REPORT ON THE PROPERTIES OF THE GRANVILLE MINING COMPANY, LTD.,

YUKON TERRITORY, CANADA

and

RECOMMENDATIONS RESPECTING THEIR EXPLOITATION

by

Allen Hastings Rogers

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Property:

The Granville Mining Company, Ltd., is registered in England and controls, through ownership of stock in various subsidiary companies, placer claims on various creeks and hills in the Klondike and Indian River districts, Yukon Territory, Canada. No attempt was made to verify title or even identify all the property, but the claims owned or controlled cover an extensive area on the following creeks, their branches and tributaries:-

Dominion Creek
Quartz Creek
Sulphur Creek
Gold Run
Eldorado Creek
Hunker Creek
Last Chance Creek
Indian River
Klondike River

Claim maps of the different creeks are issued by the government, and from these complete property maps should at once be prepared, showing claims owned or controlled on the various creeks, as it is only by so doing that the comprehensive view of each situation necessary to formulate plans for working can be gained.

Location:

The location of these creeks can be seen from the accompanying map. Some of the property is at a distance of about fifty miles from Dawson, the distributing point, but the whole district is now traversed by excellent roads. A narrow gauge railway reaches the top of the divide near the Dome, and reduces the wagon haul to the Indian River creeks from twenty to twenty-five miles. Dawson is reached by steamer via the Lewes and Yukon Rivers from Whitehorse, the head of navigation, this being reached from Skagway, on the coast of Alaska, by the White Pass and Yukon Railway. The distance from Skagway to Whitehorse is 111 miles, and from Whitehorse to Dawson by river, 460. Stage service is maintained between Whitehorse and Dawson during the winter, the distance being 330 miles and the time, five to six days. By steamer the time from Whitehorse to Dawson is about 48

hours while in the opposite direction, against the current, it is about five days.

Climate:

Dawson is situated in latitude 64°5' north, and longitude 139°20' west of the meridian of Greenwich. Lying as it does within a few miles of the Arctic Circle, the winter climate is very severe and conditions approximate those of the Arctic regions. The summers are short, but the long sunlight during this season makes up, to some extent, for their brevity, and many kinds of green vegetables are successfully grown. Precipitation amounts, on the average, to less than 12 inches, so that the supply of water for mining purposes is scanty. Less than the average falls during July and August, which is unfortunate, as this is the time the water is most needed. A large part of the annual precipitation falls as snow which, melting in the spring, runs rapidly away, causing sometimes severe freshets. These spring waters might be impounded by dams except that the topography is such that no sites at sufficient altitude are available. The difficulty of obtaining a gravity supply of sufficient water constitutes the most serious obstacle to working the immense deposits of hill gravels.

Topography:

The region in question is hilly to mountainous, but the slopes are easy and no great altitudes are reached. The highest point in the district, known as the Dome and lying on the divide between the Klondike and Indian River creeks, is reported as 4250 feet elevation above sea level. The Yukon at Dawson

is at an altitude of 1200 feet. The Klondike creeks have an average fall of about 60 feet to the mile while the Indian River creeks are somewhat less steep, averaging about 40.

Geology:

The placer deposits seem to be practically confined to such areas as are underlain by schists, of which a number of varities are distinguished, and the gold, no doubt, originated from the schist. The schist is generally "good bedrock", being fractured and fairly soft, so that while forming good natural riffles for catching the gold, is easily dug. In some parts the schist has weathered to a plastic mass which did not retard the gold so well. Neither did it permit of the descent of the gold into the bedrock, so that it is necessary to dig but a few inches to recover the values. Some dikes of granite porphyry and other intrusives have been distinguished and in some instances, where such rock constitutes the bedrock, it is difficult to handle.

The gravels consist of three kinds, to classify them according to location, creek, bench and white channel. The white channel gravels,- so called because they are composed of nearly pure quartz,- occupy the ancient beds of the streams, lying several hundred feet above the present beds. The old channels were generally much wider than the present ones but only parts of them remain, the streams in cutting down to their present levels having destroyed part of them. Their remains are found on the hills alongside the creeks at eleva-

tions of from one to three hundred feet or more higher. The gravels vary in thickness up to about 150 feet according as more or less of them have been removed by erosion. As a general thing, the gold is mostly at, or near, bedrock, the overlying ground carrying little value except in such few instances as where a layer of silt in the body of the gravel offers a chance for the gold to concentrate.

The bench gravels are of small consequence in point of extent. They occupy terraces which the streams have left in cutting their beds down to the present levels. The gravels are similar to the present creek gravels but, while in some instances have proved rich, are of limited extent.

The creek gravels, i.e., those covering the present beds of the creeks, are the most important source of the gold of the Klondike. They are composed in large proportion of quartz pebbles and boulders which undoubtedly are the remains of the white channel gravels mixed with fragments of the underlying schists, sand and silt. They are generally of little thickness, rarely exceeding ten feet, and in most instances carry little gold in themselves, the bulk of the values being found at bedrock.

The creek gravels are almost invariably frozen except beneath the water of the creek. The white channel gravels are also frozen except where great depth is attained where the frost does not seem to be able to penetrate. The perpetually frozen condition of the creek gravels is maintained

throughout the summer by the protection which a layer of frozen silt called "muck" affords. This material consists mainly of decomposed vegetable matter and fine silt and a large proportion, rising 50%, is water in the form of ice. On top of the muck there is a thick growth of moss and grass; bushes and small trees also grow. The depth of muck varies on the different creeks, but is rarely less than ten feet and is sometimes thirty. Of course, it contains no values.

Costs:

In such a severe climate as rules from November to April, all operations involving the use of water are necessarily brought to a standstill. In the early days of the field, it was during this period that the shafts were sunk and drifts run on bedrock to extract the gold-bearing gravel. The ground was thawed by building wood fires against it and the gravel hoisted out was piled up, to lie until the spring thaw furnished water with which to sluice it. But the modern methods of dredging and hydraulicking cannot, of course, be practised during such severe cold and at the present time it is rare that any operations are conducted during the winter season. This constitutes one of the greatest obstacles to operation in this region. The necessity for keeping an organization together with little or nothing for them to do during the winter and the unproductive state in which equipment must lie during six months of the year constitute a heavy

charge against the operations of the other six months. The long season of idleness, together with the high cost of living, obliges the payment of high wages to the laborers during the operating season. Men must make during five or six months enough to average a fair wage for the whole year and pay the high cost of living in idleness during the winter. Whether they remain in the country or go outside during the winter, the result is much the same for the cost of transportation is very high.

Still another condition inherent to the locality which makes for high costs is the frozen condition of the gravels. Frozen gravel is an extremely tough and resistant substance, and can be moved or broken in its frozen condition only with the greatest difficulty. But even were it possible to dig it, it would still be necessary to thaw it in order that its disintegration may liberate the gold. The most successful practise that has been developed is thawing it in place by the introduction of steam through small pipes which are driven into it. As fuel is very expensive the cost of this operation is great, but as a means of applying heat it is, without doubt, the most efficient.

If the overlying muck is removed from the gravel, the summer's heat will thaw it after two or three seasons. This has been proposed as a means of avoiding the high cost of thawing and, while the removal of a large proportion of the muck is believed feasible, as hereafter discussed, it appears doubtful that natural thawing of the gravel will offer any

advantage over steam thawing owing to the time required and the high cost of the complete removal of the muck.

The basis of a very large proportion of the high costs in the Klondike is the unproductive character of the country coupled with the high costs of transportation. Owing to the short season, no staple crops will ripen and nearly everything has to be imported. It has not been possible, so far, to mature grain of any kind, and while oats are grown to a very limited extent, they are cut before ripening for hay. As the native grasses are sparse in quantity and poor in quality, horse feed is very expensive so that the cost of local transportation by horses is high. It would appear likely that, with the excellent and constantly improving roads of the district, automobile trucks could be used during the summer season with great advantage for much of the local hauling. While fuel and oil would be higher than in the United States, repairs and maintenance should cost but little more. During the winter haulage by horses is much less expensive as much heavier loads can be moved.

Although the surrounding country is fairly well wooded, the cost of wood for fuel is great, due to the high cost of labor and transportation. Some coal is mined within a comparatively short distance but it is of poor quality and has so far been little used. That mined near Carmack's, on the Yukon River about 250 miles above Dawson, is the best. It is sold at present for $5.00 per ton at the mine, and the present rate on it to Dawson is $5.00. The Yukon Gold Company has

been experimenting with it this season and it is said to have contracted for a large supply during 1912, no doubt at much lower prices.

Owing to the high cost of fuel, power generated by steam is very costly, but this is no longer necessary due to the hydro-electric installation of the Granville Power Company. This company will furnish to the subsidiary companies of the Granville Mining Company, power at the rate of two cents per KWH. which, compared with former power costs in the Klondike, is very cheap.

Some of the prices of commodities and service ruling at present are as follows:-

Labor per 10-hour day	$6. (or $4. and board)
Teams with driver	$18. to $20.
Mechanics, carpenters, etc.	$10.
Wood, per cord,	$10. to $14.
Wagon freight, summer, about	$0.50 per ton-mile.
Wagon freight, winter, about	$0.25 per ton-mile.
Board of man per day	$1.50 to $2.

Present rate per ton, Vancouver or Seattle to Dawson, $63.50. (This, it is believed, will be considerately lowered next season)

Working Methods and Costs:

There are two general methods of working gravel deposits, viz:- Underground, or "Drifting", as it is called, and Open cast. The first system is applicable where the pay gravel is overlain by barren or low grade material, while in the case of the latter system, the overlying material may, or may not, pay

to work. There are various methods of open cast or open cut work, varying from those where all the material is shovelled by hand or by power appliances, to those employing water under pressure through nozzles, known as the hydraulic method, and the modern gold dredge.

I believe that all known methods have been used in working the Klondike gravels. The method most generally employed in the early days of the district was the drifting method. The fact that nearly all the gold was found within a few feet of the surface of the bedrock, either above or below, and the frozen condition of the overlying material, made this most adaptable for the quick realisation of the bulk of the gold. A shaft would be sunk to, or into, bedrock, from the bottom of which drifts would be run out as far as practicable, and then from the breasts of these, the ground worked out towards the shaft. In order to thaw the ground, wood fires were first used, but these very shortly gave way to steam points. These are heavy pipes which are driven into the gravel and connected with a boiler on the surface, conduct steam into it and thaw it.

This method, when skillfully conducted, was fairly effective in extracting a large percentage of the value which the ground contained. It was practised, however, for the most part, by men who had had no previous experience in mining and, in consequence, there is today a good deal of ground unworked owing to the fact that, through inexperience, drifts

caved in before the ground was worked out and their recovery would be too difficult and expensive to pay. In a great many cases pillars of ground were left to support the workings, and there is still some ground which, through belief that it was low grade, was never opened. These mining operations were conducted during the winter months, and the material extracted was piled up to await the spring thaw, when it was washed up. The washing was hurriedly conducted through short sluices, so that, in many cases, the tailings still contain good values. It is popularly believed that not over 75% of the gold was saved in the early days, but I am of the opinion, from seeing the results of panning tailings, that this proportion is very much too low, and I believe that the recovery would have been nearer 95%. This seems only reasonable when it is remembered that no very coarse gold would be lost.

