

Reviewed 9/21
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FINAL VERSION
SITE HAZARD ASSESSMENT
WORKSHEET 1
Summary Score Sheet

SITE INFORMATION:

Ivanhoe Mine
Palmer Mining District
Loomis, Okanogan County, WA 98827

Section/Township/Range: S16 - T39N - R26E
Latitude: 48° 52' 28.93"
Longitude: 119° 34' 28.82"

Ecology Facility Site ID No.: 6245923

Site scored/ranked for the February, 2010 update: September 2, 2009

SITE DESCRIPTION (management areas, substances of concern, and quantities):

The Ivanhoe Mine is located in undeveloped forest land east of Palmer Lake, situated at approximately 3450' elevation on land administered by the Bureau of Land Management. Although abandoned for many years, the mine once reportedly produced ore containing gold, silver, lead, and antimony. Surface workings stripped the hanging wall of a vein over an area of approximately 3,300 square feet. Additional mining was conducted via a shaft sunk to a depth of 1,560 feet. Additional prospect holes are located north of the surface works. A small area of waste rock is situated immediately west of the surface workings.

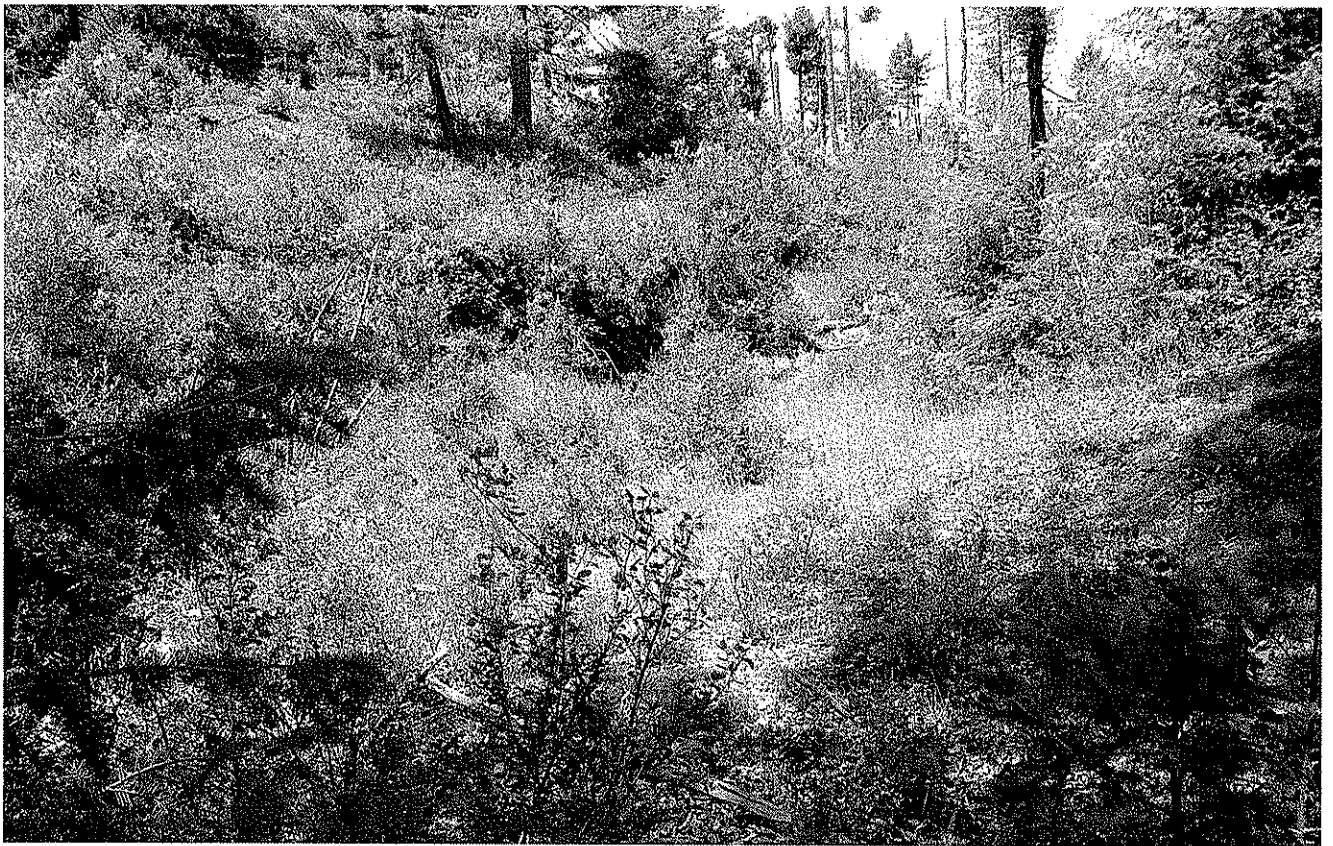


Waste rock pile is being reclaimed by natural vegetation.

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Adit opening at base of surface workings.



View of surface workings, looking north toward adit.

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The site was visited by Michael Huchton, of the Okanogan County Health District, on October 13th, 1995. During this visit, a composite soil sample was created from four locations. This sample was analyzed for Total Metals, as summarized in the table below. Results in bold print indicate contaminants that were present in concentrations exceeding established cleanup levels.

Analyte	Tailings Concentrations (mg/kg)	Cleanup Level (mg/kg)
Antimony	ND	--
Arsenic	486	20
Beryllium	1.45	--
Calcium*	709	--
Chromium	41.0	2000
Lead	25.1	250
Mercury	0.83	2.0
Selenium	0.62	--
Silver	6.71	--
Copper	6.20	--
Zinc	115	--
Nickel	128	--

Cleanup level values reflect Model Toxics Control Act (MTCA) Method A Cleanup Levels for Ground Water and Method A Soil Cleanup Levels for Unrestricted Land Uses.

