Inventory, Characterization, and Water Quality of Springs, Seeps, and Streams near Midnite Mine, Stevens County, Washington

By Kenneth C. Ames, Noah P. Matson, Debra M. Suzuki, and Peter B. Sak

---

U.S. GEOLOGICAL SURVEY

Open-File Report 96-115

Prepared in cooperation with
U.S. BUREAU OF MINES

Tacoma, Washington
1996

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Gordon P. Eaton, Director

For additional information write to:

District Chief
U.S. Geological Survey
1201 Pacific Avenue, Suite 600
Tacoma, Washington 98402

Copies of this report may be purchased from:

U.S. Geological Survey
Earth Science Information Center
Open-File Reports Section
Box 25286, MS 517
Denver Federal Center
Denver, CO 80225

CONTENTS

FIGURES

TABLES

CONVERSION FACTORS

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
acre	4,047	square meter
gallon (gal)	3.785	liter
cubic foot per second (ft^3/s)	0.02832	cubic meter per second

Inventory, Characterization, and Water Quality of Springs, Seeps, and Streams near Midnite Mine, Stevens County, Washington

By Kenneth C. Ames, Noah P. Matson, Debra M. Suzuki, and Peter B. Sak

ABSTRACT

In 1995, the U. S. Geological Survey, in cooperation with the U.S. Bureau of Mines, collected data on water bodies in basins adjacent to or near Midnite Mine, an inactive uranium mine located on the Spokane Indian Reservation, in Stevens County, Washington. There are no data describing the quantity or quality of ground water within the minesite prior to mining activity or within basins adjacent to or near Midnite Mine that were unaffected by mining activity. As a result, it has been difficult to assess the effectiveness of reclamation activities. This study included an inventory and characterization of springs, seeps, streams, and boreholes in parts of the Sand Creek and Blue Creek Basins that were not influenced by activities at Midnite Mine, and the collection of water-quality samples during baseflow conditions from selected sites. The geologic settings, and hence the water chemistry, of the basins also were similar to those of Midnite Mine, so the collected data could be compared to data from the Midnite Mine drainage basin.

Thirty-two bodies of water were identified and characterized during the first field trip in June and early July 1995, and included 11 springs, 15 seeps, 2 streams, and 4 boreholes. Most sites were located within nine drainages, where the vegetation was dense. The quantity of water available decreased greatly by the second field trip (late July 1995). As a result, 24 environmental and 5 quality-assurance samples were collected during the first field trip, and 10 environmental and 1 quality-assurance samples were collected during the second field trip.

The concentrations of 16 selected radiochemical constituents were determined primarily by alpha spectrometry, and a gamma scan was used to determine 14 additional radionuclides. The isotopic ratios of hydrogen and oxygen also were determined, and concentrations of various trace elements and common constituents were determined by standard methods.

Concentrations of most radiochemical constituents were generally small, and many concentrations were less than their respective precision estimates. Yet, concentrations of suspended radium-226, uranium-234, and uranium-238 were large in some samples, all with maximum concentrations greater than 500 picocuries per liter. Trace element concentrations were generally small, and most were below the laboratory reporting limits.

The water samples collected generally had a near-neutral pH. The hardness as calcium carbonate of most samples was below 120 milligrams per liter. The total dissolved solids were also quite small, with a median concentration of 119 milligrams per liter. Silica, calcium, and bicarbonate (measured as alkalinity) were the predominant minerals contributing to the dissolved solids; however, magnesium, sodium, sulfate, and iron were major constituents in some samples.

INTRODUCTION

Midnite Mine is an inactive open-pit uranium mine, located within the Spokane Indian Reservation, Stevens County, Washington, about 40 miles northwest of Spokane (fig. 1). Approximately 900 acres were leased from the Spokane Indian Tribe by Dawn Mining Company, of which 321 acres were developed for uranium mining (Marcy and others, 1994). The U.S. Bureau of Mines (USBM), the Bureau of Indian Affairs (BIA), and the Bureau of Land Management (BLM) are concerned about the quality of ground water within the minesite and the effects that water migrating from the minesite might have on the quality of ground and surface waters in surrounding basins. However, there were no pre-mining data for the quality of ground water within the minesite or within the basins adjacent to or near Midnite Mine. Thus, it has been difficult for the USBM, BIA, and BLM to assess the effectiveness of reclamation activities or to guide efforts to return the minesite to pre-mining conditions.

Background

In 1954, uranium was discovered at the minesite and operations at Midnite Mine began in 1956; mining continued until 1982 (Sumioka, 1991). Since then, the BIA and BLM have been planning the reclamation of areas disturbed by mining. Ground and surface waters from within the mined area are being held in a retention pond at the down-gradient boundary of the mine and in two unused pits (3 and 4), and various on-site water-treatment technologies are being tested. Approximately two and one-half million tons of unprocessed ore, waste material, and protore remain on-site (Sumioka, 1991).

The oxidation of sulfide minerals in pits 3 and 4 and in the retention pond has resulted in acidic waters at Midnite Mine. As a result, large quantities of metals, including radium and uranium, have been leached from the ore body and overburden and concentrated in the ground waters and surface waters of the mine (Marcy and others, 1994). Therefore, a thorough understanding of the hydrogeology and hydrochemistry at Midnite Mine and in the basins adjacent to or near Midnite Mine is needed to guide reclamation activities. The USBM designed and began operation of a well monitoring network at the minesite in 1988 to assess the quality of the ground water and to define ground-water flow patterns there (Marcy and others, 1994). This effort continued through 1995, and in 1996 the BIA will assume responsibility for the Midnite Mine ground-water monitoring program.

In 1994, a cooperative effort between the U.S. Geological Survey (USGS) and the USBM was initiated to assess the quality of ground water in areas surrounding Midnite Mine that were not influenced by mining activity. To do this, samples were collected by the USGS from springs, seeps, streams, and four boreholes in basins adjacent to or near Midnite Mine during baseflow conditions in the summer of 1995.

Purpose and Scope

The purpose of this report is to present the data collected during the summer of 1995 from springs, seeps, streams, and boreholes in basins adjacent to or near Midnite Mine. The geologic settings of these basins, and hence the water chemistry, also were similar to those of Midnite Mine, so collected data could be compared to data from Midnite Mine. Data were collected from parts of the Sand Creek and Blue Creek drainage basins and include an inventory and characterization of springs, seeps, and streams, and the determination of the concentrations of various common constituents, trace metals, and radiochemical constituents for selected water samples collected. From a reconnaissance of 10 main drainages in the study area, 32 sites were identified. Thirty-four environmental and 6 quality-assurance samples, for a total of 40 samples, were collected from as many as 24 sites during 2 field trips. The first field trip took place during June 1995 and continued through early July; the second field trip took place during the latter part of July 1995.

Study Area and Locations of Springs, Seeps, and Streams

The study area consisted of approximately 8 square miles surrounding the Midnite Mine drainage basin (fig. 2), and is located within the Sand Creek and Blue Creek drainage basins. Sand Creek borders the study area to the north and west, and Blue Creek borders it to the south and east. Ten drainages were identified within these borders, and springs and seeps were identified in 9 of the 10. However, most springs and seeps identified were located within three drainages in the southeastern part of the study area.

The study area has a continental climate, with warm, dry summers and moderately moist, cold winters. Precipitation at Wellpinit, approximately 5 miles east of the study area, had a mean annual precipitation of 19.4 inches from 1951 to 1980 (U.S. Department of Commerce, 1983).

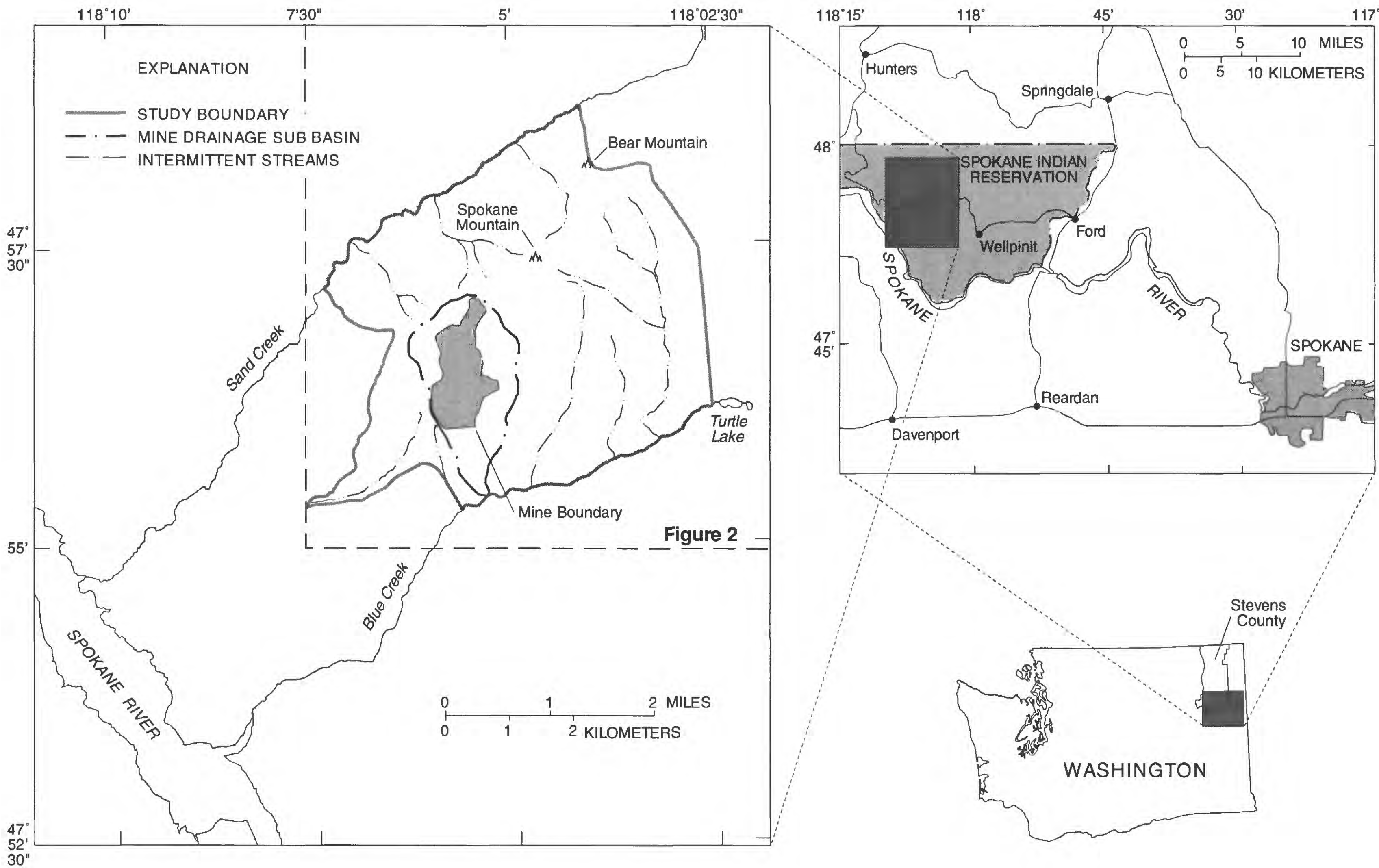

Figure 1.--Location of Midnite Mine and study area.

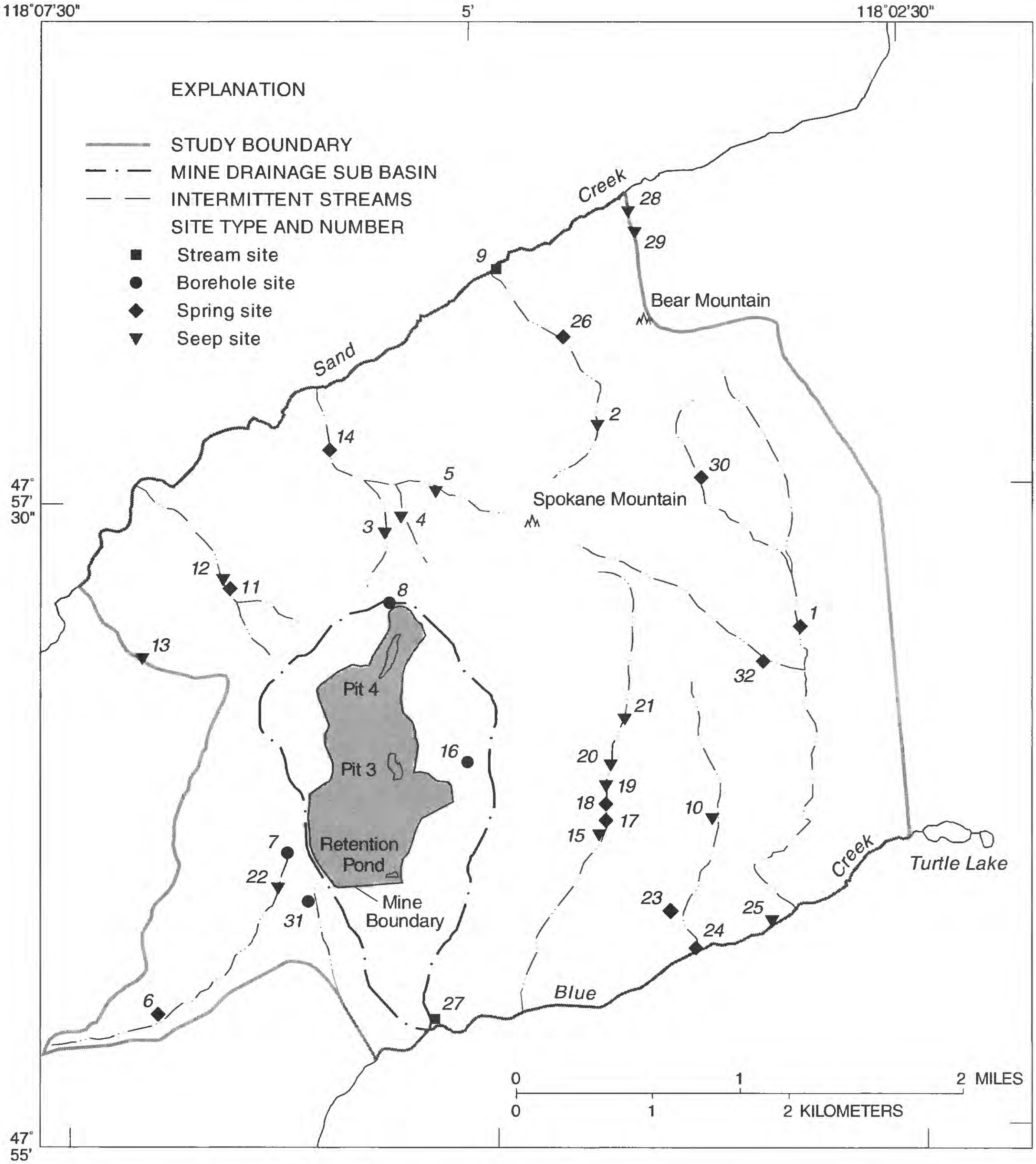

Figure 2.--Location of sites within the study area.

However, the spring of 1995 proved to be unusually wet, and the quantity of precipitation at Midnite Mine between January and June was almost equal to the quantity usually received over the course of an entire year. Although some snowfall may have not been recorded, the quantity of measurable precipitation at Midnite Mine from January to June 1995 was 13.73 inches (D. Seymour, Bureau of Land Management, Portland, Oreg., written comm., 1995). In addition, record high discharge at Blue Creek above Midnite Mine drainage (USGS station 12433542) was recorded during the spring of 1995, with instantaneous measurements exceeding 30 ft^3/s (cubic feet per second) (W. Taylor, U.S. Geological Survey, Spokane, Wash., written comm., 1995).

The altitude within the study area ranges from 2,070 feet at USGS station 12433542 to 3,869 feet at the top of Spokane Mountain. The land surrounding Midnite Mine is used primarily as rangeland for cattle and it supports resident populations of deer and elk (Sumioka, 1991). Vegetation in the study area is primarily ponderosa pine, bluebunch wheat grass, snowberry, and spirea (Sumioka, 1991), but Douglas fir and western larch also are abundant in the northwestern part of the study area, and maple is abundant in the drainages.

Geology

The study area is located on the western limb of the north striking, east vergent overturned Deer Trail Anticlinorium, and lies along the contact between the Togo formation (a Precambrian roof pendant) and the Loon Lake Granite (Becraft and Weis, 1963; Nash, 1977; Robbins, 1978; Fleshman and Dodd, 1982). Fleshman and Dodd (1982) later classified the Loon Lake Granite as a Late Cretaceous porphyritic quartz monzonite. The Loon Lake unit is exposed on the west side of Midnite Mine, in the locality of pits 3 and 4 (Fleshman and Dodd, 1982).

In the vicinity of Midnite Mine, the Togo formation is approximately 2,700 feet thick and consists of a thinly bedded slaty argillite and phyllite with discontinuous lenses of dolomitic marbles, calc-silicates, and quartzite, grading upward into a medium-grained, well cemented quartzite (Fleshman and Dodd, 1982). Metasomatic reactions within the Togo formation, associated with the emplacement of the quartz monzonite in the Late Cretaceous, resulted in the genesis of uranium ore bodies. Along the contact between the Togo formation and the quartz monzonite, uranium ore bodies (up to 55 feet wide, 1,100 feet long, and 140 feet thick) lie within 285 feet of the present-day land surface (U.S. Bureau of Mines, 1994).

During the Eocene, all of the units were intruded by felsic to intermediate composition Sanpoil-volcanics feeder dikes (Fleshman and Dodd, 1982). The topography of the region was shaped by several glacial advances during the Pleistocene (Robbins, 1978), resulting in Quaternary deposits that are up to 30 feet thick in the vicinity of Spokane Mountain.

