

Colorado School of Mines  
Mining Engineering Department

Underground Opening and Support Facilities of the Edgar Experimental Mine  
Idaho Springs, Colorado

Submitted by:  
David K. Mosch  
Edgar Mine Manager  
and  
Dr. Vilem Petr  
Assistant Research Professor

For:  
Dr. T. G. Rozgonyi  
Professor & Head  
CSM Mining Engineering  
Department

updated  
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## 1.0 Introduction

The Colorado School of Mines (CSM) Experimental Mine, also known as the Edgar Mine, was one of the very rich gold and silver mines in the Idaho Springs mining district. The Edgar Mine was named after the Edgar mineral vein that runs along the hillside above the mine. CSM acquired the mine in 1921, when officers of the then bankrupt Big Five Mining Company, agreed to lease the mine to the school. CSM has since acquired additional land and workings to form the present holdings of the Experimental Mine, which are now the property of the school. The mine is considered to have the safest rock formations and best underground workings of any comparable facility.



Train Passing Office and Shop Facility

During the past 80 years, the Experimental Mine has been used by both private companies and various state and federal agencies to develop a wide range of products and concepts. Some of the more notable research projects that have been preformed at the mine include:

- The U.S. Army's tunnel detection program
- The National Institute for Occupational Safety and Health's (NIOSH) rock burst detection method development program
- The rock mechanics data acquisition methods study for the Department of Energy
- The "in-situ stope leaching" project preformed by the former U.S. Bureau of Mines

Today the mine, because of its modern infrastructure and covenant location, continues to be used for research and training by the Colorado School of Mines, several small private research companies and by the Colorado State's Mine Rescue training group. Even with these projects going on at the mine, the facility is large enough to accommodate many other major research projects. The advantage of using the Edgar Mine for projects, over other facilities, is the ability to share the operating costs with other companies and government agencies, and to utilize student labor when appropriate.

## 2.0 Location

The Colorado School of Mines, Experimental Mine is located approximately 20 miles west of Denver, Colorado in the small town of Idaho Springs.

The mine and Idaho Springs are an easy 30-minute drive on Interstate 70 from Denver and a 1-hour drive from Denver International Airport. When traveling Interstate 70 take exit 224, the second Idaho Springs exit, turn north and proceed to Colorado Boulevard, then turn west and go to 8th Avenue. On 8th Avenue, it is a short drive up the hill to the Experimental Mine.

