THE

ADVANTAGES AND NECESSITY

OF A

DEEP DRAIN TUNNEL,

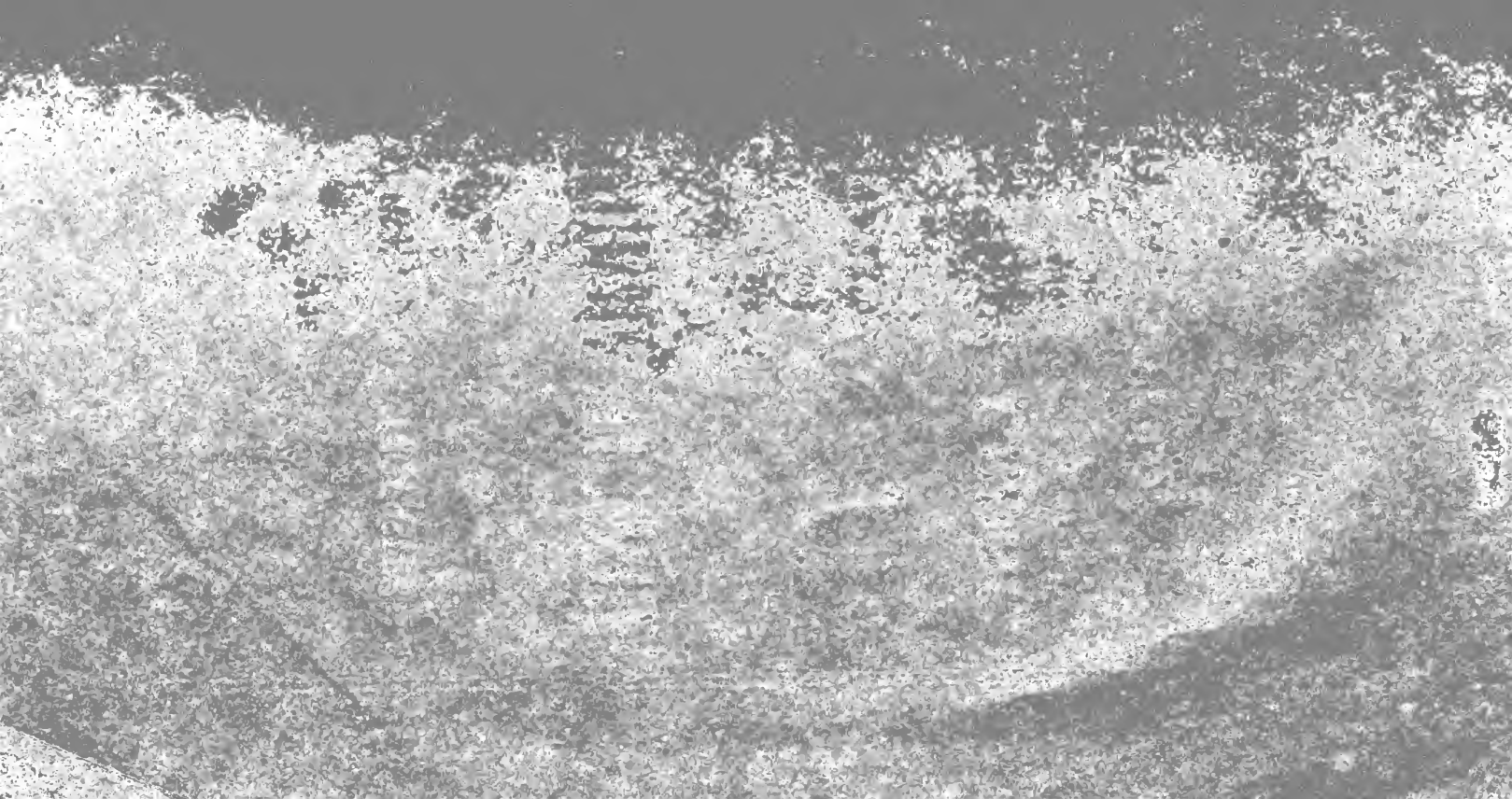
FOR THE

GREAT

COMSTOCK LEDGE,

BY A. SUTRO.

SAN FRANCISCO, FEBRUARY, 1865.



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dolph Heinrich Joseph

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CONTENTS.

PROPOSITION

— TO —

MINING COMPANIES.

The undersigned convinced of the necessity of constructing a deep drain Tunnel to the Comstock ledge, and desirous of seeing this great work speedily carried out, begs leave to lay the following proposition before the different Companies of the Comstock ledge, and is of the opinion that its acceptance will insure the carrying out of this important enterprise.

The proposition would be about as follows:

ports were matters of fact, and no wonder that the enterprising American people, particularly the adventurous portion of Californians, became excited over visions of great wealth and pictures of the immense amounts of precious metals produced by the Spanish-American mines for the last three centuries. The natural consequence was, a great influx of people to these newly discovered regions, and a vigorous prosecution of work, which shortly established the fact that the great Comstock ledge not only contains ores of great value, but that the same extends for miles in length, and promised to be of

The Companies will by these means secure to the Tunnel Company a small interest on the capital invested. *They have to pay out nothing until they derive benefit from the drainage of their mines, and then pay nothing, should they have no ore.* Should they have ore, the amount to be paid to the Tunnel Company is so small compared to the advantages they will derive, that they will save the amount to be paid per ton, *alone in the advantages they would enjoy in extracting the ore from the mines.*

If the following pages are studied carefully, it will be found that the cost of erecting the necessary pumping machinery, and the cost of maintaining the steam engines, is so immense, that the advantages offered by the tunnel company, must strike the mining companies to be of vital importance to their own interests.

The Tunnel Company will have to take all the risk as to the future yield of these mines. They have to embark in an undertaking which involves the outlay of millions for a number of years, before any benefit can be derived from it, and after they complete the work, they only ask a low interest on the capital invested, from those parties who can afford to pay, by being enabled, through their agency, to extract ores from their veins.