In recent years a good deal of ground has been worked by open cutting. This has resulted in a much more thorough extraction of the values and in most cases, where ground has been so worked by intelligent operators, it will not pay to rework. In this operation, self-dumping buckets or steam scrapers have been used and so have largely reduced the cost and extended the scope of the operation.

The foregoing descriptions apply to the creek gravels particularly; the hill gravels were, and are still, worked by drifting, but very early, hydraulic mining was applied to them, and it is by this method that nearly all operations on

the hills are now carried on. Owing to their high elevation above the creeks, ample room for tailings is afforded below.

The method of greatest importance at the present time, both in point of amount of material worked and in values recovered, is dredging. There are at the present time nine dredges in operation in the district of sizes varying from 5½ to 16 cu. ft. bucket capacity, and two more of 7 cu. ft. are about to go into commission. About 35,000 cubic yards of gravel per day are being dug by this method, and within a few years this amount will be greatly increased, as the dredge, where suitable, affords the most effective and cheapest method of working the ground.

During the past there have been few attempts to utilize the steam shovel for digging the ground, the gravel generally being transported to a washing plant for treatment. Except where the ground was very rich, the attempts resulted in failure.

Of the systems in use, there are but three appliances which merit serious consideration for the large scale operations necessary for low costs. These are the hydraulic nozzle, the dredge and the steam shovel. Of these, the hydraulic nozzle occupies one field while the dredge and, possibly, the steam shovel, occupy another. The nozzle is adapted for breaking down gravel from a bank and transporting it through sluices where the gold is caught, and has two requirements, viz:- water under pressure and room below the works for a tailings dump. The water under pressure may

in instances, be brought to the work through a ditch at such an elevation as to give, through a pipe, pressure at the nozzle, or, it may be given the requisite pressure by power applied through a pump. The latter involves continuous expenditure for the power while, with the former, the expenditure practically ends with the construction of the ditch. Unfortunately, conditions in the Klondike are very unfavorable to bringing water in a ditch as there is no supply at a great elevation except at long distances, so that the first cost is very high.

The cost of pumping water is, of course, dependent on the cost of power. Several attempts have been made to pump water for hydraulicking the white channel gravels, using steam generated by wood fuel for power. As might have been expected, the gravels, although of good grade, could not stand the high cost incident to such expensive power generation, and the trials proved failures financially. The head against which the water must be pumped varies from 300 to 700 feet, so that the theoretical amount of power required to raise one miner's inch of water will vary from 0.85 HP to 1.99 HP. As the efficiency of the application of power may easily be as low as 50%., while seldom, if ever, will 80% be realized, from 1.5 HP to 4 HP will generally be required.

The White Channel gravels, when thawed, are easily thrown down by the attack of the hydraulic nozzle, and, where proper grade is given to the sluices, a unit of water will move a large amount of gravel. The number of cubic yards

which one miner's inch flowing continuously will move in one day of 24 hours is called the "duty" of the miner's inch. According to what appears good authority, experience has shown the duty of the miner's inch in White Channel gravels to be about 5 cubic yards. This is a high duty, and while the gravels, owing to their freedom from large boulders, are easily handled, can probably only be attained by placing the sluices at high slopes. Fortunately, the high elevation at which the gravels are situated, permits of this, so that it would appear likely that this figure may be realized.

The cost of a horse-power per day when using wood as fuel will vary in this district from $1.00 to $1.50 or more, according to the price of wood and the effeciency of the apparatus employed. Recalling the power required to pump one miner's inch under the heads requisite, viz:- 1.5 HP to 4 HP,- and the fact that the duty of the miner's inch is estimated to be 5 cubic yards, and it will be seen that the cost per cubic yard may be from $0.40 to $1.20 for power alone. Such figures are, of course, prohibitory for working any but the richest gravels, and explain why the previous attempts to pump water for hydraulicking the White Channel gravels of the Klondike have been failures. It is only when cheap power is available that pumping water is worth considering, and it is due to the fact that such cheap power is available from the Granville Power Company's hydro-electric

plant that this company proposes to work some of these gravels by pumping.

In order to see at a glance the cost of pumping for hydraulic work on the White Channel gravels, the following table has been prepared. The table shows the cost per cubic yard for the power for pumping at the various rates per kilowatt-hour given at the top of the columns at the various heads given in the column at the left. In preparing it, it has been assumed that the duty of the miner's inch is 5 cubic yards, and that the pumping plant realize an efficiency of 65%.

TABLE SHOWING COST OF POWER PER CUBIC YARD OF GRAVEL

Constants: Duty of the miner's inch, 5 cu. yds., Efficiency of pumping plant, 65%.

Head ft.	Cost per K W H. cents.								
	1	2	3	4	5	6	7	8	9
100	1.56	3.13	4.69	6.25	7.81	9.38	10.94	12.50	14.06
200	3.13	6.25	9.38	12.50	15.63	18.75	21.88	25.00	28.13
300	4.69	9.38	14.06	18.75	23.44	28.13	32.82	37.50	42.19
400	6.25	12.50	18.75	25.00	31.25	37.50	43.75	50.00	56.25
500	7.81	15.63	23.44	31.25	39.06	46.88	54.69	62.50	70.31
600	9.38	18.75	28.13	37.50	46.88	56.25	65.63	75.00	84.38
700	10.94	21.88	32.82	43.75	54.69	65.63	76.56	87.50	98.44
800	12.50	25.00	37.50	50.00	62.50	75.00	87.50	100.00	112.50
900	14.06	28.13	42.19	56.25	70.31	84.38	98.44	112.50	126.56

From this table the cost for any head and at any rate per KWH can be taken. For example: With power at 0.6¢ per KWH the cost under a head of 526 feet will be found as follows:

Cost under	500 ft.	head at 6¢,	46.88;	at 0.6¢	4.688¢
" "	200 "	" " " ,	18.75;	under 20 ft. at 6¢	.188
" "	600 "	" " " ,	56.25;	" 6 " " "	.056
	therefore, cost under 526-ft. head is				4.932¢

At 2¢ per KWH and under the same head the cost will be

Cost	under	500-ft.	head	at 2¢,				15.63
"	"	200	"	"	"	",	6.25; under 20 ft. at 2¢	.625
"	"	600	"	"	"	",	18.75; under 6 ft. at 2¢	.188
								16.443

Besides the cost of the water, there is the cost of labor and supplies in the operations of piping and sluicing. There appear to be no satisfactory data on this point, but the item should be small. For a large operation moving several thousand cubic yards per day, it would seem that 5 to 8 cents per cubic yard should cover this expense. The final item of cost is that for the rock cuts necessary for directing the gravel from the face to the sluices. This will vary largely with the different hills. Where the pay gravel does not extend far back from the rim of the bedrock, the cost will be small; in cases where it is necessary to follow the pay to long distances from the rim, it may be of advantage to drive a tunnel deep below the surface of the bedrock and make connections with the face by means of upraises through which to wash the gravel to the sluices situated in the tunnel. It is only by a separate consideration of each case that a proper estimate of the cost of the bedrock cuts can be made.

The field which the hydraulic nozzle occupies can rarely be filled by the dredge. The modern gold dredge is an assembly of machinery for digging the gravel, washing and screening

it, and passing it over gold-saving appliances to be discharged in the rear. The whole assembly is carried on a scow which floats on a pond lying between the bank of gravel ahead and the tailings behind. As the dredge digs forward the pond moves forward and tends to remain of the same size because, as fast as the dredge digs out the ground ahead, the tailings fill in to the rear. Water for washing is pumped from the pond to which it returns with the tailings, and the pond is of sufficient size to permit the greater part of the sediment resulting from the washing to settle.

The dredge, therefore, requires no dumping ground for tailings; it deposits them in the same space which the gravel previously occupied. Its requirement of water is small for the waste from the pond can be kept down to a small amount. To be sure, it pumps the water it uses, thus requiring power, but the head against which it has to pump is low. Its compactness permits of housing the greater part of its equipment, a great advantage in an inclement climate, and this also permits of greater security against robbing of the sluices. Its total power requirements are probably smaller than any other system that can be devised and the attention required is small.

The conditions favorable for working gravel by dredge are that the surface of the ground be not too steeply inclined to permit of maintaining the water in the pond; that

The ground to be dug be not too deep to be practicable (at the present time, the maximum depth worked is 70 feet) nor so shallow as to make it impossible to float the boat (the minimum would appear to be about six feet); that the boulders contained in the gravel be not too large nor too great in proportion to be handled by the bucket line; that the ground to be dug be not so consolidated, whether by frost or cement, as to be impossible or very difficult of attack by the bucket lips or of disintegration in the screen; and that the bedrock be not too hard to permit of digging off its surface the amount necessary to extract the gold which has sunk into it.

These conditions are, or can be, fulfilled in almost all of the creek and river gravel deposits of the Klondike, and, as has been the case in the past two or three years, the dredge will, in the future, extract by far the greatest proportion of the gold which the field produces. The disadvantage of consolidation by frost has been overcome by thawing, either by artificial heat or by natural means, while in respect to the other requirements, the gravels leave nothing to be desired, and the bedrock, in most cases, is easily dug. For this district, the dredge has the further important advantage, due to its housing, of beginning work earlier in the spring and continuing later in the fall than other methods which operate without shelter. This advantage alone would be enough to decide in favor of the dredge were there any other method that, operating out-of-

doors, otherwise offered equal inducements in respect to capacity and costs.

The cost of dredging in the Klondike, originally very high, is constantly coming down, due to cheaper power, better understanding of the conditions resulting in better methonds and longer operating seasons and the increase in the capacity of the machines. The cost by the 16-foot dredge of the Canadian Klondike Company this season will probably not exceed 7 cents per cubic yard while the maximum cost incurred by the small boats on the creeks will probably not exceed 15 cents. The Yukon Gold Company, in their annual report for 1910, showed the average cost for dredging to be 31.09 cents, of which 14.60 cents was for thawing the ground, leaving the actual cost of dredging at 16.49 cents. They operated 159 days but this season they are likely to operate 175 days. Their boats are of two sizes, 5½ and 7 cubic feet respectively. The Canadian Klondike Company had one 7½ foot dredge in operation the whole of the season of 1910, operating 233 days on the Klondike River. The 16-foot dredge was only completed the last of the season, and as the small boat operated with power from steam generation, the cost incurred is not indicative of what can be done with the power furnished by the Granville Power Company.

It would seem reasonable to expect, with the low cost power available from the Granville plant,- viz:- 2 cents per KWH, a cost on the Klondike River, using dredges of large

capacity, of about 7 cents per cubic yard and an operating season of about 200 days. It is not probable that the average season will be longer than this; the operations of the Canadian Company during the last days of the season of 1910 were conducted with great difficulty, and, as long as it is possible to keep going the whole winter, it is better to shut down a little earlier than to extend the season at a loss. If it were possible to keep going the whole winter, the advantage in keeping the organization intact might offset the increased expense of so doing, but as this is probably impossible, there would appear to be nothing gained as regards this advantage in continuing a few days longer.