Acknowledgments

The authors express their appreciation to Donna Bruce of the BIA for her assistance and for the use of the Land Operation Facilities in Wellpinit. The authors also recognize the significant contributions made to this project in the field by Robert Dryznkowski, Janel Martin, Greg Perry, Daryl Slawnikowski, and William Taylor of the USGS. Ann Mullin of the USGS National Water Quality Laboratory provided exceptional analytical support. Barbara Williams of the USBM and Kelly Courtright of BLM contributed to the study design. Connie Dean of the USGS provided support with the data-base management.

METHODS

This chapter presents the processes used to inventory and characterize springs, seeps, and streams; the procedures used to collect and process water samples; and the individual laboratory methods used to determine values and concentrations of common constituents, trace metals, and radiochemical constituents.

Site Inventory

All water bodies identified in the study area were field located in June 1995, and are on the USGS Turtle Lake 7.5-minute quadrangle. The latitude, longitude, and altitude of each water body were determined with either a geographical positioning system receiver or a USGS topographic map. The type of water body (spring, seep, or stream), the physical setting, and the predominant vegetation were characterized for each site. For this study, springs were defined as bodies of water where flow was concentrated, constituting the source of a small stream, whereas seeps were defined as bodies of water that displayed no concentrated flow (Linsley and others, 1986).

Sample Collection and Processing

Thirty-four environmental samples were collected from springs, seeps, streams, and boreholes during two field trips in June and July, 1995. Water-quality samples were collected during two field trips, to distinguish between higher and lower baseflows. The quantity of water at each of the collection sites decreased greatly between the first and second field trips and, as a result, the number of environmental samples collected and processed also decreased from 24 to 10 samples. During the first field trip, samples were collected from 8 springs, 10 seeps, 2 streams (Sand Creek and Blue Creek), and 4 boreholes. During the second field trip, samples were collected from two springs, three seeps, three boreholes, and two streams.

Most of the collection sites were too remote to readily maneuver the water-quality processing vehicle to each site, so all samples were collected in 5-gallon plastic buckets and transported to a central processing location at the BIA facilities in Wellpinit. The plastic buckets were rinsed with native water at each site prior to sample collection. Four-inch diameter plastic pipes, cut lengthwise in half and pointed at one end, were used to channel flow from the springs into the plastic buckets. The pipes were cleaned and rinsed with 5 percent (by volume) hydrochloric acid and de-ionized water prior to installation.

Shallow wells were installed at 10 seeps and consisted of 6-inch diameter plastic pipes, 6 to 8 feet in length, with 25 slots cut on opposite sides of the pipe from about 1.5 inches above the bottom of the pipe to about 18 inches above the bottom. A slip cap was placed at the bottom and top of each pipe, and the pipes were placed into the ground with about 2 feet of pipe remaining aboveground. Samples from the wells were collected with handheld piston pumps into the plastic collection buckets.

Samples were collected from Sand Creek and Blue Creek at equal-width increments across the streams, with the same vertical transit rate at each increment. Because the channels were too shallow to use a DH-81 sampler (a 1-liter sample bottle with a 5/16-inch diameter nozzle opening) during either field trip, a handheld 1-liter polyethylene bottle was used.

Samples from boreholes were usually collected with a portable Grundfos Redi-Flo2 model low-discharge submersible pump with Teflon tubing. Approximately three borehole volumes of water were evacuated at each site before samples were collected, usually with a purge time of less than 30 minutes. A handheld pump was used during the first field trip to collect water from the borehole at site 16.

After collection, the samples were transferred from the plastic buckets to an 18-liter churn splitter, which was rinsed with the sample water prior to sample transfer. An ultraclean water processing protocol, outlined by Horowitz and others (1994), was used to prepare all sample aliquots. Minor modifications to the protocol were made to adapt to existing field conditions. Unfiltered water samples were prepared for the subsequent determinations of total concentrations of aluminum, cadmium, copper, manganese, zinc, and sodium, suspended solids, chemical oxygen demand (COD), and the isotopic ratios of hydrogen (δD) and oxygen ($\delta^{18}O$).

Once the unfiltered samples were prepared, a peristaltic pump transferred water from the churn splitter through a 0.45 micrometer capsule filter. Filtered water samples were prepared for the subsequent determinations of dissolved concentrations of calcium, magnesium, sodium, silica, cadmium, copper, nickel, strontium, iron, manganese, zinc, barium, lead, molybdenum, vanadium, beryllium, lithium, chromium, silver, selenium, potassium, arsenic, mercury, sulfate, chloride, fluoride, dissolved solids, nitrite-nitrogen, ammonia-nitrogen, and phosphate. The metals samples were subsequently acidified; the nitrite, ammonia, and phosphate samples were chilled. Thirteen liters of sample water were also filtered to determine concentrations of dissolved radium-226, radium-228, uranium-234, uranium-235, uranium-238, thorium-230, polonium-210, lead-210, gross gamma, gross alpha, and gross beta. For most samples, 1 gram of suspended sediment was collected on a 0.45 micrometer ashless pancake filter, to determine concentrations of suspended radium-226, uranium-234, uranium-235, and uranium-238.

Laboratory Methods

Although the concentrations of most common constituents and trace elements were determined by atomic absorption spectrometry or inductively-coupled plasma emission spectrometry (ICPES), other methods were used as well: colorimetric means (for phosphorous and nitrogen); the ion-selective electrode electrometric method (for fluoride); and ion chromatography (for chloride and sulfate).

The total concentrations of cadmium, copper, manganese, and zinc were determined by direct atomic absorption spectrometry. A sample was digested with hot hydrochloric acid, filtered to remove particulate matter, and subsequently introduced directly into a flame to vaporize it (Fishman and Friedman, 1989). Concentrations of dissolved arsenic were determined by hydride-generation atomic absorption spectrometry (HGAAS). The gaseous hydride of arsenic was formed and stripped from a sample prior to analysis by HGAAS; as a result, other constituents in the sample that might interfere with the arsenic spectra were removed (Timme, 1994). Concentrations of mercury were determined by cold-vapor atomic absorption spectrometry. The mercury was chemically reduced, removed from the sample, and then fed by a room-temperature carrier gas into a cell for analysis (Fishman and Friedman, 1989; Timme, 1994).

Dissolved concentrations of calcium, magnesium, sodium, silica, barium, iron, manganese, beryllium, cadmium, chromium, cobalt, copper, lead, lithium, molybdenum, nickel, silver, strontium, and zinc were determined by ICPES. The samples were filtered, acidified, and then aspirated into an induction-coupled argon plasma (Fishman and Friedman, 1989). Dissolved and total concentrations of aluminum were determined by a direct-current plasma method, which is similar to ICPES except that direct-current argon plasma was used as an excitation source (Fishman and Friedman, 1989).

Water samples were tested for 16 radiochemical constituents, including gross alpha and gross beta (dissolved), radon-222 (dissolved), radium-226 (dissolved and suspended), radium-228 (dissolved), uranium-234 (dissolved and suspended), uranium-235 (dissolved and suspended), uranium-238 (dissolved and suspended), lead-210 (dissolved), polonium-210 (dissolved), thorium-230 (dissolved), and thorium-232 (dissolved). Gross alpha and beta radioactivity were measured and reported as equivalent activities of natural uranium, strontium-90, yttrium-90, cesium-137, and thorium-230 (Thatcher and others, 1977). A gamma scan also was used to determine the dissolved concentrations of radium-226, radium-228, uranium-234, uranium-235, uranium-238, and 14 additional radionuclides. These analyses were performed by Quanterra Environmental Services in Richland, Wash.; gross alpha, gross beta, and radon-222 analyses were determined by the USGS National Water Quality Laboratory (NWQL) in Arvada, Colo. Values of δD and $\delta^{18}O$ also were determined by NWQL.

The concentrations of uranium-234 (dissolved and suspended), uranium-235 (dissolved and suspended), uranium-238 (dissolved and suspended), polonium-210 (dissolved), thorium-230 (dissolved), and thorium-232 (dissolved) were determined by alpha spectrometry. The constituents were separated from the water sample and electrodeposited as thin layers on metal disks (Thatcher and others, 1977). The activities of the constituents were then measured by a silicon surface-barrier detector, which resolved all of the peaks of interest. To determine the concentrations of the remaining constituents, the nuclides were isolated by precipitation and other separation methods (ion exchange, emanation, and extraction) and were then analyzed with a low-background counter (Thatcher and others, 1977).

Concentrations of radon-222 were determined with a liquid scintillation process (Pritchard and others, 1980). A syringe was used to withdraw water from a sample, the water was subsequently injected into a vial beneath a mineral-oil-based liquid scintillation mixture (in which radon is highly soluble) (American Society for Testing and Materials, 1995). After capping and shaking the vial to promote the transfer of the radon-222 to the scintillation phase, the vial was allowed to stand for approximately 3 hours. The liquid scintillation mixture was then withdrawn from the vial and analyzed by a liquid scintillation counter to determine the activity of radon-222.

The ratios of the isotopes of hydrogen and oxygen were given as δD and $\delta^{18}O$, in which:

$$\delta = \frac{R_{sample} - R_{VSMOW}}{R_{VSMOW}} \times \frac{\delta^{\circ}_{SLAP}}{\frac{R_{SLAP} - R_{VSMOW}}{R_{VSMOW}}} \quad (1)$$

where $R = \frac{D}{H}$ and $\frac{^{18}O}{^{16}O}$, respectively (Coplen and others, 1991; Gat and Gonfiantini, 1981). The results were reported relative to Vienna Standard Mean Ocean Water (VSMOW) and normalized on the Standard Light Antarctic Precipitation (SLAP) scales (Gat and Gonfiantini, 1981). The ratios of D to H in the water samples were determined by mixing hydrogen gas of a known isotopic composition with the water sample. The mixture was allowed to undergo isotopic exchange in an air bath until equilibrium was reached (Coplen and others, 1991). An aliquot was then withdrawn from the mixture and the abundance of D and H were determined with a mass spectrometer. The ratios of ^{18}O to ^{16}O were determined similarly to hydrogen, except that carbon dioxide was used instead of hydrogen gas (Epstein and Mayeda, 1953).

INVENTORY AND CHARACTERIZATION OF SPRINGS, SEEPS, AND STREAMS

An inventory and characterization of springs, seeps, and streams in parts of the Sand Creek and Blue Creek Basins provided data that could be compared to data from the Midnite Mine drainage basin. Thirty-two bodies of water, not influenced by activities at the minesite, were identified within the study area and included 11 springs, 15 seeps, 2 streams, and 4 boreholes and are listed in table 1. The locations are shown in figure 2. Most sites were located within nine drainages, where the vegetation was generally dense. The quantity of water available at each of the sites decreased between the two field trips. For example, the discharge of Blue Creek above Midnite Mine drainage was approximately 2.5 ft^3/s during the first field trip, but had decreased to less than 1 ft^3/s during the second field trip. As a result, fewer samples were collected during the second field trip than during the first field trip. A brief description of each site is given in appendix A.

QUALITY OF WATER FROM SPRINGS, SEEPS, AND STREAMS

This chapter discusses the values and concentrations of various common constituents, trace elements, and radiochemical constituents determined for water samples collected from as many as 24 sites in basins adjacent to or near Midnite Mine during 2 field trips in 1995. The concentrations of most common constituents, trace elements, and radiochemical constituents were near or below the laboratory detection levels (tables B1 to B3). The minimum, median, and maximum concentrations of selected common constituents and all trace elements and radiochemical constituents determined are presented in tables 2 to 4.

Common Constituents

The water samples generally had a near-neutral pH, with a median value of 7.0 (table 2); only one sample (number 950726-07) had a field pH less than 6.5. The hardness of the water samples was generally below 120 mg/L (milligrams per liter) as calcium carbonate. Therefore, most water samples are considered soft or moderately hard, using the classification scheme shown below (Hem, 1992). Samples 950630-31 and 950726-31 (both from site 31), with concentrations larger than 180 mg/L, were very hard.

Hardness range (mg/L of $CaCO_3$)	Description
0-60	Soft.
61-120	Moderately hard.
121-180	Hard.
More than 180	Very hard.

Concentrations of dissolved solids were generally small, with a median concentration of 116 mg/L and a maximum concentration of 326 mg/L (table 2). Silica and calcium contributed most to the dissolved solids; median concentrations of dissolved silica and calcium were 40 and 14 mg/L, respectively. The median alkalinity concentration of 52 mg/L and the pH levels observed indicate that bicarbonate is a predominant mineral in the water. Magnesium, sodium, sulfate, and iron were major constituents in some samples. For example, dissolved sulfate was a major constituent in sample number 950726-31, with a concentration of 100 mg/L. However, the median concentrations of magnesium, sodium, sulfate, and iron were small compared with median concentrations of silica and calcium; median concentrations of magnesium, sodium, sulfate, and iron were 3.6 mg/L, 7.8 mg/L, 4.6 mg/L, and 110 µg/L (micrograms per liter), respectively. Concentrations of dissolved chloride, fluoride, aluminum, barium, iron, and manganese were generally too small to be considered as major constituents in the water samples.

Table 1.--*Locations and descriptions of springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.*

[--, no sample; G, grass; S, shrubs; PP, ponderosa pine; AL, alder; DF, Douglas fir; M, maple; W, western larch; LP, lodgepole pine]

Site number	Sample number	Latitude	Longitude	Altitude (feet)	Water body type	Physical setting	Vegetation at site	Town-ship	Range	Section	Quarter-quarter section
1	950620-01	47 57 00	118 03 12	2,610	spring	meadow	G,S,PP	28N	38E	5	P
2	950623-02	47 57 51	118 04 24	2,960	seep	valley bottom	G,S,PP	29N	38E	31	P
3	950622-03 950725-03	47 57 24	118 05 31	2,960	seep	valley bottom	G,S,PP	28N	38E	1	F
4	950622-04	47 57 26	118 05 27	2,960	seep	valley bottom	G,S,PP	28N	38E	1	G
5	950619-05	47 57 32	118 05 15	2,960	seep	valley bottom	G,S,PP	28N	38E	1	B
6	950628-06 950724-06	47 55 30	118 06 55	2,200	spring	meadow	G,S	28N	37E	14	L
7	950630-07 950726-07	47 56 08	118 06 09	2,520	bore-hole	valley bottom	G,S,PP	28N	37E	11	R
8	950629-08 950726-08	47 57 06	118 05 32	3,420	bore-hole	ridge	G,S	28N	38E	1	L
9	950627-09 950723-09	47 58 24	118 04 53	2,320	stream	channel	S,G	29N	37E	36	N
10	950623-10 950725-10	47 56 14	118 03 40	2,540	seep	valley bottom	G,S,PP,AL,DF	28N	38E	7	E
11	--	47 57 10	118 06 28	2,800	spring	side of hill	S,PP,M,W	28N	37E	2	K
12	--	47 57 12	118 06 30	2,680	seep	valley bottom	S,PP	28N	37E	2	K
13	--	47 56 54	118 06 59	2,600	seep	flat	S	28N	37E	2	P
14	950627-14	47 57 42	118 05 52	2,500	spring	meadow	G,S,PP	28N	37E	1	D
15	950621-15	47 56 11	118 04 20	2,400	seep	valley bottom	S,PP,G	28N	38E	7	P
16	950630-16	47 56 62	118 05 05	2,680	bore-hole	flat	G,S,PP	28N	38E	12	H
17	950621-17	47 56 14	118 04 17	2,440	spring	channel	S,M,PP,DF	28N	38E	7	L

Table 1.--*Locations and descriptions of springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Site number	Sample number	Latitude	Longitude	Altitude (feet)	Water body type	Physical setting	Vegetation at site	Town-ship	Range	Section	Quarter-quarter section
18	950622-18	47 56 18	118 04 17	2,480	spring	channel	S,G,M,DF	28N	38E	7	L
19	950623-19	47 56 22	118 04 17	2,520	seep	small meadow	G,S,AL,DF,PP	28N	38E	7	L
20	--	47 56 27	118 04 15	2,540	seep	ditch	G,S,PP,DF,LP	28N	38E	7	F
21	950622-21	47 56 38	118 04 10	2,600	seep	ditch	G,S,PP,AL	28N	38E	7	F
22	950626-22	47 56 00	118 06 11	2,440	seep	valley bottom	G,S,PP	28N	37E	14	A
23	--	47 55 41	118 04 04	2,320	spring	channel	G,S	28N	37E	18	B
24	950624-24 950724-24	47 55 44	118 03 46	2,320	spring	flat	G,PP	28N	37E	18	H
25	950620-25 950724-25	47 55 01	118 03 11	2,360	seep	valley bottom	G,S	28N	37E	17	E
26	--	47 58 08	118 04 30	2,740	spring	channel	M,S,G	29N	37E	31	M
27	950626-27 950723-27	47 55 28	118 05 18	2,070	stream	channel	S,G,M,PP	28N	37E	13	K
28	--	47 58 37	118 04 06	2,610	seep	valley bottom	G,S,DF,M	29N	38E	30	Q
29	--	47 58 32	118 04 04	2,780	seep	valley bottom	G,S,M	29N	38E	31	B
30	950629-30	47 57 34	118 03 42	2,760	spring	channel	G,S,PP	28N	37E	13	K
31	950630-31 950726-31	47 55 56	118 06 02	2,440	bore-hole	flat	S,PP	28N	38E	6	A
32	950628-32	47 56 51	118 03 21	2,560	spring	channel	G,S,PP	28N	38E	8	D

[1] Sample number gives year, month, date, and site at which the sample was collected. For example, sample number 950620-01 was collected June 20, 1995, at site 1.

[2] Springs were defined as bodies of water where flow was concentrated, constituting the source of a small stream; seeps were defined as bodies of water that displayed no concentrated flow.