It may as well be stated here, that some parties are fearful of getting into litigation, by having an outside company construct this tunnel, and striking the Comstock at this great depth; on this point we would state, that the objects of this Tunnel Company being for the purpose of draining these mines, they would

people at large of the Pacific States, by securing the permanent working of the Comstock ledge, which in our opinion would be accomplished by constructing a deep drain tunnel, we most cheerfully endorse Mr. Sutro's proposition to the Companies, and shall do all in our power to assist him in carrying out his project.

San Francisco, March 1, 1865.

JOHN PARROTT,
LOUIS McLANE,
W. C. RALSTON.

THE COMSTOCK MINES.

INTRODUCTORY REMARKS.

Over five years have now elapsed since the news of rich silver mines, having been discovered on the eastern slope of the Sierra Nevada mountains, first attracted the attention of the people of California.

At first, the reports of fabulous wealth contained in these mines, were received with some doubt and incredulity, but soon it became patent to the minds of thinking men, that these reports were matters of fact, and no wonder that the enterprising American people, particularly the adventurous portion of Californians, became excited over visions of great wealth and pictures of the immense amounts of precious metals produced by the Spanish-American mines for the last three centuries. The natural consequence was, a great influx of people to these newly discovered regions, and a vigorous prosecution of work, which shortly established the fact that the great Comstock ledge not only contains ores of great value, but that the same extends for miles in length, and promised to be of a permanent character. This conclusion has proven correct by experience, and we now have a range of mines which, in all likelihood, will be worked long after our present generation has passed away.

But mining for silver was a new thing for our people. We had no experience at it; hardly had any idea about the opening and working of such mines, and not the slightest knowledge about the reduction of silver ores. A few persons amongst us, who had acquired experience at foreign silver mines, readily

gave their advice, and work fairly commenced. But soon it was found that the methods employed in older countries for reducing ores, would not apply here, for various reasons, such as the climate, expense of labor, fuel, etc., etc.; and it became a matter of serious doubt, whether these mines could be profitably worked on account of these obstacles. To ship the ores to other countries, could only apply to rich ores, the supply of which was limited. To smelt the same was out of question, on account of scarcity of fuel. To roast, by the Freyberg method, was expensive, and the bulk of the ores could not stand the expense. To work them by patio was difficult on account of cold weather the largest portion of the year. These were the only methods known in the world—none of them applicable to our mines. What was to be done? The inventive genius of the American people soon found a remedy; a trial was made to work these ores in iron pans, and it was a success. We must admit that considerable loss is occasioned in this style of working, but without it our mines could not be worked to any advantage, and it is now generally admitted, that this is the only and most profitable method to be employed for average ores, which abound in these mines. From the day of introducing these pans, which, it may be stated, have since been vastly improved, the country commenced to flourish. Cities were built, roads constructed, large reduction works erected, in short, from a state of wilderness, in a few years, a flourishing country sprang up, many millions of bullion are produced annually, and many thousands of people find employment.

But not only here do we see the effects of this new wealth. California, and particularly San Francisco, are directly benefited by it. Every branch of commerce derives benefit from our mines, we being entirely dependent on our sister State for supplies.

But will this prosperous state continue? And how long? No one doubts the permanency of these mines. One particular claim may run out of its chimney of good ore; one may have very rich ore at present, next year its neighbor will have it.

This is the nature of silver mines; they contain bunches, or chimneys of ore, sometimes producing many millions, but these chimneys are distributed throughout the length of the whole range, horizontally and perpendicularly. For this reason, any particular locality on a mining range like the Comstock, may prove of great value; but the expense of exploration, and the difficulties to be encountered in prospecting, make many shrink from the undertaking, and give up all hopes of realizing their wishes.

As long as mining was carried on comparatively near the surface, everything went on well enough; a small engine of 10, 20, or thirty horse power was erected, at a trifling cost, a shaft sunk, a few galleries opened, plenty of ore extracted, sent to the mills, and silver bars produced, as if by magic. But we are a go ahead people. What takes ten years to accomplish in Mexico or South America, we do in one year; and, as a natural consequence, after five years' labor, we have attained an average depth in our mines of four hundred feet.

And what questions do present themselves to the thinking mind, now? How long will it take to attain a depth of one thousand, fifteen hundred or two thousand feet? What obstacles are encountered, at present, and what will be the obstacles to be met at this greater depth? *These are serious questions to be considered by the owners of the Comstock ledge, and the people at large of this State, who are entirely dependent on the prosperity of these mines.*

And these questions, more particularly we intend to answer, with a view of providing means to avoid a calamity which would befall us in a very short number of years, if we do not at once take the matter in hand, and provide timely measures, the nature of which we intend in this paper further to explain:

I.

THE GREAT OBSTACLE IN MINING—AND ITS REMEDY.

The great obtacle to be encountered in mines, is water ; this is the fatal agent, which makes it only a question of time, when a mine will have to be abandoned, no matter how rich, on account of the obtacles its removal presents.

In every instance, the time must come when the cost of drainage will be greater than the produce of the mine ; this may take five, ten, twenty or fifty years, according to the value of the ores and the quantity of the water to be encountered.

Now let us examine into our particular instance ; as stated above, the average depth of our mines is about 400 feet ; hardly any water of consequence has been encountered heretofore ; but within the last twelve months, it has become a serious obstacle. The Ophir mine, at present, is flooded in such a manner that their small engine and pump cannot free the mine from water. A new and more powerful engine and pumps are being erected, which, no doubt, will accomplish this desirable result. But how long will this machinery answer the purpose ? Competent engineers will tell you, that the power of your machinery will have to be increased by the square, as the depth and quantity of water increases, and that in the course of not many years, at the rate we are progressing, our mines will be worked at a depth where the cost of pumping will nearly, or entirely, consume the net profits derived from them, basing our calculations on the yield at the present time.

