INACTIVE AND ABANDONED MINE LANDS—Bonanza Mine, Bossburg Mining District, Stevens County, Washington

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Contents

Introduction ............................................. 1
Summary ..................................................... 1
Access .................................................... 2
Ownership .................................................. 2
History ..................................................... 2
Geologic setting ........................................... 3
Openings ................................................... 5
Materials and structures ................................ 5
Water ....................................................... 6
Milling operations ......................................... 6
Waste rock dumps ......................................... 8
General information ....................................... 8
Mine operations data ....................................... 8
Physical attributes ......................................... 9
Vegetation ................................................ 10
Wildlife .................................................... 10
Water quality ............................................... 10
Acknowledgments ......................................... 11
References cited ........................................... 11
Appendix A. Methods and field equipment .................. 12
Appendix B. Water quality standards for hardness dependent metals ....... 13
Appendix C. Mining companies associated with the Bonanza mine. ......... 14

FIGURES
Figure 1. Map showing the general location of the Bossburg Mining District in Stevens County and a site map of the Bonanza mine ................1
Figure 2. Geologic map of the Bonanza mine area ........................................... 4
Figure 3. Photo showing open stope along surface lineament ........................ 5
Figure 4. Photo showing caved portal of the Gibbs Crosscut ............................. 5
Figure 5. Photo showing sidehill excavation above east limb of a north-plunging anticline . . . 6
Figure 6. Photo showing Bonanza mill tailings at the south impoundment ..........6
Figure 7. Aerial photograph of the Bonanza mill site ...................................... 7
Figure 8. Photo showing typical exposed tailings cross section ....................... 7
Figure 9. Photo showing existing residence .................................................... 8
Figure 10. Photo showing atypical dark grey tailings at north impoundment. ....... 8
Figure 11. Photo showing waste rock dump at the upper Bonanza site, July 2003 .... 9
Figure 12. Photo showing reconfigured waste rock dump at the upper Bonanza site, July 2007 ....................................... 10
Figure 13. Photo showing partial overview of waste rock dumps at the lower Bonanza site, July 2007 ..................................... 11

TABLES
Table 1. Location and map information ................................................. 8
Table 2. Mine features ................................................. 9
Table 3. Soil analysis .................................................. 9
Table 4. Soil quality standards for unrestricted land use ........................................... 9
Table 5. Benthic macroinvertebrates (BMI) ................................................................. 10
Table 6. Surface water field data ................................................................................. 10
Table 7. Surface water analysis and applicable
        Washington State Water Quality Standards......................................................... 10
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).

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 DGER. Reports are posted online at http://www.dnr.wa.gov/ResearchScience/Topics/GeologyPublicationsLibrary/Pages/pubs.aspx.

SUMMARY

The Bonanza lead mine (Fig. 1) is located one-half mile north of the Evans Cutoff Road in Stevens County, in secs. 2 and 11, T37N R38E. Outcrops of galena were discovered at the property in 1885. Approximately 102,000 tons of ore were mined from 1907, the first year production records are available, through closure in 1953. Most of this total took place during the 11 years prior to closure by a partnership of Earl Gibbs and Ira Hunley doing business as Bonanza Lead Co. Total production of lead from all owners and lessees is 24.9 million pounds, accounting for one-fifth of all lead produced in Stevens County until 1980. The overall grade was 12.2 percent lead. Additional silver, copper, and zinc recoveries are shown below under Mine Operations Data. The Bonanza Mill is located 2 miles north of Colville on State Route (SR) 395 in sec. 31, T36N R39E.

The Anaconda Copper Mining Co., Inc., held a lease/purchase option on the mine in 1951 and 1952, as did the Bunker Hill Co., Inc., in 1961. Both major companies conducted significant, but unsuccessful...
ful, exploration programs in an effort to locate extensions of the Bonanza mineralization. The former mine lands have been subdivided and are now held by private parties. The mine is collapsed internally and caved to the surface in places.

The mine was developed on seven levels by two inclined shafts at the upper Bonanza site and a crosscutting adit entering the 6 level from the center of sec. 11 at the lower Bonanza site. Total development exceeds 9600 feet.

