INACTIVE AND ABANDONED MINE LANDS—
Deep Creek Mine, Northport Mining District,
Stevens County, Washington

by Fritz E. Wolff,
Matthew I. Brookshier,
and David K. Norman

WASHINGTON
DIVISION OF GEOLOGY
AND EARTH RESOURCES
Information Circular 108
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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). Initial work was funded through interagency grants from the U.S. Forest Service (USFS), Region 6. Other agencies sharing in the project are the U.S. Bureau of Land Management (BLM), the U.S. Environmental Protection Agency (USEPA), and the Washington Department of Ecology (DOE).

More than 3800 mineral properties have been located in the state during the last 100 years (Hunting, 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. Reports such as this one provide documentation on mines or groups of mines within specific mining districts or counties. The IAML database may be viewed by contacting the Division of Geology (360-902-1450). IAML reports are posted online at http://www.dnr.wa.gov/ResearchScience/Topics/GeologyPublicationsLibrary/Pages/pubs.aspx.

SUMMARY

The Deep Creek mine is a partially explored and partially mined zinc-lead deposit situated in dolomitic marble host rock. At the close of the last period of active mining in 1956, 763,000 tons had been produced averaging 4.3 percent zinc and 1 percent lead. An estimated 1.2 million tons of ore was left in stopes and undeveloped drill-inferred orebodies. Outcrops of mineralization identical to that found in the mine have been identified as far as 2400 feet northwest of the mine.

The mine is located on the west side of Aladdin Road, 7 miles south of Northport, Wash. The E½NE¼
sec. 26, T39N R40E, was the focus of underground operations and most exploration activity (Fig. 1). None of the original claims were patented, and the unpatented claims have long since been closed. All the land in sec. 26 not directly managed by the Bureau of Land Management (BLM) or in trust has been purchased by private parties as 10- and 20-acre subdivided parcels less 55 percent of mineral rights.

Metal sulfides were accidentally discovered at the mine in 1914 when the Washington Quarry Co. encountered a 40-foot width of banded sphalerite. The mineralized rock proved unsuitable as marble building material, and the operation was suspended. Northport Mining Co., later known as Gorien Zinc Co., acquired the property in 1915 and produced a small tonnage of ore from the surface. No further mining took place until 1941, at which time Western Knapp Engineering Co., Inc., sank a 350-foot inclined shaft and began development, but stopped short of actual production. The Jamieson-Higginbotham partnership bought the property in 1943 and began processing ore at their nearby Sierra Zinc mill. The partnership mined 78,000 tons before selling the property to Goldfield Consolidated Mines Co. in 1947.

Goldfield extended the shaft to a final depth of 750 feet and produced approximately 400 tons per day (tpd) until closure. Stable ground conditions enabled Goldfield to mine a total of five discontinuous orebodies with open stopes up to 600 feet high. The operation was profitable in spite of large inflows of water from the Deep Creek aquifer, which necessitated cement grouting in advance of mining development (Waddell, 1963). Goldfield produced an additional 685,000 tons of ore (Fulkerson and Kingston, 1958). There is no record of a mill ever having been in use at the Deep Creek mine site; all of Goldfield’s production was milled at the Sierra Zinc mine, 10 miles south on Aladdin Road.

Exploration drilling by American Zinc Co. and others discovered two additional orebodies in the period 1964 through 1979, but no mining took place. The mine has been stripped of all underground and surface equipment [except the compressor], and the workings are flooded to within a few feet of the shaft collar.

No water discharged from either the shaft or a short adit at the time of DGER site characterizations in July 2003 and August 2006. A 20-foot-diameter pond adjacent to the adit portal is charged from underground. It is the top of the North Zone orebody, which was ultimately mined to a depth of approximately 700 feet (Klobusicky, 1971). A sample taken from the pond met both state standards shown in Table 8 for the metals analyzed: cadmium, copper, lead, and zinc. There is no acid mine drainage.