These are serious reflections and forbode a gloomy future for our young State ; *but we will show conclusively, that a work, entirely feasible, practicable*, and though of gigantic proportions, can be constructed without any difficulty, provided all parties interested will cooperate, which will not only remove all anxiety for our future welfare, but which will place our mines into such a position *that they may be worked profitably, economically and extensively for a century to come.*

NECESSITY OF A GRAND DRAIN TUNNEL.

This work is the construction of a Grand Drain Tunnel, commencing at a point in the foot hills of Carson River Valley, a little less than four miles or about 20,000 feet from the Comstock ledge, and which Tunnel would strike the Comstock ledge at a depth of 1800 feet below the surface.

Works of this kind have by experience been found to be a matter of necessity, and have been carried out wherever nature favored such an undertaking.

Now let us see what has been done in other parts of the world in order to obtain drainage in mines. A late writer, speaking of the completion of the great drain tunnel in the Harz mountains in Germany, says :

"Already in the beginning of the sixteenth century, the mechanical appliances for raising water were found to be insufficient, and it was found to be a matter of necessity to construct drain tunnels. The first one, called the Seventy-eight feet Tunnel, was completed in 1525, the Frankensharner Tunnel in 1548, the One Hundred and Fourteen feet Tunnel in 1551 and the Raven Tunnel in 1573. By means of these Tunnels, which were connected with all parts of the mines, it was found possible to work them for about 200 years ; but towards the end of last century it became impossible to master the water, and in consequence it was concluded, in the year 1771, to run a still deeper tunnel ; work was commenced in 1777 and the same was completed in 1799. It was called the Deep George Tunnel, and its length, including cross cuts, is 57,000 feet ; it drains the mines under Clausthal to a depth of 900 feet.

This relieved the mines from water for a while, but as work progressed and greater depth was attained, the flow of water increased so rapidly that the grandest pump works were found to be insufficient.

The topographical features of the country are such that no

deeper drainage could be obtained, except at an apparently impracticable distance, and in consequence the danger was imminent, that these mines, which had supported thou-ands of persons for centuries, would shortly have to be abandoned entirely.

THE TUNNEL AT GITTELDE, BRUNSWICK.

In the year 1850, C. Borchers, a celebrated mining engineer, first conceived the plan to commence a Tunnel in the Dukedom of Brunswick, at a place called Gittelde, which would give a deeper drainage, of about 300 feet, below the deep George Tunnel, or a depth under the church of Clausthal, of about 1200 feet. Surveys were made and the distance found to be 72,000 feet or about fourteen miles, and the time estimated to complete it, was twenty-two years. On the 21st July, 1851 work on this great tunnel called the "Ernst August Tunnel" was commenced, and on the 22d of June 1864, the last connection was made; It therefore only took twelve years and eleven months to complete this, the greatest of all mining works."

It may as well be stated here, that the mines of the Harz produce about $500,000 in precious metals per annum, an amount taken from the Comstock every fortnight. Now, if they found it a matter of neccessity, and economy to run a tunnel fourteen miles long in the Harz mountains, in order to obtain an additional drainage of 300 feet, in a country where fuel is cheap, how evident must it appear, that a tunnel into the Comstock, less than four miles in length, which will give drainage to a depth of 1800 feet, and which would secure the future working of the richest mine in the world, would not only prove of great benefit, but ought to be commenced and completed without delay.

At the place selected for a starting point, the hills form a semicircle, which brings the distance from the valley within four miles of the Comstock. The formation of the hills on the selected tunnel route, is such that deep ravines exist, from which shafts can be sunk at a comparatively small depth. The formation of

rock has been examined by Baron Richthofen, a well known Prussian geologist, who was formerly engaged at the geological survey of Austria, and lately attached as geologist to a Prussian naval expedition to eastern Asia, and who is a European authority in geological matters. This report is annexed, and will be an interesting document in mining circles.

It is proposed to sink four shafts on the tunnel route, which will be about 500, 800, 1,100 and 1,200 feet deep to the level of the tunnel, on which powerful steam engines and pumps will have to be erected, and from each, two drifts will be run—one towards the mouth of the tunnel, the other towards the Comstock ledge. This would give nine points to work from, and calculating the distance, including shafts, at about 24,000 feet, the distance to be sunk and run, would give an average of 2,666 feet from each point.

Work of this kind can be pushed on with great rapidity, provided, short and double shifts of men are employed ; the tunnel will be wide enough to allow three men to work abreast, and it is proposed to employ double that number, so that the moment the men at work with their picks get tired, the other three step in their places, and in this manner change off every fifteen or twenty minutes ; the whole shift to be changed every six or eight hours. A foreman would be employed with each gang, whose duty it would be to see that work is carried on without any interruption, and to discharge all hands who do not perform their task properly. In this manner work can be pushed with considerable speed, and it is the opinion of competent mining engineers, that at least an average of three feet per day can be made. It would therefore require 888 days to do the whole work. Allowing en extra year to sink partly the deepest of the proposed shafts, the tunnel can be finished in 3½ years. The shafts will be located in such a manner that the deeper ones will come nearer together, in order to accomplish a connection at as nearly the same time as possible ; with that view, a working survey is

being made now, which will require about one month to complete. The proposed size of the tunnel will be about 12 feet wide, by 10 in hight, so as to allow of a good sized rail road track,—one to run cars in. the other to run them out.

Wherever hard rock is encountered, drilling machinery will be employed, which is at the present time used quite successfully in Europe, and particularly at Mount Cenis, in the Alps. This drilling machinery is propelled by condensed air, which being discharged at every revolution, replenishes the air in the tunnel.

The above facts will at once explain the feasibility of the enterprise, and in order to more fully understand the difficulties to be encountered in pumping and the advantages to be derived from a drain tunnel, we will more carefully examine into the merits of each.

COST OF PUMPING IN ENGLAND.