On the creeks, the possible season seems to be somewhat shorter than in the Klondike valley. It is maintained by some that it should be as long as on the river but the natural concentration of cold air in the narrow creek valleys no doubt produces harder frost in the early days of winter than in broad open spaces like the Klondike valley. It is, no doubt, reasonable to expect an average operating dredging season of 175 days on the creeks. The cost will naturally be higher due to inability to use the largest size dredges and to somewhat cramped spaces in which the creek boats often have to operate. With 5- to 7-foot boats, it is reasonable to calculate a cost of 13 cents per cubic yard of material dug, of which 2 cents would be paid to the Granville Power Company for power.

In preliminary plans for this company's operations, some consideration has been given to digging with steam shovel. The particular advantage claimed for the steam shovel is that it permits inspection of the bedrock as the work progresses and thus that cleaner work would result. I am not aware that the claim that the dredge does not properly clean the ground as it passes through it, is based on anything more than suspicion; certainly, as far as I could learn, nothing has been done in the Klondike to prove or disprove such a claim. Very little data on the work done by dredges anywhere exists, but I believe that some drilling of dredged ground has been done in California with the result of showing that the amount left behind was very small. A critical examination of the system of digging by dredge indicates that, where properly handled, every square inch of ground passed over by it is scraped by the buckets, so that, if proper attention is given to the depth in bedrock at which pay ceases by sampling with pan, there should be no more difficulty in properly mining a piece of ground by dredge under water than by shovel in plain sight.

The shovel plant suffers severely in comparison with the dredge in point of mobility. The machinery and equipment of a 5-foot dredge weighs approximately 500 tons, but it is carried on a boat which, floating on the water, moves forward easily as the work progresses. The capacity of this dredge would be about 2000 cubic yards per day and, while a movable shovel plant of this capacity would not weigh so much

by, perhaps, 200 tons, it would still be an ungainly thing to handle on land. Furthermore, the necessity for keeping a reasonably even track for it would require that much worthless ground be dug or that pay ground be left behind for the surface of the bedrock is not regular. This feature of the bedrock does not effect a dredge, but it might offset very largely that advantage of seeing the bedrock which the shovel offers.

Another disadvantage of the shovel plant is found in the matter of water supply. The dredge discharges and settles the water immediately about it and so has to raise it again at but a low head. The shovel, with its open pit, must either be furnished with a large supply of fresh water or, if necessary to re-use the water, must gather it up a long distance away with the consequent loss and necessity for repumping against a high head. Where ample water is available, this might not be a disadvantage, but in the case of the Klondike district there is no water supply which is sufficient to supply even a moderate sized plant without repumping.

A number of portable shovel plants have been tried in various placer districts, and a great many more have been designed but not tried, but they all suffer the inherent disadvantages set forth above in comparison with the dredge. The fact is that, except in possibly a few instances, wherever a shovel plant could be used, a dredge could better be used.

The exceptions above cited that suggest themselves are where the bedrock, while rough and rich, is very hard and tough, making it impossible to dig by dredge and require cleaning by hand; or where, as at the upper end of creeks, the gravels are thin and narrow and the slope, while too great to permit of dredging, is not sufficient, or the water is lacking for hydraulicking. In such cases the steam shovel probably offers the cheapest method of digging the ground.

But in no case would a portable washing plant be desirable. Under most conditions, opportunity would be afforded to locate a stationery plant on the hillside above the creek at such an elevation as to afford dump room for the tailings from one season's operations, transporting to it, by tram cars, the gravel from the shovel. The water would have to be pumped because in no case, it is believed, is there anywhere in the district sufficient at such locations to supply even a moderate sized washing plant. Such a location might be the claims on upper Eldorado, but until the plant is designed, it would be impossible to do more than guess at the cost of so treating gravel. It is not probable that it would fall below 30 cents per cubic yard, and in view of the necessity of moving the washing plant each season, might even be higher.

Wherever a dredge or shovel will be used, viz:- for working the creek gravels, the gravel is generally found covered with "muck". This material is composed of fine silt

and partially decomposed vegetable matter and is invariably capped with a thick layer of moss. It supports, besides, some vegetation in the form of stunted trees, brush and grass. One variety of the latter grows in hard bunches which stand up above the moss and are known as "niggerheads." The muck, besides the silt, contains water in very large proportion, probably 50%, and the whole is perpetually frozen, constituting a rock-like mass. The thick layer of moss serves as an excellent insulation and prevents the summer's heat from penetrating the muck. The removal of the muck is necessary where it is desired to thaw the underlying gravel by natural agencies, and the fact that, once thawed, flowing water transports it easily, has suggested the idea of ground-sluicing it. The fact that approximately one-half its volume is ice which only needs thawing to run away of itself, while, of the balance, a large proportion is silt of the lightest character, leads to the belief that a very large proportion may be so removed, while what remains will be so disturbed and broken up that the heat of the sun can penetrate it.

But there are difficulties in getting the water onto the muck, the chief obstacle being the overlying growth of vegetation. The moss and grass form a very tough sod which effectually resists the cutting action of water. If it is undercut, it falls down, and by reason of its tenacity, forms a blanket which still protects the muck from heat and water. If plowed, the sod is simply turned over and forms long tenacious ribbons which are as effective in protecting the muck

as before being disturbed. It must be actually removed or destroyed before the muck below can be removed to any great extent.

The general practise in clearing this material has been to plow it or cut it up with a knife-like harrow and then to drag it off the ground by hooks drawn by horses. In some cases it is piled up and burned, in others, where, for example, a ditch line is being cleared, left to lie; but in all cases it must be removed before the muck will begin to thaw.

The most effective method of disposing of it is to burn it in place, but this is rendered difficult on the creeks because it is generally water-soaked. The cause of this water-soaked condition is the shade afforded by the brush and trees, and the lack of drainage. It would appear that, if we could remove these influences, the moss might be burned. This has been done in the Klondike valley by burning off the brush and trees while ditches have furnished the drainage and much of the moss has been burned. On none of the creeks, so far as I am aware, has this procedure ever been tried but it appears perfectly feasible and certainly if it can be practised, will cost very much less than plowing and dragging.

As to the method to be pursued in washing away the muck, the best appears to be that which has been practised to a limited extent on Quartz Creek during the past season. The creek was diverted from its proper channel to a new one which had been prepared by plowing a few furrows. This was

Muck Removal: New Channel of Quartz Creek. Width here about fifty feet.

Muck Removal: Diversion Dam at Head of New Channel. Man standing in Old Channel just below dam.

done the latter part of last season and since then the creek has cut for itself a new channel, in many cases 100 feet in width, to the gravel. This can be done before the moss is removed and the new channel will assist in draining the moss so that it can be more easily burned.

As soon as the creek is running on gravel, it should be turned to another channel for the water is much more effective when running on top of the muck than when simply running against it. It is only when no more opportunity to run the water over the muck exists, that the creek should be allowed to run on the gravel. When, however, this is the case, some benefit can be derived by placing small wing dams so as to direct the flow of the stream against the bank of muck. These are in common use, and are generally made of boards so that they can easily be moved.

In many cases it will be of advantage to lay out more than one new channel so that the stream may either be divided between them or the flow may be alternated from one to another. A given amount of water will be more effective in thawing if run in a shallow stream than if in a deep one for the heat of the sun will be more effectively transmitted through it. It may be more advantageous to alternate the flow, allowing the sun to have full effect in the interim for thawing, while the water afterwards removes the thawed material to expose a new surface of frozen material.

This proceedure need not necessarily wait for the re-

moval of the moss; the two can proceed coincidently. As pointed out above, the new channels will drain the moss thus rendering it easier to burn. But constant endeavor should be made to burn the moss as much as possible for, as the new channels cut down, the moss blanket will drop and render the efforts of the water ineffectual.

It will also be advantageous to bring water from the sides of the valley through transverse channels, where ditches are already in existence. This is the case in a number of instances, and this water may be used also to advantage in running it down the banks of the longitudinal channels. In fact the whole aim should be to keep the water always running over muck, so that when it leaves the area under treatment, it may be loaded up with as much sediment as it will carry.

In the muck sometimes occurs a layer of sand. This material is, of course, too heavy to be removed by the small flows and gentle grades which are available. During a few weeks every spring, however, the flow of the streams increases eight or ten fold, and by properly directing these heavy streams, much of the sand can be carried off. A great deal of advantage will be obtained from these freshets and the work of every summer should be planned so as to prepare for them.

The final result of this proceedure will be to cut

Muck Removal: Note Muck cut up into irregular masses in foreground. This was done by small streams from side ditch.

Muck Removal: New Channel of Quartz Creek. Note how moss, in falling down, protects banks.

the overlying muck into cone-like masses the volume of which will be less than one-quarter of the original material. Their composition will be mainly sand and the heavier particles of silt and their consequently porous character should render them easily thawed by the sun. This, I think, is all that should be aimed at; the removal of this residuum so as to leave the gravel clean will cost infinitely more than that of the earlier portion. It can be more cheaply dredged. It is probably true that the gravel will not thaw below it or, if so, then only after the lapse of several years, so that it will be cheaper to thaw by steam than to depend on natural thawing so far as the gravel is concerned.

As experience in the removal of the muck is gained, no doubt constant lowering of costs will result. What the cost at the start will be must, at the present time, be largely a matter of conjecture for the attempt to remove it from large tracts has never been made and, in the matter of costs, there is little to guide us in the small operations. Operating over large areas, it would appear that 5 cents per cubic yard should be an ample allowance, but the cost will vary with the different creeks, owing to varying depths and exposure to sun. But to get the benefit of low costs, ample time must be allowed for the work to be carried out for there are but

about six months of strong sun and in the early part of the season everything is frozen.

Exploitation of Property:

On some of the creeks the claims owned by the company are too scattered to permit of formulating plans for the exploitation of the ground at the present time and, indeed, to render such a policy advisable owing to the desire of acquiring adjoining ground. In other cases the preparation of the ground for working will require some years before any profit can be realized. Believing it desirable to begin to realize some of the values at the earliest possible date, the closest attention was devoted to such portions of the property as seemed capable of giving quickest results, leaving the others for later consideration. These portions of the property are described in detail below, together with the result of the study made for their development and exploitation.

Bonanza Basin.

This property, which is controlled by the ownership of 148,000 shares out of 150,000 total share capital of the Bonanza Basin Dredging Co., is situated within the city limits of Dawson and covers the valley of the Klondike River from a line about one-half mile from its mouth to a line above the mouth of Bonanza Creek, extending approximately one mile along the river. It is composed of 31 claims and covers approximately 200 acres of ground.

