NATURAL RESOURCES

INACTIVE AND ABANDONED MINE LANDS— Van Stone mine, Northport Mining District, Stevens County, Washington

by Fritz E. Wolff,
Donald T. McKay, Jr.,
and David K. Norman

WASHINGTON
DIVISION OF GEOLOGY
AND EARTH RESOURCES
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site location

WASHINGTON STATE DEPARTMENT OF
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DISCLAIMER

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Inactive and Abandoned Mine Lands— Van Stone Mine, Northport Mining District, Stevens County, Washington

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INTRODUCTION

The Department of Natural Resources (DNR), Division of Geology and Earth Resources (DGER), has created a database (Access software) and a series of written open file reports (OFRs) documenting present-day characteristics of selected Inactive and Abandoned Mine Lands (IAML) in the state. This program of site characterization was initiated in 1999 (Norman, 2000). The continuing body of work was accomplished through interagency grants awarded by the U.S. Forest Service (USFS), Region 6. Documentation focuses on physical characteristics and hazards (openings, structures, materials, and waste) and water-related issues (acid mine drainage and/or metals transport). Accurate location, current ownership, and land status information is included. Acquiring this information is a critical first step in determining if remedial or reclamation activities are warranted and also serves to update information on many properties last characterized during or before the 1970s. The IAML database may be viewed by contacting Fritz Wolff (360-902-1468). The OFRs are online at http://www.wa.gov/dnr/htdocs/ger/iaml.

More than 3800 mineral properties have been located in the state during the last 100 years (Huntting, 1956). Many are undeveloped prospects of little economic importance. Therefore, in considering the population to include in the Inactive and Abandoned Mine Lands (IAML) inventory, we have identified approximately 60 sites that meet one of the following criteria: (a) more than 2000 feet of underground development, (b) more than 10,000 tons of production, (c) location of a known mill site or smelter. This subset of sites includes only metal mines no longer in operation.

We have chosen to use the term *inactive* in the project's title in addition to the term *abandoned* because it more precisely describes the land-use situation regarding mining and avoids any political or legal implications of surrendering an interest to a property that may re-open with changes in economics, technology, or commodity importance.

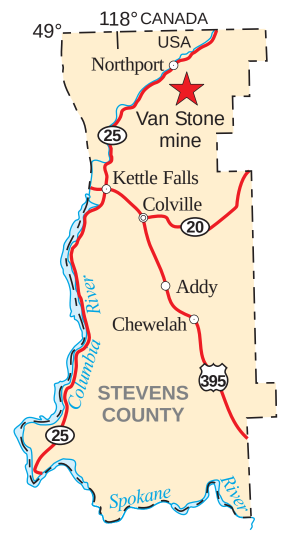
Other agencies sharing information in cooperation with DGER are the U.S. Bureau of Land Management (BLM), the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology (DOE).

SUMMARY

The Van Stone mine is the largest open pit metal mine in Washington at this time, although it is no longer in production and is undergoing closure. The principal commodity produced was zinc, with minor lead, silver, and copper values. It is an example of an inactive mine that is not truly abandoned. The Van Stone is located 24 miles northeast of Colville, Wash. The mine, mill, tailings impoundments, various easements and rights of way, patented claims, and deeded land occupy portions of secs. 27, 28, 29, 30, 32, 33, and 34 of T38N R40E (Fig. 1).

George Van Stone and Henry Maylor discovered galena (lead sulfide) float while deer hunting in 1920 and traced it to an outcrop in an area that is now the South pit. From the date of discovery until Hecla Mining Co. took an option on it in 1926, the owners periodically worked the property. Hecla drove several thousand feet of exploration drifts but abandoned the project two years later.

The tenor of ore from all production averaged 3.8 percent Zn and 0.5 percent Pb. According to Kesten (1970), American Smelting and Refining Co. (Asarco) extracted about 7.5 millions tons of



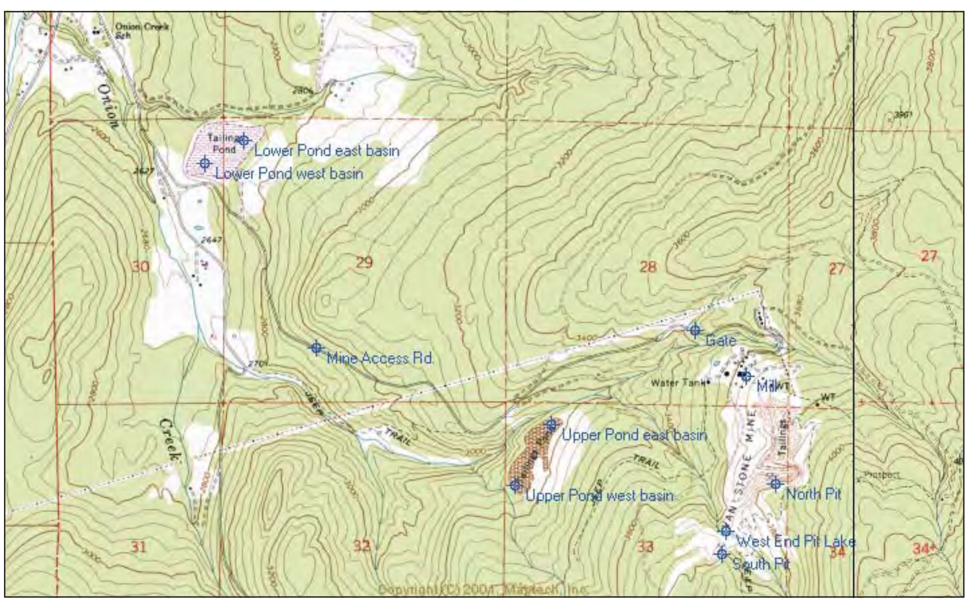


Figure 1. Map showing the location of the Van Stone mine in Stevens County *(top)* and a more detailed map of the mine site showing the tailings impoundments *(bottom)*. Section lines are 1 mile apart.

combined waste rock and ore during the time period 1950 to 1970. After Washington Resources, Inc., purchased the property in 1971, the mine lay idle until purchased by Equinox Resources, Ltd., in 1990. Equinox mined 1.27 million tons, of which 0.27 million tons were ore. Asarco produced about 90 percent of the lead and zinc concentrates shipped from the Van Stone mill, Equinox 10 percent. The total metal recovered from both periods of production was approximately 95,300 tons of zinc and 11,600 tons of lead. Beacon Hill Consultants (1999) estimates that 2.13 million tons of combined ore and waste remain below elevation 3400 feet, now under the West End pit lake.