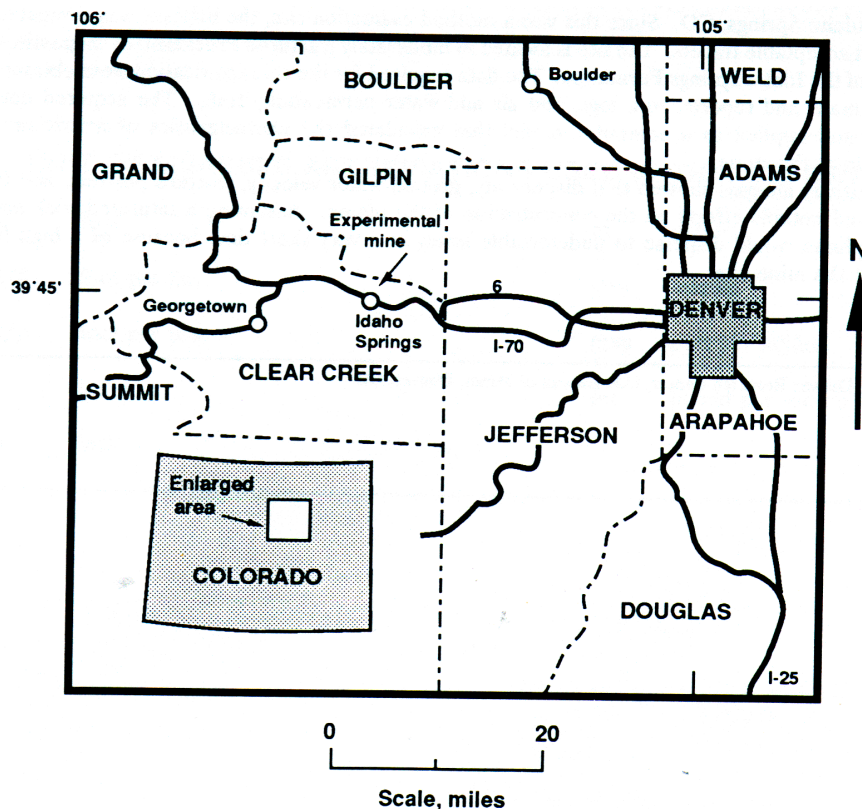
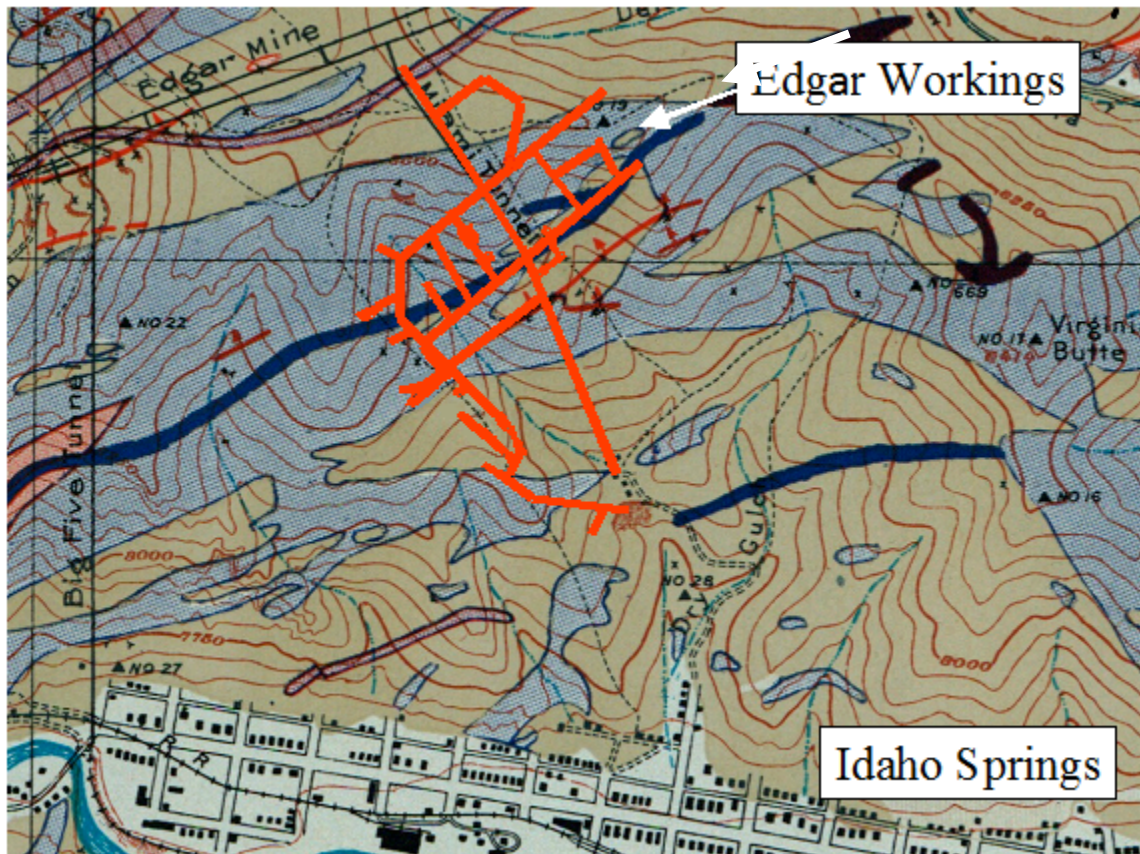


Figure 2.1 Edgar Mine Location

### 3.0 Geology

The Experimental mine is composed of Precambrian rock units which have been subjected to at least three periods of deformation during the Precambrian and early Tertiary times. These Precambrian rock types include Quartz-plagioclase gneiss, Quartz-plagioclase-biotite gneiss, Quartz-Biotite-Hornblend gneiss and Biotite-microcline-pegmatites.

Also near the Experimental Mine are small porphyritic plutons and dikes of early Tertiary age. These rocks include the bostonite and monzonite types of igneous rock.



**Blue-** rock type is Quartz-plagioclase gneiss and Quartz-plagioclase-biotite gneiss.

**Brown** - rock is Quartz-Biotite-Hornblend gneiss and Biotite-microcline-pegmatites.

**Black and purple** are Tertiary porphyry dikes. (bostonite & monzonite)

**Red** is the approximate location of the mine workings.



Figure 2.1  
Edgar Mine Geology Map

The mine site is situated on the steeply dipping northwest flank of a northeastward –trending anticline and contains many small fault zones. The fault zones strike in a northeast direction and dip to the north between 30 and 80 degrees. These fault zones, most of which are barren, often contain economic concentrations of a variety of metal bearing minerals.

