered the Great Excelsior mineralization in 1900. Two years later, Norton incorporated the Great Excelsior Mining Co. and constructed a 20-stamp mill to recover gold by crushing, gravity concentration, and mercury amalgamation. The mine changed hands in 1905. The new company, President Group Mining Co., rebuilt the mill around the gold-cyanidation process because the original mill technology lost over 50 percent of the values due to the ore's tendency to slime. Mill recoveries by cyaniding failed to improve recovery dramatically, and the mine was shut down in 1916. Moen (1969) reported that a pilot test using circa-1916 flotation techniques on 30 tons of crude ore yielded precious metal recoveries of 85 to 90 percent.

In 1922, H. E. Barnes relocated the claims, which had become invalid due to failure of the parties to carry out annual assessment work. Barnes maintained the claims until 1960. The Exploration Division of American Smelting and Refining Co. (Asarco) restaked the deposit as the "Wells Creek Group" in 1966. They determined that the deposit was subeconomic under 1971 market conditions and abandoned the property. This activity, however, marked the beginning of modern interest in the property as a large-tonnage, potentially open-pit, operation.

Douglas McFarland restaked the Wells Creek claim group in 1974. Silver Standard Mining Ltd., in cooperation with Hanna Mining Co., drilled two holes directly south of the mine openings in 1975. In 1976, Quintana Exploration leased the claims and core-drilled six additional holes. From 1977 to 1983, U.S. Borax and Chemical Co., through a wholly owned subsidiary Pacific Coast Mines Inc., conducted comprehensive geophysical and geochemical surveys, geologic mapping, and core-drilled 45 holes totaling 15,214 feet (Nooksack Mines, Inc., 1987). This work significantly expanded not only the known areal extent and depth of mineralization, but provided a better understanding of the deposit's mineralogy and geologic origin.

Steelhead Resources, Ltd., acquired rights to explore the property in 1985. Steelhead continued geologic mapping and drilled 61 reverse-circulation holes with an overall footage of 24,776 feet. Robertson and MacGregor (1988) summarized the extensive 1987 drilling program in a report to the U.S. Forest Service: "The mineralization occurs in an arcuate zone 600 feet wide by 1300 feet long. The analysis indicates a probable ore reserve of 5.9 millions tons averaging 0.033 ounce per ton gold, and 2.047 ounce per ton silver at a gold equivalent cutoff grade of .02." Gold-equivalent cutoff grades were calculated based on a 60:1 ratio of silver to gold.

These latter day assays of average metal content agree remarkably well with an extensive sampling program conducted in 1934 at ten-foot intervals in the Excelsior underground mine openings: 0.012 ounce per ton gold and 2.02 ounces per ton silver (Stoess and Slater, 1935).

Steelhead, state, county, and federal agencies, and the public attended meetings in Bellingham and Glacier, Washington, in the fall of 1987 to discuss the plan of operations and environmental considerations. A nesting northern spotted owl was observed near the mine site in June 1986. A spotted owl management circle now encompasses the latter-day exploration area and historic mine (WDFW, 2003).

Steelhead contracted with FMC Gold Corp. of Denver to conduct a "make-or-break" evaluation of the Excelsior property in August of 1989 (Caldwell, 1989). Stanford Metals, Ltd., leased the property from Excelsior in 1991. The results of these agreements are unknown (DGER mine files).

A summary of events from the foregoing discussion is in Appendix C, Table 1.

GEOLOGIC SETTING

The historic Excelsior Mine openings occur in a brecciated zone 400 feet long from north to south and 270 feet wide from east to west (Fig. 3). The breccia and the underlying fractured slate dip 55 degrees west into a steep hillside. The host rocks occur in the Wells Creek volcanics, a 4000-foot thickness of felsic volcanic breccias with interlayered marine shales, siltstones, greywacke, and shaley-tuffs. Regional metamorphism and large-scale hydrothermal alteration have replaced the primary feldspars with adularia and sericite. The host rocks were probably deposited under active geothermal conditions from heated brine in a sub-seafloor environment (Franklin, 1985).

The sequence of rocks in the mine area (and the area extended by exploration drilling) has been subdivided into eight mappable units. From the oldest to youngest they are: (1) slate, (2) lower green tuff, (3) fragmented tuffaceous greywacke, (4) dark sediments, (5) felsic volcanic breccia, (6) felsic volcanics, (7) gray siliceous tuff, and (8) upper green tuff (Robertson and McGregor, 1988). The underlying slate unit and the overlying upper green tuff are relatively unaltered except by regional metamorphism, while the middle units are all hydrothermally altered and contain varying amounts of silver-gold mineralization. The hydrothermal alteration in the mine series rocks is intensive and generally pervasive, depending on local permeability.