Water quality is benign in and around the area affected by surface mining, including Middle East Fork Onion Creek, which flows between the North and South pits. Surface waters observed here were clear, exhibited a basic pH ranging from 8.1 to 9.5, and were at or below acceptable levels for cadmium, lead and zinc (Table 6). Impoundments in the Lower tailings pond exhibited elevated lead concentrations. Soil samples taken from the Upper and Lower tailings ponds exhibited lead and zinc concentrations above the levels for unrestricted land use shown in WAC 173-340-900 (Table 4). A small, green-stained area adjacent to the mill's south side analyzed 18,400 ppm copper. Numerous reagent containers were found inside the mill and in tanks at various points outside. The containers appeared sound and uncompromised (Appendix C).

Equinox reactivated the Asarco mill and installed plastic pipe to carry tailings to the Lower impoundment. After obtaining surface mining reclamation permit no. 12667, which required reclamation on portions of the post-1971 waste rock dumps as authorized by the Surface Mining Act [RCW 78.44], Equinox mined an ore body in the west end of the North pit from March 1991 through February 1993, at which time the mill was shut down and the property placed on inactive status. The property has been idle since that time. Equinox Resources went through several permutations of ownership. Mano River Resources, Ltd., of the UK emerged as the parent company in 1998. Although some mitigation work was accomplished on the tailings impoundments post-mining, Equinox/Mano River failed to meet the conditions stipulated in the reclamation permit.

Figure 2. Streaks of sphalerite in dolomite. Pen for scale.

Figure 3. Overview of the North pit (foreground) and West End pit (background) with pit lake. View to the west.

Advantage Real Estate, a Colville, Wash., firm, took possession of the property from Mano River in 2005. Advantage is in the process of selling the equipment and recycling certain infrastructure materials. Cunningham Engineers and Advantage have planned a tailings stabilization program for near-future implementation. Major elements of the work plan are shown in Appendix D.

HISTORY

Local residents George Van Stone and Henry Maylor discovered galena float while deer hunting in 1920 and traced it to an outcrop in an area that is now the South pit. From the date of discovery until Hecla Mining Co. took an option on it in 1926, the owners worked the property periodically. These efforts were frustrated by two problems, which only became clear as time and development progressed: (1) The mineralization in the Van Stone orebody is approximately 90 percent zinc and 10 percent lead. Since no mill had been constructed to separate the fractions, the material shipped to lead smelters carried a steep penalty for zinc content. (2) The mineralization contains discontinuous streaks of high grade in places, followed by barren ground or narrow stringers and isolated pods and disseminations. The spotty mineralization created a substantial operations problem for a small-scale underground operation.

Hecla Mining Co. took an option on the property in 1926 and carried out considerable exploration and underground development work (Huttl, 1953). Surface mining at the South pit consumed the underground development in 1953. We believe the adit was located at about the current pit floor elevation adjacent to the East Middle Fork Onion Creek. Hecla surrendered its option in 1927.

The mine remained idle until 1939 when Willow Creek Mines of Nevada, Inc., acquired a lease and option agreement. Willow Creek drilled 69 diamond drill holes delineating the South orebody, and additionally discovered the extensive North orebody, which produced most of the historic values. American Smelting and Refining Co. (Asarco) took over the property from Willow Creek in 1950 and continued exploration drilling through the greater part of 1951. This work developed sufficient ore at economically recoverable depths and grades to warrant construction of a 1000-tpd flotation mill. The first shipment of lead and zinc concentrates took place in November 1952 (Huttl, 1953). Asarco built considerable infrastructure to support such a large-scale operation. The property has a machine shop, repair shop, engineering and staff office, core shed, scale house, and a number of loading docks and storage sheds for reagents and petroleum products. The buildings, all of which are in excellent condition, are standard wood-frame construction with galvanized sheet-metal siding and roofs.

Figure 4. West End pit lake. Note glacial alluvium slope in foreground. View to the northwest.

Figure 5. North pit. View to the east.

During Asarco's period of operation, 7.5 million tons were mined from the South and North pits. Of the total, approximately 2.675 million tons were classified as ore and thus processed by the mill. The tailing slurries were thickened near the mill and discharged downhill to an impoundment via 8-inch wood-stave pipe, later replaced with cement-asbestos pipe. (This impoundment is referred to as the Upper tailings pond in the remainder of the report.) In 1961, the west berm of the Upper pond failed, releasing water into Onion Creek, which flooded the Clugston–Onion Creek country road (*Statesman Examiner*, April 26, 1961). This event prompted construction of the Lower tailings impoundment located in the NW¼ sec. 29 and NE¼ sec. 30 and necessitated extension of the tailings line a distance of approximately 2 miles to the new site. Asarco's operation was shut down periodically due to low metal prices (1957–1964, 1967–1969). In 1970, Asarco discovered a new ore body at lower elevations, adjacent to but west of the North pit, and sold the property the following year to Sumerian Mining Co. of Spokane, also known as Atlas Mine and Mill Supply and Washington Resources, Inc.

In June of 1971, Sumerian assigned purchasing rights to Callahan Mining Co. of Idaho. Callahan's partners in the project were U.S. Borax and Chemical, Inc., and Brinco, Ltd. Callahan conducted additional drilling and drove an exploration drift into the west orebody, but mined no ore.

Equinox Resources, Ltd., purchased the property in 1990. Equinox reactivated the Asarco mill and installed plastic pipe to carry tailings to the Lower impoundment. After obtaining surface mining reclamation permit no. 12667, which required reclamation of portions of the post-1971 waste rock dumps, Equinox started mining in March 1991 and continued until February 1993, at which time the mill was shut down and the property placed on inactive status. No mining has taken place since that time. Equinox mined a total of 1.27 million tons, of which 0.27 million tons are classified as proven ore at a cutoff grade of 2 percent combined lead and zinc. Equinox Resources became a wholly owned subsidiary of Mano River Resources, Ltd., of the UK in 1998. Mano River/Equinox accomplished some mitigation work on the tailings impoundments after cessation of mining, but failed to meet the conditions stipulated in the reclamation permit. The Washington State Department of Ecology

(DOE) is lead agency on issues at the Van Stone dealing with tailings, mill site, water quality, and dam safety. DGER is lead agency on issues dealing with the two open pits and waste rock dumps.