The mine site is also characterized by the presence of at least three joint sets at any one place and up to five sets locally in portions of the mine.

Over the years, many rock mechanic studies have been preformed at the mine. A general summary of the mine's rock mechanic data are given in Table 3.1.

Table 3.1  
Rock Mechanic Data of the Edgar Mine

Uni-axial Compressive Strength	40 - 150 MPa
Elastic Modulus	60 to 90 GPa
Poisson's ratio	0.2
Friction angle	30 <sup>o</sup> to 45 <sup>o</sup>
Rock Mass Rating	40 to 80

### **Edgar Experimental Mine Infrastructure**

#### **Description of Underground Workings**

The Edgar Mine has nearly 2 miles of underground passageways. There is 7400 feet of rail driven tunnels and 1850 feet of rubber tire tunnels. The mine has 2-30 foot shafts 3-50 foot shafts and 1-200 foot shaft. There are also 2-30 foot stopes. The Edgar mine workings are divided into two sections, the Army tunnel and the Miami tunnel. The Miami tunnel was started in the 1890's and was driven to access the Edgar's silver vein. The back of the Edgar Tunnel (1200 feet from the Miami portal) has long since caved. The Army tunnel was driven less then 20 years ago to perform tunnel detection experiments has in recent years been expanded past the vent raise connecting to the Miami tunnel using slash round

blasting. The mine is relatively dry and has a constant year-round temperature of 54 degrees Fahrenheit.

### **Length, Size, and Condition of Openings**

The underground workings of the Experimental Mine consist of a maze of horizontal openings which when summed up are a length of 9250 feet. These openings vary in size, length and distance from the surface. In general, the size of the openings in the mine varies in length from less than 30 feet to a maximum length, along the path of the Miami tunnel and Edgar mine drift, of 1300 feet.

The size of the openings varies from a small size of 6 feet wide by 6 feet tall to a maximum size of 15 feet wide by 15 feet tall. All workings have uneven walls that are typical of openings made with small drills to make blast holes. Figure 4.2, shows a plan view lay-out map of the workings and Table 4.1 gives information about each openings length, size, and distance to the surface.

In the mine, 90% of the workings are in excellent condition, 5% of the workings need minor amounts of work to make them operational and 5% of the workings would be very expensive to make safe and operational.

### **Underground Utilities**

The mine is well equipped with utility systems that allow operation of equipment for maintenance and experimentation. A detailed list of the various types of utilities is contained in Table 4.2.

### **Power**

The mine has an electric distribution system consisting of seven transformer step-down stations, from which single phase - 110 volt and 3 phase - 440 volt power are distributed throughout the mine. Seventy four percent of the mines openings are equipped with 110-volt, single-phase power and 62% of the workings have 440volt, 3-phase power. The mine has a surplus of power equipment and wire that may be used to equip any other part of the mine, if required.



## **Compressed Air and Water**

The mine has two LLE Ingersoll Rand air compressors with a combined rating of 1600 cubic feet per minute at 120 pounds per square inch. An 850 cubic foot per minute portable air compressor is also available.

Water is stored in a 60,000-gallon reservoir in the Miami tunnel and a 15,000 gallon reservoir in the army tunnel. Each is equipped with 7-½-horse power pumps. All water is acquired from the city of Idaho Springs and is of drinking standards quality.

Compressed air and water are distributed throughout the openings with schedule-40 pipe of various sizes. Seventy five percent of the workings are equipped with compressed air and water.