The waste rock is light gray to white dolomite that appears barren to the naked eye. But analyses of screened fines from several dumps exceeded state soil standards for contaminants of concern (see Tables 4 and 5). We observed a viscous fluid leaking from a bank of four capacitors on the compressor pad. The material may be polychlorinated biphenyl oil (PCB) based on the circa-1950 date of manufacture, but was not tested. PCBs are known carcinogenic compounds.

ACCESS

The mine is located on the west side of Aladdin Road, 7 miles south of Northport, Wash., on private land. The site is obvious by the presence of the white waste rock dump approximately 1000 feet west of the highway (Fig. 2). Deep Creek flows south to north between the road and the mine. The bridge over Deep Creek is on private property and usually gated and locked.

OWNERSHIP

The mine area underlies most of the E½NE¼ sec. 26, T39N R40E, which has been extensively subdivided into 10- and 20-acre parcels “less 55% mineral rights”. The original grantor was Washington Resources, LLC (1982), and we believe this entity retains the majority position of minerals in the subdivided parcels (G. Schmidt, USEPA, written commun., 2007). The shaft, waste rock dump, and compressor building are located in the N½NE¼NE¼ sec. 26. At the present time there are no active unpatented lode claims in sec. 26 and no patented lode claims (BLM, LR2000 database, March 2007).

The W½NE¼ sec. 26 is held in trust for the M. W. Gotham Estate; BLM holds title to surface rights on the E½NW¼ sec. 26, less 55% mineral rights set-aside by Washington Resources, LLC (Stevens Co. Assessor, written commun., March 2007).

HISTORY

Lead and zinc mineralization was first discovered near the Deep Creek mine in 1914 by the Washington Quarry Co. A 40-foot width of banded sphalerite was encountered in the quarry that caused the company to abandon the production of building ma-
rior of the mine’s profitability: (a) significant inflows of ground water, and (b) exceptionally competent host rock and ore.

The mine workings lie beneath saturated sands and gravels of the Deep Creek valley in carbonate rocks laced with post-ore shear zones that provide efficient pathways for water ingress. One stope intercepted alluvium gravels 300 feet from the surface. As a result, high-pressure water posed a constant operating problem, rendering it necessary to grout ahead of development headings and maintain a significant pumping capacity. Pressures as high as 250 psi were encountered. Waddell (1963) reported that “At one point water pressure forced the drill steel out of the hole, folded it like a string, and knocked down the drill”. Prior to the adoption of grouting as a required part of the mining process, one level alone produced 2200 gallons of water per minute. By 1956 when the mine closed, 60,000 feet of grout holes had been drilled and 28,000 sacks of cement had been injected. Optimization of grouting techniques dropped the cost of the process from 15 percent of total mining expense in the initial years, to less than 2 percent (Waddell, 1963).

Both the ore and the dolomitic host rock proved to be extremely competent, permitting large open stopes to be developed by vertical raises, sublevels, and the use of long-hole blastng. The orebodies exhibit an elongated vertical axis and approximate an ellipse in cross section. Walls of mined-out stopes up to 600 feet high and more than 200 feet wide stood unsupported at the conclusion of mining (Waddell, 1963).

American Zinc Co. Inc. purchased the property in 1964. They staked additional claims and drilled several core holes. One encountered a 33-foot intercept of 4.84 percent zinc and 1.0 percent lead that is referred to as the North No. 2 Zone. No attempt was made to dewater the shaft or start production.

Atlas Mine and Mill Supply Co. of Spokane purchased the mine from American Zinc in 1971 and transferred title to Washington Resources, LLC, a business entity related to Atlas. Great Basins Petroleum Ltd. held a lease and option in 1979 from Washington Resources. The two corporations performed assessment work on a group of 17 contiguous unpatented claims. Great Basins did not exercise the option (DGER mine files).

Mills (1977) reported that the mine had been stripped of all underground and surface equipment [except the air compressor] and that the workings had been flooded to within a few feet of the shaft collar, which was also the prevailing situation at the time of DGER field work in 2003 and 2005.