While the Excelsior mine was considered a gold producer, recent exploration work has determined that the silver content of the deposit exceeds that of gold. Franklin (1985) found argentite to be the primary silver-bearing mineral. Silver is also present in antimony-copper-bearing minerals such as polybasite, freibergite, and tetrahedrite. Electrum, a

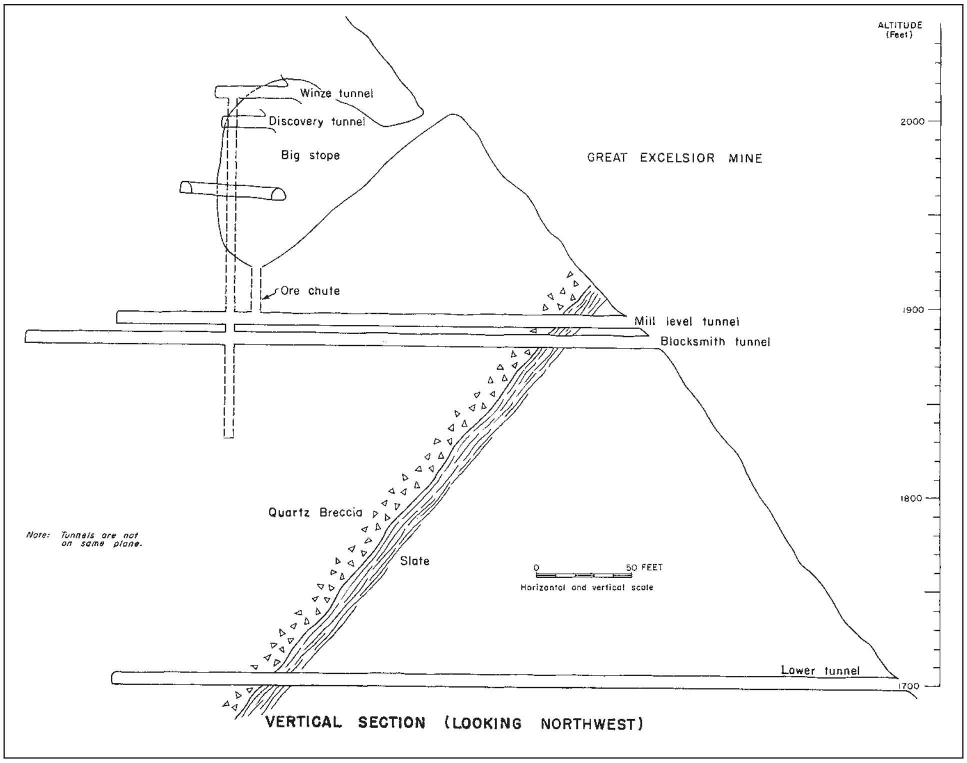

Figure 3. Vertical section of openings in relationship to steeply dipping metavolcanics (after Moen, 1969).