[3] Vegetation is listed in decreasing order of relative abundance.

Table 2.--*Minimum, median, and maximum values and concentrations of selected common constituents in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.*

[mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than]

Characteristic	Number of samples	Concentrations		
		Minimum	Median	Maximum
pH, field (standard units)	34	6.4	7.0	7.8
Hardness (mg/L as $CaCO_3$)	33	23	50	220
Calcium, dissolved (mg/L as Ca)	33	5.5	14	70
Magnesium, dissolved (mg/L as Mg)	33	1.5	3.6	11
Sodium, dissolved (mg/L as Na)	34	4.4	7.8	16
Alkalinity, field (mg/L as $CaCO_3$)	33	26	52	172
Sulfate, dissolved (mg/L as SO_4)	33	0.2	4.6	100
Chloride, dissolved (mg/L as Cl)	33	0.6	1.3	4.6
Fluoride, dissolved (mg/L as F)	33	< 0.1	0.1	0.4
Silica, dissolved (mg/L as SiO_2)	34	< 0.1	40	62
Solids, dissolved (mg/L)	33	76	116	326
Aluminum, dissolved (µg/L as Al)	33	< 10	50	1,400
Aluminum, total (µg/L as Al)	34	< 10	785	87,000
Barium, dissolved (µg/L as Ba)	33	< 2	36	100
Iron, dissolved (µg/L as Fe)	34	< 3	110	23,000
Manganese, dissolved (µg/L as Mn)	34	1	21.5	3,400
Manganese, total (µg/L as Mn)	34	< 10	115	2,300

Trace Elements

Concentrations of trace elements determined for the water samples were generally small (table 3). There were, however, large concentrations of total copper and total zinc in a number of samples collected during the first field trip, including samples 950623-02, 950622-04, 950623-10, 950621-15, 950630-16, 950621-17, 950622-18, 950623-19, and 950626-22 (table B2). The largest concentrations of both total copper and zinc were observed in sample number 950622-04, with concentrations of 2,500 µg/L and 1,600 µg/L, respectively. The brass hand pump used to collect water samples from shallow wells during the first field trip may have affected the concentrations of copper and zinc in those samples. Nevertheless, concentrations of copper and zinc in samples from other seeps were an order of magnitude lower than those from site 4, so the reported concentrations probably represent actual conditions. A plastic hand pump was used during the second field trip to eliminate that potential source of contamination. Concentrations of dissolved strontium were large in two samples collected from site 31 (numbers 950630-31 and 950726-31): 640 µg/L and 600 µg/L, respectively.

Table 3.--*Minimum, median, and maximum concentrations of trace elements in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.*

[Concentrations in micrograms per liter, except for arsenic, which is given in milligrams per liter; <, less than]

Constituent	Number of samples	Concentrations		
		Minimum	Median	Maximum
Arsenic, dissolved	17	< 1	< 1	4
Beryllium, dissolved	33	< 0.5	< 0.5	< 10
Cadmium, dissolved	33	< 1	< 1	4
Cadmium, total	34	< 10	< 10	< 10
Chromium, dissolved	34	< 1	< 5	19
Cobalt, dissolved	33	< 1	< 3	27
Copper, dissolved	33	< 1	< 10	74
Copper, total	34	< 10	< 25	2,500
Lead, dissolved	33	< 1	< 10	40
Lithium, dissolved	33	< 4	< 10	47
Mercury, dissolved	32	< 0.1	< 0.1	< 0.1
Molybdenum, dissolved	34	< 1.0	< 10	10
Nickel, dissolved	33	< 1	< 10	20
Silver, dissolved	33	< 1	< 1	3
Strontium, dissolved	33	37	92	640
Zinc, dissolved	34	< 3	6	2,200
Zinc, total	34	< 10	25	1,600

Radiochemical Constituents

Concentrations of radiochemical constituents determined for the water samples collected were generally small (table 4). However, some concentrations of radon-222 (dissolved), radium-226 (suspended), uranium-234 (suspended), and uranium-238 (suspended) were relatively large. For example, the maximum concentration of dissolved radon-222 determined for sample number 950726-08 was 59,000 pCi/L (picocuries per liter) (table B3). Maximum concentrations of suspended radium-226, uranium-234, and uranium-238 (all greater than 500 pCi/L) were all approximately two orders of magnitude higher than their respective dissolved concentrations. Although median concentrations of suspended radium-226, uranium-234, and uranium-238 were considerably smaller than their maximum concentrations (all were below 19 pCi/L), they remained approximately two orders of magnitude greater than their respective dissolved median concentrations.

Table 4.--*Minimum, median, and maximum concentrations, with precision estimates, of radionuclides, δD, and $\delta^{18}O$ in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.*

[pCi/L, picocuries per liter; µg/L, micrograms per liter; pCi/g, picocuries per gram; PE, precision estimate; --, no data; GS, concentrations determined by gamma scan; VSMOW, Vienna Standard Mean Ocean Water]

		Concentrations				
Constituent	Number of samples	Minimum[1]	Minimum PE	Median	Maximum	Maximum PE
Alpha, gross, dissolved (pCi/L as Thorium-230)	34	-0.152 *	0.426	2.18	24.0	3.69
Alpha, gross, dissolved (µg/L as natural Uranium)	34	-0.205 *	0.576	3.18	25.0	4.21
Beta, gross, dissolved (pCi/L as Strontium-90)	34	1.47	1.06	5.25	34.0	3.45
Beta, gross, dissolved (pCi/L as Cesium-137)	34	1.98	1.45	3.78	41.4	7.64
Radon-222, dissolved (pCi/L)	25	42	18	750	59,000	226
Radium-226, dissolved (pCi/L)	34	0.047	0.016	0.144	4.22	0.666
Radium-226, suspended (pCi/g)	23	3.10	1.36	8.31	584	252
Radium-228, dissolved (pCi/L)	34	0.192 *	0.408	0.762	4.83	1.38
Uranium-234, dissolved (pCi/L)	33	0.093	0.039	0.781	14.3	1.61

Table 4.--*Minimum, median, and maximum concentrations, with precision estimates, of radionuclides, δD, and δ¹⁸O in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Constituent	Number of samples	Concentrations				
		Minimum[1]	Minimum PE	Median	Maximum	Maximum PE
Uranium-234, suspended (pCi/g)	23	3.45	0.475	18.8	952	345
Uranium-235, dissolved (pCi/L)	33	-0.018 *	0.029	0.0141	0.554	0.100
Uranium-235, suspended (pCi/g)	23	-0.409 *	0.369	0.659	44.0 *	99.8
Uranium-238, dissolved (pCi/L)	33	0.062	0.038	0.590	12.7	1.42
Uranium-238, suspended (pCi/g)	23	3.35	0.462	13.7	1,120	382
Lead-210, dissolved (pCi/L)	34	0.185 *	0.326	0.610	16.3	3.33
Polonium-210, dissolved (pCi/L)	33	0.0 *	0.019	0.075	5.05	0.758
Thorium-230, dissolved (pCi/L)	33	-0.011 *	0.009	0.0121	0.045	0.025
Thorium-232, dissolved (pCi/L)	33	-0.004 *	0.005	0.0031	0.019 *	0.019
Potassium-40, dissolved, GS (pCi/L)	33	0.0759 *	6.28	17.6	38.8	5.99
Chromium-51, dissolved, GS (pCi/L)	33	-6.19 *	10.5	0.235	4.48 *	10.2
Cobalt-60, dissolved, GS (pCi/L)	33	-0.412 *	0.236	0.0475	0.345	0.214
Zinc-65, dissolved, GS (pCi/L)	33	-0.762 *	0.581	-0.118	0.625	0.360
Ruthenium-106, dissolved, GS (pCi/L)	33	-3.04 *	2.03	0.294	4.20	1.87
Cesium-134, dissolved, GS (pCi/L)	33	-0.227 *	0.215	-0.0461	0.238	0.193
Cesium-137, dissolved, GS (pCi/L)	33	-0.225 *	0.219	0.0114	0.211	0.193

Table 4.--*Minimum, median, and maximum concentrations, with precision estimates, of radionuclides, δD, and $\delta^{18}O$ in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Constituent	Number of samples	Concentrations				
		Minimum[1]	Minimum PE	Median	Maximum	Maximum PE
Thallium-208, dissolved, GS (pCi/L)	29	-0.0154 *	0.204	0.394	0.547	0.189
Lead-212, dissolved, GS (pCi/L)	33	-0.0943 *	0.437	0.342	0.995	0.648
Bismuth-214, dissolved, GS (pCi/L)	33	-0.160 *	0.412	0.799	3.03	0.666
Lead-214, dissolved, GS (pCi/L)	33	-0.0416 *	0.406	0.486	1.85	0.641
Radium-223, dissolved, GS (pCi/L)	33	-0.768 *	0.878	0.208	1.38	0.810
Radium-226, dissolved, GS (pCi/L)	33	-0.160 *	0.412	0.799	3.03	0.666
Thorium-228, dissolved, GS (pCi/L)	33	-0.0473 *	0.627	1.14	2.00	0.627
Radium-228, dissolved, GS (pCi/L)	33	0.0289 *	0.940	1.43	4.34	1.02
Uranium-234, dissolved, GS (pCi/L)	33	-0.271 *	0.681	0.474	1.93	0.961
Thorium-234, dissolved, GS (pCi/L)	33	-36.3 *	42.3	21.2	93.7	45.7
Uranium-235, dissolved, GS (pCi/L)	33	-0.514 *	0.958	0.680	2.21	0.895
Uranium-238, dissolved, GS (pCi/L)	33	-0.0416 *	0.406	0.486	1.85	0.641
δD (per mil VSMOW)	33	-123	--	-120	-110	--
$\delta^{18}O$ (per mil VSMOW)	24	-16.08	--	-15.78	-13.97	--

[1] Negative values indicate that the concentration of the radionuclide is less than the instrumentation background.
* Precision estimate equal to or greater than reported value.

SUMMARY

The objective of this study was to collect data from springs, seeps, streams, and boreholes in basins adjacent to or near Midnite Mine, within the Spokane Indian Reservation, Stevens County, Washington. This included an inventory and characterization of springs, seeps, and streams, and the collection of water-quality samples. Concentrations of various common constituents, trace elements, and radiochemical constituents determined for water samples collected as part of this study could then be compared with data from the Midnite Mine drainage basin.

The study area consisted of approximately 8 square miles surrounding the Midnite Mine drainage basin and was bordered to the north and west by Sand Creek and to the south and east by Blue Creek. Although water bodies were identified in 9 of the 10 major drainages in the study area, the majority were located within 3 basins situated south and east of Midnite Mine. The study area has a continental climate, and the mean annual precipitation was approximately 19 inches between 1951 and 1980, but the spring of 1995 proved to be unusually wet. In addition, record discharge was observed at the Blue Creek stream gaging station above Midnite Mine. The vegetation in the study area consisted primarily of ponderosa pine, grass, and various shrubs, and was dense in places, especially adjacent to the stream channels.

Thirty-two bodies of water not influenced by activities at Midnite Mine were identified in the study area, including 11 springs, 15 seeps, 2 streams, and 4 boreholes. In addition to the location and type of the water body, other characteristics such as the physical setting and vegetation were recorded for each site. Most sites were located within nine drainages, where the vegetation was generally dense. The quantity of water at each site decreased greatly between the two field trips and, as a result, the number of water-quality samples collected during the second field trip was smaller than during the first field trip.

Thirty-four environmental samples were collected from as many as 8 springs, 10 seeps, 2 streams, and 4 boreholes during 2 field trips in the months of June and July 1995. Water-quality samples were collected by various means, transferred into 5-gallon plastic buckets, and transported to a central processing location. An ultraclean processing protocol was used to prepare sample aliquots.

The concentrations of common constituents and trace metals were determined by standard methods, including atomic absorption spectrometry and inductively-coupled plasma spectrometry. Concentrations of 16 radiochemical constituents were determined primarily by alpha spectrometry, and a gamma scan was used to determine the concentrations of 14 additional radionuclides. The ratios of the isotopes of hydrogen and oxygen also were determined.

The water samples analyzed generally had a near-neutral pH and were soft or moderately hard; concentrations of dissolved solids were small. Silica, calcium, and bicarbonate were the major minerals contributing to the dissolved solids; however, magnesium, sodium, sulfate, and iron were major constituents in some samples. Concentrations of dissolved chloride, fluoride, aluminum, barium, iron, and manganese were too small to be considered major constituents in the water samples.

Trace element concentrations in the water-quality samples were generally small, and most were below the laboratory detection limits. Likewise, concentrations of most radiochemical constituents in the water-quality samples were generally small, and many concentrations were not greater than their respective precision estimates. Yet, some suspended concentrations of radium-226, uranium-234, and uranium-238 were large, with maximum concentrations greater than 500 picocuries per liter.

REFERENCES CITED

American Society for Testing and Materials, 1995, Standard test method for radon in drinking water, Method D 5072-92, v. 11.02, p. 671-673.

Becraft, G.E., and Weis, P.L., 1963, Geology and mineral deposits of the Turtle Lake quadrangle, Washington: U.S. Geological Survey Bulletin 1131, 73 p., 6 pl.

Coplen, T.B., Wildman, J.D., and Chen, Julie, 1991, Improvements in the gaseous hydrogen-water equilibration technique for hydrogen isotope ratio analysis: Analytical Chemistry, v. 63, p. 910-912.

Epstein, S., and Mayeda, T., 1953, Variation of O^{18} content of water from natural sources: Geochimica et Cosmochimica Acta, v. 4, p. 213-224.

Fishman, M.J., and Friedman, L.C., 1989, Methods for determination of inorganic substances in water and fluvial sediments: Techniques of Water-Resources Investigations of the United States Geological Survey, Book 5, chap. A1, 545 p.

Fleshman, B.R., and Dodd, S.P., 1982, National uranium resource evaluation program: Bendix Field Engineering Corporation, Grand Junction, Colo., 1982, 62 p.

Gat, J.R., and Gonfiantini, R., 1981, Stable isotope hydrology: Deuterium and Oxygen-18 in the water cycle: Technical Reports Series, No. 210, p. 35-84.

Hem, J.D., 1992, Study and interpretation of the chemical characteristics of natural water: U.S. Geological Survey Water-Supply Paper 2254, p. 159.

Horowitz, A.J., Demas, C.R., Fitzgerald, K.K., Miller, T.L., and Rickert, D.A., 1994, U.S. Geological Survey protocol for the collection and processing of surface-water samples for the subsequent determination of inorganic constituents in filtered water: U.S. Geological Survey Open-File Report 94-539, 57 p.

Linsley, R.K., Kohler, M.A., and Paulhus, J.L., 1986, Hydrology for engineers: San Francisco, McGraw-Hill, p.186-187.

Marcy, A.D., Scheibner, B.J., Toews, K.L., and Boldt, C.M.K., 1994, Hydrogeology and hydrochemistry of the Midnite Mine, northeastern Washington: U.S. Bureau of Mines Report of Investigations 9484, 40 p.

Nash, J.T., 1977, Geology of the Midnite Mine area, Washington--maps, description, and interpretation: U.S. Geological Survey Open-File Report 77-592, 39 p.

Pritchard, H.M., Gesell, T.F., and Meyer, C.R., 1980, Liquid scintillation analyses for Radium-226 and radon-222 in potable waters: Liquid Scintillation Counting Recent Applications and Development, v. 1, p. 348.

Robbins, D.A., 1978, Applied geology in the discovery of the Spokane Mountain uranium deposit, Washington: Economic Geology, v. 73, p. 1,523-1,538.

Sumioka, S.S., 1991, Quality of water in an inactive uranium mine and its effects on the quality of water in Blue Creek, Stevens County, Washington, 1984-85: U.S. Geological Survey Water-Resources Investigations Report 89-4110, 62 p.

Thatcher, L.L., Janzer, V.J., and Edwards, K.W., 1977, Methods for determination of radioactive substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A5, 95 p.

Timme, P.J., 1994, National Water Quality Laboratory 1994 Services Catalog, p. 87-92.

U.S. Bureau of Mines, 1994, Midnite Mine characterization work plan, Washington 1994: U.S. Department of the Interior, U.S. Bureau of Mines, p. 3-4.

U.S. Department of Commerce, 1983, Climatological data, annual summary, Washington 1983: National Oceanic and Atmospheric Administration, v. 87, no. 13, 28 p.

APPENDIX A.--SITE DESCRIPTIONS

Site 1

Site 1 was a spring flowing into a small meadow and was located due east of Midnite Mine (fig. 2) at an altitude of 2,610 feet. The vegetation consisted primarily of grass and small shrubs, with mostly ponderosa pine surrounding the meadow. Access to this site was relatively good and could be reached to within 100 feet by vehicle. The discharge at site 1 was 0.02 ft^3/s during the first field trip; however, no measurable flow was observed during the second field trip. Therefore, a water-quality sample (number 950620-01) was collected only during the first field trip.

Site 2

Site 2 was a seep situated in a small clearing within an intermittent stream channel and was located north and east of Midnite Mine at an altitude of 2,960 feet. The vegetation consisted primarily of grass, shrubs, and ponderosa pine. Although the site was adjacent to a road, access to this site was only fair and became difficult during or immediately after significant rainfall. A shallow well was installed at site 2 because there was no measurable flow at the surface. The recharge rate in the well during the first field trip was sufficient to collect a water-quality sample (number 950623-02). However, during the second field trip the water level in the well was too low and the recharge rate was too slow to allow collection of a water sample.