In preparation of material on the Deep Creek mine for the Mineral Availability System (MAS), DGER geologist J. Lucas (1976) made detailed ore reserve calculations based on drilling or mining information available at the time (Table 1). Two orebodies were found by core drilling after Goldfield stopped operations, the “North No. 2 Zone” and the “New Zone”. Based on the assumption that these orebodies had approximately the same dimensions as those previously mined, and after deducting the volume of ore from partly mined-out orebodies, Lucas estimated a combined total of 1,253,920 statute tons remained of “indicated” ore (from underground data) and “inferred” ore (from drill data). Lucas also postulated that two additional same-sized orebodies discovered by drilling favorable ground

<table>
<thead>
<tr>
<th>Ore zone</th>
<th>A axis of ellipse (ft)</th>
<th>B axis of ellipse (ft)</th>
<th>Height of remaining ore (ft)</th>
<th>Indicated ore (tons)</th>
<th>Inferred ore (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Zone (mined out)</td>
<td>N/A</td>
<td>N/A</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lead Zone (mined out)</td>
<td>N/A</td>
<td>N/A</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>South Zone</td>
<td>60</td>
<td>100</td>
<td>300</td>
<td>122,932</td>
<td>163,909</td>
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<tr>
<td>West No. 1 Zone</td>
<td>25</td>
<td>200</td>
<td>411</td>
<td>140,347</td>
<td>174,495</td>
</tr>
<tr>
<td>West No. 2 Zone</td>
<td>20</td>
<td>200</td>
<td>400</td>
<td>109,287</td>
<td>none</td>
</tr>
<tr>
<td>North No. 2 Zone*</td>
<td>20</td>
<td>100</td>
<td>700</td>
<td>119,517</td>
<td>136,591</td>
</tr>
<tr>
<td>New Zone*</td>
<td>60</td>
<td>100</td>
<td>700</td>
<td>286,842</td>
<td>none</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>778,925</td>
<td>474,995</td>
</tr>
</tbody>
</table>

Table 1. Estimated Ore Reserves. *; not mined.
to the west might add an additional 616,000 tons of “speculative” ore (DGFR mine files).

**GEOLOGIC SETTING**

Zinc-lead ore in the Deep Creek mine occurs along sheared planes or brecciated zones as nearly vertical chimneys or pipe-like bodies. The host rock consists of interbedded white, gray and dark-gray bands of dolomite or dolomitic marble ranging from less than an inch to several feet in thickness. Mineralization at Deep Creek has historically been placed in the middle unit of the Metaline Formation of Cambrian age (Yates, 1970). More recent studies based on information from drill cores and mining have noted that the Metaline Formation probably extends into the middle Ordovician and that lithologies vary so widely in lateral continuity and stratigraphic succession that the assignment of the dolomite at Deep Creek to the “middle unit” is inaccurate. “Stratigraphic relationships of Metaline lithofacies have been difficult to define because of a lack of continuous exposure, stratigraphic markers, plus the effects of mineralization and diagenetic and hydrothermal alteration. Post-and syndepositional faulting contribute to the difficulties and...the result is a mosaic of interlayered and lensoidal sequences that represent a wide range of depositional environments” (Bush and others, 1992). Based solely on zinc to lead ratios, overall mineralogy, and geomorphology at mines nearby, the Deep Creek deposit appears to occupy about the same stratigraphic position as the Van Stone, Anderson-Calhoun, Electric Point, and Gladstone mines.

Seven orebodies situated en-echelon around an elliptical area roughly 500 feet wide and 1400 feet long in the Deep Creek flood plain have been discovered, but only five have been mined or partially mined. There is no apparent structural connection between them. Figure 3 shows a plan view of the known and drill-indicated orebodies on the 450 level. The sulfide mineralization exhibits distinct ore-to-host rock boundaries.

An unpublished report by T. Klobusicky for Columbia Resources in 1971 contains a great deal of information passed on by Goldfield management concerning the progression of ore discoveries and to what extent they were mined:

1. The North Zone ore cropped out on the surface, and as such, represented the principal orebody and was the target of the original shaft-sinking program. It bottomed out between the 750 and 850 levels.
2. The Lead Zone ore was identified on the 250 level and stoped upward from the 550 level. It was only partially mined since the apex and bottom were never determined.
3. The South Zone has a blind apex between the 250 and 350 levels. It was stopeed from the 750 level to the 350 level, or approximately 350 vertical feet.