In order that we may get a correct idea of the cost of pumping from a great depth, and the machinery required to do so, we will take the statistics of a celebrated mine in Europe, the "Consolidated United Copper Mines," of Cornwall:

They employ nine steam engines; three of 90 inch cylinder; three of 85; one of 80; and two of 65; and a water wheel 48 feet in diamater, all employed in pumping; the water discharged per minute is from 2,000 to 3,000 gallons. The water is raised at an average of 170 fathoms. The average cost for drainage in ten years, has been, per year, £12,700 sterling.

The stream of water, which would be encountered at a depth of 1,800 feet, draining the Comstock ledge from the Sierra Nevada Mine to the Uncle Sam, has been variously estimated at 3, 4, 5, and as high as 10 square feet, and the rapidity with which it would flow out of the tunnel, at from 5 to 6 miles per hour. Now let us take the lowest figures 3 square feet, and the stream to flow 5 miles per hour; that is to say, the stream would

fill a trough or canal 2 feet wide, and 1½ feet high, and the water would flow 5 miles per hour. We would then get the following figures: 5 miles contain 26,300 feet; each foot in length would give 3 cubic feet or 78,900 cubic feet of water per hour. This amount reduced to minutes gives 1,315 cubic feet of water per minute, or 8,195 imperial gallons. The cost of draining the "C. U. Copper Mines," of Cornwall, per annum, is $63,500, at a depth of 1,020 feet; at 1,450 feet, (allowing for tunnels in existence now,) the cost would be at least one-half more, or $95,250. Now the quantity of water to be raised here, according to the above estimate, is 3.28 times as much, which would give an annual cost of performing this work in England, of $312,420.

The difference in cost of fuel, labor, etc., between the state of Nevada and Cornwall, has variously been estimated to be from ten to fifteen times as much here, but taking the lower figures, we would get an annual cost of draining these mines here, of $3,124,200.

The number of engines required at theabove mines named in Cornwall is nine, of an average diameter of cylinder of 82 inches; we would require 3.28 times as many on account of the greater quantity of water and again one half as many more on account the greater depth; we would therefore require 4.92 times as many engines, or say 44 of 82 inch cylinder. The cost of engines of this size, including setting up, pumps, pipes, etc., has been estimated to be from $100,000 to $150,000 each. Let us base our calculations on the first named estimate: Forty-four engines at $100,000 would give a total cost of $4,400,000. The additional interest, current here above that in England, would be say 1½ per cent. per month, or on the whole outlay for machinery $66,000 per month.

We have now the following amounts:

Cost of pumping per month,.....	$260,350
Interest on capital invested,.....	66,000
Or a monthly expense of.....	$326,350

for drainage by pumping.

Estimating the number of tons produced by these mines to be 1000 tons per day, or 30,000 tons per month, the cost of drainage per ton of ore raised, would be $10.88.

COST OF PUMPING IN NEVADA.

In making the above estimate, we have taken estimates of an English mine as our basis. Now let us figure the cost of pumping, taking the quantity of water as above stated and make our calculations from the statements made by pumping works and mills in Nevada.

Most estimates are made that the cost of running a steam engine for twenty-four hours is from $2,00 to $2,50 per horse power. Some are made as low as $1,50. We will again take the lower figures.

The ordinary way of calculating, is to count 33,000 pounds, to be lifted one foot high per minute, as one horse power.

We have 8195 gallons, or 1315 cubic feet, at 62.32 pounds per cubic foot, we get 81,950 lbs to be lifted per minute ; divided by 33,000, this would give 27.86 horse powers, to lift the given quantity one foot high ; in order to lift it 1450 feet, we have to multiply by that number, which would give 4039 horse powers. Now it takes just double the given power, to overcome the friction of water in pipes, the friction of engine, etc., etc., which would give 8078 horse powers, to raise the given quantity of water 1450 feet. Calculating the cost of running the pumping machinery, as stated above at $1,50 per day per horse power, we would have an expense of $12,117 per day, or $363,510 per month, or on every ton of ore raised an expense of $12,12.

Some statistics have been furnished by Capt. Taylor of the Best & Belcher mine whose pumping works, are among the best

71,000,

and most economically conducted in Nevada. He gives the following account of daily expenses in pumping :

In consequence of these accidents, the mine will be flooded frequently, and delays occasioned of days, weeks, or even months, throwiug the miners out of employ, stopping the mills, and cutting off looked for dividends ; thus creating great hardships in all quarters.

But this is not the only evil arising therefrom : the filling of

The engineers and pitmens wages would be considerably less in large pumping works, but not having brought into account any allowance for wear and tear, this will be nearly balanced.

He raises the water 270 feet and discharges 253 gallons per minute. At 1450 feet, the water would be raised 5.37 times as high, which would give a daily expense of $472,56. The quantity of water, from the whole length of the Comstock ledge at 1800 feet, would be 32.39 times as much, making a daily cost of $15,306,21, or an expenditure per month of $459,186,30, or per ton of ore $15,36.

RECAPITULATION.

Cost of pumping the estimated water from a depth of 1,800 feet under the surface :

	Cost per ton taking the yield at 30,000 tons per month.	Cost per day.	Cost per month.	Cost per annum.
Calculations based on the cost at the Consolidated United Copper Mines of Cornwall.	$10.83.	$10,878.	$326,350.	$3,916,200.
Calculations based on cost of running steam engines in Nevada.	$12.12.	$12,117.	$363,510.	$4,362,120.
Calculations based on the cost of pumping at the Best & Belcher Mine, Nevada.	$15.36.	$15,305.	$459,186.	$5,500,232.

These are astonishing figures, but they are nevertheless correct; but even one half, one third, or one quarter of these amounts will give sums, so immensely large, that a system of drainage by tunnelling must appear to be a matter of necessity.

Many persons not acquainted with mechanics and engineering, will be at a loss to understand why it costs so much to pump from per ton of ore raised, would be $10.88.

