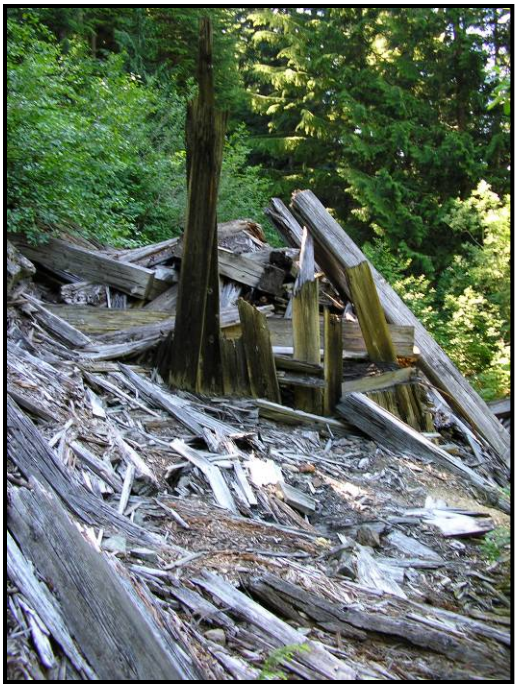

SUMMARY REPORT
ENGINEERING EVALUATION / COST ANALYSIS
Monte Cristo Mining Area
Mt. Baker-Snoqualmie National Forest
Snohomish County, Washington

September 2009

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Date: September 18, 2009

Cover Photographs: Upper Left = United Companies Concentrator; Upper Right = Ore Collector Crusher Base; Lower Left = Mystery Mine Discharge.

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Figure 1. Site Layout Map

1.0 PURPOSE OF REPORT

The purpose of this summary report is to provide the public with a preview of the Engineering Evaluation/Cost Analysis (EECA) that the U.S. Department of Agriculture, Forest Service (Forest Service) and Cascade Earth Sciences (CES) are preparing for the Monte Cristo Mining Area (MCMA). Specifically the Forest Service wishes to: 1) Inform the public of the contamination issues in the MCMA; 2) Provide the public with a possible response to that problem; 3) Obtain initial public reaction to the possible response; and 4) Inform the public of the formal public involvement process that will follow, including the release of a final EECA providing a more detailed discussion of the problem and possible solutions.

The EECA is prepared under the Comprehensive Environmental Response and Liability Act (CERCLA) cleanup authorities [42 USC 9604(a) and 7 Code of Federal Regulations [CFR] 2.60(a)(39)] and Federal Executive Order 12580. This EECA will focus on the mining features listed below and not the entire MCMA; further investigations and response may be needed following the completion of this EECA and any Removal Action selected based on the EECA. The key mining features that will be included in the EECA consist of ten mines and four facilities associated with storage, processing, and ore haulage. These features are listed below:

- Pride of the Mountains Mine
- New Discovery Mine
- Pride of the Woods Mine
- Mystery Mine
- Justice Mine
- Golden Cord Mine
- Rainy Mine
- Sheridan Mine
- Sidney Mine
- Boston-American Mine
- United Companies Concentrator (Concentrator)
- Ore Collector (Collector)
- Assay Shack
- Haulage Ways

The mines and facilities outlined above are geographically divided into four areas; Upper Glacier Creek (Pride of the Mountain, New Discovery, and Pride of the Woods Mines), Mystery Ridge/Basin (Mystery, Justice, and Golden Cord Mines), Lower Glacier Creek and Monte Cristo Townsite (Concentrator, Collector, Assay Shack, Haulage Ways, Rainy Mine, and the Boston-American Mine), and Seventysix Creek (Sheridan and Sidney Mines). The five mines in the Upper Glacier Creek and Seventysix Creek areas are within the Henry M. Jackson Wilderness Area (HMJ Wilderness Area). Table 1 provides relevant information about the ten mines and four facilities and Figure 1 provides a map of the MCMA and associated features.