4. The West 1 Zone was indicated by diamond drilling from the 450 level, obtained commercial grade on the 550 level, and was mined from a stope initiated on the 750 level. Its bottom was not determined.

5. The West 2 Zone was identified on the 750 level and stopeed to the 450 level. Klobusicky stated that the orebody probably continues to the surface due to its location roughly under an outcrop south of the shaft.

6. The New Zone orebody was discovered by angle and horizontal drilling from the 850 level shaft station. It lies directly beneath the North Zone, and there was at the time of the discovery a difference of opinion as to whether it was a continuation of the North Zone or the apex of totally different structure. Goldfield drove an exploration drift northward that intersected the mineralization, but the development was abandoned when the mine shut down.

7. The North 2 Zone was discovered in one of American Zinc's surface core holes drilled in the late 1960s. The −45 degree drill hole encountered a 33-foot intercept assaying 4.84 percent zinc and 0.96 percent lead 250 feet below the surface. The vertical raise shown in Figure 4, 200 feet northwest of the shaft collar, is located right above the drill intercept and adit 2.

Numerous small but isolated outcrops of zinc and lead mineralization are scattered across the dolomite unit in sec. 26, 1000 feet above and up to 2600 feet west of the Goldfield shaft as shown in Figure 1 (Campbell, 1946).

Locally, the ore-bearing dolomite unit is in contact with the Kaniksu batholith along a fault 1000 feet south of the mine (Fig 5). The host rock appears to be standing on edge as a limb of an overturned anticline (as shown in Fig. 6). It is bounded immediately to the east in the approximate center of Deep Creek by the vertical Nelson fault and on the northwest by the Stonewall thrust fault that casts the Metaline Formation over the younger Ledbetter Slate.

Tremolite is relatively abundant in some orebodies and increases substantially in the lower levels of the mine. Mills (1977) suggested that its presence was the result of low-level thermal metamorphism brought on by proximity to the intrusion and helped explain the “banding, recrystallization and grain growth” observed in the dolomite. The bedding has been almost obliterated, but the general attitude strikes N30°W and dips 88 degrees to the southeast.

The genesis of lead-zinc deposits along the Kootenay Arc, of which the Northport District lies in the approximate center, has been the subject of much discussion and differing opinions. However by the early 1970s, it had become apparent to regional
investigators that one model did not fit all deposits, and depending on the evidence available at the time, ores have been attributed to Mississippi Valley–type replacement deposits, hydrothermal alteration in proximity to batholithic rocks, and syngenetic stratabound deposits (Weissenborn and others, 1970).

A comprehensive geologic evaluation of the Deep Creek deposit by J. W. Mills indicated that a combination of processes may have been involved. Mills mapped the geology of all accessible openings on each level in 1953 while employed by Goldfield (DGER mine file). “One of the most significant outcomes of that study was the recognition contrary to previous studies by others that the mineralization as seen today is not in the form in which it was deposited. It is not a replacement along shear zones, and the ore mineralization is not related in any way to the neighboring [Kaniksu] granodiorite pluton. Rather it began as a breccia filling by sulfides in a relatively low temperature environment in pre-Cretaceous time. During the late Jurassic the original deposit and its enclosing rocks were intensely deformed and metamorphosed, original bedding was all but erased, sulfides were slightly mobilized preferentially and given an entirely new textural imprint. Emplacement of the pluton was still later and quite unrelated to mineralization.” The size, shape, and constituents of the pipe-like orebodies at the Deep Creek mine are virtually identical to those at the Electric Point and Gladstone mines 8 miles to the east, except that the sulfides at Deep Creek are free of the complete oxidation observed on Gladstone Mountain by Jenkins (1924).

