REPORT ON THE

LOOKOUT GROUPS OF COPPER MINING CLAIMS

AT NIBLACK ANCHORAGE, ALASKA

consisting of

I. A Compilation of the Data submitted on the property and existing conditions.

II. Future developments justified.
This thesis is respectfully submitted to the Faculty of the Massachusetts Institute of Technology in partial fulfillment of the requirements for the degree of Bachelor of Science.

by:

______________________

______________________
ACKNOWLEDGMENT

We wish to express our gratitude to Professor W. Spencer Hutchinson, Professor Charles E. Locke, Vernon T. Wakefield, Arthur A. Wakefield, and Catesby W. Taylor for their interest in this work, and for the many helpful suggestions they have given to us.
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LETTER OF AUTHORIZATION

Milwaukee, Wis.

January 1, 1923.

Messrs. T.M. Taylor and B.P. Lane,
Massachusetts Institute of Technology,
Cambridge, Massachusetts.

Dear Sirs:

The G.M. Wakefield Mineral Land Company
is the present owner of property situated at Niblack
Anchorage, Alaska. This property was leased to the
Niblack Anchorage Development Company and was mined
by them from 1904 to 1908, but since that time no
further work has been attempted.

The title of said property has reverted to
us, and it is our intention to reopen operations
either ourselves or thru an operating company. With
this in mind, the present owners request that you sub-
mit to them, not later than June 5, 1923, a report on
the possible future development which you believe
justified under the existing conditions.

Realizing that it is impossible for you to
make a personal examination of this mine, I am enclos-
ing, herewith, all the information which I have at
hand concerning the above property and desire that you base your report on this information, together with any other reliable information which you may be able to obtain.

Very truly yours,

[Signature]

General Manager.
May 30, 1923.

G.M. Wakefield Mineral Land Co.,
Milwaukee, Wisconsin.

Dear Sirs:

We are today forwarding to you the enclosed report as requested by you in your letter of January 1, 1923.

We hope that you fully realize the situation under which the report was written, and wish to emphasize the fact that our report is based on second hand information, according to your instructions, and that we cannot, therefore, assume the responsibility for the assumptions on which the report is based. Therefore, we have compiled a composite report of the information submitted to us and our recommendations are based entirely on the information contained therein.

We trust that this report will meet the needs of your company.

Very truly yours,

T. M. Taylor

Benjamin P. Lane
RECOMMENDATIONS

On the basis of the accompanying report we submit the following recommendations to the G. M. Wakefield Mineral Land Company concerning their mining claims at Niblack Anchorage, Alaska.

We recommend that no attempt be made to operate the Niblack Mine under present conditions and prices.

We recommend the serious consideration of operating the Niblack Mine when the price of Electrolytic copper in the New York Market averages nineteen cents per pound.

We further recommend that since it is probable that the average price of copper will be nineteen cents per pound within a period of ten to fifteen years that the G. M. Wakefield Mineral Land Company investigate more fully the size of ore reserve on its property at Niblack Anchorage and the possibility of generating sufficient power on their property.

We further recommend that samples of the Niblack ore be tested by the differential flotation
process to ascertain the behavior of the ore under this method of treatment.

We recommend that, if the above tests are satisfactory, and if the conditions for profitable extraction of the Niblack ore arrive, that the chalcopyrite be separated from the pyrite and gangue material by the differential flotation process, and that these concentrates be shipped to Tacoma for smelting.
PART I

A COMPILATION OF THE DATA
SUBMITTED ON THE PROPERTY AND
EXISTING CONDITIONS
PART I

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SITUATION

Niblack Anchorage is located in the Ketchikan Mining District, on the Southeastern coast of the Prince of Wales Island (Area 2,800 sq. miles), in southern Alaska, and is twenty-five miles southwest of Ketchikan and thirty miles distant by water. Niblack Anchorage is a small embayment and harbor two miles in length, with sufficient water for the largest ships. The entrance is but one hundred yards wide and opens in Moria Sound on the southeast. Part of the Lookout Claims fronts on the harbor and affords an excellent wharfage.

Ketchikan, an incorporated town of about 2,500 population, is the closest source of supply. It is located on the coast, approximately 600 miles from Seattle, Washington, from which point it is reached by several fleets of steamers. It is the first port of entry for Southeastern Alaska, and has a cable connection with Seattle, Washington, and an established United States Post Office.

Niblack Anchorage may be reached from Ketchikan by small packets. In any case it would be desirable for the mining company to own a small
gasoline launch by which it could maintain communication with Ketchikan very easily.

**TOPOGRAPHY**

Niblack Anchorage is surrounded by well timbered mountains which rise abruptly from the waters edge to altitudes of 2,000 to 2,500 feet. A broad valley extends Northwestward from the head of the bay and is occupied by two small lakes, the lower, Myrtle Lake, being 94 feet above sea level and 122 acres in area, while the upper lake, or Niblack Lake, is 450 feet high and 363 acres in area.

The mine is located about one half a mile southwest of the foot of Myrtle Lake where the ground rises gently from tide water. Between the mine and the harbor there are a few acres of fairly level but very rough ground which gives ample room for a smelting plant while the steeper slopes offer excellent facilities for a concentration plant.

Southeastern Alaska is characterized by mild winters, cool summers, and heavy precipitation, which is greatest at points exposed to the sea and diminishes somewhat inland. Nearly all the precipitation below an elevation of 500 feet is in
the form of rain. Most of the rain falls between the first of September and the last of January, though the amount varies greatly from year to year. The season of least rainfall is generally from April to July.

The temperature throughout the year is mild, the thermometer rarely falling to zero Fahrenheit at the lower elevations. The snow is heavy in the mountains but near sea level not more than a few inches fall at a time during an ordinary winter and this soon disappears.

The meteorological reports show that the climatic conditions in the Ketchikan district are favorable for the development of mining enterprises. The abundant precipitation is rather trying to those who are accustomed to a more arid climate, but this rainfall, though a drawback to the prospector, does not interfere with the mining operations. In fact it is an advantage as it furnishes considerable water power which may be utilized by the mining enterprises. Except at high altitudes, snow does not interfere materially with transportation or mining. The harbor at Niblack is closed for a period of two to three months during the winter but can be kept open very easily with the aid of a small launch.
Southeastern Alaska is mostly forested, but the portion covered with marketable timber is small. The most abundant tree is the hemlock, while the spruce is found also widely distributed throughout the region. On account of its low shearing strength the spruce is not suitable for mining operations but the hemlock may be used, and in fact is used for ore bunkers, bins, and supports. There is an abundance of good timber on the Lookout Claims which may be used for buildings, dams, and mining operations.

**GENERAL DESCRIPTION OF DISTRICT**

The Ketchikan Mining District is the most southerly mining district of Southeastern Alaska. It is separated from the Wrangell Mining district on the north by Sumner Strait and Earnest Sound and extends eastward and southward to the Canadian Boundary.

During the Russian occupation of Alaska, little attention was paid to its mineral resources. Gold was discovered in 1861. It is said that deposits of copper were discovered in the Prince of Wales Island between 1870 and 1874 but little attention was paid to them. In 1892 gold was found in
the Ketchikan district and in 1897, during the Klondike excitement, some development work was begun.

In 1899 the Niblack Anchorage properties was discovered and shortly after were sold to the present owners the G. M. Wakefield Mineral Land Company. This company leased the property to the Niblack Development Company which worked the property from 1903 to 1908. Since that time no appreciable work has been done on the property.

Continuous working of some of the properties of the Prince of Wales Island has been carried on, however, while other properties have recently been reopened. The output of the Ketchikan mining district during the years 1915, 1916, 1917 (latest obtainable) was, according to the United States Geological Survey Reports, as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Ore Mined Tons</th>
<th>Copper Pounds</th>
<th>Gold Fine Oz.</th>
<th>Silver Fine Oz.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1915</td>
<td>50,997</td>
<td>1,728,182</td>
<td>1,727.88</td>
<td>11,666</td>
</tr>
<tr>
<td>1916</td>
<td>76,111</td>
<td>2,526,703</td>
<td>2,769.61</td>
<td>19,361</td>
</tr>
<tr>
<td>1917</td>
<td>41,768</td>
<td>2,643,543</td>
<td>2,545.71</td>
<td>20,218</td>
</tr>
</tbody>
</table>

Theodore Chapin in Bulletin 692, pages 85 to 89 inclusive reports the following activities on the Prince of Wales Island during the year 1917 (latest obtainable).
"The Granby Consolidated Mining, Smelting & Power Co. (Ltd.) were the largest operators in the vicinity of Kasaan Bay. The Mamie mine, which was taken over by the Granby Co. in 1913, was closed down in the spring, and work was increased at the It mine. The ore bodies at the It occur in limestone near the contact of a large intrusive mass of quartz diorite and appear to have formed along the borders of an older dioritic dike now largely altered to epidote and other secondary minerals. The ore occurs as bunches of chalcopyrite in the altered dike and in the garnet rock formed by the replacement of the limestone. The power plant at the beach is equipped with a coal-burning boiler and air compressor. During the summer of 1917 a geologic map of the vicinity was made and prospecting was carried on which has led to the discovery of other surface outcrops.

