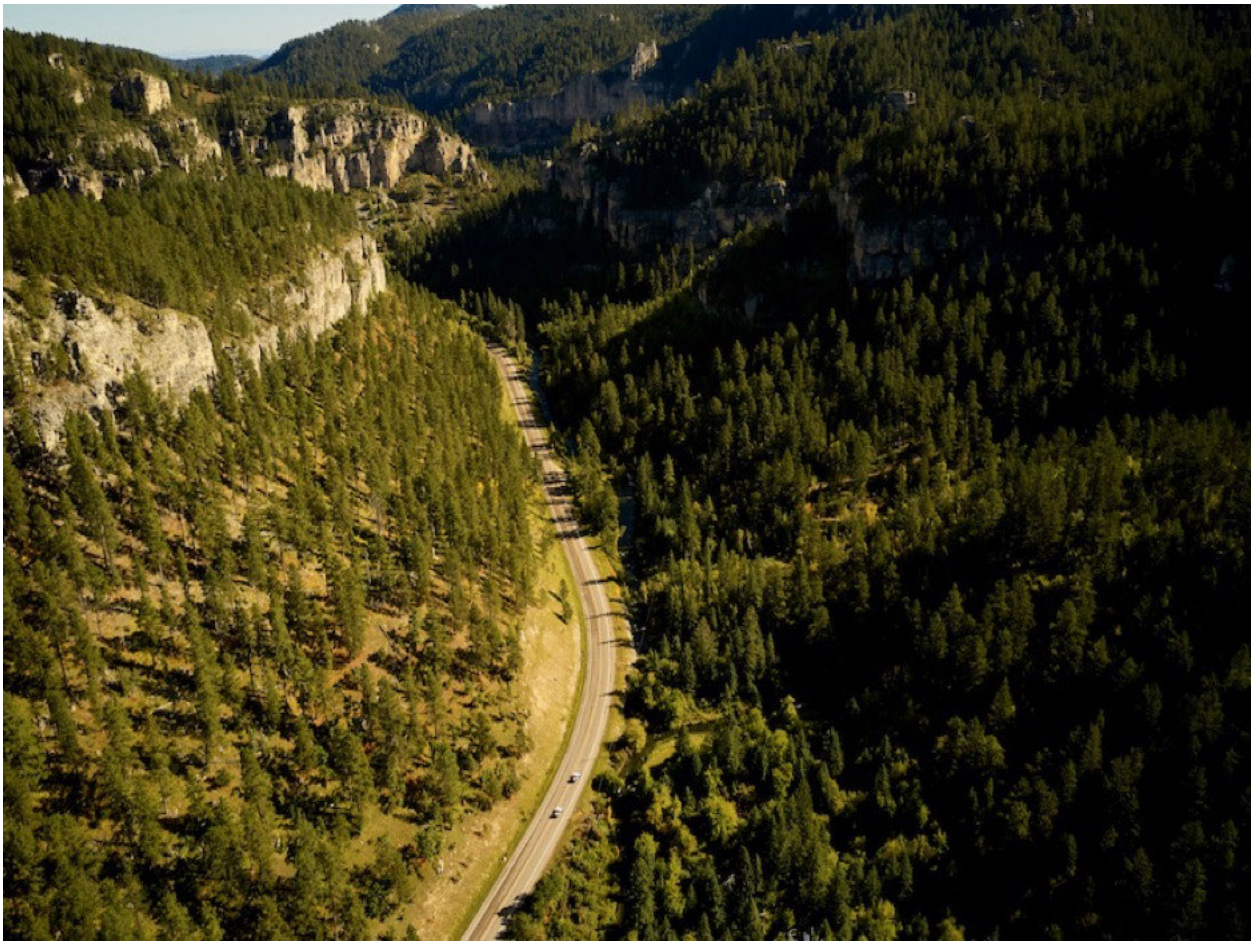
POTENTIAL IMPACTS OF GOLD MINING IN THE RAGGED TOP AREA ON SPEARFISH CANYON, SOUTH DAKOTA



Prepared for

Spearfish Canyon Owners Association

by

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August 28, 2020

Rapid City, SD

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INTRODUCTION

The Deadwood Standard Project (DSP), managed by Valentine Mining Company (VMC) which is based out of Lead, SD is setting forth plans to mine outside of Spearfish Canyon above Savoy (Figure 1). Permit area shown on the map is between the Ragged Top mountain on the northeast and Spearfish Canyon on the west and southwest side.

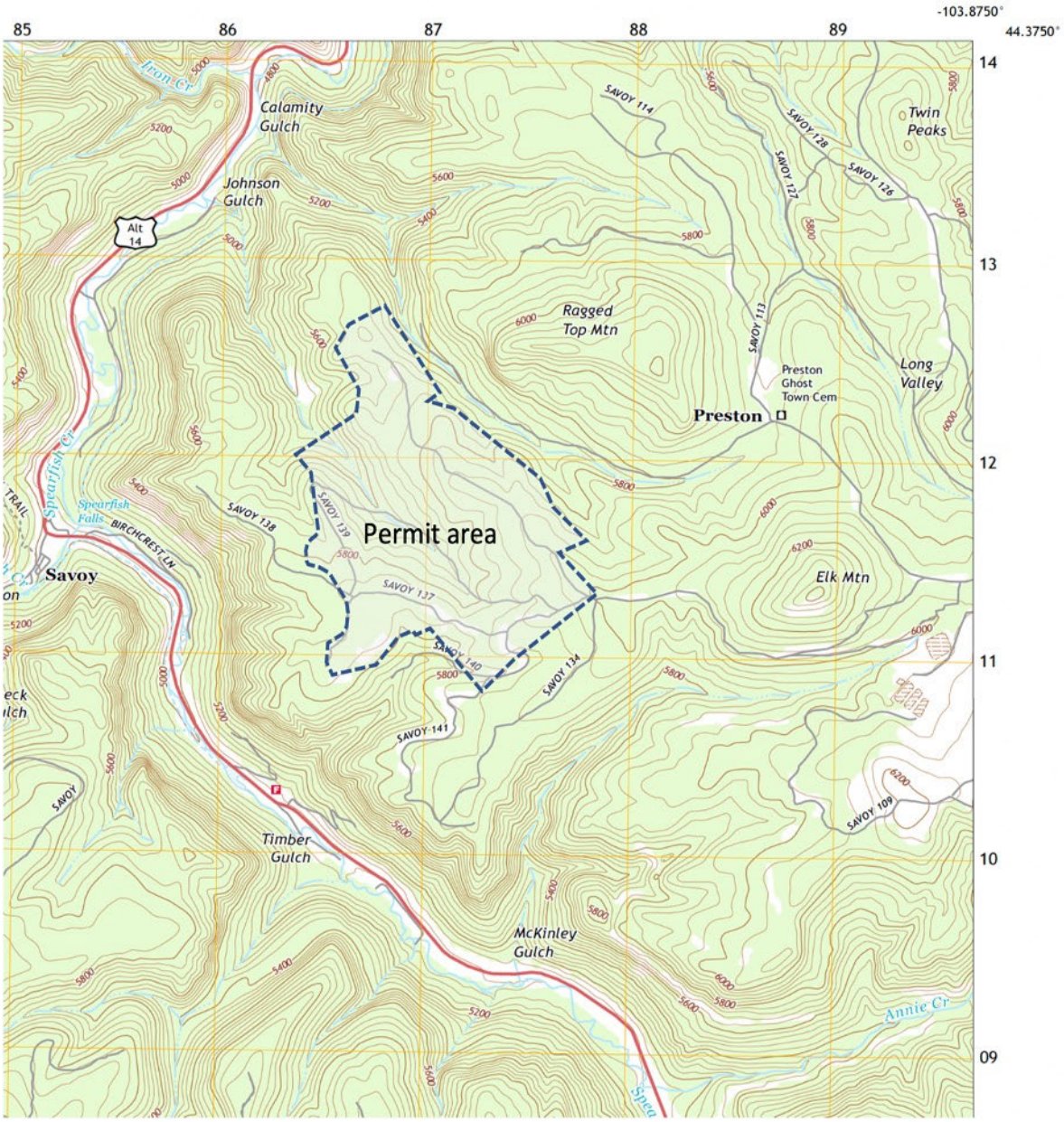

Figure 1. Topographic map showing VMC permit area and nearby locations along upper Spearfish Canyon. USGS Savoy quadrangle. 7.5 minute series.

Ragged Top's permit (Mine Permit 416) was approved by the DENR in 1984 for the Homestake Mining Company, which then was transferred to other companies in the subsequent years, and finally was transferred to VMC. The mine would be located mainly on private land, outside a county exclusion zone that prohibits any new surface mining operations in Spearfish Canyon, but the Valentine Mining Company would still need a county-issued conditional use permit and a state mine permit to operate in the area. A mining plan was prepared and submitted to Lawrence County for approval. Public hearing for the proposed mining is scheduled for September 10, 2020.

This report is to establish geologic and mining parameters, evaluate the company's proposal and outline potential impacts on Spearfish Canyon and surrounding areas.

GEOLOGY

Ragged Top Mining District:

The Ragged Top District is located in the southwest quarter of T. 5 N., R. 2 E., Lawrence County, South Dakota. It lies on a limestone plateau bounded on the west by Spearfish Canyon, on the south by McKinley Gulch, on the north Calamity gulch (Figure 2), and on the east by a series of Tertiary intrusions which divide the Paleozoic sediments on the west from Precambrian rocks to the east. The plateau stands at an elevation of 5600 to 5800 feet, but it is deeply dissected by short, steep tributaries of Spearfish Creek such as Johnson Gulch, McKinley Gulch and Calamity Gulch.

History of the Ragged Top Mining District: Gold was discovered in the Ragged Top area in 1896. The period from 1896 to 1900 was one of selective mining during which high grade ores were shipped to smelters outside the area. From late 1900 to 1906 large tonnages of low-grade ore were treated by the cyanide process at mills adjacent to the larger mines. The entire carbonate platform was staked by number of mining companies during this period (Figure 2).

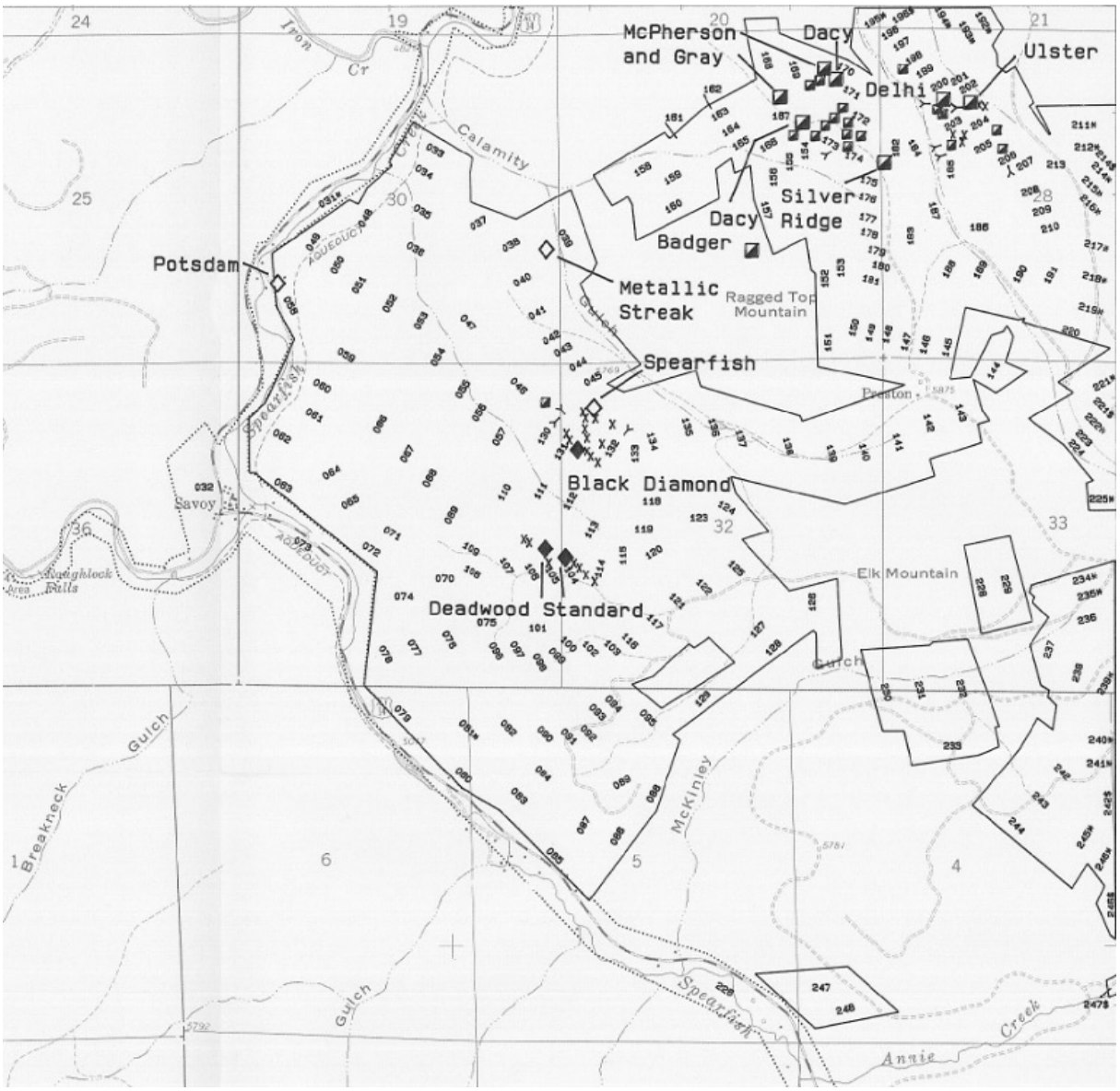

Figure 2. Map showing Deadwood Standard mining company and other gold mining company claims in the Ragged Top area (From Dewitt et al, 1986).

