Bellingham/Lake Whatcom Coal Mines
Blue Canyon Mine
Preliminary Assessment Report
Whatcom County, Washington
TDD: 03-01-0002

Ecology and Environment, Inc.
Contract: 68-S0-01-01
September 2004

Region 10

START-2

Superfund Technical Assessment and Response Team

Submitted To: Joanne LaBaw, Task Monitor
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LIST OF ACRONYMS

Acronym	Definition
AMD	acid mine drainage
amsl	above mean sea level
asl	above sea level
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
cfs	cubic feet per second
CLP	Contract Laboratory Program
CRQL	Contract Required Quantitation Limit
Cs	cesium
E & E	Ecology and Environment, Inc.
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
IDW	investigation-derived waste
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
PAs	preliminary assessments
Pb	lead
PPE	probable point of entry
ppm	parts per million
SQL	Sample Quantitation Limit
START	Superfund Technical Assessment and Response Team
TDL	target distance limit
USGS	United States Geological Survey
WCHD	Whatcom County Health Department
WCHHS	Whatcom County Health and Human Services
WDFW	Washington Department of Fish and Wildlife
WDOH	Washington Department of Health

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1. INTRODUCTION

Ecology and Environment, Inc. (E & E) was tasked by the United States Environmental Protection Agency (EPA) to provide technical support for completion of preliminary assessments (PAs) and pre-Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) screenings at several abandoned coal mines in the Bellingham/Lake Whatcom area, located in Whatcom County, Washington. The EPA is doing this work in response to a citizens' petition from two environmental groups in Bellingham, the Environmental Exposure Network and the Clean Water Alliance. These groups believe the mines may contain pollutants, such as mercury and other heavy metals.

Following review of existing information and initial site visits, three of the mines, including the Blue Canyon Mine, were selected by the EPA for sampling. E & E completed PA activities under Technical Direction Document Number 03-01-0002, issued under EPA, Region 10, Superfund Technical Assessment and Response Team (START)-2 Contract Number 68-S0-01-01.

The specific goals for the Blue Canyon Mine PA, identified by the EPA, are:

- Determine the potential threat to public health or the environment posed by the site;
- Determine the potential for a release of hazardous constituents into the environment; and
- Determine the potential for placement of the site on the National Priorities List.

Completion of the PA included reviewing existing site information, collecting receptor information within the range of site influence, determining regional characteristics, conducting site visits, and performing limited sampling. This document includes a discussion of background site information (Section 2), a discussion of migration/exposure pathways and potential receptors (targets; Section 3), conclusions (Section 4), and a list of pertinent references (Section 5).

2. SITE BACKGROUND

2.1 SITE LOCATION

Site Name:	Blue Canyon Mine
CERCLIS ID Number:	WAN001002481
Location:	Whatcom County, Washington
Latitude:	48° 41' 25" North
Longitude:	122° 16' 41" West
Legal Description:	Township 37 North, Range 4 East, Southeast ¼ Section 15 Township 37 North, Range 4 East, Northeast ¼ Section 22 Willamette Meridian
Site Owners/Contacts:	Nielsen Brothers, Inc. Attn: Mr. Aubrey Stargell P.O. Box 2789 Bellingham, Washington 98227-2789 Alan W. and Janan E. Carter 223 171st Place NE Bellevue, Washington 98008 Whatcom County Parks and Recreation Department Attn: Lynne Givler 3373 Mt. Baker Highway Bellingham, Washington 98226-9522

2.2 SITE DESCRIPTION/OWNERSHIP HISTORY

The Blue Canyon Mine is an abandoned coal mine situated on a steep, forested mountainside near the southern end of Lake Whatcom on its eastern shore (Figure 2-1). The mine occupies portions of Sections 15 and 22, Township 37 North, Range 4 East. The mine was the second largest coal mine in Whatcom County, and was operated between 1891 and 1919 (Moen 1969), and in 1933 (Vonheeder 1975). The mine exploited a coal seam discovered in 1887 at Blue Canyon.

The workings and surface facilities of the Blue Canyon Mine are described (Jenkins 1923) and illustrated in maps generated by the Blue Canyon Coal Mining Company (BCCM 1902), a mining engineer (Evans 1908), and the Whatcom County Coal Mining Company (WCCM 1914; Figure 2-2).

Based on these sources, the principal mine openings are the First Opening, Second Opening, and Mine No. 1 through Mine No. 8. Several of the workings are described below.

The First Opening was the easternmost opening, driven in Blue Canyon Creek in the southeast quarter of Section 15 at an elevation of 1,122.7 feet above sea level (asl). The majority of the workings were driven off the First Opening. A slope was driven north 10° west down the dip of the coal seam for a distance of 540 feet from the First Opening. Three levels were driven off this slope. The first level was driven approximately 400 feet northeast from an entry near the surface of the First Opening. The second level extended approximately 500 feet northeast and 800 feet southwest of the slope, from an entry approximately 280 feet from the surface of the slope and at an elevation of 1,009.1 feet asl. The third level was located at the end of the slope, at a level of 919.5 feet. Workings of the third level were driven for 270 feet to the northeast and 1,500 feet to the southwest. The southwest extension of the second level surfaced at Mine No. 3 and Mine No. 4, located approximately 800 feet and 900 feet west, respectively, of the First Opening. The southwest extension of the third level surfaced at Mine No. 5 and Mine No. 6, located near the center of the line between Sections 15 and 22. (Jenkins 1923)

The Second Opening, dated 1907, was located at a stated elevation of 658 feet asl on the line between Sections 15 and 22, approximately 1,750 feet west of the First Opening. The tunnel and other workings associated with the Second Opening are referred to as Mine No. 2. The tunnel was driven north 7° east for 778 feet through faulted rock to the coal bed. From this location, a slope was driven down the dip of the coal bed north 10° west for 300 feet. Two levels were extended from the slope, one from near the top and the other from near the bottom. Each level was driven for a distance of over 1,600 feet toward the northeast, following the irregular strike of the folded coal bed. (Jenkins 1923)

Mine No. 1 was the name of the westernmost tunnel, located in the northwest quarter of Section 22 at a stated elevation of 393 feet asl, connecting the workings of Mine No. 2 with the surface. Mine No. 1 is located near the bunkers on the Northern Pacific Railroad line running along the shore of Lake Whatcom. (Jenkins 1923)

The underground workings and surface features that existed as of 1914, based on historic mine maps (Evans 1908; WCCM 1914), are illustrated in Figure 2-2 and listed below:

- Access road to the mine area;
- Network of timber roads connecting various points of the mine;
- Tramway from the Second Opening to bunkers along the lake shore;

- Abandoned tramway from the First Opening and other upper portals to the bunkers by the lake shore;
- Lower water reservoir south of the Second Opening;
- Flume from Mine No. 3 and Mine No. 4 to bunkers at the base of the mountainside;
- An air chute near Mine No. 1 and ventilation fans at Mine No. 3 and Mine No. 4;
- An electric railroad between Mine No. 1 and the base of the tramways;
- Railroad along Lake Whatcom shoreline;
- Rock dumps near the Second Opening and Mine No. 1;
- Several water lines;
- Powder house near Mine No. 1;
- Settling tank near the base of the flume;
- Coal bunkers and washer along the Lake Whatcom shoreline; and
- Boarding houses along the Lake Whatcom shoreline.

Based on an earlier mine map dated 1902 (BCCM 1902), other surface features of the Blue Canyon Mine have historically included the following:

- Upper reservoir near Mine No. 4;
- Boiler house near First Opening;
- Engine house near First Opening;
- Engine/boiler house near Second Opening;
- Lamp room house near Second Opening; and
- Boarding house near Mine No. 3.

The Blue Canyon Coal Mining Company was incorporated in 1890, and operated the mine from 1891 to 1904 (Moen 1969; Vonheeder 1975). Between 1904 and 1907, the mine operated sporadically under several different managements (Moen 1969). Between 1904 and 1907, the mine was operated by William Lawton and then leased to J.M. Walter (Vonheeder 1975). In 1907, the mine was reorganized as the Whatcom County Coal Mining Company by J.M. Walter, who operated the mine until 1919 (Moen 1969; Vonheeder 1975).