The Goodro mine near the head of Kasaan Bay changed hands during the year and is now operated by the Salt Chuck Mining Co. No production was made during 1917. Development work was carried on, and a flotation mill that was started in the spring was completed before the end of the year. The mill is situated on the edge of the Salt Chuck. The ore is trammed from the mine to the mill, dumped into bins,
passed over a grizzly into a crusher, and conveyed to a 75-ton bin, from which it is automatically fed to the ball-mill (using four sizes of chilled steel balls), whence it is taken by a bucket conveyor to the flotation tank for treatment. Mixtures of pine tar and creosote will be used. The fines are frothed off and go to settling tanks. A scraper belt conveys the coarse ore and gangue on bottom to a trommel. The oversize from trommel goes to the mill, and the undersize to a Deister-Overstrom table, where the ore is separated from the gangue. The capacity of the mill is 60 tons a day. The ore bodies are in gabbro, and the ore minerals are essentially bornite and chalcocite and lesser amounts of other copper sulphides. The ore also carries gold and traces of platinum and palladium. Mine assays of the concentrates show copper content as high as 81 per cent, indicating the presence of some native copper.

The Rush & Brown mine near the head of Karta Bay was operated on about the usual scale. The mine is developed on two lodes, a contact deposit of copper-bearing magnetite and a shear zone mineralized with copper sulphides. The new working shaft on the sulphide ore body has been deepened to the 350-foot level
and drifts extended each side of the shaft. At the foot of the shaft is an ore lens from 2½ to 3½ feet wide composed of high-grade chalcopyrite together with a little pyrite. The entire width of the ore body at this level is not evident but in the upper levels it is from 4 to 14 feet and carries lenses of ore from 2 to 4 feet wide. The magnetite ore body is a contact deposit occurring along the border of intrusive diorite and altered sediments. It has been developed by a glory hole 100 feet deep and by workings on the underground levels for 250 feet in depth. In the fall of 1917 a boiler for a compressor plant was being installed.

The Paul Young prospect is about a mile southwest of the Rush & Brown mine on the first stream west of Iron Creek, at an elevation of 100 feet. It is about three-quarters of a mile northwest of the Venus claim and 2 miles from the coast. The deposit occupies a shear zone that strikes northwest nearly parallel to the stream and is exposed along the northeast bank. The only work done is surface stripping along the stream. The country rock is black slate, and the ore occurs in calcite veins that follow an intrusive porphyry dike. The slate is impregnated and veined with these sulphides. The width of the
deposits is not evident, but they appear to extend beneath the creek bottom. The water was turned from its course for a short distance to uncover the deposit in the creek bottom, but the exposed rock is again covered with gravel. The deposit is exposed in the creek bank 250 feet lower down. Here the black slate is impregnated with pyrite and chalcopyrite which accompany tiny reticulating quartz veinlets.

The Rich Hill group of claims, comprising the Rich Hill, Magnet, Buffer, Ouray, Interval, and Red Snapper, has recently been opened up and is now being developed by the Granby Co., who have the property bonded. The claims are on Kasaan Peninsula, about 2 miles southeast of Kasaan. The main workings are on the Rich Hill claim and are confined to a single lens of very rich chalcopyrite ore. This lens was opened by a cut 50 feet long and 20 to 30 feet deep and yielded 160 tons of ore, which brought $20,000. The mineralized zone can be traced northwest and southeast of the open pit for some distance, and a short adit is now being run to cut the deposit below the floor of the open cut. On the adjoining claims prospecting has been carried on and a number of mineralized lodes have been opened. On the Ouray claim a wide contact
zone extends from the beach to an elevation of 450 feet. The rock of this zone is a garnet-epidote-magnetic contact rock that carries chalcopyrite. Several openings have been made, which disclose bodies of commercial ore.

South of Karta Bay and northwest of Twelve-mile Arm, including the vicinity of Hollis, is a mineralized area in which gold lodes predominate. The country rock is a complex assemblage of igneous and sedimentary rocks. The bedded rocks include tuff, breccia, schist, limestone, black slate, argillite, and graywacke, and are cut by a large boss of quartz diorite and associated porphyritic dikes. The lodes are quartz veins that occur in the intrusive and the bedded volcanic rocks as well as in the sediments.

A number of lodes have been opened in this gold quartz belt and several small plants installed, but none has made a large production. This strongly mineralized region has never received the attention which it has deserved, and no doubt will be developed in the future. One large company might consolidate a number of these small properties and operate them to advantage.
The only mine in this region that was operated in 1917 was the Dutton mine, on Harris Creek. The Crackerjack claims join the Ready Bullion and extend south and southeast. On the surface three veins are recognized, known as the lower, middle, and upper veins. These are approximately parallel and form a lode system following intrusive porphyry dikes that cut the black slate. The dikes and black slate strike N. 25° W. and dip 35° - 60° SW. The principal work has been done at an elevation of 850 feet at No. 1 tunnel. This tunnel penetrates black slate for 300 feet, until it cuts the vein and drifts on it for 700 feet along the hanging wall of the porphyry dike. The quartz vein borders the porphyry for a footwall and follows a well-defined hanging wall, although above the wall occur parallel quartz stringers that cut pyritized slate, which is said to carry both gold and silver. The hanging-wall vein averages about 5 or 6 feet across and at one place is over 12 feet. Along the footwall of the dike a smaller quartz vein occurs. A number of other adits have been opened on this lode system.

The Lucky Nell claim, formerly known as the Flora and Nellie, is about 8 miles northwest of Hollis on the divide between Maybeeso and Harris creeks, at an
elevation of about 1,400 feet. The lode is a quartz fissure vein in porphyry. It is being developed by an open cut and two adits with a connecting winze. The principal work has been done on the lower adit, which has been driven along the vein for 500 feet.

The vein strikes about N. 70° E. and dips 65° - 80° SE. The vein is marked by two strong walls and average about 4 feet in width. It is strongly metallized with pyrite, chalcopyrite, galena, and sphalerite, and is reported to carry high values in gold and silver.

The Jumbo mine on Copper Mountain, near the head of Hetta Inlet, was operated on about the usual scale but experienced some difficulty in getting shipping facilities for the transportation of ore to the smelter. The mine is developed on large contact deposits along intrusive diorite that forms the footwall of the deposits. The hanging wall is crystalline limestone and metamorphosed sediments. The copper deposits are irregular-shaped bodies of chalcopyrite pyrrhotite ore and chalcopyrite-magnetite ore set in a gangue of garnet, calcite, epidote, and diopside.

Copper prospects were being opened by Hal Gould on the south end of Sukkwan Island, about 3/4 miles
northeast of Jackson Passage. The prospects occur in a zone of contact schist along the border of the large mass of intrusive granite that occupies the interior of the island. This schist has been prospected along the granite contact for about a mile, and throughout this distance shows more or less mineralization. In places it is impregnated with pyrite and in others is veined with stringers of chalcoprysite and pyrrhotite that follow the schistosity of the rock and cut across it. Only surface work had been done in 1917.

Development work was continued on the Big Harvor mine in Trocadero Bay, but no production was made.

A molybdenite lode has recently been opened up near Shakan. The property is three-quarters of a mile south of Shakan, at an elevation of 600 feet. The deposit has been known for several years, but when first discovered the molybdenite was mistaken for galena, and when the assays showed negative results for lead the property was abandoned. It has recently been relocated by W. H. Butt and bonded to the Alaska Treadwell Mining Co., who are installing
machinery for its development.

The deposit is a fissure vein of quartz, about 6 feet wide, that cuts diorite but occurs near the contact of the diorite and tuffaceous sediments. The quartz vein contains considerable feldspar, especially along the footwall, where in places it resembles an igneous rock. The diorite from the footwall is also mineralized. The vein carries molybdenite and also chalcopyrite and pyrite. The vein strikes N. 85° E. and 25° S. The deposit is covered by two claims, the Alaska Chief Nos. 1 and 2.

Aside from the output of the Vermont Marble Co., who operated on about the usual scale, there was no production of marble. Development work was continued at the El Capitan quarry, on Dry Pass, for a part of the summer, and a number of diamond-drill holes were put down, aggregating 1,000 feet. The cores show white crystalline marble, with some beds of blue and some of black and white."

The following described mineral lode claims and mining locations are possessed in full title by

The George M. Wakefield Mineral Land Company, a corporation organized and existing under and pursuant
to the laws of the State of Wisconsin for an undivided eighty-five hundredths (85/100) interest, and Minnie E. Swineford, executrix of the estate of A.P. Swineford, deceased, of Ketchikan, Alaska, for an undivided fifteen hundredths (15/100) interest, to wit:— The Luella, Judge, Bradford, Jefferson, Forest and Iron Copper patented claims, and Mary, Snowflake and Pride unsurveyed and unpatented claims, comprising what is known as "Lookout Group No. 2" of Mineral Lode Claims; also West-Mammouth, East-Mammouth, Lookout, Conundrum, Conundrum Extension and Blue Bell patented claims comprising what is known as "Lookout Group No. 1", all of said property being situated on or near Niblack Anchorage on the Prince of Wales Island in the Ketchikan Mining District, Alaska, and which mining claims and locations are some of the water claims and more particularly described in the location notices filed in the Recorder's Office of said district.

There are, at present, no leases, options, mortgages, or bonds against the above described property to the best of our knowledge.
GEOLOGY

United States Geological Survey Bulletin 347

By (Fred E. Wright
(Charles W. Wright

Extracts from pages 43 - 93.

The sedimentary rocks of the Ketchikan District, which are important in deciphering the geologic history of any region, are subdivided into three groups separated by their differences in age. The oldest group - the Paleozoic strata - embraces a number of unconformable series which are much folded in places and highly metamorphosed. They are known to range in age from Silurian to upper Carboniferous and to have their most extensive development during the Carboniferous.

The sediments of the Mesozoic era are represented only locally by interstratified slate, graywacke, and conglomerate beds of considerable thickness. These strata are often metamorphosed, indurated, and considerably folded, and in most places contain no fossils. Their classification is therefore based largely on structural and petrographic evidence.