Advantage Real Estate, Colville, Wash., took possession of the property from Mano River in 2005. Advantage is in the process of selling the equipment and recycling certain infrastructure materials. Cunningham Engineers and Advantage have planned a tailings stabilization program for near-future implementation. Major elements of the work plan are shown in Appendix D.

GEOLOGIC SETTING

The Metaline Limestone is the principal host for lead-zinc mineralization in northeastern Washington. Yates and others (1964) places the Van Stone mineralization in the Middle Unit, which is principally dolomite. Early investigators felt the mineralization at Van Stone originated by hydrothermal replacement due to the orebody's close proximity to the granitic Spirit pluton. Later investigators (Neitzel, 1972) found evidence that the sulfide mineralization was of syngenetic origin modified by one or more periods of regional metamorphism, overturned folding, and finally thermal metamorphism that caused recrystallization and grain growth of both the dolomite and sulfides. These processes have concentrated what may have been disseminated galena and sphalerite into streaks, pods, and elongated tabular masses of commercial ore (Fig. 2). These features make up the higher-grade portions of the ore body separated by low-grade areas where the sulfides are found in small streaks and lenticles (Mills, 1977).

Figure 6. South pit. Geologist for scale (arrow). View to the south.

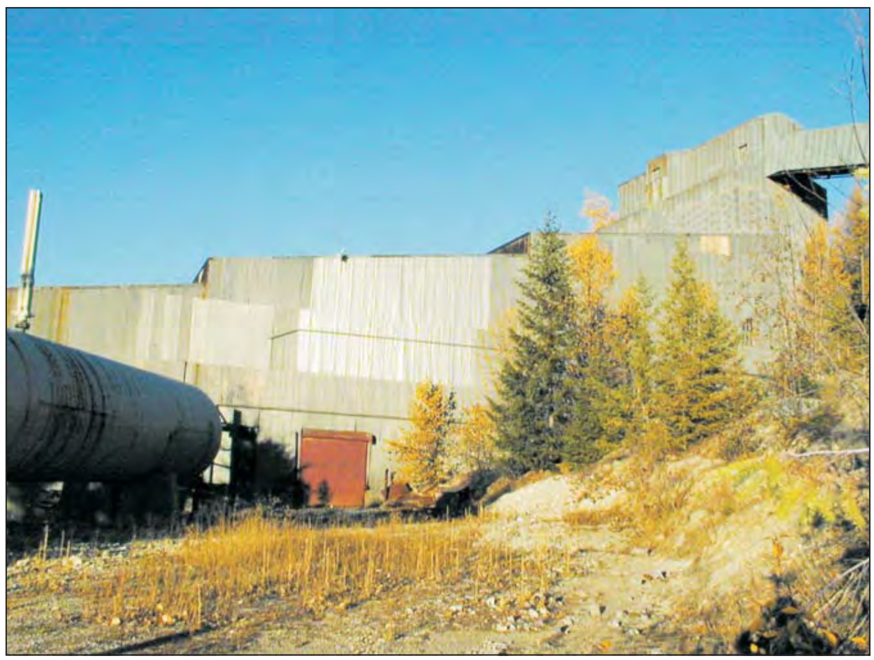


Figure 7. Mill buildings. View to the north.

OPENINGS

The North pit (Figs. 3–5) is a composite of two different operations separated in time, but contiguous geographically. We refer to the area mined initially by Asarco as the North pit highwall and the area mined by Equinox as the West End pit. The North pit highwall excavation is 400 feet wide rim-to-rim and approximately 1000 feet long. Its longitudinal axis strikes N80E. The floor is littered with boulders and scree. The pit walls show significant structural cracks and signs of failure. The difference between the highest rim elevation and the pit floor is approximately 430 feet. The area is inaccessible except by helicopter or boat because the benches transition into cliff bands and the West End pit lake prohibits land access at the pit floor.

The West End pit is 700 feet long and 700 feet wide, including pit walls. With the exception of an unexcavated blast at a bench on the north side of the lake, all the mining done by Equinox was below the current water level at elevation 3510 down to elevation 3400 (Randy Miller, caretaker, written commun., 2003). The south bank of the lake is a steep and badly eroding exposure of glacial alluvium.

The South pit (Fig. 6) is smaller and structurally in better condition than either end of the North pit. It lies 130 feet above the West End outlet dam and approximately 1000 feet south. It resembles a box canyon in that the entry and exit points are through a narrow cut in the northwest corner. Maximum elevation difference from rim to floor is 180 feet. Snowmelt and precipitation have created a lake 2 to 3 feet deep in the center.

STRUCTURES

The mill building and crusher plant are the largest structures on the property (Figs. 7 and 8). Both were in excellent condition in October 2002. A machine shop, warehouse, and receiving shed are located near the north side of the mill. A core-storage shack, assay office, mine office, and scale house are closely spaced along the entry road. A two-ton flatbed truck with hydraulic

Figure 8. *(top)* Rock house, crusher plant, and connecting conveyer feed to mill on the left. View to the south.

Figure 9. *(middle)* Tailings thickener. Mill in background. View to the east.

Figure 10. *(bottom)* Cement-asbestos pipe stockpile.

boom is parked in the scale house. A vehicle repair garage and mine operations office (one building) stand uphill east of the mill. A 100-foot diameter tailings thickener lies about 75 feet to the west of the mill at a slightly lower elevation (Fig. 9). Two shacks were constructed due west of the thickener along what appears to be the Equinox tailings discharge line. One contains a pump used to return waste water from the thickener to the mill. It is unknown whether the tailings line was flushed at the time of shut down or is full of tailings.

Beacon Hill (1999) states that the Equinox holdings include 200M, 60M, and 20M-gallon water tanks, associated water mains and hydrants, and a water right to 75 gpm from the NE¼NE¼ sec. 30. A water retention dam and weir house located in sec. 4, T37N R40E, is described as “covered by Special Use Permit from the Colville National Forest, dated 1960, subject to re-issuance”.