The current owners of the properties believed to have been included in the mine are Nielsen Brothers, Inc., of Bellingham, Washington; Alan W. and Janan E. Carter of Bellevue, Washington; and Whatcom County Parks and Recreation Department.

2.3 SITE OPERATIONS AND WASTE CHARACTERISTICS

The Blue Canyon Mine operated between 1891 and 1919 (Moen 1969), and in 1933 (Vonheeder 1975). The mine was the second largest coal mine in Whatcom County. Annual reported production figures for the period from 1891 to 1902 range from 5,853 to 48,200 tons (Vonheeder 1975). The annual production for the period from 1908 to 1919 is reported to have ranged from 6,000 to 8,000 tons (Moen 1969). The mine produced 333 tons of coal in 1933 (Vonheeder 1975). The total production for the mine was 280,000 tons (Moen 1969). Between 1894 and 1896, the United States Navy used some of the coal for its Alaskan Fleet (Moen 1969; Vonheeder 1975). After that time, the largest market for Blue Canyon coal was the homes and businesses of the Bellingham and Lake Whatcom area. The coal was classified as high volatile C bituminous in rank (Beikman et al. 1961). Sulfur content is reported to range from 0.308% to 1.05% (Jenkins 1923).

The coal seam averaged approximately 7 feet thick, but ranged from 0 to 40 feet in thickness. Coal was mined using the room and pillar method from the First Opening workings. The room and pillar mining method involves mining out rooms and leaving behind pillars of coal to support the mine roof. Typically, approximately half the coal is removed and the rest left behind as pillars. The pillars were left standing and not mined out upon retreat. Coal was removed from stopes between the two levels of the Second Opening. The produced coal was relatively fine grained in nature, making it impossible to handle in the manner used in most other coal mines. (Jenkins 1923)

The coal was transported from the mine workings to bunkers along the Lake Whatcom shoreline by several mechanisms over the history of operations. As of 1902, coal was apparently transported via a tramway from the Second Opening to bunkers along the lake shore (BCCM 1902). Earlier, coal was apparently transported from the First Opening and other upper portals to the bunkers by the lake shore via a tram shown to be abandoned in a 1902 mine map (BCCM 1902). By 1914, a flume was constructed to move coal from Mine No. 3 and Mine No. 4 to bunkers at the base of the mountainside along the Northern Pacific Railroad line on the Lake Whatcom shoreline (WCCM 1914; Jenkins 1923). By 1914, there was also an electric railroad between Mine No. 1 and the coal bunkers (WCCM 1914).

The fine-grained nature of the coal is attributed, at least in part, to crushing as a result of the weathered rock and soil sliding down the mountainside. The sliding is attributed to over-steepening of

the mountainside by glacial scouring and to the slippery nature of the metamorphic basement rock underlying the sedimentary rocks which host the coal beds. This mass wasting is reported to have been responsible for the shifting and collapse of the mine workings and associated mine facilities. For example, the bed of the Northern Pacific Railroad along the Lake Whatcom shoreline was raised on a yearly basis to maintain its elevation above lake level. The entrances of the mine were reported in 1923 to have shifted downward and caved. (Jenkins 1923)

Another operational difficulty of the Blue Canyon Mine was the highly gassy nature of the coal. In 1894, a mine gas explosion killed 23 miners. The explosion resulted from ignition of the volatile gas constituents of the coal. (Moen 1969; Vonheeder 1975)

The mine is reported to have closed in 1919 as a result of operational difficulties posed by the irregular thickness of the coal bed, coal gas, and caving and downhill sliding (Moen 1969). Several mine buildings were destroyed by fire in 1920, and the area subsequently fell into disuse (Vonheeder 1975). Apparently the mine did operate subsequent to its closure in 1919; minor production (less than 350 tons) is reported to have occurred in 1933 (Vonheeder 1975).

2.4 PREVIOUS INVESTIGATIONS

Based on available information, no investigations of the Blue Canyon Mine have been conducted. However, ancillary background information gathered as part of the PA may be pertinent to the Blue Canyon Mine, as discussed in the subsections below.

2.4.1 United States Geological Survey Coal Quality Data

The United States Geological Survey (USGS) has collected information on coal sampled from across the United States over the last 25 years (Tewalt et al. 2001). Results are compiled in the USGS's COALQUAL database (USGS 2004a). Although most samples represented in the database were collected from major coal producing areas around the country, two coal samples were collected from exposures of the Chuckanut Formation in Whatcom County (near Glacier, Washington) and Skagit County (near Hamilton, Washington) in 1979 and 1975, respectively. The Chuckanut Formation is the geologic unit that contains the coal beds developed in the Bellingham/Lake Whatcom area (Jenkins 1923). These two samples were collected from distances greater than 20 miles from the Bellingham/Lake Whatcom area coal mines (including the Blue Canyon Mine), and may not be representative of the coal beds targeted in the Bellingham/Lake Whatcom area mines. Nonetheless, it is important to note that the total mercury concentrations in these samples were relatively high, at 0.46 parts

per million (ppm) and 1.1 ppm (USGS 2004a). By comparison, for the more than 7,000 samples in the COALQUAL database, the mean mercury concentration is 0.17 ppm, and the median concentration is 0.11 ppm. The maximum mercury database value for coal in the ground is 1.8 ppm, after deleting one higher value as a statistical outlier (Tewalt et al. 2001).

2.4.2 1999 Fish and Sediment Sampling

A study conducted by the Washington State Department of Ecology (Ecology) reported a mercury concentration of 0.5 milligrams per kilogram (mg/kg), wet weight, in a composite sample of smallmouth bass fillets collected from Lake Whatcom. The study also sampled sediments from the lake and several tributaries. Total mercury concentrations ranged from 0.04 to 0.46 mg/kg, dry weight, with a mean of 0.19 mg/kg, dry weight. (Ecology 1999)

2.4.3 2001 Fish Sampling

To determine if consumers of Lake Whatcom fish were at risk from mercury exposure, Ecology, the Washington Department of Fish and Wildlife (WDFW), the Washington State Department of Heath (WDOH), and the Whatcom County Health Department (WCHD), at the request of Whatcom County Health and Human Services (WCHHS), conducted a fish tissue and consumption study (Ecology 2001). Approximately 273 samples of finfish were collected and analyzed for mercury. The average mercury level in smallmouth bass was 0.49 mg/kg, wet, with a maximum concentration of 1.84 mg/kg, wet. Thirteen samples collected during this study exceeded the EPA National Toxics Rule human health criterion of 0.825 mg/kg, wet. (Ecology 2001)

Following the study, the WDOH conducted a health assessment to determine whether fish from Lake Whatcom pose a potential threat to consumers. As a result of the health assessment, the WDOH recommended to WCHHS a fish advisory for smallmouth bass and yellow perch. (WDOH 2001)

2.4.4 2004 Lake Whatcom Mercury Study

In 2002, Ecology, the USGS, and the WCHD initiated a joint investigation to evaluate distribution and possible sources of mercury in Lake Whatcom and five other lakes in Whatcom County. Objectives of the investigation are summarized below:

- Determine the distribution of mercury in surface sediments from Lake Whatcom.(Ecology 2004);

- Evaluate historical trends in total mercury levels and sedimentation rates (Ecology 2004);
- Estimate mercury loadings in 10 tributaries to Lake Whatcom (Ecology 2004);
- Use differences in mercury accumulation rates in other lakes in Whatcom County along with other data to infer the deposition from known local and regional sources of airborne mercury and to determine if accumulation rates can be attributed to global sources (USGS 2004b);
- Use available data on concentrations of mercury in the tissue of fish from Lake Whatcom and other lakes in Whatcom County to help identify sources of mercury (USGS 2004b);
- Estimate the relative importance of potential sources of mercury in Lake Whatcom tributaries and in water diverted from the Middle Fork of the Nooksack River by examining the relation between concentrations of mercury in surface sediments of the lake and the proximity of potential sources (USGS 2004b);
- Investigate the possibility that geochemical, biological, and physical processes occurring in Lake Whatcom or in connected wetlands affect the distribution of mercury in sediment and fish tissue (USGS 2004b); and
- Suggest additional sampling or other information needed to confirm mercury sources and refine the understanding of processes identified after completing the first four objectives (USGS 2004b).