The Tertiary sediments are made up of shale,
sandstone, and conglomerate occupying small areas which in places are coal-bearing. The unmetamorphosed and loosely consolidated state of these beds, the presence in them of numerous fossil plants, and the lack of intense folding are their principal characteristics. Paleontologic evidence shows these beds to be essentially Eocene in age, but at one point fossil plants of late Cretaceous age were identified.

The igneous rocks include (1) the intrusive masses, as the granitic batholiths, gabbros, and peridotites which invade the sedimentary rock beds, (2) the extrusives, or those which represent surface lava flows during the different geologic periods, as the greenstones, andesites, and basalts. The most abundant and important of the igneous rocks are the Coast Range granitic intrusives, which occupy about one-half of the aggregate land area of the Wrangell and Ketchikan districts.

The geology of the Niblack property is similar to that of the rest of the Ketchikan district. The formation consists of greenstone and sericite schists striking N. 45° W to N 68° W and upturned to a dip of 45° to 65° to the southwest. A number of igneous bodies have intruded the whole area opening

(1) From Engineer's Report.
up and folding the formations. The sedimentary rocks, mostly limestone of Silurian or Devonian age, are tilted at a high angle with a general dip to the southwest.

The general field of ore deposition seems to have been controlled by the larger intrusions of granite and porphyritic lavas, while the position of the individual bodies or ore shoots was determined by the later intrusions of more basic lava. The granite and acid lavas are found occurring mostly to the west of the Lookout Group on the higher elevations forming the core of the uplifted portion of the vicinity. The more basic lavas, however, are found traversing the Moria and Lookout Groups, some in a North-South direction, others bearing Northwest-Southeast. The dip of these more basic dykes is very nearly vertical on most places on the claims.

ORE DEPOSITS

(U.S.G.S. Bul. 347, pp. 43-93)

In the Ketchikan District four general types of ore deposits have been recognized, vein deposits, breccia veins, lode deposits, and contact deposits. Placer deposits, from which the greatest percentage of gold is derived, have not been developed in this
section of Alaska.

The most valuable deposits on the Prince of Wales Island are the contact deposits. Such deposits occur mostly in limestone or calcareous rocks usually within 1,000 ft. of the intrusion rock masses. They are believed to be of magmatic origin and to have been formed by gaseous and aqueous emanations given off from the igneous intrusive during cooling and solidification.

The copper ores usually favor contact aureoles adjacent to the granodiorite or syenite intrusives. The characteristic minerals associated with these contact deposits are chalcopyrite, pyrrhotite, pyrite, and magnetite in a gangue of garnet, epidote, calcite, quartz, amphibole, wollastonite and several rare minerals. Within these contact aureoles the mineral deposits assume many forms. They occur not only as veins filling fissures a few hundred feet in length, crosscutting the intruded rock bed, but also as intrusive masses themselves and as banded replacement deposits when mineralization has taken place along the bedding planes of quartzite country rock and the intervening bands have been more or less completely replaced by vein material.
The principal copper mines in the region are developing deposits of a low grade copper-iron sulphide ore which can be profitably exploited only by severe economy in extraction. The copper ores generally contain high percentages of iron and lime and are classified as "basic ores" by the smelters.

DESCRIPTION OF MINE WORKINGS

The following description of the mine workings was published in Bulletin 347, U.S. Geological Survey.

"The Niblack mine, located on the Judge claim of Lookout group No. 2, is situated on the southwest side of the Anchorage and but a few hundred feet from tide water. This property was first developed in 1902-3 by the Wakefield Mineral Lands Company and in 1904 was leased by the Niblack Copper Company, the present operators. The principal mine workings are on the Judge claim close to tide water, where the copper ore was first discovered \( \text{fig. 4} \). At a point 150 feet from and 30 feet above high tide is a two-compartment shaft inclined at an angle of 68°. From this shaft four levels have been extended at depths of 50, 100, 150, and 225 feet from the surface, and during 1907 the shaft was extended an additional 75 feet in depth, from
which point the fifth level was opened up. The total amount of underground drifting, including raises and winzes at the close of 1907, is estimated at about 5,500 feet.

Three large ore bodies have been opened in this mine, besides smaller veins and masses occurring in the shaft and along the drifts. The north or foot-wall vein, which has yielded a large tonnage of the ore, is 200 feet in length, and averages 20 feet in width, and about 100 feet in depth, having the shape of a drawn-out lens. It extends from the surface to the 100-foot level, is parallel in strike and dip to the greenstone-schist inclosing rock, and pitches northwesterly. It is displaced in depth by fault planes crossing the rock formation at an acute angle and marked by a gouge 2 to 6 inches wide. Where the surface of this fault plane was observed in the stopes its face was grooved and polished. Other slipping planes occur at angles to this main fault and one apparently cuts off the ore body in the face of the northwest drift on the 50-foot level. The south vein, which has been developed principally from the 150-foot level, is similar in character, but not so large. In this, as was also noted in the other deposits, the sulphides of iron and copper appear to have replaced the greenstone inclosing
rock to considerable extent, and fragments of the altered greenstone are present in the ore mass. These rock fragments are impregnated with the sulphides and often appear to grade into the massive ore without definite dividing lines. On the 225-foot level a newly discovered ore body has been exposed over a length of 90 feet and width of 15 feet. This body was intersected by an altered diabase dike apparently more recent than the ore deposition. The shaft is being sunk lower in order to investigate this ore body. The smaller ore bodies consist of veinlets a few inches wide, cutting the greenstone in various directions, and seams of sulphide ore in the more schistose rock following the stratification. In the country rock a decided penciling or slight folding occurs in the more schistose beds, forming grooves pitching 50° NW., along the lines which the ore bodies seem to follow.

The ore minerals are chalcopyrite and pyrite with small amounts of sphalerite and hematite and with some galena, the gangue minerals being quartz and calcite. Besides the copper content, gold and silver, amounting to $1.50 to $2.50 per ton, and 1 to 2 per cent of zinc are present in the ore. The ores also contain considerable iron and sulphur and sufficient silica for smelting purposes.
The Lookout group of five claims, belonging to the Wakefield Mineral Land Company, is situated on the south slope of Niblack Anchorage between 1,000 feet and 2,000 feet elevation and about 1 mile from tide water (Fig. 6). These claims were first located in 1900, and in 1901 considerable development work was done and the adjacent areas were prospected. No important discoveries, however, were made and only a small amount of assessment work has since been done. The principal developments are on the Conundrum claim, where a 160-foot tunnel has been driven along a belt of mineralized schist striking N. 65° W. and dipping 70° SW. Along the hanging-wall side of this belt is a schistose greenstone, containing stringers of mineral-bearing quartz. A second tunnel 60 feet in length has been started on the same belt 150 feet above the lower tunnel. On the Lookout claims at 1,600 feet elevation an open cut exposes a mineralized belt of considerable width, consisting of brecciated sericite and greenstone schist intermixed with quartz and small masses of sulphides which also penetrate the schists. These mineralized belts are low in grade and at present can not be mined with profit. The introduction of a concentration plant to obtain a richer product for shipment is under consideration."
PRODUCTION RECORD OF THE NIBLACK PROPERTY

The Niblack Property has been worked only from 1905 - 1908 by the Niblack Copper Company. During this time the ore mined was shipped directly to the Takoma Smelter. The following data on this ore mined was obtained from the smelter reports:

(See Appendix A Page 48 for detailed calculations)

Amount of Ore Smelted, Tons 30,467.169
Average Gold Content - oz. per ton .0441
Average Silver Content - oz. per ton .679
Average Copper Content per cent 3.206
Average Market Value from 1905 - 1908
Gold in dollars 20.00
Silver in cents 61.006
Copper in cents 17.065
Average total value per ton ore in dollars 12.550
Smelter Penalties and Deductions
Average Silver 5% loss in dollars per ton dry ore .021
" Copper 3% lb." " " " " " " 1.919
": Treatment Rate " " " " " " 3.369
" Penalty Charge " " " " " " .296
" Freight and Unloading Charge " " " 1.367
" Total Deductions 6.972
" Net Amount Received from Smelter " " 5.578
" " " " " " in ¢ per lb. copper 8.70¢
The data given above was taken directly from the individual cargo reports given by the Smelter Company. All our calculations hereafter in this report are based on 3% Copper, .0441 oz. Gold, and .667 oz. Silver. These are slightly lower than the averages derived above but are perhaps even high when we consider that the ore was most probably hand picked to some extent at least.
PART II

FUTURE DEVELOPMENT JUSTIFIED
INTRODUCTION

This section of the report is confined to a discussion of the methods applicable to the operation, development and valuation of the Niblack Property.

METHOD OF EXTRACTION

We lack the information necessary for the determination of a suitable mining method. We therefore suggest that the necessary data be obtained by competent engineers before any further operation is undertaken.

There is at the present time no ore definitely blocked out. From the data at hand, we estimate that the total reserves of 3% copper ore would not justify a greater extraction than 300 tons per day. Our calculations in the following pages are based on this figure.

METHOD OF ORE TREATMENT

CONCENTRATION

Heretofore there has been no concentration attempted on the ore of the Niblack Property, as it has been shipped directly to the Tacoma Smelter. With the recent developments in ore concentration, however,
there is a possibility that a considerable saving might be made.

The ore consists* of about 10% chalcopyrite, about 50% sulphides (chalcopyrite and pyrite) and 50% gangue. It is assumed, for lack of definite information, that the gold and silver is associated with the sulphide material. Two methods of concentration present themselves as being most suitable to this type of ore. (1) Separating the sulphides from the gangue, (2) separating the chalcopyrite from the other sulphides and gangue.