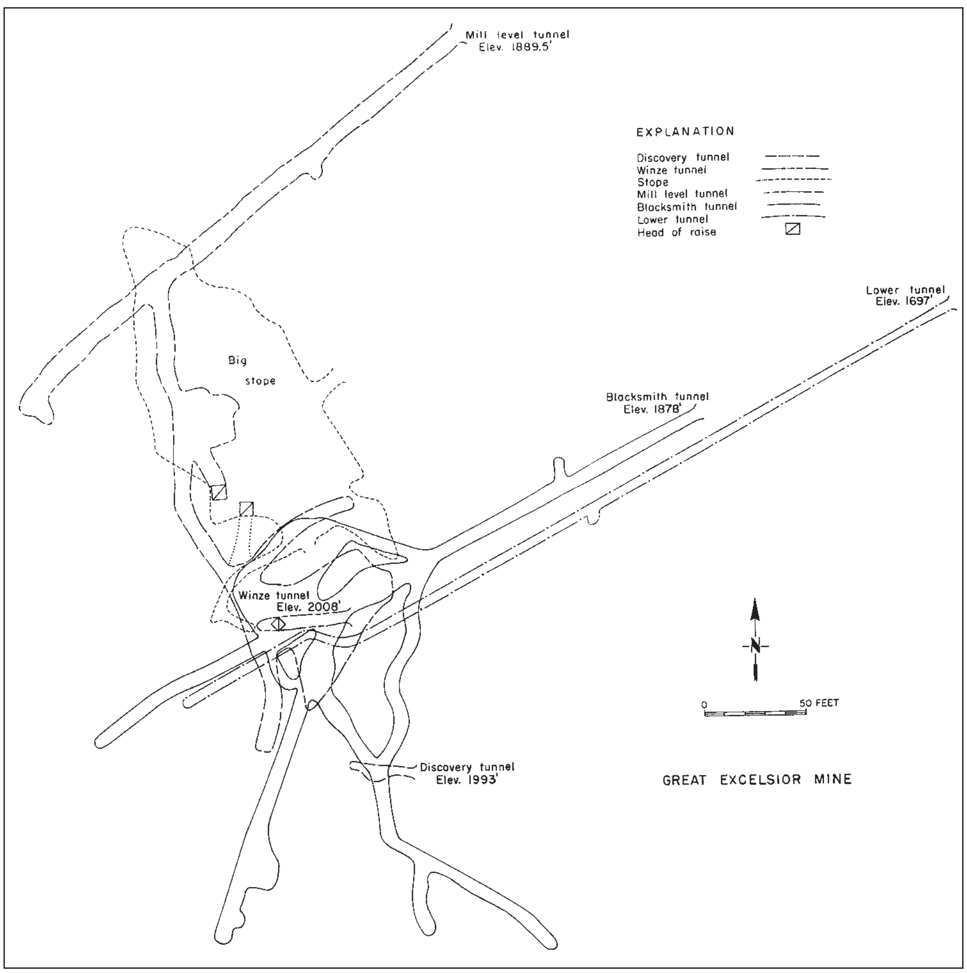

Figure 4. Composite plan view of mine openings (after Moen, 1969).

naturally occurring gold-silver alloy (~65% Au, 35% Ag) was also found and is probably the source of most gold values. Pyrite, sphalerite, galena, chalcopyrite, and bornite are locally present, but in sub-economic concentrations. Robertson and McGregor (1988) state that the sulfides in drill core are so finely grained as to be virtually invisible to the naked eye unless moistened. This may explain the extraordinary loss of precious metals due to sliming during the early (1917) attempts at concentration.

OPENINGS

For purposes of clarity, we use the same nomenclature for the underground mine as Moen (1969) and Stoess and Slater (1935). The ore body lies on the west bank of Wells Creek. Slopes in the mine area vary from 50 degrees to vertical. Figures 3 and 4 provide an excellent depiction of the relationship of the various openings to each other. We found the Lower tunnel portal at elevation 1700 feet, approximately 150 feet vertically above Wells Creek. It is completely caved and overgrown. A 1974 letter to G. McKelvey, Homestake Mining Co., quotes claim holder Douglas McFarland as reporting the Lower tunnel to be full of water at the time (R. C. Parker, consultant, written commun., 1974, DGER mine files). A 10-foot-deep gully extends downslope immediately opposite the portal site, indicating that significant quantities of water have discharged in the past. The Lower tunnel was reported caved in 1986 (USFS file).

The Blacksmith tunnel portal at elevation 1878 feet is open but unstable (Fig. 5). It lies immediately under the east shoulder of a rudimentary road leading south, approximately 300 yards from the Mill Level tunnel.

The Mill Level tunnel is obvious as one approaches the historic mine area, since the portal has been extended beneath colluvium and retimbered circa 1986. It leans to the south, and supporting timbers appear deteriorated. It is found at elevation 1890 feet, beneath a near-vertical exposure of mineralized felsic volcanic breccia (Fig. 6). Maps in DGER mine files indicate that at 200 feet from the portal, a drift heads south for 240 feet and accesses two stopes. The Hoist stope was approximately 30 feet high by 40 feet in diameter. A few feet north of the Hoist stope, a narrow manway described by Parker (written commun., 1974) as a “small hole . . . through which a man might squeeze, but only at an unacceptably high level of personal risk” leads upward 40 feet to the Big stope. Mine maps indicate the Big stope was 180 feet long and approximately 60 feet wide. The ceiling in parts of the stope stood as much as 80 feet above the floor (Moen, 1969).

A number of openings occur at the foot of a cliff band approximately 100 feet above and to the south of the Mill Tunnel portal as one faces uphill. The northernmost opening is an inaccessible adit of unknown length that exits into a cliff above a slide area. It is not shown on historic mine maps, nor is the second opening, which is only 12 feet long and accessed via a precipitous trail leading straight up the sidehill (Fig. 6). If one follows a rough trail to the south, a surface opening from the Big stope is encountered at elevation ~1980 feet. McFarland (oral commun., 2003) reported the internal portion of the stope still standing, however we observed that a few large slabs appear to have spalled off the ceiling close to the surface entrance. The opening is partially blocked by rudimentary fencing and is clearly hazardous (Fig. 7). The floor dips to the west at a –45 degree angle.

About 50 feet south, we encountered a 4-foot by 5-foot steeply dipping winze. It is more than 100 feet deep. The opening is unprotected except for a triangular piece of field fence

Figure 5. Blacksmith tunnel portal. Backpack for scale. View to the west.