According to Shapiro and Gries (1970) a few short millruns are recorded between1912 and 1916, but the additional production was very small. Except for systematic sampling and testing of a few of the major properties in 1938, there has been no mining or exploration activity at Ragged Top since the start of World War I until Homestake Mining Company started exploration in the early 80s. No modern mining has ever been done within its boundaries; there have, however, been ,many cases of relic mining, and the permit has changed hands several times through the years.

Deadwood Standard Gold Mining and Milling Company: The Deadwood Standard Gold Mining and Milling Company was organized in 1900 to develop and operate the Ed Hanscha and Old Slavonian properties south of Ragged Top (Shapiro and Gries, 1970). These totaled about 212 acres of mineral claims in sections 31 and 32, T. 5 N., R. 2 E., and in sec. 5 of the adjacent township.

There has been no activity at the property since World War I. The location of the ore bodies along the outcrop bordering Johnson Gulch suggests the possibility that the northern edge of the original ore body may be missing by erosion. If so, logical starting points for drill holes to explore the Deadwood formation might be north, and slightly downslope from the existing prospect pits and trenches in the area.

Geology of the Ragged Top Mining District:

About 1000 feet of gently dipping Paleozoic sedimentary rocks are present in the Ragged Top area. They range from Late Cambrian to Early Pennsylvanian in age Figure 3 and 4. Paleozoic sedimentary succession from old to young are: Deadwood Formation, Winnipeg Formation and Whitewood Limestone, Englewood Limestone and Pahasapa Limestone.

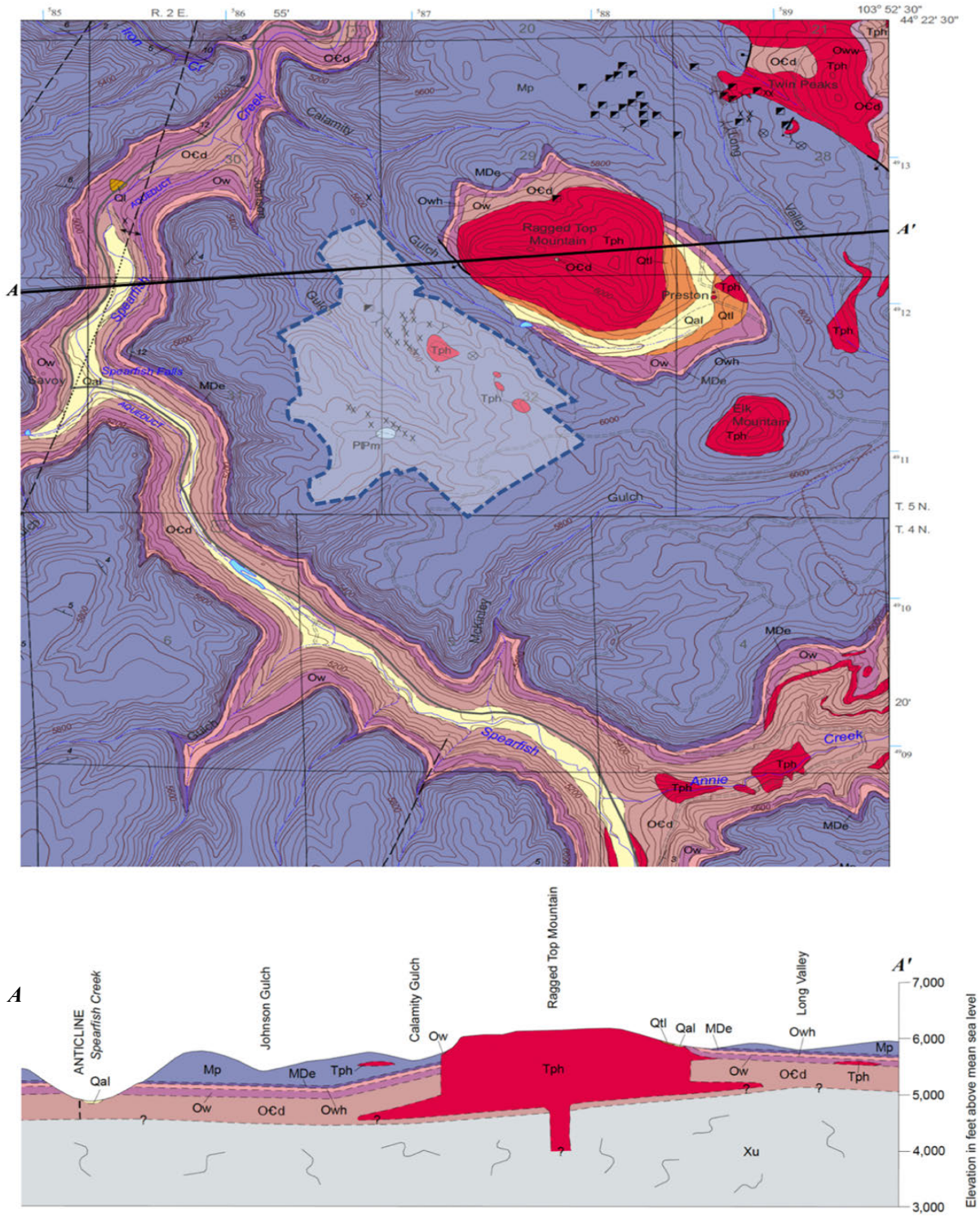

Figure 3. Geologic map and geologic cross section (A-A') of ragged Top and upper Spearfish Canyon showing Paleozoic formations, Tertiary intrusions and permit area (modified from Lisenbee et al., 2013). Refer to next page for further explanation.

FOLDS (Laramide)

Anticline
Location of trace of axial surface. Long dashed where approximately located; short dashed and queried where inferred in cross section; dotted where concealed

Syncline
Location of trace of axial surface. Long dashed where approximately located; short dashed and queried where inferred in cross section; dotted where concealed

Monocline, anticlinal bend
Location of trace of axial surface. Shorter arrow indicates steeper beds. Long dashed where approximately located

Monocline, synclinal bend
Location of trace of axial surface. Shorter arrow indicates steeper beds. Long dashed where approximately located

Basin

STRIKE AND DIP OF BEDDING

Horizontal

Inclined

STRIKE AND DIP OF FLOW FOLIATION IN IGNEOUS ROCKS

Inclined

Vertical

STRIKE AND DIP OF FRACTURES

Inclined

OTHER FEATURES

Limestone quarry

Mine shaft

Trench

Group of prospect pits

Prospect pit

Area of open pit mine

Mine tailings

EXPLANATION

Quaternary

Qal — **Alluvium** - Unconsolidated to loosely consolidated clay, silt, sand, and gravel. Deposited in present-day drainages. Maximum thickness of 70 ft (21.3 m) reported from well logs

Qt — **Terrace deposit** - Unconsolidated clay- to boulder-sized clasts. Deposited up to 40 ft (12.2 m) above present-day stream drainages. Estimated maximum thickness 30 ft (9.1 m)

Ql — **Landslide deposit** - Unconsolidated, randomly oriented angular blocks of locally derived bedrock and debris deposited along steep slopes as slumps and rockfalls

Unconformity

Tertiary

Tph — **Phonolite** - Dark gray, dark bluish-gray to greenish-gray with brownish weathering. Aphanitic to porphyritic, with a fine-grained phaneritic groundmass of orthoclase with aegirine, becoming finer-grained along sill margins. Contains 1-30 percent phenocrysts of orthoclase, sanidine, and plagioclase up to 0.75 in (2 cm) long that are typically zoned, and often kaolinized. Also contains up to 40 percent Na-pyroxene crystals up to 0.31 in (8 mm) long, often enclosing feldspar and as clots and radial sprays to several millimeters. May have up to 29 percent euhedral grains of nepheline and sodalite up to 0.004 in (0.1 mm) across with some altered to zeolite. Accessory minerals include zircon, apatite, hematite, leucoxene, titanite, and magnetite. Some intrusions weather along planes of trachytic texture with a platy, foliated appearance, especially along intrusion margins (Sofranoff, 1979)

Permian / **Pennsylvanian** — Lower Permian / Upper Pennsylvanian

PPm — **Minnelusa Formation** - Red, brown, yellow, to beige sandstone and shale. Reddish terra rossa siltstone and local conglomerate of angular chert fragments derived from the Pahasapa Limestone occur along the lower contact. Exposed thickness approximately 140 ft (42.7 m)

Disconformity

Mississippian / **Devonian** — Lower Mississippian / Upper Devonian

Mp — **Pahasapa Limestone** - Gray, beige, to white massive limestone. Very fine- to coarse-grained. Contains two brownish-orange sandstone beds up to 15 ft (5 m) thick approximately 60 ft (18 m) and 180 ft (55 m) below the top of the formation. Vuggy and cavernous in the upper 125-150 ft (38-46 m). Typically forms prominent cliffs. Upper contact is an irregular erosional surface. Thickness of 435-637 ft (132.6-194.1 m) reported from well logs

MDe — **Englewood Limestone** - Lavender, pink, to purple-gray, argillaceous dolomitic limestone and shale. Finely- to very finely-crystalline, laminated to medium-bedded. Typically bioturbated. Locally contains botryoidal, chalcedony-replaced evaporite nodules, and coarse sand along the upper contact. Thickness 35-50 ft (11-15 m)

Disconformity

Ordovician / **Cambrian** — Upper Ordovician / Lower Ordovician / Middle to Upper Cambrian

Oww — **Whitewood Limestone and Winnipeg Formation (undifferentiated)** - Combined thickness 115-200 ft (35.1-60.9 m)

Owh — **Whitewood Limestone** - Variegated orange, beige, and gray dolomite and dolomitic limestone with thin shaly partings. Finely crystalline, slightly calcareous. Thin-bedded to massive, typically bioturbated. Thickness 35-80 ft (11-24 m)

Ow — **Winnipeg Formation** - Lower portion is the Icebox Shale Member; 45-65 ft (13.7-19.8 m) of fissile, green to gray shale containing small, black phosphatic nodules. Upper portion is the Roughlock Siltstone Member; 35-55 ft (10.7-16.8 m) of greenish-gray to yellowish siltstone and fine-grained sandstone. Total thickness of 80-120 ft (24.4-36.6 m) reported from well logs

Disconformity

OCd — **Deadwood Formation** - Lower units are brown, gray, to green massive sandstone overlain by glauconitic shale, minor intraformational conglomerate, and bioturbated siltstone. Middle units are brown to green intraformational conglomerate, glauconitic shale, and sandstone with minor limestone. Upper units are dark green to light gray, bioturbated, glauconitic sandstone and intraformational conglomerate. The uppermost 10-20 ft (3.0-6.1 m) is the vertically burrowed "Scolithus sandstone." Exposed thickness approximately 275-300 ft (84-91 m). Total thickness of 440-470 ft (134.1-143.2 m) reported from well logs

Stratigraphy:

Deadwood Formation: The Deadwood formation consists of sandstone, quartzite, conglomerate, shale, argillaceous limestones and dolomites, and a distinctive edgewise intraformational conglomerate. In the Ragged Top area, only the upper part of the formation, consisting of sandstones and dolomites, is exposed. The uppermost bed, which is an excellent stratigraphic marker consists of a white to pink-stained quartzitic sandstone, a few inches to a few feet in thickness, with abundant worm borings called “the Scolithus sandstone’’.

Winnipeg Group: The middle Ordovician is represented by 60 feet of green shale, locally called the Ice Box member, overlain by 25 to 30 feet of white to greenish-gray argillaceous siltstone, the Roughlock member. Neither is well exposed in the Ragged Top area, but good outcrops are evident at numerous points along the sides of Spearfish Canyon (Figure 4).

Whitewood Formation: The Whitewood dolomite is about 50 feet thick and it consists of mottled buff to red granular dolomite.

Englewood Formation: Along Spearfish Canyon, the Englewood formation consists of buff to pink dolomitic limestone. The thickness of this formation reaches to 40 to 50 feet in the canyon area (Shapiro and Gries, 1970).

Pahasapa Formation: The Pahasapa consists of several hundred feet of limestone, dolomitic limestone, and dolomite. Outcrops along Spearfish Canyon suggest an alternation of massive, cliff-forming members and thin-bedded units which weather to steep, talus-covered slopes. Its high cliffs extend many miles along the canyon of Spearfish Creek and constitute the walls of numerous other deep canyons, including those of Mc Kinley Gulch, Johnson Gulch and Calamity Gulch within the permitted property.

Although earlier workers suggest a thickness of 580 to 630 feet in Spearfish Canyon, observations during exploration activates suggest 490 feet at the Deadwood Standard property, under the divide between McKinley and Johnson Gulches. A drill hole by VMC penetrated the entire section reaching to 800 below surface (DENR records) but no information is available for

this drill hole. When asked, company officials would not comment on this hole and its violation of drill permit by VMC in 2017.