Sites 3, 4, and 5

Sites 3, 4, and 5 were seeps located about 1/2 mile north of the mine boundary and 3/4 mile west of Spokane Mountain, all at an altitude of 2,960 feet. Grass, shrubs, and ponderosa pine were the most abundant vegetation. Each site was accessible by vehicle. A shallow well was installed at each site, and water samples (numbers 950622-03, 950622-04, and 950619-05) were collected from all three sites during the first field trip. However, during the second field trip the recharge rates in the wells at sites 4 and 5 were too slow to allow the collection of water samples. As a result, a water sample (number 950725-03) was collected only at site 3.

Site 6

Site 6, 1 mile southwest of the mine boundary, was a spring located within a small but heavily vegetated stream drainage, surrounded by a meadow at an altitude of 2,200 feet. The site was easily accessible by a dirt road near an abandoned house. The discharge of the spring was approximately 0.1 ft^3/s during the first field trip and about 0.05 ft^3/s during the second field trip. As a result, water samples (numbers 950628-06 and 950724-06) were collected during both field trips.

Site 7

At site 7, a borehole was located in a valley bottom 1/8 mile west of the mine boundary, at an altitude of 2,520 feet. The vegetation consisted of grass, shrubs, and ponderosa pine. It was easily accessible off of a dirt road at the intersection of an intermittent stream channel. The water level was 18.5 feet below land surface during the first field trip and dropped to 26.5 feet below land surface during the second field trip. Water samples (numbers 950630-07 and 950726-07) were collected during both field trips.

Site 8

At site 8, a borehole was located on a ridge directly north of Midnite Mine, adjacent to the mine boundary at an altitude of 3,420 feet. It was surrounded by grass and shrubs, with some ponderosa pine and was fairly accessible through Midnite Mine at the end of a dirt road. However, access to the site could be limited during the winter months due to snowfall. The water level was 89 feet below land surface during both field trips. Water samples (numbers 950629-08 and 950726-08) were collected during both field trips.

Site 9

Site 9 was at Sand Creek, 1 1/4 miles north of Spokane Mountain, at an altitude of 2,320 feet. Shrubs and grass were the most abundant vegetation close to the stream, but open meadows surrounded the channel area. Access to the site was good, allowing vehicle access to within 50 feet. The discharge at Sand Creek was approximately 2 ft^3/s during the first field trip, but dropped to about 0.5 ft^3/s by the time of the second field trip. Water samples (numbers 950627-09 and 950723-09) were collected during both field trips.

Site 10

Site 10 was a seep located in a broad drainage 1 mile west of Turtle Lake, at an altitude of 2,540 feet. The site was surrounded by grass with some shrubs, ponderosa pine, alder, and Douglas fir. Although the site was 1,400 feet from the nearest road, the terrain was relatively flat and thinly vegetated, which made it fairly accessible. A well was installed and water-quality samples (numbers 950623-10 and 950725-10) were collected during both field trips. (The water collected was sediment laden and multiple filters were used during processing.)

Site 11

Site 11 was a spring located on the side of a hill approximately 3/4 mile northwest of the mine boundary, at an altitude of 2,800 feet. The vegetation was dense and consisted primarily of shrubs, ponderosa pine, and maple. The discharge during the first field trip was approximately 1.1×10^{-7} ft^3/s (225 mL/minute). The dense vegetation made access to this site poor and, as a result, no samples were collected during either field trip.

Site 12

Site 12 was a seep located on a valley bottom about 3/4 mile northwest of the mine boundary, at an altitude of 2,680 feet. The vegetation consisted of shrubs and ponderosa pine. The access to this site was poor because of dense vegetation and no samples were collected during either field trip.

Site 13

Site 13 was a seep located 1 mile west of the mine boundary, at an altitude of 2,600 feet. The surrounding vegetation consisted of shrubs and alder. The seep was next to a dirt road, where the road intersects an intermittent stream channel. No recharge was observed in test pits around the seep. As a result, no well was installed and no water samples were collected during either field trip.

Site 14

Site 14 was a spring situated within a meadow 1 mile north of the mine boundary, at an altitude of 2,500 feet. The vegetation consisted of grass, shrubs, with some ponderosa pine. Site 14 was accessible only by four-wheel-drive vehicle. Discharge from the spring during the first field trip was estimated to be about 4.7×10^{-7} ft^3/s (1 L/minute), but no water at the site was observed during the second field trip. As a result, a water sample (number 950627-14) was collected only during the first field trip.

Site 15

Site 15 was a seep located 1 mile east of the mine boundary, at an altitude of 2,400 feet. Vegetation consisted of mostly shrubs with some ponderosa pine and grass. The site was below a steep hill, but within 400 feet of one of the primary roads to Midnite Mine. A well was installed and a water sample (number 950621-15) was collected during the first field trip. Because there was little water in the well during the second field trip, no water sample was collected.

Site 16

At Site 16, a borehole was located approximately 1/4 mile east of the mine boundary, at an altitude of 2,680 feet. The area was flat, covered with grass, shrubs, and some ponderosa pine. Access to the site was good by foot; however, the site could not be accessed directly by vehicle, so the Grundfos pump could not be used to collect water samples. The depth to water during the first field trip was 8 feet below land surface and, with a piston hand pump, a water-quality sample (number 950630-16) was collected. The water level had dropped slightly by the second field trip to 10.5 feet below land surface, which created too much head to be overcome by the hand pump, so no water-quality sample was collected during the second field trip.

Site 17

Site 17 was a spring situated within an intermittent stream channel about 3/4 mile east of the mine boundary, at an altitude of 2,440 feet. The vegetation consisted of shrubs, maple, ponderosa pine, and Douglas fir. The discharge was approximately 1.2×10^{-6} ft^3/s (2.5 L/minute) during the first field trip. Although site 17 was accessible only by a 1/2 mile hike through moderately dense foliage, a water sample (number 950621-17) was collected during the first field trip. There was no flow observed during the second field trip, so no water sample was collected.

Site 18

Site 18 was a spring, about 1/8 mile above site 17, at an altitude of 2,480 feet. The vegetation was moderately dense and consisted of shrubs, grass, maple, and Douglas fir. The discharge was 2.4×10^{-6} ft^3/s (5 L per minute) during the first field trip, and a water sample (number 950622-18) was collected. Similar to site 17, no flow was observed during the second field trip and no water sample was collected.

Site 19

Site 19 was a seep located in a small meadow, at an altitude of 2,520 feet. The vegetation consisted of grass, shrubs, alder, and Douglas fir. A shallow well was installed because there was no measurable flow at the surface. This site was approximately 1,500 feet from vehicle access. A water sample (number 950623-19) was collected during the first field trip, but the well was dry during the second field trip and no water sample was collected.

Site 20

Site 20 was a seep located in a ditch, at an altitude of 2,540 feet. The vegetation consisted of grass, shrubs, ponderosa pine, and Douglas fir. No recharge was observed in test pits around the seep. As a result, no well was installed and no water samples were collected during either field trip.

Site 21

Site 21 was a seep located in a ditch, at an altitude of 2,600 feet. The vegetation consisted of grass, shrubs, ponderosa pine, and alder. There was vehicle access approximately 750 feet east of the site. A shallow well was installed and a water sample (number 950622-21) was collected during the first field trip. The well was dry during the second field trip, thus no water sample was collected.

Site 22

Site 22 was a seep located within a valley bottom about 1/4 mile southwest of Midnite Mine, at an altitude of 2,440 feet. The vegetation consisted primarily of shrubs and maple within the valley bottom with ponderosa pine away from the water. The site was accessible and was easy to find on subsequent trips because the path to the site follows a short barbed-wire fence. A shallow well was installed and a water sample (number 950626-22) was collected during the first field trip. However, the water level in the well was too low and the recharge rate too slow to collect a sample during the second field trip.

Site 23

Site 23 was a spring located within an intermittent stream channel about 1 mile southeast of Midnite Mine, at an altitude of 2,320 feet. The vegetation consisted primarily of grass and shrubs, and access to the site was through a large thicket of nettles. The discharge was estimated to be less than 4.7×10^{-8} ft^3/s (100 mL/minute) during the first field trip. As a result, no water samples were collected during either field trip.

Site 24

Site 24 was a spring located in a flat area near Blue Creek about 1 mile southwest of Turtle Lake, at an altitude of 2,320 ft. The discharge was approximately 0.02 ft^3/s during the first field trip and about 0.01 ft^3/s during the second field trip. The vegetation was primarily grass and ponderosa pine, and the site was easily accessible by vehicle. Water samples (numbers 950624-24 and 950724-24) were collected during both field trips.

Site 25

Site 25 was a seep located in a valley bottom near Blue Creek about 3/4 mile southwest of Turtle Lake, at an altitude of 2,360 feet. The vegetation consisted primarily of grass and shrubs, with some ponderosa pine. The site was within 100 feet of vehicle access. A shallow well was installed, and water samples (numbers 950620-25 and 950724-25) were collected during both field trips.

Site 26

Site 26 was a spring located in a channel about 1/2 mile west of Bear Mountain, at an altitude of 2,740 feet. The vegetation was grass, shrubs, and maple. Access to the site was poor, and could only be reached by traversing about 1 mile through dense vegetation. The flow rate was less than 0.01 ft^3/s and no water sample was collected from site 26 during either field trip.

Site 27

Site 27 was at Blue Creek above Midnite Mine (USGS stream gaging station 12433542) located about 3/4 mile south of the mine boundary. The vegetation consisted of shrubs, grass, maple, and ponderosa pine. The discharge was approximately 2.5 ft^3/s during the first field trip, but had decreased to less than 1 ft^3/s during the second field trip. It was easily accessible just off the Blue Creek Campground road, and water samples (numbers 950626-27 and 950723-27) were collected during both field trips.

Site 28

Site 28 was a seep situated near the mouth of an intermittent stream drainage approximately 1/2 mile north of Bear Mountain, at an altitude of 2,610 feet. The vegetation primarily consisted of grass, shrubs, and Douglas fir. Access to this site was poor and could only be reached by traversing through dense vegetation. As a result, no water samples were collected during either field trip.

Site 29

Site 29 was a seep located in the same drainage as site 28, at an altitude of 2,780 feet. The vegetation primarily consisted of grass, shrubs, and Maple. Site 29 was even less accessible than site 28, so no water-quality samples were collected during either field trip.

Site 30

Site 30 was a spring located in the channel of an intermittent stream 3/4 mile east of Spokane Mountain, at an altitude of 2,760 feet. The vegetation consisted primarily of shrubs with some ponderosa pine. Access to this site was good; it could be reached within 100 feet by vehicle. The discharge was about 1.2 $x10^{-7}$ ft^3/s (250 mL/minute) during the first field trip, but there was no water at the site during the second field trip. As a result, a water sample (number 950629-30) was collected only during the first field trip.

Site 31

At site 31, a borehole was located in a flat area about 1/4 mile southwest from the mine boundary, at an altitude of 2,440 feet. The vegetation consisted primarily of shrubs and ponderosa pine. There was direct vehicle access to the site, which was situated just off one of the main entrance roads to Midnite Mine. The water level was 8 feet below land surface during the first field trip and dropped to 12 feet below land surface by the second field trip. Water samples (numbers 950630-31 and 950726-31) were collected during both field trips.

Site 32

Site 32 was a spring within the channel of an intermittent stream 1 mile northwest of Turtle Lake, at an altitude of 2,560 feet. The vegetation consisted primarily of grass, shrubs, and ponderosa pine. The site was easily accessible and was located at the intersection of a dirt road and the intermittent stream drainage. The discharge was about 1.9 $x10^{-7}$ ft^3/s (400 mL/minute) during the first field trip; however, there was no flow observed during the second field trip. A water sample (number 950628-32) was collected only during the first field trip.

APPENDIX B.--DATA TABLES

Table B1.--*Values and concentrations of common constituents in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.*

[µS/cm, microsiemens per centimeter at 25°Centigrade; °C, degrees Centigrade; mg/L, milligrams per liter; µg/L, micrograms per liter; --, no data; <, less than]

Sample number	Specific conductance, field (µS/cm)	Specific conductance, lab (µS/cm)	pH, field (standard units)	pH, lab (standard units)	Water temperature (°C)	Chemical Oxygen Demand (mg/L)	Hardness, total (mg/L as $CaCO_3$)
950620-01	93	92	6.6	7.0	9.8	13	30
950623-02	169	169	6.7	6.5	9.8	120	63
950622-03	89	93	7.4	7.3	--	49	28
950725-03	106	116	7.2	6.9	13.5	210	41
950622-04	180	108	6.8	6.5	--	46	--
950619-05	68	75	7.0	7.0	11.3	< 10	23
950628-06	181	184	7.0	7.2	11.0	12	63
950724-06	184	182	6.8	6.6	11.5	11	61
950630-07	188	187	6.7	6.5	11.0	< 10	68
950726-07	201	199	6.4	6.9	11.0	12	64
950629-08	125	121	6.5	6.7	11.0	< 10	40
950726-08	121	120	6.6	6.8	11.5	< 10	40
950627-09	73	73	7.4	7.3	11.0	< 10	24
950723-09	81	83	7.4	7.1	17.5	63	27
950623-10	169	169	6.9	7.2	10.5	65	53
950725-10	187	186	6.8	7.2	16.5	390	60
950627-14	121	120	7.4	7.5	10.0	110	41
950621-15	164	165	6.9	7.2	11.5	28	62
950630-16	369	350	7.7	6.8	10.0	20	100
950621-17	203	207	7.2	6.9	9.5	< 10	86
950622-18	143	146	7.0	7.0	9.5	41	55
950623-19	151	144	7.0	7.2	10.0	10	50
950622-21	167	--	6.8	7.0	10.0	17	63
950626-22	287	236	6.9	7.0	16.8	200	100
950624-24	84	89	6.7	6.4	8.5	17	23
950724-24	87	87	6.7	7.2	11.0	65	26
950620-25	97	99	6.7	7.1	11.5	14	30
950724-25	94	94	6.7	6.9	12.0	27	31
950626-27	118	120	7.7	7.8	--	13	44
950723-27	112	112	7.8	7.1	18.5	14	40
950629-30	102	105	7.2	7.3	13.0	< 10	36
950630-31	504	488	7.7	7.0	--	16	220
950726-31	529	508	7.4	7.1	11.5	< 10	200
950628-32	150	150	7.0	7.3	14.0	< 10	50

Table B1.--*Values and concentrations of common constituents in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Sample number	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sodium adsorption ratio	Alkalinity, field (mg/L as $CaCO_3$)	Alkalinity, lab (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)
950620-01	8.5	2.0	6.2	0.5	--	43	1.5
950623-02	16	5.5	6.3	0.3	66	65	9.7
950622-03	7.6	2.2	6.7	0.6	38	40	3.4
950725-03	11	3.2	8.3	0.6	59	58	1.0
950622-04	--	--	6.9	--	47	51	2.3
950619-05	5.5	2.2	4.6	0.4	26	29	6.5
950628-06	17	5.0	9.7	0.5	73	76	13
950724-06	16	5.0	10	0.6	71	72	14
950630-07	19	4.9	9.0	0.5	43	43	40
950726-07	18	4.7	9.3	0.5	41	42	45
950629-08	8.0	4.8	7.6	0.5	46	50	6.8
950726-08	8.3	4.6	7.8	0.5	47	49	6.4
950627-09	7.2	1.5	4.4	0.4	29	31	5.0
950723-09	8.1	1.6	4.7	0.4	32	34	3.3
950623-10	14	4.3	11	0.7	81	84	0.2
950725-10	16	4.9	13	0.7	87	89	0.2
950627-14	11	3.2	7.9	0.5	52	54	5.2
950621-15	19	3.6	6.6	0.4	64	76	3.8
950630-16	26	8.9	7.9	0.3	159	99	14
950621-17	26	5.1	8.0	0.4	93	102	4.6
950622-18	16	3.6	7.7	0.5	65	71	2.8
950623-19	14	3.7	7.9	0.5	72	70	3.0
950622-21	19	3.8	8.5	0.5	77	--	--
950626-22	29	6.6	9.2	0.4	108	109	7.1
950624-24	6.0	2.0	6.6	0.6	36	36	3.8
950724-24	7.6	1.8	6.0	0.5	35	37	3.6
950620-25	8.7	2.0	5.3	0.4	36	41	3.9
950724-25	9.0	2.0	5.8	0.5	39	41	3.2
950626-27	13	2.7	6.0	0.4	50	52	5.8
950723-27	12	2.4	6.1	0.4	50	51	3.9
950629-30	11	2.1	6.2	0.4	49	51	2.2
950630-31	70	11	16	0.5	172	156	86
950726-31	65	10	16	0.5	166	147	100
950628-32	14	3.6	9.2	0.6	66	70	5.7