MATERIALS

The mill and all support-building infrastructure and equipment are in essentially the same condition and location as they were at the time Equinox stopped mining. For this reason, mill reagents, solvents, fuels, and hazardous materials are found at many places, principally in and around the mill and shop area. (See Appendix C for a complete list.)

It is impossible to say how many thousands of feet of buried pipeline exist, and although we have identified the various materials, we can’t know which lines are which. As discussed under Milling Operations below, the original Asarco-installed tailings line was 8-inch wood-stave pipe. After the Upper tailings dam failed, there is some evidence to support the idea that the follow-on line was 8-inch cement-asbestos (C-A). We found in excess of 1000 feet of C-A pipe stored near the mill (Fig. 10), and an 8-inch C-A discharge pipe enters the Lower tailings pond at the northeast corner. According to caretaker Randy Miller, all the wood-stave and cement-asbestos pipe were purchased and used by Asarco (written commun., 2003).

The Equinox era is characterized by 8-inch black ABS continuous-welded pipe. It appears to be buried in an excavation leading due west from the thickener wheel toward the tailing pond(s). A long length of this material was also found along the haul road leading down to the pit lake. Equinox installed 6-inch steel pipe with Victaulic couplings to return wastewater to the mill from the Lower pond.

We observed various installations of ABS, steel, and C-A pipe at both the Upper and Lower ponds.

Figure 11. *(top)* Aquatic plant *Veronica anagallis-aquatica* at West End pit lake berm.

Figure 12. *(middle)* Flotation reagent containers on ball mill floor.

Figure 13. *(bottom)* Ball mill and rake classifier in mill.

WATER

Water on the Van Stone site appears relatively benign with a one exception. Water samples taken at the West End pit lake and Middle East Fork Onion Creek met the requirements for cadmium, lead and zinc listed in two Washington State water quality standards: WAC 173-201 (surface water) and WAC 246-290 (ground water)(Table 6). Lead content from samples taken at the Lower tailings pond east and west basins exceeded these standards.

The West End pit lake is approximately 5 acres in area and 100 feet deep. Its static elevation is 3510 feet. It is dammed by a rock-fill berm 30 feet wide that allows water to seep into the adjacent Middle East Fork Onion Creek (Beacon Hill, 1999). During years of high snowfall, the spring runoff may create an overflow condition at the berm. Lentz (2002) observed an estimated discharge over the berm of 20 gpm in May 2001. He estimated that drainage from the Highwall pit contributes 5 to 10 gpm to the West End lake each year. We observed a considerable growth of aquatic plants in the gently sloping littoral area near the lakeshore. Lentz (2002) reported that the plant had been identified as *Veronica anagallis-aquatica* (Fig. 11) and stated that it is "ubiquitous around the entire shoreline, even occupying steep rocky slopes of the lakebed." We observed a diverse benthic macroinvertebrate group identified by Marc Hayes (DNR, written commun., 2002): caddisflies, segmented worms, stoneflies, and true bugs (Homoptera). This sample is indicative of moderately high water quality. The sample taken here meets the requirements of ground and surface water standards for cadmium, lead, and zinc (Table 6).

The South Pit lake is approximately 0.1 acre in area and 3 feet deep. In October 2002, the surface was several feet below the pit's entrance throat at elevation 3640 feet. It does not appear to overflow into Middle East Fork Onion Creek. No plant or aquatic life was observed. Analysis of the sample taken here slightly exceeds the hardness-dependent standard for zinc shown in Appendix B.

Samples taken at both basins of the Lower tailings pond exceed ground and surface water standards for lead by 10 to 15 orders of magnitude, but the zinc analyses met both standards.

The two basins at the Upper tailings pond are separated by a dam. The west basin is dry. Water impounded in the east basin is approximately 8 feet deep. Safety considerations precluded sampling. The pond's plastic liner is failing in places.

Figure 14. *(top)* Galena (PbS) concentrate on bottom of rake pan.

Figure 15. *(middle)* Reagent feeders on balcony with flotation cells in background on lower floor.

Figure 16. *(bottom)* Copper sulfate solution storage tanks in mill building. Source of crystal deposits lower right unknown.

MILLING OPERATIONS

The 100- tpd flotation mill constructed by Asarco in 1952 was a state-of-the-art operation for the time. It is a steel-frame building covered with galvanized sheet metal located on a hillside several thousand feet north of the open pit. Run of mine ore was crushed to pass through a –½ inch screen at the rock house located south of the mill. A gallery of inclined metal-covered conveyor belts delivered mill feed to the top floor of the mill.

Although the mill was shut down at the end of Asarco's tenure in 1970, it was reactivated and put in production by Equinox in 1991. At the time of DGER's site characterization in October 2002, the mill structure was intact and all machinery in place, including a significant quantity of reagents (Fig. 12). (See Appendix C.) Huttl's (1953) description of the mill includes the following information: "10 x 20 foot access doors at each of the mill's three levels facilitate efficient maintenance and recharging of consumable materials. On the grinding level, two Marcy grate-discharge balls mills (Fig. 13) operate in closed circuit with Dorr rake classifiers (Fig. 14). Four banks of six flotation machines each are located on the mid-level. Flotation reagents are added from feeders (Fig. 15) located on a balcony." On the lowest level, we found two 2500-gallon fiberglass storage tanks and one 1500-gallon tank for copper sulfate solution (Fig. 16), together with pumps, air compressors, approximately two tons of sodium carbonate in large sacks (Fig. 17), and separate storage bins for lead and zinc concentrate. The two large tanks are empty. The 1500-gallon tank is mostly full. Copper sulfate was used to activate the surface of sphalerite prior to flotation, and sodium carbonate additions controlled pH.

The classifier pans, flotation cells, and concentrate storage bins contained 3 to 4 inches of caked sphalerite and galena. Concentrate spilled out of the storage bins onto the loading platform. A soil sample taken outside the mill at a point 25 feet south of the lower floor contained 184,000 mg/kg copper (18.4%). The area affected is approximately 100 square feet (Fig. 18). Two 3000-gallon tanks, located a few feet south of the upper mill level and connected to it by plumbing, contained an unknown petroleum product (Fig. 19). The tanks were not labeled. We opened a valve to obtain a sample (not analyzed). The material may have been a solvent frothing agent. It was not diesel or gasoline.

Figure 17. *(top)* Sodium carbonate (sacks) and copper sulfate (barrels) on mill bottom floor.

