1931

A summary of operations and practice at Shenandoah-Dives

Howard Histed

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A SUMMARY OF OPERATIONS AND PRACTICE
at
SHELDONIAN-DIVES

by
Harvey Histed

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SCHOOL OF MINES AND METALLURGY OF THE UNIVERSITY OF MISSOURI
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Approved by
Professor of Mining.
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A SUMMARY OF OPERATIONS AND PRACTICE

at

SHEMANDOH-DIVES

LOCATION OF THE PROPERTY:

The property of the Shenandoah-Dives Mining Company is located in the Animas Mining District, San Juan County, Colorado. The Mine is located on King Solomon Mountain, four miles east and one mile south of Silverton. Silverton is on a branch line of the narrow gauge Denver & Rio Grande Western Railway, on which the nearest smelter is located at Durango, a distance of about fifty miles.

Included in this report is a claim map showing all the claims and their relative locations. The claims cover the vein outcrops and adjacent ground along the strike of the vein for a distance of 8000 feet. The elevation of the various points along the profile of the outcrop varies from 11,200 to 13,000 feet above sea level with the corresponding severe climatic conditions.

The mill is situated on the main highway from Silverton to Eureka and about two miles from

Page 1.
1. Looking up Arrastra Gulch from the Mill.

-2. Looking down Arrastra Gulch from the Mine.
Silverton. The mine is reached by aerial tramway. The Mayflower lies in a natural outlet in Arrastra Gulch and affords an all year operating connection by aerial tramway to the mill. Otherwise, the mine is normally reached by trail over which mule packing is carried on during the open season.

**HISTORY:**

The North Star was one of the pioneer mines of the region, having been intermittently exploited three or four years previous to 1883; from 1883 the mine produced steadily to 1900. The Shenandoah-Dives was also the scene of early activity. The ore from these two groups was hand sorted, sacked, and packed on mule back to the railroad.

The Mayflower was worked from 1916 to 1918. Production from these claims were: North Star, $2,000,000; Shenandoah-Dives, $1,250,000; Mayflower, $2,000,000, all in net payments by the smelter.

The properties were brought to the notice of a group of Kansas City capitalists by Charles A.
Chase of Denver, Colorado. Mr. Chase examined the various groups and made a favorable report on consolidating the groups and operating them as a combined project. The Shenandoah-Dives Syndicate, an informal organization, was formed and acquired options.

Under the direction of Mr. Chase systematic prospecting and development was started. Two prospect drifts were driven under the old workings of the North Star during the first nine months of 1926. The two drifts were almost continuously in ore of a milling grade for a distance of about 800 feet. This work was done from the Shenandoah-Dives side which offered the most convenient base at that time. Orville R. Whitaker, of Denver, Colorado, was called in consultation on the project in October 1926. He gave unqualified approval.

The Mayflower portal offered the only reasonable operating base on the whole length of the property. The scene of operations was shifted to the Mayflower in October 1926. Tentative plans called for a long drift into the heart of the mountain from which a 2000 foot shaft to surface was to
be raised.

The drift was accordingly started, in the vein and from the old breast of former operators. Little or no ore was found until August 1927 when there was found midway in the Slide claim excellent ore which continued to the end line of the claim. The major plans for connecting with the Shenandoah-Dives and North Star were postponed to permit development of Mayflower and Slide claims for possible early production.

Early in 1928 a sub-lease was obtained on the old mill of the Iowa Gold Mining and Milling Company. This concentrator was an antiquated gravity affair that was very inefficient. Modern milling equipment of 100 tons capacity was installed in the old building. The equipment consisted of ball mill and gravity and flotation machinery. The new plant went into operation late in June and the enterprise became more than self-sustaining. Ore for the mill came largely from development.

In April 1929 the Syndicate organized the Shenandoah-Dives Mining Company, a Colorado Corporation, to take over the property. The new corpora-
tion began a major construction program consisting of mill, aerial tramway, mine hotel, and installation of required mine machinery. This construction work lasted into February 1930 at which time the new plant started functioning on a 300 ton basis.

Since that time operation has been continuous and the production increased to 500 tons. The project has passed the doubtful stage and a number of experiments and trial methods have crystallized into definite practice.