The ground was sampled in 1906 by putting down 91 drill holes and the result of this prospecting covered in a report by Charles E. Gardner. As a result of this drilling, it was estimated that there were 4,838,000 cubic yards of gravel of an average depth of 24 feet and a tenor of 34 cents per cubic yard. Some of the holes, giving low results, were considered to indicate ground too low grade to pay, and areas corresponding to such holes were left out of the calculation. Including such areas with the values shown by the drilling indicates a total yardage in the property of 7,000,000 cubic yards, of an average value of 21 cents. If we are to be guided by the results of the drilling, some of this ground is, no doubt, too low grade to pay but it is probable that, in dredging the property, some of this ground will have to be dug. Furthermore, there is no doubt that, with a proper dredge, his estimate of cost, viz:- 15 cents, is much too high, so that some of the ground which he rejected would pay. Another feature of his estimate

of cost is subject to modification, viz:- the expense required to thaw the frozen ground which he encountered. This can without doubt be accomplished by burning off the vegetation and later, if necessary, flooding it with the river. It has been found on the Boyle concession, situated just above the Bonanza Basin, that, where the ground is burned over, the permanent frost disappears and practically no expense has been incurred on this property for thawing.

Since the Gardner report was written an amount approximately 600,000 cubic yards has been dredged by the Bonanza Basin Company. This diminishes by so much the ground to be dredged. Allowing for this, it is probably safe to expect this property to yield at least five million cubic yards of an average tenor of 25 cents per cubic yard.

The cost per yard for dredging will depend on the size of boat adopted. The larger the boat, the smaller will be the operating cost, but, as the amount of gravel is not unlimited, the cost per cubic yard for amortization of the large boat becomes heavy. The effect of this is shown in the following comparison where it is seen that the larger boat, although working at a lower operating cost, puts upon the gravel a larger total cost than the small boat so that the final profit is less. The reason for this is the necessity of writing off the cost of the large boat over but three years. If there were ten years' ser-

vice in sight for the large dredge, the amortization cost per yard would be but 1.7¢ making the cash value of the Bonenza Basin gravel as realized by her $648,000. Such a condition depends on the ability to find work for her after finishing the Basin to the extent of her life. Otherwise, the small dredge will prove the more economical, especially as she is of a size that might afterwards be utilized for the creeks.

Table showing value of Bonenza Basin property when worked by 7½ and 15-foot dredges. Total contents of property assumed, 5,000,000 cubic yards of an average value of $0.25.

Size of Dredge	7½ ft.	15 ft.
Rate digging per month, cu. yds.	120,000	300,000
Months to complete digging	42	17
Years to complete digging	7	3
Cost of dredge	$175,000	$350,000
Cost operation incl. repairs, etc. cu. yd.	10.0¢	8.0¢
Amortization (interest rate 5%)	3.0	6.7
Interest on cost dredge, 5%	1.2	1.0
Total cost of dredging per cu. yd.	14.2¢	15.7¢
Profit per cubic yard	10.8	9.3
Annual profit	$ 77,100	$ 155,000
Present Cash Value	$446,000	$ 422,000

A dredge for this property should be capable of digging to a maximum depth of 40 feet, the average depth being 24 feet. It will never be necessary to dig a bank above 10 feet in height. In all respects it would be standard in design and the hull would preferably be of steel, as the lighter weight of such construction will probably more than

offset the increased cost, due to the high transportation charges which must be incurred.

Dago Hill Mining Co.

This subsidiary company controls the property lying in the vicinity of the junction of Last Chance Creek with Hunker Creek. No details as to claims owned were obtained, but by title or option, the ground covering Dago Hill, Last Chance Creek and the other hills in the vicinity, Discovery, Treasure, and Preido Hills is pretty thoroughly controlled.

Immediately available for work are Dago and Discovery Hills. The deposits on these hills are known as the White Channel gravels, which have already been described. The gravels lie at an elevation rising 300 feet above the creek bottoms, so plenty of space for tailings exists. It is proposed to work them by hydraulicking, pumping the water for nozzles. This is perfectly feasible, the only question being one of costs as has already been discussed.

The gravels on Dago Hill amount, according to an estimate made by McConnell of the Canadian Geological Survey, to above 10,000,000 cubic yards. Their maximum depth above bedrock is above 100 feet, the highest point of the hill lying at an elevation above sea level of 1,725 feet. The highest elevation of bedrock is 1,572 while the lowest is 1,522, the slope being parallel with, and in the same direction as, that of Hunker Creek.

These gravels represent the ancient bed of Hunker Creek and the former coarse gold paystreak still exists

intact from Last Chance Creek on the east to Dago Gulch on the west. Its north and south limits are very imperfectly known, for while a great many shafts have been sunk to bedrock, but very little information as to what they disclosed exists. Most of the data regarding the value of the gravel has been derived from sampling along the edges where about 120,000 cubic yards have been worked by hydraulicking. There are, also, several claims which have been drifted out. McConnell estimates the pay streak at from 300 to 500 feet in width, while the length from Last Chance Creek to Dago Gulch isabout 3700 feet. He believes that an average width of 600 feet can be worked, and estimates the volume of gravel contained in the pay streak to be 6,423,000 cubic yards. Until opportunity is offered properly to sample the ground it will be as impossible to state with any degree of definiteness the volume of workable gravels as it is their value.

And the question of the value is naturally a very serious one, for the equipment of the property should not be undertaken without a reasonable certainty of being able to work the gravels at a profit. I cannot agree with Thorne's estimate of the value of these gravels for he takes as an average of the deep gravels, the value shown by working the shallow gravels on the rim. This figure, viz:- 53.6 cents per cubic yard, is the average obtained from working some 90,000 cubic yards, where, however, the average depth was from 15 to 28 feet. At these places, the upper barren or very low

grade gravels, have been removed by natural erosion leaving but little low grade material to be moved in order to get at the rich concentrated material which lies at, or near, bedrock. Admitting that the bedrock is as rich further back into the hill, there will be two or three times as much worthless material to be moved to uncover it, so that the average return per cubic yard moved will be much less.

Beyond the figures given by Thorne for the value of the Dago Hill gravels, the only ones obtainable were the results published by McConnell, some results of panning tests furnished by Mr. Treadgold and a statement by one of the operators, Mr. Scouse. McConnell's figures show clearly the low grade character of the overlying gravels, and I copy below a table from his report giving the detail of this sampling. The work was, apparently, carefully done, and seems to me to be worthy of great weight. Unfortunately, there were but two samples taken from which McConnell estimates the average value of the whole pay streak at 19 cents, a figure which is probably too low.

Detail of Sampling a Square Yard Column of Gravel
Dago Hill.

From McConnell's Report on the Klondike High Level Gravels.

			Total Value.
84-90 feet.	Average value per cubic yard,	.007..	.014
78-84 "	" "	.009..	.018
72-78 "	" "	.012..	.024
66-72 "	" "	.014..	.028
60-66 "	" "	.020..	.040
54-60 "	" "	.0675.	.135
48-54 "	" "	.0275.	.055

42-48 feet.	Average value per cubic yard,	.030..	.060
36-42 "	" "	.041..	.082
30-36 "	" "	.040..	.080
24-30 "	" "	.0425.	.085
18-24 "	" "	.050..	.100
12-18 "	" "	.060..	.120
6-12 "	" "	.114..	.228
1-6 "	" "	$2,200..	$4.400
	Total values in square yd. column, 30 yds. high,		$5.469

The result of this sampling indicates an average value for the whole section of but 18 cents per cubic yard; that above a height of 12 feet above bedrock the gravel is practically worthless and that, had it been necessary to work only the lower 12 feet, the return would have been $1.15 per cubic yard. Consideration of this table also explains why I take exception to Thorne's estimate of value; taking the values from bedrock to 24 feet above gives an average of 60 cents, a figure not far from that given by him as applying to the whole hill. The figures obtained from Mr. Treadgold are the results of panning 38 samples, including 267 pans, the arithmetical average of which gives $2.67 per cubic yard. As nearly all these samples were taken at, or near, bedrock, while with one or two exceptions, they do not represent any definite area of bedrock or height of gravel, it is impossible to draw any conclusions as to the value of the whole from them. The statement of Scouse was to the effect that, in drifting, he had recovered 80 to 90 cents per square foot of bedrock.

Where the overlying gravels are practically barren, the value per square foot of bedrock affords a very easy means of estimating the value per cubic yard. If it had been possible to determine the area from which Thorne's estimate was made, a very reliable figure would have been arrived at. Unfortunately, since his measurements were made, considerable additional ground has been worked so that our measurements did not check his. Nor was it possible to obtain a new figure as, owing to shortage of water, the ground worked this season has not been cleaned up. Were the average value per square foot known, the average value per cubic yard, knowing the average depth, could be obtained by simple proportion.

The average depth of the gravel in the pay streak is given by Thorne as 68.5 feet. I am unable to check his figure from the only data available, viz:- McConnell's report, as from his data, the average depth figures 73 feet. For every square foot of bedrock, then, it will be necessary to move 73 cubic feet or 2.89 cubic yards, so that, if the average value per square foot be as stated by Mr. Scouse, the average value per cubic yard will be from 28 to 31 cents. The lower of these figures checks the most reliable sample quoted by Thorne, viz:- 27.2 cents average obtained in sinking the Leonette shaft, and it is probable that the hill contains a considerable yardage approximating these figures. Whether the amount is

sufficient to warrant the cost of the installation can be told only by more thorough sampling. Indeed, the exigencies of working may make it difficult to maintain this average owing to the possible necessity of working lower grade material in order to get at the higher grade.

While some prospecting is being done this fall, the available openings for samples are few, and I would earnestly recommend that this ground be drilled before the attempt be made to work it. The hill has been laid out in co-ordinates this summer, ready for drilling and the calculation of volumes, so that, as drills can be obtained in the camp, work could be started this winter. The average cost per hole would probably be in the neighborhood of $200, and 90 holes would be the probable maximum number. Work, however, could be started before the drilling was completed if results along the rims warranted it, but the season of 1912 would be lost for working. The uncertainty as to profit or loss thoroughly warrents this, however.

The plan for working these gravels contemplates the bringing of water from the Klondike River through a canal along the base of Australia Hill to the Hunker Valley and thence pumping the water to the working faces. The pipe line proposed follows the right limit of Hunker to a point nearly opposite Dago Gulch, whence it crosses Hunker Creek and ascends along the left limit of Dago Gulch to an elevation of 1,680 feet to discharge into a ditch. This ditch will follow closely the southerly rim of the White Channel,

and affords a permanent means of distribution of the water to the working faces. The total head, including friction against the pumps will be about 530 feet and the power required, figuring the efficiency of the pump and motor at 65%, will be 2.3 H. P. per miner's inch. For the main pipe line to pump 1,000 miner's inches, 7700 feet of 30 inch pipe will be required, the weight being about 516,000 pounds.

As may be seen from the plan, the pay streak occupies a zone running through the gravels from the Scouse cuts on the northeast to the Wilson cut on the southwest. Now the grade of the sluices necessary will be at least 8 inches to the 12 foot box, or 5.5%, so that, as the faces are worked back into the hill, the depth of the bedrock cuts to carry the sluices becomes deeper. At the middle of the hill the sluice would require a fall of 100 feet, making a cut that would be impossible to maintain, so that, if it be decided to work out the whole of the ground, a tunnel should be driven in bedrock to carry the sluices. From this tunnel, cross cuts should be driven from which raises should be put up, and through these the gravel should be washed to the sluices in the tunnel, as shown in the sketch. For a distance of about 500 feet from the rim, the tunnel will not be needed but as a large proportion of this ground is worked out, it may be necessary to drive the tunnel immediately. This work would also afford a means of opening faces in the centre of the hill, a thing that may be de-

Dago Hill: View of Portion of the Secuse Cut .