The first method could be done most cheaply by gravity concentration with jigs and tables. The concentration ratio in this case would be 2:1, that is, of every 100 tons of ore mined 50 tons would be separated as concentrates and 50 tons would be thrown away as waste. By this method all the copper, gold and silver would be recovered, except for a slight loss in concentration.

The second method could be done by differential flotation, which has been recently perfected so that the chalcopyrite may be successfully separated from the

*See Appendix B, page 50.
pyrite. The concentration ratio in this case would be 6:1. By this method two-thirds\(^*\) of the gold and silver would be thrown away with the waste while 86%\(^x\) of the copper and one third of the gold and silver could be recovered. If the saving in freight charges would be greater than the loss of valuable material in this process, then this second method would be cheaper than the first method mentioned.

**SMELTING**

Smelting could either be done on the grounds or at a customs smelter. Smelting on the property would materially reduce the freight charges and the smelter's profit could also be realized. However, this would require a considerable extra capital expenditure, a greater labor force, and would necessitate the importation of fuel.

If smelting were to be done at a customs smelter the Tacoma smelter is undoubtedly the best suited for the ore. There are several small smelters nearer than Tacoma but the shorter distance would not compensate for the extra reliability of the Tacoma smelter.

\* See Appendix C.

\(x\) This figure is the customary recovery of copper by well managed plants using the differential flotation method.
The following description of the Tacoma smelter is given in Weed's Mines Handbook, 1922.

"Office: American Smelters Securities Co.,
120 Broadway, New York.

Officials: H.Y. Walker, Mgr., Box 1605, Tacoma, Wash.
C.E. Little, Asst. Mgr., R.F. Barker, Sup't.

Property: A smelting plant with a 52 acres site, 6 miles from Tacoma on Puget Sound. Property is well located for receipt and dispatch of materials, and has extensive wharves, with ore bunkers and automatic devices for unloading cargoes.

The smelter has 2,500 tons daily capacity and treats copper, gold and silver ores and concentrates from the entire Western Coast of North America and a considerable tonnage of South American Ceres.

Equipment: 3 Blast and 1 reverberatory furnaces. The 575 ft stack is one of the highest in the world. The convertor department has a capacity of 300 tons of blister copper daily.

The electrolytic plant capacity is 8,500 tons per month.

Electric power is received at 40,000 volts
and is stepped down to 100 volts for use, the works requiring about 6000 horsepower. Fuel is petroleum, brought in tank steamers from the oil fields of Southern California.

The Tacoma Smelter is one of the most important custom plants on the Pacific Coast, the management is progressive, and the metallurgical practice excellent. In addition to copper the products are arsenic and liquid sulphur dioxide."

**SUMMARY**

From the above it can be seen that there are six possible ways of treating the Niblack Ore. These are:

1. No Concentration, ship run of mine ore to Tacoma.
2. Concentrate 2:1, ship concentrates to Tacoma.
3. Concentrate 6:1, ship concentrates to Tacoma.
4. No Concentration, Smelt on property.
5. Concentrate 2:1, Smelt on property.
6. Concentrate 6:1, Smelt on property.

The estimated cost and returns of each of these methods have been computed and are given below:
ESTIMATED PROFITS OF THE SIX METHODS OF ORE TREATMENT

Given in cents per pound of copper produced.

A. Smelting on Property.

<table>
<thead>
<tr>
<th>Ratio of Concentration</th>
<th>None</th>
<th>2:1</th>
<th>6:1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Value of Product</td>
<td>18.01</td>
<td>18.10</td>
<td>16.82</td>
</tr>
<tr>
<td>Cost of Production</td>
<td>20.65</td>
<td>19.64</td>
<td>16.56</td>
</tr>
<tr>
<td>Gross Profits</td>
<td>02.64(loss)</td>
<td>01.54(loss)</td>
<td>.26</td>
</tr>
</tbody>
</table>

Per cent gross profit on capital invested (loss) (loss) 1%

B. Smelting at Tacoma.

<table>
<thead>
<tr>
<th>Ratio of Concentration</th>
<th>None</th>
<th>2:1</th>
<th>6:1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Value of Product</td>
<td>18.2</td>
<td>18.10</td>
<td>16.80</td>
</tr>
<tr>
<td>Cost of Production</td>
<td>19.44</td>
<td>21.92</td>
<td>16.41</td>
</tr>
<tr>
<td>Gross Profits</td>
<td>01.32(loss)</td>
<td>03.82(loss)</td>
<td>00.39</td>
</tr>
</tbody>
</table>

Percent gross profit on capital invested (loss) (loss) 3.5%

BASIS OF COMPUTATION

The gross value of product is based on the amount of valuable metal in the ore less the losses which would occur in operations on the property. The following values were used in the computation:

(See Appendix D for calculations).
300 Tons of ore mined per day.
Copper 3% of the ore at 16¢ per lb.
Gold .0441 oz. per ton at $20.00 per oz.
Silver .677 oz. per ton at $0.60 per oz.
The percentages of the precious metals were obtained
from the results of the smelting operations of over
30,000 tons during 1905 - 1908. (See Page 24).

The following extraction and loss figures
were used:

2:1 Concentration
90% recovery

6:1 Concentration
85% recovery of copper
33-1/3% recovery of gold and silver
(See Appendix C)

Copper content of slag 0.5%
Silver content of slag .2 oz. per ton
Gold content of slag .008 oz. per ton

Assume with no concentration 300 tons slag to 300 tons charge
Assume with 2:1 concentration 125 " " 150 " "
Assume with 6:1 concentration 25 " " 50 " "

The cost of production includes the following
items:
1. Mining cost at 3.00 per ton.
2. Concentration cost at 1.50 per ton.
3. Freight\textsuperscript{\textdegree} unloading charge ($3.00 per ton concentrates and ore).
   ($8.00 per ton copper)
(The price of freight of the copper is increased because of the small shipments)
4. Smelter deductions 12\% deduction of copper
   5\% loss of silver
5. Smelter handling charge $3.50 per ton.
6. Refining and selling 3\textcent per lb. copper
7. Amortization in 10 years.

\textit{(Items 4 and 5 are included in Smelting at Tacoma only. Losses in smelting on property are deducted in "gross value of product" as stated above).}
CONCLUSIONS AS TO METHOD OF ORE TREATMENT

From this table it can be seen that the most suitable method of ore treatment is to concentrate the ore by differential flotation (6:1) and ship the concentrates to Takoma for smelting.

The chief advantages of this method are the reduction in freight rates, smelter treatment charges, and smelter deductions. This method requires a comparatively small capital expenditure which is a big advantage over the methods requiring a smelter plant and hence large capital expenditures. The differential flotation method has been developed technically to a high degree and has been used on a large scale in a number of plants with success, hence there is little doubt concerning satisfactory operations from this standpoint. A proposed flow sheet for differential flotation is given on page 34a.

The disadvantages of this method are that it wastes most of the gold and silver values of the ore. Hence the potential earning power of the mine is reduced. It also would require more labor than methods with no concentration and would necessitate the presence of an expert on differential flotation to obtain a satisfactory recovery of copper.
PROPOSED FLOW SHEET
300 Ton Mill
For the concentration of Chalcopryrite ore
VALUATION OF ORE RESERVES

SUMMARY

A*. Milling Ore Reserve .......... 1,200,000 tons
B. Average Assay Copper .......... 3%
    Gold and Silver ......... $0.43 per ton
C. Copper Contained ............ 72,000,000 lbs.
D. Concentration efficiency ore to metal
    paid for by smelter without their
    deduction .................. 85%
E. Copper recoverable by concentration .. 61,200,000 lbs.
G.(5) Copper loss in smelting ........ 5,200,000 lbs.
    Copper salable ............. 56,000,000 lbs.

VALUE OF ORE RESERVE AS OWNER

OPERATOR

F. Expected sales price of Copper .......... $0.1671 per lb.
    plus Gold and Silver content
G. Expected cost of production per lb. of
    recoverable copper ........ 0.1395 per lb.
H. Expected operating profit per lb. of
    copper - (F - G) ............ 0.0276 per lb.

*These letters refer to explanation headings following.
SUMMARY - con't

J. Total Expected Operating Profit . . . . . . $1,545,600
Operating life, valuation factor
10 years @ 15% and 4% . . . . . . . . . . 0.428649
K. Present Value of Operating Profit,
June 1, 1923 . . . . . . . . . . . . . $662,500
Less Necessary Capital Expenditure
L. Development . . . . . . . . . . . . . $215,000
M. Equipment . . . . . . . . . . . . . 495,000 710,000
Value of Ore Reserves June 1, 1923 . . . . . Nothing

Table showing the value of the Ore at date before operations begin for various prices of copper.
Calculations by slide rule.

<table>
<thead>
<tr>
<th>N.Y. Electrolytic Quotation in cents per lb.</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>16/</td>
<td>Nothing</td>
</tr>
<tr>
<td>17</td>
<td>$194,000</td>
</tr>
<tr>
<td>18</td>
<td>431,000</td>
</tr>
<tr>
<td>19</td>
<td>599,000</td>
</tr>
<tr>
<td>20</td>
<td>941,000</td>
</tr>
<tr>
<td>21</td>
<td>1,185,000</td>
</tr>
<tr>
<td>22</td>
<td>1,430,000</td>
</tr>
<tr>
<td>23</td>
<td>1,675,000</td>
</tr>
</tbody>
</table>
MILLING ORE RESERVE

In Judge Shaft


(1) North Ore body - 200 feet in length, averaging 20 feet in width, and extending from surface to the 100-foot level.