High-grade masses of galena intermixed with pyrite occur in discontinuous lenses at or near the contact of two metasediments: phylite overlain by argillite. The ore horizon was generally 4 to 6 feet thick on the east and west limbs and crest of a gently plunging anticline and as much as 27 feet thick at a fold hinge. Various investigators have attributed the ore deposit's genesis to two different models: (a) vein formation of hydrothermal origin in a shear zone, and (b) mineralization co-deposited at the same time as the sediments, that is, a stratiform, syngenetic deposit. Both models indicate the effect of low-grade metamorphism on the sulfides.

Waste rock dumps at both the upper and lower sites exceed Model Toxic Control Act (MTCA) levels for arsenic and lead, as do tailings at the Bonanza mill site, which also contain significant concentrations of copper, cadmium, mercury, zinc, and cyanide.

Water discharges from the lower Bonanza adit, referred to as the 'Gibbs Crosscut', at about 5 gallons per minute. Two water samples taken at different seasons and years indicate the water meets State toxicity standards shown in Table 7 for heavy metals when corrected for the exceptionally high hardness. Since this opening is caved and the mine may be flooded or partially so, the two conditions taken together may represent hydraulic blowout potential.

DGER performed field work at the Bonanza mine site in July 2003 and June 2007, and at the Bonanza mill site in Sept. 2002. The U.S. Environmental Protection Agency (USEPA) conducted a time-critical Removal Action at the Bonanza mill in October 2002 that capped the exposed tailings with gravel and geotextile barrier, stabilized the shoreline adjacent to the Colville River, and reconfigured the drainage ditch to prevent contact of surface water with the tailings.

**ACCESS**

From Kettle Falls, follow SR 25 approximately 7 miles north to the Evans Cutoff Road and proceed east 1.5 miles to a left turn on Bonanza Hill Road. At 0.5 miles, turn right and follow the mine access road to the upper Bonanza development and site of the historic inclined shaft at elevation 2260 feet. The adit of the lower Bonanza development (Gibbs Crosscut) is located at elevation 2020 feet in the center of sec. 11. Follow the gravel road shown in Figure 1 to the site. All lands formerly mined are privately held.

The mill site at Palmer Siding is adjacent to the Colville River and the Burlington Northern railway, approximately 2 miles north of Colville on SR 395 and 14 miles south of the mine.

**OWNERSHIP**

The underground mine development covers a north–south trending band 3050 feet long by 1600 feet wide, beginning in the center of sec. 11 and extending into the south half of sec. 2, all in T37N R38E. The lode claims and lands owned in fee simple were quit claimed to the Gibbs estate by Bunker Hill in 1979. Since then, the property has been subdivided into at least five tax lots and parcels of 10 acres or more of mixed private ownership (Stevens Co. Assessor, written commun., 2007). Mineral rights agreements ranging from 'all' to 'partial', if included, are widely dispersed. Specifics on mineral rights can be obtained from Stevens County Assessor's office or local title companies. There are no unpatented claims in secs. 11 or 2 (BLM, LR2000 database, Jan. 2008). A patented lode claim, no. 24380 issued in 1894, is no longer shown on the tax rolls or parcel map. The patent was issued to the Consolidated Bonanza Mining and Smelting Co. under Mineral Survey 319.

**HISTORY**

Jenkins (1924) described the Bonanza ore body as "boldly outcropping on the surface" at the time of its discovery in 1885. A linear cut approximately 1000 feet long by 25 feet wide and an open pit east of the present upper Bonanza site indicates that pre-1907 production came from these mineralized surface exposures (Fig. 1).

Fulkerson and Kingston (1958) reported that Deer Trail Consolidated Mining Co., Ltd., took possession of the mine in 1907 and continued production through 1920. During this period, 7200 tons of hand-sorted ore averaged 18 percent lead. Deer Trail sank a 30-degree inclined shaft and opened up stopes on four levels, separated by approximately 50 feet in elevation. G. J. Vervaeke, a former lessee at the mine, purchased title in 1923 and built a small gravity concentrator near the shaft using jigs and tables (Puffett and Anderson, 1954). Vervaeke made the last extension of the inclined shaft from the 4 level to the 7 level. In total, the shaft has a slope distance of 580 feet and bottoms out 340 feet below the surface (DGER mine map file).