The principal ore mineral at Deep Creek is a pale-yellow to dark-brown sphalerite found in massive veinlets within the mined orebodies and sparsely disseminated throughout the dolomite around the mine area (Fig. 7). Galena occurs similarly, but is less abundant. The ore averaged about 4.3 percent zinc and 1.0 percent lead over the production history of the mine. Additional smelter credits indicate the ore contained 0.002 percent copper, 0.05 opt silver, and 0.0001 opt gold (Fulkerson and Kingston, 1958). Although pyrite is disseminated throughout the deposit, it was observed to concentrate in halos surrounding individual orebodies, extending as much as 100 feet along bedding planes in advance of enriched ore zones. As such, Gold-
field personnel found pyrite to be the best indicator of ore; neither the color of the dolomite nor the relative abundance of tremolite was observed to have any particular correlation with economic grade mineralization (Waddell, 1963).

Waddell (1963) reported, “The mine’s largest exploration program, conducted in 1956, was one of the few explorations that failed to discover a new ore body. The 550 level was extended 750 feet to the south, and diamond drill stations were established on 200 foot centers. Thirteen core holes totaling nearly 6,000 feet were drilled, to the east and west, at right angles to the bedding.” Several holes stopped short of their intended target due to excessive water pressure that hampered core recovery and rendered advancing the hole impossible.

OPENINGS

The mine was developed by a S17°W-striking 65-degree inclined shaft on nine levels. Mining progressed to a depth of 700 feet and exploration to a depth of 750 feet (850 level). Total development was about 8000 feet. At the time the shaft was sunk, the four orebodies to the south were unknown (Waddell, 1963). The shaft is flooded and the hoist and headframe have been removed. Compressed air lines, water pipe and electrical conduit descend from the collar, which is capped by a concrete slab (Fig. 8). One adit bearing due west enters the cliff 40 feet south of the shaft. A map indicates that it extends 150 feet into the cliff to a blind heading (Campbell, 1946). Another adit identified as “adit 2” enters the base of the cliff near the compressor building. The raise shown in Figure 4 is on the extended centerline of this adit and is approximately 200 feet deep.

MATERIALS AND STRUCTURES

The former bunkhouse and office buildings have collapsed. Goldfield’s compressor house has been salvaged, but the Ingersoll-Rand Imperial two-stage air compressor is still installed on the concrete pad (Fig. 9). The bank of four capacitors used to start the compressor’s synchronous motor has been used for target practice and leaks a viscous fluid (Fig. 10). This material was not tested by DGER, but is likely polychlorinated biphenyl oil (PCB) based on the circa-1950 date of manufacture. PCBs are known carcinogenic compounds. See “Machinery” section below for manufacturer and model number information.

WATER

No water discharged from the shaft or adits at the time of DGER site characterizations. A 20-foot-diameter pond adjacent to the portal of adit 1 is charged from underground (Fig. 11). Klobusicky (1971) reported that this pond is the top of the North Zone orebody, which cropped out next to the shaft collar. If the orebody was stoped continuously from the 750 level to the surface, as records indicate, the pond is on the order of 700 feet deep. Seasonal overflows from the pond infiltrate within 50 feet. A sample taken from the pond met both state standards shown in Table 8 for the metals analyzed: cadmium, copper, lead, and zinc. The pond water pH measured 8.3.
MILLING OPERATIONS

There is no record of a mill ever having been in use at the Deep Creek mine. However, Superfund Technical Assessment and Response Team (START, 2002) investigators found areas of fine-grained light-brown soil, thickness unknown, that might be tailings, if a mill ever existed, or fines washed out of the waste rock. We believe most of the ore produced prior to 1943 was shipped directly to Cominco’s zinc plant at Trail, B.C. During the major phase of mining operations, 1941 to 1956, ore from the Deep Creek mine was trucked to the Sierra Zinc mill, and concentrates went to the Bunker Hill plant at Kellogg, Idaho (Waddell, 1963).

WASTE ROCK DUMPS

The waste rock dumps are light gray to white dolomite that appears barren to the naked eye except for occasional pyrite (Fig. 12). But analyses of screened fines from several dumps by START (2002) investigators detected elevated levels of cadmium, lead, and zinc, that exceed state soil standards (see Tables 4 and 5). The dump material has been scavenged in the past for maintenance of the mine access road and Aladdin Road (Waddell, 1963). The estimated total volume of waste rock is 8000 cubic yards.