**ECONOMIC GEOLOGY:**

The combined properties are on one of the principal veins of the district, and is traceable through the country by a continuously strong and well defined outcrop. Its direction is approximately 46 degrees southeast; the dip is northeasterly, varying from 50 degrees to nearly vertical.

The vein varies from ten to thirty feet in width and consists of a non-uniform filling of quartz and altered country rock. The mineral is irregularly distributed through both components of the filling.
The country rock is essentially latite which is underlain by the Eureka rhyolite. Paralleling the vein on first one side, then on the other, and often wholly contained within the vein is a dike of andesite. This dike first appears on the Mayflower above the portal of the 120 level tunnel. From there toward the North Star the dike has been traced for about two thousand feet both on surface and underground. Much of the country rock has undergone such intense alteration that definite classification is virtually impossible.

There is evidence of considerable faulting along the vein, with a probable downward displacement of the hanging wall. Lateral displacement, however, is negligible. Crossing the vein area great number of joints or stress fractures. They are smooth, but without gouge, and present such a deceiving appearance of a hanging wall that the strong tendency is to turn into the foot wall while searching for ore. Past experience, however, has shown these joints have no bearing on the location of ore.

Portions of the vein are split up into a
myriad of small stringers and veinlets. In other places the vein proper is compact but paralleled by small stringers twenty or thirty feet into the hanging wall or foot wall.

The economic minerals are gold, silver, lead, and copper. The copper, in the form of chalcopyrite, is the carrier of the gold. Zinc appears in many places. On the surface may be found some ore mineral, chiefly galena which occurs in scattered places and in some open cuts from which a small amount of high grade shipping ore was taken. One or two open cuts yielded considerable free gold.

In the Mayflower, Slide, and Terrible claims the ore has chiefly been chalcopyrite with lesser and more irregular quantities of galena. In the North Star, Dives, and the Shenandoah claims the mineral is largely galena and tetrahedrite, although anglesite was present in the upper 200 feet of the North Star.

MINE PRACTICE:

The original plan called for the development of a retreating system of mining. This was to be
done by means of the long drift and shaft as before mentioned. Levels were to be worked out and abandoned from the top down.

This plan was, however, postponed in favor of earlier production and an advancing system of mining has therefore been carried on. It is this advancing system which is to be described. In the near future a start will be made on raising the shaft and the retreating system will then be started.

The Main Level, an 8 by 8 drift, was the first entry into the mountain and it now serves as the main working level and main haulage level. From this level raises are driven at about 300 foot intervals. At intervals of 150 feet vertically above the Main Level, level timbers are placed in these raises and small stations cut out. Eventually these raises are connected by drifts.

Drifting is carried on two shifts per day. The drilling crew consists of two machine men. The machine is mounted on a cross bar and the top holes drilled off the muck pile while the mucking is going on. After the muck is cleaned out, the cross bar is dropped down and the round finished. The ground
stands well and no supporting timber is required. Drifting is done with Gardner-Denver 7 drifters and electric blasting. Progress is from 250 to 300 feet per month.

Mucking on the Main Level is done by a Nordberg-Butler Shuveloader. Loaded and empty cars are switched by hand, a switch usually being kept within 300 feet of the face. The crew consists of one operator and two trammers. About five hours are required to clean out a five foot round. On upper levels mucking is done by hand into 16 cu. ft. cars and hand-trammed to a dumping place. Two muckers work together and tram a short distance. Extra trammers are provided according to the length of tram. At present, experiments are being conducted with scraper loading.

Raises are sixteen feet long and the width depends on the width of the vein. Raises are started by cutting out the back of the drift to make room for two chutes and a manway. Stall timbers are placed, chutes built and raising is started. Timbering consists of a line of stulls on both sides of the manway. Chutes are closed off by 3 inch
plank nailed on the sides of the stulls.

The raise crew consists of three men, two miners and a helper. For drilling, two stoper drills are used at the same time. About six hours are required for drilling. Eight hours are required to raise the timbering two five-foot sets. Ingersoll-Rand R 51 self rotating stopers are used for raising and Leadville air hoists or small electric hoists are provided for hoisting timber and tools. Raise progress is about 80 feet per month for a single crew of three men.