Results of the study are provided in two separate reports (USGS 2004b and Ecology 2004), and are briefly summarized below.

Possible sources of mercury to Lake Whatcom that were evaluated include atmospheric deposition from local, regional, and global sources of airborne mercury; tributaries to Lake Whatcom; and local landfills, dumpsites, and mining operations (USGS 2004b and Ecology 2004). It was noted that another possible mechanism of mercury loading to Lake Whatcom is percolation of groundwater into the lake; however, possible mercury inputs from groundwater were not evaluated during the study due to lack of data (USGS 2004b).

Local airborne sources of mercury include the Georgia Pacific chloralkali plant, which operated in Bellingham between 1964 and 2000, and three nearby incinerators, the first of which began operating in 1974. Relative contributions of mercury deposition to Lake Whatcom and other lakes in Whatcom County from local sources of aerial emissions were estimated by air modeling. Improvements in air pollution controls and operating procedures at these facilities have resulted in reduced mercury air emissions from these sources over their history (USGS 2004b).

To estimate mercury loading by tributaries, surface water was sampled periodically from 10 tributaries between July 2002 and May 2003. One of the streams sampled flows through the area of

the Blue Canyon Mine (Hood 2004). Concentrations of total mercury in the samples from the stream ranged from less than 0.002 to 0.017 micrograms per liter (µg/L), the highest concentration of the tributary samples collected during the study (Ecology 2004; USGS 2004b). This concentration exceeds the 2003 Washington State chronic freshwater surface water standard of 0.012 µg/L (Ecology 2003). The calculated mercury loading to Lake Whatcom by the stream between July 2002 and May 2003 was estimated to be 0.22 grams of mercury, representing 6.9% of the total mercury loading from the 10 tributaries sampled during the study (Ecology 2004; USGS 2004b). It was noted that the stream near Blue Canyon drains a basin containing historic coal mines, but that lack of ancillary environmental parameters precluded the assessment of potential impacts of the coal mining activities (USGS 2004b).

As part of the study, approximately 30 surface sediment samples and three deep sediment core samples were collected from Lake Whatcom. All samples were analyzed for total mercury, and 15 of the samples were analyzed for methylmercury. Other analyses performed include total organic carbon, percent solids, grain size, total lead (Pb), ^{210}Pb, and cesium-137 (^{137}Cs; Ecology 2004; USGS 2004b).

Concentrations of total mercury in surface sediments throughout Lake Whatcom ranged from 0.014 to 0.22 mg/kg, dry weight. It was concluded that these mercury sediment concentrations are not high compared to levels measured at other areas in Washington (Ecology 2004).

Radiometric dating of the sediment cores was performed using stable Pb, ^{210}Pb, and ^{137}Cs data in order to evaluate sedimentation rates and timing of mercury loading. The sediment core results indicate abrupt increases in mercury enrichment after 1910 at all three Lake Whatcom core sample locations. Most of the increases in mercury deposition in Lake Whatcom sediments (and sediment in the other lakes studied) occurred in the early to mid-1900s, which is before the major local sources of airborne mercury (Georgia Pacific chloralkali plant and the incinerators) began operating (Ecology 2004; USGS 2004b). This was interpreted to indicate that local atmospheric mercury emissions were not the dominant sources of mercury to the lake, and to suggest that the general global air pollution resulting from the Industrial Revolution in the first half of the twentieth century was responsible for a significant amount of the mercury loading in Lake Whatcom (USGS 2004b). Similar patterns of mercury enrichment were observed in core samples collected from the other Whatcom County lakes studied (Ecology 2004b; USGS 2004). Mercury levels in Lake Whatcom sediment peaked in the period between approximately 1987 and 1995, and the subsequent decline in mercury concentrations appear to suggest that mercury sources to the lake have been reduced (Ecology 2004b).

2.4.5 Coal Mine Drainage Studies

One of the principal environmental impacts that can result from coal mining is coal mine drainage. Coal mine drainage can be either acidic or alkaline, and can degrade receiving surface waterbodies and groundwater. Acid mine drainage (AMD), in which acidity exceeds alkalinity, results from a complex suite of reactions involving the oxidation of pyrite (iron sulfide) and other sulfide minerals. AMD typically results in elevated concentrations of ferric (Fe^{3+}) and ferrous (Fe^{2+}) iron, manganese (Mn^{2+}), aluminum (Al^{3+}), and sulfate (SO_4^{2-}). Neutral or alkaline mine drainage, in which alkalinity equals or exceeds acidity, can also have relatively high concentrations of iron, manganese, sulfate, and other constituents. Upon aeration of the water or neutralization of the acidity, ferric oxides, hydroxides, and/or oxyhydroxysulfate minerals commonly precipitate, forming a reddish-yellow or yellowish-brown coating (often referred to as yellowboy) on rocks and other surfaces. (PDEP 1999)

Trace metals such as arsenic, selenium, and mercury are locally present in coal and coal waste, and can be released to surface water and groundwater under coal mine drainage conditions (Seal 2004).

The chemical reactions that occur during development of AMD are analogous to those that occur during natural geologic weathering, which takes place over extended periods of time (e.g., hundreds to thousands of years); however, with AMD the reaction rates are orders of magnitude greater than in natural weathering systems. The exact lengths of time required for initiation, propagation, and termination of acid generation in coal mine AMD scenarios are not well characterized, but appear to be on the order of years to decades. Results of modeling and evaluation of a limited number of case studies indicate that the peak acid load occurs 5 to 10 years after mining, followed by a gradual decline over 20 to 40 years. (OSM 2003)

2.5 START-2 ACTIONS

To obtain information about coal mining in the Bellingham/Lake Whatcom area, including the area of the Blue Canyon Mine, the START-2 reviewed numerous reports, maps, and other documents. In addition, the START-2 conducted interviews with representatives of federal, state, and local agencies; representatives of academic institutions; and owners or representatives of properties in the vicinity of the former coal mining activities. A list of these data sources for the Bellingham/Lake Whatcom Coal Mines PA/pre-CERCLIS screening project is provided in Appendix A.

START-2 actions also included visits to the site on January 21and 22, March 3, and July 1, 2004. Photographic documentation of the START-2 site visits is provided in Appendix B. Much of the area of the mine has been recently clear-cut. Brush and decaying vegetation cover much of the area.

Observations of historical mining features were therefore limited. Features observed during the initial site visits on January 21 and 22, 2004, are illustrated in Figure 2-3 and are described below:

- A mine portal (Portal A) is located at the base of the steep slope northeast of the unnamed intermittent drainage at an elevation of approximately 1,000 feet above mean sea level (amsl). The portal is collapsed, but recognizable as a mine portal based on the protrusion of parallel iron rails from the hillside and a small topographic depression at that location (Photographs 8 and 9, Appendix B). Other features at Portal A include a suspected waste rock pile approximately 20 feet in diameter and 8 feet tall situated where the rails protrude from the slope (Photograph 8, Appendix B). The pile locally contains black, coaly material beneath a surficial layer of decaying leaves and vegetation (Photograph 10, Appendix B). A relatively flat area located southeast of the pile and the unnamed intermittent drainage also locally contains black, coaly material. The extent of the coaly material was not determined due to the cover of live and decaying vegetation.

- A suspected portal (Portal B) is located approximately 150 feet southwest of Portal A at an approximate elevation of 1,000 feet amsl. Portal B appears to be a collapsed mine portal based on the slight topographic depression in the hillside and the presence of a small suspected waste rock pile near the suspected portal (Photograph 11, Appendix B). The pile is approximately 30 feet long, 20 feet wide, and up to 10 feet high. The pile is covered with vegetation and decaying leaves, and consists of black coaly rock fragments in a black matrix.