2.0 LOCATION, ACCESS, AND SETTING

The MCMA is located in Snohomish County, Washington, near the west-center margin of the HMJ Wilderness Area, and approximately 28 air-miles east-southeast of Granite Falls, Washington. Driving time one-way via the Mountain Loop Road from Darrington or Granite Falls to the Barlow Summit trailhead near the MCMA is estimated to be approximately 45 minutes depending on road conditions. The Monte Cristo Townsite (Townsite), which lies at the core of the MCMA at an elevation of 2,755 feet above mean sea level, is reached by hiking or biking about 4.5 miles from the trailhead to the Townsite. The MCMA is drained by two creeks separated by Wilman Peak. Glacier Creek flows west to northwest about 2.5 miles from Glacier Basin to the Townsite, and Seventysix Creek flows northwest about 2 miles to the confluence with Glacier Creek at the Townsite. The headwaters of both streams lie at elevations of well over 6,000 feet, and their confluence at the Townsite marks the beginning of the South Fork of the Sauk River (SFSR) which flows 6.8 miles northwest to and through Monte Cristo Lake (MCL), and continues into the Sauk River, the Skagit River, and eventually Skagit Bay.

3.0 HISTORY

Prospecting in the MCMA began in the spring of 1889, and active claim staking and mine development ensued soon after. A railroad was completed to the Townsite in 1893, and construction began on a 300-tons-per-day concentrator. Mineral production flourished for a few years until massive floods destroyed rail access in 1897. Production was intermittent for a period of time; however, the mines were permanently closed in the fall of 1907. Additional unsuccessful attempts were made to revive the district through the winter of 1920 but due to a variety of reasons, not the least of which were severe weather and access problems, the district has been idle since. A total of 54 mines and prospects, as well as ore transport, storage, and processing facilities, were identified in the district during a U.S. Bureau of Mines study completed in the early 1980's. All mines in the MCMA used standard underground mining practices for the period. Mineral production is estimated to be at least 310,000 tons of ore containing precious and base metals. Most of the production came from the Mystery, New Discovery, Pride of the Mountains, Pride of the Woods, Golden Cord, Comet, Justice, and Rainy Mines. The most significant mineral deposit in the district is the northeast-trending, northwest-dipping shear zone developed by the Justice, Golden Cord, Mystery, Pride of the Woods, New Discovery, and Pride of the Mountains Mines. The zone is exposed underground and on the surface over a strike length of 5,800 feet. Run of mine ore from the Glacier Creek/Basin mines was sent to the Ore Collector for coarse crushing, from there the tailings were discharged to the surrounding land and Glacier Creek.

There have been numerous studies and investigations conducted at the MCMA in the past; previous environmental studies and investigations are summarized below:

- Raforth, R.L., Norman, D.K., and Johnson, Art, 2002. *Second Screening Investigation of Water and Sediment Quality of Creeks in Ten Washington Mining Districts, with Emphasis on Metals*. Washington State Department of Ecology Publication No. 02-03-024, June 2002.
- Forest Service, 2002. *Abbreviated Preliminary Assessment - Monte Cristo Concentrator, Mt. Baker-Snoqualmie National Forest, Snohomish County, Washington.* October 2002.
- Forest Service, 2003. *Abbreviated Preliminary Assessment - Mystery Mine, Mt. Baker-Snoqualmie National Forest, Snohomish County, Washington.* February 2003.
- Wolff, F.E., D.T. McKay, Jr., and D.K. Norman, 2003. *Inactive And Abandoned Mine Lands – Mystery and Justice Mines, Monte Cristo Mining District, Snohomish County, Washington*. Washington Department of Natural Resources, Division of Geology and Earth Resources, Open file Report 2003-7, p. 22. April 2003.
- Crofoot, G.W., and M.L. O'Brien, 2004. *Monte Cristo Mine Area Site Hazard Assessment.* Snohomish Health District and Washington Department of Ecology. January 2004.
- Forest Service, 2006a. *Abbreviated Preliminary Assessment – Sidney Mine in the Monte Cristo Mining District, Mt. Baker-Snoqualmie National Forest, Snohomish County, Washington.* September 2006.
- Forest Service, 2006b. *Abbreviated Preliminary Assessment - Pride of Woods, New Discovery, and Pride of Mountains Mines in the Monte Cristo Mining District, Mt. Baker-Snoqualmie National Forest, Snohomish County, Washington.* September 2006.
- CES, 2008b. *Final Site Inspection Report Monte Cristo Mining Area, Mt. Baker-Snoqualmie National Forest, Snohomish County, Washington*. CES.