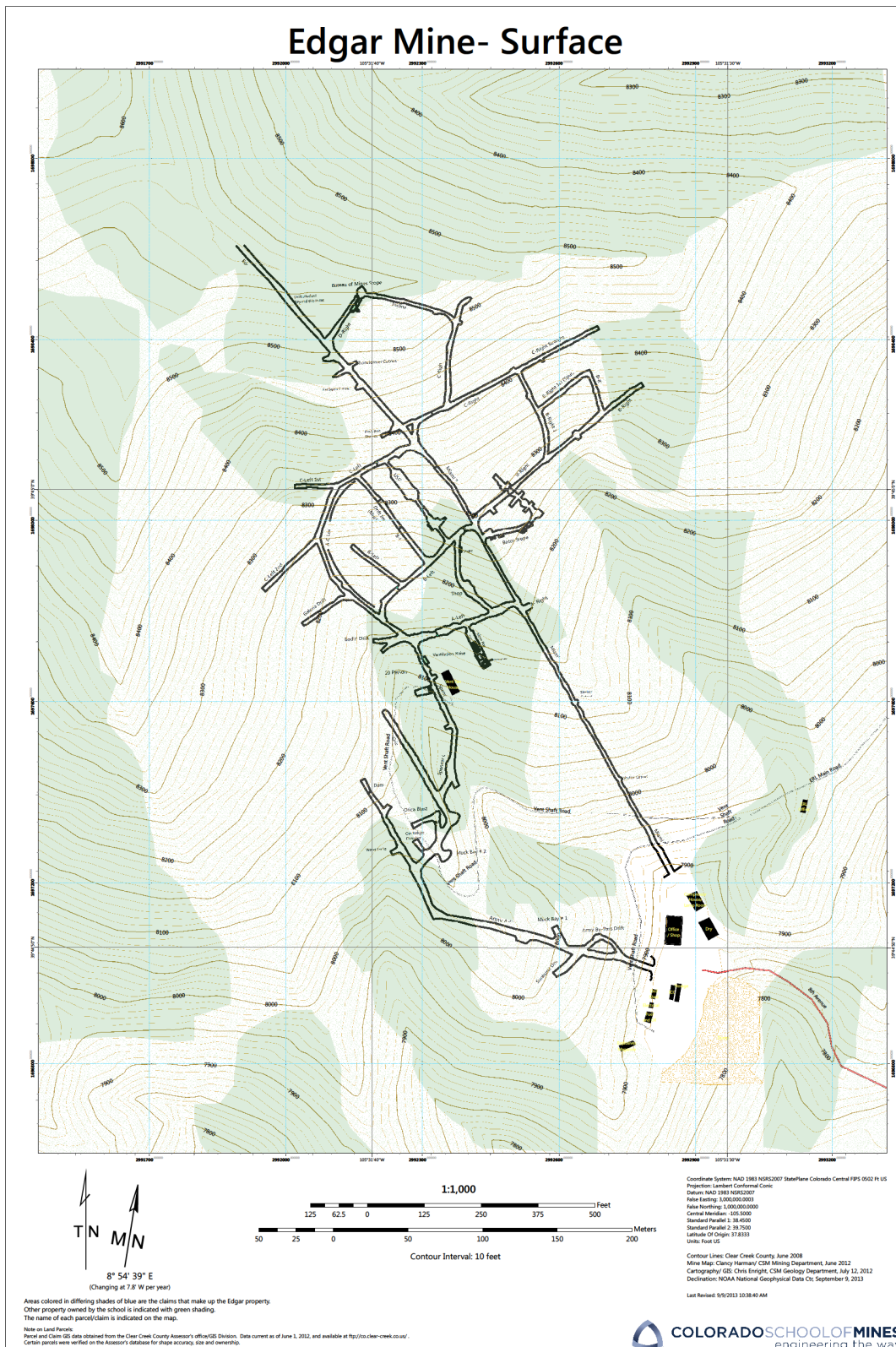
## **Ventilation System**

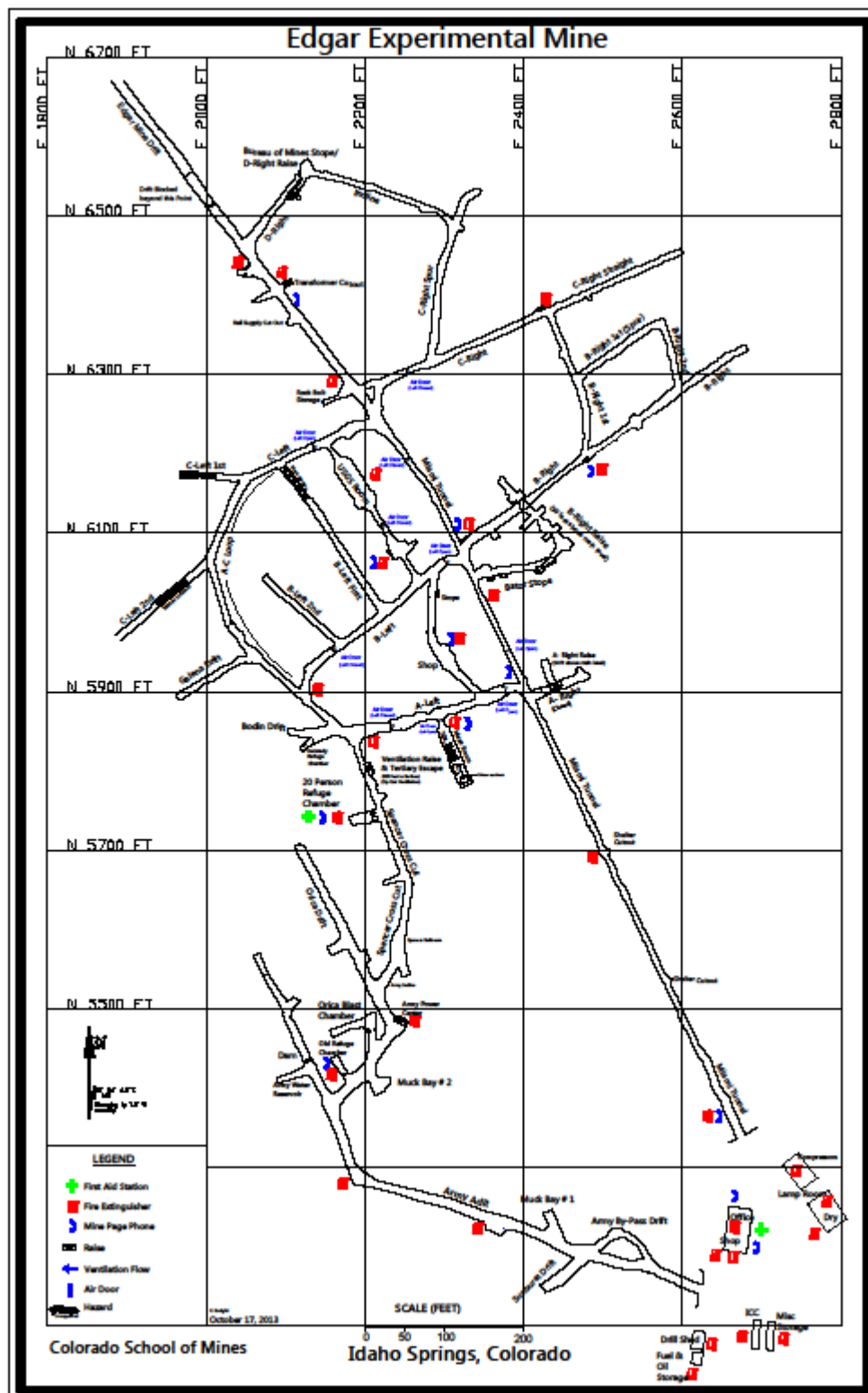
The Edgar Mine is equipped with an in cast ventilation system consisting of a series of fans of various sizes. The Mine is ventilated with a 60 horsepower variable speed 45,000 cubic foot per minute exhausting silencer equipped fan, which is at the top of a 200-foot vertical shaft, which connects with the workings of the Army along the A-left straight drift and the Miami the AC loop. Auxiliary fans of various sizes are used to ventilate dead-end drifts in both sections of the mine. Also, both sections of the mine have more then one opening to the surface, which allows the workings to be ventilated naturally when the mine is not in operation.

## **Mine Communication System**

The mine is equipped with three communication systems. First, a set of 12 motorola radios run through leaky feeder cable throughout the mine. This system also has 20 tracking tags and a tag reader system to pinpoint the tags in the mine. The second is a set of 12 mine intercom-type paging phones are located strategically throughout to allow quick access from any portion of the mine. The mine also has an antenna system to allow small radio communication, if needed.

The Edgar mine workings in relation to surface contours  
(Contours are on 10-foot intervals)





## Emergency Escape Systems

The primary escape from both the Miami and the Army tunnels is through the main portals. However, if these routes are inhibited, both portions of the mine have rooms that may be sealed and are equipped with life support equipment. The Miami workings, also has a second escape route up the 200 ft. ventilation raise.