Table B1.--*Values and concentrations of common constituents in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Sample number	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, residue at 180°C, dissolved (mg/L)	Solids, residue, total (mg/L)	Nitrogen, nitrite, dissolved (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as N)
950620-01	1.2	0.19	46	106	9	< 0.01	--
950623-02	2.1	0.2	39	150	556	0.01	--
950622-03	1.3	0.27	40	98	260	0.01	--
950725-03	1.5	0.2	36	106	848	< 0.01	0.13
950622-04	1.6	0.2	0.2	92	520	0.01	--
950619-05	0.8	0.17	38	92	5	< 0.01	--
950628-06	1.4	0.1	50	154	1	< 0.01	--
950724-06	2.1	0.1	56	160	212	< 0.01	< 0.015
950630-07	1.5	< 0.1	35	144	3	< 0.01	--
950726-07	1.9	0.1	35	146	6	< 0.01	< 0.015
950629-08	0.8	< 0.1	35	98	< 1	< 0.01	--
950726-08	0.9	< 0.1	36	98	4	< 0.01	< 0.015
950627-09	0.6	0.39	33	76	1	< 0.01	--
950723-09	0.6	0.4	34	78	7	< 0.01	< 0.015
950623-10	1.7	0.2	62	162	1,090	0.01	--
950725-10	2.2	0.2	< 0.1	168	6,300	< 0.01	0.21
950627-14	1.1	< 0.1	40	106	368	< 0.01	--
950621-15	1.2	0.1	51	142	908	< 0.01	--
950630-16	4.6	< 0.1	3.9	142	13	< 0.01	--
950621-17	1.1	0.1	50	166	13	< 0.01	--
950622-18	1.1	0.1	48	130	420	< 0.01	--
950623-19	1.2	0.1	46	124	244	0.01	--
950622-21	--	--	48	--	--	0.01	--
950626-22	2.7	0.1	49	176	1,930	0.01	--
950624-24	1.0	0.2	42	88	308	0.01	--
950724-24	1.1	0.1	43	92	190	0.01	< 0.015
950620-25	2.1	0.2	40	108	28	< 0.01	--
950724-25	1.6	0.1	44	98	142	< 0.01	< 0.015
950626-27	1.3	0.1	40	116	3	< 0.01	--
950723-27	1.3	0.1	39	100	6	< 0.01	< 0.015
950629-30	0.9	< 0.1	39	98	8	< 0.01	--
950630-31	1.3	0.2	15	312	38	< 0.01	--
950726-31	1.2	0.2	21	326	16	< 0.01	2.4
950628-32	1.7	< 0.1	52	122	1	< 0.01	< 0.015

Table B1.--*Values and concentrations of common constituents in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Sample number	Phosphorous, dissolved (mg/L as P)	Aluminum, dissolved (µg/L as Al)	Aluminum, total (µg/L as Al)	Barium, dissolved (µg/L as Ba)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Manganese, total (µg/L as Mn)
950620-01	--	< 10	990	31	25	< 10	20
950623-02	--	60	8,800	100	4,100	3,400	610
950622-03	--	950	6,700	18	630	260	610
950725-03	0.31	170	14,000	37	2,900	570	1,500
950622-04	--	--	120	--	23,000	1,600	1,200
950619-05	--	20	790	11	47	< 10	10
950628-06	--	50	120	79	30	6	30
950724-06	0.07	80	3,200	79	170	120	210
950630-07	--	20	100	13	23	66	120
950726-07	< 0.01	< 10	90	13	33	84	110
950629-08	--	10	40	< 2	9	1	30
950726-08	0.03	< 10	50	< 2	< 3	1	< 10
950627-09	--	150	220	14	130	7	20
950723-09	0.03	80	210	15	72	5	< 10
950623-10	--	320	33,000	< 100	150	50	260
950725-10	0.04	70	87,000	< 100	120	70	850
950627-14	--	160	780	22	180	15	1,200
950621-15	--	< 10	19,000	100	9	1,000	2,300
950630-16	--	< 10	60	7	8	1,600	1,600
950621-17	--	< 10	440	61	120	1	110
950622-18	--	50	13,000	52	61	23	230
950623-19	--	850	7,800	< 100	390	< 10	170
950622-21	--	220	6,600	51	130	400	530
950626-22	--	30	31,000	100	55	890	1,400
950624-24	--	1,400	8,100	< 100	460	20	90
950724-24	0.07	320	3,600	36	340	4	10
950620-25	--	20	2,600	34	13	5	20
950724-25	0.05	240	3,600	35	280	3	90
950626-27	--	110	310	28	270	12	40
950723-27	0.11	20	190	25	99	7	20
950629-30	--	50	270	35	60	26	30
950630-31	--	< 10	250	64	27	550	650
950726-31	0.03	< 10	< 10	68	4,500	700	680
950628-32	--	110	240	63	69	5	< 10

Table B2.--*Concentrations of trace elements in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.*

[mg/L, milligrams per liter; µg/L, micrograms per liter; --, no data; <, less than]

Sample number	Arsenic, dissolved (mg/L as As)	Beryllium, dissolved (µg/L as Be)	Cadmium, dissolved (µg/L as Cd)	Cadmium, total (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)	Copper, dissolved (µg/L as Cu)	Copper, total (µg/L as Cu)
950620-01	--	< 0.5	< 1	< 10	< 1	< 3	< 10	< 10
950623-02	--	< 0.5	< 1	< 10	< 1	27	30	280
950622-03	--	< 0.5	< 1	< 10	< 1	< 3	< 10	40
950725-03	4	< 0.5	< 1	< 10	< 5	22	< 10	30
950622-04	--	--	--	< 10	19	--	--	2,500
950619-05	--	< 0.5	< 1	< 10	< 1	< 1	< 1	< 10
950628-06	--	< 0.5	< 1	< 10	< 5	< 3	< 10	< 10
950724-06	2	< 0.5	< 1	< 10	< 5	6	< 10	< 10
950630-07	< 1	1.4	< 1	< 10	< 5	< 3	< 10	< 10
950726-07	< 1	< 0.5	< 1	< 10	< 5	< 3	< 10	< 10
950629-08	< 1	1.3	< 1	< 10	< 5	< 3	< 10	< 10
950726-08	< 1	< 0.5	< 1	< 10	< 5	< 3	< 10	< 10
950627-09	--	< 0.5	< 1	< 10	< 5	< 3	< 10	< 10
950723-09	3	< 0.5	< 1	< 10	< 5	3	< 10	< 10
950623-10	1	< 10	< 1	< 10	< 1	< 1	25	600
950725-10	< 1	< 10	< 1	< 10	< 1	< 1	4	200
950627-14	--	< 0.5	< 1	< 10	< 5	< 3	< 10	< 20
950621-15	--	< 0.5	< 1	< 10	< 1	< 1	25	340
950630-16	< 1	< 0.5	< 1	< 10	< 5	< 3	10	180
950621-17	--	< 0.5	< 1	< 10	< 1	< 1	74	350
950622-18	--	< 0.5	< 1	< 10	< 1	< 1	< 10	240
950623-19	< 1	< 10	< 1	< 10	< 1	< 1	18	140
950622-21	--	< 0.5	< 1	< 10	< 1	< 3	< 10	100
950626-22	--	< 0.5	4	< 10	< 5	< 3	< 10	700
950624-24	< 1	< 10	< 1	< 10	< 1	< 1	2	30
950724-24	< 1	< 0.5	< 1	< 10	< 5	7	< 10	30
950620-25	--	< 0.5	< 1	< 10	< 1	< 3	30	70
950724-25	< 1	< 0.5	< 1	< 10	< 5	5	< 10	40
950626-27	--	< 0.5	< 1	< 10	< 5	< 3	< 10	< 10
950723-27	< 1	< 0.5	< 1	< 10	< 5	< 3	< 10	< 10
950629-30	--	< 0.5	< 1	< 10	< 5	< 3	< 10	< 10
950630-31	< 1	< 0.5	< 1	< 10	< 5	< 3	< 10	< 10
950726-31	< 1	< 0.5	2	< 10	< 5	10	< 10	< 10
950628-32	--	< 0.5	2	< 10	< 5	< 3	< 10	< 10

Table B2.--*Concentrations of trace elements in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Sample number	Lead, dissolved (µg/L as Pb)	Lithium, dissolved (µg/L as Li)	Mercury, dissolved (mg/L as Hg)	Molybdenum, dissolved (µg/L as Mo)	Nickel, dissolved (µg/L as Ni)	Silver, dissolved (µg/L as Ag)	Strontium, dissolved (µg/L as Sr)	Zinc, dissolved (µg/L as Zn)	Zinc, total (µg/L as Zn)
950620-01	< 10	11	< 0.1	< 1.0	< 10	< 1	78	< 3	< 10
950623-02	< 10	10	< 0.1	3.2	< 10	< 1	110	36	170
950622-03	< 10	10	< 0.1	6.6	< 10	< 1	43	< 3	30
950725-03	< 10	9	< 0.1	10	< 10	< 1	64	5	60
950622-04	--	--	< 0.1	1.1	--	--	--	2,200	1,600
950619-05	< 1	9	< 0.1	< 1.0	< 1	< 1	37	6	< 10
950628-06	< 10	5	< 0.1	< 10	< 10	< 1	120	5	< 10
950724-06	< 10	< 4	< 0.1	< 10	< 10	2	110	3	20
950630-07	< 10	27	< 0.1	10	< 10	1	100	< 3	< 10
950726-07	< 10	33	< 0.1	< 10	20	2	100	5	< 10
950629-08	< 10	42	< 0.1	< 10	< 10	< 1	50	< 3	< 10
950726-08	20	37	< 0.1	< 10	< 10	< 1	49	6	< 10
950627-09	10	< 4	< 0.1	< 10	< 10	2	42	< 3	< 10
950723-09	< 10	4	< 0.1	< 10	< 10	1	47	< 3	< 10
950623-10	< 1	< 10	< 0.1	< 1.0	2	< 1	140	40	370
950725-10	< 1	< 10	< 0.1	< 1.0	2	< 1	160	< 10	230
950627-14	10	11	< 0.1	< 10	< 10	< 1	80	< 3	30
950621-15	< 1	< 4	< 0.1	< 1.0	2	< 1	120	67	260
950630-16	< 10	6	< 0.1	< 10	< 10	< 1	66	44	140
950621-17	< 1	9	< 0.1	< 1.0	< 1	< 1	110	55	170
950622-18	< 1	< 10	< 0.1	< 1.0	< 1	< 1	110	12	170
950623-19	< 1	< 10	< 0.1	< 1.0	1	< 1	100	< 10	120
950622-21	< 10	14	--	1.4	< 10	< 1	110	31	90
950626-22	< 10	7	< 0.1	10	< 10	< 1	170	23	490
950624-24	< 1	< 10	< 0.1	< 1.0	< 1	< 1	50	< 10	80
950724-24	< 10	< 4	< 0.1	< 10	< 10	< 1	60	7	40
950620-25	< 10	7	< 0.1	< 1.0	< 10	< 1	74	77	< 10
950724-25	20	5	< 0.1	< 10	< 10	3	73	6	30
950626-27	< 10	4	< 0.1	< 10	< 10	< 1	91	< 3	< 10
950723-27	20	4	< 0.1	< 10	< 10	1	88	< 3	< 10
950629-30	< 10	13	--	< 10	< 10	< 1	92	8	< 10
950630-31	< 10	47	< 0.1	< 10	< 10	< 1	640	< 3	< 10
950726-31	40	44	< 0.1	< 10	< 10	< 1	600	4	10
950628-32	< 10	9	< 0.1	< 10	< 10	1	130	< 3	< 10

Table B3.--*Concentrations and precision estimates of radionuclides, δD, and δ¹⁸O in water samples from sp·ings, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.*

[pCi/L, picocuries per liter; pCi/g, picocuries per gram; µg/ L, micrograms per liter; PE, precision estimate; -, concentration of radionuclide less than instrumentation background; --, no data; VSMOW, Vienna Standard Mean Ocean Water]

Sample number	Alpha, gross, dissolved (pCi/L as Thorium-230)	Alpha, gross, dissolved, PE (pCi/L as Thorium-230)	Alpha, gross, dissolved (µg/L as natural Uranium)	Alpha, gross, dissolved, PE (µg/L as natural Uranium)	Beta, gross, dissolved (pCi/L as Strontium-90)	Beta, gross, dissolved, PE (pCi/L as Strontium-90)
950620-01	1.60	0.928	2.21	1.30	3.82	1.09
950623-02	6.10	1.39	6.56	1.57	5.63	1.34
950622-03	2.45	1.10	3.39	1.56	2.26	0.967
950725-03	2.42	1.25	3.45	1.81	5.53	1.27
950622-04	3.00	1.30	4.08	1.80	3.98	1.21
950619-05	1.43	0.828	1.84	1.07	1.60	0.896
950628-06	1.25	1.04	2.06	1.74	3.21	1.18
950724-06	1.92	1.26	3.35	2.24	5.09	1.25
950630-07	1.98	1.11	3.24	1.85	3.59	1.07
950726-07	2.30	0.787	2.38	0.830	5.52	1.77
950629-08	14.4	3.21	21.2	5.23	22.3	2.16
950726-08	19.0	3.06	19.7	3.44	34.0	3.45
950627-09	1.44	0.822	1.96	1.14	2.28	0.871
950723-09	0.623 *	0.758	0.781 *	0.953	2.50	1.06
950623-10	1.64	1.11	3.10	2.14	3.36	1.06
950725-10	8.21	1.65	8.30	1.76	6.16	1.82
950627-14	1.86	1.01	3.12	1.74	2.64	0.904
950621-15	4.19	1.87	5.43	2.47	6.91	1.92
950630-16	0.222 *	0.365	0.229 *	0.377	9.27	1.46
950621-17	4.18	1.96	5.98	2.86	4.94	1.80
950622-18	3.97	1.57	5.88	2.40	2.69	1.16
950623-19	3.55	1.58	5.91	2.72	4.33	1.26
950622-21	2.47	0.813	2.51	0.846	2.63	1.08
950626-22	24.0	3.69	25.0	4.21	15.2	1.95
950624-24	-0.152 *	0.426	-0.205 *	0.576	1.54	0.923
950724-24	0.133 *	0.620	0.170 *	0.793	3.73	1.15
950620-25	4.32	1.78	4.88	2.04	4.32	1.74
950724-25	0.138 *	0.643	0.185 *	0.862	3.17	1.11
950626-27	2.06	1.18	3.09	1.81	3.39	1.19
950723-27	0.883	0.874	1.22 *	1.22	3.48	1.13
950629-30	0.559 *	0.755	0.769 *	1.04	1.47	1.06
950630-31	11.3	2.05	11.3	2.18	6.88	1.34
950726-31	19.6	3.12	19.9	3.45	20.5	2.75
950628-32	0.520 *	0.830	0.859 *	1.38	3.11	1.18

Table B3.--*Concentrations and precision estimates of radionuclides, δD, and δ18O in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Sample number	Beta, gross, dissolved (pCi/L as Cesium-137)	Beta, gross, dissolved, PE (pCi/L as Cesium-137)	Radon-222, dissolved (pCi/L)	Radon-222, dissolved, PE (pCi/L)	Radium-226, dissolved (pCi/L)	Radium-226, dissolved, PE (pCi/L)
950620-01	5.14	1.68	530	25	0.078	0.018
950623-02	8.52	2.48	360	26	1.57	0.256
950622-03	3.06	1.39	--	--	0.085	0.018
950725-03	7.58	2.13	120	20	0.367	0.063
950622-04	5.32	1.82	140	21	0.498	0.089
950619-05	2.06	1.20	2,900	53	0.053	0.016
950628-06	4.79	1.94	1,100	34	0.198	0.037
950724-06	7.82	2.34	1,600	39	0.190	0.039
950630-07	5.32	1.82	--	--	0.310	0.058
960726-07	7.00	2.50	1,700	41	0.434	0.072
950629-08	31.1	5.88	--	--	0.281	0.052
950726-08	41.4	7.64	59,000	226	0.273	0.052
950627-09	3.05	1.26	100	20	0.100	0.022
950723-09	3.18	1.44	150	21	0.047	0.016
950623-10	5.41	1.96	--	--	0.162	0.030
950725-10	8.33	2.80	230	22	0.140	0.029
950627-14	3.97	1.52	88	19	0.076	0.019
950621-15	8.96	2.86	900	30	0.157	0.031
950630-16	18.2	4.60	--	--	0.093	0.020
950621-17	6.78	2.70	670	28	0.104	0.025
950622-18	3.77	1.74	--	--	0.060	0.017
950623-19	6.47	2.17	--	--	0.088	0.017
950622-21	4.35	1.94	--	--	0.117	0.026
950626-22	27.5	6.26	1,100	34	2.54	0.405
950624-24	2.06	1.27	1,400	40	0.166	0.031
950724-24	4.81	1.66	1,600	39	0.147	0.028
950620-25	5.18	2.23	870	30	0.118	0.026
950724-25	4.20	1.61	1,300	42	0.133	0.028
950626-27	4.79	1.85	42	18	0.105	0.024
950723-27	4.69	1.70	71	20	0.068	0.015
950629-30	1.98	1.45	670	29	0.114	0.025
950630-31	17.3	5.30	--	--	3.58	0.604
950726-31	33.4	7.39	830	32	4.22	0.666
950628-32	4.64	1.92	1,200	38	0.155	0.031

Table B3.--*Concentrations and precision estimates of radionuclides, δD, and δ*^{18}*O in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Sample number	Radium-226, suspended (pCi/g)	Radium-226, suspended, PE (pCi/g)	Radium-228, dissolved (pCi/L)	Radium-228, dissolved, PE (pCi/L)	Uranium-234, dissolved (pCi/L)	Uranium-234, dissolved, PE (pCi/L)
950620-01	15.5	7.85	0.874	0.526	0.293	0.125
950623-02	--	--	0.793	0.510	1.06	0.174
950622-03	11.6	1.92	0.343 *	0.458	1.34	0.201
950725-03	14.1	2.60	0.730	0.365	1.45	0.242
950622-04	4.85	0.783	0.641	0.443	1.33	0.284
950619-05	14.5	5.58	0.404 *	0.426	0.093	0.039
950628-06	7.73	5.35	1.18	0.545	0.278	0.122
950724-06	--	--	0.563	0.335	0.529	0.112
950630-07	6.98	1.88	1.62	0.713	1.16	0.178
960726-07	--	--	1.58	0.733	1.04	0.143
950629-08	--	--	0.950	0.575	11.9	1.33
950726-08	--	--	1.20	0.718	13.0	1.48
950627-09	7.75	4.42	0.600	0.435	0.291	0.068
950723-09	22.7	14.6	0.354	0.299	0.171	0.068
950623-10	--	--	1.07	0.597	1.33	0.235
950725-10	3.10	1.36	0.585 *	0.598	--	--
950627-14	8.96	1.53	0.491	0.417	1.33	0.313
950621-15	4.47	0.719	1.57	0.651	0.676	0.156
950630-16	--	--	1.24	0.639	0.253	0.0733
950621-17	3.31	1.46	0.288 *	0.408	0.711	0.136
950622-18	3.98	0.757	0.683	0.490	2.10	0.308
950623-19	--	--	1.30	0.648	2.80	0.337
950622-21	5.96	1.10	0.551	0.499	1.46	0.318
950626-22	24.4	3.76	1.07	0.532	14.3	1.61
950624-24	--	--	1.28	0.617	0.138	0.058
950724-24	--	--	0.887	0.418	0.143	0.059
950620-25	8.31	1.54	0.697	0.448	0.238	0.075
950724-25	8.86	2.01	0.617	0.360	0.191	0.054
950626-27	584	252	0.585	0.497	0.781	0.139
950723-27	6.46	5.24	0.338	0.286	0.567	0.134
950629-30	3.35	0.844	1.11	0.560	0.295	0.122
950630-31	10.7	1.86	2.83	0.881	5.07	0.565
950726-31	--	--	4.83	1.38	13.2	1.93
950628-32	20.8	10.1	0.192 *	0.408	0.464	0.194