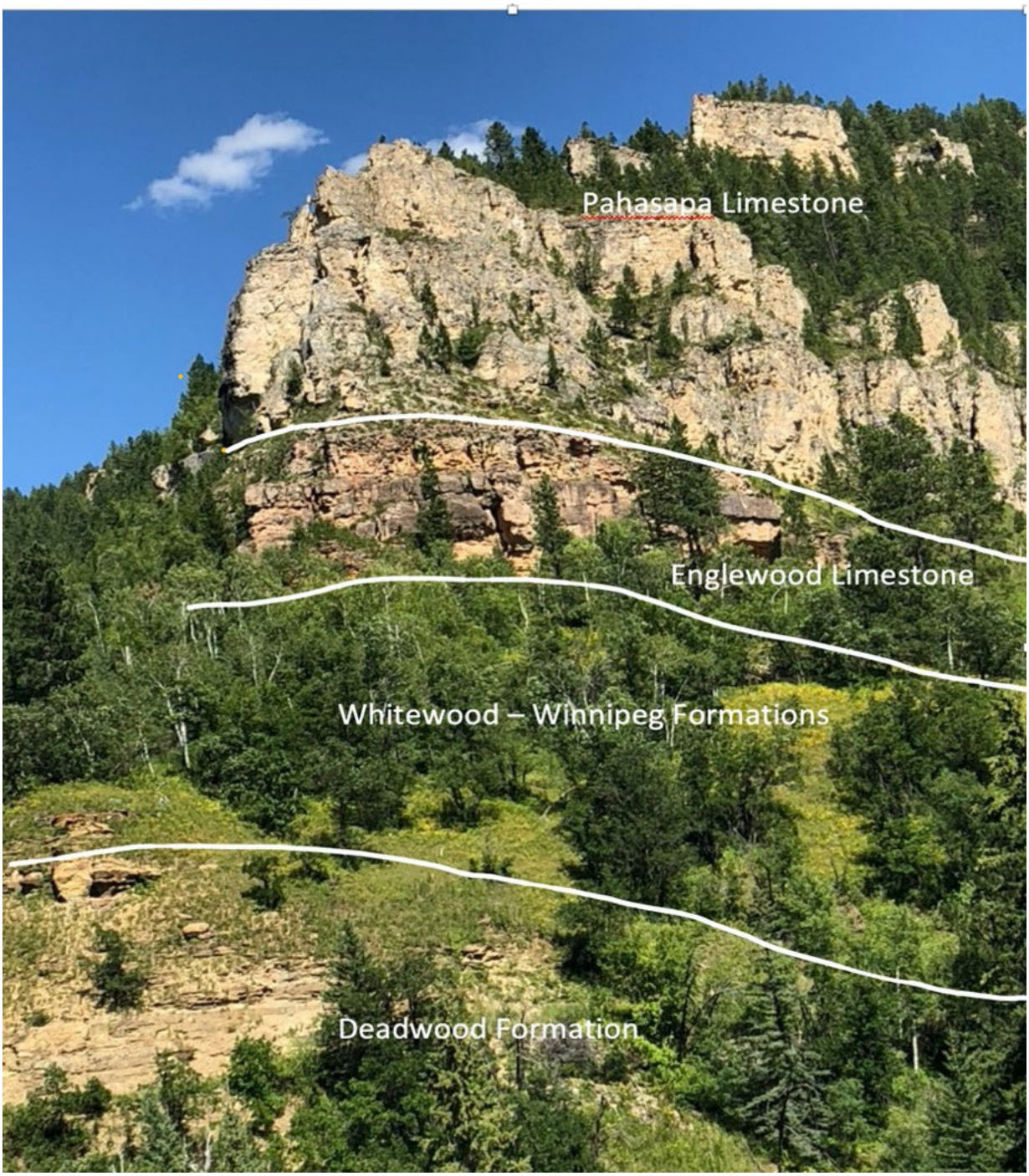

Figure 4. Stratigraphic section at Savoy Junction showing Deadwood, Whitewood-Winnipeg, Englewood and Pahasapa formations.

Minnelusa Formation: Remnants of basal Minnelusa formation have been noted in the Deadwood Standard property. On the divide between Johnson Gulch and Spearfish Creek, small remnants of sandy red shale and sandstone have been observed. These appear to be original deposits of basal Minnelusa in low spots on the pre-Minnelusa Pahasapa erosion surface and suggest that the full thickness of the Pahasapa formation remains on the property. In some areas the very top of the Pahasapa formation may be slightly eroded to the brecciated level exposing mineralized zones within the Pahasapa Formation.

Tertiary Intrusions: The Tertiary intrusive rocks in the Ragged Top area are typical of those throughout the northern Black Hills, both as to composition and geometry. In the Ragged Top area, the intruding magmas showed preference for certain zones of weakness within the sediments, near the base of the Deadwood formation, in the middle of the shale and edgewise conglomerate section of the Deadwood formation, just beneath the upper ore zone, just below the Scolithus sandstone, in the Ice Box shale member of the Winnipeg group, at or near the base of the Englewood formation, and at or near the top of the Pahasapa limestone. Similarly, sills intruding the lower Deadwood Formation above the Precambrian- Cambrian unconformity can be seen in the Homestake's open cut from the balcony of the Sanford lab's visitor center or from the park next to it.

The Ragged Top intrusive mass is a complex, and possibly a compound intrusion as illustrated in Figure 3 (cross section) and in Figure 5. Many of the tertiary intrusions in the northern Black Hills display similar sill and dike structures often called a Christmas tree structure (Figure 5). At the west end of Ragged Top, Pahasapa limestone can be found within inches of the porphyry, suggesting that the faulting across the north side wraps around the west end and perhaps extends even farther to the southeast.

MINERALIZATION IN THE RAGGED TOP DISTRICT

Gold mineralization in this permit area is associated with feeder zones (also called verticals and/or conduits) and the brecciated top part of Pahasapa limestone, as illustrated in Figure 5. Mineralization occurred when gold and silica bearing hot hydrothermal fluids moved upwards along the verticals and reached the brecciated uppermost Pahasapa Limestone and deposited gold and silver along with other metals as replacement type ore.

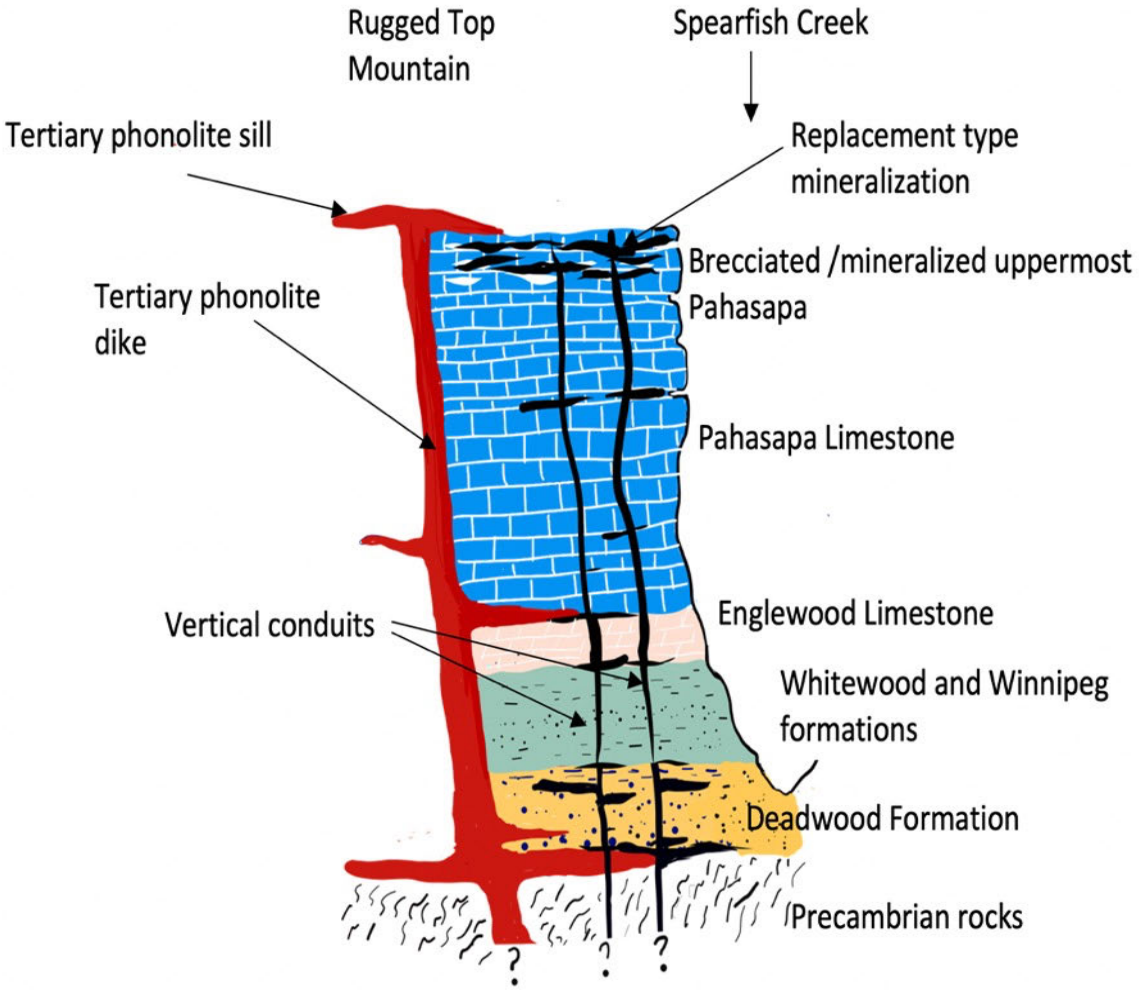

Figure 5. Illustration showing the relationship of intrusions, verticals and mineralization in the Ragged Top area (Modified after Uzunlar 1993).

Most of the production from the Ragged Top District came from replacement deposits developed along verticals cutting the Pahasapa formation (Figure 5). The ore consisted largely of brecciated fragments of carbonate rock which were completely replaced by silica. Near the surface the ore is weathered into boulders of breccia which were stained red or brown by iron oxides (Figure 6), but at depth, it is light-buff colored as observed in prospect pits. The general description of ore, however, is hard to be distinguished from the limestone except in that it is very hard and slightly darker. Porphyry is not present in these verticals in the immediate permit area.

Angular cavities occur throughout the ore and are usually lined with quartz crystals or occasionally with calcite crystals. According to Shapiro and Gries, (1970) gold and silver occur in the mineral sylvanite; but this mineral has never been observed in hand specimen, and Irving (1904) reports observing only a single speck of a mineral resembling sylvanite under the microscope. Pyrite and other sulfides are not present in the mineralized zones.

In addition to the ores associated with the verticals, ore occurred as irregular masses or blanket deposits as shown in the illustration (Figure 5), of brecciated and/or silicified carbonate rock at several localities in the Ragged Top District. Purple fluorite is often associated with the ores and sulfides are absent in the ores of Pahasapa Limestone in the Ragged Top area.

If the Pahasapa formation were originally mineralized above the productive areas within the Cambrian rocks (as shown in Figure 5), it is entirely reasonable to assume there is mineralization in the Deadwood Formation beneath the remaining mineralized parts of the Pahasapa formation in the Ragged Top Mining District. It is to be noted that there is mineralization in the Deadwood formation in Annie Creek which was mined by Wharf Resources in the 80s and currently being mined in one of the pits (Figure 7) at the Wharf mine located one mile east of Ragged Top, and in Squaw Creek to the north and northeast of the Ragged Top area.

Figure 6. Typical mineralized Pahasapa limestone in Ragged Top area, showing silicification, angular breccia fragments and iron oxide staining. No sulfides observed.

Unlike the upper oxidized ore zones within Pahasapa Limestone, the ore in Deadwood Formation at Annie Creek contains high concentrations of sulfide minerals and if present in Spearfish Canyon such as Deadwood Formation would have similar characteristics. Most mineralization below the water table will contain sulfides as it is in a reducing environment.

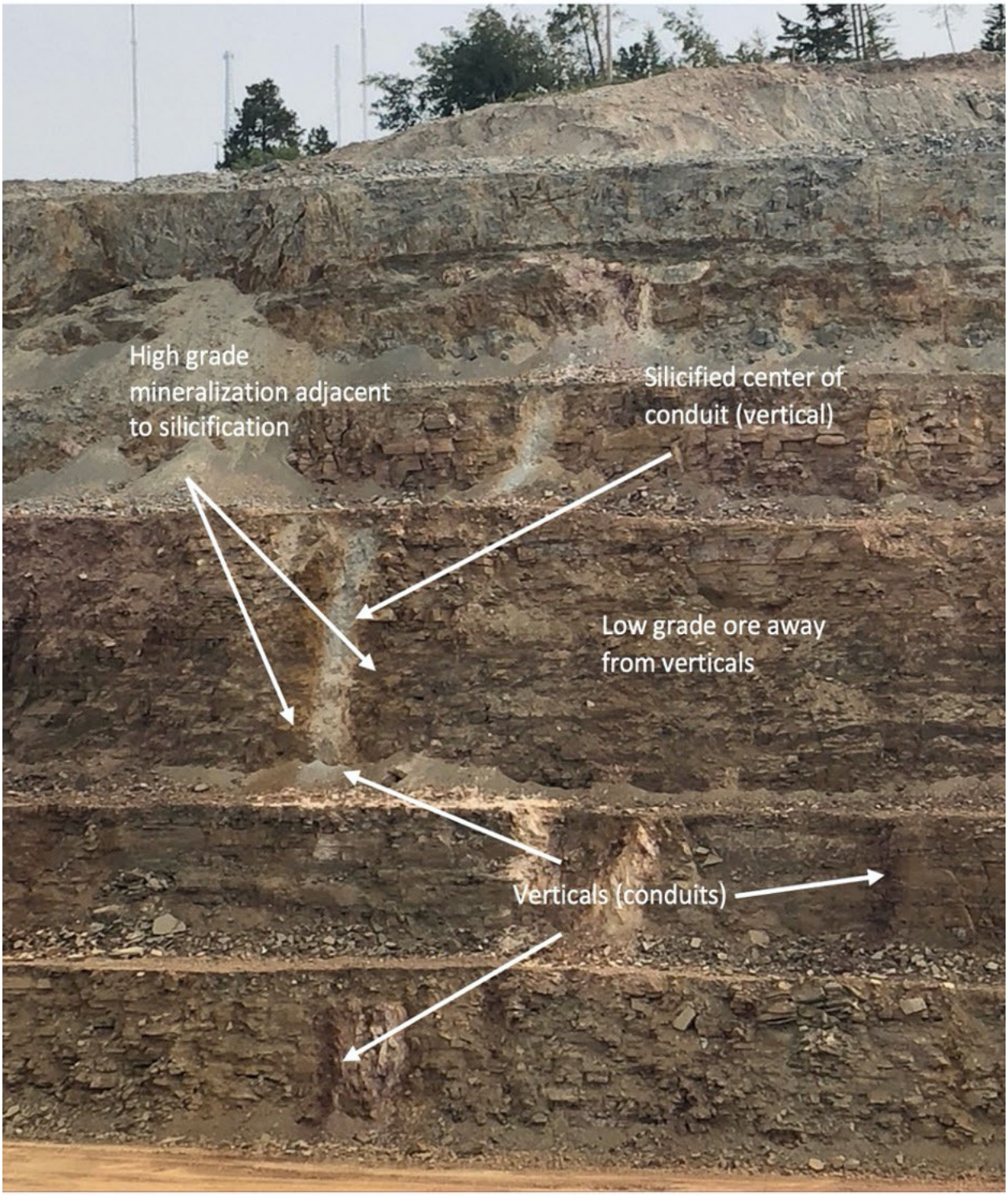

Figure 7. Photo of a wall within one of the current Wharf Mine pits in the Bald Mountain mining district, showing verticals and associated mineralization in the Deadwood Formation.