### Mine Opening Data

#### Army Tunnel Workings

Drift Name	Length	Size (in feet)		Distance to Surface		Drift Condition
		From	To	From	to	
		(Width by Height)		(In feet)		
Army North Drift	273	10X10	12X12	165	250	Good Condition
Army Tunnel	460	8X8	12X10	0	165	Excellent condition
By-Pass	102	8X8	8X8	40	90	Good Condition
Fly-Right	36	15X15	15X15	130	130	Good Condition
Rockteck Cross-Cut	130	10X10	12X12	170	190	Excellent condition
Sun Burst	53	15X15	15X15	90	90	Excellent condition

#### Miami Tunnel Workings

Drift Name	Length	Size (in feet)		Distance to Surface		Drift Condition
		From	To	From	to	
		(Width by Height)		(In feet)		
A-C Loop	404	8X8	8X8	290	440	Good Condition
A-Left	289	8X8	12X8	270	350	Excellent condition
A-Left Straight	217	8X8	8X8	190	290	Excellent condition
Bator Stope	107	8X8	8X15	340	390	Good Condition
B-Left	275	8X8	10X10	440	490	Excellent condition
B-Left 2ed	118	8X8	8X8	340	390	Good Condition
B-Left First	211	8X8	8X8	400	450	Good Condition
B-Right	445	8X8	10X10	375	450	Excellent condition
B-Right 1st	201	8X8	8X8	390	490	Excellent condition
B-Right 1st Spur	113	8X8	8X15	440	450	Excellent condition
B-Right 2ed	74	8X8	8X8	440	450	Excellent condition
C-Left	186	8X8	8X8	490	540	Good Condition
C-left 1st	84	8X8	8X8	440	440	Good Condition
C-left 2ed	157	8X8	8X8	310	320	Good Condition
C-Right 1st	223	8X8	8X8	490	590	Good Condition
C-Right	441	8X8	8X8	490	500	Excellent condition
D-Right	136	8X8	8X8	640	640	Good Condition
Edgar Mine Drift	523	8X8	12X8	640	<b>700</b>	Good Condition
Galena Drift	109	6X6	8X8	300	300	Good Condition
Incline	215	6X6	8X8	590	610	Good Condition
Miami Tunnel	<b>1391</b>	6X6	10X8	0	640	Excellent condition
ONWI Room	99	15X12	15X12	290	320	Excellent condition
Shop Drift	170	8X8	15X8	340	400	Excellent condition
USGS Room	214	8X8	20X8	400	480	Excellent condition

## Mine Opening Utility Systems

Drift Name	Utilities			Haulage System		Loading System
	Power		Compressed	Water		
	110V	440V 3ph	Air			
Army North Drift	yes	yes	yes	yes	Rubber Wheel	LHD 1&2yrd
Army Tunnel	yes	yes	yes	yes	Rubber Wheel	LHD 1&2yrd
By-Pass	yes	yes	yes	yes	Rubber Wheel	LHD 1&2yrd
Fly-Right	yes	yes	yes	yes	Rubber Wheel	LHD 1&2yrd
Rockteck Cross-Cut	yes	yes	yes	yes	Rubber Wheel	LHD 1&2yrd
Sun Burst	yes	yes	yes	yes	Rubber Wheel	LHD 1&2yrd

### Miami Tunnel Workings

Drift Name	Utilities			Haulage System		Loading System
	Power		Compressed	Water		
	110V	440V 3ph	Air			
A-C Loop	no	no	no	no	Rubber Wheel	LHD 1 yrd
A-Left	yes	yes	yes	yes	Rail	LHD 1 yrd
A-Left Straight	yes	no	yes	yes	Rail	LHD 1 yrd
Bator Stope	yes	no	no	no	None	None
B-Left	yes	yes	yes	yes	Rail	LHD 1 yrd
B-Left 2ed	yes	no	yes	yes	Rail	Over Shot
B-Left First	yes	no	yes	yes	Rail	Over Shot
B-Right	yes	yes	yes	yes	Rail	LHD 1 yrd
B-Right 1st	yes	yes	yes	yes	Rail	LHD 1 yrd
B-Right 1st Spur	no	no	yes	yes	Rail	LHD 1 yrd
B-Right 2ed	no	no	yes	yes	Rail	LHD 1 yrd
C-Left	yes	yes	yes	yes	Rail	LHD 1 yrd
C-left 1st	no	no	no	no	Rail	LHD 1 yrd
C-left 2ed	no	no	no	no	Rail	LHD 1 yrd
C-Right 1st	no	no	yes	yes	Rail	LHD 1 yrd
C-Right	yes	yes	yes	yes	Rail	LHD 1 yrd
D-Right	yes	yes	yes	yes	Rail	LHD 1 yrd
Edgar Mine Drift	no	no	no	no	Rubber Wheel	LHD 1 yrd
Galena Drift	no	no	no	no	Rail	None
Incline	no	no	no	no	Rail	Slusher
Miami Tunnel	yes	yes	yes	yes	Rail	LHD 1 yrd
ONWI Room	yes	no	no	no	None	None
Shop Drift	yes	no	no	no	Rail	None
USGS Room	yes	yes	yes	yes	None	None

## First Aid Stations and Procedures

Located in both the Miami and Army tunnels of the mine are three first aid stations that are well equipped with appropriate supplies. All workers at the mine are required to have a current first aid class and EMT services are less then 10 minutes away. Idaho Springs has a small medical facility located less then a mile away.