GENERAL INFORMATION

Names:  Deep Creek, Gorien Zinc
MAS/MILS sequence number:  0530650412
Access:  two-wheel drive
Status of mining activity:  none
Claim status:  There are no patented claims and no active unpatented claims.
Current ownership:  Stevens Co. tax parcels nos. 5065500 through 5065550 and 5065850 through 5065857 are 10- and 20-acre parcels owned by private parties in the NE¼ sec. 26, less 55% mineral rights. Parcel 5065600, covering W½NE¼, is held in a private estate trust. Parcel 5065860, covering E½ NW¼ sec. 26 is split ownership between Washington Resources, LLC, retaining 55% mineral rights only, and BLM.
Surrounding land status:  BLM manages surface rights in all the NW¼ of sec. 26 excepting the SW¼NW¼. The remainder of sec. 26 is private land.
Location and map information:  Table 2
Directions:  On the east side of Franklin Roosevelt Lake, follow SR 25 to the town of Northport. Take the Aladdin Road and proceed southeast. At approximately 6 miles, the Black Rock mine dump can be seen on the left-hand side, immediately above the highway. The Deep Creek mine entrance road, paved in white dolomitic marble, is reached in one additional mile on the righthand side of the highway. The access road crosses Deep Creek on a gated bridge.

MINE OPERATIONS DATA

Type of mine:  underground
Commodities mined:  zinc, lead, silver
Geologic setting:  Isolated chimney-shaped deposits in Cambrian/Ordovician dolomite of the Metaline Formation. The host rock has been deformed and recrystallized by regional metamorphism, which also appears to have mobilized and concentrated the sulfides from their original stratabound occurrence. The much younger Kaniksu batholith crops out 1200 feet south of the mine, but is not thought to be the parent metalliferous source.
Ore minerals:  sphalerite, galena
Non-ore minerals:  pyrite, tremolite
Host rock:  dolomite
Period of production:  1914–1919, 1941–1956

Table 2. Location and map information.

<table>
<thead>
<tr>
<th>Mine property</th>
<th>County</th>
<th>Location</th>
<th>Decimal latitude</th>
<th>Decimal longitude</th>
<th>1:24,000 quad.</th>
<th>1:100,000 quad.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Creek</td>
<td>Stevens</td>
<td>N½NE¼NE¼sec. 26</td>
<td>48.86358</td>
<td>117.71510</td>
<td>8828</td>
<td>130102</td>
</tr>
</tbody>
</table>
Development: 8000 feet of total development on eight levels, including stopes, raises, and sublevels; shaft is 750 feet deep (Waddell, 1963)

Production: ~850,000 tons valued at $12,000,000 at historic prices

Mill data: ore milled at the Sierra Zinc mine, 10 miles south

PHYSICAL ATTRIBUTES

Features: Table 3

Materials: none

Machinery: (a) Ingersoll-Rand Type 10 two-stage air compressor; synchronous motor is Westinghouse/G.E. Type HR, serial number 8151747, 250 H.P., 3 phase-60 cycle-2200 volts. (b) capacitor bank, Cornell Dublier Electrical Co., Model DBR-44, SN: AN-1, South Plainfield, N.J.

Structures: bunkhouse, office, and compressor building are collapsed; headframe and hoist house have been removed

Waste rock dumps, tailings impoundments, highwalls, or pit walls: waste rock dump

Analysis of waste rock dumps: Tables 4 and 5

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

Reclamation activity: electrical substation removed; no other activity

Analysis of tailings and dumps: Table 4

VEGETATION

Knapweed, tansy, and thistle. Trees include inland Douglas fir, larch, and birch.

WILDLIFE

White tailed deer, rocky mountain elk; rainbow trout in Deep Creek (WDFW, 2003). See Table 6 for bat habitat information.

WATER QUALITY

Surface waters observed: Deep Creek

Proximity to surface waters: 0 feet

Domestic use: none

Acid mine drainage or staining: none

Surface water migration: infiltrates

Surface water data: Tables 7 and 8

ACKNOWLEDGMENTS

The authors thank our editors Jari Roloff and Karen Meyers for helpful suggestions on the layout and content of this report. Robert Berwick provided a digital reproduction of the map.