COST OF PUMPING IN NEVADA.

In making the above estimate, we have taken estimates of an English mine as our basis. Now let us figure the cost of pumping, taking the quantity of water as above stated and make feet, it would require nine such engines and pumps to lift the same quantity of water from a depth of 1,800 feet. The water is raised by the first pump 200 feet high, from the lowest point, and discharged into a reservoir; from thence it is lifted by another pump to a point 200 feet higher, and so on until it reaches the surface. We must therefore have nine engines to do this work; and, if we calculate the quantity of water, which would be met at 1,800 feet, to be three times the quantity met at 200 feet, we would require twenty-seven engines, of fifty-horse power, to pump out a single mine at that depth, where only one is required now.

The above estimates give simply the cost of pumping out the continuous flow of water. It must be borne in mind though, *that the body of accumulated water at present contained in the ledge, where large subterreanean reservoirs or lakes are known to exist, is very large.* In order to remove this great body of water, at least twelve months would be required, employing all the above enumerated engines, at a cost of running them, for that length of time, of from $3,000,000 to $4,000,000.

EVILS OF PUMPING.

Independant of the actual cost of pumping, there are other disadvantages connected with the same, which must not be lost sight of. *Engines, boilers, pumps, etc., etc., rapidly wear out*, and new ones have to take their places in the course of time; pumps are liable to get out of order at any time, and they being placed at the very lowest point in the mine, if not instantly repaired, the

water will rise above them and then it is impossible to reach the pump in order to repair it.

In consequence of these accidents, the mine will be flooded frequently, and delays occasioned of days, weeks, or even months, throwiug the miners out of employ, stopping the mills, and cutting off looked for dividends; thus creating great hardships in all quarters.

But this is not the only evil arising therefrom: the filling of the chambers and galleries with water swells the ground and timbers, which after the water is removed shrinks, *and consequently leaves the mine in an insecure state, making it liable to cave in.* The timbers, undergoing these changes, decay sooner, and must be renewed oftener in consequence. Miners in distant parts of the mine remain in a constant state of anxiety, fearing some accident to the pumps; they certainly do not work with that feeling of security they would otherwise posess.

Another objectionable feature of pumping is, the fact that the mine which reaches the greatest depth is compelled to do all the pumping, not only for itself, but also for its neighbors, thus draining them without receiving any remuneration. This will retard mining operations to a large extent, as many companies would prefer to suspend the working of their mines until the adjoining claims have reached the same level, in order to bring them to equitable terms. A drain tunnel will avoid all these difficulties.

ADVANTAGES OF A DRAIN TUNNEL.

As to the advantages derived from a drain tunnel, at this great depth, we will enumerate a few:

Shafts can at once be sunk the whole depth connecting with the tunnel, thus insuring the most thorough ventilation; this is a matter of great importance in deep mines; the health of the miners is thereby secured and they can work along with vigor and energy, not being stifled with fumes of powder and foul air;

and it is a fact, ascertained by experience, that they will perform one-half more work, which reduced to dollars and cents will make an immence saving in the course of the year.

THE VALUE OF THE MINES WILL BE LARGELY INCREASED.

At present the value of a mine is estimated, to a large extent, by the body of ore actually in sight, and very few of them have explored their pay ore to more than one hundred feet in depth. After this drain tunnel is completed, nothing will prevent the mines from being opened at once to the whole depth of 1,800 feet, *showing the different bodies of ore contained in the same, exposing millions of dollars to the eye, and thus increasing their value in proportion.* Having thus thousands of tons of ore in sight, preparations can be made to work the same in an economical manner, and mills can be erected with perfect security.

Many advantages would arise from the more perfect system of mining and timbering, which could be adopted ; it could be done more systematically and economically than at present.

Hauling being very expensive, quite a considerable saving would arise from the fact that the ore in a well drained mine is nearly dry. At present about 10 per cent. of water is contained in the ore as hauled to the mills, and calculating the average cost of hauling at $4 per ton, this would save 40 cents on every ton, or $400 per day, or the large sum of $144,000 per annum.

Particular advantages would arise to those claims on the Comstock ledge, who never have found any ore yet, or who have run out of it. They are tired of paying assessments, and their mines will probably not be prospected for many years to come. This drain tunnel will enable them to explore their claims at a great depth, at but a small expense ; and there is every reason to think that many of them will prove of great value.

GREAT DEPTH WHICH WILL BE ATTAINED HEREAFTER.

The mines can be worked a great depth below the level of this tunnel by pumping the water into the same. This is accomplished in Europe, in a very ingenious manner, at comparatively small expense, by collecting the water in the upper parts of the mine in reservoirs and conducting it in pipes to hydraulic engines placed at the level of the tunnel ; *thus using a portion of the very water which causes all the obstacles at present, as a most useful and economical motive power to propel pumps ; which, in their turn raise the water from great depths below.* It may safely be stated, therefore, that by means of this tunnel the Comstock ledge can profitably be worked to a depth of at least 3,000 feet.

The necessity of completing this tunnel, without delay, must be apparent to every one who reads these pages attentively, and gives this important subject the attention it deserves. No time ought to be lost to commence operations at once, and to push the same with the greatest energy, day and night, until completed. By the time this work can possibly be finished, *the decline of our mining interests, and all other interests in Nevada, will fairly have commenced.* If this matter is delayed until the mines cannot be worked any deeper by machinery, the country will go to ruin, waiting for a drain tunnel to be completed.

Much has been spoken and written about the importance of a railroad across the mountains ; it has been the subject of discussion in the newspapers, in the Halls of the Legislature, and in Congress, for a number of years past. It is certainly a subject of great interest to the people of Nevada and California. *But this tunnel is of still greater importance, for we venture to say, that but few people would be in Nevada by the time a railroad is finished, if this tunnel is not constructed.*

Every person owning in the Comstock ledge is deeply interested in the carrying out of this enterprise, and so is every resident of the State of Nevada ; whether miner, merchant, farmer,

banker, teamster, millman, or of any other occupation. But the people of California, and particularly San Francisco, are not the less interested; every dollar produced by these mines finds its way to California, in exchange for its produce.