All stoping is done by the shrinkage method. On about twenty foot centers chute holes are raised from the drifts and about fifteen feet above the track these chutes are widened out, connected thru, and stoping operations are started. If the ore is continuous between two raises, the raises are used for manways and ventilation. If the ore is not continuous a manway is carried up in about the center of the stope.

Ingersoll-Rand R 51 self-rotating stopers are also used for all stoping operations. Each machine is manned by a machine man and a helper.
A complete flow sheet of the mill is contained in the group of drawings. The concentration methods are flotation, tabling, and amalgamation. Amalgamation is under trial.

Wilfley tables at two points make lead concentrates which is amalgamated for its gold. By flotation a copper-gold concentrate is made together with an iron-copper concentrate which is reground and floated for copper.

Originally built for 300 tons per 24 hours, the capacity of the mill has been built up to 500 tons with the probability of further increases. No additional equipment has been installed, the greater capacity being brought about by finer crushing at the mine and by building up the circulating load in the ball mill and classifier.

The mill was designed by Arthur J. Weinig, Metallurgical Engineer, of Golden, Colorado, and was built by The Stearne-Roger Manufacturing Company of Denver, Colorado.

Reagents consists of xanthate, pine oil, and lime.
Water supply is obtained from several small converging streams about five thousand feet up Arrastra Gulch. The water is carried to the mill by a pipe line reduced gradually from 10 inches to 6 inches and delivers the water to the mill at about 60 pounds pressure.

DESCRIPTION AND ARRANGEMENT OF EQUIPMENT:

Stoping operations produce many large pieces of ore. In small mines the common practice is bulldozing these large pieces to facilitate handling. The new equipment in this mine, however, was designed with the purpose of eliminating this costly bulldozing practice. Two stage crushing at the mine reduces the ore to an easy size for subsequent handling; the problem of the large sizes is, therefore, restricted to mine transferring and hauling.

Chutes and crusher openings are large enough to accommodate large sizes; cars are of sufficient size and stability. The wisdom of the plan is proved by low costs and resulting continuous operation through an economic crisis.
MINE HAULAGE:

Main Level hauling is done in 12 steel 60 cu. ft. round bottom cars. These cars are mounted on trucks made up of steel channel frames and roller bearings with full floating axles. The cars are dumped by a rotary dump. One-half size M.C.B. couplings, one end swiveled, permit cars to be dumped without uncoupling. The cars are of a sturdy design, have a minimum of moving parts, and are large enough to handle big slabs. Motive power is provided by a Goodman 5-ton storage battery locomotive.

Hauling on the 300 level is done in 4 - 70 cu. ft. side-dump cars. The box of the car is hinged on the truck and dumping is done with an air lift. A General Electric 3½-ton storage battery locomotive does this hauling.

Three gable-bottom cars are used to transfer the ore from crusher pocket to tramway bin. Dumping is automatic, being accomplished by a shoe in the track over which a roller on the car rides and opens the doors on both sides. The doors are toggle-locked. A Goodman 3-ton storage battery

Page 14.
3. The Rotary Dump.

4. The Rotary Dump In Operation.
locomotive is used for this transfer.

All tracks over which major hauling is done consists of 30 pound rails laid on 30 inch gauge. Switches are the split type with five-foot switch points and 15 foot leads. Curves are held to a minimum of 30 foot radius. Malone switch stands are used to operate the switches. The 30 inch gauge provides good stability both for loading cars and running trains at a good rate of speed. The use of storage battery locomotives does away with the necessity of track bonding and trolley wires.

CRUSHER PLANT:

The crusher plant is located between the Main Level and the Base Level and adjacent to the Main Level adit cross cut. Advantage was taken of the excavation already present in the form of old stopes which were enlarged to make room for the machinery. The fine ore pocket is an old stope that needed only re-timbering at the bottom to make it serviceable.

The equipment consists of a 16A Telsmith primary breaker, a Link-Belt conveyor, 48 ft. centers, a 4 ft. Symons Cone crusher, an FB2
Traylor vibrating screen, and a Link-Belt belt conveyor, 25 ft. long.

The rotary dump is directly over the coarse ore pocket which feeds to the Telsmith crusher. The flow of ore into the crusher is controlled by a finger-type chute-gate made up of 8 - 90 pound rails, angle-braced, and regulated by an overhead chain block.