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**Table 3.** Mine features. – – –, no data.

<table>
<thead>
<tr>
<th>Description</th>
<th>Condition</th>
<th>Fenced (yes/no)</th>
<th>Length (feet)</th>
<th>Width (feet)</th>
<th>Height/depth (feet)</th>
<th>True bearing</th>
<th>Elev. (feet)</th>
<th>Decimal latitude</th>
<th>Decimal longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>inclined shaft</td>
<td>flooded and blocked</td>
<td>no</td>
<td>– – –</td>
<td>– – –</td>
<td>750</td>
<td>S17W</td>
<td>1877</td>
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<td>117.71499</td>
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<td>no</td>
<td>20 feet in diameter</td>
<td>≤700</td>
<td>N/A</td>
<td>1870</td>
<td>48.86348</td>
<td>117.71494</td>
<td></td>
</tr>
<tr>
<td>adit 1</td>
<td>sound/open</td>
<td>no</td>
<td>150</td>
<td>4</td>
<td>5</td>
<td>W</td>
<td>1870</td>
<td>48.86348</td>
<td>117.71494</td>
</tr>
<tr>
<td>adit 2</td>
<td>caved</td>
<td>no</td>
<td>~420</td>
<td>~ – – –</td>
<td>~ – – –</td>
<td>~ – – –</td>
<td>~ – – –</td>
<td>~ – – –</td>
<td>~ – – –</td>
</tr>
<tr>
<td>exploration adit/outcrop</td>
<td>open</td>
<td>no</td>
<td>~15</td>
<td>4</td>
<td>5</td>
<td>W</td>
<td>2560</td>
<td>48.86480</td>
<td>117.72150</td>
</tr>
<tr>
<td>raise</td>
<td>open</td>
<td>no</td>
<td>~25</td>
<td>~230</td>
<td>vertical</td>
<td>2100</td>
<td>48.86417</td>
<td>117.71647</td>
<td></td>
</tr>
</tbody>
</table>

---

**Table 4.** Soil Analysis. Metal concentrations are mg/kg. – – –, no data; **, data from START (2002). Analyses in bold indicate levels that exceed one or more standard shown in Table 5.

<table>
<thead>
<tr>
<th>Sample location</th>
<th>Arsenic</th>
<th>Cadmium</th>
<th>Copper</th>
<th>Lead</th>
<th>Zinc</th>
<th>Mercury</th>
</tr>
</thead>
<tbody>
<tr>
<td>waste rock dumps**</td>
<td>24.9–25.2</td>
<td>– – –</td>
<td>558–799</td>
<td>4220–7780</td>
<td>0.14–0.25</td>
<td></td>
</tr>
<tr>
<td>brown soil/tailings**</td>
<td>23.8–425</td>
<td>– – –</td>
<td>632–13,300</td>
<td>4240–123,000</td>
<td>0.17–3.2</td>
<td></td>
</tr>
</tbody>
</table>

---

**Table 5.** Soil quality standards for unrestricted land use. WAC 173-340-900, Model Toxics Control Act, Table 749-2: Priority contaminants of ecological concern for sites that qualify for the simplified terrestrial ecological evaluation procedure (partial data). Concentrations are milligrams/kilogram. Levels for silver, gold, and iron are not specified.

<table>
<thead>
<tr>
<th>Metals</th>
<th>Arsenic</th>
<th>Cadmium</th>
<th>Copper</th>
<th>Lead</th>
<th>Zinc</th>
<th>Mercury</th>
</tr>
</thead>
<tbody>
<tr>
<td>unrestricted land use</td>
<td>20</td>
<td>25</td>
<td>100</td>
<td>220</td>
<td>270</td>
<td>9</td>
</tr>
<tr>
<td>industrial or commercial use</td>
<td>20</td>
<td>36</td>
<td>550</td>
<td>220</td>
<td>570</td>
<td>9</td>
</tr>
</tbody>
</table>