It is worth noting that there is no evidence of mineralization in the Deadwood Formation in Spearfish Canyon. We can only suggest that the canyon is too far west of the center of mineralization which is certainly associated with vertical fractures and igneous activity (Uzunlar, 1993).

A complex intrusion of quartz monzonite porphyry crops out northeast side of the Ragged Top District. The intrusion has intruded the Deadwood formation in more than one horizon. It is intruding at the base of the Whitewood dolomite, and near the top of the Pahasapa formation (Figure 3 – cross section). It is highly possible that parts of the quartz monzonite and intruded sedimentary rocks such as Deadwood and Pahasapa formations are mineralized in the area.

HYDROLOGY

Surface waters: Precipitation that falls on the proposed project area likely infiltrates infiltrates what? due to high permeability of the limestone plateau. Most precipitation is released back into the atmosphere through plant transpiration and evaporation, but a portion of the precipitation that percolates downward through the Pahasapa Limestone to top of the Englewood Formation is a confining layer in which water most likely moves laterally along the top of the formation and discharges to the surface as springs along Spearfish Canyon.

Ragged Top mining district has three tributaries (gulches) on the west side that drain directly into Spearfish Creek. From north to south, these are Calamity Gulch, Johnson Gulch and McKinley Gulch (Figure 8). Due to karstic nature of the Pahasapa Limestone none of these tributaries are live streams but each have large areas of watershed that could gather large amounts of stormwater, resulting in substantial runoffs along these gulches.

The western branch of Calamity Gulch runs parallel to northeastern edge of the permit area which collects rainwater from the Ragged Top mountain. The upper half of Johnson Gulch is within the permit boundaries and would be completely disturbed by the mining operations.

The area receives about 27 inches of rain (Figure 9) – the highest levels in the Black Hills – annually, and runoff generated could create major sediment transport into Spearfish Creek through these tributaries as described above.

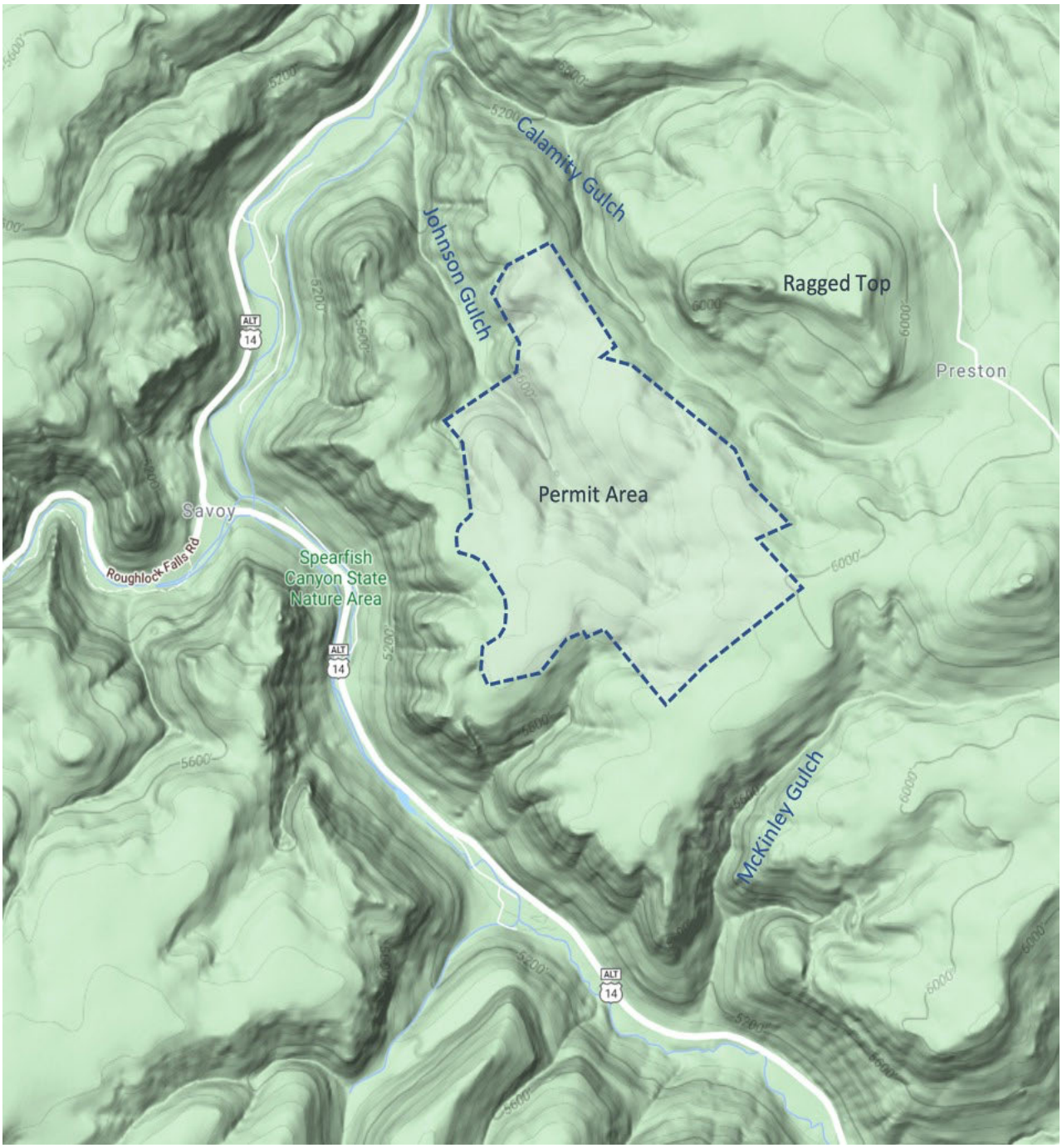

Figure 8. Terrain map showing permit area, canyon topography and other physiographic features in the Ragged Top area.

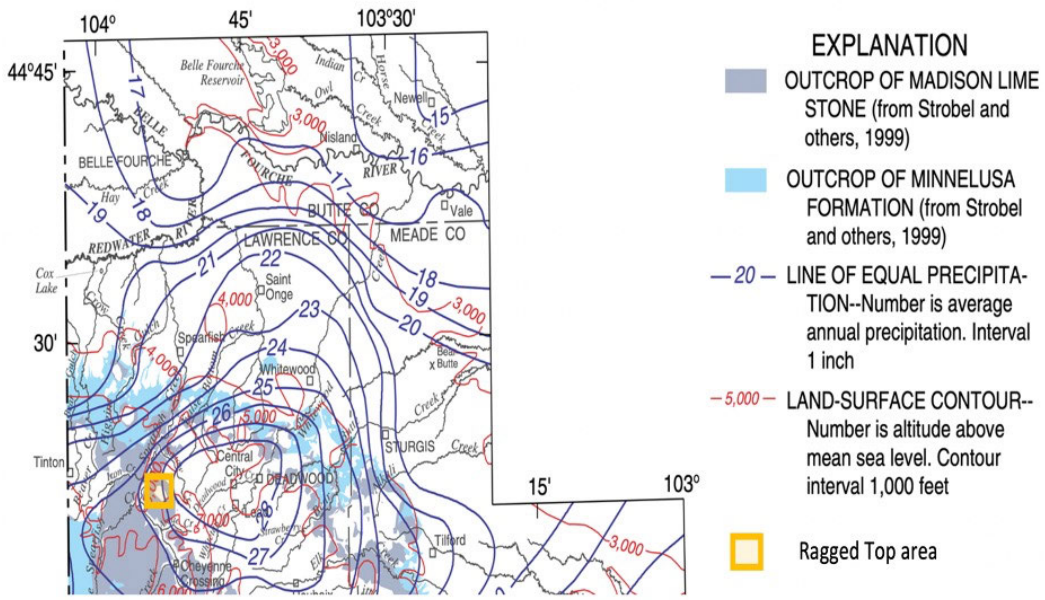

Figure 9. Map showing distribution of average annual precipitation for northern Black Hills area, water years 1950-98 (Modified from Driscoll et al, 2000).

Groundwater: Ground and surface water interact extensively in the Black Hills, and both streamflow and aquifer recharge are influenced by climatic conditions. The major aquifers in the Black Hills area are the Deadwood, Madison, Minnelusa, Minnekahta, and Inyan Kara aquifers. Madison and Deadwood are present in the Ragged Top area and are used extensively, as well as heavily influence the surface-water resources of the area.

VMC LLC maintains a network of surface water and groundwater quality monitoring stations associated with the project and has collected baseline water quality data for surface water and groundwater. Seven groundwater monitoring wells are present in the vicinity of the project area (Figure 10).

Based on data collected from monitoring wells within the permit area, the water table is about 450-500 feet below the surface (company officials oral communications, August 2020). Therefore, Pahasapa Limestone is not considered an aquifer in the Ragged Top district. Although the Ragged Top area receives 27 inches of rain annually it is not a major contributor to Pahasapa (Madison) aquifer (Figure 11).

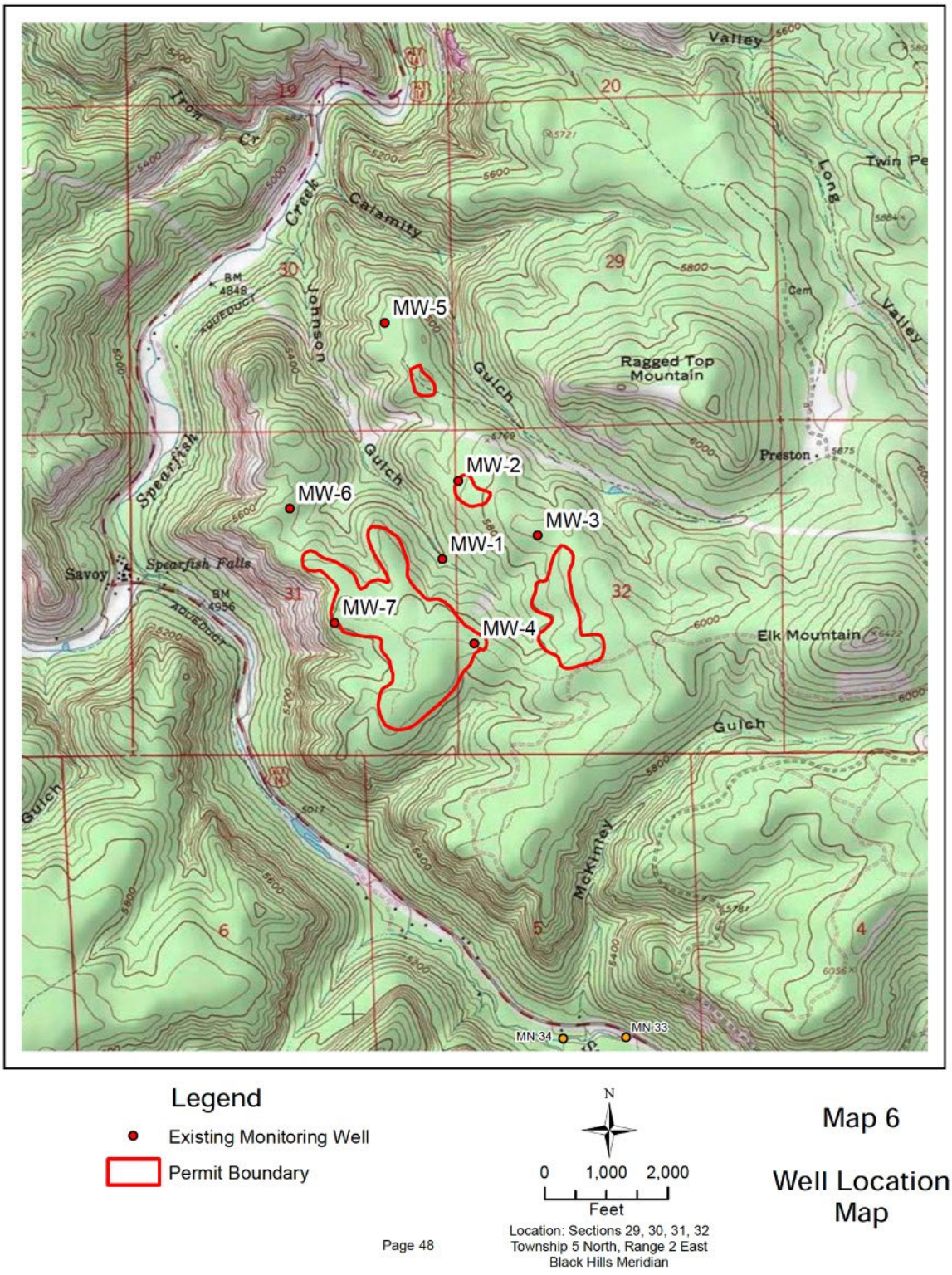

Figure 10. Topographic map of the area showing groundwater monitoring wells and proposed mining pit (from VMC permit application)