It is a gratifying fact to the undersigned that this important undertaking is commencing to be appreciated by all intelligent persons who go to the trouble to investigate its merits. He has for several years past endeavored to explain its importance, but could find no encouragement whatever to carry it out.

But it is apparent that the proper time has now arrived to carry out this great work. Persons who never dreamed of the difficulties to be encountered from water in (working) mines, commence to realize the importance of drainage and have become enthusiastic friends of this enterprise.

The attention of many has been drawn towards this undertaking, by the fact that the Nevada Legislature has of late granted the undersigned the exclusive privilege for fifty years, to construct a tunnel from the valley of Carson river; he is fully determined to overcome all obstacles, should any present themselves, and feels satisfied that with the assistance of the many friends of this enterprise, the day will soon arrive when work will fairly be commenced.

A. SUTRO.

San Francisco, February 24, 1865.

REPORT OF BARON RICHTHOFEN.

VIRGINIA, February 16, 1865.

A. SUTRO, ESQ., Dayton:

Dear Sir:

I learned with great interest of your magnificent project to run a deep drain tunnel to the Comstock vein, from a place near the mouth of Webber Cañon, three and a third miles north of Dayton, and I cheerfully comply with your request to state to you my views about the importance and feasibility of this enter-

prise. Its value will, of course, chiefly depend upon the question whether these mines will ever be worked to considerable depth; that is, whether the Comstock vein will extend far down, and whether it will retain its metallifferous character in depth. Both questions have to be decided from the study of the structure and nature of the Comstock vein, and from comparing the results with the observations at such mines in other countries, which have already been worked to great depth. My experience on the Comstock vein is based on close and repeated examinations of nearly all the mines on its course. I believe, to concur with almost everybody, who has equal experience about them, in the opinion, that it is a true fissure vein, of extraordinary length, and extending downward much farther than any mining works will ever be able to be carried on. It would be too lengthy to enumerate the various reasons which lead most positively to this conclusion. It is now assumed almost universally as a fact, and the number of those who consider it as a gash vein, or a system of gash veins, is fast diminishing.

As to the downward continuance of the ore bearing character, every instance goes to show that the average yield in precious metals remains about equal at every depth. Some mines had accumulations of ore near the surface (Ophir, Mexican, Gold Hill), in others they commenced very near under the surface (Gould & Curry, Potosi, Yellow Jacket, Belcher), at others, again, considerable work had to be done before bodies of ore of any amount were struck (Chollar, the southern part of Gold Hill, Uncle Sam, and others), and some which had no ore heretofore, appear to have good prospects to find it soon. The fact that some rich bodies of ore, which were found near the surface, gave out at the depth of a few hundred feet, induced the common belief, that the Comstock vein was becoming poorer in its lower parts. But the explorations of the last months have entirely defeated this opinion. On the contrary, the enormous amount of bullion, which is being produced by the mines at

present, may almost appear to prove that the vein is improving in depth. But this conclusion is probably equally fallacious, as it must be borne in mind that many mines have been developed at different levels, and ore is being extracted from several of those. Hoisting works, and the mode of extracting the ore, have also been improved, and, of course, help to increase the daily produce. This average equality of the produce of the vein at every different level, is not only true for the amount of ore extracted, but also for its yield. The rich body of ore in the Ophir and Mexican mines, forms the only exception to this rule, as none of equal average percentage in silver and gold has been found again. Even the relative proportion of gold and silver in the ore has not undergone any material change, though the bullion, on account of the more imperfect processes of reduction, contained at first proportionally more gold than at present. The ore found in the Uncle Sam mine, at the depth of 414 feet, is as rich in gold as any found in other parts within 100 feet from the surface.

There is no reason to doubt that this equality of average produce and yield thoughout the entire length of the vein, will continue downward to any depth. Besides, the very obvious theoretical conclusion that vast amounts of silver could not be carried into the fissure from the overlying or the enclosing rocks, but naturally had to rise from unknown depth, through the channel of the fissure itself, to be deposited in it wherever the conditions for sublimation or precipitation were given in its open space. Experience in other countries by no means shows of a regular decrease or an increase in yield as of common occurrence, though either of them may happen. More commonly, the produce of true fissure veins in precious metals, has been found to be about constant.

It is, notwithstanding, a well known fact, that the profits of silver and gold mining decrease rapidly in reaching deeper levels. The magnificent silver veins in the Karpathians, for in-

stance, which are the only ones in Europe, closely resembling the Comstock vein, have been worked formerly with great profit, and pay now but little above their expenses. But this is principally due to the increased expense in working them. Drainage is the heaviest item, mostly where the water has to be raised to a great hight. It devours so much of the produce, that, with increasing depth, the net profits will be diminished, then totally absorbed, and, finally, exceeded by the cost of raising the water. Drain tunnels have, therefore, been constructed wherever it could be done with a reasonable expense, provided the veins could be struck at a considerable depth. It appears that, for the Comstock vein, the day is not far distant when the expenses of raising water will be so large, that a great quantity of those middle class ores, which are the principal source of wealth of these mines, will no more yield any profits, and the benefits from the richer ores will also be diminished; and, if mining in this fast country proceeds as rapidly towards lower levels as it did heretofore, it will have to be abandoned after some years, if the difficulty is not met with by the means proposed by you. It is useless for me to dwell upon the great benefits which the mines would derive from the construction of a deep drain tunnel. Calculations on a very moderate basis show the advantages by plain figures so obviously as to strike every thinking mind.