Figure 18. *(left)* Copper sulfate spill in soil. Mill door in background. View to the north.

Figure 19. *(middle)* Unknown petroleum product storage tanks (full).

Figure 20. *(bottom)* Upper tailings site, west basin. View to the southwest. Note dam failure at upper right corner (arrow).

WASTE ROCK DUMPS AND TAILINGS

The total volume of waste rock removed during all mining operations is estimated at 5.7 million tons. Some glacial overburden was removed in the early phases, but most of the material is dolomitic limestone shot rock. Waste rock dumps are spread over the entire area between the mill and the West End pit lake, a distance of about 2000 feet. The largest dump on the western extremity of the disturbed area extends 125 feet above the pre-mining land surface. Particles range from about 3-foot boulders to cobblestones and gravel. Five waste rock dumps are located within 600 feet east and west of the South pit.

Mill tailings were discharged at two widely separated sites: Asarco (1952–1970) initiated use of the Upper site in 1952 and the Lower site in 1961. Equinox (1990–1993) replaced the original wood-stave pipe with ABS pipe and discharged at the Lower site. The tailings at both sites are of the same composition as the dolomitic limestone host rock, ground to –200 mesh (Huttl, 1953). It doesn't appear that any effort was made to stabilize the im-



Figure 21. *(top)* Upper tailings pond, east basin. View to the east.

Figure 22. *(middle)* Upper tailings pond, point of 1961 berm failure in west basin. View to the northwest.

Figure 23. *(bottom)* Lower tailings pond outfall. View to the northwest. Channel lined with riprap and fabric.

poundment perimeters. All section numbers referenced below are in T38N R40E.

Upper Tailings Pond

The first tailings impoundment used by Asarco is located in the NW¼ sec. 33, about 0.75 miles west of the mill at an average elevation of 3194 feet. The exact location of the 8-inch wood-stave discharge line cannot be ascertained from the surface, but historic maps indicate that it headed south from the thickener, crossed Middle East Fork Onion Creek and turned west toward the impoundment. The impoundment has a west basin largely filled to the top of the berm. Grasses and lodgepole pine seedlings are becoming established, small cottonwoods to 3 feet tall are common, and inland cedar saplings are present but sparse (Fig. 20). The east basin is lined with black polyethylene and contains water 6 to 8 feet deep whose surface lies 8 feet below the top of the berm (Fig. 21). The liner is brittle, cracking, and ripped in places.

In April 1961, the dam at the western extreme end of the west basin failed (Fig. 22), sending a wall of water down Onion Creek. The flood widened Onion Creek by 20 to 30 feet and created a debris dam that plugged a culvert at the county road and eventually failed. Oddly, we found little evidence of erosion or rilling downslope from the breech. The channel supports a vigorous stand of pine and fir. It appears Asarco abandoned this disposal area soon after the accidental discharge in favor of an 80-acre site in secs. 29 and 30, approximately 2 miles to the northwest. Some revegetation has taken place on the west basin. Equinox installed an 8-inch ABS tailings discharge line to the Upper site in case of failure at the Lower repository. This line, which was never used (Miller, written commun., 2002), can be seen emerging from the forest near the south end of the berm separating the two basins.

Lower Tailings Pond

The tailings line to the Lower pond crosses the mine access road and continues cross-country by virtue of various easements and rights of way in a circuitous route north of the road. The line's location can be seen on the 1970 DNR aerial photo series (black and white), and faintly on the NE-C-2000 color air photos. The site covers approximately 37 acres. An outfall channel in the northeast corner of the east basin provides a means of egress for meltwater collecting in the pond. The channel bed is lined with fabric and some rock (Fig. 23). The outfall invert, at elevation 2698, was 4 feet above the pool height in October 2002. Both basins at this site contain stands of bul-

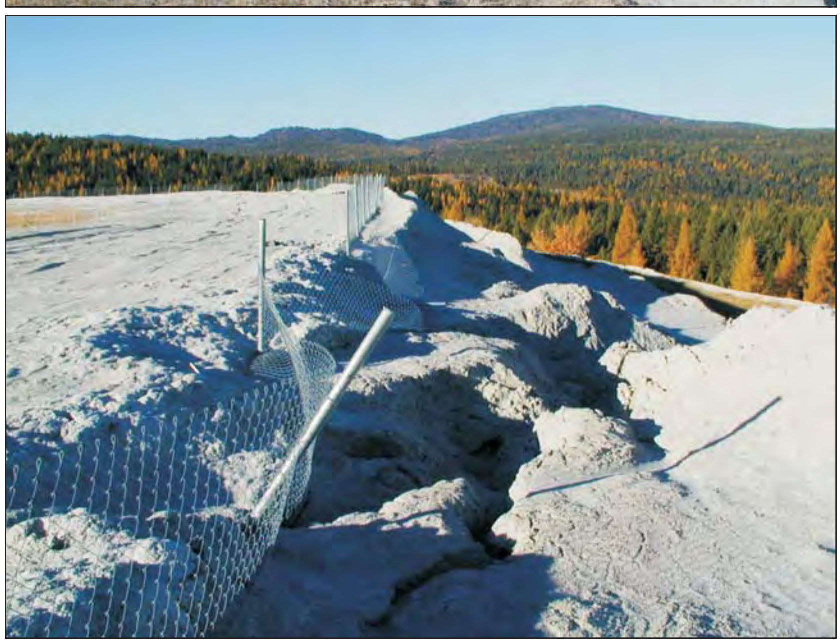


Figure 24. *(top)* Bullrush stand at Lower tailings pond, west basin. View to the southwest taken October 2002.

Figure 25. *(middle)* Bench between lifts at Lower tailings pond. View to the west taken October 2002.

Figure 26. *(bottom)* Rilling and erosion at the northwest corner of the Lower tailings pond. View to the southwest taken October 2002.

rushes and grass covering about 10 percent of the total surface (Fig. 24). Eight-inch cement-asbestos pipe and wood-stave pipe from the Asarco era lie on the surface in various places. Stacks of black ABS flexible tailings line and 6-inch steel water-return line from the Equinox era are also located at numerous points. According to caretaker Randy Miller (written commun., 2003) all of the tailings produced by Equinox were discharged at the lower site. The height of the impoundment dam varies from 30 feet at the northeast corner to 90 and 100 feet respectively on the south and west extremities. Two lifts are present, separated by a 30-foot-wide bench (Fig. 25). The edges of the berm are rilled with holes, cracks, gullies, and it is piping in places. A chain link fence is intact on parts of the perimeter, but collapsed at other points where the berm has slumped (Fig. 26).