Bonanza Mining and Milling Co. Inc. operated the mine in 1929 and built a flotation mill at the site that burned down the following year. Northern Lead Mining Co., Inc., operated the mine in 1931 and 1932. Whether these two companies had title to the property or not is unknown. There is a break in the production record until 1942 when a lease was undertaken by Russell Parker, owner and superintendent of the First Thought gold mine near Orient. Mr. Parker received a $5000 mine development loan from the Reconstruction Finance Corporation. This money was used to reopen the discovery shaft located 80 feet east of the Deer Trail production shaft. Referred to as the ‘Parker Shaft’, it accessed old workings on the 1 level and 2 level (DGER mine map file). From 1942 through 1943, Parker produced 356 tons of ore grading 25 percent lead and built a rudimentary gravity mill near the shaft (Fulkerson and Kingston, 1958).
In January 1945, Dr. Ira M. Hunley, Spokane, purchased the mine from the Vervaeke estate. Hunley formed the Bonanza Lead co-partnership in 1946 with Earl Gibbs, a Colville miner. In addition to expanding the mine's development, Gibbs and Hunley built a 100 ton per day (tpd) selective flotation mill at Palmer Siding, 2 miles north of Colville on SR 395.

Bonanza Lead partnership drove over 3100 feet of drifts, stopes, and raises, including the 2000-foot Gibbs Crosscut shown in Figure 1. This adit intersected the eastern limb of the mineralized anticline described below, thus obviating the necessity of reconditioning the inclined shaft and provided a means of draining the mine. Production from 1946 through early 1951 was 73,555 tons of ore containing 18.3 million pounds of lead and 163 thousand ounces of silver. During this period, improved selective separations in the mill also recovered 92,600 pounds of zinc and 16,000 pounds of copper.

Bonanza Lead operated the mine until Feb. 9, 1951, at which time the Anaconda Copper Mining Co., Inc., acquired a lease/purchase option from Gibbs and Hunley that included a $500,000 down payment on a $2 million total purchase price; the balance to be paid via 12 percent net smelter returns. The mine was then producing about 100 tpd with 65 combined mine and mill employees (Puffett and Anderson, 1954). Anaconda engineers mapped all the accessible underground development (DGER mine map file). “Anaconda continued operations and undertook an extensive diamond drilling program to locate additional ore, but the program was reported to be unsuccessful” (Wallace Miner, March 12, 1953). Anaconda terminated the option agreement in March 1953 after recovering 10,580 tons of ore-grade waste rock (Fulkerson and Kingston, 1958).

In June 1954, Bonanza Lead applied for a Defense Minerals Explorations Administration (DMEA) loan to find a possible oreshoot thought to extend downward [from the 7 level to a proposed 9 level]. Based on a comprehensive review of Anaconda’s unfavorable drilling results, an underground examination, and detailed cross sections, the request was denied (Puffett and Anderson, 1954).

Gibbs and Hunley operated the Young America mine in 1952 and 1953 under the Bonanza Lead co-partnership (Wolff and others, 2007). In October 1957, Gibbs formed a corporate entity, Bonanza Lead, Inc., which dissolved in July 1961.

The Bunker Hill Co., Inc., entered into a lease/purchase option agreement with the estate of E. Gibbs in 1961 for the purpose of exploring the Bonanza lode claim and 1800 acres of land owned in fee simple in secs. 1, 2, 3, 10, 11, and 12, T37N R38E. Bunker Hill reportedly conducted geochemical soil surveys in conjunction with some diamond drilling in 1962 (Wallace Miner, Oct. 19, 1962). The results are not available, but it appears the exploration was unable to locate additional ore reserves, and the mineral rights and property involved were surrendered to successors of the Gibbs estate in 1979 for the purpose of clearing title (Stevens Co. Assessor’s Office, written commun., 2007).