Table B3.--*Concentrations and precision estimates of radionuclides, δD, and $\delta^{18}O$ in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Sample number	Uranium-234, suspended (pCi/g)	Uranium-234, suspended, PE (pCi/g)	Uranium-235, dissolved (pCi/L)	Uranium-235, dissolved, PE (pCi/L)	Uranium-235, suspended (pCi/g)	Uranium-235, suspended, PE (pCi/g)
950620-01	99.5	18.8	-0.018 *	0.029	3.12	2.82
950623-02	14.8	2.14	0.038	0.026	0.578	0.214
950622-03	70.0	8.46	0.0616	0.0324	1.14	0.256
950725-03	36.6	5.02	0.024	0.023	0.978	0.445
950622-04	3.45	0.475	0.044 *	0.053	0.133	0.035
950619-05	23.5	6.89	0.004 *	0.015	1.61 *	1.71
950628-06	18.8	6.22	0.025 *	0.046	0.270 *	0.934
950724-06	--	--	0.015 *	0.017	--	--
950630-07	8.92	1.99	0.033	0.022	0.487	0.402
960726-07	--	--	0.038	0.021	--	--
950629-08	--	--	0.395	0.076	--	--
950726-08	--	--	0.440	0.088	--	--
950627-09	11.4	3.67	0.006 *	0.013	0.555 *	0.899
950723-09	15.8	6.00	0.001 *	0.013	1.63 *	2.23
950623-10	--	--	0.042	0.037	--	--
950725-10	18.1	3.32	--	--	1.01	0.618
950627-14	28.5	3.44	0.004 *	0.046	0.581	0.164
950621-15	6.77	0.850	0.038	0.036	0.224	0.058
950630-16	--	--	0.00585 *	0.0160	--	--
950621-17	18.5	3.13	0.013 *	0.017	0.710	0.456
950622-18	36.4	5.69	0.066	0.036	1.42	0.493
950623-19	--	--	0.091	0.033	--	--
950622-21	20.1	2.79	0.014 *	0.028	0.659	0.233
950626-22	--	--	0.554	0.100	--	-
950624-24	--	--	0.000 *	0.016	--	--
950724-24	--	--	0.011 *	0.015	--	--
950620-25	49.7	6.15	0.003 *	0.011	1.92	0.475
950724-25	44.5	6.07	0.009 *	0.011	0.913	0.450
950626-27	952	345	0.009 *	0.018	44.0 *	99.8
950723-27	11.8	4.71	0.009 *	0.016	-0.409 *	0.369
950629-30	6.59	1.48	-0.002 *	0.023	0.071 *	0.173
950630-31	12.0	1.80	0.128	0.036	0.377	0.210
950726-31	--	--	0.255	0.092	--	--
950628-32	31.0	10.3	0.006 *	0.047	0.576 *	2.16

Table B3.--*Concentrations and precision estimates of radionuclides, δD, and $\delta^{18}O$ in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Sample number	Uranium-238, dissolved (pCi/L)	Uranium-238, dissolved, PE (pCi/L)	Uranium-238, suspended (pCi/g)	Uranium-238, suspended, PE (pCi/g)	Lead-210, dissolved (pCi/L)	Lead-210, dissolved, PE (pCi/L)
950620-01	0.235	0.108	75.8	15.6	0.630	0.348
950623-02	0.956	0.161	13.3	1.96	0.379	0.332
950622-03	0.781	0.137	28.0	3.48	0.366	0.327
950725-03	0.804	0.157	21.6	3.23	1.62	0.795
950622-04	1.07	0.245	3.35	0.462	0.640	0.354
950619-05	0.083	0.037	12.1	4.78	0.492	0.354
950628-06	0.198	0.101	13.9	5.26	0.186 *	0.303
950724-06	0.270	0.074	--	--	1.36	0.755
950630-07	0.848	0.140	8.20	1.88	0.644	0.341
960726-07	0.868	0.124	--	--	0.520 *	0.625
950629-08	8.63	0.972	--	--	16.3	3.33
950726-08	9.20	1.07	--	--	14.9	3.30
950627-09	0.216	0.057	6.96	2.79	0.290 *	0.310
950723-09	0.127	0.058	12.0	5.11	0.982	0.684
950623-10	0.926	0.181	--	--	0.605	0.348
950725-10	--	--	13.7	2.75	0.296 *	0.593
950627-14	0.764	0.215	17.7	2.20	0.691	0.397
950621-15	0.475	0.125	6.22	0.785	0.437	0.360
950630-16	0.201	0.0634	--	--	0.308	0.304
950621-17	0.539	0.113	13.6	2.52	0.451	0.363
950622-18	1.41	0.225	25.2	4.08	0.614	0.353
950623-19	1.89	0.240	--	--	0.359	0.333
950622-21	0.943	0.235	15.2	2.18	0.678	0.395
950626-22	12.7	1.42	--	--	0.920	0.432
950624-24	0.068	0.040	--	--	0.624	0.372
950724-24	0.062	0.038	--	--	0.590 *	0.628
950620-25	0.150	0.058	38.2	4.81	0.185 *	0.326
950724-25	0.167	0.050	32.2	4.58	0.223 *	0.571
950626-27	0.590	0.115	1,120	382	1.53	0.526
950723-27	0.564	0.133	11.0	4.54	1.71	0.783
950629-30	0.260	0.113	6.16	1.41	0.210 *	0.327
950630-31	2.93	0.342	11.4	1.72	0.650	0.365
950726-31	6.86	1.04	--	--	0.765	0.642
950628-32	0.438	0.184	18.9	7.84	0.295 *	0.359

Table B3.--*Concentrations and precision estimates of radionuclides, δD, and $\delta^{18}O$ in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Sample number	Polonium-210, dissolved (pCi/L)	Polonium-210, dissolved, PE (pCi/L)	Thorium-230, dissolved (pCi/L)	Thorium-230, dissolved, PE (pCi/L)	Thorium-232, dissolved (pCi/L)	Thorium-232, dissolved, PE (pCi/L)
950620-01	0.193	0.075	0.014 *	0.016	0.004 *	0.009
950623-02	0.269	0.093	0.036	0.026	0.006 *	0.012
950622-03	0.164	0.073	0.123	0.044	0.010 *	0.013
950725-03	0.143	0.058	0.007 *	0.015	0.004 *	0.011
950622-04	0.682	0.168	0.031	0.023	0.000 *	0.012
950619-05	0.053	0.038	0.000 *	0.012	-0.000787 *	0.002
950628-06	0.040	0.037	0.008 *	0.015	0.003 *	0.011
950724-06	0.069	0.041	0.012 *	0.016	0.013 *	0.016
950630-07	0.176	0.066	0.013 *	0.017	0.000 *	0.014
960726-07	0.077	0.050	--	--	--	--
950629-08	5.05	0.758	0.006 *	0.012	-0.001 *	0.002
950726-08	3.07	0.508	0.006 *	0.013	-0.003 *	0.004
950627-09	0.074	0.051	0.021	0.020	0.007 *	0.011
950723-09	0.031	0.029	0.012 *	0.014	0.019	0.018
950623-10	0.054	0.039	0.017 *	0.019	0.019 *	0.019
950725-10	--	--	0.013 *	0.017	0.010 *	0.014
950627-14	0.174	0.067	0.008 *	0.012	0.000 *	0.013
950621-15	0.040	0.034	-0.006 *	0.004	-0.000814 *	0.002
950630-16	0.0385	0.0323	0.000 *	0.034	-0.002 *	0.005
950621-17	0.075	0.046	0.003 *	0.011	-0.002 *	0.003
950622-18	0.045	0.042	0.003 *	0.009	0.000 *	0.013
950623-19	0.000 *	0.019	-0.011 *	0.009	-0.002 *	0.004
950622-21	0.045	0.041	0.012 *	0.020	0.006 *	0.014
950626-22	3.93	0.597	0.037	0.029	0.004 *	0.011
950624-24	0.075	0.048	-0.003 *	0.004	-0.004 *	0.005
950724-24	0.0340 *	0.0346	0.012 *	0.017	0.000 *	0.018
950620-25	0.046	0.035	0.009 *	0.019	-0.004 *	0.005
950724-25	0.010 *	0.015	0.002 *	0.010	-0.003 *	0.003
950626-27	0.181	0.076	0.045	0.025	0.017	0.016
950723-27	0.011 *	0.016	0.014 *	0.018	0.000 *	0.015
950629-30	0.035 *	0.036	0.000 *	0.011	0.003 *	0.008
950630-31	0.082	0.059	0.002 *	0.018	0.005 *	0.012
950726-31	0.253	0.082	0.018 *	0.026	0.009 *	0.018
950628-32	0.130	0.076	0.036	0.023	0.003 *	0.007

Table B3.--*Concentrations and precision estimates of radionuclides, δD, and $\delta^{18}O$ in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Sample number	Gamma Scan, dissolved					
	Potassium-40, (pCi/L)	Potassium-40, PE (pCi/L)	Chromium-51 (pCi/L)	Chromium-51, PE (pCi/L)	Cobalt-60 (pCi/L)	Cobalt-60, PE (pCi/L)
950620-01	21.3	6.73	-2.88 *	13.9	0.0567 *	0.187
950623-02	27.6	4.69	0.845 *	2.12	-0.0671 *	0.186
950622-03	35.2	5.02	4.48 *	10.2	0.167 *	0.215
950725-03	1.02 *	6.41	-1.22 *	3.31	0.285	0.223
950622-04	35.3	5.11	3.19 *	15.0	0.275	0.209
950619-05	0.235 *	5.36	-4.93 *	14.7	0.120 *	0.193
950628-06	0.148 *	8.31	-3.75 *	4.80	-0.131 *	0.226
950724-06	2.89 *	6.68	-1.44 *	3.18	0.144 *	0.207
950630-07	34.9	5.20	0.235 *	3.51	0.345	0.214
960726-07	31.5	4.93	3.66	2.97	0.0724 *	0.222
950629-08	4.89 *	7.71	-6.19 *	10.5	0.0971 *	0.210
950726-08	38.4	5.58	1.77 *	3.37	0.0185 *	0.240
950627-09	16.1	3.82	-1.85 *	4.89	0.0400 *	0.207
950723-09	9.34	6.08	0.339 *	3.16	-0.158 *	0.237
950623-10	38.8	5.99	-2.37 *	4.05	-0.130 *	0.268
950725-10	--	--	--	--	--	--
950627-14	24.2	4.38	-3.25 *	4.46	0.0607 *	0.209
950621-15	9.86	6.13	-1.22 *	2.55	0.153 *	0.210
950630-16	6.77 *	6.95	0.720 *	3.49	-0.0786 *	0.229
950621-17	25.9	4.40	1.46 *	2.06	0.195	0.192
950622-18	34.0	5.07	1.24 *	13.5	0.000 *	0.217
950623-19	15.2	12.9	1.72 *	20.2	0.202 *	0.408
950622-21	32.1	5.16	1.92 *	2.46	-0.113 *	0.212
950626-22	2.48 *	9.04	-2.73 *	12.0	-0.0239 *	0.291
950624-24	17.6	3.85	1.83 *	4.33	-0.0531 *	0.252
950724-24	1.95 *	5.02	-0.544 *	3.10	0.129 *	0.203
950620-25	36.7	5.41	-0.641 *	2.42	-0.00566 *	0.210
950724-25	25.5	4.39	-0.449 *	2.60	0.0475 *	0.190
950626-27	31.0	5.33	1.75 *	4.24	0.000 *	0.208
950723-27	19.3	3.80	0.401 *	2.97	-0.237 *	0.232
950629-30	0.210 *	6.67	3.62 *	4.79	0.316	0.213
950630-31	0.0759 *	6.28	-0.521 *	7.07	-0.412 *	0.236
950726-31	1.32 *	5.94	-0.968 *	3.15	0.164 *	0.217
950628-32	2.66 *	4.87	0.343 *	4.68	-0.119 *	0.220

Table B3.--*Concentrations and precision estimates of radionuclides, δD, and $\delta^{18}O$ in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

	Gamma Scan, dissolved					
Sample number	Zinc-65 (pCi/L)	Zinc-65, PE (pCi/L)	Ruthenium-106 (pCi/L)	Ruthenium-106, PE (pCi/L)	Cesium-134 (pCi/L)	Cesium-134, PE (pCi/L)
950620-01	-0.332 *	0.534	0.324 *	1.69	-0.0130 *	0.188
950623-02	0.625	0.360	0.967 *	1.44	-0.0155 *	0.164
950622-03	0.425 *	0.515	-3.04 *	2.03	-0.0701 *	0.204
950725-03	0.00772 *	0.470	-0.334 *	1.93	0.108 *	0.197
950622-04	0.171 *	0.501	-0.159 *	2.13	0.0183 *	0.210
950619-05	-0.368 *	0.602	-1.84 *	2.01	-0.119 *	0.216
950628-06	-0.126 *	0.525	1.40 *	2.30	-0.129 *	0.234
950724-06	0.253 *	0.475	0.595 *	1.83	-0.109 *	0.191
950630-07	-0.0208 *	0.498	0.0609 *	1.86	-0.227 *	0.215
960726-07	-0.118 *	0.423	-0.134 *	1.76	-0.166 *	0.196
950629-08	-0.403 *	0.618	1.01 *	2.43	-0.198 *	0.246
950726-08	-0.394 *	0.538	-0.0720 *	2.12	-0.00824 *	0.211
950627-09	-0.150 *	0.516	1.24 *	1.94	0.0905 *	0.224
950723-09	-0.431 *	0.471	4.20	1.87	-0.0825 *	0.209
950623-10	-0.762 *	0.581	1.54 *	2.03	0.0898 *	0.222
950725-10	--	--	--	--	--	--
950627-14	-0.0417 *	0.489	-0.0728 *	1.83	0.0579 *	0.185
950621-15	0.297 *	0.444	1.16 *	1.78	-0.112 *	0.190
950630-16	0.594	0.502	0.811 *	1.72	-0.153 *	0.202
950621-17	-0.410 *	0.437	-0.746 *	1.62	0.107 *	0.158
950622-18	-0.513 *	0.575	-1.21 *	1.93	0.167 *	0.183
950623-19	0.154 *	1.12	3.21 *	4.20	-0.0461 *	0.455
950622-21	-0.384 *	0.501	1.39 *	1.67	0.182 *	0.182
950626-22	-0.582 *	0.657	-1.55 *	2.65	-0.122 *	0.269
950624-24	-0.234 *	0.541	-0.264 *	2.17	0.0267 *	0.230
950724-24	0.203 *	0.417	0.996 *	1.82	0.238	0.193
950620-25	-0.351 *	0.449	-1.36 *	1.80	-0.0824 *	0.201
950724-25	-0.481 *	0.434	-0.0718 *	1.61	-0.181 *	0.173
950626-27	0.229 *	0.493	-1.80 *	1.91	0.0136 *	0.194
950723-27	-0.00807 *	0.459	0.736 *	1.93	-0.104 *	0.204
950629-30	0.150 *	0.440	-0.267 *	1.92	0.0279 *	0.199
950630-31	-0.363 *	0.498	0.607 *	1.81	0.0176 *	0.186
950726-31	0.153 *	0.452	1.08 *	1.92	-0.102 *	0.196
950628-32	0.0686 *	0.444	0.294 *	1.92	-0.0462 *	0.202

Table B3.--*Concentrations and precision estimates of radionuclides, δD, and $\delta^{18}O$ in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