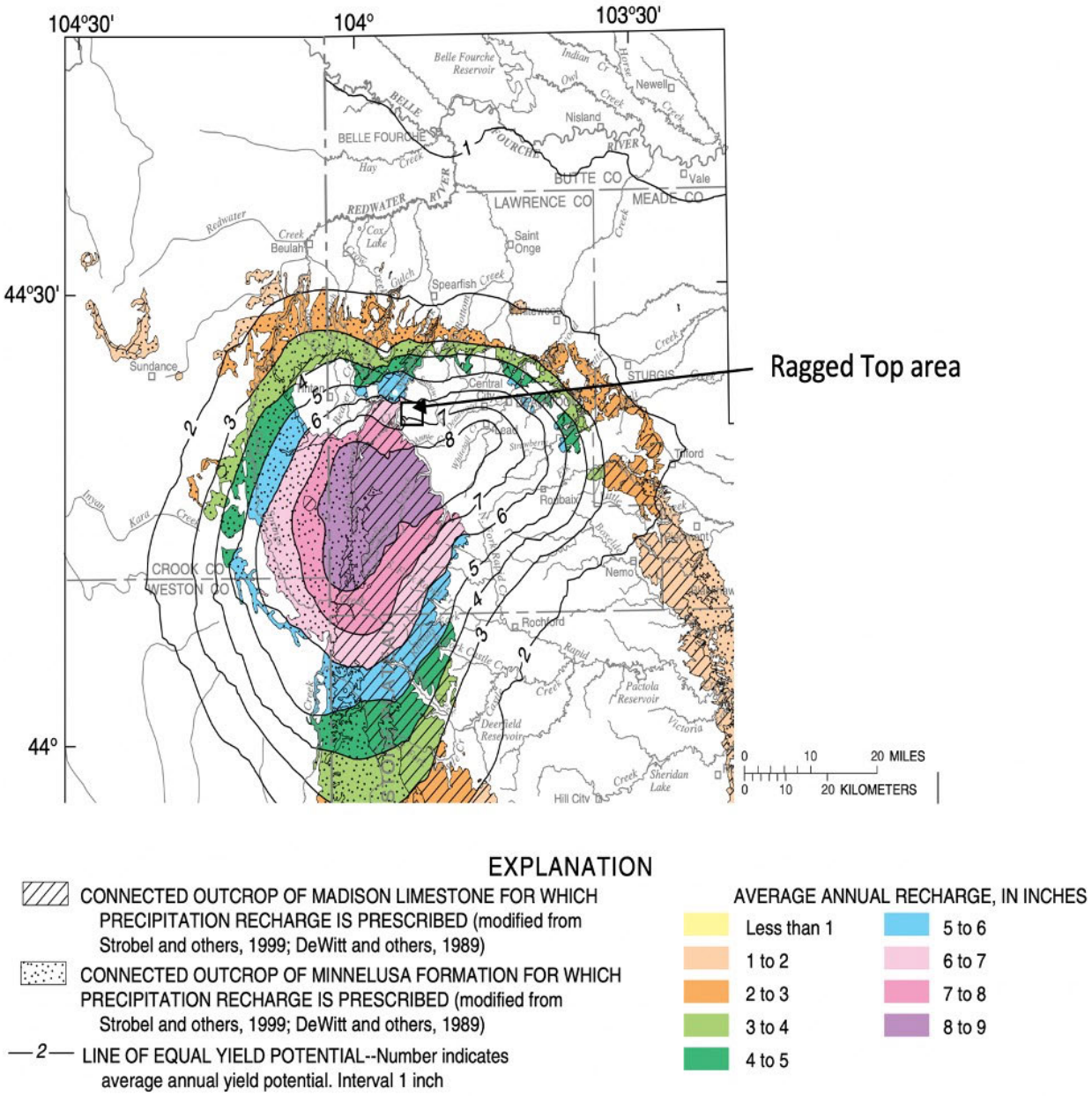

Figure 11. Average annual recharge from precipitation on outcrops of the Madison Limestone and Minnelusa Formation in the northern Black Hills (Modified from Driscoll et al, 2002).

PERMITTING

The following phrases in *italics* describing the nature of the permit, is directly copied from the application submitted to the Lawrence County Commission.

VMC LLC holds a valid state of South Dakota Large Scale Mining Permit for the project. Mine Permit 416 authorizes mining 870,000 tons of gold ore from 14 small surface quarries ranging in size from ½ acre to 5.2 acres. Permit 416 also authorizes ancillary activities such as topsoil stockpiling, overburden stockpiling, crushing, and ore haulage. Mine Permit 416 does not authorize onsite mineral processing. This CUP application requests county approval of mining at the Deadwood Standard Project as currently authorized by Mine Permit 416. Importantly, no onsite mineral processing using cyanide or other chemical reagents would be authorized in the CUP, which is consistent with Mine Permit 416.The mine would be located mainly on private land, outside a county exclusion zone that prohibits any new surface mining operations in Spearfish Canyon, but the Valentine Mining Company would still need a county-issued conditional use permit and a state mine permit to operate in the area.

The mining company has secured a number of investors, most of who are from South Dakota, to establish the mine. Despite the existing permit, the company was looking to attain a new permit in 2012 because the proposed mine boundaries were slightly larger than the 122 acres allowed under Permit 416. The newly modified Permit 416 differs from the 2012 version and proposes less than 40 acres total area of disturbance. According to company officials, the mine would be a surface mining operation, expected to run for several years and produce about 70,000 ounces of gold in total.

The site is designated on the state's preliminary list of Special, Exceptional, Critical or Unique lands, so a hearing before the state Board of Minerals and Environment would be required to obtain clearance to proceed with the permit process. Currently, the company has completed a baseline study including groundwater, surface water, wildlife and vegetative surveys.

Type of permit – Permit 416 is a **large-scale** mining permit and falls within the following South Dakota DENR guidelines.

Large Scale Mine Permits

Large Scale Mine Permit (Operations that mine more than 10 acres disturbance and extract more than 25,000 tons annually, as well as any operation that uses cyanide or other chemical or biological leaching agents).

The annual report requirements for a large scale mine permit are similar to those for a small scale mine permit. The only difference is that the annual fee is $100 for a large scale mine permit or $50,000 if the operation is a large-scale precious metal, coal, or uranium mine that was permitted after January 1, 2009.

Large Scale Gold Mines:

Large scale gold mines have **separate annual reporting requirements**. These mines are required to submit annual reports by January 1 of each year. Every November, the department mails each large scale gold mine an annual report form. The completed annual report contains the following information:

1. *The total and previous year's amount of affected land;*
2. *The total and previous year's amount of surface mining disturbed land (mine pits, waste rock disposal areas, leach pads, and process ponds);*
3. *The total and previous year's amount of land that has undergone interim reclamation;*
4. *The total and previous year's amount of land that has undergone final reclamation and meets the required postmining land use;*
5. *The total and previous year's amount of land that has undergone final reclamation and does not meet the required postmining land use;*
6. *The total amount of ground water withdrawn during the previous year;*
7. *The total amount of surface water withdrawn during the previous year;*
8. *The total amount of ore mined during the previous year;*
9. *The total amount of ore processed during the previous year;*
10. *The total amount of waste rock mined during the previous year;*
11. *The total amount of gold and silver produced during the previous year;*
12. *The total amount of cyanide used during the previous year;*

13. *A brief discussion of the coming year's operational plans including any revisions that might require department or board approval; and*
14. *A map showing all reclamation completed and any changes to the approved operating and reclamation plan.*

Reclamation Bonding Requirements:

Reclamation Bonding: For small scale mine permits, the Board of Minerals and Environment sets the reclamation bond to cover reclamation costs in an amount not to exceed $2,500. For large scale mine permits, the board sets the reclamation bond to cover the entire cost of hiring a third party contractor to conduct reclamation activities.

Cyanide Bonding: Operations that employ cyanide leaching or other chemical or biological leaching agents are required to submit additional financial assurance or bonding with the department. The new application points out the fact that there will not be any ore processing on site, therefore cyanide leaching or contamination will not be discussed in this report.

Post Closure Bonding: Prior to release of the reclamation bond, an operator must submit a bond to cover post closure costs after the reclamation bond is released. A post closure plan must also be submitted at the same time.

Examples from the Area: The following passage was directly copied from DENR website

> *On February 18, 2011, Wharf Resources submitted a large scale mine permit application for its expansion project near Lead. The proposed mine expansion project will involve open pit mining and disposal of overburden primarily to the south of the existing Wharf Mine and to the west of the Golden Reward Mine. A portion of the reclaimed Golden Reward Mine will be redisturbed during the project. Ore extracted from the expansion area will be hauled to the existing heap leach facility at the Wharf Mine for processing. As new mine areas are developed, waste rock and overburden will be used to backfill previously mined areas. A portion of State Highway 473 will be relocated during the project.*

Wharf Resources plans to disturb approximately 308 acres within the 528-acre expansion area, and total production is estimated to be about 175 million tons of ore and overburden. The proposed expansion will extend the total life of the mine from 2012 to 2020. The proposed future land use is a mixture of rangeland (woodland grazing), home sites, recreation, and industrial or commercial development which will include enhancements to the Terry Peak ski area.

From November 16 through 18, the Board of Minerals and Environment held a hearing on the mine permit application. After hearing testimony from Wharf and its consultants, the department, and interveners Gary Heckenlaible and Bonnie Gestring, the board unanimously approved the mine permit application. On January 19, 2012, after the board accepted the $32.8 million reclamation bond and the $30.8 million postclosure bond, Large Scale Mine Permit No. 476 was issued to Wharf Resources.

Wharf recently was requested by DENR to increase total bond to $96 million.

FUTURE POTENTIAL MINING IN THE AREA AND ASSOCIATED RISKS

Expansion of project - Going deeper: As illustrated in figure 5 (also posted here as Figure 12 for easier following) the area potentially contains more than one level of mineralization. Although formations below Pahasapa limestone are not mineralized in Spearfish canyon they could contain economic mineralization (ore) in the lower formation below Pahasapa Limestone, as it was and is in the mines operated by Wharf less than a mile south of Ragged Top, Deadwood Formation may be too deep to be economically mined even with current gold prices above $2000/oz. However, if there is low grade but continuous mineralization below the current permit area, then the mining operation could easily reach to multi-million tons ore removal from the area. If gold prices keep above $2000/oz or even go higher passing $2500 per ounce in the coming years, the company could decide to apply for permit to build a mill and cyanide processing on site. A scenario like this would certainly be a tremendous threat to Spearfish Canyon. The ore processing and cyanide leaching aspects of the mining operation are not

discussed in this report per company's proposal to seek a processing plant site away from the proposed permit area or contracting processing and leaching to a third party.

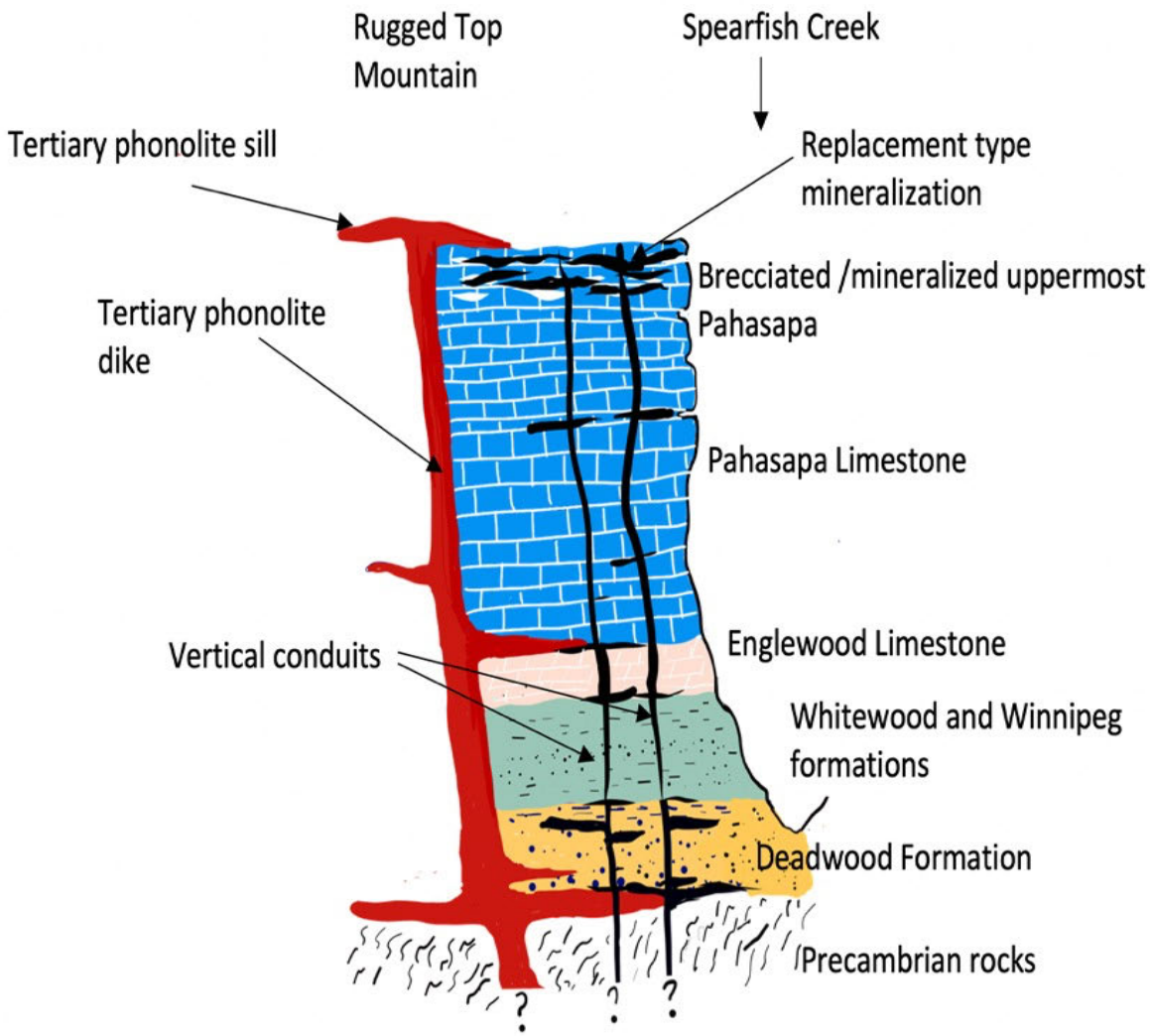

Figure 12. Diagrammatic sketch showing potential ore horizons (in black) within Paleozoic formations below Pahasapa Limestone in Ragged Top mining district. Modified from Uzunlar, 1993.