4.0 NATURE AND EXTENT OF CONTAMINATION

Analytical results of samples collected during the EECA, the Site Inspection, and earlier studies indicate that concentrations of several contaminants of interest, particularly arsenic, are above screening levels in one or more media at multiple features in the MCMA. Soil and waste rock in the vicinity of the Collector and Concentrator contain the highest concentrations of arsenic in the MCMA, and most of the subject mines

contain very high arsenic concentrations as well. The highest concentrations of arsenic in water occur in mine drainage and dump seeps, particularly at the Pride of the Mountains, Pride of the Woods, and Mystery Mines but several others exhibit elevated arsenic as well. Surface water samples at aquatic stations reveal that higher concentrations of arsenic occur in the downstream reaches of Glacier and Seventysix Creeks, particularly below the mines and processing facilities. Arsenic concentrations generally increase down the SFSR, particularly in MCL. Arsenic concentrations in pore water and sediments at aquatic stations generally follow the same pattern, although arsenic in pore water at MCL is particularly high. This may represent fine tailings transport downstream.

5.0 HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

Antimony, arsenic, and lead were identified as major human health contaminants of potential concern (COPCs). Based on current and future land use, potential receptors were identified as individuals who might come in contact with contaminants through recreational activities (i.e., hunting, hiking, and camping) or as seasonal residents. Due to the remote nature of several of the mines, the MCMA was divided into Near and Remote Features. Near Features were defined as those close to the Townsite, and having fairly easy human access. Remote Features are typified by difficult terrain, lack of amenities, infrequent use, and difficult access. The potential for significant activity is considered to be moderate to high at the Near Features and very low at the Remote Features.

The Risk Assessment determined that there are no unacceptable human health impacts from lead in surface water or in soil/waste rock, and there were no unacceptable non-carcinogenic (i.e., non-cancer) health effects expected from exposure to antimony in soil. Potentially unacceptable non-carcinogenic risks are likely from ingestion of arsenic in soil/waste rock under the worst case exposure conditions, only at Near Features. Unacceptable carcinogenic risks are also likely from ingestion of and dermal contact with arsenic in soil/waste rock, as well as ingestion of sediment under the worst case exposure conditions. Unacceptable carcinogenic risks are also expected from ingestion of arsenic in soil/waste rock under the typical/normal exposure condition, but only at the Near Features. The following table presents the recommended preliminary cleanup goals and the critical pathway of concern for protection of human health.

Preliminary Risk-Based Human Health Cleanup Goals - MCMA

Medium	Arsenic Clean-up Goal	Location	Basis
Soil / Waste Rock	67.4 mg/kg	Near Features	Protection of Worst Case Scenario - ingestion and dermal contact
	658.7 mg/kg	Remote Features	
Sediment	0.06 mg/kg	Near Features	Protection of Worst Case Scenario - ingestion of fish
Surface Water	0.005 µg/L	Near Features	Protection of Worst Case Scenario - ingestion of fish

Notes: mg/kg – milligrams per kilogram; µg/L = micrograms per liter.

There were multiple contaminates identified as contaminates of potential ecological concern (COPECs) as part of the Ecological Risk Assessment. Significant ecological impacts are expected for individual plants and invertebrates exposed to COPECs in soil, waste rock, and tailings near the mines and facilities. Populations of terrestrial plants, invertebrates, birds, and mammals are not predicted to be at risk given the large uncontaminated areas, with better quality habitat, that surround the more contaminated areas. A low, but definite potential for risk was predicted for aquatic receptors exposed to COPECs in surface water. Numerous very high unacceptable risks were calculated for invertebrates and wildlife exposed to COPECs in sediment, particularly for antimony and arsenic. These sediment risks appear to extend several miles downstream from the Townsite.

The pattern of risk reinforces the transport and fate pathways shown in the Conceptual Ecological Exposure Model, with mine adits and waste rock potentially contributing COPECs to the creeks and river, and then deposition of the COPECs to stream sediment. To reduce predicted terrestrial risks, COPEC removal or other action to reduce potential exposures of ecological receptors would be required. Controlling the primary sources of COPECs to Glacier Creek and Seventysix Creek would be a logical first step to reducing predicted risks in the streams adjacent to and downstream from the MCMA. This control could allow effective remediation or natural attenuation of COPECs in downstream sediment.