	Gamma Scan, dissolved					
Sample number	Cesium-137 (pCi/L)	Cesium-137, PE (pCi/L)	Thallium-208 (pCi/L)	Thallium-208, PE (pCi/L)	Lead-212 (pCi/L)	Lead-212, PE (pCi/L)
950620-01	-0.112 *	0.170	0.547	0.189	-0.0943 *	0.437
950623-02	0.00820 *	0.179	0.518	0.183	0.169 *	0.467
950622-03	0.0114 *	0.202	--	--	0.975	0.459
950725-03	-0.0658 *	0.213	0.170 *	0.209	0.342 *	0.596
950622-04	0.211	0.193	-0.0154 *	0.204	0.0726 *	0.517
950619-05	0.102 *	0.199	0.229	0.202	0.166 *	0.507
950628-06	-0.0156 *	0.224	0.463	0.251	0.242 *	0.711
950724-06	-0.0605 *	0.214	0.471	0.227	0.459 *	0.496
950630-07	0.192 *	0.209	0.246	0.212	0.581	0.289
960726-07	0.0532 *	0.194	0.405	0.219	0.944	0.285
950629-08	0.132 *	0.248	--	--	0.494	0.386
950726-08	0.174 *	0.212	0.176 *	0.232	0.507	0.309
950627-09	-0.0529 *	0.221	0.231	0.222	0.0302 *	0.486
950723-09	0.137 *	0.197	0.468	0.212	0.609	0.272
950623-10	0.0958 *	0.237	0.265	0.236	0.777	0.331
950725-10	--	--	--	--	--	--
950627-14	-0.0161 *	0.198	0.391	0.213	0.122 *	0.492
950621-15	-0.225 *	0.219	0.467	0.205	0.549	0.307
950630-16	0.101 *	0.198	0.511	0.214	0.271 *	0.501
950621-17	0.157 *	0.172	0.439	0.192	0.600	0.262
950622-18	0.111 *	0.198	0.423	0.192	0.808	0.285
950623-19	0.149 *	0.436	0.414 *	0.492	0.995	0.648
950622-21	-0.0354 *	0.205	0.440	0.205	0.0484 *	0.565
950626-22	-0.132 *	0.259	--	--	0.466 *	0.553
950624-24	0.128 *	0.222	0.204 *	0.230	0.196 *	0.548
950724-24	0.0657 *	0.191	0.373	0.255	0.251 *	0.455
950620-25	-0.0676 *	0.213	0.129 *	0.292	0.0780 *	0.493
950724-25	0.0115 *	0.179	0.293	0.183	0.221 *	0.485
950626-27	-0.151 *	0.201	0.521	0.223	0.235 *	0.505
950723-27	-0.00268 *	0.181	0.325	0.191	0.762	0.296
950629-30	-0.0574 *	0.199	0.542	0.218	0.0783 *	0.589
950630-31	0.0666 *	0.181	--	--	0.601	0.462
950726-31	-0.208 *	0.218	0.394 *	0.405	0.0516 *	0.572
950628-32	-0.0973 *	0.195	0.209	0.205	0.433	0.301

Table B3.--*Concentrations and precision estimates of radionuclides, δD, and $\delta^{18}O$ in water samples from springs seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

	Gamma Scan, dissolved					
Sample number	Bismuth-214 (pCi/L)	Bismuth-214, PE (pCi/L)	Lead-214 (pCi/L)	Lead-214, PE (pCi/L)	Radium-223 (pCi/L)	Radium-223, PE (pCi/L)
950620-01	0.134 *	0.359	0.330	0.314	0.232 *	0.777
950623-02	0.893	0.398	0.631	0.330	0.136 *	0.754
950622-03	0.660	0.449	0.712	0.364	0.673 *	0.871
950725-03	0.763	0.444	-0.0416 *	0.406	-0.211 *	0.931
950622-04	1.12	0.440	0.387	0.386	-0.246 *	0.908
950619-05	0.395 *	0.423	0.480	0.370	0.112 *	0.934
950628-06	0.663	0.478	0.609	0.432	0.272 *	1.05
950724-06	0.936	0.458	0.973	0.392	0.0875 *	0.827
950630-07	0.932	0.442	0.465	0.359	0.0634 *	0.894
960726-07	0.864	0.416	0.283 *	0.378	0.208 *	0.849
950629-08	0.708	0.537	0.793	0.472	0.880 *	1.19
950726-08	0.297 *	0.448	0.340 *	0.401	0.167 *	0.963
950627-09	0.744	0.461	0.459	0.407	-0.675 *	0.982
950723-09	0.830	0.444	0.708	0.366	0.0249 *	0.895
950623-10	1.18	0.505	0.666	0.435	0.389 *	1.03
950725-10	--	--	--	--	--	--
950627-14	1.08	0.440	0.828	0.378	-0.341 *	0.894
950621-15	0.844	0.438	0.760	0.391	0.689 *	0.916
950630-16	0.632	0.424	0.326 *	0.354	0.492 *	0.859
950621-17	0.359	0.342	0.254 *	0.310	0.0543 *	0.736
950622-18	0.529	0.375	0.486	0.358	-0.0692 *	0.791
950623-19	1.39	0.917	1.37	0.823	0.617 *	1.91
950622-21	0.659	0.397	0.627	0.380	0.822 *	0.957
950626-22	3.03	0.666	1.80	0.555	0.105 *	1.08
950624-24	1.01	0.529	0.974	0.448	0.481 *	1.05
950724-24	-0.160 *	0.412	0.344 *	0.373	0.586 *	0.934
950620-25	0.799	0.426	0.382	0.341	0.509 *	0.859
950724-25	0.0349 *	0.356	0.135 *	0.307	-0.204 *	0.767
950626-27	0.871	0.417	0.363	0.359	0.0873 *	0.904
950723-27	0.934	0.435	0.256 *	0.385	-0.768 *	0.878
950629-30	0.569	0.413	0.175 *	0.386	0.532 *	0.938
950630-31	1.55	0.451	1.85	0.641	1.38	0.810
950726-31	1.71	0.488	1.31	0.411	1.14	0.910
950628-32	0.623	0.411	0.505	0.388	0.516 *	0.905

Table B3.--*Concentrations and precision estimates of radionuclides, δD, and $\delta^{18}O$ in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

	Gamma Scan, dissolved					
Sample number	Radium-226 (pCi/L)	Radium-226, PE (pCi/L)	Thorium-228 (pCi/L)	Thorium-228, PE (pCi/L)	Radium-228 (pCi/L)	Radium-228, PE (pCi/L)
950620-01	0.134 *	0.359	1.68	0.581	1.94	0.630
950623-02	0.893	0.398	2.00	0.627	1.23	0.679
950622-03	0.661	0.449	0.497 *	0.585	0.819 *	0.825
950725-03	0.763	0.444	1.03	0.784	1.98	0.773
950622-04	1.13	0.440	-0.0473 *	0.627	1.40	0.791
950619-05	0.395 *	0.423	0.701	0.618	1.07	0.750
950628-06	0.663	0.478	1.35	0.731	1.40	0.932
950724-06	0.937	0.458	1.36	0.655	2.84	0.840
950630-07	0.932	0.442	0.712	0.613	1.51	0.814
960726-07	0.864	0.416	1.17	0.631	1.93	0.886
950629-08	0.708	0.537	0.444 *	0.815	0.0289 *	0.940
950726-08	0.297 *	0.448	0.507 *	0.668	1.42	0.825
950627-09	0.744	0.461	0.474 *	1.03	1.07	0.816
950723-09	0.830	0.444	1.35	0.613	1.73	0.799
950623-10	1.18	0.505	0.766	0.683	1.40	0.943
950725-10	--	--	--	--	--	--
950627-14	1.08	0.440	1.14	0.623	1.49	0.755
950621-15	0.844	0.438	1.33	0.585	2.59	0.834
950630-16	0.632	0.424	1.48	0.619	1.49	0.744
950621-17	0.359	0.342	1.25	0.547	1.13	0.656
950622-18	0.529	0.375	1.30	0.589	1.87	0.692
950623-19	1.39	0.917	1.77	1.29	1.32 *	1.81
950622-21	0.659	0.397	1.26	0.585	1.71	0.803
950626-22	3.03	0.666	1.92	0.828	2.26	1.04
950624-24	1.01	0.530	0.706 *	0.881	0.725 *	0.944
950724-24	-0.160 *	0.412	1.08	0.735	1.43	0.851
950620-25	0.799	0.426	0.368 *	0.833	1.26	0.869
950724-25	0.169 *	0.349	0.846	0.528	1.22	0.703
950626-27	0.871	0.417	1.52	0.651	1.46	0.817
950723-27	0.934	0.435	0.939	0.551	1.27	0.783
950629-30	0.569	0.413	1.59	0.638	1.79	0.844
950630-31	2.53	0.666	1.38	0.991	3.38	0.977
950726-31	1.71	0.488	1.13 *	1.17	4.34	1.02
950628-32	0.623	0.411	0.612	0.600	1.34	0.832

Table B3.--*Concentrations and precision estimates of radionuclides, δD, and δ^{18}O in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

	Gamma Scan, dissolved					
Sample number	Uranium-234 (pCi/L)	Uranium-234, PE (pCi/L)	Thorium-234 (pCi/L)	Thorium-234, PE (pCi/L)	Uranium-235 (pCi/L)	Uranium-235, PE (pCi/L)
950620-01	0.306 *	0.583	-2.58 *	33.9	0.201 *	0.702
950623-02	0.821	0.556	-13.4 *	32.8	0.620 *	0.717
950622-03	1.17	0.666	26.6 *	37.2	0.581 *	0.887
950725-03	0.722	0.715	67.4	36.3	-0.514 *	0.958
950622-04	0.339 *	0.645	45.3	36.8	2.21	0.895
950619-05	0.370 *	0.671	40.1	35.9	0.397 *	0.841
950628-06	0.474 *	0.779	35.3 *	38.0	0.814 *	0.970
950724-06	-0.271 *	0.681	16.7 *	34.5	1.10	0.886
950630-07	-0.238 *	0.679	33.5 *	35.7	0.460 *	0.903
960726-07	0.424 *	0.618	12.8 *	35.8	1.28	0.786
950629-08	0.440 *	0.833	-36.3 *	42.3	0.876 *	1.09
950726-08	-0.00550 *	0.733	7.66 *	41.2	1.21 *	1.21
950627-09	0.392 *	0.731	12.1 *	39.8	-0.0130 *	0.928
950723-09	1.09	0.664	-2.43 *	40.0	1.78	0.835
950623-10	1.05	0.767	32.7 *	39.2	2.07	1.03
950725-10	--	--	--	--	--	--
950627-14	0.766	0.661	21.2 *	34.1	0.696 *	0.833
950621-15	-0.189 *	0.689	-4.57 *	31.7	-0.0944 *	0.900
950630-16	-0.0667 *	0.659	27.6 *	38.9	0.808	0.801
950621-17	0.0883 *	0.555	15.4 *	30.9	0.486 *	0.697
950622-18	0.518 *	0.586	8.22 *	34.0	1.78	0.821
950623-19	1.74	1.52	25.4 *	73.7	0.0783 *	1.81
950622-21	1.47	0.699	52.2	35.1	0.680 *	0.887
950626-22	1.71	0.861	93.7	45.7	1.41	1.26
950624-24	1.25	0.789	10.9 *	40.1	0.0537 *	1.00
950724-24	0.0298 *	0.661	21.4 *	35.8	0.502 *	0.858
950620-25	0.988	0.650	-3.90 *	39.4	1.56	0.818
950724-25	0.234 *	0.553	-17.0 *	30.2	1.16	0.717
950626-27	0.812	0.650	18.2 *	33.9	0.707 *	0.803
950723-27	0.825	0.659	41.7	33.5	0.604 *	0.829
950629-30	0.261 *	0.673	25.4 *	34.4	0.321 *	0.970
950630-31	1.93	0.961	33.5	32.7	0.384 *	0.758
950726-31	0.908	0.684	60.0	31.7	0.749 *	0.867
950628-32	0.436 *	0.662	-2.25 *	34.3	0.606 *	0.888

Table B3.--*Concentrations and precision estimates of radionuclides, δD, and $\delta^{18}O$ in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.*--*continued*

Sample number	Gamma Scan, dissolved: Uranium-238 (pCi/L)	Gamma Scan, dissolved: Uranium-238, PE (pCi/L)	δD (per mil VSMOW)	$\delta^{18}O$ (per mil VSMOW)
950620-01	0.330	0.314	-123	--
950623-02	0.631	0.330	-115	--
950622-03	0.712	0.364	-117	--
950725-03	-0.0416 *	0.406	-115	-15.03
950622-04	0.387	0.386	-118	--
950619-05	0.480	0.370	-116	--
950628-06	0.609	0.432	-122	-15.88
950724-06	0.973	0.392	-121	-15.88
950630-07	0.465	0.359	-122	-15.92
960726-07	0.283 *	0.378	-121	-15.87
950629-08	0.793	0.472	-118	-15.55
950726-08	0.340 *	0.401	-116	-15.55
950627-09	0.459	0.407	-117	-15.61
950723-09	0.708	0.366	-116	-15.44
950623-10	0.666	0.435	-122	--
950725-10	--	--	-123	-16.04
950627-14	0.828	0.378	-120	-15.92
950621-15	0.760	0.391	-121	--
950630-16	0.326 *	0.354	-120	-15.64
950621-17	0.254 *	0.310	-121	-15.88
950622-18	0.486	0.358	-122	-15.89
950623-19	1.37	0.823	--	--
950622-21	0.627	0.380	-120	--
950626-22	1.80	0.555	-121	-15.58
950624-24	0.974	0.448	-121	-16.08
950724-24	0.344 *	0.373	-120	-16.07
950620-25	0.382	0.341	-116	--
950724-25	0.135 *	0.307	-110	-13.97
950626-27	0.363	0.359	-118	-15.02
950723-27	0.256 *	0.385	-113	-14.67
950629-30	0.175 *	0.386	-120	-16
950630-31	1.85	0.641	-121	-15.69
950726-31	1.31	0.411	-121	-15.69
950628-32	0.505	0.388	-120	-16.03

* Precision estimate equal to or greater than reported value.

APPENDIX C.--QUALITY ASSURANCE AND ANALYTICAL PRECISION

Five duplicate samples and one field blank were collected during the two field trips. Duplicate samples were collected from sites 6, 7, 14, and 32 during the first field trip, and from site 27 during the second field trip. The differences between laboratory results for duplicate samples shown in tables C1 to C3, reflect the precision of sample collection, processing, and laboratory determinations. The results of the field blank are also listed in tables C1 and C2, and the concentrations of all constituents were near or below the laboratory detection limits.

The percent difference between the concentration of a constituent in an environmental sample concentration and its duplicate was calculated by dividing the absolute difference by the mean value for the sample pair and multiplying by 100 (tables C1 and C2). The percent differences calculated for selected common constituents were generally small (table C1). The percent differences for total aluminum at sites 6 and 14 (170 and 162 percent, respectively), however, were quite high, as was the percent difference for total manganese calculated for site 6 (100 percent). The percent differences calculated for a few trace metals were small (table C2). Yet, the percent differences for most trace metals could not be determined, because the concentrations of most trace metals in the duplicate samples were below laboratory detection limits.

The absolute differences for duplicate samples of most radiochemical constituents were not significant; the total analytical uncertainty at two standard deviations (precision estimate) of one sample usually overlaps the precision estimate of the other. However, there were significant differences between duplicate samples for some constituents. For example, from sites 14 and 32 concentrations of suspended uranium-234 in the environmental samples were significantly greater than in the quality-assurance samples (table C3).

Table C1.--*Percent differences between concentrations of selected common constituents in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash., and in a field blank*

[mg/L, milligrams per liter; µg/L, micrograms per liter; dup, duplicate of preceding sample; <, less than; A, could not determine percent difference because one or more of the concentration values were less than the detectable limit]

Sample number	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)
950628-06	17	5.0	9.7	13	1.4	0.1
950628-06dup	17	4.9	9.5	12	1.8	0.1
percent difference	0	2	2	8	25	0
950630-07	19	4.9	9.0	40	1.5	< 0.1
950630-07dup	19	4.9	9.1	40	1.5	0.1
percent difference	0	0	1	0	0	A
950627-14	11	3.2	7.9	5.2	1.1	< 0.1
950627-14dup	11	3.1	7.9	5.2	0.9	0.1
percent difference	0	3	0	0	20	A
950723-27	12	2.4	6.1	3.9	1.3	0.1
950723-27dup	12	2.4	6.1	4	1.2	0.1
percent difference	0	0	0	3	8	0
950628-32	14	3.6	9.2	5.7	1.7	< 0.1
950628-32dup	14	3.6	9.2	5.7	1.6	< 0.1
percent difference	0	0	0	0	6	A
field blank	< 0.02	< 0.01	< 0.2	< 0.1	< 0.1	< 0.1

Sample number	Silica, dissolved (mg/L as SiO_2)	Aluminum, dissolved (µg/L as Al)	Aluminum, total (µg/L as Al)	Barium, dissolved (µg/L as Ba)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Manganese, total (µg/L as Mn)
950628-06	50	50	120	79	30	6	30
950628-06dup	50	30	1,500	79	37	7	90
percent difference	0	50	170	0	21	15	100
950630-07	35	20	100	13	23	66	120
950630-07dup	35	< 10	80	13	16	69	90
percent difference	0	A	22	0	36	4	29
950627-14	40	160	780	22	180	15	1,200
950627-14dup	39	150	7,500	21	160	4	1,300
percent difference	3	6	162	5	12	116	8
950723-27	39	20	190	25	99	7	20
950723-27dup	39	20	190	25	110	6	< 10
percent difference	0	0	0	0	11	15	A
950628-32	52	110	240	63	69	5	< 10
950628-32dup	52	100	260	64	60	5	20
percent difference	0	10	8	2	14	0	A
field blank	0.01	< 10	< 10	< 2	< 3	< 1	< 10

Table C2.--*Percent differences between concentrations of trace elements in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash., and in a field blank*

[mg/L, milligrams per liter; µg/L, micrograms per liter; dup, duplicate of preceding sample; <, less than; A, could not determine percent difference because one or more of the concentration values were less than the detectable limit; --, no data]

Sample Number	Arsenic, dissolved (mg/L as As)	Beryllium, dissolved (µg/L as Be)	Cadmium, dissolved (µg/L as Cd)	Cadmium, total (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)
950628-06	--	< 0.5	< 1	< 10	< 5	< 3
950628-06dup	--	< 0.5	< 1	< 10	< 5	< 3
percent difference	--	A	A	A	A	A
950630-07	< 1	1.4	< 1	< 10	< 5	< 3
950630-07dup	< 1	< 0.5	1	< 10	< 5	< 3
percent difference	A	A	A	A	A	A
950627-14	--	< 0.5	< 1	< 10	< 5	< 3
950627-14dup	--	< 0.5	< 1	< 10	< 5	< 3
percent difference	--	A	A	A	A	A
950723-27	< 1	< 0.5	<1	< 10	< 5	< 3
950723-27dup	< 1	< 0.5	< 1	< 10	< 5	< 3
percent difference	A	A	A	A	A	A
950628-32	--	< 0.5	2	< 10	< 5	< 3
950628-32dup	--	< 0.5	< 1	< 10	< 5	< 3
percent difference	--	A	A	A	A	A
field blank	< 1	< 0.5	< 1	< 10	< 5	< 3