Figure 6. Portal of Mill Level tunnel in foreground and two adits in cliff; trail at far left side of photo. View to the west.

across the trail (Fig. 8). This opening was not documented in historic maps or reports.

The Winze tunnel can be found at elevation 2008 feet by continuing south approximately 100 feet along the foot of the cliff. Maps indicate that this opening, which bears due west into the hillside, is about 40 feet long. At the face, a vertical shaft extends downward 125 feet to intersect the Blacksmith tunnel. The Discovery tunnel, approximately 24 feet in length, lies S15E, approximately 80 feet from the Winze tunnel at the same elevation.

Detailed maps from Stoess and Slater's original report depict these openings and attendant assay values. They can be viewed at DGER. The entrance to the Big stope and Mill Level tunnel show evidence of considerable human visitation. DGER personnel did not enter the openings, which should be considered hazardous. Past attempts by the claim holder to prevent entry with gates and signs have been repeatedly vandalized (S. Mitchell, written commun., 2000). One USFS warning sign remains attached to a timber at the Mill Level tunnel portal.

Figure 7. Opening to Big stope. Notebook (8½ x 11 inches) for scale. View to the west.

Figure 8. Near-vertical winze behind small fir. Note triangular field fence in center of photo. View to the north.

MATERIALS AND STRUCTURES

The mill buildings have long since disappeared, although traces of foundations and remnants of sawn timbers can be found down slope from the Mill Level portal. The bulkhead shown in circa-1917 photos (Fig. 9) is the only remaining structure still recognizable (Fig. 10). We found steel hoops that held the cyanide-leach silos together on a level platform above the bulkhead. We located the site of a former assay building, which contains scattered refractory bricks and fire-assay cupels.

WATER

A small seep trickled out of the Mill Level tunnel, but not in sufficient quantity for sampling. Bob Raforth (DOE, written commun., 2003) sampled Wells Creek upstream and downstream from the mine site during high and low flows. See Tables 4 and 5. These data suggest that the mine area has little effect on Wells Creek water quality, which meets or exceeds the requirements for state water standards shown in Table 5 and Appendix B. At low flow conditions (October 2002), the dissolved iron fraction increased approximately fourfold. Wells Creek flows through volcanogenic rocks containing as much as 3 percent pyrite upstream from the Excelsior mine (Moen, 1969), which may explain the spike in iron concentration at low flow.

MILLING OPERATIONS

As shown in Figure 9, the 20-stamp mill built in 1902 was constructed on steep slopes immediately below the Mill Level tunnel. Water transported from the east fork of Deadhorse Creek through a 2200-foot flume turned a generating turbine at the mill site. Wilfley-type shaking tables were employed to obtain a concentrate, and mercury amalgamating plates recovered gold values. However, 45 to 50 percent of the precious metal values were lost due to sliming. When the mill was rebuilt in 1914, a powerline was run in from a generator on the Nooksack River, a distance of about one mile, and a rod mill was installed for grinding (Moen, 1969). Stoess and Slater (1935) state that, "Further attempts were made to recover the values by cyaniding which proved nearly as unsatisfactory as water concentration of the valuable minerals. The net result, up to the year 1916, [is that] the mine had passed through various . . . ownerships and . . . large sums, variously estimated between $250,000 and $300,000 had been spent, most of it wasted." The mill was shut down in 1917. Laboratory tests conducted for Steelhead confirmed the circa-1916 results concerning the amenability of the ore to flotation. "The general conclusion drawn from the tests was that flotation would recover 85 to 95 percent of the gold and 80 to 90 percent of the silver" (Robertson and McGregor, 1988).

Tailings from the stamp mill were discharged through a large diameter pipe directly onto the slope above Wells Creek. We could not locate any residual tailings material.

WASTE ROCK DUMPS

Most, if not all, of the approximate 10,000 tons reported to have been mined came from stopes and development above the Mill Level tunnel. Since the development work was primarily in ore-bearing breccia, we assume that the absence of significant waste rock dumps is related to the fact that most material went through the mill. We found only a smattering of waste rock around any opening.

GENERAL INFORMATION

Names: Great Excelsior; alternate names Wells Creek, Excelsior, President

MAS/MILS sequence number: 0530730049

Access: 2-wheel-drive road and trail

Status of mining activity: none

Claim status: Per the Mining Law of 1872, lode mining claims fall in two categories:

1. *Unpatented claims* require a minimum annual expenditure of $100 assessment work per claim. A $100 maintenance fee may be paid in lieu of performing assessment work. Unpatented claims are classified as *active* or c*losed*. *Active* denotes a valid, up-to-date claim. *Closed* denotes that the maintenance fee, assessment work, or other requirements have not been met, and that the claim is no longer valid. The following table contains information on active claims only.
2. *Patented claims* are owned in fee simple by the discoverer and their assigns. A mineral survey is performed as part of the patent application process, prior to the issuance of a patent. Some lode claims initially mined underground may at a later date turn into an open pit operation. If this occurs, a Surface Mining Permit is required, which contains certain stipulations regarding reclamation.