No mining has taken place since the 1953 close of operations, when all the pipe and track were pulled from the underground workings (Puffett and Anderson, 1954). Nothing remains of the surface plant except Bonanza Lead’s circa-1946 concrete block compressor house and shop at the lower adit. As discussed below, the mine has collapsed.

GEOLOGIC SETTING

Host rocks at the site are accreted metasediments characterized by Jackson (1984) as “mid-Paleozoic basinal rocks” (Fig. 2). Laskowski (1982) noted that the rocks range in age from Ordo-vician to uncertain Devonian age, which “have been informally subdivided into ten stratigraphic units”. These units contain interbedded argillite, phyllite, some greywacke, chert, limestone, and greenstone (Mills and others, 1985). These rocks have undergone at least two major fold deformations, one or more minor deformations, and major north-trending high-angle faulting–tectonic events having a significant effect on the structural geology of the mine and the location and richness of the mineralization. Two distinct units are exposed in the mine workings: light green chloritic phyllite overlain by black carbonaceous argillite locally rich in calcite (Puffett and Anderson, 1954).

The sediments are part of a gently north-plunging anticline with locally intense folding and faulting. In the mine workings west of the shaft, the ore and sediments strike roughly northeast and dip 30 to 55°W; in the central part of the mine, the strike is east–west with dips 10 to 35°N. In the easternmost mine workings, approximately 400 feet from the shaft, the ore horizon strikes roughly north and dips 25 to 55°E (Mills, 1985). Alluvial sand and gravel several hundred feet thick overlie the downward dipping sediments on both limbs of the anticline.

The ore is found in discontinuous lenses conformable with the argillite-phyllite contact and in veins within the underlying green phyllite (Puffett and Anderson, 1954). The primary ore mineral is fine-grained ‘steel’ galena that occurs in masses intimately mixed with approximately equal pyrite content. Recovery of zinc and copper is attributed to minor amounts of sphalerite and chalcopyrite respectively. Jackson’s (1984) study of the mine’s mineralogy using scanning electron microscopy shows small inclusions of silver-bearing tetrahedrite and pyrrargyrite. In one area at a fold hinge, ore 27 feet thick was mined. The gangue minerals are milky quartz, siderite above the 4 level, fragments of foliated host rock, and barite. Disseminated pyrrhotite and magnetite are also present (Jackson, 1984).

As discussed below, the Bonanza mineralization has been ascribed to two different models: (a) vein(s) formed by hydrothermal replacement of rocks in a shear zone, and (b) sulfides deposited in a stratiform syngenetic environment in which the ore minerals were formed contemporaneously with the enclosing rocks.

The last investigators to examine the mine were W. P. Puffett (U.S. Geological Survey) and W. S. Anderson (U.S. Bureau of Mines) in support of the Defense Minerals Exploration Administration program. Their conclusion, based on observations at the time, supports the hydrothermal/shear zone model. “Above the contact the argillite has been distorted and carbonized for a thickness in excess of 50 feet, but the foliation in the phyllite beneath the contact shows little distortion. It is believed the distortion in the argillite has resulted from thrust faulting of the argillite over the phyllite and that the contact is a fault contact. The upper 20 to 50 feet of the phyllite has been strongly bleached to a light, creamy color, probably the result of hydrothermal solutions” (Puffett and Anderson, 1954). Bancroft and Lindgren (1914) observed fault gouge up to 3 feet thick sur-
rounding ore in the contact between the two host rocks. One or more aplite dikes are closely associated with sulfides in the mine, and Jenkins (1924) reported them to be “mineralized with quartz stringers grading into ore”.

However, two separate studies of the Bonanza mineralization in the 1980s revealed the presence of primary textures suggestive of a sediment-hosted stratiform deposit: Mills (1985) found “interbedded sulfides and rock-forming silicates, nodular, colloform and frambooidal textures, and atoll textures in pyrite, sphalerite, and galena...compatible with or diagnostic of sedimentary ore formation.” Jackson (1984) states that, “Colloform textures, and frambooids [raspberry-shaped clusters of pyrite grains, linked with the presence of organic materials] are undoubtedly primary textures. These features are found at most sediment-hosted stratiform deposits where they are interpreted to be of synsedimentary origin.”