Right of way for Dago Hill Supply Ditch. Ground cleared by dragging with hooks.

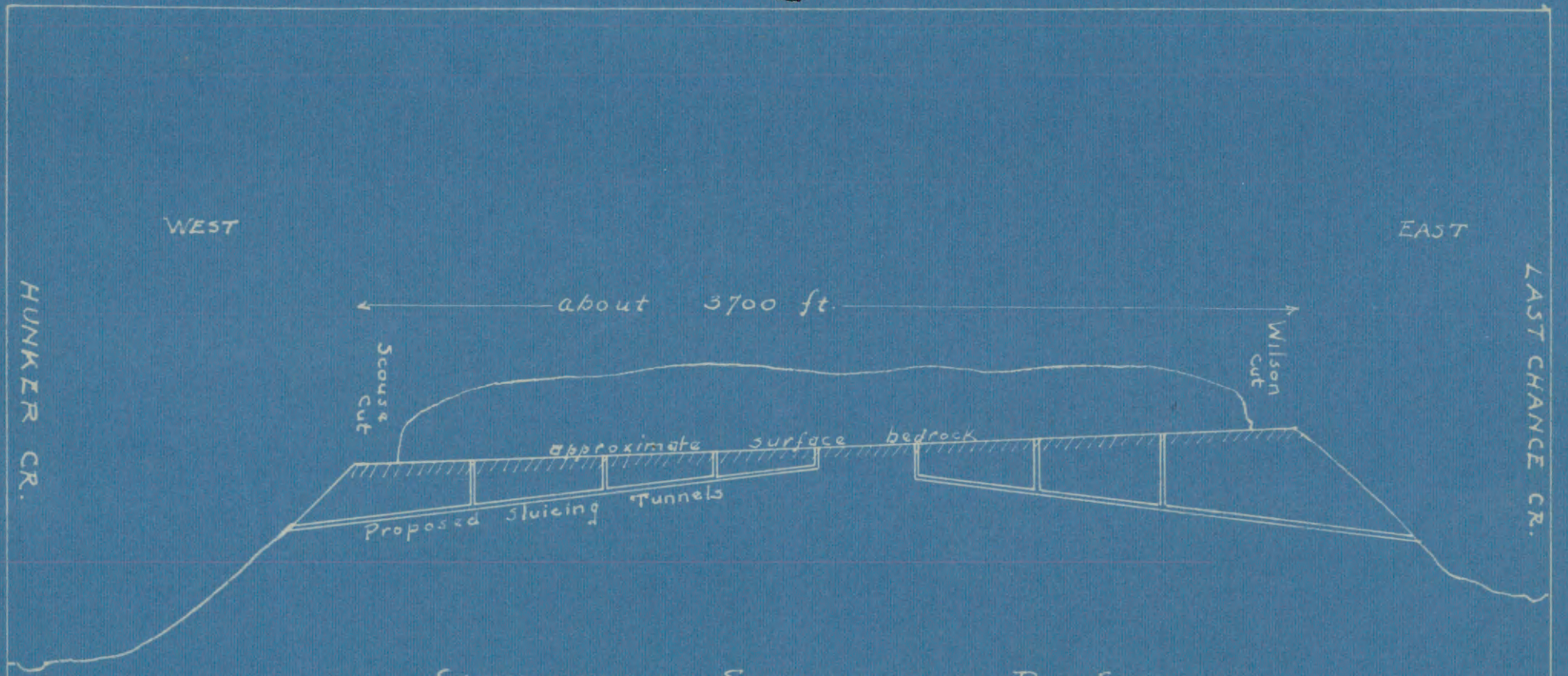
sirable, owing to the necessity of exposing to the sun's warmth a large area of gravel face.

Without knowledge of the extent and dimensions of the pay streak, it is impossible to lay out the tunnel and its tributaries with any degree of certainty. Roughly, however, some 9,000 feet of underground work will be required which will probably cost $11.00 per foot. This work could be done to a large extent in the winter, thus giving employment to the men it might be desired to keep together.

The cost of equipping the property is estimated as follows:-

Canal,		$40,000
3 4-stage centrifugal pumps	$8,250	
Freight on 96,000 lbs. @ 5¢	4,800	13,050
3 1000 HP motors and accessories	20,000	
Freight on 80,000 lbs. @ 5¢	4,000	24,000
Forebay building and foundations		15,000
Pipe: 518,000 lbs. @ 15¢ lb. installed		77,700
Upper ditch and reservoir		10,000
Auxiliary feed pipes, nozzles and sluices		10,000
Superintendence and engineering		5,000
Contingencies		15,250
		$210,000

The cost of working this ground depends principally on the cost of power for pumping, as previously discussed. Taking power at 2¢ per KWH, the cost per cubic yard will be 16.44¢. The complete estimate, based on a capacity of 5000 cubic yards per day for 120 days per season, is as follows:-



SKETCH SHOWING SECTION THROUGH PAY STREAK
DAGO HILL
Scale: Vertical 1 in. to 200 ft, Horiz: 1 in. to 600 ft.

Power for pumping,	16.44
Pumping attendance, supplies and repairs,	0.67
Piping and pitmen, repairs, etc.,	1.92
Sluices, attendance and repairs,	0.50
Bedrock cuts and tunnels,	2.00
Superintendence and General Expenses,	1.00
Total Operating,	22.53
Amortization of plant,	3.00
Total cost per cubic yard,	25.53

It will thus be seen that unless the gravels average a much better value than there is reason to expect, there will be no profit to the Dago Hill Mining Company in the operation. The charge for power goes, of course, to the Granville Power Company. This plant will have, undoubtedly, a large excess of power for some time which will be produced at practically no cost so that, if desired, the charge for power can be cut to almost nothing. In fact, the situation is that a division of profits from these gravels can be made between the Mining Company and the Power Company, for whatever the Power Company receives will be clear gain so long as it cannot sell its excess power at a better figure elsewhere.

Discovery Hill lies south of Dago Hill on the left limit of Last Chance Creek. The gravels on this hill have been extensively worked in recent years and there are probably but few hundred thousand cubic yards remaining. The work has been done with a small gravity water supply, available only in the spring and during heavy rains, but it is believed to be sufficient in amount to work out this hill

as soon as Dago Hill can be worked out at the rate proposed, and it is, therefore, believed inadvisable to incur the extra cost for pumping which the added head, due to the higher elevation of this hill (bedrock is 100 feet above Dago Hill bedrock) entails.

Treasure Hill lies above Discovery Hill and contains a small remnant of gravel which can be worked by the local water. Preido Hill lies opposite Discovery Hill on the right limit of Last Chance, and is believed to contain the continuation of the Dago Hill pay streak.

Dominion Creek.

The property on this creek is held by the Dominion Mining Company, and with but few exceptions, all the claims are owned or controlled.

The creek lies south-east of Dawson, rising on the easterly slope of the Dome and is one of the tributaries of Indian River which, in turn, discharges into the Yukon about 25 miles above the Klondike. It flows in a south-easterly direction for about 15 miles when its general course changes to south-west at the head of Dominion Flat, and in about 10 miles more it joins Australia Creek to form Indian River. Its average grade from Upper Discovery to the beginning of Dominion Flat is about 40 feet to the mile, varying in this distance from 70 feet per mile at the upper end to 24 feet at the lower end. From the upper end of Dominion Flat to the mouth the fall is but 18 feet to the mile. The average grade of the Klondike creeks, Bonanza and Hunker, are about 60 feet to the mile.

The water flowing in Dominion Creek is rather more in amount than in either of the Klondike creeks. During the dry season from 150 to 200 inches of water are said to flow at the mouth of Portland Creek, while during the spring freshets it will amount to several thousand inches. For dredging the supply is always ample at any point, and it is only where muck or other material is to be sluiced that more water would be of advantage.

Two discoveries were recognized on Dominion Creek. Upper Discovery is situated not far from the head of the creek, and Lower is located about half way between the mouths of Caribou and Portland Creeks, about four and one-half miles further down. At Upper Discovery and above, the creek gravels are but 200 feet wide or less and to the mouth of Caribou Creek the increase in width is very small. From thence down the width increases rapidly, attaining widths of 600 feet to Lower Discovery and below as high as 1,000 feet.

Throughout the major portion of the creek it is notable that the hills on the left rise more gently than those on the right. The left slope is occupied by gravels which mark the former bed of the creek and correspond in some degree to the White Channel gravels of the Klondike side. They are not, however, at any great altitude above the present bed of the creek, the elevation of the bedrock of the ancient channel being 30 to 40 feet above that of the modern channel. This ground is covered by the hillside claims. They have been extensively worked by open-cuts, and have been very productive. There are remaining, however, considerable volumes along the middle portion of the creek.

The overburden of Arctic muck on the Indian River creeks averages higher than on the Klondike creeks. All the ground was originally frozen and is so today where it

Dominion Creek: View from 4 above Lower Discovery looking upstream. Note piles of tailings and waste.

Dominion Creek: From 2 above Lower Discovery looking upstream Showing Virgin ground on 3 and 4 above Lower.

has not been worked. It is believed, however, that the major portion of the ground above 12 below Lower Discovery is thawed, for this portion of the creek has been extensively mined by drifting, and to some extent, by open cutting. At any rate, the surface is so covered with tailings and waste dumps that the removal of the muck previous to working is impracticable, and provision must be made to thaw such portion of the ground as is frozen by steam. Nothing has been done which will permit of giving an idea of the value of this ground. A large amount of prospecting of tailings and waste has been done, but owing to the irregular distribution of the material, no systematic sampling is possible. Lacking such a possibility, the nearest approach to accuracy is in multiplicity of samples. From 9, Below Lower Discovery, 178 rocker tests, each of 0.315 cubic yards, showed an average value of the tailings and waste, as given in Thorne's report, to be $0.324 per yard. 457 panned samples of 5 pans each showed an average value of $0.353 per cubic yard. As the latter were calculated on a basis of 200 pans to the cubic yard, the value is probably high, for 150 pans are generally considered to equal a cubic yard, and, furthermore, the material sampled was very loose. As this is a matter depending on how the pan is filled, however, the criticism may be unfounded. Gardner did a limited amount of work on this section of the creek. An average of 15 samples, 2 of waste and 13 of tail-

ings, taken between 15 below Upper to 75 below Lower, shows $0.39 per yard. I believe these values of waste and tailings do not differ materially from those of the waste and tailings on the Klondike creeks.