- A suspected collapsed portal (Portal C) is located along the northeast trending ridge between the unnamed intermittent drainage and Blue Canyon Creek at an elevation of approximately 1,120 feet amsl (Photograph 15, Appendix B). A flat bench lies immediately west of the suspected collapsed portal (Photograph 16, Appendix B). The bench appears to be a waste rock pile based on its morphology and the presence of coaly material at the surface. The shape of the pile is approximated by two contiguous wedges, one of which is approximately 20 feet wide, 30 feet long, and 20 feet high, and the other of which is approximately 20 feet wide, 20 feet tall, and 20 feet long. An apparent road bed contours along the hillside a short distance southeastward from the south side of the bench.

- A seep (Seep A) issues from the hillside approximately 50 feet southeast of the unnamed intermittent drainage that flows southwestward through the area of the mine (Photographs 2, 3, A-5, and A-6, Appendix B). The approximate elevation of the seep is 900 feet amsl. The seep is located in the general vicinity of Mine No. 5 as indicated in a historic map (WCCM 1914; Figure 2-2). The seep was visually estimated to flow at less than one cubic foot per second (cfs) on January 21, 2004. The seep flowed over an area of live and decaying vegetation for approximately 100 feet prior to entering the unnamed intermittent drainage. The seep contributed all of the flow in the unnamed drainage at this location; the drainage is dry upstream of the Seep A confluence. The bed of the drainage issuing from the seep contained yellowboy (Photograph 3, Appendix B), and the water exhibited a sulfur odor and a sheen locally. On January 21, 2004, START-2 tested the water with pH paper; the water had a pH greater than or equal to 6 (the pH paper

scale ranged from 0 to 6). Based on the combined observations described above, it is possible that Seep A originates at a collapsed mine portal.

- Another seep (Seep B) issues from an area of large sandstone blocks near the head of the unnamed intermittent drainage at an elevation of approximately 980 feet amsl (Photographs 6 and 7, Appendix B). On January 21, 2004, water issued from the seep at an estimated rate of less than one cfs, and did not exhibit an unusual odor or color. The START-2 tested the water with pH paper; the water had a pH greater than or equal to 6 (the pH paper scale ranged from 0 to 6). Based upon its location, it is possible that Seep B is associated with mine openings located in the general vicinity of the seep.

- Metal debris is present between Portals A and B, including a 4-foot length of 8-inch diameter iron pipe, a 10-foot length of iron rail, a 3-foot length of 8-inch diameter galvanized duct, and an iron frame for an unidentified piece of machinery (Photographs 4 and 5, Appendix B).

- A partially buried iron rail and 1.5-inch steel wire rope are present southeast of the unnamed intermittent drainage at an elevation of approximately 560 feet amsl (Photograph 13, Appendix B). The rail was likely part of the electric railroad between Mine No. 1 and the base of the tramways. The steel wire rope may have been part of one of the aerial tramways between the mine openings and the lower mine facilities. The wire rope appeared to trend toward the area of Portals A and B at this location.

- Partially buried 1.5-inch steel wire rope was also observed at a location approximately 250 feet south of Portal A at an elevation of approximately 960 feet amsl (Photograph 12, Appendix B). The wire rope trended generally northward toward Portal A at this location, and was apparently part of a former tramway.

- A possible former road bed located northwest of the unnamed intermittent drainage at an elevation of approximately 800 feet amsl was observed. A 4-foot length of 8-inch galvanized metal duct was found in the immediate vicinity, but no other signs of coal mining activity were observed.

- A gravel pad that likely was utilized during logging operations was observed south of the former mine features discussed above (Photograph 1, Appendix B).

On March 3, 2004, the START-2 returned to the Blue Canyon Mine accompanied by Ecology personnel to further evaluate the surface water drainages in the area and confirm the location of previous surface water sampling conducted as part of the joint Ecology/USGS/WCHD Lake Whatcom mercury study. Ecology personnel confirmed that the stream originating at Seep A is the same stream sampled during the Lake Whatcom mercury investigation (Hood 2004). Ecology collected a total of five surface water samples over the course of the study from the stream near its mouth into Lake Whatcom. As stated above, mercury was detected in these samples at concentrations as high as 0.017 µg/L (USGS 2004b;

Ecology 2004). START-2 measured pH and specific conductance of water at Seep A and several downstream locations with a Horiba U-10 water quality meter. The measured pH values of the water at Seep A, at a location approximately 80 feet downstream from Seep A, and at a location approximately 130 feet downstream of Seep A were 7.15, 7.38, and 7.88, respectively. The corresponding specific conductance values were 874, 834, and 866 microSiemens per centimeter, indicative of relatively high concentrations of total dissolved solids.

The presence of yellowboy in association with former coal mine features (Seep A is possibly a collapsed mine portal) at the Blue Canyon Mine suggests coal mine drainage conditions at the Blue Canyon Mine. Relatively high specific conductance values and sulfur odor at Seep A, possibly from sulfate, are consistent with possible coal mine drainage conditions at Seep A.

On July 1, 2004, START-2 returned to the site to perform limited sampling. START-2 was accompanied by Mr. Aubrey Stargell of Nielsen Brothers, Inc. Samples of sediment, soil, and coal/coaly waste rock were collected. Sample locations are illustrated in Figure 2-4. A source sample of coaly material (sample 04274050) was collected from the pile of coaly material located adjacent to collapsed Portal A (location BC01). A background soil sample (04274051) was collected from a location (location BC02) north and upslope of Portal A. Sediment samples were collected from Seep A (location BC04, sample 04274053), and from the unnamed stream both downstream (target location BC03, sample 04274052) and upstream (background location BC05, sample 04274054) of where Seep A discharges into the stream.

Samples were collected in accordance with the *Bellingham/Lake Whatcom Coal Mines Sampling and Quality Assurance Plan* (E & E 2004). Investigation-derived waste (IDW) generated during the sampling activities consisted of dedicated plastic scoops and bowls and personal protective equipment; IDW was disposed of at a municipal landfill. Each sample was analyzed for Target Analyte List metals and mercury following EPA Contract Laboratory Program (CLP) Statement of Work ILM05.3 (EPA 2004) by Bonner Analytical Testing Company of Hattiesburg, Mississippi, under the EPA CLP.

Analytical results of the soil and sediment samples are presented in Tables 2-1 and 2-2, respectively. Laboratory data forms are provided in Appendix C. Tables 2-1 and 2-2 show all analytes detected above laboratory detection limits in bold type. Analytical results were evaluated to determine whether contaminants were detected at significant concentrations in the source soil sample, or at elevated concentrations in the target sediment samples, with respect to background concentrations. For the purposes of this investigation, significant/elevated concentrations are those concentrations that are:

- Equal to or greater than the sample's Contract Required Quantitation Limit (CRQL) or the sample quantitation limit (SQL) when a non-CLP laboratory was used; and
- Equal to or greater than the background sample's CRQL or SQL when the background concentration is below detection limits; or
- At least three times greater than the background concentration when the background concentration equals or exceeds the detection limits.

Based on EPA Region 10 policy, evaluation of aluminum, calcium, iron, magnesium, potassium, and sodium (common earth crust metals) generally is employed in water mass tracing, which is beyond the scope of this report. For this reason, these elements are included in the summary tables, but are not discussed in the report text.

No hazardous substances were detected at significant/elevated concentrations in the source soil sample or target sediment samples.

Table 2-1

SURFACE SOIL SAMPLE ANALYTICAL RESULTS SUMMARY
BELLINGHAM/LAKE WHATCOM COAL MINES
BLUE CANYON MINE
PRELIMINARY ASSESSMENT
WHATCOM COUNTY, WASHINGTON

EPA Sample ID	**04274051**	**04274050**
CLP Inorganic ID	**MJ45M3**	**MJ45M2**
Station Location ID	**BC02**	**BC01**
Description	**Background Soil**	**Coal/Coaly Waste Rock**
TAL Metals (mg/kg)		
Aluminum	**19900**	**863**
Antimony	R	6.7 UJL
Arsenic	**4.4**	**5.9**
Barium	**82.9**	**67.3**
Beryllium	**0.76**	0.12 J
Cadmium	0.36 J	0.38 J
Calcium	**4100**	**1250**
Chromium	**28.2**	**4.5**
Cobalt	**7.9**	1.5 J
Copper	**15.2**	**10.5**
Iron	**18300**	**3130**
Lead	**8.9**	**10.7**
Magnesium	**5350**	272 J
Manganese	**339**	**88.6**
Mercury	0.60 U	**0.41**
Nickel	**27.1**	**5.0**
Potassium	**1990**	228 J
Selenium	4.2 U	1.2 J
Silver	1.2 U	1.1 U
Sodium	101 U	79.3 U
Thallium	2.2 J	2.8 U
Vanadium	**38.2**	**6.5**
Zinc	**45.5**	**33.6**

Note: Bold type indicates the sample result is above the detection limit.
Underlined type indicates the sample result is significant as defined in Section 2.