The Telsmith breaks to 2½ inch size and discharges onto the first conveyor belt which in turn delivers onto the vibrating screen. Undersize, minus ½ inch drops through and the oversize goes through the Symons Cone crusher. Discharge from the Symons Cone, ½ inch size, together with the undersize from the screen, is taken by the second conveyor and discharged into the fine ore bin which has a capacity of approximately 750 tons. The plant has a capacity of 80 tons per hour and most of the crushing is done at night.

AIR PLANT:

The air plant is underground in a large room cut out about fifty feet from the portal of the main level cross cut. Air is furnished by a Chicago
5. The Compressor.

6. Steel Sharpening In The Mine Shop.
Pneumatic Compressor of a 2000 cu. ft. per minute displacement, direct-connected to a 200 H.P. synchronous motor. Five-step control gives a range of capacities according to the demand and with the corresponding saving in power.

Air is delivered from the compressor through the Main Level by an 8 inch line supported high on the side of the drift. Branch lines, 4 inch, from the Main Level are carried up through the raises as needed. All air lines are made up of casing pipe and Dayton couplings. The casing pipe is cheaper and lighter than standard pipe and entirely adequate; the Dayton couplings make for a great flexibility of installation and repair.

MINE SHOP:

The mine shop, also underground, is fitted up to handle the usual mine work. Its equipment consists of the common blacksmith fixtures and accessories, an oil forge for drill steel, drill sharpener, drill press, power hack saw, and oxy-acetylene welding and cutting apparatus. A complete assortment of machine drill repair parts is
stocked and drill repairs are made in a minimum of time.

MILL SHOP:

A machine shop is maintained at the mill. It is provided with a lathe, shaper, drill press, power hack saw, bench grinder, and electric welder. The mill and mine shops are adequate to handle any and all repair work arising on the job, and where necessary, work is easily transferred from one shop to the other over the tramway.

HAULING:

All hauling to and from the railroad is done by a Coleman 5-ton motor truck. Purchased at the start of the construction period, it served for eight months on the construction work, hauling machinery and building material.

The mine had the benefit of a road, an old widened-out pack trail, built some forty years ago, over which was transported machinery into Silver Lake Basin, about 1000 feet higher than the Main Level portal. Grades on this road reach a maximum of 42 per cent. In the old days it was a
7. The truck negotiating a switchback on the mine road.
The next grade ahead is 40%.

8. Looking down the tramline toward the mill from "C" anchor tower.
common sight to see as many as twenty horses and
fifty men working on a single wagon to move it
around some of the switchbacks and up some of the
grades. The road had fallen into a state of dis-
repair but it was restored enough to make it a ser-
viceable one-way road for the Coleman.

Following the re-conditioning of the road, the
Coleman truck moved on the average of two five-ton
loads per day from the railroad in town to the mine.
The truck was manned by two men. Single pieces,
such as main crusher frames and compressor sections,
weighing up to five tons were moved easily by the
truck, many times at night. In some cases the
truck was stopped on a 40 per cent grade, the load
shifted slightly, and the truck resumed its climb
without a too great display of effort.

This truck now moves all concentrates from
the mill to the railroad, and all incoming freight
and mine timber to the mill and tramway terminal.
Everything is arranged to facilitate loading and
unloading thereby permitting the truck to spend the
maximum of time on the road.
The aerial tramway was designed by Fred C. Carstarphen, consulting engineer of Denver, Colorado. The tramway has been an innovation to this district where tramways are an old and important institution for it differs radically with almost everything heretofore considered standard practice in the San Juan. The towers were fabricated and erected by the Pittsburgh Engineering, Foundry & Construction Company of Pittsburgh, Pennsylvania. Rolling stock, driving machinery, and fixtures were made by The Stearns-Roger Manufacturing Company.

Starting at an elevation of about 11,200 at the mine, the line descends about 800 feet in a horizontal distance of about 2500 feet, then the profile flattens out somewhat and descends on an easy grade to the mill. The line is favored by the absence of any intermediate divides to cross.

Track cables are 1 1/2 inch diameter, half lock, with a breaking strain of 90 tons and a working tension of 17.5 tons. The tramway is 10,000 feet long and the track cable is divided into three sections. Each section is dead anchored at both
9. Tramway towers under construction.
The old tramway to the Iowa Mill is at the left.