The second subject about which you requested me to state my views, is the practical feasibility of your project. The best starting point of the drain tunnel will of course be at such a place, where the greatest possible depth on the vein can be reached by the shortest possible route. Besides, it has to be taken into consideration, which qualities of rock the tunnel would have to run through, and which are the facilities for sinking air shafts. I will try to argue these different points, as my numerous geological examinations and rambles over the country of Washoe have made me pretty familiar with its physical outlines and its geological structure.

As to the starting point of the drain tunnel, you have, with remarkable sagacity, selected a place which so far supercedes any other, as to be indeed the only feasible one in the country. South of Webber Cañon, the range of hills which slope into Carson Valley, recedes in the shape of an amphitheatre, and allows the almost level bottom of the desert to approach the Comstock vein within less than four miles. The level of the Carson river at Dayton, is about 1900 feet lower than the croppings of the Comstock vein at the Gould & Curry office. If the tunnel starts 100 feet above the river, at the foot of the hills, it will strike the Comstock vein 1800 feet below those croppings. Making no allowance for the Eastern dip of the vein, its length would be about 19,000 feet; thus making the proportion of depth to length, as 1 to 10.55.

There is no place more suitable along the banks of Carson river. A tunnel from the lower part of Gold Cañon (below Johntown,) would have to run 22,000 feet to the Divide, and 25,000 feet to the Gould & Curry croppings, besides starting between 200 and 300 feet higher than the place selected by you, and offering great disadvantages as to the qualities of rocks and the sinking of air shafts. A third place which might be selected for starting, would be at the bottom of the cañon which extends from the Santiago Mine down to the New York House. You would strike by such tunnel the central part of American Flat at 11,000 feet, the Gould & Curry croppings at 24,000; but comparing with the place near the mouth of Webber Cañon, you would lose about 600 feet in depth.

The disadvantages of running a tunnel from Washoe Valley or Steamboat Springs, to the Comstock vein, are so obvious that I need not dwell upon them. Those places, are, respectively, about 1300 and 1600 feet lower than the Gould and Curry croppings; the distance of the former from the same croppings is about 30,000, that of the latter about 40,000 feet. Both places can never compete with any on the Carson river; and

besides their great distance and comparatively little depth, you would have to run through extremely hard rocks, and would never be able to sink air shafts.

The three places in Carson Valley, will compare as follows :

Starting Point.	Length of tunnel to Gould & Curry cropp.	Depth below Gould & Curry cropp.	Proportion of depth to length.
1. Near mouth of Webber Canon, 3½ miles north of Dayton.	about 19,000 feet.	about 1800 feet.	1: 10.55.
2. In Gold Canon, below Johntown.	" 25,000 "	" 1500 "	1: 16.66.
3. In Canon from Santiago Mine to New York House.	" 24,000 "	" 1200 "	1: 20.00.

Though these figures are but aproximations, they show plainly the great superiority of the place selected by you.

The facilities of excavating the tunnel will mainly depend upon the quality of the rocks through which it will pass. It is a remarkably fortunate incidence that the route selected by you promises, also, in this respect, to be the most advantageous. While the tunnels, both from Gold Cañon and from New York Cañon, would have to pass to great extent through quartzose porphyry, which is the hardest, and through a certain kind of metamorphic rock, which is the toughest rock of the country; you will not meet either of these rocks. The first 6000 or 7000 feet will be run through trachyte and trachytic breccia which in a broad semicircular belt of prominent hills, swing from Dayton by the Sugarloaf to Washoe Valley. Trachytic breccia can easily be worked by the pick, yet is ordinarily solid and dry enough to require no timbering. You may form an idea of its excellent qualities for tunneling, from the fact that in Hungary wine cellars, hundreds of feet in length, are with preference excavated in this kind of rock. The solid trachyte is an excellent blasting rock. Its superior qualities have caused its general use in Washoe for building material ; it was applied as such in the construction of the solid masonry of the Gould & Curry Mill. With the use of

the drilling machine of Mount Cenis you will make speedy work in this rock.

The next 2,500 feet will, to all probability, exhibit a great variety of rock, some of which will be rather hard. This applies chiefly to certain volcanic rocks of dark color (andesite), which flank the trachytic range to the west; but as they occur in dykes parallel to the same, they will retard work but slightly.

The following 10,000 feet, which bring you to the vein, will most likely consist of the same material as is traversed by the numerous tunnels which lead at present to the Comstock vein. This rock (trachytic greenstone) would offer serious obstacles if it was in an undecomposed state. But from the general nature of its decomposition, which, evidently, was performed from below, by ascending steam and vapors, during a time of volcanic action, I believe to be justified in the conclusion that you will find it for the entire length of 10,000 feet of the same rotten nature, as in the shallow tunnels at present in existence. It varies in them constantly, some varieties being easily worked by the pick, while others, occurring in streaks parallel to the vein, are less decomposed, and have to be blasted. Timbering would probably be required but to a limited degree in a small tunnel; but if you make it of sufficient size for a double track, you may have to timber almost all of the 10,000 feet.

A third requirement, though not absolutely necessary with the present accomplishments of tunneling, will be the sinking of air-shafts. Also, in regard to these, your tunnel offers greater facilities than any other route. It passes first under a high range of hills, which is accompanied on either side by deep ravines. Each of them will be a suitable starting place for an air-shaft; the depth of the latter would be about 500 and 750 feet. The first of the two would be about 3,000 feet distant from the mouth of the tunnel, the second about 3,600 feet from the first. Approaching the Comstock vein, there are two more places suitable for air-shafts, the distance from the second to the

third being 2,500 feet, that of the third to the fourth, 4,000 feet, thus leaving about 6,000 feet distance from the fourth shaft to a point vertically under the Gould and Curry croppings. The two last shafts would have a depth of 1,200 and 1,300 feet. One of them will, no doubt, be sufficient.