Sample number	Copper, dissolved (µg/L as Cu)	Copper, total (µg/L as Cu)	Lead, dissolved (µg/L as Pb)	Lithium, dissolved (µg/L as Li)	Mercury, dissolved (mg/L as Hg)	Molybdenum, dissolved (µg/L as Mo)
950628-06	< 10	< 10	< 10	5	< 0.1	< 10
950628-06dup	< 10	< 10	20	4	< 0.1	< 10
percent difference	A	A	A	22	A	A
950630-07	< 10	< 10	< 10	27	< 0.1	10
950630-07dup	< 10	< 10	< 10	28	< 0.1	10
percent difference	A	A	A	4	A	0
950627-14	< 10	< 20	10	11	< 0.1	< 10
950627-14dup	< 10	20	20	10	< 0.1	< 10
percent difference	A	A	67	10	A	A
950723-27	< 10	< 10	20	4	< 0.1	< 10
950723-27dup	< 10	< 10	< 10	6	< 0.1	< 10
percent difference	A	A	A	40	A	A
950628-32	< 10	< 10	< 10	9	< 0.1	< 10
950628-32dup	< 10	< 10	20	9	< 0.1	< 10
percent difference	A	A	A	0	A	A
field blank	< 10	< 10	20	< 4	< 0.1	< 10

Table C2.--*Percent differences between concentrations of trace elements in water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash., and in a field blank--continued*

Sample number	Nickel, dissolved (µg/L as Ni)	Silver, dissolved (µg/L as Ag)	Strontium, dissolved (µg/L as Sr)	Zinc, dissolved (µg/L as Zn)	Zinc, total (µg/L as Zn)
950628-06	< 10	< 1	120	5	< 10
950628-06dup	< 10	< 1	120	< 3	10
percent difference	A	A	0	A	A
950630-07	< 10	1	100	< 3	< 10
950630-07dup	< 10	< 1	100	< 3	< 10
percent difference	A	A	0	A	A
950627-14	< 10	< 1	80	< 3	30
950627-14dup	< 10	< 1	80	< 3	30
percent difference	A	A	0	A	0
950723-27	< 10	1	88	< 3	< 10
950723-27dup	< 10	< 1	88	4	< 10
percent difference	A	A	0	A	A
950628-32	< 10	1	130	< 3	< 10
950628-32dup	< 10	1	130	< 3	< 10
percent difference	A	0	0	A	A
field blank	< 10	< 1	< 0.5	4	< 10

Table C3.--*Comparisons between concentrations of radionuclides, with precision estimates, and of δD and $\delta^{18}O$ in duplicate water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.*

[pCi/L, picocuries per liter; µg/L, micrograms per liter; dup, duplicate of preceding sample; PE, precision estimate; -, concentration of radionuclide less than instrumentation background; --, no data; VSMOW, Vienna Standard Mean Ocean Water]

Sample number	Alpha, gross, dissolved (pCi/L as Thorium-230)	Alpha, gross, dissolved, PE (pCi/L as Thorium-230)	Alpha, gross, dissolved (µg/L as natural Uranium)	Alpha, gross, dissolved, PE (µg/L as natural Uranium)	Beta, gross, dissolved (pCi/L as Strontium-90)	Beta, gross, dissolved, PE (pCi/L as Strontium-90)
950628-06	1.25	1.04	2.06	1.74	3.21	1.18
950628-06dup	1.43	1.12	2.50	1.99	3.25	1.19
950630-07	1.98	1.11	3.24	1.85	3.59	1.07
950630-07dup	2.85	1.36	4.28	2.09	4.50	1.26
950627-14	1.86	1.01	3.12	1.74	2.64	0.904
950627-14dup	2.32	1.09	3.72	1.80	3.54	0.961
950723-27	0.883	0.874	1.22	1.22	3.48	1.13
950723-27dup	0.782	0.851	1.09	1.19	3.65	1.14
950628-32	0.520	0.830	0.859	1.38	3.11	1.18
950628-32dup	1.08	1.04	1.95	1.91	2.04	1.11

Sample number	Beta, gross, dissolved (pCi/L as Cesium-137)	Beta, gross, dissolved, PE (pCi/L as Cesium-137)	Radon-222, dissolved (pCi/L)	Radon-222, dissolved, PE (pCi/L)	Radium-226, dissolved (pCi/L)	Radium-226, dissolved, PE (pCi/L)
950628-06	4.79	1.94	1,100	34	0.198	0.037
950628-06dup	5.02	2.03	1,100	33	0.174	0.036
950630-07	5.32	1.82	--	--	0.310	0.058
950630-07dup	6.36	2.06	--	--	0.334	0.057
950627-14	3.97	1.52	88	19	0.076	0.019
950627-14dup	5.18	1.65	97	20	0.113	0.023
950723-27	4.69	1.70	71	20	0.068	0.015
950723-27dup	4.95	1.74	--	--	0.055	0.015
950628-32	4.64	1.92	1,200	38	0.155	0.031
950628-32dup	3.21	1.83	1,100 *	38	0.188	0.035

Table C3.--*Comparisons between concentrations of radionuclides, with precision estimates, and of δD and $\delta^{18}O$ in duplicate water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Sample number	Radium-226, suspended (pCi/g)	Radium-226, suspended, PE (pCi/g)	Radium-228, dissolved (pCi/L)	Radium-228, dissolved, PE (pCi/L)	Uranium-234, dissolved (pCi/L)	Uranium-234, dissolved, PE (pCi/L)
950628-06	7.73	5.35	1.18	0.545	0.278	0.122
950628-06dup	5.88	2.79	0.642	0.449	0.284	0.067
950630-07	6.98	1.88	1.62	0.713	1.16	0.178
950630-07dup	10.6	4.13	1.47	0.638	1.20	0.202
950627-14	8.96	1.53	0.491	0.417	1.33	0.313
950627-14dup	34.2 *	12.6	0.402	0.412	0.768*	0.129
950723-27	6.46	5.24	0.338	0.286	0.567	0.134
950723-27dup	6.86	3.08	0.370	0.293	0.509	0.100
950628-32	20.8	10.1	0.192	0.408	0.464	0.194
950628-32dup	4.83 *	1.22	0.489	0.475	0.445	0.110

Sample number	Uranium-234, suspended (pCi/g)	Uranium-234, suspended, PE (pCi/g)	Uranium-235, dissolved (pCi/L)	Uranium-235, dissolved, PE (pCi/L)	Uranium-235, suspended (pCi/g)	Uranium-235, suspended. PE (pCi/g)
950628-06	18.8	6.22	0.025	0.046	0.270	0.934
950628-06dup	18.9	4.65	0.002	0.013	0.000	0.637
950630-07	8.92	1.99	0.033	0.022	0.487	0.402
950630-07dup	14.7	4.52	0.033	0.027	0.557	0.845
950627-14	28.5	3.44	0.004	0.046	0.581	0.164
950627-14dup	17.0 *	7.43	0.012	0.019	0.596	1.52
950723-27	11.8	4.71	0.009	0.016	-0.409	0.369
950723-27dup	19.6	4.75	0.016	0.015	0.569	0.908
950628-32	31.0	10.3	0.006	0.047	0.576	2.16
950628-32dup	13.9 *	2.66	0.019	0.021	0.263	0.316

Table C3.--*Comparisons between concentrations of radionuclides, with precision estimates, and of δD and $\delta^{18}O$ in duplicate water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Sample number	Uranium-238, dissolved (pCi/L)	Uranium-238, dissolved, PE (pCi/L)	Uranium-238, suspended (pCi/g)	Uranium-238, suspended, PE (pCi/g)	Lead-210, dissolved (pCi/L)	Lead-210, dissolved, PE (pCi/L)
950628-06	0.198	0.101	13.9	5.26	0.186	0.303
950628-06dup	0.216	0.056	11.5	3.44	0.286	0.307
950630-07	0.848	0.140	8.20	1.88	0.644	0.341
950630-07dup	0.903	0.163	16.5 *	4.82	0.751	0.378
950627-14	0.764	0.215	17.7	2.20	0.691	0.397
950627-14dup	0.565	0.104	23	8.74	1.39	0.51
950723-27	0.564	0.133	11.0	4.54	1.71	0.783
950723-27dup	0.413	0.087	11.6	3.50	0.904	0.676
950628-32	0.438	0.184	18.9	7.84	0.295	0.359
950628-32dup	0.275	0.083	10.3	2.16	0.755	0.399

Sample number	Polonium-210, dissolved (pCi/L)	Polonium-210, dissolved, PE (pCi/L)	Thorium-230, dissolved (pCi/L)	Thorium-230, dissolved, PE (pCi/L)	Thorium-232, dissolved (pCi/L)	Thorium-232, dissolved, PE (pCi/L)
950628-06	0.040	0.037	0.008	0.015	0.003	0.011
950628-06dup	0.0590	0.041	0.021	0.018	0.003	0.008
950630-07	0.176	0.066	0.013	0.017	0.000	0.014
950630-07dup	0.139	0.059	0.000	0.043	-0.003	0.006
950627-14	0.174	0.067	0.008	0.012	0.000	0.013
950627-14dup	0.181	0.074	0.038	0.029	0.020	0.022
950723-27	0.011	0.016	0.014	0.018	0.000	0.015
950723-27dup	0.029	0.030	0.021	0.019	0.003	0.009
950628-32	0.130	0.076	0.036	0.023	0.003	0.007
950628-32dup	0.021 *	0.031	0.015	0.017	0.002	0.009

Table C3.--*Comparisons between concentrations of radionuclides, with precision estimates, and of δD and $\delta^{18}O$ in duplicate water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Sample number	Gamma Scan, dissolved					
	Potassium-40, (pCi/L)	Potassium-40, PE (pCi/L)	Chromium-51 (pCi/L)	Chromium-51, PE (pCi/L)	Cobalt-60 (pCi/L)	Cobalt-60, PE (pCi/L)
950628-06	0.148	8.31	-3.75	4.80	-0.131	0.226
950628-06dup	35.4 *	5.43	2.49	12.7	0.0421	0.234
950630-07	34.9	5.20	0.235	3.51	0.345	0.214
950630-07dup	2.49 *	8.15	-0.925	5.52	0.326	0.315
950627-14	24.2	4.38	-3.25	4.46	0.0607	0.209
950627-14dup	23	4.29	-1.64	3.58	-0.00795	0.178
950723-27	19.3	3.80	0.401	2.97	-0.237	0.232
950723-27dup	27.8 *	4.56	-0.0272	2.82	0.0634	0.193
950628-32	2.66	4.87	0.343	4.68	-0.119	0.220
950628-32dup	63.2 *	9.03	4.57	7.53	0.388	0.362

Sample number	Gamma Scan, dissolved					
	Zinc-65 (pCi/L)	Zinc-65, PE (pCi/L)	Ruthenium-106 (pCi/L)	Ruthenium-106, PE (pCi/L)	Cesium-134 (pCi/L)	Cesium-134, PE (pCi/L)
950628-06	-0.126	0.525	1.40	2.30	-0.129	0.234
950628-06dup	0.481	0.518	0.890	2.08	-0.205	0.218
950630-07	-0.0208	0.498	0.0609	1.86	-0.227	0.215
950630-07dup	-0.252	0.707	2.01	2.68	0.122	0.279
950627-14	-0.0417	0.489	-0.0728	1.83	0.0579	0.185
950627-14dup	0.663	0.414	-1.12	1.62	-0.101	0.165
950723-27	-0.00807	0.459	0.736	1.93	-0.104	0.204
950723-27dup	0.329	0.440	-1.06	1.64	-0.0408	0.163
950628-32	0.0686	0.444	0.294	1.92	-0.0462	0.202
950628-32dup	-0.191	0.901	1.96	3.09	-0.00541	0.335

Table C3.--*Comparisons between concentrations of radionuclides, with precision estimates, and of δD and $\delta^{18}O$ in duplicate water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Sample number	Gamma Scan, dissolved: Cesium-137 (pCi/L)	Cesium-137, PE (pCi/L)	Thallium-208 (pCi/L)	Thallium-208, PE (pCi/L)	Lead-212 (pCi/L)	Lead-212, PE (pCi/L)
950628-06	-0.0156	0.224	0.463	0.251	0.242	0.711
950628-06dup	-0.171	0.209	0.483	0.217	0.835	0.277
950630-07	0.192	0.209	0.246	0.212	0.581	0.289
950630-07dup	-0.0777	0.288	0.328	0.306	0.870	0.378
950627-14	-0.0161	0.198	0.391	0.213	0.122	0.492
950627-14dup	0.0616	0.171	0.417	0.190	0.106	0.461
950723-27	-0.00268	0.181	0.325	0.191	0.762	0.296
950723-27dup	-0.181	0.190	0.329	0.185	0.807	0.268
950628-32	-0.0973	0.195	0.209	0.205	0.433	0.301
950628-32dup	0.553 *	0.354	0.586	0.348	0.749	0.440

Sample number	Gamma Scan, dissolved: Bismuth-214 (pCi/L)	Bismuth-214, PE (pCi/L)	Lead-214 (pCi/L)	Lead-214, PE (pCi/L)	Radium-223 (pCi/L)	Radium-223, PE (pCi/L)
950628-06	0.663	0.478	0.609	0.432	0.272	1.05
950628-06dup	0.692	0.424	0.679	0.360	0.0595	0.827
950630-07	0.932	0.442	0.465	0.359	0.0634	0.894
950630-07dup	0.888	0.618	0.431	0.539	0.548	1.35
950627-14	1.08	0.440	0.828	0.378	-0.341	0.894
950627-14dup	0.299	0.363	0.154	0.300	0.340	0.739
950723-27	0.934	0.435	0.256	0.385	-0.768	0.878
950723-27dup	0.441	0.371	0.326	0.317	0.795	0.751
950628-32	0.623	0.411	0.505	0.388	0.516	0.905
950628-32dup	0.349	0.706	0.477	0.608	0.952	1.33

Table C3.--*Comparisons between concentrations of radionuclides, with precision estimates, and of δD and $\delta^{18}O$ in duplicate water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

	Gamma Scan, dissolved					
Sample number	Radium-226 (pCi/L)	Radium-226, PE (pCi/L)	Thorium-228 (pCi/L)	Thorium-228, PE (pCi/L)	Radium-228 (pCi/L)	Radium-228, PE (pCi/L)
950628-06	0.663	0.478	1.35	0.731	1.40	0.932
950628-06dup	0.692	0.424	1.47	0.662	1.17	0.831
950630-07	0.932	0.442	0.712	0.613	1.51	0.814
950630-07dup	0.888	0.618	0.953	0.888	1.88	1.24
950627-14	1.08	0.440	1.14	0.623	1.49	0.755
950627-14dup	0.299	0.363	1.22	0.555	0.212	0.666
950723-27	0.934	0.435	0.939	0.551	1.27	0.783
950723-27dup	0.441	0.371	0.949	0.535	0.0851	0.709
950628-32	0.623	0.411	0.612	0.600	1.34	0.832
950628-32dup	0.349	0.706	1.71	1.02	1.58	1.27

	Gamma Scan, dissolved					
Sample number	Uranium-234 (pCi/L)	Uranium-234, PE (pCi/L)	Thorium-234 (pCi/L)	Thorium-234, PE (pCi/L)	Uranium-235 (pCi/L)	Uranium-235, PE (pCi/L)
950628-06	0.474	0.779	35.3	38.0	0.814	0.970
950628-06dup	0.694	0.644	5.02	38.1	0.616	0.791
950630-07	-0.238	0.679	33.5	35.7	0.460	0.903
950630-07dup	0.378	0.948	80.0	53.6	0.601	1.25
950627-14	0.766	0.661	21.2	34.1	0.696	0.833
950627-14dup	-0.130	0.563	-41.7	32.6	0.122	0.708
950723-27	0.825	0.659	41.7	33.5	0.604	0.829
950723-27dup	0.462	0.555	26.8	29.8	1.12	0.708
950628-32	0.436	0.662	-2.25	34.3	0.606	0.888
950628-32dup	0.0770	1.14	25.2	60.0	1.45	1.44

Table C3.--*Comparisons between concentrations of radionuclides, with precision estimates, and of δD and $\delta^{18}O$ in duplicate water samples from springs, seeps, and streams in basins adjacent to or near Midnite Mine, Stevens County, Wash.--continued*

Sample number	Gamma Scan, dissolved: Uranium-238 (pCi/L)	Gamma Scan, dissolved: Uranium-238, PE (pCi/L)	δD (per mil VSMOW)	$\delta^{18}O$ (per mil VSMOW)
950628-06	0.609	0.432	-122	-15.88
950628-06dup	0.679	0.360	-121	-15.86
950630-07	0.465	0.359	-122	-15.92
950630-07dup	0.431	0.539	-121	-15.93
950627-14	0.828	0.378	-120	-15.92
950627-14dup	0.154	0.300	-121	-15.82
950723-27	0.256	0.385	-113	-14.67
950723-27dup	0.326	0.317	-115	-14.67
950628-32	0.505	0.388	-120	-16.03
950628-32dup	0.477	0.608	-120	-15.99

* Concentration of duplicate sample is significantly different than concentration of corresponding environmental sample, at a 90-percent confidence level.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1996-791-72?/46012