6.0 ALTERNATIVE REMOVAL ACTIONS

The following are the proposed Removal Action Objectives (RAO) for the MCMA:

- Reduce the human and ecological exposure to contaminants in the mining-related waste rock at mine and ore storage facilities, in process tailings, and in contaminated soils associated with the MCMA.
- Minimize or eliminate potential for contaminant mobilization and transport from contaminated waste rock, tailings, and soils on the MCMA by stabilizing and/or isolating sources.
- Improve surface water quality by decreasing contaminant loading to Glacier Basin and Glacier Creek, Seventysix Creek, and the SFSR from mining- and processing-related sources.
- Reduce human exposure to physical hazards associated with mining- and processing-related features (e.g. open mine workings, ruins of buildings, etc.) on the MCMA.

The EECA will include the following alternatives for detailed analysis:

Mine Waste Alternatives

- Alternative 1: No Action
- Alternative 2: Institutional Controls
- Alternative 3: Onsite Cover
- Alternative 4: Removal and Disposal in MCMA Repository
- Alternative 5: Removal and Offsite Disposal

Adit/Seep Discharge Alternatives

- Alternative 1: No Action
- Alternative 2: Diversion and Infiltration
- Alternative 3: Passive Treatment and Infiltration

As required by the CERCLA guidance and 40 CFR 300.415, the EECA will individually evaluate Removal Action alternatives retained after the initial evaluation and screening against the following three criteria (effectiveness, implementability, and cost) for each of the ten mines and four facilities.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the alternative evaluation and other information developed thus far in the EECA process, preliminary recommended Removal Action alternatives are presented below for Mine Waste (MW) and Adit/Seep Discharge (DW) features, where applicable. The alternatives recommended for each of the ten mines and four processing-related facilities vary based on the unique circumstances of each mine/facility and the most applicable combination of alternatives to best achieve the RAOs. Collectively, these alternatives represent the Draft Recommended Removal Action.

7.1 Common Items

Best Management Practices - During Removal Action activities, Best Management Practices would be used to minimize and control erosion and the sedimentation of surface waters surrounding the MCMA. In addition, special care will be taken to avoid the introduction of noxious weeds during the Removal Action.

Road Access to MCMA and Selected Features – A new access road would be constructed along the north side of the SFSR. The route shown on Figure 1 is conceptual only and does not imply that a specific route is recommended. The proposed road would be constructed to the requirements of a Forest Service Level 2 or 3 road with culverts at minor stream crossings/drainage crossings.

Preservation of Historically Significant Areas –The Ore Collector, Concentrator, and Assay Shack are expected to be considered Historically Significant by State Historic Preservation Office criteria. Therefore, it is proposed that contaminated soil and waste will be carefully removed to preserve structures as much a practical. Some of the waste may be replaced with clean soil or gravel to support the structures as necessary and mimic the original appearance. Removed material would be carefully removed and screened under the supervision of an archeologist who would collect, sort, and catalog all artifacts for offsite storage.

Mitigation of Physical Hazards / Signage – In order to limit public access while maintaining potential bat habitat, bat gates or culverts should be installed at all adits, shafts, or hazardous mine openings, where feasible. In the event that water diversion and treatment alternatives are implemented, modifications and improvements made at the portals should be coordinated with implementation of mine closures. In addition, signs warning the public of the hazards would be installed at the Townsite and at the entrance to the HMJ Wilderness Area.

Restrict or Close the Area to Fishing – The Forest Service would evaluate whether to recommend further restrictions or closure of the surrounding water bodes to fishing due to the elevated concentrations of contaminants in sediment, pore water, and surface water. Additional investigation is needed to assess the downstream migration of contaminates and the impact on aquatic life and the food chain.

7.2 Glacier Basin, HMJ Wilderness Area

MW Alternative 4 - Removal and Disposal in MCMA Repository is recommended for the Pride of the Woods Mine because of the close proximity of the waste rock to Glacier Creek, its location in the floodplain, and the Glacier Basin trail (Forest Service Trail 719) that crosses the waste rock toe bringing many visitors to the mine. MW Alternative 1 – No Action is recommended at the Pride of the Mountains and New Discovery Mines. Although these mines have high concentrations of arsenic and other contaminants in the waste rock; no action is recommended because of the adverse impact of construction activities, the remoteness of the mines in the HMJ Wilderness Area, the stability of the waste rock dumps, the distance above Glacier Creek, and the inherent hazards of excavation with heavy equipment on the extremely steep slopes.