The proportion of unworked ground is very difficult to determine. Such ground as has been worked by open cut is very thoroughly cleaned but, as regards the creek gravels, but little of this has been done. Very rich ground that was worked by drifting has, no doubt, been pretty thoroughly worked, and it is doubtful if there is 10% of such ground untouched. Where bedrock was soft it was thoroughly cleaned where worked, but with blocky or fissile bedrock, it was not possible for the old operators to extract sufficient bedrock to get all the values. Hence in such ground, which was also the richest, considerable gold can, no doubt, be recovered by cutting deep into bedrock. Where the ground was low grade no doubt fully half of it was left standing. Probably throughout the area of the creek worked there is remaining today 25% of the gravels in virgin condition.

But this does not necessarily mean that they contain 25% of the original values. Such virgin ground as is left is undoubtedly of lower grade than the original average, so that the proportion of original values is undoubtedly much less than this. There seems to be no accurate knowledge of the value of this ground. Gardner took a few samples from

old shafts and cuts, and the average of nine samples taken above 56 B. L., eliminating two which showed values of $20 and $54.50 respectively, was $4.15 per yard. Values approximating this are shown by Thorne when his lines of shafts crossed what was apparently the pay streak, so that, for purposes of estimate, the virgin gravel still standing may be estimated at $4.00 per yard.

The proportion of muck and gravel in the upper part of the creek does not appear materially different from that reported by Thorne for the middle portion which he sampled, i.e. 2.5 of muck to 1 of gravel and bedrock. The bed of the creek where the water runs constitutes a very much larger proportion of the area of the creek gravels than below, however, and as there is no muck where the creek flows, this circumstance will reduce the proportion of muck throughout the total, so that, for purposes of our estimate, it may be taken at 2 of muck to 1 of gravel. As the muck is very largely covered by waste and tailings it is impossible to consider any means of moving it other than by dredge, so that of 100 yards of material moved, 66.7 cubic yards will be muck. Of the 33.3 yards remaining, 25% represents virgin ground in place or, say, 8.3 yards, and the balance, 25 cubic yards, consists of waste and tailings. At the values estimated, a determination of the average

Dominion Creek: From 71 B. L. Looking Down Stream to Dumps on 75 to 79 inclusive.

Dominion Creek: Creek Bed at 65 B. L. Showing muck banks of creek.

Dominion Creek: From 11 Below Lower Looking Upstream Showing Worked Hillside Claims on Left Limit.

Dominion Creek: From 17 B.L. Looking Upstream Showing Virgin Hillsides on Left Limit.

of the whole is as follows:-

8.3	cubic	yards	virgin ground @ $4.00	$33.20
25.	"	"	tailings @ $0.30	7.50
66.7	"	"	muck, no value,	
100.	cubic yards, total value,			$40.70

Average value per cubic yard material dug,- 40.7 cents.

There is another way to consider the value of the virgin ground in this part of the creek, and that is by reckoning back from the values shown in the tailings. A great deal can be heard regarding the proportion of gold recovered by the original miners, estimates varying from 75% to 90%. Now, when operating in the upper portion of the creeks, it seems to me that the recovery must have been high for the gold was, mostly, very coarse and, granting that but one or two boxes were used for sluicing, it was easily saved. I think the crudest kind of sluicing would be apt to save at least 90% of the gold, and what was lost would be pretty fine. Assuming that the tailings values quoted by Gardner represent the average, viz:- 30 cents,- the original ground must have carried $3.00, and this is supported by similar values reported by Thorne, although he does not specify whether a sample is of waste or tailings. Altogether, I think the foregoing estimate as close as can be made with the data at hand. For accurate knowledge, an extensive campaign of drilling is necessary, but the knowledge seems

to be sufficient to warrant the installation of one 7-foot dredge immediately. This may be considered an experimental installation to be followed by one or two others on this portion of the creek if desirable. With the costs of the Yukon Gold Company in mind, viz:- 31 cents per cubic yard including the cost of thawing, I think with the cheaper power and cheaper fuel available to the Granville Company, thawing and dredging costs would not exceed 25 cents.

On the middle portion of the creek, from Portland Creek down to 95 B. L. B., the proportion of creek gravels worked is small and but little tailings lie on the surface. Thorne reports the proportion of muck to gravel in this section as 2.5 to 1, and as all the ground is frozen, were it necessary to thaw all by steam, there would be little or no profit in the operation. The value per cubic yard given by him refers only to the gravels, and does not include the muck, so that if it be necessary to dredge the whole at a cost of 25 cents, thawing included, the 3.5 cubic yards necessary to dredge to recover the values contained in one cubic yard of gravel, would cost 87 cents while the yard of gravel would yield but 76.7 cents, which is the value reported by him. It is therefore apparent that some other method of working is necessary in order to extract the gold at a profit.

This portion of Dominion Creek is wide and of gentle

Dominion Creek: Bank of muck in Stream on 2. B. L.

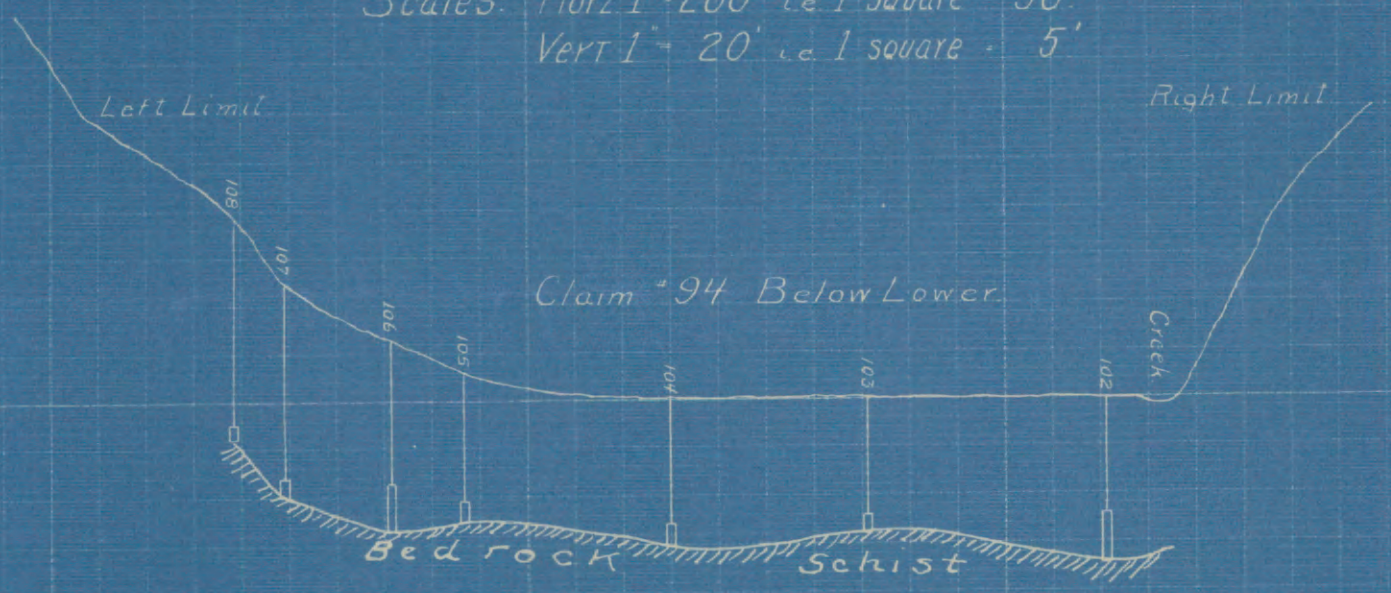
Dominion Creek: Valley Upstream from 3 Below Lower Discovery.

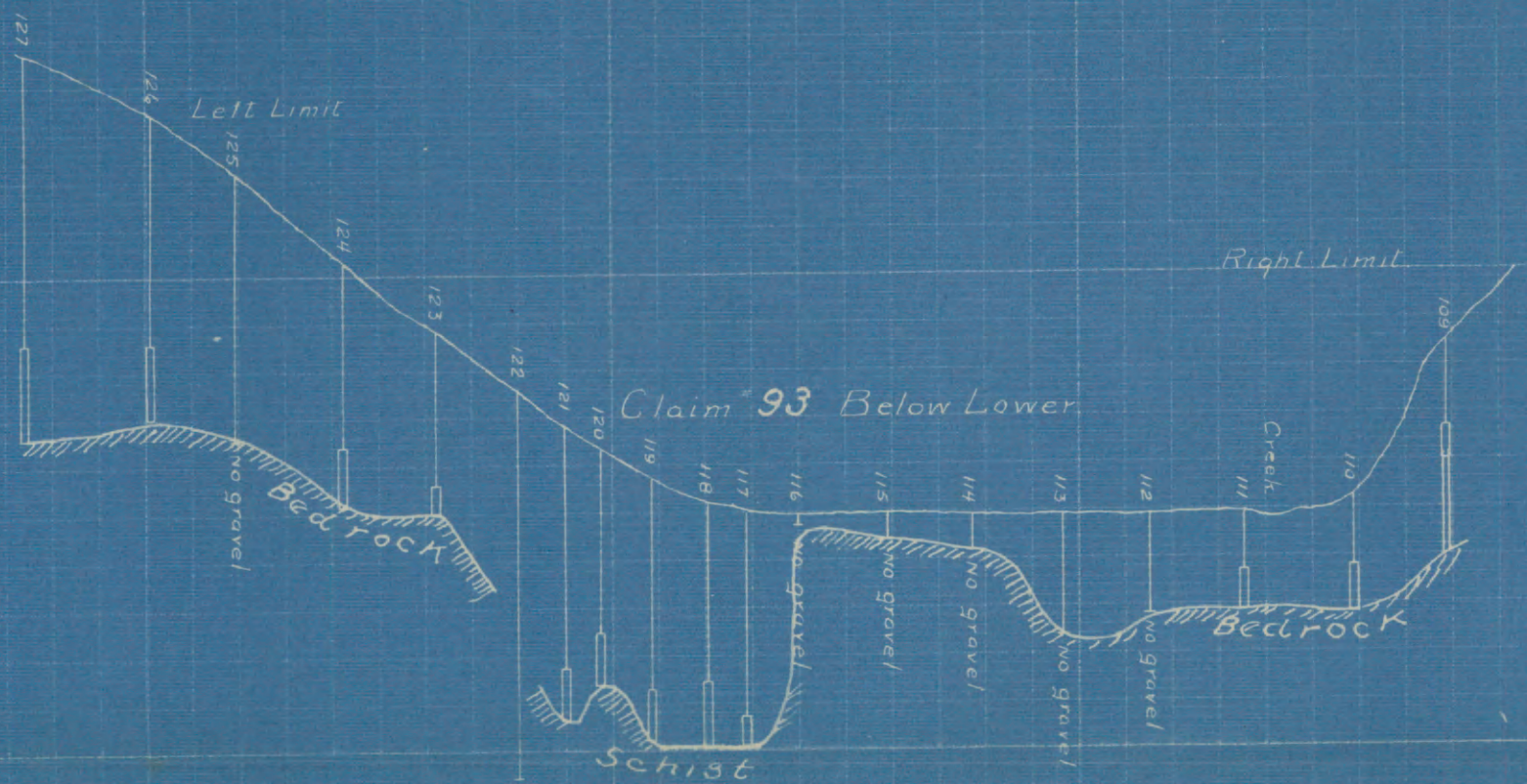
slope. On the right limit the hill rises abruptly as shown in the accompanying sections while the rise on the left is gentle. It is on this latter side that the ancient channel of the creek lies, and the bedrock is generally much higher than under the present bed. A large portion of the ground is unworked, and it is believed that the greater portion of the heavy overburden of muck can be removed by ground sluicing. The photographs give an idea of the character of the valley.