Figure 2. Geologic map of the Bonanza mine area.
twinning in galena and sphalerite found in these studies suggest the ore body has been subjected to several episodes of post-mineral metamorphism and temperatures of 300 to 500°C.

Significant high-angle post-mineral normal faults cut the phyllite and continue into the argillite. An igneous intrusion described as “30 to 40 feet of light gray porphyry with alternating bands of black argillite” was discovered in core holes drilled straight up from stations 500 feet east of the inclined shaft on the 607 drift (DGER mine map file). No ore was found in these holes (Puffett and Anderson, 1954).

Anaconda drilled 94 diamond drill holes aggregating nearly 12,000 feet from underground locations. In addition, hundreds of feet of drifts and crosscuts were driven on the 6 level in an effort to find extensions of the East and West ore bodies. Hole locations, distances, and bearings from this work are shown on Anaconda’s map. Although the exploration drilling failed to find additional ore, the work was constrained by lack of access to historic workings on the West orebody above the 6 level. Mills (1985) postulated that a modified exploration approach consistent with the stratiform mode of formation may discover extensions of the Bonanza ore body.

**OPENINGS**

All reports cited in this publication indicate the internal workings are caved at various places, and some have caved to the surface. The opening shown in Figure 3 is in the center of a linear cut 1000 feet long by 25 feet wide about 480 feet east of the waste rock dump at the upper Bonanza site. It lies above mined-out stopes extending down dip ~500 feet.

The only recognizable mine opening at the time of DGER site characterization in 2003 was the adit at the lower Bonanza site (Fig. 4). A note on Anaconda’s map identifies this as the portal of the post-1946 Gibbs Crosscut. It is approximately 2000 feet long, bearing N15°W, and enters the East orebody on the 6 level (DGER mine map file). This opening drained the mine above the 2020-foot elevation and served as the main haulage-way during Bonanza Lead’s operation.

We could not find the location of either the original 565-foot deep inclined shaft or the Parker shaft. The location shown in Figure 1 at the upper Bonanza site is probably correct.

An overgrown road leads away from the upper Bonanza site 250 feet southeast to a sidehill excavation (Fig. 5). The feature is too overgrown to enter. It may be a subsidence feature or related to early surface mining.

**MATERIALS AND STRUCTURES**

None of the infrastructure remains on site, except a 20 x 30 foot concrete block building at the lower Bonanza site. It housed an office, shop, and air compressors during post-1946 mining.
WATER

Water discharged from the Gibbs Crosscut at less than 5 gallons per minute and infiltrated 50 feet from the portal. The water was clear, had a strong sulfurous odor, and formed a white precipitate. The pH measured 6.72. Electrical conductivity was 2220 μS/cm, the highest reading obtained in the IAML Inventory to date. A possible reason for this anomaly is the extreme hardness of the water, 1590 mg/L, which is a measure of equivalent CaCO₃ content. Chemical analyses from samples taken at different seasons and years from the same discharge are shown in Table 7. These data indicate the discharge meets the requirements of WAC 246-290 (Ground water for domestic consumption) and WAC 173-201 (Surface water chronic effect on aquatic life) for the analytes shown. However, it should be noted that the extremely high hardness value masks the toxicity effect of the significant lead content (Rafforth, Wash. State Dept. of Ecology [DOE], written commun., 2000).

The Gibbs Crosscut presents a potential hydraulic blowout site, depending on the amount and location of water stored within the mine and the degree of caving. At the time of the USGS examination in 1954, the shaft was flooded below the 6 level and had to be pumped out. The mine was making water in 1914 at the time of Bancroft’s examination. He stated, “At the present time water is circulating through the shear zone and the country rock on each side of the vein is loose and caves frequently. As the water was nearly up to the No. 4 level it was impossible to examine the greater part of the mine.”