Expansion of project - Going wider: The area has tremendous potential for additional low-grade gold mines along Spearfish Canyon. It is clearly indicated in the map below (from Dewitt et al., 1986) that three are major historical mining districts on the east side of Spearfish canyon. Each of the districts have number of gold mines and prospects indicated by triangles and a number. The map (Figure 13) here is to point out the districts and not the individual mines therefore an explanation is not provided. Further details can be found in Dewitt et al, 1988. These districts are Bald Mountain mining district, Ragged Top mining district, Elk Mountain mining district and Carbonate mining district. All these districts have historically produced gold and each of them have the potential to become a major gold producer under current gold prices and effective mining methods.

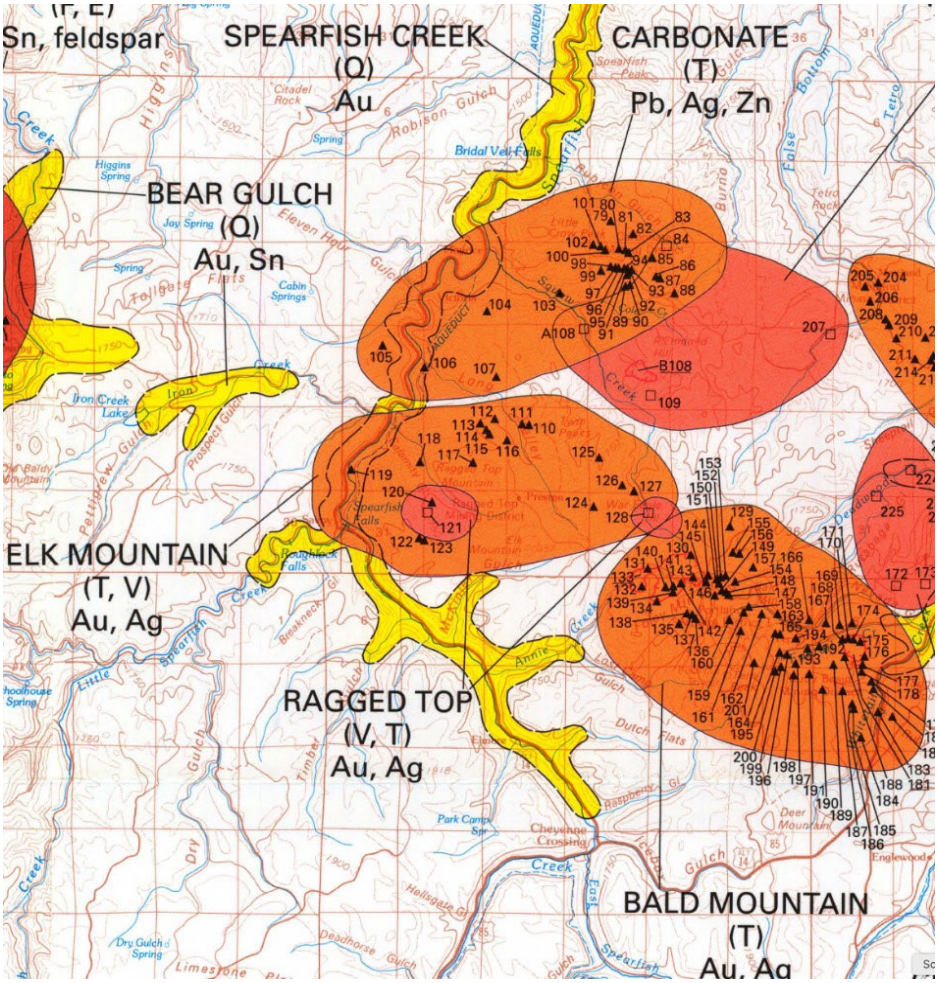

Figure 13. Map showing historical mining districts in Spearfish canyon area (modified from Dewitt et al., 1986).

Wharf Resources started with Annie Creek mine in the early 80s in Bald Mountain mining district and has mined or is currently mining or will continue to mine the entire district. Note that Bald Mountain mining district is more than mile away at the closest point to canyon rim. The Elk Mountain, Ragged Top and Carbonate mining districts are much closer to the canyon and would have severe impact if the entire mineralized zones were to be mined.

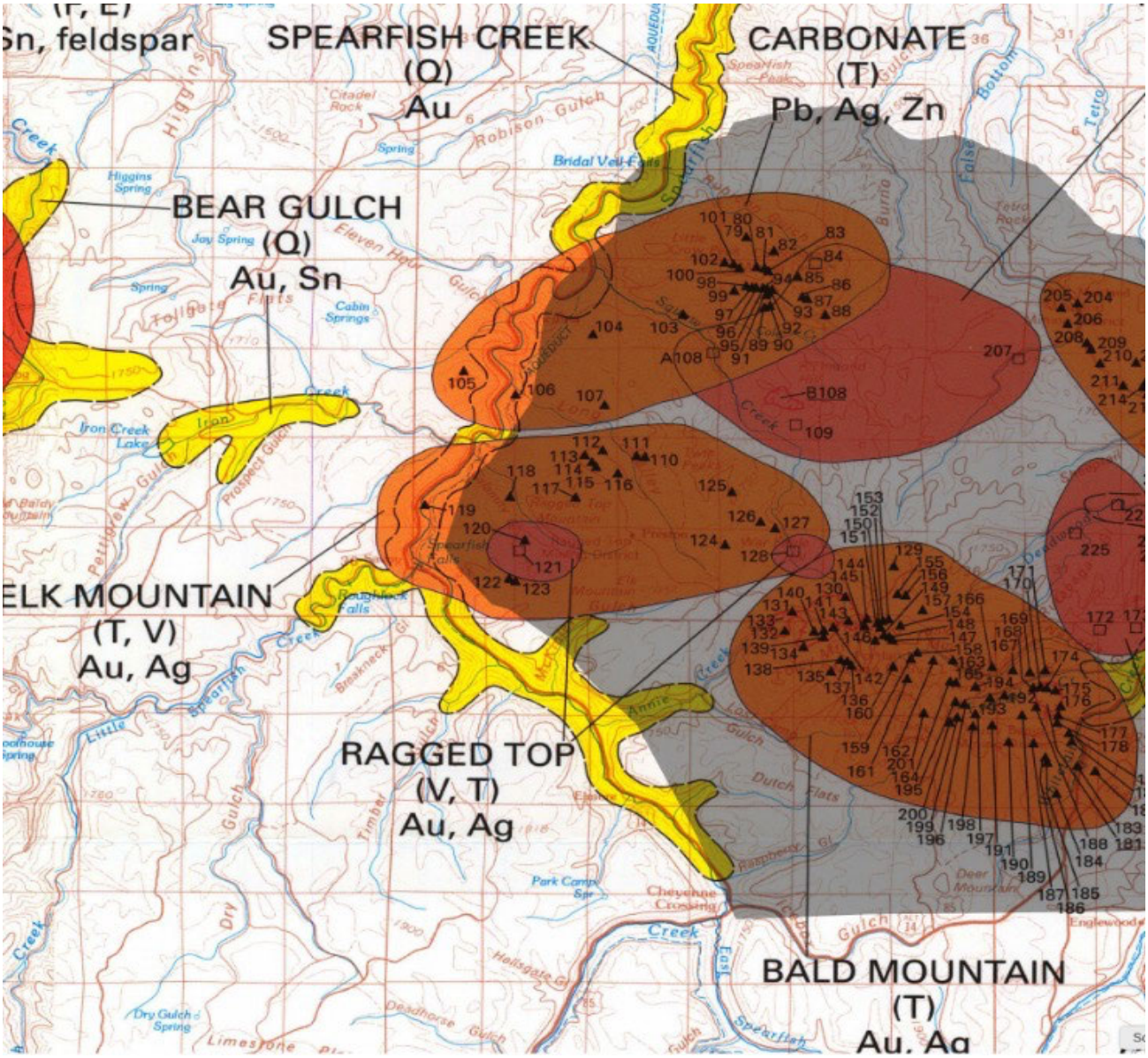

Figure 14. Map showing historic mining districts and future mining potential (gray area) in Spearfish Canyon (Modified from DeWitt et al, 1986).

In June 2019, Coeur, parent company of Wharf, entered into a purchase option agreement with Barrick for the Richmond Hill Project which is located adjacent to Coeur's Wharf mine. The option to acquire the project provides a potential opportunity for Coeur to leverage existing infrastructure to further expand Wharf's footprint and extend its mine life. From this statement it is quite clear Wharf is planning on additional expansion towards Richmond Hill. Similarly, large corporation may be interest in these districts.

Based on my extensive knowledge of these deposits and historical data; the entire area, as outlined in Figure 11 (grey shaded) east of Spearfish Canyon from Cheyenne Crossing to Bridal Veil Falls would be mineable at profit with gold prices above $2000 per ounce.

Under the current miming climate, increasing gold prices, and effective mining methods, a large mining company could consolidate these districts and initiate a large-scale gold mining operation in Ragged Top and Carbonate mining districts. Mining operation at this scale would bring up number of issues including, air and water quality, acid mine drainage, cyanide contamination, run offs, spills and many more. This could have irrecoverable negative effects on Spearfish Canyon.

Wharf started at Annie Creek initially mining the upper zones and ended up mining the entire section to the Precambrian boundary including the Deadwood Formation. During its course of mining, Wharf Resources were cited for numerous violations including spills and leaks at cyanide leach operations. Here are some of the examples of violations.

> *Notice of Violation, 1995: From August 21 – 28, 1995, discharged inadequately treated cyanide solution into Ross Valley and subsequently into Annie Creek. Approximately 300 fish were killed as a result of the discharge.*

> *Notice of Violation 1997: Surface water compliance points below Wharf's waste rock depository in the headwaters of Annie Creek and below Wharf's spent ore depository in Ross Valley, and the instream sampling point in Annie Creek has exceeded the daily maximum total cyanide limit of 0.02 mg/L numerous times since March 1, 1994. Monitoring well*

GWAC-6 is in the alluvium of Annie Creek approximately 450 feet upstream of its confluence with Spearfish Creek exceeded the 10 ppm ground water for nitrate during 1996 and 1997. Also on a few occasions Wharf exceeded selenium and copper at compliance point 001. Notice of Violation, 2000: Surface water compliance point below waste rock depository in the headwaters of Annie Creek exceeded daily maximum selenium during a period from August 1998 – July 1999. Surface water compliance point 006 exceeded the daily maximum ammonia and 30-day average for ammonia during the months of November and December 1999.

Notice of Violation, 2001: For leakage rates above 2000 gallons per acre per day, Wharf failed to immediately lower the pond level below the leakage point.
Notice of Violation 2003: Wharf violated its groundwater discharge limits for nitrate, when the nitrate concentration at a compliance monitoring well downgradient of the spent ore pile exceeded 10 ppm. Wharf also violated its surface water discharge limits for ammonia.

Notice of Violation, 2008: Wharf violated its surface water discharge permit with the release of biomass from its water treatment plant during the summer of 2007. The discharge affected fish populations in Annie Creek. Wharf also violated its permit limits for ammonia two times, and its limits for cyanide six times.

The Wharf mine has also caused extensive groundwater pollution from nitrates as a result of the breakdown of residual cyanide in the process area and spent ore impoundments and from blasting residues in ammonium nitrate fuel oil explosives found in waste rock repositories. Groundwater pollution that originated in 1995 has continued to exceed human health standards into 2011.

Accidents do happen and will continue to happen in every mining operation, therefore smaller the mine smaller the accident and its collateral damage.

SUMMARY OF PROPOSED VMC LLC APPLICATION TO LAWRENCE COUNTY COMMISSION

I will outline my comments and concerns in blue for each category listed below.

(1) Proposed Method of Operating and Processing (II-20.005 (B)(1))

The proposed method of operating and processing is based on specific activities currently authorized by Mine Permit 416. Fourteen individual pits ranging in size from 1/2 acre to 5.2 acres would be mined sequentially. Initially, only one pit would be developed, but as the project advances, several small pits may be worked concurrently to provide for blending of ore types and scheduling of topsoil stockpiling, overburden removal, ore removal, and reclamation stages at the various pits. The Mine Plan Map (Map 4) depicts the proposed location of pits, topsoil stockpiles and overburden stockpiles. The mine plan map also depicts proposed access to the various pits and stockpiles, and the location of a proposed crusher and ore stockpile.

The following description of the Method of Operating and Processing includes excerpts from Section 5 of Mine Permit 416. In this CUP application, VMC LLC is requesting authorization from Lawrence County to mine at the Deadwood Standard project as currently authorized by Permit 416. Accordingly, the descriptions of the mining process included in Permit 416 are applicable to this application. Language that has been excerpted from Permit 416 is depicted in *italics* with the associated reference.

The original Homestake Mining Company Permit 416 proposes mining ore in more than 120 acres. Valentine Mining Company submitted a modified version of the permit 416 in 2012 proposing mining in a total area more than 170 acres. This translates to 200 plus acres of disturbance considering 20% buffer zone around the proposed pit limits. Figures 12 and 13 show the area of interest, including the buffer zone, is clearly bigger than 500 acres. Request to see mine plans and related ore deposit model was declined by company officials, therefore we have to make some calculated assumptions. Assuming total disturbed area is 200 acres as pointed out in the caption of figure 12.

1 acre = 4046 m^2, 200 acres = 809,200 m^2

If top 10 meters is mined that would be roughly 8 million m^3– density of limestone is around 2.5 gr/cm^3 (2.5 ton/m^3) which brings total rock removal roughly to 20 million tons. If top 20 meters is mined total rock removal would be 40 million tons. Part of the mineralized zones are as deep as 70+ feet in which case total mined/disturbed rock would be greater than 40 million tons. Even if total disturbed are is limited to 100 acres with a total of 20 meters of mining depth total amount of rock disturbance would be about 20 million tons at minimum. It is stated in the application that the overburden is about 10 meters thick in some areas but is not specified where and how many acres. Overburden removal alone could be as much as 10 million tons. VMC claiming to extract 70,000 oz of gold from 870,0000 tons of ore. To obtain such numbers the average ore grade needs to be 0.8 oz/ ton or greater. Company officials would not elaborate on geologic or mine model with reflecting ore grade calculated based on 900 exploratory drill holes. Based on the historic data it can be said with confident that the average bulk grade within the proposed area is around 0.03-0.05 oz/ton.