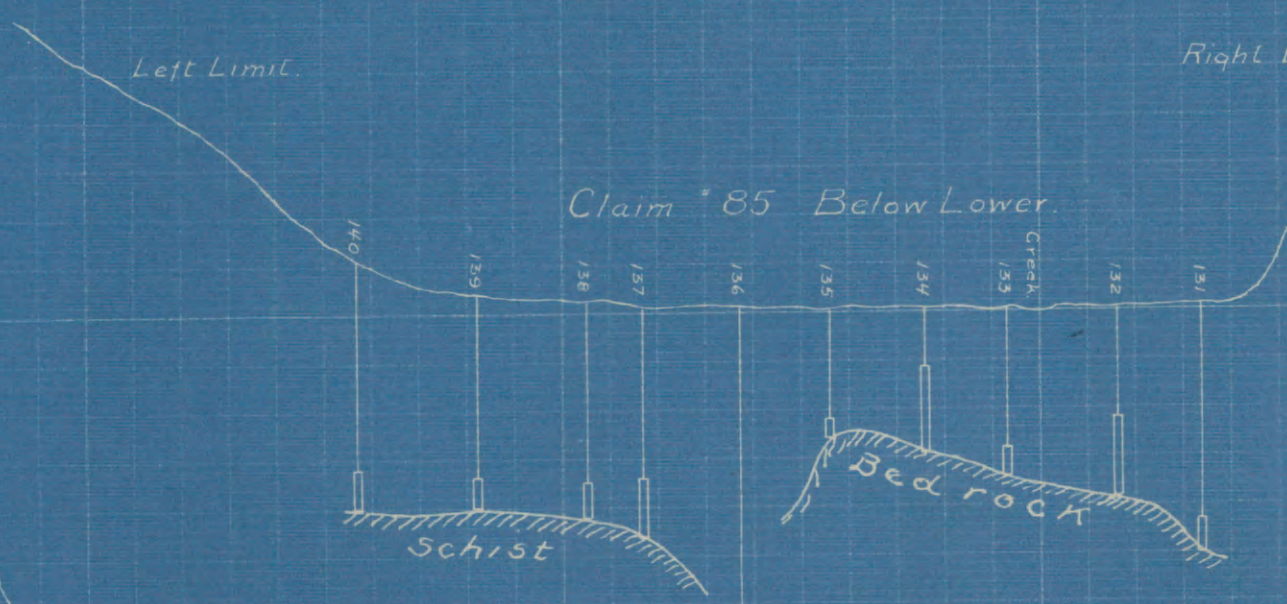
The ground sampled by Thorne, extending from 17 B. L. to 94 B. L., is approximately five miles in length. It contains 477 acres, or about 100 acres per mile. On the basis of his figures, there are approximately 1,000,000 cubic yards of gravel and 2,500,000 cubic yards of muck to each mile. In preparing to work this ground, I would recommend that it be treated in mile sections. Starting with the lowest section, a diversion ditch should be taken out of the creek at a favorable point about 85 B. L., and from it new channels started down the valley. At the same time, channels at right angles should be fed from the side ditches, the procedure to be followed having already been outlined. It will, in all probability, require three seasons to remove three quarters of the muck which, it is believed, can be economically handled in this manner. After the first season's work on the lowest section, however, work on the next section can be started, and

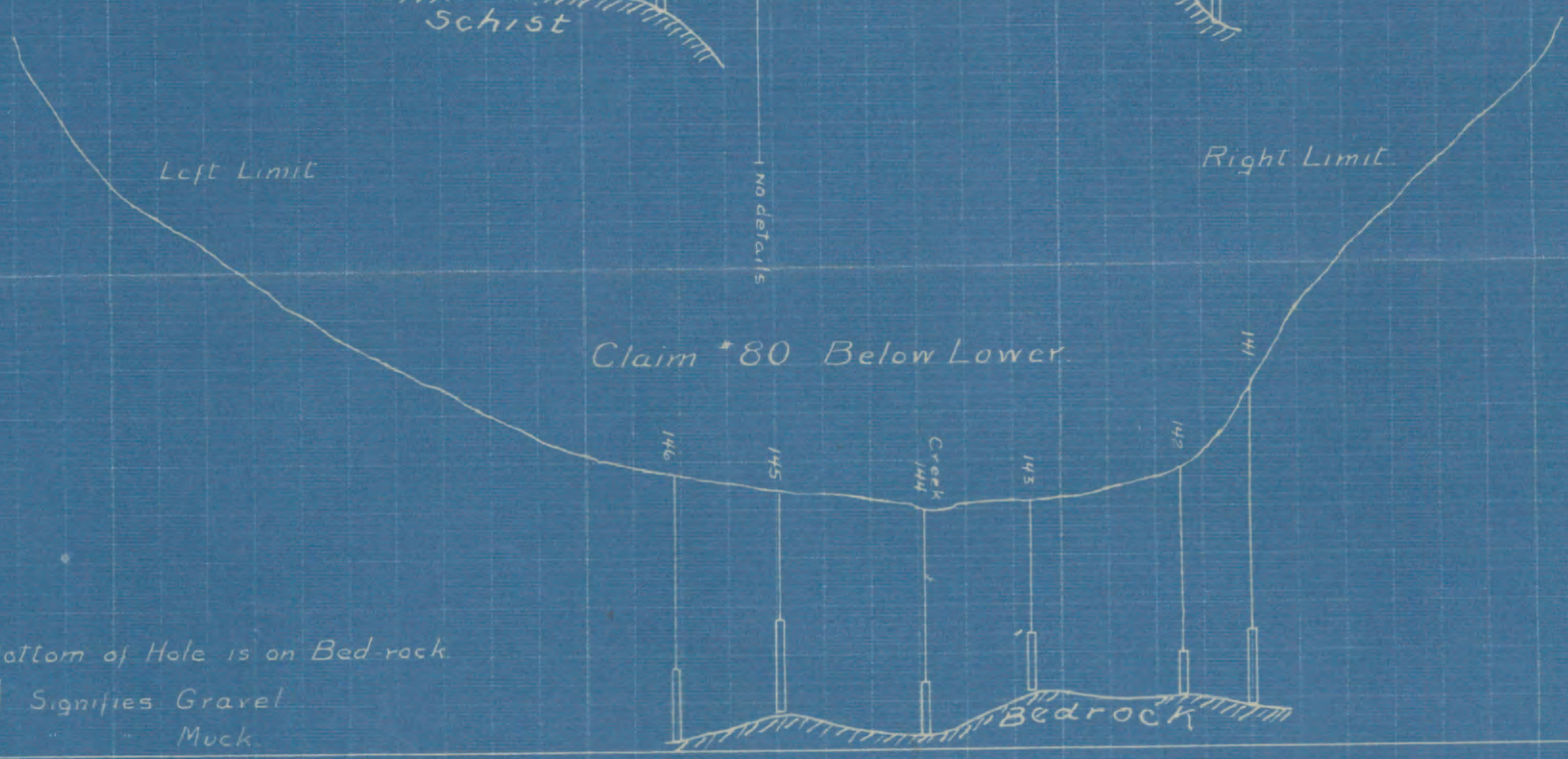
Cross Sections of Dominion Creek.

Scales: Horz 1" = 200' i.e. 1 square = 50'
Vert 1" = 20' i.e. 1 square = 5'









Bottom of Hole is on Bed-rock.
[] Signifies Gravel
! " " Muck

probably more rapid progress can be made as experience is gained.

To judge of the probabilities of performing this work, it can be safely assumed that, below Portland Creek, the average over a six month season will be 300 miner's inches. This is equivalent to 4,300,000 cubic yards of water per season. Of the material to be moved, viz:- 2,500,000 cubic yards,- one half is water, and we aim to move one half the balance or one quarter of the whole, say, 625,000 cubic yards. If the water will carry one tenth its volume of this material on these grades, which it will, quite possibly, do, it can remove double this quantity of material in three seasons. No data exist, however, to indicate what the water will carry, and it would be of assistance in estimating to determine this factor.

The result of this operation will be to leave on top of the gravel an irregular layer of sand and coarse silt which will, presumably, be thawed. If the cost be taken at 5¢ per cubic yard, the total expense incurred in stripping the mile section will have been $94,000. The remaining overburden will average about four feet in thickness, which added to the average depth of the gravel, will make the depth to be dug 11 feet. The gravel below will probably have to be thawed by steam. If these expectations be realized, a dredge could be installed the latter part

of 1914.

The total cost per cubic yard of gold bearing gravel can, then, be estimated as follows:

Removal of 1.9 cubic yards of muck 5¢	9.5¢
Digging 0.6 cubic yards thawed overburden @ 13¢	7.8
Digging & thawing 1 cu. yd. gravel @ 25¢	25.
Total cost per cu. yd. gold bearing gravel.	42.3¢

Of course, it must be understood that this attempt at an estimate is made without any practical results whatever as a guide. The dredging cost can, in the light of previous expereince, be realized, while the cost of thawing on Dominion with cheap fuel should not exceed 12 cents. The principal doubt is as to the muck, and I am inclined to think that the figure given is well within the probabilities. Until some definite, well-planned work is carried out, however, it is impossible to give any assurances, but the promise of success is excellent, and work should be started at the earliest possible date.

Some of the gravels in the old channel probably lie too high to be easily reached by dredge. An idea which suggests itself is to pick these up by steam shovel and place them on the creek gravels so that the dredge can work through them as it digs the ground in place. This would save the difficulty of a stationery washing plant and, if the ground can be thawed naturally, as seems quite possible

over a long face, this would probably be the cheapest method of handling it.

Data regarding the ground, its depth and value, are too limited at present, to be able to formulate more than the general plans outlined above. In the 477 acres from 17 B. L. to 94 B. L. 85 holes have been sunk in ten rows. This is only preliminary prospecting and any work based on such meagre data is likely to go wrong. The ground should be drilled, and besides the data heretofore recorded, the elevation of the collar of each hole should be determined so that sections of the valley can be drawn.

Quartz Creek.

The claims on this creek are held in the name of the Calder Mining Company.

The creek rises southwest of the Dome, and flowing in a southwesterly direction, discharges into Indian River as may be seen on the map. Rising at an elevation closely approximating the source of Dominion and Sulphur Creeks, it reaches the Indian River much more directly so that the grade is much heavier. The average fall from Little Blanche Creek to the mouth of Quartz Creek, a distance of approximately five miles, is nearly 70 feet to the mile. It is in this portion of the creek that the majority of the claims owned by this company lie. The valley here averages about 600 feet in width.