DW Alternative 2 - Diversion and Infiltration is recommended at the Pride of the Mountains and New Discovery Mines. This alternative is an enhanced version of natural infiltration that is actively occurring onsite. Discharge will be captured inside the portal and diverted into a buried pipeline that transports the water to a rapid infiltration basin (RIB). This would eliminate contact of the mine water with and potential leaching of contaminants from waste rock, reduce exposure to humans and the environment, and enhance natural attenuation of metals through contact with native soils. Helicopter access will be required to bring supplies and equipment to the mines.

7.3 Mystery Basin, near HMJ Wilderness Area

MW Alternative 1 – No Action is recommended at the Mystery, Justice, and Golden Cord Mines. Although these mines have high concentrations of arsenic and other contaminants in large waste rock piles; no action is recommended because of the adverse environmental impact of construction activities, the remoteness of the

mines near the HMJ Wilderness Area, the stability of the waste rock dumps, the distance above Glacier Creek, and the inherent hazards of excavation with heavy equipment on the extremely steep slopes.

DW Alternative 3 - Passive Treatment and Infiltration is recommended at the Mystery and Justice Mines. This alternative is very similar to DW Alternative 2, with the addition of an inline system that uses custom manufactured FlocLogs to enhance flocculation and settlement. The added benefit of this alternative is the potential for pH adjustment and the further removal of dissolved metals from the discharge water. Helicopter access will be required to bring supplies and equipment to the mines.

7.4 Seventysix Gulch, HMJ Wilderness Area

MW Alternative 4 - Removal and Disposal in MCMA Repository is recommended for the Sidney Mine because waste rock at the mine is tenuously placed adjacent to Seventysix Creek and has been subject to erosion during seasonal flood events since the dump was constructed. MW Alternative 1 – No Action is recommended at the Sheridan Mine. Although this mine has moderate to high concentrations of arsenic and other contaminants in waste rock; no action is recommended because of the adverse environmental impact of construction activities, the remoteness of the mine in the HMJ Wilderness Area, the stability of the waste rock dumps, the distance above Seventysix Creek, and the inherent hazards of excavation with heavy equipment on the extremely steep slopes.

DW Alternative 2 - Diversion and Infiltration is recommended at the Sidney Mine. Discharge will be captured inside the portal and diverted into a buried pipeline that transports the water to an RIB. This alternative would eliminate contact of the mine water with and potential leaching of contaminants from waste rock, reduce exposure to humans and the environment, and enhance natural attenuation of metals through contact with native soils. Helicopter access will be required to bring supplies and equipment to the mines.

7.5 Lower Glacier Creek and Monte Cristo Townsite Area

MW Alternative 4 - Removal and Disposal in MCMA Repository is recommended for the Rainy Mine, Concentrator, Collector, Assay Shack, and Haulage Ways because of the high concentrations of contaminates in close proximity to the Townsite and the frequency of recreational visitors. The excavated material would be placed in the MCMA Repository, which is discussed in the next section. MW Alternative 1 – No Action is recommended at the Boston American Mine because the contaminate concentrations in the waste rock are relatively low and pose little risk.

DW Alternative 2 - Diversion and Infiltration is recommended at the Boston American Mine to eliminate contact of the mine water with and potential leaching of contaminants from waste rock, reduce exposure to humans and the environment, and enhance natural attenuation of metals through contact with native soils.

DW Alternative 3 - Passive Treatment and Infiltration is recommended at the Rainy Mine, which includes the added benefit of potential for pH adjustment and the further removal of dissolved metals from the discharge water.