As of October 2003, all claims in secs. 5 and 6, T39N R8E, were classified as closed with the exception of "Wells Creek #2, 3, 4, 6 and 7", held by Excelsior Mining Corporation, and "Gold Porphyry #1–5", held under possessory title by private parties (BLM Land and Mineral Records LR2000 database). Excelsior Mining made a patent application for the Wells Creek claims in 1992 that has not been brought to a conclusion as of the date of this publication. The Gold Porphyry group lies in the NE¼ of sec. 5 and northeast of the Excelsior property.

Current ownership: Excelsior Mining Corporation, East Wenatchee, Wash.

Surrounding land status: Mt. Baker–Snoqualmie National Forest

Location and map information: see Table 1

Directions: Take Mt. Baker Highway (SR-542) to the town of Glacier. Turn right one mile east of Glacier on Glacier Creek Road and take an immediate left on Chase Road, which parallels North Fork Nooksack River on the south side. Follow this gravel road approximately 5 miles. At the third major hairpin turn at elevation ~1920 feet, a 12-foot wide track leads off in a northeasterly direction (Fig. 1). Park at a campsite prior to the first steep grade. The road is impassable for vehicles beyond this point. Hike about ½ mile south on a road with many landslides. The Mill Level tunnel is located at the end of this road at the foot of a cliff.

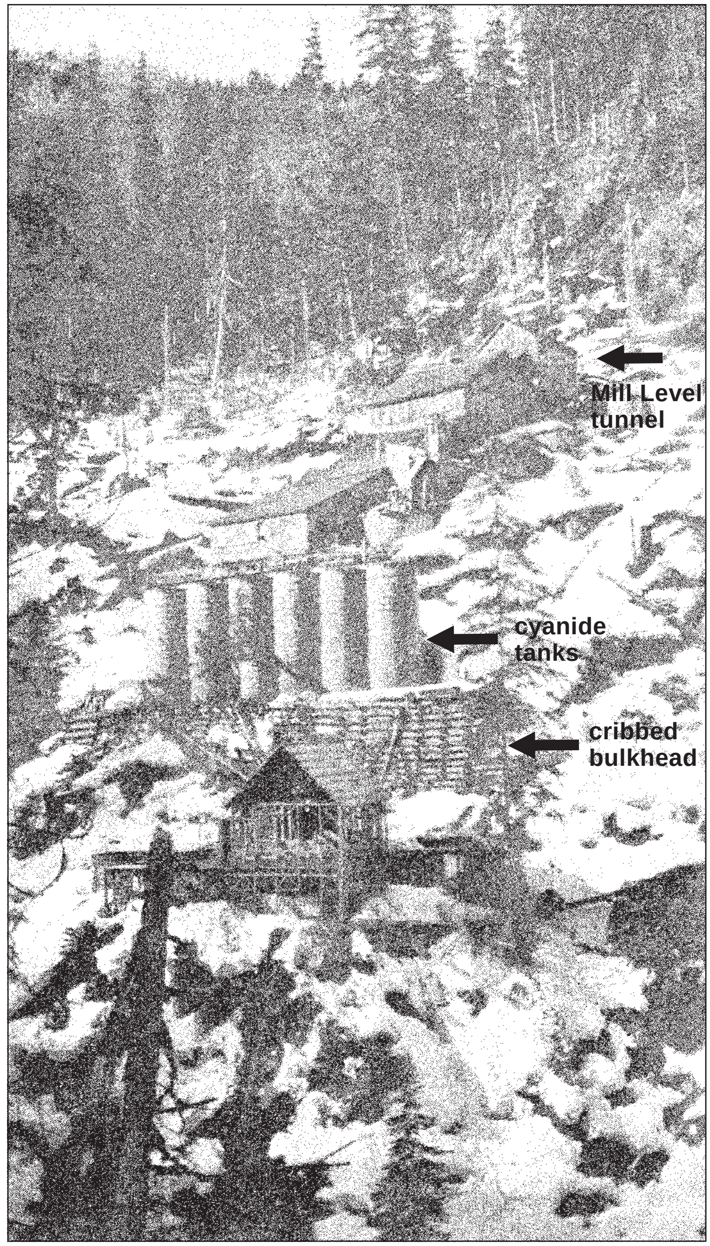

Figure 9. The Great Excelsior concentrating mill in 1917. Note cribbed bulkhead. View to southwest. *(Photo courtesy of Walter M. Stephen.)*

At one time, the mine could be accessed by trail from the Wells Creek Road. However, Parker (written commun., 1974) noted that it can "no longer be used because the trail is now completely obliterated . . . and there isn't any bridge over Wells Creek. The ranger at the Glacier Creek Station told me that two people drowned last year attempting to cross the creek."