(2) South Ore body - 150-foot level. Similar to above though slightly smaller. (Letter A.A.W. see below) Shows that this same body is found on 300-foot level, exposed over length of 200 feet with ends still undetermined, and 32 feet wide. The 300-foot level had not been opened up at time the U.S.G.S. Report was written stating that body was smaller than North Ore Body.

b. From letter of A.A. Wakefield, Ketchikan, Alaska. (As he remembered it from personal examination.)

(3) 225-foot level - Ore body exposed 90 feet in length and 15 feet wide.

(4) Smaller veins and masses in shaft and along drifts.

(5) 300-foot level - Ore body exposed to 85 feet in length and 35 feet in height, 12 feet wide, averaging 6% Cu. and $6.00 per ton gold and silver.

Work stopped at this point because of shut-down due to lawsuit.
(6) Pyritic ore body, 12 feet wide averaging \( \frac{25}{2} \% \) Cu.

C. From Report of Geo. O. Marrs, E.M.

(7) "Of ore showing on one side only but with reasonable inferred continuity I estimate about 800,000 tons on the Lookout Groups down to the 300 foot level of the Judge Shaft".

(8) "Of ore below the 300-foot level of the Judge Shaft and other ore on these claims which outcrops or shows by float or other reliable indications I estimate that 1,500,000 tons will be encountered with proper exploration and development running over 3% copper and 5,000,000 tons running 1\( \frac{1}{2} \) to 2\( \frac{1}{2} \)% copper;—this last estimate is the prospective value of the property down to the 1000-foot level from the Judge Shaft."

To be conservative we have reduced the above estimate of 1,500,000 tons to 1,000,000 tons.

**SUMMARY**

Allow 10 cubic feet per ton ore.

<table>
<thead>
<tr>
<th>Ore Lenses</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) 200 x 20 x 100 + 10</td>
<td>40,000 Tons</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) 200 x 30 x 200 + 10</td>
<td>120,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) 100 x 15 x 100 + 10</td>
<td>15,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) Estimate</td>
<td>1,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) 100 x 12 x 200 + 10</td>
<td>24,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) Estimate</td>
<td>1,000,000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Estimated 3% Av. 1,200,000 Tons
A.

Above does not include an estimated 5,000,000 tons of 2% copper ore. This will act as an additional safety factor.

Estimations contained herein are based on secondary information and we can assume no responsibility for their correctness. We have reduced the estimates in order to be conservative, yet have given Mr. Marr's estimates real consideration in view of the fact that the G.M.W.M.L.Co. have shown so much confidence in his work.

B.

AVERAGE ASSAY

There has been over 30,000 tons of ore already extracted which average 3% copper. Estimates on Ore Reserve made by Mr. Marr's are on 3% copper.

The gold and silver values averaged $1.28 per ton on over 30,000 tons smelted. The future is estimated to contain approximately the same. However, as only 1/3 is expected to be recovered (see Appendix C) due to metallurgical losses in the pyrite in the differential flotation process, the price used here is $1.28 - $0.45

C.

COPPER CONTAINED

1,200,000 x 2000 x .03 = 72,000,000 lbs.
D.

The efficiency here is one assumed for the differential flotation process. The other metallurgical losses are in the smelting and ore considered under Loss in smelting and deducted from copper recoverable by concentration.

This efficiency has been reached or surpassed by several plants using the differential flotation process on low grade copper ore, and is believed to be a conservative one.

E.

**COPPER RECOVERABLE**

72,000,000 x 85% = 61,200,000 lbs.

F.

**SALES PRICE OF COPPER**

The price of copper was here taken at 16¢ because first it is the estimated average price of copper for 1923 and secondly because it is the highest price that will fail to make the mine profitable at all.

From the chart on the page following it will be seen that copper has every prospect of rising and is on the upward movement at present. If copper continues to behave
Price of Copper Since 1865

in cents per pound
like it has for the last 30 years the average price should be approximately 17½ cents per lb. for 1924 and continue upwards. The high mark in 1917 and the low mark in 1921 are both due to the enormous demand of copper made by the World War and the over-supply on hand at the end of the war. These conditions have raised the average trend above its normal position and consequently it will be inadvisable to expect anything over a cent or two below such a price.

The Engineering and Mining Journal Press summarizes the copper situation at the end of 1922 as follows: "War scrap has been utilized. The cheaper substitutes, having been tried and found wanting, are being replaced with copper. Most of the stock of marketable copper existing at the end of 1922 has been sold for delivery in the first quarter of 1923. Current consumption is in excess of current production. Stocks at mills in the United States are normal; foreign mills have no supplies. The opinion is general that copper is in a strong and stable position."

**GOLD AND SILVER VALUES**

Gold and silver values are $0.43 per ton and must be added to the sales price of copper.

*Vol. 115, No. 3 - Statistical number, Jan. 1923.*
$0.43 \text{ per ton} \overline{\phantom{0}} = \underline{0.0071}
\underline{0.0071} \text{ Value Gold and Silver recovered}
$0.1671 \text{ Total Sales Price per lb. Copper}
G.

EXPECTED COST OF PRODUCTION
in Cents per lb. Recoverable Copper

Method: Differential Flotation, concentration 6 to 1, shipping concentrates to Tacoma, Washington, for smelting.

1. Mining Costs. Estimated @ $3.00 per ton ore mined. This is a fair estimate, we believe, considering the high cost of labor and materials, and the low cost of power and timber.

\[
\frac{\$3.00}{85\% \times 3\% \times 2000 \text{ lbs.}} = \$0.0586
\]

2. Concentration Costs. Estimated @ $1.50 per ton. The largest charge besides labor here is power which will be excessively cheap. One practically counter-balances the other, with a little to the advantage of labor. This explains our high cost in concentration for the flow sheet recommended.

\[
\frac{\$1.50}{85\% \times 3\% \times 2000 \text{ lbs.}} = \$0.0294
\]

3. Smelter Treatment Charges. Tacoma Smelter estimate, see letter Appendix F, $3.50 per ton. As concentration ratio is 6 to 1 this means 1 ton conc. = 6 tons ore mined. As far as copper content is concerned
\[ \frac{\$3.50}{6 \times 85\% \times 3\% \times 2000 \text{ lbs.}} = \$0.0114 \]

4. **Freight and Unloading Charge.** Shipping concentrates from Niblack to Tacoma, Wash. Rate quoted for large shipments of $3.00 per ton concentrates by A.A. Wakefield, Ketchikan, Alaska as the prevailing rates in 1923.

\[ \frac{\$3.00}{6 \times 85\% \times 3\% \times 2000 \text{ lbs.}} = \$0.0098 \]

5. **Deduction for Copper Loss at Smelter.** Tacoma Smelter pays on copper assay less 1.3% from per cent copper content.

\[ 1\% \text{ of } 2000 \text{ lbs.} = 20 \text{ lbs.} \quad 20 \times 1.3\% = 26 \text{ lbs.} \]

26 lbs. copper loss per ton concentrates.

\[ \frac{26}{6} = 4.33 \text{ lbs. copper loss per ton ore mined} \]

4.33 x 1,200,000 tons = 5,200,000 lbs. copper loss in smelting process.

6. **Deduction Silver Loss.** The Tacoma Smelter pays for 100% of gold @ $20.00 per oz., but assumes a 5% silver loss. Assuming market price @ 60 cents this would be in cents per lb. copper-

\[ \frac{5\% \times \frac{677}{3} \times 1/3 \times \$0.60}{85\% \times 3\% \times 2000 \text{ lbs.}} = \text{0.0001} \]
7. **Refining and Smelting.** Charges for smelter of $0.03 per lb. copper.

**Summary of Costs**

1. Mining .............................................. $0.0588
2. Concentration ................................. 0.0294
3. Smelter Treatment ............................ 0.0114
4. Freight and Unloading ........................ 0.0098
5. Silver Loss ....................................... 0.0001
6. Refining and Selling ............................ 0.0300

Operating Cost per lb. Copper ........ 0.1395

**J.**

Total Expected operating profit equals the pounds of copper salable times profit per lb.

56,000,000 lbs. x $0.0276 = $1,545,600

**K.**

Present Value of Operating Profit June 1st, 1923 equals to

$1,641,520 x 0.428,649 = $703,636

**L.**

**Development Expenditures.** Development should proceed until a two years' supply of ore has been definitely proven up averaging 3% Copper.
We estimate that 5000 ft. of drifts and 600 feet of winzes will develop the 216,000 tons necessary.

5000 ft. drifts @ $25. per ft. = $125,000

600 ft. winzes @ $150. " " = 90,000

$215,000

M.

EQUIPMENT EXPENDITURES

1. Flotation plant - 300 tons ........ $250,000
2. Power Plant (Hydro-electric) ....... 125,000
3. Mining Machinery, Wharf, etc. ....... 100,000
4. Wooden buildings for homes, shops, office, etc. ........ 20,000

$495,000
### APPENDIX A

**COMPUTATIONS FROM SMELTER CARGO REPORTS.**

The following data were furnished by the Tacoma Smelter Cargo Reports of the ore shipped from the Niblick Property to the Tacoma Smelter during 1905-1908.