7.6 MCMA Repository

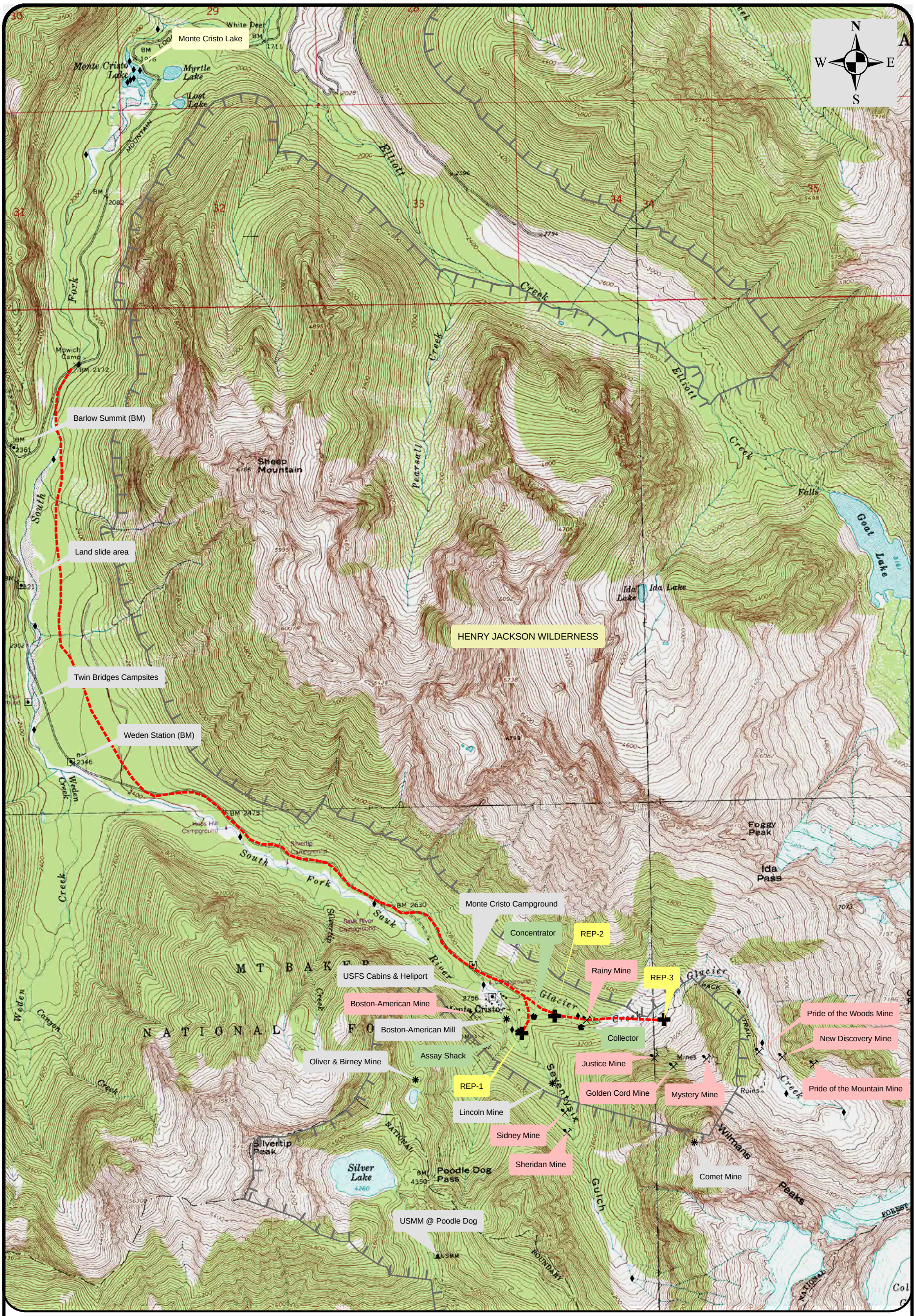
Three candidate repository locations were examined, and REP-1 (which is near the Assay Shack) is proposed as the preferred repository location. REP-1 is proposed because it is readily accessible by road, yet away from the main Glacier Creek Trail; it is of adequate size; the terrain is favorable for containment; and the land appears to be administered by the Forest Service. Under this alternative, waste rock, tailings, and contaminated soils that exceed the risk-based cleanup concentrations from the selected mines and facilities will be excavated, transported, and consolidated in a centralized MCMA repository. The estimated amount of waste material to be located in the repository is 16,000 cubic yards.

Table 1. Selected Information on Mines and Facilities
Monte Cristo Mining Area, Engineering Evaluation / Cost Analysis Summary Report