We observed three well heads labeled “Washington Dept. of Ecology Unique” near the upper Bonanza site: ABV-316, ABV-317, and ABV-318. According to DOE, they have not been abandoned and are designated for domestic use. The wells were drilled in 1995. Well logs show interbedded layers of “green shale, black shale with quartz stringers, and limestone.” Static water level was 45 feet from the surface.

At the Bonanza mill site, DGER used a kicknet to collect benthic macroinvertebrate taxa in the Colville River adjacent to and downstream from the mill tailings. The species and number of individuals found are shown in Table 5. The data indicates “that certain aspects of water quality are compromised” (M. Hayes, Dept. of Natural Resources biologist, written commun., 2003). The water quality degradation may or may not be directly attributable to the mill’s operation, as considerable industrial activity occurs upgradient from the site.

MILLING OPERATIONS

Puffett and Anderson (1954) stated that the mill at Palmer Siding was originally built by Gibbs and Hunley as a custom mill in 1942 to serve the small mines of the surrounding area. Whether it was widely used for this purpose is unknown. After the start of the Bonanza Lead operation in 1945, the mill operated entirely on production from the Bonanza mine, totaling 86,600 tons, until closure in 1953. The mill also processed about 2000 tons of ore in 1967 from the dolomite-hosted Schumaker zinc mine (Wallace Miner, Feb. 16, 1967). Orlob and Saxton (1950) reported that tailings were deposited in a “lagoon separated from the Colville River by a 10-foot dike” (Fig. 6). Historical accounts indicate that the dike was intentionally breached near the center of the site during mining operations or shortly after clo-
Gravel in the streambed is stained reddish-brown. The tailings cover 9 acres of the 13-acre site (Fig. 7) and range from a few inches to 8 feet in thickness (Fig. 8). We estimate the tailings volume to be in the range 60,000 to 70,000 cubic yards, depending on original topography. All soil samples taken by the USEPA (Herrera, 2003) and DGER exceed state standards for one or more heavy metals shown in Table 4 and 5.

In the years following cessation of mining operations, the mill site was involved in a complex series of sales, litigation, and property seizures to satisfy liens. Calix America Corporation purchased the mill site from the Gibbs estate in 1972, and the following year shipped the dismantled buildings and equipment to Customer Mining Ltd. in Canada. The site has been owned by a number of entities and non-mining business operations since 1974 (G. Schmidt, USEPA, written commun., 2003). In Sept. 2002, the property was used as a temporary storage yard for packaged lumber products, and included a private residence and domestic water well (Fig. 9). The residence was unoccupied at the time of DGER site characterization in Sept. 2002. As shown in Table 4, tailings found in the northwest corner of the site differ markedly in color and chemistry from the...
typical Bonanza material, and are clearly from some other mine, probably the Schumaker (Fig. 10). Numerous truckloads of broken concrete and asphalt pavement and an assortment of construction debris were dumped on the site.

The USEPA conducted a time-critical Removal Action in October 2002, which capped the exposed mill tailings with gravel and a geotextile barrier, stabilized the shoreline adjacent to the Colville River, and reconfigured the drainage ditch to prevent contact of surface runoff water with the tailings (Hererra, 2003).

WASTE ROCK DUMPS

The mine has two major waste rock dumps. The upper dump is associated with the shaft and pre-1946 infrastructure at elevation 2260 feet (Fig. 11). The waste rock is a mixture of black argillite and green phyllite in about equal proportions. The estimated volume is 41,500 cubic yards. The dump rock had been used as fill at various times. In 2007, Stevens County reconfigured the dump into a large stockpile, and used the material for road ballast (Fig. 12). Because of toxicity associated with the high lead and arsenic content shown below, the ballast was removed and returned to the stockpile (E. Cello-Vaché, DOE, oral commun., 2007). The lower dump, adjacent to the Gibbs Crosscut, is predominantly green phyllite (Fig. 13).

Screened samples (minus 1/8th inch) taken from both waste rock dumps exceed state standards for lead and arsenic (Tables 3 and 4).