<table>
<thead>
<tr>
<th>Year</th>
<th>Wt. Ore in Dry Tons</th>
<th>Average Gold Oz. per ton</th>
<th>Gold Ounces</th>
<th>Average Silver Oz. per ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>1905</td>
<td>4235.605</td>
<td>.04</td>
<td>160.335</td>
<td>.95</td>
</tr>
<tr>
<td>1906</td>
<td>10501.878</td>
<td>.031</td>
<td>343.927</td>
<td>.475</td>
</tr>
<tr>
<td>1907</td>
<td>9025.108</td>
<td>.033</td>
<td>297.108</td>
<td>.604</td>
</tr>
<tr>
<td>1908</td>
<td>6704.578</td>
<td>.0886</td>
<td>548.722</td>
<td>.901</td>
</tr>
<tr>
<td>TOTAL</td>
<td>30467.169</td>
<td>.0440</td>
<td>1341.092</td>
<td>.679</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Silver Ounces</th>
<th>Average Cu. Per Cent</th>
<th>Pounds Copper</th>
</tr>
</thead>
<tbody>
<tr>
<td>1905</td>
<td>4049.490</td>
<td>4.48</td>
<td>374631.346</td>
</tr>
<tr>
<td>1906</td>
<td>5027.936</td>
<td>2.743</td>
<td>583816.084</td>
</tr>
<tr>
<td>1907</td>
<td>5387.098</td>
<td>3.053</td>
<td>550851.454</td>
</tr>
<tr>
<td>1908</td>
<td>6223.059</td>
<td>3.317</td>
<td>444614.751</td>
</tr>
<tr>
<td>TOTAL</td>
<td>20687.583</td>
<td>3.206</td>
<td>1953913.635</td>
</tr>
</tbody>
</table>
## APPENDIX A

### PENALTIES AND DEDUCTIONS

<table>
<thead>
<tr>
<th>Year</th>
<th>Wt. Ore in Dry Tons</th>
<th>5% Silver Loss $</th>
<th>3¢ per lb. Cu. Loss $</th>
<th>Treatment Rate $</th>
</tr>
</thead>
<tbody>
<tr>
<td>1905</td>
<td>4235.605</td>
<td>$117.60</td>
<td>$11238.96</td>
<td>$14521.02</td>
</tr>
<tr>
<td>1906</td>
<td>10501.878</td>
<td>165.95</td>
<td>17492.02</td>
<td>36104.62</td>
</tr>
<tr>
<td>1907</td>
<td>9025.108</td>
<td>182.78</td>
<td>16416.59</td>
<td>30781.28</td>
</tr>
<tr>
<td>1908</td>
<td>6704.578</td>
<td>168.55</td>
<td>13338.44</td>
<td>21267.94</td>
</tr>
<tr>
<td>TOTAL</td>
<td>30457.169</td>
<td>$634.88</td>
<td>$58485.81</td>
<td>$102674.86</td>
</tr>
<tr>
<td>Average per Ton</td>
<td></td>
<td>.021</td>
<td>1.919</td>
<td>3.369</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Penalty Charges</th>
<th>Freight &amp; Unloading</th>
<th>Total Deductions</th>
<th>Net Am't. Received</th>
</tr>
</thead>
<tbody>
<tr>
<td>1905</td>
<td></td>
<td>$4848.36</td>
<td>$50726.44</td>
<td>$30365.15</td>
</tr>
<tr>
<td>1906</td>
<td>$7939.84</td>
<td>11895.64</td>
<td>73598.07</td>
<td>38085.87</td>
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<tr>
<td>1907</td>
<td>1095.04</td>
<td>11250.78</td>
<td>59726.27</td>
<td>75865.18</td>
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<tr>
<td>1908</td>
<td></td>
<td>13659.40</td>
<td>46434.33</td>
<td>25688.34</td>
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<tr>
<td>TOTAL</td>
<td>$9034.88</td>
<td>$41654.68</td>
<td>$212465.11</td>
<td>$170004.54</td>
</tr>
<tr>
<td>Average per Ton</td>
<td>$2960</td>
<td>$1.367</td>
<td>$6.972</td>
<td>$5.578</td>
</tr>
</tbody>
</table>
## APPENDIX A

### VALUE OF ORE

<table>
<thead>
<tr>
<th>Year</th>
<th>Wt. Ore in Dry Tons</th>
<th>100% value</th>
<th>100% value</th>
<th>100% value</th>
<th>Total Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Gold</td>
<td>Silver</td>
<td>Copper</td>
<td></td>
</tr>
<tr>
<td>1905</td>
<td>4235.605</td>
<td>$3286.72</td>
<td>$2351.76</td>
<td>$55453.11</td>
<td>$61091.59</td>
</tr>
<tr>
<td>1906</td>
<td>10501.878</td>
<td>6698.50</td>
<td>3242.70</td>
<td>101742.74</td>
<td>111683.94</td>
</tr>
<tr>
<td>1907</td>
<td>9025.108</td>
<td>5943.16</td>
<td>3655.82</td>
<td>125992.47</td>
<td>135591.45</td>
</tr>
<tr>
<td>1908</td>
<td>6704.578</td>
<td>10974.43</td>
<td>3370.45</td>
<td>59777.79</td>
<td>74122.67</td>
</tr>
</tbody>
</table>

Total Values in dollars: $26902.81, $12620.73, $342966.11, $382489.65

Amounts in Units:
- 1341.092 ounces
- 20687.583 ounces
- 1953913.635 pounds
- 30467.169 tons

Average Market Value per Unit:
- $20.060 per oz.
- $0.61006 per oz.
- $0.17055 per lb.
- $12.550 per ton
APPENDIX B

COMPUTATION OF COMPOSITION OF ORE

From Tacoma Smelter Reports of Cargo Shipments from 1906-1908 inclusive covering about 30,000 Tons of ore, the iron content runs about 24% and the copper content 3.21%

If copper is all as chalcopyrite then by proportion

\[
\frac{3.21\%}{\text{Chalcopyrite in ore}} = \frac{\text{Mol. wt. Cu}}{\text{Mol. wt. Chalcopyrite}} = \frac{63.6}{183.53}
\]

% Chalcopyrite = 11.1%

Iron as Chalcopyrite is 11.1 \times \frac{\text{Mol. wt. Fe}}{\text{Mol. wt. CuFeS}_2} = 3.4\% of ore

Total Iron in ore = 24%

Total Iron not as Chalcopyrite = 20.6% assume as pyrite.

Then \%pyrite in ore = 20.6 \times \frac{\text{Mol. wt. FeS}_2}{\text{Mol. wt. Fe}} = 43%

Total % \text{FeS}_2 + \text{CuFeS}_2 = 54\% about say 50\%
APPENDIX C

COMPUTATION OF GOLD AND SILVER LOSSES

IN DIFFERENT FLOTATION CONCENTRATION

Since there is approximately 50% Sulphides and 50% gangue as shown in Appendix B, then in 100 tons of ore there would be:

50 Tons Sulphides
50 Tons Gangue.

By concentrating 6:1

\[
\frac{100}{6} = 16 \frac{2}{3} \text{ tons of Concentrates would be made.}
\]

These would consist, theoretically, of all sulphides.

Hence there would be a loss of sulphides equal to

\[
50 - 16 \frac{2}{3} = 33 \frac{1}{3} \text{ Tons.}
\]

The recovery of the sulphides would then be

\[
\frac{16 \frac{2}{3}}{50} = 33 \frac{1}{3}\%
\]

Since the gold and silver is assumed evenly distributed in the sulphides, then the recovery of gold and silver would be 33 1/3%.
APPENDIX D

COMPUTATION OF 1:1 TACOMA

PER POUND OF COPPER.

<table>
<thead>
<tr>
<th>Assay</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ore mined per day</td>
<td>300 Tons</td>
</tr>
<tr>
<td>Copper at 3% of ore</td>
<td>18,000 lbs. per day</td>
</tr>
<tr>
<td>Gold at .0441 oz. Ton</td>
<td>13.23 oz. per day</td>
</tr>
<tr>
<td>Silver at .677 oz. Ton</td>
<td>203.1 oz. per day</td>
</tr>
</tbody>
</table>

Total Assay Value of Ore Per Daily Output

Copper 18,000 lbs. at 16c. lb. = \$2880.00
Gold 13.23 oz. at \$20.00 per oz. = 264.60
Silver 203.1 oz. at 60c. per oz. = 121.86

\[\text{Value per pound of copper = } \$0.1812\]

Operating Costs

Mining Cost at \$3.00 per ton mined

\[\frac{\$3.00 \times 300}{18,000} = .05 = \$0.0500\]

Concentrating Cost

No concentration
APPENDIX D - 2

Smelter Deductions and Freight

Freight and unloading charge at $3.00 per ton.  
\[
\frac{3.00 \times 300}{18,000} = \frac{0.05}{18,000} = 0.0500
\]

Smelter operating cost at $3.50 per ton.
\[
\frac{3.50 \times 300}{18,000} = \frac{0.0584}{18,000} = 0.0584
\]

Deduction for 1.80% loss copper
\[
\frac{0.16 	imes 1.3}{3.0} = 0.0693
\]

Deduction for 5% loss of silver
\[
\frac{0.05 \times 203.1 \times 0.60}{18,000} = \frac{0.003}{18,000} = 0.0003
\]

Refining and selling
\[
0.0300 = 0.2080
\]

Amortization
\[
0.0036
\]

Mining Cost (Ford. from App. D-1)
\[
0.0500
\]

TOTAL COST
\[
0.2616
\]
APPENDIX D - 3

CAPITAL COSTS

Working Capital  $15,000
Wooden Buildings  15,000
Mining Machinery & Development  100,000
Power Plant  61,000
General  30,000
$221,000

Expenses of raising the Capital  $232,000

* Amortization in ten years.

\[
\frac{23,200}{18,000 \times 360} = 0.00357
\]

Interest Rate at 1% per annum per lb. copper

\[
\frac{232,000 \times 0.01}{18,000 \times 360} = 0.000357
\]

* This is not true amortization as this does neglect the interest which would be derived from the fund. For comparative purposes, however, this method of computation is satisfactory.
APPENDIX D - 4

COMPUTATION OF 2:1 TACOMA

Assay Value of Concentration.