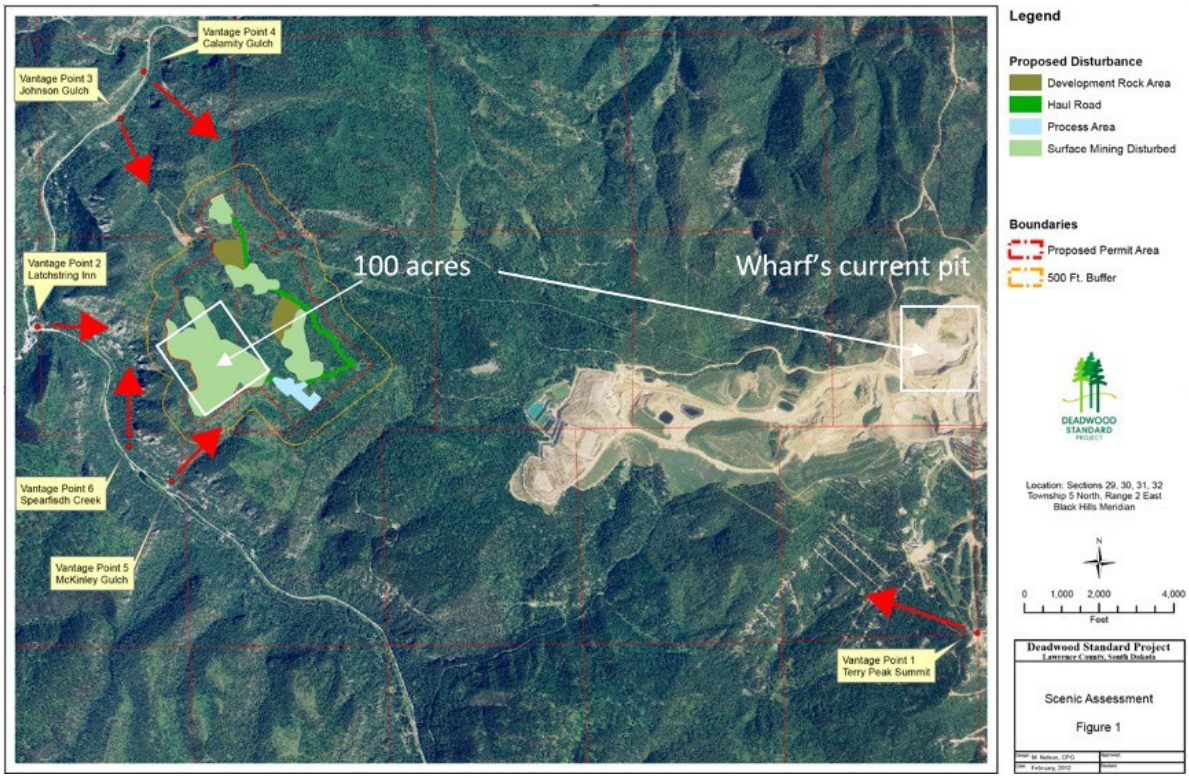

Figure 15. Proposed permit area (Figure modified from VMC permit application), showing vintage points and currently operation Wharf mine. The yellow box is about100 acres. Total disturbed area including roads and prep sites could easily exceed 200 acres.

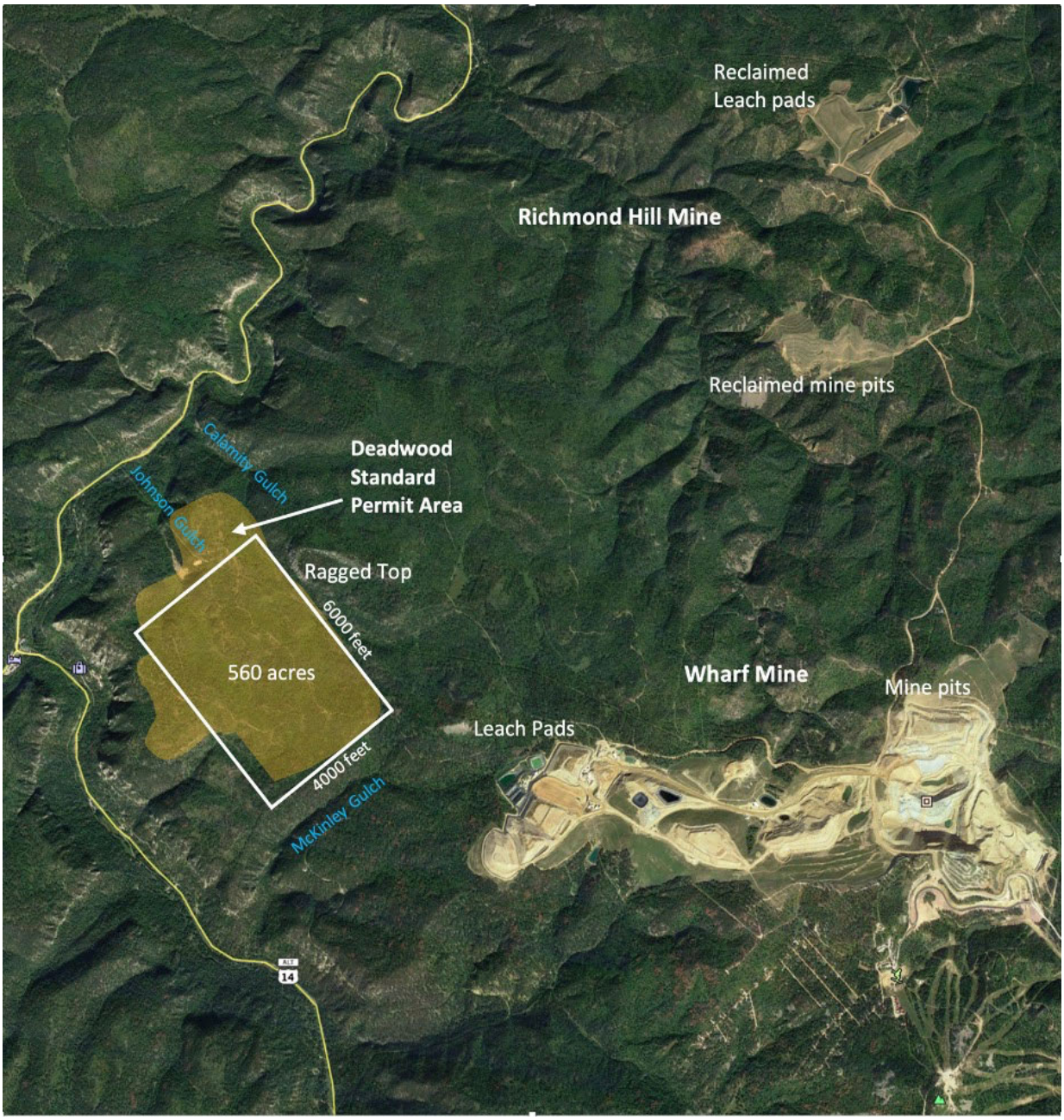

Figure 16. Google image showing approximate Deadwood Standard (VMC) permit area with the buffer zone. Richmond Hill Super fund site and Wharf mine also shown for comparison (note: mining pits both in Richmond Hill and Wharf mine labeled separately).

Timber and Topsoil Removal

VMC LLC proposes to conduct timber and topsoil removal as authorized in Permit 416:

Development operations would begin with timber clearing using a logging contractor. Stump removal would be undertaken by the mining contractor during topsoil removal. Generally, most of the ore blocks in the Johnson Gulch area contain 1-3 feet of topsoil and subsoil, and 20-30 feet of waste overburden. Topsoil and subsoil horizons would be removed and stockpiled adjacent to the pits, on the upslope side if possible. Sediment collection ditches would be utilized where necessary to minimize losses by erosion (Permit 416, Section 5.1.2).

The area receives more than 25 inches of rain annually, highest in the Black Hills. If the mine reaches to full capacity in short period of time removed and stockpiled soil and waste rock could be subject to rapid erosion which subsequently create large amounts of sediment transport to Spearfish Creek from Johnson Gulch and Calamity Gulch.

VMC LLC proposes to conduct overburden removal as currently authorized in Permit 416:
Waste overburden would be removed to a predetermined plane immediately above the ore horizon by ripping and shooting. Ripper- dozers, air-track drills, and wheel loaders of 3-6 yd^3 capacity would be utilized to excavate the overburden waste rock. ANFO blasting agents and cap-sensitive water gel and emulsion explosives would be used to loosen the waste overburden rocks. All mining and blasting operations would be done in accordance with applicable Federal Metal and Nonmetallic Mine Safety and Health Regulations.

Generally, an 8-12% haulage decline would be established during ripping operations to facilitate overburden removal. In some cases, overburden removal would be interrupted in order to selectively mine intermediate, marginal ore horizons. Surveyors and a geologist would be present during all phases of development and production to assist and guide the contractor in maintaining grade control.

A small track loader (1 yd^3 capacity} or backhoe would be used to remove the remaining waste overburden in the concave undulations between the ripping plane and the top of the ore horizon.

In most instances, the waste undulations wiII be removed in one continuous operation across the pit bottom prior to initiating ore production. Generally, the waste-cleaning operation would be guided primarily by accurate survey control based on drill-hole intercepts, visual geologic control, and production sampling (Permit 416, Section 5.1.3).

Thirty feet of overburden will require drilling and blasting. This would result in more than 10 million tons of stockpiled rock if it's done across 100 acres. If the mine reaches to full capacity in short period of time removed and stockpiled soil and waste rock could be subject to rapid erosion which subsequently create large amounts of sediment transport to Spearfish Creek mainly from Calamity Gulch and possibly from McKinley Gulch.

Extensive drilling and blasting will be accumulating high amounts nitrates from blasting which will be contaminating groundwater and surface water even after reclamation completed.

Sampling

VMC LLC proposes to conduct sampling as currently authorized in Permit 416:
Because of the limited amount of primary sampling (core drilling) within the Johnson Gulch ore areas, supplementary fill-in drilling with core or rotary, reverse-circulation drills would be required on patterns such as 50 x 50 ft. All holes not mined would be plugged according to ARSD 74:11:08:04 "Minimal Acceptable Plugging Method" or ARSD 74:11:08:07 "Plugging Artesian Wells". In the event that temporary plugging is necessary in order to reopen a hole, a four-foot length of wooden post or steel pipe would be installed in the collar and clearly marked to indicate its presence. This type of secondary, fill-in sampling would be done on an ongoing basis in the planned mining areas prior to pit development. Sampling techniques used within a producing pit would include collecting bottom (floor) samples, blasthole drill samples, and face pick samples.

This is a standard operation mainly monitored by DENR. If done correctly there should not be any problems.

Ore Removal

The gold mineralization occurs in two shallow, approximately horizontal layers or "horizons". Excavation depths would range from 2 feet (ft) to 72 feet (ft) with an average depth of approximately 24 ft. Seventy-five percent of the ore lies at a depth of less than 35 feet with the shallowest ore located in areas relatively closer to the canyon.

VMC LLC proposes to conduct ore removal as currently authorized in Permit 416:
Access to the ore horizon would be obtained by means of the haulage decline established during the overburden removal phase. This decline would generally be driven to the bottom of the ore horizon, thence along the lower boundary of the ore horizon. In most cases, the haulageway would cross one axis of the pit and extend to the opposite side, dividing the pit into two opposing vertical ore faces.

Because of the generally erratic, undulating nature of the ore horizon (usually 2-5 ft. thick), a combination of ore removal techniques would be employed. In areas where the ore horizon is relatively uniform and continuous, ripping techniques would be utilized. In uniform areas where ripping is impractical, an air-track drill would be used to drill vertical holes (H - 3i in. dia.) from· the upper boundary of the ore horizon. These holes would be slashed to a vertical face using ANFO blasting agents and cap sensitive water gel or emulsion explosives.

To maximize ore grade control, no more than two or three rows of holes would be drilled and blasted beyond the existing vertical ore face. Similarly, a concerted effort would be made to minimize rock displacement (heave) during blasting due to grade control considerations. Wheel loaders of 3-6 yd 3 capacity would then muck the blasted ore, loading into trucks situated in the pit, or at the top of the ramp, depending on the size of the pit. If excessive ore dilution results from the use of wheel loaders, the ore would be mucked using a backhoe situated on top of the ore horizon above the final pit floor (Mine Permit 416, Section 5.1.5).

In late 2012, VMC LLC conducted an investigation of noise, which characterized baseline sound-levels in Spearfish Canyon and measured noise generated by heavy equipment operation,

equipment back-up alarms and blasting. The reports of these investigations, *Background Sound-level Study for the Deadwood Standard Mine Project* (Kliche, 2013a) and *Sound-Level and Vibration Monitoring In and Above Spearfish Canyon for the Deadwood Standard Mining Company* (Kliche, 2013b) are available for review upon request. The baseline sound-level assessment found that the dominant source of noise in Spearfish Canyon is traffic including cars, pick-up trucks and louder vehicles such as logging trucks and motorcycles. Natural sounds such as the gurgling of Spearfish Creek and the sound of waterfalls also contribute to baseline sound-levels. The sound-level monitoring found that noise associated with equipment operation, equipment back-up alarms and blasting at production scale were not audible in Spearfish Canyon and were not detectable by sensitive sound-level monitoring instruments set up in the canyon.

Blast vibration was measured during test blasts conducted for the noise study. Very low levels of blast vibration were detected at the canyon rim during two of the three test blasts. However, the maximum values were well below accepted damage criteria levels established by the U.S. Bureau of Mines (Sinkind et al., 1989). No blast vibrations were detected at a monitoring station within Spearfish Canyon.