*It appears that the laboratory inadvertently substituted calcium for cadmium in the analysis results. Because of the very high concentration shown in the results, it is assumed that calcium was the analyte tested, rather than the cadmium test that should have been performed.

This site was revisited on July 9th, 2009, by Douglas Hale of Okanogan County Public Health. All of the features noted in the previous site visit were identified, as well as the newly discovered prospect pits to the north. A small man-made pond was located approximately 560' to the west-southwest; however, there was no drainage or standing water observed in the vicinity of the mine works.

Two soil samples were collected from the waste rock pile, and the lab results are summarized in the table below:

2009 Sample Results

Analyte	Sample IV001 Concentrations (mg/kg)	Sample IV002 Concentrations (mg/kg)	Cleanup Level (mg/kg)
Arsenic	710	525	20
Barium	65.5	148	--
Cadmium	6.50	7.50	2.0
Chromium	21.8	58.0	2000
Lead	19.2	21.0	250
Mercury	0.3070	0.7882	2.0
Selenium	<2.5	<2.5	--
Silver	4.98	<0.25	--

Cleanup level values reflect Model Toxics Control Act (MTCA) Method A Cleanup Levels for Ground Water and Method A Soil Cleanup Levels for Unrestricted Land Uses.



Small pond to southwest of mine site.

SPECIAL CONSIDERATIONS (include limitations in site file data or data which cannot be accommodated in the model, but which are important in evaluating the risk associated with the site, or any other factor(s) over-riding a decision of no further action for the site):

ROUTE SCORES:

Surface Water/Human Health: 6.3
Air/Human Health: 0.8
Groundwater/Human Health: 13.4

Surface Water/Environmental: 13.0
Air/Environmental: 0.0

OVERALL RANK: 5

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WORKSHEET 2
Route Documentation

1. SURFACE WATER ROUTE

- a. List those substances to be considered for scoring: Source: 1,2
Arsenic, cadmium
- b. Explain basis for choice of substance(s) to be used in scoring.
Soil sample analysis shows arsenic and cadmium contamination of on-site soils in excess of MTCA Method A Cleanup Levels for Unrestricted Land Use.
- c. List those management units to be considered for scoring: Source 1,2
Contaminated on-site soils.
- d. Explain basis for choice of unit to be used in scoring:
Analytical confirmation of this contaminant in on-site soils.