Ore mined per day = 300 tons

Copper at 3% of ore = 18,000 lbs.

90% of copper recovered in Concentration = 16,200 lbs.

Gold at .0441 oz. ton = 13.23 oz. per day

Silver at .677 oz. ton = 203.1 oz. per day

Assuming same loss as the loss of copper

Gold recovered by concentration = 11,91 oz. @ $20. = $238.20
Silver " " " = 182.8 oz. @ 60¢ = 109.68
Copper 16,200 lbs. @ 16c. = 2,937.68

Value per lb. of copper = $ .1610
APPENDIX D - 5

Operating Costs

Mining Cost at $3.00 per ton mined.

\[
\frac{3 \times 300}{16,200} = \frac{.0555}{.0555}
\]

Concentration Cost at $1.50 per ton

\[
\frac{1.50 \times 300}{16,200} = .0278
\]

Smelter Deductions & Freight

Freight & Unloading charge at $3.00 per ton conc.

\[
\frac{150 \times 300}{16,200} = .0278
\]

Smelter operations cost at $3.50 per ton conc.

\[
\frac{150 \times 350}{16,200} = .0324
\]

Deduction for 1.3% loss of copper in smelting

\[
\frac{.013 \times 150 \times 2000 \times .16}{16,200} = .0385
\]

Deduction for 5% loss of silver in smelting

\[
\frac{.05 \times 182.8 \times .60}{16,200} = .0003
\]

Refining and Selling

\[
.0300 = .1291
\]

Amortization

TOTAL COST \[.0068 = .2192\]
APPENDIX D - 6

CAPITAL EXPENSES

Concentration Plant  $140,000

The General Engineering Co gives an empirical figure of $300 - $450 per ton capacity per 24 hours for coarse concentration mill. Using the highest figure $450 x 300 = $135,000. Allowing $5,000 for unforeseen expenses this equals $140,000.

Working Capital  20,000
Wooden Buildings for homes, shops, etc.  20,000
Power Plant  61,000
Mining Machinery and Development  100,000
General Expenses  30,000

$381,000

Expenses of raising Capital (5%)  19,000

$400,000

Amortization = \frac{40,000}{16,200 \times 360} = .00684

Interest rate at 1% per annum per lb. copper.

= \frac{400,000 \times .01}{16,200 \times 360} = .000684

* See note on page 54

See note on page 54
APPENDIX D - 7

COMPUTATION OF 6:1 TACOMA

PER POUND OF COPPER.

Assay Value of Concentration

Ore mined per day = 300 Tons

Copper at 3% of ore = 9 Tons = 16,000 lbs.

85% of Copper extracted by conc. = 15,300 lbs.

Gold at .0441 oz. per ton = 13.25 oz. per day

Gold recovered in concentration = 4.41 oz. per day

Silver at .677 oz. 1 ton = 203.1 oz. per day

Silver recovered in conc. = 67.7 oz.

Total assay value of the concentrated daily output.

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity</th>
<th>Assay Value (in oz.)</th>
<th>Total Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>15,300</td>
<td>$5.44 per oz.</td>
<td>$8440.00</td>
</tr>
<tr>
<td>Gold</td>
<td>4.41 oz.</td>
<td>$4 per oz.</td>
<td>88.20</td>
</tr>
<tr>
<td>Silver</td>
<td>67.7 oz.</td>
<td>$1.33 per oz.</td>
<td>89.60</td>
</tr>
</tbody>
</table>

Value per lb. of copper = $1.680
APPENDIX D - 8

Operating Costs

Mining Cost at $3.00 per ton of ore mined = $ .0588

\[
\frac{3.00 \times 300}{15,300} = .0588
\]

Concentration Cost at $1.50 per ton = .0294

\[
\frac{1.50 \times 300}{15,300} = .0294
\]

Smelter Deductions & Freight

Freight & unloading charges at $3.00 per ton Conc.

\[
\frac{.50 \times 3.00}{15,300} = .0098 \quad .0098
\]

Smelter operating cost = $3.50 per ton conc.

\[
\frac{3.50 \times .50}{15,300} = .0114 \quad .0114
\]

Deductions for 1.3% loss of copper in smelting

\[
\frac{(1.3\%)(50\text{Tons})(2000\text{lbs}) \times .16}{15,300 \text{ lbs.}} = .0136
\]

Deductions for 5% loss of silver in smelting

\[
\frac{.05 \times 67.7 \times \$.60}{15,300} = .0001 \quad .0001
\]

Refining and Selling

Amortization

\[
\frac{.0300}{.0649} \quad \frac{.0110}{.1641}
\]

TOTAL COST
APPENDIX D - 9
CAPITAL COSTS

300 Ton Differential Flotation Mill $250,000.

The General Engineering Co. gives an empirical figure of $600-$800 per Ton capacity per 24 hrs. for such a mill. Taking the highest figure 300x800 = $240,000. An extra allowance of $10,000 is made for unforeseen difficulties in erection. This should be allowed on account of the distant situation of the mill.

Working Capital 50,000.
Wooden Buildings for Homes, shops, etc. 20,000
Power Plant (Hydroelectric) 125,000
Mining Machinery & Development 100,000
General Expenses 30,000

$575,000

Expense of raising capital 28,000

$603,000

Amortization \[ \frac{603,000}{15,300 \times 360} = 0.01095 \]

Interest Rate at 1% per annum per lb. copper

\[ \frac{(603,000 \times 0.01)}{(15,300 \times 360)} = 0.001095 \]
APPENDIX D - 10

COMPUTATION OF 1:1 HOME

PER POUND COPPER

Assay Value

Ore mined per day = 300 tons
Copper at 2% = 18,000 lbs. per day
Gold at .0441 oz./ton = 13.23 oz. per day
Silver at .677 oz./ton = 203.1 oz. per day.

Assume 300 Tons per day slag at .5% copper

Copper lost in slag = 300 x 2000 x .005 = 3000# Cu.
Copper recovered = 18,000 - 3,000 = 15,000 lbs.

Assume 2 oz. per ton Silver = 60 oz. per day

Recovery = 143.1 oz. eq. silver
.008 oz. per ton Au = 2.4 oz. per day
Recovery of 10.83 oz. gold

Recovery of Copper 15,000 lbs. at 16c. lb. = $2400.
Silver 143.1 oz. at 60c. oz. 86.
Gold 10.83 oz. at $20. oz. 217.
$2703.

Value per lb. of Cu. = $.1801
APPENDIX D - 11

OPERATING COSTS

Mining Cost at $3.00 per ton mined

\[
\frac{3 \times 300}{15,000} = .0600 \quad \# .0600
\]

Concentration Cost

No Concentration

Smelting Cost

Operating Cost at $4.00 per ton

\[
\frac{\$4.00 \times 300}{15,000} = .0800
\]

Refining and Selling = .0300 \quad .1100

Freight at $8.00 per Ton

\[
\frac{\$8.00}{2000} = .0040 \text{ per lb.} \quad .0040
\]

Amortization \quad .0316

TOTAL COST \quad \# .2056
APPENDIX D - 12

CAPITAL COSTS

Working Capital $65,000
Smelting Plant 1,250,000
Crushing Plant 10,000
Mining Machines and Development 100,000
Buildings 25,000
Power Plant 125,000
General 40,000

Total $1,615,000

Expense of Raising Capital $80,000

Amortization \[ \frac{0.10 \times 1,695,000}{15,000 \times 360} = \$0.0316 \]

Interest at 1% per annum per lb. copper
\[ \frac{1,695,000 \times 0.01}{15,000 \times 360} = \$0.00316 \]
APPENDIX D - 13

COMPUTATION OF 2:1 HOME

PER POUND COPPER.

Assay Value.

Ore mined = 300 Tons per day conc. to 150 Tons @ 90% Recovery.

Copper at 3% = 18,000 lbs. per day

Gold at .0441 oz./ton = 13.23 oz. per day

Silver at .677 oz./ton = 203.1 oz. per day

Assume 125 Tons slag per day

Copper .5% Ag. 20 oz. per ton Au .008 oz. per ton

125 x 2000 x .005= 1250 lbs copper in slag.

Copper Recovery .9 x 18,000 -1250=16200-1250=14950 lbs.

Silver Recovery .9 x 203.1-.2x125=1828-25=157.8 oz.

Gold Recovery .9 x 13.23-.008x125=11.91-1=10.91 oz.