Key:

CLP	= Contract Laboratory Program.
EPA	= United States Environmental Protection Agency.
ID	= Identification.
J	= The associated value is an estimated quantity. The value is greater than the method detection limit, but less than the laboratory's quantitation limit.
L	= Low bias.
mg/kg	= Milligrams per kilogram.
R	= The data are unusable. The analyte may or may not be present in the sample.
TAL	= Target Analyte List.
U	= The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

Table 2-2

SEDIMENT SAMPLE ANALYTICAL RESULTS SUMMARY
BELLINGHAM/LAKE WHATCOM COAL MINES
BLUE CANYON MINE
PRELIMINARY ASSESSMENT
WHATCOM COUNTY, WASHINGTON

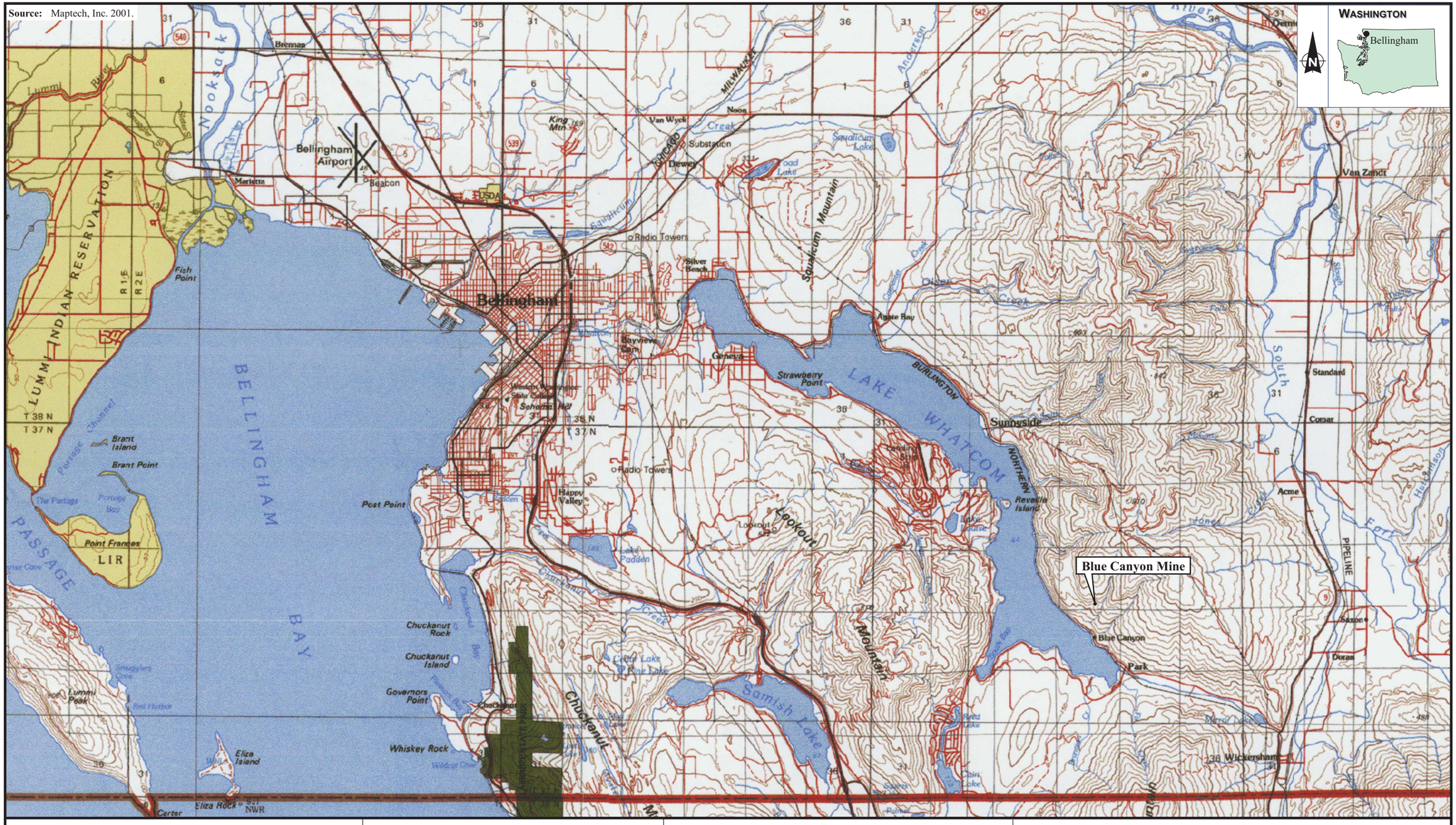
EPA Sample ID	04274054	04274053	04274052
CLP Inorganic ID	MJ45M6	MJ45M5	MJ45M4
Station Location ID	BC05	BC04	BC03
Description	Background Sediment	Seep Sediment	Downstream Sediment
TAL Metals (mg/kg)			
Aluminum	**17700**	**15700**	**14600**
Antimony	R	R	R
Arsenic	**7.7**	**8.6**	**3.7**
Barium	**152**	**137**	**144**
Beryllium	0.51 J	0.38 J	0.50 J
Cadmium	0.38 J	0.32 J	0.27 J
Calcium	**3200**	**3510**	**3740**
Chromium	**32.4**	**25.6**	**22.4**
Cobalt	**14.7**	**9.7**	**12.4**
Copper	**26.8**	**24.8**	**17.8**
Iron	**26400**	**41700**	**21200**
Lead	**8.7**	**5.8**	**5.3**
Magnesium	**6030**	**7650**	**5120**
Manganese	**595**	**416**	**563**
Mercury	0.56 U	0.79 U	0.75 U
Nickel	**34.4**	**32.5**	**30.2**
Potassium	**1130**	**1650**	**1500**
Selenium	1.3 J	3.8 J	1.3 J
Silver	1.1 U	1.6 U	1.5 U
Sodium	63.0 U	105 U	192 U
Thallium	2.2 J	2.7 J	2.5 J
Vanadium	**53.7**	**30.0**	**32.5**
Zinc	**75.5**	**67.1**	**49.3**

Note: Bold type indicates the sample result is above the detection limit.
Underlined type indicates the sample result is significant as defined in Section 2.