We observed breeding pairs of mallards, goldeneyes, buffleheads, and hooded mergansers on the impounded water surface in both basins.

Equinox constructed an approximately 1-acre waste-water retention pond near the southeast corner of the Lower pond, but Miller (written commun., 2003) stated that it was never put in use. It is fenced and contains a small amount of standing water and thick algae (Fig. 27).

GENERAL INFORMATION

Name: Van Stone

MAS/MILS sequence number: 0530650434

Access: two-wheel drive

Status of mining activity: none

Claim status: Four patented claims: Mother Lode, North Star, Noonday, and Moonlight under mineral survey no. 1288 embracing a portion of sec. 34, T38N R40E, dated 8/20/1957. Unpatented claims are closed (BLM Land and Mineral Records LR2000 database, 2005).

Current ownership: Jack McKotter (Advantage Real Estate, Colville, Wash.)

Surrounding land status: private

Location and map information: see Table 1

Directions: From Northport on the east bank of the Columbia River, proceed 4 miles south on State Route 25 toward Kettle Falls to the Clugston–Onion Creek Road. Turn left and proceed about 6 miles south on the county road to the Onion Creek School and the intersection with the Van Stone mine access road. Bear left or east on the mine road and continue in a southeasterly direction approximately 4 miles to the mine site. A locked gate about ¼ mile from the mine office prohibits direct road access to the property. Contact Randy Miller (509-732-6672) for permission to enter.

MINE OPERATIONS DATA

Type of mine: open pit

Commodities mined: zinc, lead, silver

Geologic setting: brecciated dolomite unit of the Middle Cambrian Metaline Limestone

Ore minerals: sphalerite, galena, chalcopyrite

Non-ore minerals: quartz, pyrite

Period of production: 1952–1970, 1991–1993

Development: two open pits

Production: 8.77 million tons combined ore and waste

Mill data: 1950s flotation mill; zinc and lead concentrates

PHYSICAL ATTRIBUTES

Features: see Table 2

Materials: see Appendix C

Machinery: see above

Structures: see above

Waste rock dumps, tailings, impoundments, highwalls, or pit walls: see above

Analysis of tailings and dumps: see Tables 3 and 4

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

Reclamation activity: Partial revegetation at upper and lower tailings ponds (bulrushes, grass, cottonwoods) lining of outfall at lower pond. No reclamation of waste rock dumps or pit walls.

VEGETATION

Sparse fir and larch, willows, grass. The waste rock dumps are barren.

WILDLIFE

We observed deer, elk, and bear on the site, as well as lark sparrows feeding on seeds. Breeding pairs of mallards, goldeneyes, buffleheads, and hooded mergansers were noted on both basins of the Lower tailings pond.

WATER QUALITY

Surface waters observed: Middle East Fork Onion Creek

Proximity to surface waters: 0 feet

Domestic use: none

Acid mine drainage or staining: no

Figure 27. Waste-water retention facility near the Lower tailings pond. View to the southwest.

Table 1. Location and map information.

Mine property	County	Location	Decimal latitude	Decimal longitude	1:24,000 quad.	1:100,000 quad.
Van Stone	Stevens	secs. 27–30,32–34, T38N R40E	48.7606	117.7564	Onion Creek	Colville

Table 2. Mine features.

Description	Condition	Fenced (yes/no)	Elev. (feet)	Decimal latitude	Decimal longitude
mill	good	no	3667	48.76584	117.76004
South pit	fair	no	3640	48.75761	117.76056
North pit rim	poor, crumbling	no	3940	48.76172	117.75515
West End outflow	stable	no	3510	48.76003	117.76209
Upper tailings pond	stable	no	3194	48.76200	117.77536

Table 3. Soil analysis. Metal concentrations are mg/kg. – – –, no data. Numbers in parentheses indicate the factor by which the analysis exceeds standards shown in Table 4.

Sample location	Arsenic	Cadmium	Copper	Iron	Lead	Mercury	Zinc
soil sample 25 feet south of red door at mill, green copper oxide	– – –	– – –	18,400 (1840X)	– – –	– – –	– – –	– – –
Lower tailings grab sample	– – –	10.8	– – –	– – –	1170 (5X)	– – –	2790 (10X)
Upper tailings grab sample	– – –	16.4	– – –	– – –	485 (2X)	– – –	5070 (19X)
concentrate spillage at west Pb-Zn bins, grab sample	– – –	346 (14X)	– – –	– – –	124,000 (563X)	– – –	38,200 (141X)

Table 4. Soil quality standards for unrestricted land use. WAC 173-340-900, Model Toxics Control Act, Table 749-2: Priority contaminants of ecological concern for sites that qualify for the simplified terrestrial ecological evaluation procedure (partial data). Concentrations are mg/kg. Levels for gold and iron are not specified.

Metals	Arsenic III	Cadmium	Copper	Lead	Mercury	Zinc
mg/Kg	20	25	100	220	9	270

Water field data: see Tables 5 and 6

Surface water migration: seepage into Middle East Fork Onion Creek from West End pit lake; runoff and overflow from tailings basins infiltrate forest soils

Table 5. Surface water field data.

Description	Flow (gpm)	Conductivity (µS/cm)	pH	Bed color	Temp (°F)	Elev. (ft)
West End pit lake	seepage	640	8.7	natural	41	3510
South pit lake	impoundment	550	8.5	natural	32	3600
Middle East Fork Onion Creek	~300	200	8.1	natural	36	3590
Lower tailings pond east basin	impoundment	580	9.5	black poly lining	32	2730
Lower tailings pond west basin	impoundment	>1980, off scale	8.5	gray	33	2735

ACKNOWLEDGMENTS

The authors thank our editor Jari Roloff for the layout and helpful suggestions on the content of this report. Additional appreciation goes to Randy Miller, formerly of Equinox Resources, Ltd., for information pertaining to post-1990 operations. DNR Northeast Region geologist Chuck Gulick reviewed and made helpful comments on portions of the report.