Mine Operations Data

Type of mine: underground

Commodities mined: silver, gold

Geologic setting: The mineralization occurs in the Wells Creek volcanics, a 4000-foot thickness of felsic volcanic breccias, interlayered with marine shales, siltstones, greywacke, and shaley-tuffs. Regional metamorphism and large-scale hydrothermal alteration have replaced the primary feldspars with adularia and sericite. The host rocks were probably deposited under active geothermal conditions from heated brine in a sub-seafloor environment. The mineralization is characterized by microscopic argentite, tetrahedrite, polybasite, and electrum replacing pyrite and calcite (Franklin, 1985).

Ore minerals: tetrahedrite var. freibergite $(Ag,Cu)_{12}(Sb,As)_4S_{13}$, electrum (65Au-35Ag), argentite (Ag_2S), polybasite $(Ag,Cu)_{16}Sb_2S_{11}$ (Franklin, 1985)

Non-ore minerals: quartz, calcite, adularia, sericite

Host rock: felsic volcanic breccias, tuffaceous siltstones and graywackes, and felsic tuffs (Franklin, 1985)

Period of production: 1902 to 1917 (Stoess and Slater, 1935)

Development: three major adits 450, 350, and 440 feet in length, a 125-foot vertical shaft, and numerous crosscuts and stopes totaling 1700 feet (Moen, 1976)

Production: $69,000 in combined gold and silver from approximately 10,000 tons (Moen, 1976)

Mill data: 20-stamp mill, gravity table concentration and mercury or cyanidation recovery of gold values; no equipment or structures have survived

Table 1. Location and map information

Mine name	County	Mine location	Decimal longitude	Decimal latitude	1:24,000-scale quad.	1:100,000-scale quad.
Great Excelsior	Whatcom	secs. 5 and 6, T39N R8E	121.80651	48.89964	Bearpaw Mt.	Mt. Baker

Figure 10. Remains of cribbed bulkhead shown in Figure 9.

Physical Attributes

Features: see Table 2

Materials: 120 feet of 6-inch steel drill casing

Machinery: none

Structures: none

Waste rock dumps, tailings, impoundments, highwalls, or pit walls: We found no tailings. Water may be impounded in the Lower tunnel. A barely discernible waste rock dump occupies an approximate 100 x 120 foot area near the Mill Level tunnel. It is heavily vegetated and made up of boulders, sand, and unstained shot rock. The 100-foot plus highwall standing over the Mill Level tunnel adit has slopes ranging from 50 degrees to vertical. It appears that a considerable volume of colluvium has sloughed off the steeply dipping exposure of felsic volcanic breccia (Fig. 7). Several debris slumps have occurred on steep, loosely consolidated slopes along the former mine access road paralleling Wells Creek.

Analysis of tailings and dumps: none

Waste rock, tailings, or dumps in excess of 500 cubic yards: unknown

Reclamation activity: none

Table 2. Mine features. **, data from DGER mine map file

Description	Condition	Fenced (yes/no)	Length (feet)	Width (feet)	Height/depth (feet)	True bearing	Elev. (feet)	Decimal longitude	Decimal latitude
Winze tunnel	open	no	40	5	5	west	2008	no coverage	no coverage
Winze	open	no	4	5	>100	west	1980	no coverage	no coverage
Discovery tunnel	open	no	24	5	5	west	1993	no coverage	no coverage
Big stope	open	no	180**	60**	80**	west	1980	no coverage	no coverage
Mill Level Tunnel adit	open and accessible; portal timbers lean to south.	no	440**	6	7	S50W	1890	121.80651	48.89964
Blacksmith tunnel	open, partially blocked by slough	no	350**	6	7	S70W	1878	no coverage	no coverage
Lower tunnel	caved	no	450**	6**	7**	S70W**	1700	no coverage	no coverage

VEGETATION

A relatively thick stand of second growth western hemlock, Douglas fir, western red cedar, and alder covers the mine site and access road area, in conjunction with a few old growth trees. A typical assemblage of lowland forest zone brush and groundcover grows on the site. All plants and trees appear healthy.