Key:

CLP = Contract Laboratory Program.
EPA = United States Environmental Protection Agency.
ID = Identification.
mg/kg = Milligrams per kilogram.
R = The data are unusable. The analyte may or may not be present in the sample.
TAL = Target Analyte List.
U = The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

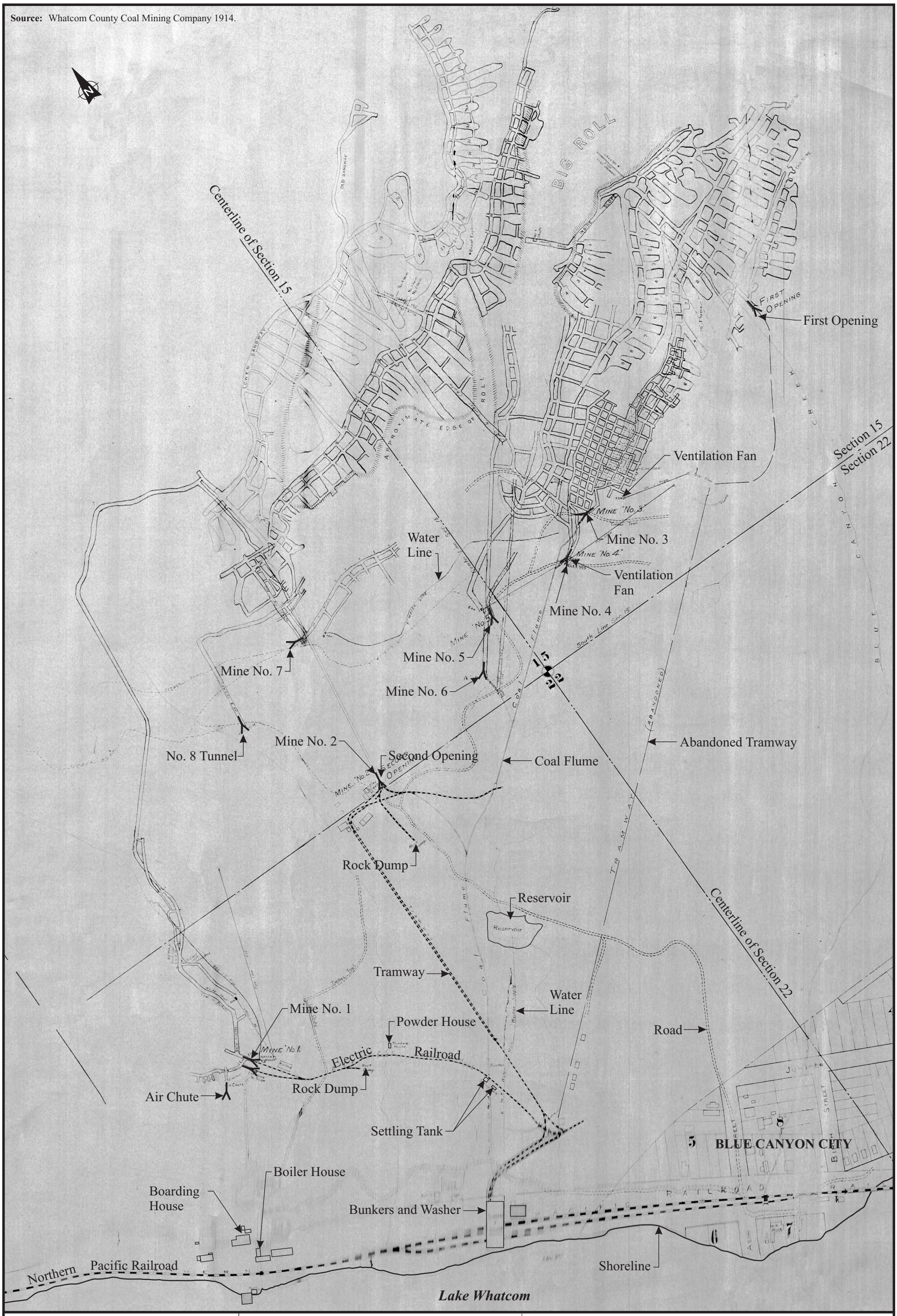
Source: Maptech, Inc. 2001.



ecology and environment, inc. International Specialists in the Environment Seattle, Washington	0 .75 1.5 Approximate Scale in Miles	BELLINGHAM/LAKE WHATCOM COAL MINES Whatcom County, Washington	Figure 2-1 SITE VICINITY MAP BLUE CANYON MINE

Date:	Drawn by:	
9/21/04	AES	10:START-2\03010002\fig 2-1

Source: Whatcom County Coal Mining Company 1914.



ecology and environment, inc. International Specialists in the Environment Seattle, Washington	BELLINGHAM/LAKE WHATCOM COAL MINES Whatcom County, Washington	Figure 2-2 HISTORIC MINE MAP BLUE CANYON MINE		
	0 130 260 Approximate Scale in Feet	Date: 9/21/04	Drawn by: AES	10:START-2\03-01-0002\fig 2-2

Source: Maptech, Inc. 2001.

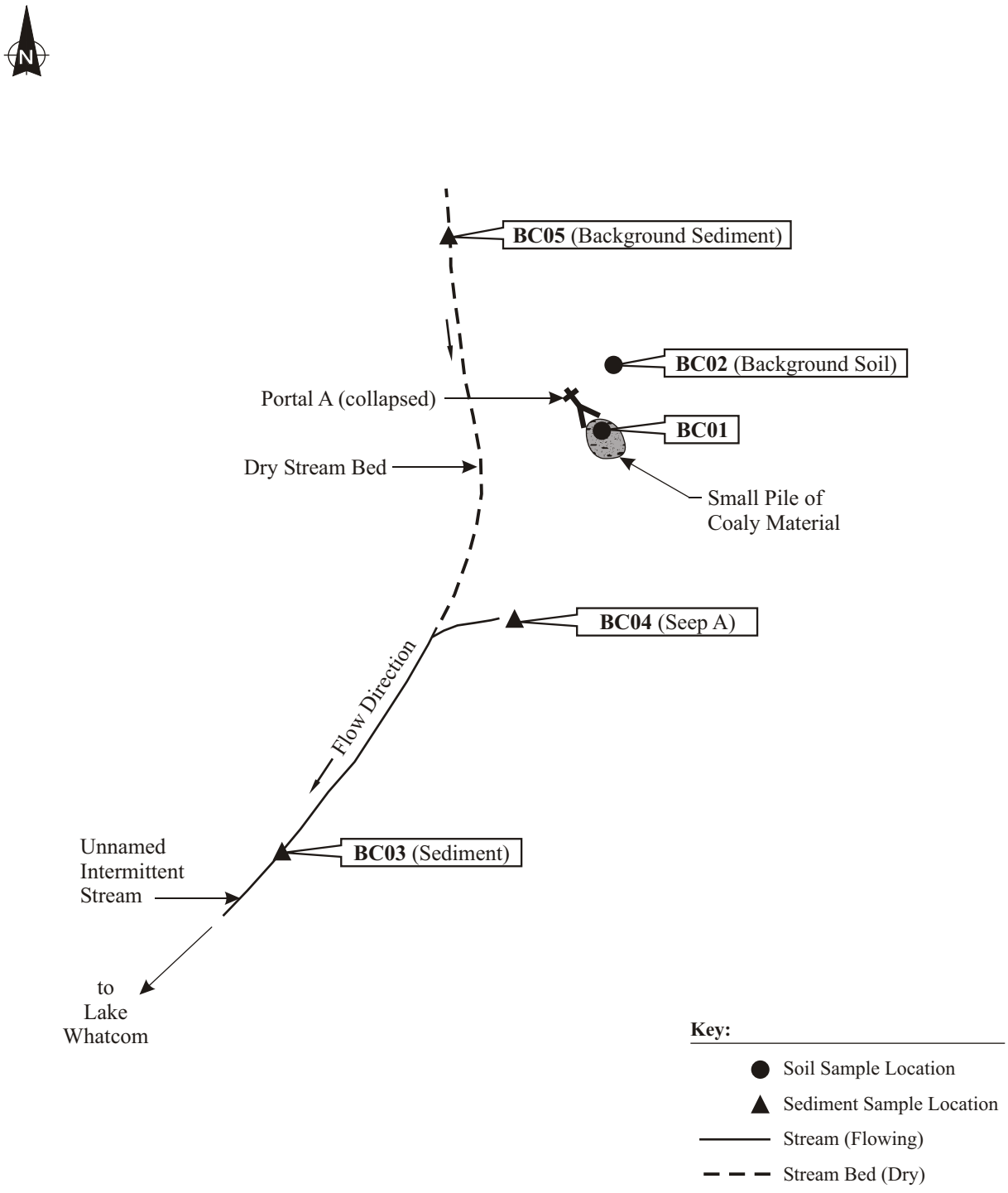
ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

0 300 600
Approximate Scale in Feet

BELLINGHAM/LAKE WHATCOM COAL MINES
Whatcom County, Washington

Figure 2-3
SITE MAP
BLUE CANYON MINE

Date:	Drawn by:	
9/21/04	AES	10:START-2\03-01-0002\fig 2-3



Note: Sample locations are approximate.

ecology and environment, inc. International Specialists in the Environment Seattle, Washington	BELLINGHAM/ LAKE WHATCOM COAL MINES Whatcom County, Washington	Figure 2-4 SAMPLE LOCATION MAP BLUE CANYON MINE		
	0 50 100 Approximate Scale in Feet	Date: 9-21-04	Drawn by: AES	10:START-2\03-01-0002\fig 2-4

3. MIGRATION/EXPOSURE PATHWAYS AND TARGETS

This section describes migration/exposure pathways and potential targets (or receptors) within the site's range of influence. This section addresses only the surface water migration pathway and potential targets within the site's range of influence. The groundwater migration, soil exposure, and air migration pathways have been excluded at this time per direction of the EPA Task Monitor because relatively few receptors have been identified for these pathways.