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Table 6. Surface water analysis. Metal concentrations are in micrograms/liter (µg/L); hardness is in milligrams/liter (mg/L); USEPA, U.S. Environmental Protection Agency; – – –, no data; **, standards for these metals are hardness dependent; ≤ indicates metal was not detected; the number following is the practical quantitation limit above which results are accurate for the particular analysis method—the metal could be present in any concentration up to that limit and not be detected. Conversion formulae are shown in http://www.ecy.wa.gov/pubs/wac173201a.pdf. Standards calculated for hardness values specific to Part 1 below are shown in Appendix B. Numbers in bold indicate analyses which exceed one or more of the water standards shown in Part 2 below.

PART 1: ANALYSIS BY USEPA METHOD 6010, INDUCTIVELY COUPLED PLASMA

Sample location	Arsenic	Cadmium**	Copper**	Iron	Lead**	Mercury	Zinc**	Hardness
West End pit lake	– – –	≤5	– – –	– – –	≤10	– – –	100	330
South pit lake	– – –	≤5	– – –	– – –	15	– – –	**600**	530
Middle East Fork Onion Creek	– – –	≤5	– – –	– – –	≤10	– – –	15	90
Lower tailings pond, east basin	– – –	≤5	– – –	– – –	**207**	– – –	271	780
Lower tailings pond, west basin	– – –	≤5	– – –	– – –	**172**	– – –	131	1300

PART 2: APPLICABLE WASHINGTON STATE WATER QUALITY STANDARDS

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

Appendix A. Methods and field equipment

METHODS

We recorded observations and measurements in the field. Longitude and latitude were recorded with a global positioning system (GPS) unit in NAD83 decimal degree format. Literature research provided data on underground development, which was verified in the field when possible.

Soil samples from dumps or tailings were taken from subsurface material and double bagged in polyethylene. Chain of custody was maintained.

Soil samples were analyzed for the metals listed in this report by inductively coupled plasma/mass spectrometry (ICP/MS) following USEPA Method 6010. Holding times for the metals of interest were observed.

Instrument calibration was performed before each analytical run and checked by standards and blanks. Matrix spike and matrix spike duplicates were performed with each set.

FIELD EQUIPMENT

barometric altimeter
binoculars
digital camera
flashlight
Garmin GPS III+, handheld GPS unit
Hanna Instruments DiST WP-3 digital conductivity meter and calibration solution
litmus paper, range 0–14, and 4–7
Oakton digital pH meter
Oakton digital electrical conductivity meter
Taylor model 9841 digital thermometer

Appendix B. Water quality standards for hardness-dependent metals

Conversion formulae are given in WAC 173-201A at http://www.ecy.wa.gov/pubs/wac173201a.pdf.
Chronic standard in micrograms/liter (µg/L)

Sample location	Hardness (mg/l)	Cd (µg/l)	Pb (µg/l)	Zn (µg/l)
West End pit lake	330	2.5	9.0	286
South pit lake	530	3.5	14.6	429
Middle East Fork Onion Creek	90	1.0	2.2	95
Lower tailings pond, east basin	780	4.7	21.3	595
Lower tailings pond, west basin	1300	6.8	35	918

Appendix C. Consumable and hazardous materials

Location	Description	Content	Quantity	Units
mill	Nalco 9810	full	1	55 gallon
mill	Nalfloat	partial	1	55 gallon
mill	H_2SO_4	full	2	55 gallon
mill	Aerofloat 211	full	25	55 gallon
mill	sodium isopropyl xanthate	full	11	55 gallon
mill	Nalco 9743	full	3	55 gallon
mill	Nalco 9714	full	1	55 gallon
mill	unknown	full	1	55 gallon
mill	Dow Chlorothene NU solvent	partial		55 gallon
mill	#5525 solvent degreaser	full	1	55 gallon
mill	miscellaneous petroleum lubricants	full	4	55 gallon
mill	miscellaneous petroleum lubricants	empty	7	55 gallon
mill	SIPX pellets, sodium isopropyl xanthate	full	6	55 gallon
mill	copper sulfate	full	10	50 pound
mill	copper sulfate tank	empty	2	2500 gallon
mill	copper sulfate tank	partial	1	1500 gallon
mill	sodium carbonate	full	2	2000-pound sacks
outside mill, SE corner	unknown petroleum substance	full	2	3000-gallon tanks
100 feet south of mill	propane tank	empty?	1	~20,000-gallon tank
Building #19	ammonium acetate	full	25	pounds
Building #19	copper sulfate	full	50	pounds
core shack	Aerofloat Promoter	full	7	55 gallon
scale house	hydrochloric acid concentrated	full	9	gallons
scale house	sulfuric acid		5	gallons
scale house	glacial acetic acid		5	gallons
repair shop	diesel fuel	partial	4	tanks
repair shop	Gear Lube	full	1	55 gallon
repair shop	solvent	partial	1	55 gallon
repair shop	grease	full	1	25 gallon
repair shop	transformers	dry	3	
outside mill west of propane tank, on ground	8-inch cement-asbestos pipe, 10-foot lengths		>1000	feet

Appendix D. Post-2005 Tailings Reclamation Work Plan

Reclamation Plan Report:
July 14, 2005

CUNNINGHAM ENGINEERS
609 Goldcreek Loop • Colville, Washington 99114
Telephone (509) 684-5036 • Fax (509) 684-5036
Wenatchee, Washington • Telephone (509) 664-7031 • Fax (509) 664-7031

Jack McCotter
Equinox Resources
Van Stone Mine
P.O. Box 32
Colville WA 99114   Ph: 738-2105 Cell: 675-0869

Subject: Revision of Final Reclamation Plan for Van Stone Mine Tailings

References:
1. **Engineer's site visit 03/01/05, measurements, eval. of characteristics**
2. **Best Management Practices for Reclaiming Surface Mines in Washington and Oregon, Revised December, 1997**
3. **Van Stone Mine Closure Plan, from Beacon Hill, June 1999**
4. **Forest Practices Application #3011072**
5. **Preliminary reviews with DNR 07/01/05, Dept. Of Ecology May - June, 2005**

Attachments:
1. **Drawing sheets 05006-1, 05006-2 Reclamation Plan Details**
2. **Calculations for existing and final pond capacity**

Dear Mr. McCotter,

Per your request, we have completed a new reclamation plan for the Van Stone Mine Tailings area which implements the best and most cost effective reclamation practices for this particular site. This report provides background information for the recommended reclamation features and meets all requirements for reclamation for subject site and will be less expensive and more effective than doing the closure plan provided by Beacon Hill Consultants in reference 3.