2. AIR ROUTE

- a. List those substances to be considered for scoring: Source: 1,2
Arsenic, cadmium
- b. Explain basis for choice of substance(s) to be used in scoring:
Soil sample analysis shows arsenic and cadmium contamination of on-site soils in excess of MTCA Method A Cleanup Levels for Unrestricted Land Use.
- c. List those management units to be considered for scoring: Source: 1,2
Contaminated on-site soils.
- d. Explain basis for choice of unit to be used in scoring:
Analytical confirmation of this contaminant in on-site soils.

3. GROUNDWATER ROUTE

- a. List those substances to be considered for scoring: Source: 1,2
Arsenic, cadmium
- b. Explain basis for choice of substance(s) to be used in scoring:
Soil sample analysis shows arsenic and cadmium contamination of on-site soils in excess of MTCA Method A Cleanup Levels for Unrestricted Land Use.
- c. List those management units to be considered for scoring: Source: 1,2
Contaminated on-site soils.
- d. Explain basis for choice of unit to be used in scoring:
Analytical confirmation of this contaminant in on-site soils.

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WORKSHEET 4

Surface Water Route

1.0 SUBSTANCE CHARACTERISTICS

1.1 Human Toxicity										
Substance		Drinking Water Standard (µg/L)	Value	Acute Toxicity (mg/kg-bw)	Value	Chronic Toxicity (mg/kg/day)	Value	Carcinogenicity		Value
								WOE	PF*	
1	Arsenic	10	8	763 (rat)	5	0.001	3	1	1.75	7
2	Cadmium	5	8	225 (rat)	5	0.0005	5	0.8	ND	--

*Potency Factor

Source: 1, 2, 5

Highest Value: 8
(Max = 10)

Plus 2 Bonus Points? 2

Final Toxicity Value: 10
(Max = 12)

1.2 Environmental Toxicity					
Substance			Acute Water Quality Criteria		Non-Human Mammalian Acute Toxicity
			(µg/L)	Value	(mg/kg) Value
1 Arsenic			360	4	NS --
2 Cadmium			3.9	8	NS --

Source: 1, 2, 5

Highest Value: 8
(Max = 10)

1.3 Substance Quantity	
Explain Basis: 20' x 30' = 600 sq. ft.	Source: <u>1, 6, 11, 15</u> Value: 5 (Max = 10)

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2.0 MIGRATION POTENTIAL

		Source	Value
2.1	Containment: Management unit scored as a spills/discharges/contaminated soil at the surface, with ineffectively maintained run-on/runoff controls (vegetated buffer). Explain basis: Native vegetation provides an un-maintained barrier to runoff.	<u>1, 6, 15</u>	<u>4</u> (Max = 10)
2.2	Surface Soil Permeability: Sands/gravels/gravelly sandy loam	<u>1, 3, 6, 15</u>	<u>1</u> (Max = 7)
2.3	Total Annual Precipitation: 11.6 inches (based on Oroville station)	<u>6, 7</u>	<u>1</u> (Max = 5)
2.4	Max 2yr/24hr Precipitation: 1.20 in	<u>6, 14</u>	<u>2</u> (Max = 5)
2.5	Flood Plain: Not in a flood plain	<u>8, 11</u>	<u>0</u> (Max = 2)
2.6	Terrain Slope: $40'/265' \times 100 = 15.1\%$	<u>11</u>	<u>5</u> (Max = 5)