Values

Copper 14,950 lbs. @ 16¢ per lb. = $2395.00

Silver 157.8 oz. @ 60¢ per ounce = 94.70

Gold 10.91 oz. @ $20.00 per oz. = 218.20

$2707.90

Value per lb. Cu $0.1810
APPENDIX D - 14

OPERATING COST

Mining Cost at $3.00 per ton ore mined
\[
\frac{3 \times 300}{14,950} = 0.0602
\]

Concentration Cost at $1.50 per Ton
\[
\frac{1.50 \times 300}{14,950} = 0.0301
\]

Smelting Cost at $4.25 per ton smelted
\[
\frac{4.25 \times 150}{14,950} = 0.0427
\]

Refining and Selling Cost

Freight at $8.00 per ton
\[
\frac{8.00}{2,000} = 0.0040
\]

Amortization

\[
0.0294
\]

TOTAL COST

\[
0.1964
\]
APPENDIX D - 15

CAPITAL COSTS

Working Capital $65,000
Smelting Plant 1,000,000
Concentration Plant and Mining Machinery & Development 140,000 100,000
Power Plant 125,000
Buildings 25,000
General 50,000
$1,505,000

Expense of Raising Capital
$1,580,000

Amortization .10 x $1580000 = $0.0294
14950 x 360

Interest Rate at 1% per annum per lb. copper
$1,580,000 x .01 = $0.00294
14,950 x 360
APPENDIX D - 16

COMPUTATION 6:1 HOME

PER POUND COPPER

Ore mined = 300 Tons per day concentrated to 50 tons. 25% Cu recovered, 33 1/3% Au & Ag recovered.

Copper at 3% = 18,000 lbs. per day

Gold at .0441 oz/ton = 13.23 oz. per day

Silver at .677 oz/ton = 203.1 oz. per day

Concentration Recovery

\[ .85 \times 18,000 = 15,300 \text{ lbs. copper} \]

\[ 1/3 \times 13.23 = 4.41 \text{ oz. Au} \]

\[ 1/3 \times 203.1 = 67.7 \text{ oz. Ag} \]

Smelting Recovery

Assume 25 Tons Slag .3% Cu .2 oz.Ag .008 oz. Au.

\[ 25 \times 2000 \times .005 = 250 \text{ lbs.} \]

\[ 15,300 - 250 = 15,050 \text{ lbs. Cu} \]

\[ 0.2 \times 25 = 5 \text{ oz.} \]

\[ 67.7 - 5 = 62.5 \text{ oz. Ag} \]

\[ 0.008 \times 25 = 0.2 \text{ oz.} \]

\[ 4.41 - 0.2 = 4.21 \text{ oz. Au} \]

Values

Copper 15,050 lbs. @ 16¢ = $2410.00

Gold 4.21 oz. @ $20.00 = 84.20

Silver 62.5 oz. @ 60¢ = $37.50

$2531.70

Per pound Copper = $0.1682
APPENDIX D - 17

OPERATING COST

Mining Cost at $3.00 per ton mined

\[
\frac{3 \times 300}{15,050} = .0598
\]

Concentration Cost at $1.50 per ton

\[
\frac{1.50 \times 300}{15,050} = .0299
\]

Smelting Cost at $4.50 per Ton

\[
\frac{4.50 \times 50}{15,050} = .0150
\]

Selling and Refining .0300

.0450

Freight Charges at $8.00 per Ton

\[
\frac{8.00}{2000} = .0040
\]

Amortization .0269

TOTAL COST .1656
APPENDIX D - 18

CAPITAL CHARGES

Working Capital $65,000
Smelting Plant 700,000
Concentrating Plant 250,000
Mining Machinery & Development 100,000
Buildings 25,000
Power Plant 200,000
General 50,000

$1,390,000

Expense of Raising Capital 70,000

Amortization $1,460,000 x .10 x 360 = $0.0269

Interest Rate at 1% per annum per lb. copper

$1,460,000 x .01 x 360 = .00289
ORBISON AND ORBISON

Appleton, Wis., May 6, 1921

Mr. Vernon T. Wakefield Gen. Mgr.

The G.M. Wakefield Mineral Land Company,

505 Mitchell Bldg.,

Milwaukee, Wis.

Dear Sir:-

In reference to the development of your Alaska power, I have, from the blue prints of the property which you left with me and from prices received on the machinery required, made an estimate of the cost of improvement, operation and amount of power that can be obtained, as follows:

**DAM**

The dam, made of a crib of rough timber 1 foot to 2 feet in diameter, planked on the up-stream face with two (2) thicknesses of 2" plank, will require about 7,000 lineal feet of the timber, 16,000 feet of 2" plank, and 1,600 cu. yds. of stone.

I can give an approximate cost, as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>7,000 lin ft. timber</td>
<td></td>
<td>$1.00</td>
<td>$7,000.00</td>
</tr>
<tr>
<td>16,000 ft. B.M. plank</td>
<td></td>
<td>40.00</td>
<td>640.00</td>
</tr>
<tr>
<td>1,600 cu yds. rock filling</td>
<td></td>
<td>1.50</td>
<td>2,400.00</td>
</tr>
<tr>
<td>Coffer Dam, drift bolts, etc.</td>
<td></td>
<td></td>
<td>1,120.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>$11,160.00</strong></td>
</tr>
</tbody>
</table>
The large item in the above is the timber. Your brother can tell more about the cost per lineal foot than I can. It has to be cut and delivered in the stream, floated to above dam, put in place, and notched to receive the next course, and drift bolted. Saying that the timber will average to scale 12" x 12", there will be around a million feet (or 1,000 thousand) for which I would say $7.00 per thousand a low price.

TURBINE;

I have specified a horizontal shaft, double discharge turbine, to operate under 115 ft. head, developing 800 H.P., at a speed of 600 R.P.M., using about 80 cu. ft. of water per second. This turbine to be installed in cast iron scroll case; includes steel plate draft tube, coupling on the turbine shaft for direct connection to generator; also, suitable flywheel with Woodward Oil Pressure Governor and relief valve for giving proper speed regulation. Inlet on the turbine case will be about 36" diameter; includes also iron body, bronze-mounted gate valve at the inlet to the scroll case. Estimated shipping weight of turbine, complete with governor, relief valve, draft tubes and gate valve, will be about 50,000 pounds. The price is
given at $21,000. too high by far. I think that when the time comes, this turbine can be had for $15,000.00

**GENERATOR:**

The price quoted is $6,000.00. I think that this is too high, but will leave it so, though you will probably buy for under $5,000.00.

**PENSTOCK:**

The penstock, 4 ft. in diameter by 420 ft. long will cost with bands erected about $9.00 per ft., $3,780.

**POWER HOUSE:**

This I estimate will cost, with excavation, coffer dam, etc., to get the full head and fall, say $21,000.00: but by discharging the water above in the harbor, $10,000 can be saved. Doing this will take ten (10) or twelve (12) feet from the head, and reduce the power about 10%. You will ultimately use all the power of the fall: therefore, I would not recommend reducing the head.

**INCIDENTALS:**

There will be a switchboard, station wiring, and other incidentals, like trimming the tunnel and building a bulk head for connection to the penstock. For these
items I allow $5,000.00.

**TOTAL COSTS:**

- Dam: $11,160.00
- Turbine: $15,000.00
- Generator: $5,000.00
- Penstock: $3,780.00
- Power House: $21,000.00
- Incidents: $5,060.00
- **TOTAL**: $61,000.00

**AMOUNT OF POWER:**

With eighty (80) second feet and 115 feet head, you will have \( \frac{80 \times 115}{11} \) = 837 horse power.

Deduct for Generator efficiency \( \frac{83}{11} \) " "

754 electrical horse power or multiplied by 3/4th equals 565 K.W.; or

\[ 565 \times 24 \times 365 = 4,949,000 \text{ K.W. Hours per yr.} \]

It is likely some water will be wasted, and will put down the actual K.W. made at 4 1/2 millions per year.
COST OF OPERATION:

Interest, 7% on $61,000 ----- $4,270.00
Depreciation, 3% on $61,000.00 1,830.00
Labor, 2 men at $2,000 ---- $4,000
" 1 man " 1,500 ---- 1,500 5,500.00
Incidentals ------- ------ -- 3,400.00
Total ---------- ----------- $15,000.00

This $15,000.00, divided by 4,500,000, is 3-1/3 mills per K.W.H.

To generate power with coal costs eight (8) mills and up, depending on the size and efficiency of the plant and the cost of coal. This power is worth to you at your mine at least one cent (1c.), if you can use it. If you can use only a part of it at present, it would be well worth while to improve it.

Respectfully,

ORBISON AND ORBISON

By Thomas W. Orbison.

TWO LMS

-5-
All quotations on ores and metals not under contract subject to change without notice.

TRUE COPY

Tacoma Smelter
American Smelting & Refining Co.
Tacoma, Wash.

H.Y. Walker
General Manager
R. F. Barker
General Superintendent
C. E. Little
Assistant Manager

March 21, 1923.

Mr. Benjamin P. Lane,
526 Beacon Street,
Boston.

Dear Sir:

In answer to your letter of March 15th, in which you ask that we send you our rates on pyritic ore similar to that shipped from Niblack mine:

Beg to say that ore of this class would be handled on approximately the following basis:

A deduction of 1.3% from the copper assay and a deduction of 3c. per pound from the copper quotation. Treatment rate $3.50 per ton.

Trust this is the information you desire, I am,

Yours truly,

(Signed) R. F. Barker

RFB/E
**APPENDIX G**

**COMPARISON OF LABOR COST**

<table>
<thead>
<tr>
<th></th>
<th>1904</th>
<th>1923</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$175.00</td>
<td>$350.00</td>
</tr>
<tr>
<td></td>
<td>2.50</td>
<td>3.50</td>
</tr>
<tr>
<td></td>
<td>2.50</td>
<td>3.00</td>
</tr>
<tr>
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<td>3.00</td>
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</tr>
<tr>
<td></td>
<td>3.00</td>
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</tr>
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</tr>
<tr>
<td></td>
<td>5.00</td>
<td></td>
</tr>
</tbody>
</table>

(1923 all labor pay $1.00 per day for board and lodging. It is deducted already as shown)

This shows that labor rates have increased from 20% to 117%.

The hours that laborers will work have been reduced from average of 10 to average of 8 per day.