The surface water migration pathway target distance limit (TDL) begins at the probable point of entry (PPE) of surface water runoff from the site to a surface waterbody and extends downstream for 15 miles. Figure 3-1 depicts the surface water 15-mile TDL for Blue Canyon Mine.

Surface water in the vicinity of Blue Canyon Mine will enter an unnamed intermittent drainage and flow southwestward to the PPE at the mouth of the unnamed intermittent drainage in Lake Whatcom. The intermittent drainage is treated in this PA as a part of the overland pathway since the annual average precipitation in the area of the site is greater than 20 inches (WRCC 2004). The overland distances from potential source areas to the PPE vary from 2,000 feet for Seep A to approximately 2,360 feet for the waste rock pile associated with Portal C. All of Lake Whatcom is included within the surface water TDL. In addition, Whatcom Creek flows out of Lake Whatcom at the lake's northwestern end, approximately 9.1 miles from the PPE. The surface water pathway continues another 4.2 miles in Whatcom Creek until the creek empties into Bellingham Bay. The surface water TDL extends radially from the mouth of Whatcom Creek another 1.7 miles into Bellingham Bay.

START-2 estimates an average annual flow in Lake Whatcom of 15 cfs by combining the individual annual average flows for seven identified creeks that empty into Lake Whatcom and subtracting the average annual flow of Whatcom Creek. The seven creeks are: Carpenter Creek, Olsen Creek, Smith Creek, Anderson Creek, Brannian Creek, Silver Beach Creek, and Austin Creek. Whatcom Creek had an annual average flow rate of 88 cfs over 11 years of record between 1946 and 1968. (USGS 2003)

Potential source areas at the mine have no containment to prevent a release of hazardous substances to the surface water pathway. START-2 estimates the drainage area above and including the potential source areas at 80 acres (USGS 1994). Soils in the vicinity of the site consist mainly of Squires very channery loam with 30% to 60% slopes. These are moderately deep, well-drained soils that are

formed in a mixture of volcanic ash, loess, glacial till, and colluvium derived from phyllite. Permeability and available water capacity are moderate. Runoff is medium, and the hazard of water erosion is moderate (USDA 1992). The two-year, 24-hour probable maximum rainfall for the Bellingham area is 2.5 inches (NOAA 1973). START-2 assumes the potential sources of Blue Canyon Mine are not located within a floodplain given their elevations (greater than 400 feet) above Lake Whatcom and small width of the unnamed intermittent drainage.

Lake Whatcom is the drinking water source for the city of Bellingham. The city has a single water intake located in Lake Whatcom near the community of Geneva. The intake operates continuously through the year and supplies water to approximately 17,000 hook-ups (Evans 2003). The Whatcom County Water Resources Department estimates that 85,700 people obtain their drinking water through the public supply. In addition, another 250 residences draw their drinking water directly from the lake (Whatcom 2003). START-2 estimates that these 250 domestic intakes serve an additional 627.5 individuals (250 intakes multiplied by 2.51, the average number of persons per household for Whatcom County; DOC 2001). Therefore, the total count of individuals obtaining their drinking water from Lake Whatcom is 86,328.

Lake Whatcom is popular for boating, and therefore, is considered a major water recreation area. Sport fishing is also a popular activity in Lake Whatcom. The lake is a productive fishery for smallmouth and largemouth bass, kokanee, cutthroat trout, rainbow trout, mackinaw, and perch. However, the WDFW, the regulatory agency over sport fishing in the state of Washington, does not track harvest data in Lake Whatcom. Whatcom Creek also is fished, and the WDFW tracks the salmon harvest in the creek. During 1999, the most recent year of data, 672 salmon were harvested from Whatcom Creek for an estimated total harvest of 6,108 pounds (WDFW 2002; Wydoski and Whitney 1979). Lastly, Bellingham Bay also is fished for salmon. Bellingham Bay is part of the WDFW's statistical Area 7, which comprises the area of the Strait of Georgia. The 1999 harvest for salmon in statistical Area 7 was 86,753 pounds (WDFW 2002). START-2 estimates that the portion of the surface water TDL that lies within statistical Area 7 is approximately 1%. Therefore, 1% of the salmon harvest (865 pounds) from statistical Area 7 is assumed to occur in the surface water TDL. No Tribal or subsistence fisheries were identified in the TDL. Table 3-1 presents the harvest data by waterbody segment and fish type.

The following sensitive environments are located within the surface water pathway TDL:

- Lake Whatcom is a critical migratory pathway for anadromous fish (WDFW 2003a);
- Lake Whatcom has habitat known to be used by the bald eagle, *Haliaeetus leucocephalus*, a Federal-listed threatened species (WDFW 2003a);

- Bellingham Bay has habitat known to be used for the Steller sea lion, *Eumetopias jubatus*, a Federal-listed threatened species (WDFW 2003a);
- Lake Whatcom has State land designated for wildlife and game management of waterfowl (WDFW 2003a); and
- Whatcom Creek is a critical migratory pathway for anadromous fish (WDFW 2003b).

It is estimated from National Wetland Inventory maps that 0.69 miles of wetland frontage occur along the 15-mile surface water pathway TDL. Lake Whatcom has 0.27 mile of wetland frontage and Whatcom Creek has 0.42 mile of wetland frontage. No wetland frontage in Bellingham Bay is present within the 15-mile surface water TDL (USFWS 1997a, 1997b, 1997c, 1997d, 1997e, and 2001).

Table 3-1

FISH HARVEST WITHIN THE 15-MILE TARGET DISTANCE LIMIT
BELLINGHAM/LAKE WHATCOM COAL MINES
BLUE CANYON MINE
PRELIMINARY ASSESSMENT
WHATCOM COUNTY, WASHINGTON

Stream Segment	Fish Species	Number Harvested	Average Pound per Fish[a]	Pounds Harvested
Lake Whatcom	Small Mouth Bass	At least 1	At least 1	At least 1
	Large Mouth Bass	At least 1	At least 1	At least 1
	Kokanee	At least 1	At least 1	At least 1
	Cutthroat Trout	At least 1	At least 1	At least 1
	Rainbow Trout	At least 1	At least 1	At least 1
	Mackinaw	At least 1	At least 1	At least 1
	Perch	At least 1	At least 1	At least 1
Whatcom Creek	Chinook Salmon	6	22	132
	Chum Salmon	660	9	5,940
	Coho Salmon	3	8	24
	Pink Salmon	3	4	12
Bellingham Bay	Chinook Salmon	34	22	748
	Coho Salmon	5	8	40
	Pink Salmon	18	4	72
	Sockeye Salmon	1	5	5
	Total	**At least 737**		**At least 6,980**

Source: WDFW 2002.

[a] Average pound per fish gathered from Wydoski and Whitney 1979.

Source: Maptech, Inc. 2001.