10. Approaching No. 4 tramway tower.
ends, moderate adjustment of length being cared for by blocks and turnbuckles. The cables are supported on steel towers of box type. They are of steel and sixteen feet square, some of two-bent and some of three-bent construction. At the end of each intermediate section of cable is an anchorage tower, the bucket passing over a rail where the cables are deflected to the anchor.

The traction cable is 7/8 inch diameter, plow steel 6 x 19, Seale Lang lay, spliced continuous.

The drive consists of two vertical grip sheaves each geared to a speed reducer and a 50 H.P. motor. Normally the line operates by gravity and the motors act as brakes. When running empty or with heavy up-freight loading the motors supply power for driving.

Buckets are 14 1/2 cu. ft. capacity and are suspended from four-wheel trucks. Attaching and detaching is done automatically.

A feature of the line is the great clearance allowed for freight loads. The distance between stationery cables is eight feet, and towers and terminals provide clearance for a load of overall


Page 26.
13. Transporting a crusher mantle over the stub tram. The mantle is suspended between two timber carriers.

14. The distributing rail over which mine supplies are moved into the timber shed at portal.
width of a little less than eight feet. This permits easy handling of all mine freight from 30 ft. long rails to large-size electric motors.

Inasmuch as the upper terminal is located 120 feet below the principal mine workings, an auxiliary tramway was built to carry the freight up to the mine. This auxiliary is a complete tramway 400 feet long and rising the 120 feet in that distance. Drive is by a horizontal grip sheave belt-connected to a 30 H.P. motor.

Freight loads are switched onto the auxiliary without the necessity for reloading. A telpherage system extends from the upper terminal of the auxiliary and loaded buckets and carriers are pushed by hand to various destinations. Groceries are delivered to the kitchen or storeroom; coal is dumped directly into the coal bin; mine timber and supplies are unloaded in the timber shed or onto mine trucks.

SURFACE BUILDINGS:

The buildings at the mine are the boarding
15. The mine buildings, the tramway upper terminal, and auxiliary tramway.
house, or hotel, and a shed for mine timber.

The hotel, 40 ft. by 70, of four stories and basement, contains some notable features. Of a mill-type adapted to domestic purposes, it is insulated both in walls and roof; all enclosed spaces are eliminated. The frame is made up of 8 - 40 ft. bents on 10 ft. centers.

The walls are 2 by 4 vertical studding, covered on the outside by 1 inch cove siding and on the inside by plaster board known by the trade name of Sheetrock. The roof is quite flat, sloping about 1 inch to the foot, and consists of 2 by 8 purlins on 18 inch centers, covered on the outside by 1 inch sheathing and on the under side are plasterboard strips 16 inches wide. All spaces between outside and inside cover, in both roof and walls are filled with an insulating material known by the trade name of Insulex. This insulex is a gypsum product that is mixed with water and poured into the open spaces as the roof and siding are put on.

The floor consists of 3 inch plank spanning the ten-foot distance between beams; in the opposite direction is laid $\frac{3}{4}$ inch oak flooring.
Joists are eliminated. Partitions are of 1\(\frac{1}{2}\) inch tongue and groove plank, set vertically edge to edge. This gives a solid wooden partition of the thickness of the plank. The solid partitions and elimination of floor joists remove any concealed hiding places for vermin.

Heat is by steam. Fuel is slack coal and fired by a "Combustioner" stoker with screw feed conveyor and fan, and thermostatic control.

Plumbing is all exposed. Water supply is obtained from inside the mine and delivered by a two inch line.

The basement contains the furnace, storeroom for groceries, bedrooms and bath for the hotel staff. A private stairway leads into the kitchen.

The first floor is entirely given over to the kitchen and dining room and First-aid room. The kitchen and dining room are all one big room but separated by a small serving counter. All cooking is done by electricity. The dining room, with a seating capacity of 100 men is operated by the company on a non-profit basis, the only endeavor being to serve good meals and to make expenses.
17. Pouring Insulex in the roof of the mine hotel.

18. The Commissary.

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The First-Aid room is at the entrance from
the mine. It is equipped with the customary
apparatus and a pressure atomizer for the treatment
of heavy colds which are so dangerous at the high
altitude.