GENERAL INFORMATION

Name: Bonanza
MAS/MILS sequence number: 0530650228
Access: two-wheel drive
Status of mining activity: none
Claim status: no patented or unpatented claims
Current ownership: private
Surrounding land status: private
Location and map information: see Table 1

MINE OPERATIONS DATA

Type of mine: underground and open cut
Commodities mined: lead, minor zinc, copper, and silver
Geologic setting: hydrothermal replacement in a shear zone or massive sulfides in a strataform synsedimentary horizon; regional metamorphism caused north-trending high-angle faults and folds
Ore minerals: galena, sphalerite, chalcopyrite, tetrahedrite, pyrargyrite

<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>Bonanza</td>
<td>Stevens</td>
<td>secs. 2 and 11, T37N R38E</td>
<td>48.72886</td>
<td>117.98980</td>
<td>Echo Valley</td>
<td>Colville</td>
</tr>
</tbody>
</table>

Non-ore minerals: quartz, calcite, siderite, barite, magnetite, pyrrhotite

Host rock: carbonaceous argillite and phyllite

Development: >9600 feet, including stopes, raises, drifts, and shafts

Production: 102,000 tons; >$2,000,000 at historic metal prices: 24,880,359 pounds Pb; 21,913 pounds Cu; 230,687 pounds Zn; 238,485 oz Ag; 12 oz Au (Fulkerson and Kingston, 1958)

Mill data: 100 tpd flotation mill

**PHYSICAL ATTRIBUTES**

Features: see Table 2

Materials: none

Machinery: none

Structures: concrete block compressor house, shop.

Waste rock dumps, tailings impoundments, highwalls, or pit walls: four

![Figure 11. Waste rock dump at the upper Bonanza site, July 2003. View is to the northwest.](image-url)
Analysis of waste rock dumps: see Tables 3 and 4

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

Reclamation activity: none

VEGETATION

Inland grasses, sparse lodgepole pine. Weeds include knapweed, bursage, poison hemlock, and yellow toadflax.

WILDLIFE

None observed: no bats or bat evidence. For benthic macroinvertebrates, see Table 5.

WATER QUALITY

Surface waters observed: discharge from lower Bonanza site ‘Gibbs Crosscut’ infiltrates waste rock dump

Proximity to surface waters: none

Domestic use: livestock

Acid mine drainage or staining: none

Water field data: see Tables 6 and 7

Surface water migration: none

Table 6. Surface water field data (Raforth and others, 2000).

<table>
<thead>
<tr>
<th>Description</th>
<th>Flow (gpm)</th>
<th>Conductivity (µS/cm)</th>
<th>pH</th>
<th>Remarks</th>
<th>Temp. (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>lower Bonanza site, Gibbs Crosscut portal</td>
<td>5</td>
<td>2220</td>
<td>6.72</td>
<td>clear flow, white precipitate</td>
<td>53.4</td>
</tr>
</tbody>
</table>

Table 5. Benthic macroinvertebrates (BMI).

<table>
<thead>
<tr>
<th>Location</th>
<th>Elevation (ft)</th>
<th>Date</th>
<th>Taxon</th>
<th>Common name</th>
<th>Number of individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colville River, Bonanza Mill site</td>
<td>1540</td>
<td>Sept. 2002</td>
<td>Coleoptera, Elmidae</td>
<td>beetle</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Diptera, Chironomidae</td>
<td>fly</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ephemoptera, Bactidae</td>
<td>mayfly</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ephemoptera, Heptageniidae</td>
<td>mayfly</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 7. Surface water analysis. Metal concentrations are in micrograms/liter (µg/L); hardness is in milligrams/liter (mg/L); USEPA, U.S. Environmental Protection Agency; ---, no data; *, standards for these metals are hardness dependent; ≤ 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. 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