3.0 TARGETS

		Source	Value
3.1	Distance to Surface Water: >10,000'	<u>11</u>	<u>0</u> (Max = 10)
3.2	Population Served within 2 miles (see WARM Scoring Manual Regarding Direction): $\sqrt{0} = 0$	<u>10</u>	<u>0</u> (Max = 75)
3.3	Area Irrigated by surface water within 2 miles downstream: $0.75 \times \sqrt{\text{acres}} = 0.75 \times \sqrt{0} = 0$	<u>10</u>	<u>0</u> (Max = 30)
3.4	Distance to Nearest Fishery Resource: > 10,000'	<u>11</u>	<u>0</u> (Max = 12)
3.5	Distance to, and Name(s) of, Nearest Sensitive Environment(s): Mine is located on federally administered game management land. A small wetlands is located ~440' southwest of the mine.	<u>11</u>	<u>12</u> (Max = 12)

4.0 RELEASE

Explain Basis: None documented by analytical evidence.	Source: <u>1, 2, 6, 15</u> Value: 0 (Max = 5)
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WORKSHEET 5

Air Route

1.0 SUBSTANCE CHARACTERISTICS

1.1. Introduction – Review WARM Scoring Manual before scoring

1.2 Human Toxicity										
	Substance	Amb. Air Standard (µg/m ³)	Value	Acute Toxicity (mg/ m ³)	Value	Chronic Toxicity (mg/kg/day)	Value	Carcinogenicity		Value
								WOE	PF*	
1	Arsenic	0.00023	10	ND	--	ND	--	1	50	9
2	Cadmium	0.00056	10	25 (rat)	10	ND	--	0.8	6.1	7

* Potency Factor

Source: 5, 6

Highest Value: 10

(Max = 10)

Plus 2 Bonus Points? 2

Final Toxicity Value: 12

(Max = 12)

1.3 Mobility (Use numbers to refer to above listed substances)				
1.3.1 Gaseous Mobility		1.3.2 Particulate Mobility		
Vapor Pressure(s) (mmHg)		Soil Type	Erodibility	Climatic Factor
1		Sandy loam	86	1 - 10

Source: NA

Value: NS

(Max = 4)

Source: 3, 6

Value: 1

(Max = 4)

1.4 Highest Human Health Toxicity/ Mobility Matrix Value (from Table A-7)

Final Matrix Value: 6

(Max = 24)

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1.5 Environmental Toxicity/Mobility						
Substance		Non-human Mammalian Inhalation Toxicity (mg/m ³)	Acute Value	Mobility (mmHg)	Value	Matrix Value
1	Arsenic	ND	--	ND	--	--
2	Cadmium	25 (rat)	10	(particulate)	1	5

Highest Environmental Toxicity/Mobility Matrix Value (from Table A-7)

Final Matrix Value: 5
(Max = 24)

1.6 Substance Quantity	
Explain Basis: Estimated extent of surface soil contamination = approx. 600 sq.ft.	Source: <u>1, 6, 11, 15</u> Value: 4 (Max = 10)

2.0 MIGRATION POTENTIAL

	Source	Value
2.1 Containment: Waste pile outdoors, and uncovered.	<u>1, 6, 15</u>	<u>10</u> (Max = 10)

3.0 TARGETS

	Source	Value
3.1 Nearest Population: Approximately 4,450 ft.	<u>1, 6, 11</u>	<u>2</u> (Max = 10)
3.2 Distance to [and name(s) of] nearest sensitive environment(s) [fisheries excluded]: Not scored, as no environmental toxicity is available.	<u>6, 11</u>	<u>0</u> (Max = 7)
3.3 Population within 0.5 miles: √ pop. = 0	<u>6, 11</u>	<u>0</u> (Max = 75)

4.0 RELEASE

Explain Basis for scoring a release to air: None documented	Source: <u>6</u> Value: 0 (Max = 5)
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WORKSHEET 6
Groundwater Route