Reclamation plan philosophy and background information:
The existing tailings pile is very fine and easily erodable. The final reclamation practices proposed in this report apply a philosophy to implement only those practices already proved on site. An evaluation of the success and limitations of current natural and applied reclamation processes was conducted to determine the most practical and cost effective long-term reclamation measures to apply to this site.

Some reclamation work has been already completed following the plan in reference 3. On site plot testing of erosion control blankets, rock mulch, flat slope reseeding and pond reduction have been prepared with mixed results. Several practices have been successful, and other practices have shown where practice improvements could be made, or indicate that a different practice should be employed. Tailings slope vegetation limits: Rye bunch grass: 4 to 1, but 5:1 is recommended, snowberry bush: 3 to 1 slope, reforestation trees: 3 to 1.

Straw net erosion control blankets have proved retention of the fine tailings materials, and are most successful in areas where more water and fertilizer are available, and where the slope is below the maximum rated slope quoted for that particular blanket. Rock mulch application areas are successful where a range of rock size is used. Failure occurred at the west run off channel when the watercourse moved outside the armored channel.

Flat slope reseeding has been very successful after small amounts of topsoil and fertilizer amendments were applied. Reducing pond size by cutting down the exit channel has also been successful in the past, and can be further developed to reduce impounded water below 10 acre-ft. Present capacity in the east pond is 14 to 18 acre-ft. (see calculations attachment)

Reclamation Plan discussion:

1. *Construct north drainage around tailings to protect adjacent fish bearing stream from a silt event. This drainage will discharge runoff and silt to the forest floor west of tailings.* The stream has an RMZ of 90' as described in reference 4. The plan on drawing sheet 1 shows a place near the northwest corner of tailings pile, where tailings encroach on this RMZ. So an exception is requested to permit the dry channel to pass through this area to protect the stream from a siltation event. Effective zone in this area is approximately 77' wide.

2. *Inspect pond drainage channel before re-cutting. Place Fabric+Rock where needed if existing channel shows signs of erosion.* It is very important that this channel be developed and reinforced so a failure similar to the failed west channel will not occur in the future.

3. *Conduct incremental excavations at pond outflow, to drain the pond below 10 acre-ft of volume.* Measurement and calculation of the final pond capacity may be required and the results reported to the Dam Safety Office of Department of Ecology, in order to remove this site from their permit list. This engineering work can be done when requested, and completed in one or two days. Exposed pond liner to be covered per item 9 below.

4. *Clear forest on west side of tailings, (See reference 4, FPA #3011072) and push existing topsoil west, out of extended toe area. Stockpile soil in a berm along west side of toe area.* After tailings slope is recontoured and extended west, use this soil to amend the tailings before replanting, then replant per plan item 13 below. Ponderosa and western larch replanting is also recommended along the new base area of the tailings and where viable.

5. *Harvest soil from extended south toe area and relocate the road on south side to miss the extended tailings slope. (< 10% GRADE PREFERRED)* Note: A new Forest Practices Application permit is required for this work per DNR review on July 1, 2005 (ref 5.)

6. *Push tailings from under the small south pond across swale to join main tailings pile, seed exposed native soil as required with pasture mix and clover.* Ponderosa and western larch also recommended. This pond is resting on tailings and should be consolidated with the larger tailings pile to avoid encroaching access road, for most cost-effective reclamation.

7. *Develop runoff channel through this swale, in native soil, reinforce if needed. New culvert crossing req'd.* A natural drainage area has developed for seasonal saturated flow and some surface flow. This flow must be accommodated and enhanced for final reclamation.

8. *Armor major drainage gullies on north side of tailings.* This side of the tailings pile is very close to the property line and it is impractical to change the slope. Rock mulching is practical on a limited basis, to reinforce some of the major gullies already developed here. Geofabric may be required if rock could be undermined by the water flow.

9. *Top area of tailings: Knock down the built up berms around top of tailings and between east and west ponds. Directing most of the material into east pond. Okay to leave west pond area as it is. Be sure to cover any exposed portion of pond liner around either pond with at least 16" of native glacial till soils, OR with at least 24" of tailings material + amendments for planting.* Flattening the top of the pile will remove steep slopes there, permitting complete reseeding of the plateau around the ponds, and give a more natural appearance. Covering the pond liner with amended tailings will protect the liner from frost and ultraviolet damage, and support wetland vegetation around the ponds.

10. *Knock down west and south tailings slopes to 20% or less, beginning at NW corner, and working around to the south.* This is the bulk of the reclamation work. Shallow slopes, if well drained, have shown good reclamation results in the past if amended and reseeded.

11. *Apply a North American Green® S75 straw net or equal on NW corner of tailings pile, where shallow and steep slopes merge from 5:1 to 3.5:1. Also consider S150 straw net or equal OR a geofabric with rock mulch where slopes exceed 30%. Fabric+rock mulch is required for steep runoff channels on north side.* These reclamation practices are based on the site evaluation, and vendor specifications from *North American Green®.*

12. *Spread soil amendment and/or fertilizer on groomed slopes and cut new side-slope channels spaced 35' apart at a shallow, nearly flat 1% slope. These side slope channels can be oriented in a counter clockwise pattern around the tailings pile from the NW corner to the swale on south side near the east end. (Sequence: Peel back amendment, cut channel, and then replace amendment.) Armor channel bottoms with S75 if channel erosion is observed. (See drawing sheet 2 for cross slope channel details)*

13. Reseed shallow slopes and other dry disturbed areas with a dryland mix (including rye bunch grass). Reseed areas having more moisture with standard pasture mix + clover. Contact a reparian biologist with the DNR or a private company regarding vegetation enhancement around the pond(s).

Closing Remarks:
Thank you for this opportunity to be of service. Call me if you have any questions. Any changes proposed by Equinox must be review and accepted by the engineer or the DNR. Use the space on the back of page for additional comments or for listing as-built changes to the reclamation plan.

Best regards,

____

Joseph L. Cunningham, PE
CUNNINGHAM ENGINEERS
cc: file 05006

<u>Additional comments recorded after this report date:</u> *(use back of this page if needed)*