Table 3. Bat information

Opening	Aspect	Air temp. at portal	Air flow: exhaust	Air flow: intake	Multiple interconnected openings	Bat evidence
Mill Level tunnel	NE	68°F	~2mph	no	yes	no
Big Stope opening	E	68°F	slight	no	yes	no

WILDLIFE

A northern spotted owl nest site was discovered near the mine by Washington Department of Fish and Wildlife (WDFW) in June of 1986. The mine, including the area of exploration drilling circa-1970 to present, lies within a 'spotted owl management circle, established territory'. Coho salmon, summer and winter steelhead, and Dolly Varden trout have been observed in Wells Creek (WDFW, 2003).

For bat information, see Table 3.

WATER QUALITY

Surface waters observed: Wells Creek

Proximity to surface waters: 150 feet

Domestic use: none

Acid mine drainage or staining: none

Water field data: see Tables 4 and 5

Surface water migration: none

ACKNOWLEDGMENTS

The authors thank our editor Jari Roloff for helpful suggestions on the layout and content of this report. Additional appreciation goes to Bob Fujimoto and Dick Sawaya, U.S. Forest Service Region 6, and Bob Raforth, Washington State Dept. of Ecology. Samantha Chang, U.S. Forest Service Region 6, provided helpful information regarding the mine's history.

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Table 4. Surface water field data. Samples collected by Robert L. Raforth (Wash. Dept. of Ecology, Water Quality Divn., written commun., 2003); low-flow samples collected Oct. 2002, high-flow samples collected June 2003

Description	Flow (feet/second)	Conductivity (μS/cm)	pH	Bed color	Temp.	Elev. (feet)	Decimal longitude	Decimal latitude
Wells Creek, upstream, high flow	200	128	7.7	natural	6.2°C	1600	121.80492	48.89952
Wells Creek, downstream, high flow	200	128	7.6	natural	6.4°C	1580	no coverage	no coverage
Wells Creek upstream, low flow	150	143	7.54	natural	7.8°C	1600	121.80492	48.89952
Wells Creek downstream, low flow	150	146	7.38	natural	7.9°C	1580	no coverage	no coverage

Table 5. Surface water analysis. Metal concentrations are μg/L; Hardness is in mg/L. < indicates metal was not detected; the number following is the practical quantitation limit above which results are accurate for the particular analysis method—the metal could be present in any concentration up to that limit and not be detected. Samples collected by Robert L. Raforth (Wash. Dept. of Ecology, Water Quality Divn., written commun., 2003); low-flow samples collected Oct. 2002, high-flow samples collected June 2003. – – –, no data; **, standards for these metals are hardness dependent. Conversion formulae are shown in http://www.ecy.wa.gov/pubs/wac173201a.pdf. Standards calculated for hardness values specific to Part 1 below, are shown in Appendix B

PART 1: ANALYSIS BY USEPA METHOD 6020, INDUCTIVELY COUPLED PLASMA/MASS SPECTROMETRY*

Sample location	Aluminum	Arsenic	Cadmium	Copper	Iron	Lead	Mercury	Zinc	Hardness
Wells Creek, upstream, high flow	480	0.22	<0.02	0.19	160	<0.02	<0.002	1.5	53
Wells Creek, downstream, high flow	390	0.23	<0.02	0.18	140	<0.02	<0.002	1.6	54
Wells Creek upstream, low flow	591	0.25	<0.02	0.17	505	<0.02	<0.002	1.5	64
Wells Creek, downstream, low flow	649	0.24	<0.02	0.18	530	<0.02	<0.002	1.4	64

PART 2: APPLICABLE WASHINGTON STATE WATER QUALITY STANDARDS

Type of standards (applicable Washington Administrative Code)	Arsenic	Cadmium	Copper	Iron	Lead	Mercury	Zinc	Hardness
Surface water standards (WAC 173-201A, Standard for aquatic life in surface freshwater, chronic level maximums at 100 mg/L hardness)	190	**	**	none	**	0.012	**	100
Ground water standards (WAC 246-290, Washington State Department of Health, standards for ground water, domestic consumption)	50.0	none	1300	300 (cosmetic only)	15	2.0	5000	– – –

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Appendix A

METHODS

We recorded observations and measurements in the field. Longitude and latitude were recorded in NAD83 decimal degree format. Literature research provided data on underground development, which was verified in the field when possible.

All water samples were collected as simple grab samples in pre-cleaned 500 mL HDPE bottles with preservative and kept on ice for transport to Sound Analytical Services, Inc. (SAS). Soil samples from dumps or tailings were taken from subsurface material and double bagged in polyethylene. Chain of custody was maintained.

Water and soil samples were analyzed for arsenic, cadmium, copper, iron, lead, and zinc by inductively coupled plasma/mass spectrometry (ICP/MS) following USEPA Method 6010. Samples were analyzed for mercury by cold vapor atomic absorption (CVAA), USEPA Method 7470 (water), and Method 7471 (soil).