1.0 SUBSTANCE CHARACTERISTICS

1.2 Human Toxicity										
Substance	Drinking Water Standard (µg/L)	Value	Acute Toxicity (mg/ kg-bw)	Value	Chronic Toxicity (mg/kg/day)	Value	Carcinogenicity		Value	
							WOE	PF*		
1 Arsenic	10	8	763 (rat)	5	0.001	3	1	1.75	7	
2 Cadmium	5	8	225 (rat)	5	0.0005	5	0.8	ND	--	

* Potency Factor

Source: 1, 2, 5

Highest Value: 8
(Max = 10)

Plus 2 Bonus Points? 2
Final Toxicity Value: 10
(Max = 12)

1.2 Mobility (use numbers to refer to above listed substances)		
Cations/Anions [Coefficient of Aqueous Migration (K)]		OR Solubility (mg/L)
1	Arsenic >1.0 = 3	
2	Cadmium >1.0 = 3	

Source: 5, 6

Value: 3
(Max = 3)

1.3 Substance Quantity:	
Explain basis: 600 sq. ft. x 10' H = 6,000 cu. ft./27 = ~222 cu. yds.	Source: <u>1, 6, 15</u> Value: 3 (Max=10)

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2.0 MIGRATION POTENTIAL

		Source	Value
2.1	Containment (explain basis): Waste pile with no liner, no cover, and unmaintained vegetation acting as runoff control ($3 + 2 + 2 + 1 = 8$).	<u>3</u>	<u>8</u> (Max = 10)
2.2	Net precipitation: $6.4'' - 3.0'' = 3.4''$	<u>7</u>	<u>1</u> (Max = 5)
2.3	Subsurface hydraulic conductivity: Sands/gravels/gravelly sandy loam	<u>1, 3</u>	<u>4</u> (Max = 4)
2.4	Vertical depth to groundwater: Nearest well is located in section 22, and has a depth of 308' to the first significant water bearing layer.	<u>4, 6</u>	<u>1</u> (Max = 8)

3.0 TARGETS

		Source	Value
3.1	Groundwater usage: Private supply, no alternates available	<u>1, 9</u>	<u>5</u> (Max = 10)
3.2	Distance to nearest drinking water well: ~6,640 feet	<u>6, 11</u>	<u>1</u> (Max = 5)
3.3	Population served within 2 miles: $\sqrt{\text{pop. } 20 \text{ homes} \times 3 \text{ residents} = 60}$; $\sqrt{60} = 7.75$	<u>6, 11</u>	<u>8</u> (Max = 100)
3.4	Area irrigated by wells within 2 miles: $0.75 \times \sqrt{\text{acres}} = 0.75 \times \sqrt{0} = 0$	<u>4, 6</u>	<u>0</u> (Max = 50)

4.0 RELEASE

	Source	Value
Explain basis for scoring a release to groundwater: None documented	<u>6</u>	<u>0</u> (Max = 5)

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SOURCES USED IN SCORING

1. Initial Investigation by Michael Huchton, October 13th, 1995.
2. Soil sample analysis reports by Kuo Testing Labs and Cascade Analytical.
3. Soil log(s) on file at Okanogan County Health District.
4. Water Well Reports on file at Okanogan County Health District.
5. Washington Department of Ecology, Toxicology Database for Use in Washington Ranking Method Scoring, January 1992.
6. Washington Department of Ecology, WARM Scoring Manual, April 1992.
7. See attached table identified as Reference 7.
8. Flood Insurance Rate Maps (FIRM).
9. Ecology Water Rights Information System (WRIS).
10. Washington Department of Fish & Wildlife StreamNet database.
11. GIS data layers provided by Okanogan County Planning Department, composite map is attached as Reference 11.
12. US Census 2000 data.
13. SENTRY Public Water system data from Washington Department of Health.
14. NOAA Atlas II Precipitation Frequency Data Output, site specific estimate.
15. Site Hazard Assessment visit by Douglas Hale, July 9th, 2009.