## **Ground Support Systems**

The rock mass rating throughout the mine is generally very high and is in the range of 40 to 80. Locally however, openings require significant support. Throughout most of the mine, rock bolting is performed on an “as needed” basis, to stabilize local problems. In the faults zones and veins, rock bolting is performed in conjunction with fencing type mesh and closely spaced bolt locations. The majority of the rock bolts used at the Edgar mine is the “Split-Set” type. An occasional “resin” bolt is used as needed. No wood support is used in the active workings of the mine.

## **Distance to the Surface of Underground Openings**

Both the Army and the Miami tunnels are horizontal openings that, as they go in, gain distance vertically to the surface. They are both located on the side of a substantial mountain. Each drift or opening is listed on Figure 4.1 and the approximate distance to the surface above each opening is listed in Table 4.1. A map of the underground workings, with surface contours and surface roads, is shown in Figure 4.2

## **Surface Plant**

The Edgar mine is equipped with modern surface plant facilities, such as; an office, shop, compressor room, lamp room, change rooms, rest rooms, storage sheds for parts, fuel storage building and powder magazine. Also included in the facility is a building that is used as a classroom, with tables, chairs and chalkboards. This building is about 1000 feet south of the mine plant.

## **Main buildings: Office, Shop, Dry Room and Lamp Room**

### **Office**

The office has a late model computer with Internet capability, a Fax, map storage and filing cabinets. The office is often used as a lunchroom for workers.

### **Shop**

The surface shop contains a full set of mechanic tools with supplemental specialized tools to perform maintenance on the fleet equipment at the mine. In addition, the shop has its own compressor; stick and wire feed welders, hydraulic hose equipment, drill press, grinder and a parts-cleaner. The surface shop also has limited warehouse capability for equipment parts and maintenance items.

## **Compressor House & Lamp Room**

The mine has a building that serves as both a compressor house and a mine light charging room. Two late model LLE Ingersol Rand 150-horse power air compressors are housed in the north end of this building. At the south end,

the mine has a charging station with a capability of charging up to 50 Wheat Lamp type mine lights. The lamp room also serves as sign in room where workers take their brass tag before going underground.

### **Change Room or “Dry Room” Facility**

The change room is a clean and modern facility that contains separate restrooms and lockers for both men and women.

### **Explosive Storage**

The mine has a secure and modern explosive magazine located about 400 feet south of the main surface plant facility. The magazine consists of a 70-foot long horizontal opening into the hill with a double steel door, which is kept locked. Within the magazine are two rooms, one to store detonators and one for storing high explosives and blasting-agents. The high explosives section of the magazine has a 2-ton storage capability. The magazine and mine site have been permitted with both the Bureau of Alcohol, Tobacco and Firearms (ATF), and with the State of Colorado’s Division of Minerals and Geology.

### **Surface Roads & Surface Drill Holes and Pads**

#### **Roads**

The road between Idaho Springs and the mine is open year-round and is maintained by the mine staff. At the mine site, parking is adequate for 15 vehicles. Above the mine is a network of roads that access drill hole sites and old equipment storage. These roads are maintained by mine staff as needed.

#### **Drill Pads and Drill Holes**

On the surface above the mine site, are drill holes that were used for tunnel detection. Two groups of holes consisting of 15 holes in all are located on drill pads along and adjacent to the trace of the Army tunnel. Nine additional holes are located throughout the mine site and are located as far as 1000 feet from the mine openings. These holes are generally in excess of 300 feet deep and are from 4 inch to a foot in diameter.

#### **School House**

The “school house” is a facility that is ideal for making presentations. It will seat about 30 people and has a white board, projector screen, computer projector apparatus and many interesting exhibits. This facility is used less than 20 days a year.

### **Equipment**

The following is a list of equipment that is available at the mine site for experimental work at the mine.