Holding times for the metals of interest were observed (28 days for mercury, 180 days for other metals). Instrument calibration was performed before each analytical run and checked by standards and blanks. Matrix spike and matrix spike duplicates were performed with each set.

FIELD EQUIPMENT

barometric altimeter
binoculars
digital camera
flashlight
Garmin GPS III+, handheld GPS unit
Hanna Instruments DiST WP-3 digital conductivity meter and calibration solution
litmus paper, range 0–14, and 4–7
Oakton digital pH meter
Oakton digital electrical conductivity meter
Taylor model 9841 digital thermometer

Appendix B

WATER QUALITY STANDARDS FOR HARDNESS DEPENDENT METALS

WAC 173-201A. Chronic standard (μg/l). Hardness data from Robert L. Raforth (Wash. Dept. of Ecology, Water Quality Divn., written commun., 2003)

Sample location	Hardness (mg/l)	Cd (μg/l)	Cu (μg/l)	Pb (μg/l)	Zn (μg/l)
Wells Creek, high flow	54	0.7	6.7	1.3	62.0
Wells Creek, low flow	64	0.7	7.8	1.5	71.6

Appendix C:

General Summary of Events at the Great Excelsior Mine Area

Source of information for this table is the DGER mine files (unpublished reports, correspondence, mining company annual reports to stockholders, newspaper clippings, etc.).

Date	Entity	Activity
1900	W. H. Norton and others	Staked the Golden Rule and Golden Rule Extension claims.
1902 to 1905	W. H. Norton	Formed Great Excelsior Mining Co. Began underground mining, constructed gravity/mercury amalgamation mill, made shipments of concentrate.
1905 to 1916	Hugh Eldridge	Formed President Group Mining Co. Renamed claims after U.S. Presidents. Continued mining and expanded mill to include cyanidation recovery of gold values. Mill shut down in 1916 due to low recovery of precious metals.
1922 to 1960	H.E. Barnes	Relocated the claims, which had become invalid for failure to due assessment work. Abandoned claims in 1960.
Sept. 1966 to Aug. 1971	Asarco	American Smelting and Refining Co. relocated and restaked claims as “Wells Creek 1 thru 10”. Conducted exploration and abandoned claims in 1971.
May 1972	Glacier Creek Mines and Mineral Co.	Restaked claims and abandoned same year.
1974	Douglas McFarland	Restaked Wells Creek claims.
Oct. 1974 to July 1975	Silver Standard Mines Ltd. (SSML)	SSML as lessee. Hanna Mining Co. optioned property and funded drilling of two holes totaling 2018 feet.
July 1976 to Sept. 1976	Quintana Minerals Inc.	Obtained lease from SSML and drilled six holes from two locations south of Excelsior mine workings. Silver Standard option expired in 1977.
1977 to 1984	Pacific Coast Mines Inc. (PCMI), a wholly owned subsidiary of U.S. Borax and Chemical Co.	PCMI acquired an option from McFarland and a special-use permit from the USFS for exploration and conducted geologic mapping, geochemical and geophysical surveys, and diamond-drilled 45 holes totaling 15,214 feet. PCMI’s combined total of 54 claims included the Wells Creek group (10) and TAH group (44). Hardin and others staked 22 claims known as the “Porphyry” group to the east of and partially overlapping the Wells Creek and TAH claims.
1984	PCMI	Nooksack Mines Inc., a wholly owned subsidiary of Steelhead Resources Ltd., entered a joint venture agreement with PCMI, wherein Nooksack would be the operating entity.
July 1986	Excelsior Mining Co.	Excelsior Mining Co. incorporated in the State of Washington by K. Holm and D. McFarland.
1985 to July 1990	Steelhead Resources Ltd.	Steelhead continued road building for drill sites and geologic interpretation of previous drill results. In 1987, North American Metals Corp. of Vancouver, B.C., (a wholly owned subsidiary of Homestake Mining Co.) acquired a 35 percent interest in the Excelsior property. Sixty-one reverse circulation drill holes were completed in 1987, totaling 24,776 feet. Nooksack Mines Inc. acquired the Porphyry claim group via lease/option in 1987.
Aug. 1989	FMC Gold Inc.	Steelhead and FMC entered agreement for FMC to perform an overall evaluation and feasibility study on the property. Results unknown.
July 1990	Steelhead Resources Ltd.	Terminated exploration activity.
Jan. 1991	Stanford Metals Ltd.	Nature of agreement with Excelsior Mining Co. unknown.
1992	Excelsior Mining Co.	Applied to BLM for patented claim status on WC #2, 3, 4, 6 and 7 claims. Application under appeal as of 2003.
1996 and 1997	Excelsior Mining Co.	Conducted a Controlled Source Audio-frequency Magnetotellurics (CSAMT) survey of the Wells Creek claim area.