Dr. Kliche has done extensive tests and analysis of sound and seismic vibrations of blasting and operation related activities and has concluded that noise associated with equipment operation, equipment back-up alarms and blasting at production scale were not audible in Spearfish Canyon. He also pointed out that seismic vibrations created by blasting are very low level and would not create rock avalanches or landslides on the canyon walls adjacent to permit area.
I trust Dr. Kliche's scientific findings and agree with his assessment.

Crushing and Hauling

Permit 416 authorizes mining of ore at the Deadwood Standard Project with haulage to the Homestake Mill in Lead, SD for mineral processing. The mineral processing facility in Lead, SD is no longer present, and accordingly, mineral processing at the Homestake Mill is not possible. This application for a Lawrence County Conditional Use Permit differs from Permit 416 in that we are requesting authorization by the county of mining at the Deadwood Standard Project with processing at an unspecified offsite facility. Additional discussion of mineral processing is

presented in the following section. Pertinent sections of Permit 416, which relate to crushing and hauling of ore, are provided below.

*Ore would be loaded into off-road trucks and transported to a centrally located crushing plant on site. The ore would then be crushed to minus 3/8 inch and re-loaded into highway trucks for transport to (*an approved offsite processing facility). *Approximately two miles of road would be upgraded leading into the Johnson Gulch mine area. All upgrading would be done in accordance with conventional section, rolling dip, and turnout design specifications. Road upgrading and widening would be minimized, with proper drainage and crown surfacing being critical. Haul roads would be treated as necessary to control dust during the summer months. Typical highway trucks utilized would be 15-ton capacity, tandem axle end-dump units (Permit 416, Section 5.1.6).*

VMC proposes to conduct crushing and haulage as currently authorized by Mine Permit 416.

It is not clear where the ore will be shipped since there is no decision on site for processing. If a new site away from the property gets approval then hauling trucks could be using highway 14, in which case number of issues could arise from this hauling operation including air pollution from exhaust fumes and dust from crushed ore, constant noise increasing at night, heavy traffic, highway safety issues and many more.

Mineral Processing

VMC LLC is examining options for an off-site mineral processing facility. Mineral processing may occur at an existing mineral processing facility, or at a new mineral processing facility. A new facility could be constructed to process gold ore specifically for the Deadwood Standard Project, or as a toll-milling facility that would receive ore from the Deadwood Standard Project and other gold mining projects in the northern Black Hills.

Design, permitting and construction of a mineral processing facility requires significant investment of capital, and it is therefore important to first have county authorization for mining of ore from the Deadwood Standard Project prior to investing in a mineral processing facility. Additionally, county authorization is necessary to facilitate negotiations for mineral processing at an existing facility.

VMC requests that the County approve this proposed CUP with a condition that would allow pre-mining activities, but not allow mining until an offsite mineral processing facility has been selected by VMC LLC and authorized by the state. Pre-mining activities may include *activities such as surveying, road improvements, ore delineation, and ore metallurgical analysis.*

If mineral processing is contracted out to an offsite location, then it wouldn't pose any treat to Spearfish Canyon. However as pointed out in the paragraph above it could create huge problems if hauling trucks use the current highway system or a new haulage road within the canyon.

Reclamation

VMC LLC proposes to conduct site reclamation as currently authorized by Permit 416:
All overburden and topsoil stockpiles would be returned to mined areas on an ongoing basis, using conventional earth-moving and compaction equipment. In most cases all overburden would be returned to mined areas within one to three months after production completion. In some instances, mined areas would be backfilled by directly transferring waste overburden from developing pits. Final overburden contouring would be designed to best approximate the original surface topography.

Any newly constructed roads would be built to blend with the landscape. After mining activities requiring their use are complete, the roadways would be ripped and reseeded to stabilize the area and minimize erosion.

Areas to be reclaimed would be worked with a disk and packed to create a firm seedbed. Seeding would be done with a special grass drill equipped with packer wheels, depth bands and agitators. Seed would be broadcast if areas to be seeded are small or if the terrain is too rough

for equipment. Seed application rates would be doubled for broadcast seeding. After seeding and fertilizing, the area would be mulched, as discussed above (Permit 416, Section 6.4).

Permit 416 provides a seed mixture along with fertilization and mulching protocols to facilitate successful revegetation. After seeding, VMC would also conduct weed and erosion control activities until the reclamation is deemed complete by the South Dakota Department of Environment and Natural Resources. The state would administer a reclamation bond for the project, which would be released only after site reclamation is complete and the reclaimed areas are functioning in accordance with the post-mining land use.

Reclamation will be strictly monitored by the state authorities (DENR) so it should not be a problem as long sufficient bonds are placed.

Environmental Protection Measures

Because mineral processing would be conducted offsite, the proposed Deadwood Standard Project would most closely resemble a limestone quarry. Accordingly, common environmental protection measures typical for quarries are appropriate. In addition, VMC LLC has developed several proposed environmental protection measures (EPMs) specific to the Deadwood Standard Project and incorporated recommendations developed by the county during 2012, which are relevant to the current application. VMC proposes that the following EPMs be included in the CUP as conditions of approval.

General:

EPM-1: In May of each year, Deadwood Standard Project/VMC LLC shall file a written annual report with the Lawrence County Planning and Zoning Administrator, setting forth Deadwood Standard Project compliance with the terms, requirements, and conditions of the Conditional Use Permit as well as an update on the general operations and reclamation of its mining operations. Such report shall address selected key socioeconomic information such as employment, payroll, work force, residency, taxes, anticipated activities, impacts on adjacent lands (that is, drilling, blasting, noise, dust, traffic, etc.) and any additional areas as may be determined by the Lawrence County Commission.

EPM-2: The owner and operator shall comply with all applicable county ordinances, and state and federal laws and regulations.

EPM-3: All excavations, extraction of materials and minerals, and open pits shall conform to the approved operating plans and permit conditions of the South Dakota Department of Environment and Natural Resources (DENR) and any applicable United States Environment Protection Agency (EPA) water discharge permit standards.

EPM-4: Copies of any Notices of Violations sent to Deadwood Standard Project from the DENR or EPA shall be transmitted to the Lawrence County Planning and Zoning Administrator within ten (10) days of receipt.

EPM-5: Deadwood Standard Project/VMC LLC shall cooperate with Lawrence County in regulating employees', contractors', service person's and supplier's vehicle speeds and the observance of traffic signs on all public roads in the vicinity of Deadwood Standard Project Mining Operation.

EPM-6: Deadwood Standard Project/VMC LLC shall schedule, if reasonably possible, normal off-site heavy truck weekday deliveries during daylight hours.

EPM-7: Deadwood Standard Project/VMC LLC shall provide hazard training and work cooperatively with Lawrence County Emergency Management Office to ensure county emergency responders are properly trained to manage any hazard situations that may arise.

Mineral Processing:

EPM-8: Mining and haulage of ore from the permit area shall not occur until an off-site mineral processing facility is selected by VMC LLC and authorized by the state.

Again, offsite processing facility should not be allowed to use the highway or a road within the canyon due to reason listed under section *Crushing and Hauling and Mineral Processing.*

EPM-9: Pre-mining activities may occur prior to selection and authorization of the mineral processing facility such as surveying, road improvements, ore delineation, and ore metallurgical analysis.

These are standard small-scale pre-operation activates that should not be a concern at this point.

Reclamation:

EPM-10: Mined areas shall be reclaimed and shaped to control erosion and eliminate hazards to domestic animals and wildlife, to protect public health and safety and the environment, and to provide for appropriate future beneficial land use. Temporary silt fences and retention berms will be used to control erosion until a final vegetative cover has been established.

EPM-11: All disturbed areas shall be regraded, landscaped, and revegetated in such way as agreed upon by VMC LLC and the local conservation district, to establish a diverse, effective, and long-lasting vegetative cover. For any future land use, the revegetation shall be capable of self-regeneration and at least equal in extent of cover to the pre- existing, natural vegetation of the surrounding area.

EPM-12: Where necessary to remove overburden in order to mine the ore, topsoil shall be removed from the affected area and segregated from other spoil. If such topsoil is not replaced on a backfill area within a time short enough to avoid deterioration of the topsoil, vegetative cover or other means shall be employed so that the topsoil is preserved from wind and water erosion, remains free of any contamination, and is in a usable condition for regenerating and sustaining vegetation when restored during the reclamation.

EPM-13: Reclamation of the land shall conform with the rules, approved reclamation plans and permit conditions of the DENR and in consultation with the Natural Resources and Conservation Service (NRCS). Reclamation will proceed in a timely and orderly fashion as determined by the DENR and the NRCS. All state required annual reclamation reports shall be made available for review by the public upon request.

Above activates will be closely monitored by the state.

Noxious Weeds:

EPM-14: All noxious weeds shall be controlled pursuant to the Lawrence County Invasive Species Department regulations and applicable state law.

Most likely it will be monitored by the county or the state.

Water Quality:

EPM-15: Any disturbance to the prevailing hydrologic balance of the affected land, to the surrounding area, or to the quality and quantity of water in surface and groundwater systems both during and after the mining operation and during reclamation shall be minimized. Operations shall be conducted to protect all waters from pollution by siltation, waste, debris, and toxic fluids or materials.

EPM-16: All surface areas of disturbed or affected land, including spoil piles, shall be stabilized and protected so as to effectively control erosion and air and water pollution.

EPM-17: Deadwood Standard Project shall monitor groundwater and surface water quality during mining. Collected data shall be provided to DENR and Lawrence County on an annual basis. If any water quality samples show an exceedance of state water quality standards, DENR and Lawrence County shall be notified within twenty-four (24) hours. Results of the water quality monitoring program shall be made available for review by the public upon request.

Any disturbance on the Pahasapa whether on the west or east side of the canyon will have an impact on both surface and groundwater. These issues were discussed in the HYDROLOGY section.

FINDINGS, QUESTIONS, CONCERNS AND RECOMMENDATIONS

1. The existing original state permit authorized 120 acres of disturbance, but the Deadwood Standard Project permit application in 2012 was proposing to disturb approximately 170 acres, including the addition of a mill site, which was not authorized in the original permit. In the current application the entire permit boundary including the buffer zone appears to extend to approximately 500+ acres. This is way more than what VMC application proposes to mine.

2. The mine application does not specify the total amount of production in terms of rock removal over the life of the mine. It outlines that 870,000 tons of ore to be extracted and processed but it doesn't give total amount of rock mass to be disturbed. Our estimates show that minimum of 20 million tons of rock need to be disturbed to extract the said amount of ore.

3. The company proposes to mine total 70,000 ounces of gold from 870,000 tons of ore. Company should share an ore deposit model supporting their calculations as historical ore grades doesn't support above numbers.

4. There is inadequate information on mine operation & facilities to determine impacts. Projects must provide detailed site location map, detailing proposed areas of disturbance, all waste disposal sites, structures, access and haul roads.

5. The mine application does not specify the total amount of production in terms of rock removal over the life of the mine. It outlines that 870,000 tons of ore to be extracted and processed but it doesn't give total amount of rock mass to be disturbed. Our estimates show that minimum of 20 million tons of rock need to be disturbed to extract the said amount of ore. A 3D ore deposit model is needed to satisfy above numbers.

6. The company does provide satisfactory independent analysis to determine whether blasting near the rim could result in damage to the canyon. Based on the information provided by

company representatives blasting and other described mining activities will not have noticeable impact on the canyon and its residents.

7. There is inadequate information to evaluate the potential impacts to water. Precipitation that falls on the proposed project area likely infiltrates due to high permeability of the limestone plateau. Most precipitation is released back into the atmosphere through plant transpiration and evaporation, but a portion of precipitation percolates downward through the Pahasapa Limestone to top of the Englewood Formation is a confining layer which water most likely moves laterally along the top of the formation and discharges to the surface as springs along Spearfish Canyon.

8. Hydrological studies are needed to identify the potential impacts to Spearfish Canyon and Spearfish Creek as water quality will be impacted from mining activities including blasting and mucking. The Wharf mine caused extensive groundwater pollution from nitrates from blasting residues in ammonium nitrate fuel oil explosives found in waste rock repositories.

9. Valentine Mining Company dismisses any concerns about cyanide releases or other water quality impacts, because it states that mineral processing will be on an off-site location. If offsite processing plant requires access through existing highway or new road in the canyon, number of issues could arise from this hauling operation including air pollution from exhaust fumes, dust, noise pollution, heavy traffic, highway safety and many more.

10. The existing application doesn't provide sufficient information to determine the risks to Spearfish Creek. A comprehensive hydrologic study is needed to evaluate the connection between the groundwater in the project area and Spearfish Canyon.

11. There is also insufficient information on the geochemistry of the ore to determine potential impacts to water quality from metals leaching. Whole rock geochemical analysis of ore and unmineralized rocks are needed to determine the potential impacts.

12. There is inadequate information on proposed and existing grading, drainage patterns and landscaping. The permit application does not include a stormwater management plan to specify how the project will control mine run-off.

13. Company must reveal the information obtained from and the reasoning behind the 800 feet deep hole drilled in violation of the drill permit by VMC in 2017. Furthermore, the company must be more transparent on their future expansion plans for either mining deeper levels of the Paleozoic sections or adding more surface areas to their mining program.

14. Large corporations may be interested in consolidating the old mining camps east of the canyon and may propose to operate a large-scale gold mine. Wharf mine in 2019 signed an agreement with Barrick to utilize Richmond Hill area to expand their current operations.

15. This study shows that the entire area east for the canyon from Cheyenne Crossing to Bridal Veil Falls is subject to future mining if gold prices remain above $2000 per ounce. Such development would have devastating impact on the canyon and its inhabitants including people, animals and plants.

Concluding Remarks: It is not clear whether VMC LLC is ready. It appears that there are substantial issues to be resolved before obtaining an operations permit, including comprehensive groundwater baseline studies, surface-water, stormwater mitigation, mining program and processing site.

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