This portion of the creek has been prospected by shafts and averages 73 cents per cubic yard of gravel which is reported to be about 9 feet deep and overlain by 35 feet of muck. Thorne's report shows in a continuous block from claims 26 to 36 inclusive, 1,100,000 cubic yards averaging about $1.10 per cubic yard, but as two claims are taken at what is probably an excessive valuation, it is believed that the average yield would be nearer the figure given above.

Conditions on this portion of the creek are quite

Quartz Creek; View of Valley from 33 Below.

Quartz Creek; Hydraulicking Muck along New Channel.

similar to those on Middle Dominion. For every foot of gravel there are 1.7 feet of muck, and it becomes desirable to remove as much of this muck as possible by ground sluicing. It is on this creek that, as already mentioned, a start has been made by changing the course of the stream and a new channel has been cut for approximately a mile in length and perhaps an average of fifty feet in width. Probably upwards of 100,000 cubic yards of muck have been removed by this procedure but, unfortunately, since the creek cut to gravel, it has been allowed to remain there, and as I understand that practically all the cutting was done early this season, considerable time has been lost.

What has heretofore beensaid with respect to Dominion Creek costs applies here. In the block of claims referred to, viz:- 26 to 36 inclusive, the aggregate area of which is 77 acres,- it is estimated that there are 1,900,000 cubic yards of muck, three quarters of which, or 1,400,000 cubic yards, can be removed at a cost of 5 cents per yard, or $70,000. The remaining 500,000 cubic yards will constitute something less than an average of four feet overburden on the gravel, which will make the dredging depth 13 feet. The total cost per cubic yard of gravel will, therefore, figure as follows:-

11.6 cubic yards of muck @ 5¢	0.58
3.8 " " " overburden @ 13¢	.494
9. " " " gravel @ 25¢	2.25
Total cost on 9 cubic yards of gravel	$3.324

or 37 cents per cubic yard, leaving a probable profit of $0.36 per cubic yard.

The steeper grade on this creek should render the water capable of carrying more material per inch than on Dominion Creek. However, the quantity of water available is very much less, and probably the available flow will not average more than 100 inches throughout the season, so that, in spite of the increased grade, the time required to clear this ground will probably be about the same as that required for Dominion, so that a dredge can be installed here in 1914.

The future of the creek depends a great deal on the success had in acquiring more ground, as the balance of the property appears to be in small blocks interspersed with claims of other ownership. From claim 36 to the mouth of the creek there is no doubt excellent dredging ground, and while some of these claims are in possession of the company, there are others that are not.

Sulphur Creek.

The claims on this creek are owned in the name of the Sulphur Mining Company.

The creek rises on the south side of the Dome, between the sources of Dominion and Quartz Creeks, and flows in a southeasterly direction a distance of about 20 miles to empty into Indian River. From Discovery down stream about four miles the grade is about 50 feet per mile and thence to the mouth the fall is but about 25 feet per mile. The valley is very wide near the mouth of the creek and would constitute an excellent dredging proposition if the ground is rich enough. Little information regarding it appears available. The proportion of muck to gravel is reported as less than on either Quartz or Dominion Creeks. Little prospecting has been done apparently, but undoubtedly there is a great extent of pay ground in the creek as former production was very heavy.

The claims so far owned by the company are few in number, and exist in scattered blocks of, at most, four claims and, until more property is acquired, there does not appear to be anything to do with the ground, as the procedure would be the same as that recommended for Dominion Creek.

Other Property.

Besides the foregoing property there are some claims in scattered blocks on Eldorado Creek in the name of the Deepvale Mining Company. Most of this property is located a considerable distance up the creek where the grade is steep and the gravel narrow. The conditions, therefore, are the least favorable for dredging of any of the creek properties, and it would probably be advisable to attempt a small experimental shovel installation here. The details have not been given careful consideration as yet for considerable surveying will be necessary. There is, furthermore, a good deal of muck sluicing to be done before any work can be started. This should be commenced next spring, and it is probable that a shovel plant could be started the following season, i. e., 1913.

The Big Creek Mining Company owns a large number of creek and hillside claims on Lower Dominion Creek and Granville Flats. The creek claims will probably be worked in a manner similar to the ground on Middle Dominion, but with respect to the property as a whole, no definite study has been made.

Granville Power Company.

This subsidiary owns a power plant located on the north fork of the Klondike River. It is situated at a distance of about 27 miles from Dawson and reached by a wagon road that is, for the most part, excellent. The plant has been thoroughly described in the report by J. G. White & Co., and although construction was only just begun at the time the report was made, the plant has been finished substantially as described in the report.

The first unit was put into commission about May 1st, 1911, and power has since been furnished regularly to the Canadian Klondike Company. Owing to failure to receive the sub-station meters specified to be installed by the contract with them, the Yukon Gold Company refused acceptance of service on May 15th for the period to May 31st, but on August 10th began receiving power, and has since then received power continuously. The total output of the plant under these conditions is about 2250 KW, on the average, of which the Canadian Klondike Company takes 750 KW and the Yukon Gold Company 1500 KW. The probable output for this season will be between five and six million kilowatt hours.

The capacity of the plant is, at present, limited by the size of the ditch, for while the two wheels are probably capable of an output of 7,000 KW, the ditch was con-

structed to carry sufficient water for but about 5,000 KW. The original plans called for a ditch carrying 7 feet depth of water, and 5 feet were excavated by shovel, the intention being to finish the excavation to 7 feet by means of a floating dredge while the plant was in operation. The dredge has been purchased and is on the ground but it has seemed inadvisable to put it to use at the present time as the capacity of the ditch is much above present requirements. Furthermore, the water has materially increased the section of the ditch in a great many places so that more water is flowing than the original dimensions would imply. Preparations for measuring the flow were being made during the latter part of the summer, and with the results of these measurements, decision as to dredging can be made. If dredged it will probably be advisable to widen the ditch into the upper bank without disturbing the bottom which is constantly improving in condition with use.

Much trouble was anticipated in maintaining the lower bank against the erosion of the water. Parts of the ditch are dug through muck which offers little resistance to erosion as soon as the ice which it contains is melted. Notable success, however, has been attained by the management in maintaining the ditch, but only at the cost of constant watchfulness, and several breaks have been narrowly averted. For greater security, the lower bank has

been protected by a mattress woven of spruce sapling, and it appears now to be very secure. As an additional precaution, it is the intention to plant willows, also.

The installation of the pipe lines has been carried out somewhat more elaborately than originally planned, but nothing has been done that will not serve a useful purpose. The anchorage provided was found to be inadequate, and has been made more secure, while instead of simply covering the pipes with gravel they have been enclosed with frames which have been lagged with poles and covered with moss before finally covering with gravel. Another feature is a drain below each pipe which removes all seepage so that, with the insulation afforded by the well protected air space, the danger of freezing is reduced to a minimum.

The installation of the second unit was completed in August, and all the apparatus is running satisfactorily with the exception of the wheel governors. These "hunt" badly, and in consequence, have to be regulated by hand. The question of their operation is being taken up with the manufacturers. In other respects the plant operates satisfactorily, and has the remarkable record of operating without lost time from the start to August 9th, when a short circuit caused a short stop.

The transmission line to Bear Creek, that which

supplies the Canadian Klondike and the Yukon Gold Companies, has been in operation all summer without trouble. That to Dominion Creek is completed to the top of the divide at the head of Lombard Gulch. It will require about 8 miles additional line to deliver power to a sub-station located about at Lower Discovery. Until,plans for work on this and the other Indian River creeks are more definitely formulated, no definite statement as to extensions can be made.

The revenue from the operation of the plant this year will not be, probably, quite as much as was expected by J. G. White & Co. This is mainly for the reason that no service will be rendered to the Granville Mining Company subsidiaries, and there will also be a question with the Yukon Gold Company as to their liability for the minimum payment specified by their contract. In all probability their consumption of power will figure less than their minimum payment, and I judge it is their intention to question their liability on the grounds that, owing to lack of meters, the Granville Company was not ready to deliver power on May 15th. Their probable consumption is 2,300,000 KWH which, at 3 cents, amounts to but $69,000 as compared with $85,000 guaranteed. The Canadian Klondike Company will have taken probably 3,250,000 KWH for the

season. Expenses of operation are estimated to be $40,000, which is a great discrepancy from the estimate of J. G. White & Co. The difference lies very largely in the maintenance of ditch for which they allowed very liberally. We therefore see

Income from sale of 2,300,000 KWH's to Yukon Gold Co. @ 3¢,		$ 69,000
Income from sale of 3,250,000 KWH's to Canadian Klondike Co. @ 2¢,		65,000
Total Income,		$134,000
Operating expenses,	$40,000	
Amortization,	30,243	
		70,243
Net Earnings,		$ 63,757

Amortization is figured to retire $1,000,000, the total estimated cost, in 20 years, interest being figured at 5%. On the basis of the above cost and output the cost per KWH, not including interest on the investment, is about 1.3 cents.

The question of profits in later years is difficult to estimate accurately, but some idea may be gained by remenbering that, in dredging, which will be the method by which the bulk of the gravels will be worked, about one KWH is required to dig one cubic yard. Outside of the Yukon Gold, from which a higher rate is received, the Power Company receives 2 cents per KWH. Next year, the Yukon and Canadian Companies will probably dig between them seven million yards, while it is possible that the Granville subsidiaries can move 500,000. Probably by 1915

ten million yards per season will be dredged, so that a gross income of at least $200,000 per year may be expected. Deducting the estimated operating cost of $40,000, which, by the way, is likely to decrease, leaves a net operating income of $160,000 per year.

The question of the life of the business is dependent on the continuation of the mining business of the district. The Canadian Klondike operation bids fair to extend over a long period, although it depends, of course, on the rate at which it is worked. It would seem perfectly safe to expect, however, that it has a life of twenty years. The life of the Yukon Gold operation is stated to be fourteen years although, with respect to the ground now held, this estimate would appear to be high in consideration of the rapid rate of extraction. They may, however, by the purchase of other property, realize this life or extend it materially. The life of the Granville properties is difficult to estimate, partly because of the proposed method of working, and partly because of the incomplete character of some of the holdings as, for example, on Sulphur Creek. On the Indian River and tributary creeks, there are large areas of gravel which are likely to require from ten to twenty years to work out, depending largely on the success had in working them by the proposed methods and in getting together the property in some other instances. It is believed that there is dredging ground

along the upper Klondike, and there is also a possibility of furnishing power for dredging on the Stewart River and, possibly, the Yukon. As previously indicated, it appears doubtful that it will pay to pump water for hydraulicking the White Channel gravels if power must be paid for at 2 cents per KWH. Whenever the power plant has an excess of power available, however, the Power Company can well afford to sell power for a lower figure for such service can be furnished without additional operating expense. In view of the probability of such excess existing, this is likely to come about, so that some revenue can, no doubt, be obtained from this source. Dago Hill,- on the assumption that it contains six million cubic yards of pay gravel and that it be worked at the rate of 600,000 cubic yards per season,- will show a ten year life, while there are other hills that will also, no doubt, be afterwards worked by pumping. These operations will not, however, add to the life of the power plant. This must depend on the dredging operations and, from the information I gathered, I should judge there was a good possibility of occupation for the plant for twenty years.

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