### Rock Excavation Equipment

- Elphinstone 1500- 5 yard capacity load haul dump machine
- Wagner ST2 – 2 yard capacity load haul dump machine
- Wagner ST2 – 2 yard capacity load haul dump machine with ejector bucket
- JCI 125 – 1 yard capacity load haul dump machine
- Caterpillar 10,000 lb 4wd forklift
- Eimco 12-b rail overshot loaders (three each)
- Gardner Denver GD10 rail overshot loader
- Double drum slusher hoists (two each)

### Drilling Equipment

- Single boom Ingersoll Rand jumbo drifter with a GD93 drill with independent rotation mounted on a 2 cylinder diesel Young Buggy
- Tamrock Minmatic twin boomer electro hydraulic jumbo
- Atlas Copco H266 single boomer electro hydraulic jumbo
- Sullivan Twin boom rail drill air over hydraulic
- CP63 core drill with equipment
- GD83 pusher leg drills (ten each)

### Rock Haulage Equipment

- ELMAC D45B Ten ton underground dump truck
- Plymouth five ton diesel locomotive
- Atlas two-ton Battery locomotive
- Lyster one-ton diesel locomotive
- Two-ton capacity side dump rail cars (7each)
- Flat cars 3 feet by 2 feet (3 each)
- Flat cars 6 feet by 2 feet (2 each)
- Rail type man haulage rail cars (2 each)

#### Miscellaneous Equipment

- Bobcat 753 skid steer loader
- Case w14 surface loader with 2 yard bucket
- 1994 f-350 4wd Ford Flat-bed truck
- 1990 f-250 4wd ford work truck
- Caterpillar sr4 generator 325 kva
- Getman articulated work truck
- Getman articulated 1000 gal water truck
- Eimco articulated shotcrete placement truck
- JCB 210 backhoe loader
- Massey Ferguson 20C 3 seat boss buggy
- Ford 345D 3 seat powder buggy
- New Holland 345D 7 seat man buggy
- 185 Gardner Denver gas powered air compressor
- Fans of various sizes and designs (15 each)
- Small pumps (5 each)
- Hydraulic pumps

#### 4.0 Local Community

Idaho Springs, located at the south edge of the mine property, is a town of 8,000 people. The town is a 30-minute drive from Denver on Interstate 70, which passes through the south edge of the town.

Idaho Springs contains 12 restaurants, 4 hotels, 1 auto parts store, 1 hardware store, 1 lumberyard and a protolum product retail warehouse. These stores provide immediate service for needed items in repair of research/mine equipment.

The weather in Idaho Springs is moderate. Although the town is at a elevation of 7,800 feet above sea level, the town has only a few snow storms a year and the temperature seldom stays below freezing for more than a few days.

The people of Idaho Springs are friendly and are proud to have the Experimental mine in their town.

#### 5.0 Other Related Properties

The Colorado School of Mines controls several other mine properties near Idaho Springs that may be available for experiments, if so desired.

One of these properties is called the Joe Reynolds Mine which is located approximately 8 miles west of Idaho Springs. This property was a large and very productive silver mine with ten levels. Although most of these levels have caved, the lowest level, called the Elida tunnel level, is open.

The portal would need to be prepared before safe access could be attained. This level has a power line to the portal and is accessible for 9 months out of the year. The tunnel at this level is 1800 feet long and gains approximately 500 feet of cover at the end of its path. The rock types encountered in this mine include: biotite gneiss, migmatite, quartz diorite, biotite-muscovite granite and alaskite granite.

#### 7.0 Engineering and Technical Support

The Golden campus of the Colorado School of Mines has vast research capabilities with labs and expertise in all geo-technical disciplines. Additional support from the campus may be obtained through the Mining Engineering Department.

#### 8.0 Site Security and Surface Storage Capability

Although the Edgar mine is near the town of Idaho Springs, portions of the Experimental mine can be made extremely secure. There are no houses to the east, north and west of the mine site, and no-mine roads or trails for at least a mile. The mine site itself is about 1,000 feet north of a lockable gate. All underground openings are secured by steel gates with keys that are cannot be duplicated. The site may be made as secure from other researchers and the public as required.

The mine site has various flat areas that may be used for storage of trailers, buildings and equipment. An area could be easily cleared and excavated if required.

#### 9.0 Access to the Experimental Mine Facilities and Support

The Edgar Experimental Mine is available for all types of research. The mine is fully staffed with a Manager, Superintendent and support personnel. Use of the facilities and support must be negotiated with the Mining Engineering Department of the Colorado School of Mines.