The second floor contains one-man bed rooms
and a bath for the staff, mine office, and the
commissary. The commissary is the general loung-
ing room of the building; it carries a wide variety
of goods,—drugs, confections, clothing of all
kinds, blankets, cigars, tobacco, jewelry, and most
anything to be desired by the miners. The com-
missary is operated as a concession. Its exis-
tence is well justified by the service it renders
and the prices compare very favorable with those
in places much less remote.

The third and fourth floors are devoted to
bed rooms and bath rooms for the miners. Bedrooms
are 10 feet by 17 and accommodate four men. All
bathrooms are equipped with lavatories, toilets,
urinals, and tub and shower baths.

The mine shed for timber, the most recent
addition, is located at the portal of the Main
19. Old snow sheds at the mine portal.

20. The mine timber shed - built on the site of the above picture.
Level cross cut. It is of mill type construction, made up of five 43 ft. truss members on 14 ft. centers. Inside there is a clear space 56 ft. by 42 for storage of various sizes of round timber and plank. The timber is delivered directly by the telpherage. The mine track extends into and through the building and out onto the dump.

The buildings at the mill are the general office and the mill building. The general office is a 40 by 30 ft. structure of two stories and a basement. The construction is identical with that of the mine hotel. The office occupies the upper floor; the assay office on the lower floor. The side-hill location of the building permits the basement one-half the floor space of the upper two floors. The basement is fitted up for a small apartment and is occupied by one of the unmarried staff men.

The mill is built on a series of benches on a hillside. The floors and foundations are concrete, all poured together. A series of retaining walls support the ground between benches. Panels are enclosed by double one inch sheathing with a layer of
Sisalkraft building paper between. The structure was made large enough for two 300-ton units although but one unit has been installed to date.

**SUPPLY AND COST OF LABOR:**

The larger operation has been, to date, during a period of business depression and accompanied unemployment. There has been available much more than the required supply of labor. The return of better times and general lessening of unemployment may bring a scarcity of labor. The backbone of the labor supply, however, is made up of long time residents of the San Juan Basin. Telluride, Rico, and Silverton too, some years ago were all substantial towns for long enough time for children to grow up in the region. Hence, many miners are the sons of San Juan Miners; a great many are married men who own their own homes, are steady workers and good citizens.

Many nationalities are represented and among all of them are both very good and not so good workers. Americans, Swedes, Italians, Slavs, Finns, Germans, Lithuanians, and Russians are
present in large numbers.

All men engaged in breaking ground are on a contract basis. The basic wage for common unskilled labor is $4.60 on surface and $5.00 underground. Contract earnings are from $7.00 per day upward.

ORGANIZATION:

The principal office of the company is in Kansas City, Missouri. The officers are:

J. W. Oldham, President; Charles Charpiot, Secretary-Treasurer; Charles A. Chase, General Manager, is located at Silverton.

The home office is kept informed of all work and activities by regular reports. These reports present detailed mine and mill performance and costs. Included in this report is a diagram to show mine development and stoping. A copy of this diagram is contained in the group of drawings.

PROSPECTS AND LIMITATIONS OF THE PROPERTY:

The enormous amount of untouched vein above and ahead of all work done to date assures a long
life to the mine, even should many large portions prove unproductive.

The mine is too new and the ore occurrences are yet unsolved to the point of making accurate estimates of the life; but also there is evidence of downward extension of the ore below all present workings.

The possibilities within the company's present property are large. The strategic position of the Mayflower, however, presents something more. Owing to the extreme severity of the topography and climatic conditions, the Mayflower affords the only comfortable operating base for a number of properties on both sides and in extension of the Shenandoah-Dives vein; as a result of their inaccessibility many veins have scarcely been scratched.

The Shenandoah-Dives Mining Company with its fortunate location, present mine haulageways, and substantial and large-capacity equipment is in a position to mine these adjacent veins with no additional outlay. All that, of course is in the distant future but the facts are not to be overlooked in considering the life of the project.
All in all, the operation, having made its major start during a period of major business recession and time of extremely low metal prices, seems to stand out as the beginning of a great enterprise.

21. Tramway break-over tower.
22. Tramway tower No. 11 135 ft. high.
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SILVERTON, COLORADO
Scale: 1" = 50'