<table>
<thead>
<tr>
<th>Sample location</th>
<th>Arsenic</th>
<th>Cadmium*</th>
<th>Copper*</th>
<th>Iron</th>
<th>Lead*</th>
<th>Mercury</th>
<th>Zinc*</th>
<th>Hardness</th>
</tr>
</thead>
<tbody>
<tr>
<td>lower Bonanza site, Gibbs Crosscut portal, July 2003</td>
<td>---</td>
<td>≤ 2.5</td>
<td>5.7</td>
<td>---</td>
<td>9.4</td>
<td>---</td>
<td>9.5</td>
<td>1590</td>
</tr>
<tr>
<td>lower Bonanza site, Gibbs Crosscut portal, October 2000*</td>
<td>≤ 10</td>
<td>≤ 10</td>
<td>≤ 10</td>
<td>500</td>
<td>≤ 10</td>
<td>≤ 0.2</td>
<td>≤ 10</td>
<td>---</td>
</tr>
</tbody>
</table>

PART 2: APPLICABLE WASHINGTON STATE WATER QUALITY STANDARDS

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

The authors thank our editors Jari Roloff and Karen Meyers for helpful suggestions on the layout and content of this report. Additional appreciation goes to Dave Frank, USGS Spokane office, Minerals Division, for supplying DMEA file material; Gretchen Schmit and Earl Liverman, USEPA Seattle and Coeur d’Alene office respectively, for material on the Bonanza mill site Removal Action.

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Appendix A. Methods and field equipment

**METHODS**

We recorded observations and measurements in the field. Latitude and longitude were recorded with a global positioning system (GPS) unit in NAD83 decimal degree format. Literature search 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. Mercury analysis is per EPA 7471A. Total cyanide analysis is per EPA 9012A.

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
- Tyler Screen, No. 6 mesh
Appendix B. Water quality standards for hardness dependent metals


<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>lower Bonanza site, Gibbs Crosscut portal</td>
<td>1590</td>
<td>7.9</td>
<td>120.7</td>
<td>41.7</td>
<td>1089.2</td>
</tr>
</tbody>
</table>
## Appendix C. Mining companies associated with the Bonanza mine

<table>
<thead>
<tr>
<th>Company</th>
<th>Registered in Washington?</th>
<th>Date registered with Sec. of State</th>
<th>Date stricken or dissolved</th>
<th>Comment</th>
<th>Place of business</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consolidated Bonanza Mining and Smelting Co.</td>
<td>yes</td>
<td>July 1891</td>
<td>July 1923</td>
<td>nonpayment of fees</td>
<td>Spokane</td>
</tr>
<tr>
<td>Deer Trail Consolidated Mining Co., Ltd.</td>
<td>yes</td>
<td>March 1900</td>
<td>July 1923</td>
<td>nonpayment of fees</td>
<td>Ontario, Canada</td>
</tr>
<tr>
<td>Bonanza Mining Co., Inc.</td>
<td>yes</td>
<td>August 1928</td>
<td>July 1933</td>
<td>fees paid 1929 and 1930</td>
<td>Spokane</td>
</tr>
<tr>
<td>Northern Lead Mining Co., Inc.</td>
<td>yes</td>
<td>February 1931</td>
<td>July 1933</td>
<td>fees paid 1931</td>
<td>Spokane</td>
</tr>
<tr>
<td>Victory Metals, Inc.</td>
<td>yes</td>
<td>February 1942</td>
<td>July 1945</td>
<td></td>
<td>Seattle</td>
</tr>
<tr>
<td>E. Gibbs and I. Hunley, a partnership doing business as Bonanza Lead Co.</td>
<td>no</td>
<td>N/A</td>
<td>N/A</td>
<td>Hunley’s interest sold to Gibbs in 1954</td>
<td>Colville</td>
</tr>
<tr>
<td>Anaconda Copper Mining Co., Inc.</td>
<td>yes</td>
<td>February 1951</td>
<td>July 1981</td>
<td>dissolved</td>
<td>Butte, Montana</td>
</tr>
<tr>
<td>Bonanza Lead Co., Inc.</td>
<td>yes</td>
<td>October 1957</td>
<td>July 1961</td>
<td>dissolved</td>
<td>Colville</td>
</tr>
<tr>
<td>Bunker Hill Co., Inc.</td>
<td>yes</td>
<td>July 1948</td>
<td>June 1968</td>
<td>merged with Gulf Resources and Chemical Co., Inc.; dissolved June 1968</td>
<td>Kellogg, Idaho</td>
</tr>
</tbody>
</table>