Mines & Processing-Related Facilities Monte Cristo Mining Area EECA-SI	Ownership - Administration	Workings / Features	Mine Closure (bat gate, culvert, fence, cupola)	Waste Rock, Soil, Tailings, Volume (bcy)		Adit Drainage / Dump Seep Flow Rate (gpm)	Adit Drainage / Dump Seep Total Arsenic (µg/L)
Upper Glacier Creek (Glacier Basin) Area							
Pride of the Mountains Mine	Forest Service; HMJ Wilderness Area	5 adits (2 partially caved and 3 caved); 1 x inclined shaft (mostly caved); 1 large waste rock dump	Bat culvert x 3	5,000	WR	Adit drainage (1.8)	Adit drainage (162 to 6,350)
New Discovery Mine	Forest Service; HMJ Wilderness Area	3 adits (open); 3 waste rock dumps (1 barren)	Bat gate x 3	2,400	WR	Adit drainage (<4.5)	Adit drainage (2.8 to 31.6)
Pride of the Woods Mine	Forest Service; HMJ Wilderness Area	1 adit (partially caved); 1 waste rock dump	Bat culvert x 1	900	WR	Dump seep (0.045)	Dump seep (4,060)
			Sub Total Waste Materials :	**8,300**	**bcy**		
Mystery Ridge/Basin Area near Glacier Creek							
Mystery Mine	Mixed Forest Service and Private	3 adits (1 open; 2 caved); 1 glory hole (open); 2 waste rock dumps; 1 waste rock dump small, dispersed and partially covered	Adit bat gate x 1; glory hole cupola or fence x 1	32,000	WR	Adit drainage (4.5 to 40); dump seep (0.045 to 4.5)	Adit drainage (439 to 3,300); dump seep (240 to 1,100)
Golden Cord Mine	Forest Service	3 adits (all caved); 2 waste rock dumps; 1 dispersed waste rock dump	None	3,500	WR	None	None
Justice Mine	Forest Service	2 adits (1 open; 1 caved); 1 waste rock dump	Bat gate x 1	14,000	WR	Adit drainage (<4.5 to 90); dump seep (1.35)	Adit drainage (196 to 235); dump seep (186 to 264)
			Sub Total Waste Materials :	**49,500**	**bcy**		
Lower Glacier Creek and Monte Cristo Townsite Area							
Rainy Mine	Mixed Forest Service and Private ? ?	1 adit (open); 2 shafts (caved or covered); 1 x 2-level waste rock dump	Bat culvert x 1	3,300	WR	Adit drainage (0.045)	Adit drainage (14.0)
Ore Collector	Private	Stone, concrete, brick, and wood ruins	NA	2,500	WR	None	None
Haulage Ways	Mixed Forest Service and Private ? ?	Estimate 2,500 ft of road and rail routes connect Ore Collector, Concentrator, and Assay Shack	NA	200	S	None	None
Concentrator (United Mines) and Tailings	Mixed Forest Service and Private	Stone, concrete, brick, and wood ruins	NA	8,200	S + T	None	None
Assay Shack	Forest Service	Broken glass and bricks	NA	200	S	None	None
Boston-American Mine	Mixed Private and Forest Service ? ?	1 adit (open, steel door closure); 1 x 2-level waste rock dump	None	6,000	WR	Adit drainage (1.35); dump seep (0.135)	Adit drainage (1.3); dump seep (7.8)
			Sub Total Waste Materials :	**20,400**	**bcy**		
Seventysix Creek Area							
Sheridan Mine	Forest Service; HMJ Wilderness Area	1 adit (open); 1 waste rock dump	Bat gate x 1	650	WR	None	None
Sidney Mine	Forest Service; HMJ Wilderness Area	1 adit (open); 1 waste rock dump	Bat gate x 1	425	WR	Adit drainage (1.35)	Adit drainage (19 to 28.8)
			Sub Total Waste Materials :	**1,075**	**bcy**		

Abbreviations: bcy = bank cubic yards, ft = feet or foot, mi = mile,
gpm = gallons per minute (1 gpm = 0.00223 cubic foot per second),
HMJ = Henry M. Jackson, NA = not applicable, S = soil, T = tailings, WR = waste rock.

Mine Waste Rock =	**70,675**	**Waste Rock Total**
Soil & Tailings =	**8,600**	**Soil and Tailings Total**
TOTAL =	**79,275**	



Legend

- Subject Mines
- Reference Sites
- Subject Facilities
- Repository Candidates
- Other Mines
- Proposed Road
- Aquatic Site Data
- Henry M. Jackson Wilderness Boundary

0 2,300 4,600 9,200 Feet

Figure 1. Site Location Map.

PROJECT NUMBER: 2723029	Monte Cristo Mining Area
DATE: 9/17/09	
DWG BY: 8TCE / DWG NO.: Figure 1.mxd	USDA Forest Service Mt. Baker-Snoqalmie National Forest Monte Cristo, Washington
PROJECT MANAGER: DGW	
REVISED:	CASCADE EARTH SCIENCES A Valmont Industries Company