None of the prominent mining countries of the world can boast of equal facilities for a drain-tunnel. I do not know of any that drains mines at an equal depth, and yet, many drain-tunnels have more than double the length of the one proposed by you. If, in the Harz mountains, where labor and fuel are cheap, it was considered economical to construct a drain-tunnel of 72,000 feet in length for draining the mines to the depth of 1,200 feet, all this for a product which is scarcely one-thirtieth of that of Washoe, how much more economical must it be in the latter country, with its enormous value of labor and fuel, to run a drain-tunnel of but 19,000 feet in length to drain the Comstock vein at 1,800 feet depth, for augmenting the net profits from a produce of $15,000,000 a year!

The future of Washoe, indeed, depends entirely on the execution of this magnificent enterprise. It is of vital importance for the State of Nevada, and will have great influence on the neighboring California, which chiefly derives the benefits of the mines of Washoe. The numerous advantages will only be fully understood when the work will be completed. Allow me to draw your attention still to one among them. Several companies on the Comstock vein have been very unfortunate; they either found no ore at all in their mines, or, if it was found at first, it gave out, and the owners are discouraged to do any further prospecting work. It is very probable, that in deep levels, some of these poor mines may be among the best. But it is still of far greater importance, that it will then be possible to determine how far north and south the Comstock vein extends, and how far it is ore-bearing. Notwithstanding the well defined character and enormous width of this vein in the Uncle Sam

mine, and its rich ore, the vein, which is very shapeless near the surface, has not yet been traced with certainty farther south, and prospecting on American Flat is almost entirely abandoned. Capital is being invested very unwillingly in the exploration of either this southern or the northern end of the vein, where equal labor and capital invested have not been rewarded. At the depth of 1,800 feet, all irregularities will probably have ceased, and then these unprofitable mines on both extreme ends, may still prove to be valuable claims.

Allow me to congratulate you to have been the first to have taken an enterprise of such vast importance firmly in your hand. With the sincere wish, that you may overcome the difficulties which you will no doubt meet in carrying out a work of such magnitude,

I remain yours very sincerely,

FR. RICHTHOFEN.

OPINION OF MINING SUPERINTENDENTS—AND OTHERS.

The undersigned, fully aware of the importance and urgent necessity of providing means for draining the Comstock ledge by means of a deep drain tunnel, and foreseeing the difficulties which must present themselves, before long, in removing the water from these mines; and being satisfied that the best interests, of not only the owners of the Comstock ledge, but the people at large of this State, would be seriously affected by neglecting this matter: we would most earnestly recommend the immediate construction of such a work, and ask the co-operation of all parties interested, in order that this important undertaking may speedily be carried out.

VIRGINIA, February 15th, 1865.

A. E. Davis, Gen'l Sup't Ophir S. M. Co.
Harvey Beckwith, Sup't Mexican Mine.

O. H. Frank, Sup't Central S. M. Co.
Pat. N. McKay, Sup't California S. M. Co.
Jas. Morgan, President Sides Co.
H. H. O'Reiley, Sup't White & Murphy Co.
Thomas G. Taylor, Sup't Best & Belcher M. Co.
Charles Bonner, Sup't Gould & Curry S. M. Co.
Sam'l F. Curtis, Sup't Savage M. Co.
Chas. L. Peck, Sup't Hale & Norcross S. M. Co.
I. Adams, Sup't Chollar S. M. Co.
Pat. N. McKay, Sup't Potosi G. & S. M. Co.
J. M. Walker, Sup't Bullion M. Co.
P. S. Buckminster, Sup't Imperial S. M. Co.
John H. Mills, President of Superior Co.
Robert Apple, Sup't Minerva Consolidated M. Co.
R. Graves, Sup't Empire M. & M. Co.
W. Tozer, President Challenge S. M. Co.
L. U. Colbath. Sup't Challenge S. M. Co.
L. S. Bowers, owner in Gold Hill.
Lindauer & Hirschman, owners in Gold Hill.
Chas. Pioda, owner in Gold Hill.
J. Woodruff, Sup't Bacon M. & M Co.
Wm. Arrington, President Confideuce Co.
Robert Apple, President Apple M. & M. Co.
Winters, Kustel & Co. owners in Gold Hill.
M. A. French, owner in Gold Hill.
John B. Winters, President Yellow Jacket S. M. Co.
H. Woodcock Sup't Crown Point Co.
F. A. Tritle, President Belcher M. Co.
Wm. Arrington, President Overman Co.
C. C. Thomas, Sup't Uncle Sam Co.
Paxton & Thornburg, Bankers.
Wm. Sharon, Ag't of Bank of California.
Jas. H. Latham, Ag't Wells, Fargo & Co.
B. F. Hastings & Co. Bankers.

E. Ruhling & Co. Bankers.
Almarin B. Paul & Co. "
Maynard & Flood, "
M. C. Hillyer, Trustee Chollar S. M. Co.
A. Meyer, Trustee Hale & Norcross S. M. Co.
D. E. Avery, Gen'l Ag't New York & Washoe M. Co.
J. R. Williams Sup't Sierra Nevada S. M. Co.
W. E. Bidleman, Sup't Utah Co.
J. Neely Johnson, owner in Virginia City mines.
H. F. Rice, Ag't Wells, Fargo & Co's, Carson.
F. Richshoen.
John Cradlebaugh.
Gillig, Mott & Co.
W. M. Brown, Mining Engineer.
C. V. Beseler, " "
John A. Veatch, " "
John White, formerly of the United Mines, Cornwall.
S. M. Johns, formerly of the Wheal Prosper Mine, Cornwall.
J. F. Lewis, Chief Justice Supreme Court.
C. M. Brosnan, Justice of Supreme Court.
W. O. Beatty, Justice of Supreme Court.
Richard Rising, District Judge, Storey County.
R. S. Mesick, " " "
C. Burbank, " " "
J. L. Crossman, Lieu't Governor.
C. W. Noteware, Secretary of State.
H. W. Nightingill, Controller of State.
E. Rhoades, State Treasurer.
N. W. Winton, State Senator.
M. S. Thompson, "
J. Seely, "
A. J. Lockwood, "