15-Mile Target Distance Limit

Blue Canyon Mine

Probable Point of Entry

ecology and environment, inc. International Specialists in the Environment Seattle, Washington	0 .75 1.5 Approximate Scale in Miles	BELLINGHAM/LAKE WHATCOM COAL MINES Whatcom County, Washington	Figure 3-1 15-MILE MAP BLUE CANYON MINE
			Date: 9/21/04 | Drawn by: AES | 10:START-2\03010002\fig 3-1

4. CONCLUSIONS

The Blue Canyon Mine is an abandoned coal mine that operated between 1891 and 1919 (Moen 1969), and in 1933 (Vonheeder 1975). The mine was the second largest coal mine in Whatcom County. Details of the abandonment of the mine are not known. Based upon available information, it is likely that the mine portals collapsed soon after major mining activities ceased (Jenkins 1923). In spite of the size of the mine, little physical evidence of the coal mine remains, due to fire, decay, overgrowth, landsliding, and a 1983 debris flow. START-2 identified several mine features during site visits, including suspected collapsed portals, abandoned equipment, coaly waste rock, and drainage from a suspected collapsed portal. It is possible that coal mine drainage conditions exist at the Blue Canyon Mine, and that constituents of the drainage include trace metals. No evidence of dumping was observed at the surface. No contaminants were detected in the source soil sample or target sediment samples at significant/elevated concentrations.

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APPENDIX A
PROJECT DATA SOURCES

PROJECT DATA SOURCES:

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RESEARCH FACILITY CONTACTS

Bellingham Public Library
210 Central Avenue
Bellingham, Washington 98225
Margaret Ziegler, Reference Librarian

Center for Pacific Northwest Studies/Washington State Archives: Northwest Regional Branch
Goltz-Murray Archives Building
Western Washington University
Bellingham, Washington 98225-9123

Washington State Department of Natural Resources
Division of Geology and Earth Resources
1111 Washington Street SE, Room 148
P.O. Box 47007
Olympia, Washington 98504-7007

APPENDIX B

PHOTOGRAPHIC DOCUMENTATION

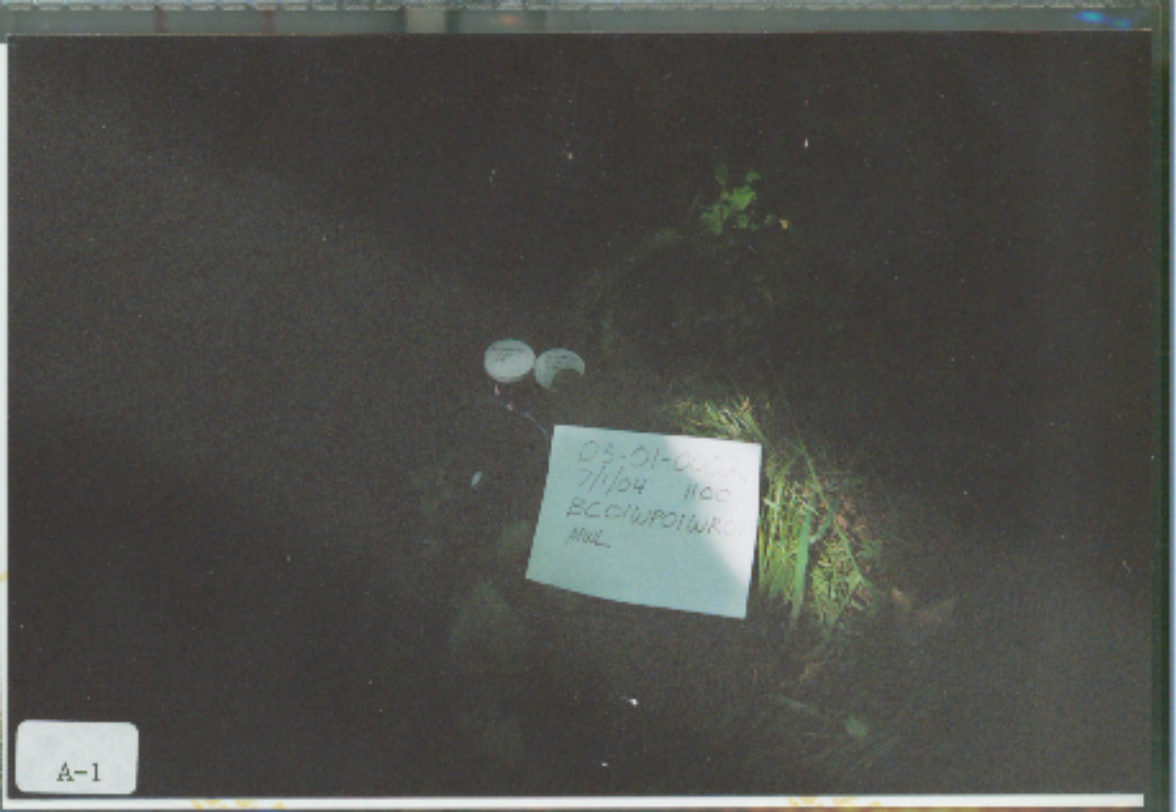
PHOTOGRAPH IDENTIFICATION SHEET

Cameras: **TDD No. 03-01-0002**
Canon AiAF Powershot A70 Digital Camera (Photographs 1 to 19)
Kodak Max HQ Flash reusable camera (Photographs A-1 to A-7) Site Name: Blue Canyon Mine
Lens Type: 35 mm

Photo	Time	Date	By	DIR.	Description
1	0927	1/21/04	ML	N	BM on gravel pad.
2	1330	1/21/04	ML	N	Seep A (right of logbook). Backpack and logbook for scale.
3	1332	1/21/04	ML	W	Pool 30 feet downstream of Seep A with yellowboy.
4	1335	1/21/04	ML	Down	Metal debris.
5	1356	1/21/04	ML	Down	Metal frame.
6	1410	1/21/04	ML	N	BM near Seep B.
7	1412	1/21/04	ML	Down	Stream approximately 10 feet downstream of Seep B.
8	1435	1/21/04	ML	SW	Iron rails and small suspected waste rock pile at collapsed Portal A.
9	1436	1/21/04	ML	N	Iron rail and collapsed Portal A.
10	1438	1/21/04	ML	Down	Coaly material at suspected waste rock pile near collapsed Portal A, logbook for scale.
11	1535	1/21/04	ML	N	BM at suspected collapsed Portal B.
12	0910	1/22/04	ML	Down	Steel wire rope.
13	0920	1/22/04	ML	Down	Iron rail and steel wire rope.
14	1222	1/22/04	ML	Down	Coaly material at suspected waste rock pile near Portal A.
15	1245	1/22/04	ML	N	BM at topographic depression, suspected collapsed Portal C.
16	1250	1/22/04	ML	S	BM at bench near suspected collapsed Portal C.
17	1355	1/22/04	ML	N	Blue Canyon Creek.
18	1412	1/22/04	ML		BM testing pH of Blue Canyon Creek.
19	1415	1/22/04	ML	N	BM attempting to survey GPS location at Blue Canyon Creek.
A-1	1110	7/1/04	ML	Down	BC01WP01WR01 sample location.
A-2	1111	7/1/04	ML	SW	Suspected collapsed Portal A and sample BC01WP01WR01 location.
A-3	1135	7/1/04	ML	Down	BC02BG01SS01 sample.
A-4	1220	7/1/04	ML	Down	BC03DG01SD01 sample. Mixed sun and shade.
A-5	1300	7/1/04	ML	Down	BC04SP01SD01 sample.
A-6	1301	7/1/04	ML	NE	BC04 location.
A-7	1338	7/1/04	ML	Down	BC05DG02SD01 sample.

Key:

BM	= Ben Martich
ML	= Mark Longtine
E	= East.
N	= North.
S	= South.
TDD	= Technical Direction Document.
W	= West.



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BELLINGHAM COAL MINE PAS
Whatcom County, Washington

Photo 1

Photo 2

BELLINGHAM COAL MINE PAS
Whatcom County, Washington

Photo 3

Photo 4

BELLINGHAM COAL MINE PAS
Whatcom County, Washington

Photo 5

Photo 6

BELLINGHAM COAL MINE PAS
Whatcom County, Washington

Photo 7

Photo 8

BELLINGHAM COAL MINE PAS
Whatcom County, Washington

Photo 9

Photo 10

Photo 11

Photo 12

BELLINGHAM COAL MINE PAS
Whatcom County, Washington

Photo 13

Photo 14

BELLINGHAM COAL MINE PAS
Whatcom County, Washington

Photo 15

Photo 16

Photo 17

Photo 18

Photo 19