---

**Table 6.** Bat habitat information.

<table>
<thead>
<tr>
<th>Opening</th>
<th>Air temp. (°F) at portal</th>
<th>Air flow: exhaust</th>
<th>Air flow: intake</th>
<th>Multiple interconnected openings</th>
<th>Bats or bat evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>open adit 1 at cliff base</td>
<td>east</td>
<td>55</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>

---

**Table 7.** Surface water field data. Sample taken July 22, 2003.

<table>
<thead>
<tr>
<th>Description</th>
<th>Flow (gpm)</th>
<th>Conductivity (μS/cm)</th>
<th>pH</th>
<th>Bed color</th>
<th>Temp. (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pond at adit 1 portal</td>
<td>none</td>
<td>530</td>
<td>8.4</td>
<td>clear</td>
<td>54</td>
</tr>
</tbody>
</table>
shown in Figure 5, which was extremely helpful in visualizing the distribution of orebodies in the mine.

REFERENCES CITED


Washington Department of Fish and Wildlife (WDFW), 2003, Habitat and species map: Washington Department of Fish and Wildlife digital report [generated February 2003], 1 plate, 1:24,000-scale


Appendix A. Methods and field equipment

METHODS

We recorded observations and measurements in the field. Longitude and latitude were recorded with a global positioning system (GPS) unit in NAD83 decimal degree format. Literature research provided data on underground development, which was verified in the field when possible.

Soil samples from dumps or tailings were taken from subsurface material and double bagged in polyethylene. Chain of custody was maintained.

Soil samples were analyzed for the metals listed in this report by inductively coupled plasma/mass spectrometry (ICP/MS) following USEPA (U.S. Environmental Protection Agency) Method 6010. Holding times for the metals of interest were observed.

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

<table>
<thead>
<tr>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>barometric altimeter</td>
</tr>
<tr>
<td>binoculars</td>
</tr>
<tr>
<td>digital camera</td>
</tr>
<tr>
<td>flashlight</td>
</tr>
<tr>
<td>Garmin V, handheld GPS unit</td>
</tr>
<tr>
<td>Oakton digital pH meter</td>
</tr>
<tr>
<td>Oakton digital electrical conductivity meter</td>
</tr>
<tr>
<td>Taylor model 9841 digital thermometer</td>
</tr>
</tbody>
</table>
Appendix B. Water quality standards for hardness dependent metals

Conversion formulae are given in WAC 173-201A at http://www.ecy.wa.gov/pubs/wac173201a.pdf. Chronic standard in micrograms/liter (µg/L)

<table>
<thead>
<tr>
<th>Sample location</th>
<th>Hardness (mg/L)</th>
<th>Cd (µg/L)</th>
<th>Cu (µg/L)</th>
<th>Pb (µg/L)</th>
<th>Zn (µg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Creek mine pond</td>
<td>230</td>
<td>1.9</td>
<td>23.1</td>
<td>6.2</td>
<td>211.7</td>
</tr>
</tbody>
</table>

Appendix C. Mining companies associated with the Deep Creek mine

<table>
<thead>
<tr>
<th>Company</th>
<th>Registered in Washington?</th>
<th>Date registered with Sec. of State</th>
<th>UBI number</th>
<th>Date stricken or dissolved</th>
<th>Comment</th>
<th>Place of business</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washington Quarry Co.</td>
<td>no</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Northport, Wash.</td>
</tr>
<tr>
<td>Northport Mining Co.</td>
<td>no</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Northport, Wash.</td>
</tr>
<tr>
<td>Gorien Zinc Co.</td>
<td>no</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Northport, Wash.</td>
</tr>
<tr>
<td>Jamieson-Higginbotham partnership</td>
<td>no</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Colville, Wash.</td>
</tr>
<tr>
<td>American Zinc Co. Inc.</td>
<td>yes</td>
<td>unknown</td>
<td>F015872</td>
<td>March 1972</td>
<td>withdrew</td>
<td>St. Louis, Missouri</td>
</tr>
<tr>
<td>Columbia Resources Inc.</td>
<td>yes</td>
<td>May 1972</td>
<td>D213643</td>
<td>May 1976</td>
<td></td>
<td>Spokane, Wash.</td>
</tr>
</tbody>
</table>