

State Department of Geology and Mineral Industries

702 Woodlark Building
Portland, Oregon

ZINC RESERVES IN OREGON

INTRODUCTION.

On the basis of previously published reports of zinc in non-active mines in the Santiam, Silver Peak, and Bohemia mining districts, twelve properties were visited ~~during May~~ by geologists of the State Department of Geology and Mineral Industries. Five of these have developed reserves of ore, and the others show distinct possibilities. The results of this survey have been correlated with information supplied by private agencies to give the following estimates of tonnage:

- x (1) Development is such that actually proven reserves are small; but the total of reserves that we classify as "highly probable" total in excess of 600,000 tons of ore on which, on the basis of numerous assays, should yield approximately 50,000 tons of metallic zinc. This figure includes both the proven and probable ore.
- x (2) It is entirely possible that before the limits of ore in these mines are reached, the tonnage may exceed 1,500,000 tons, which should yield over 130,000 tons of metallic zinc, in addition to the above estimated tonnage from "Proven" and "Probable" classifications.

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ZINC RESERVES AT THE SILVER PEAK MINE Douglas County, Oregon

SUMMARY

Development and Production: The Silver Peak ore bodies are developed by three levels: the lowest crosscut is 600 feet long with 600 feet of drifts; the second main crosscut is 55 feet higher and is 480 feet long with 700 feet of drift; the third level is 195 feet above the first and is 170 feet long.

Production has been nominal, and values from it are averaged as follows:

1926-1937 Totals:	Tons Produced	Au ozs.	Ag ozs.	Cu.	Zn.
	6623	.095	3.77	5.61	6.00

Assays and Sampling: Returns from sampling and assaying across widths, averaging about 7 feet, give values of lower than the mine run as considerable waste material which can be sorted out in mining was included in the channel sampling.

Tonnage Reserves: Calculations of tonnage have been made on the basis of 8 cubic feet of ore to the ton. With widths of massive sulphide varying from 3 to 15 feet, the average is probably over 8 feet if both the two parallel orebodies are combined. The simplest possible calculations, based on a total length of 300 feet and a vertical distance of 200 feet, give an estimate of more or less certain ore of around 60,000 tons. The estimate of probable ore will add at least 40,000 tons. The ore is primary and should go without change to considerable depth, so "possible" ore might add at least another 300,000 tons. On the basis of the average zinc content of 6 percent, the proven tonnage of metallic zinc is 3600 tons; "probable" 2400 tons; and "possible" 18,000 tons, a total of 24,000 tons.

Shenon 33:15-23 gives the following description: "Location and access: The copper deposits of the Silver Peak district lie in the southern parts of Douglas County, Oregon, in secs. 23 and 26, T. 31 S., R. 6 W. By airline the mines are about 7 miles directly south of Riddle, a shipping point on the Southern Pacific Railroad, but by road the distance is about 9½ miles. The road is steep and narrow, but except during stormy periods is readily passable."

....."Deposits south of Silver Peak - History and Development: The mines of the Silver Peak Copper Co. and the Umpqua Consolidated Mining Co. are on a steep slope south and slightly west of Silver Peak, at a mean altitude of about 3,300 feet. The property of the Silver Peak Copper Co. is in sec. 26, T. 31 S., R. 6 W., and that of the Umpqua Consolidated Mining Co. which adjoins it on the north is in sec. 23. Ore was first discovered here in 1910 by Robert Thomason, on what is now Silver Peak Copper Co.'s ground. In 1912 J. E. Reeves purchased a patented timber claim which included a large portion of the ore that has since been developed. Little work was done until 1920, when the Oregon Exploration Co. located mineral claims over part of the timber claim. From 1922 to 1929 the property was in litigation, but during this period and in the following year 3,256 tons of ore was shipped from workings now owned by the Silver Peak Copper Co. In 1929 the Oregon Exploration Co. was reorganized as the Umpqua Consolidated Mining Co. This company shipped one car of ore (38 tons) in 1930. Both mines were idle at the time the writer visited them in September, 1930.

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"The orebodies have been explored on three principal levels. The lowest, the main level of the Umpqua Consolidated Mining Co., is a crosscut adit 600 feet long with two drifts aggregating about 600 feet. The main level of the Silver Peak Copper Co., 55 feet higher than the working mentioned and connected to it by a raise, is another crosscut adit about 480 feet long with 550 feet of drifts. The third level, known as No. 1, 195 feet above the Umpqua level, is an adit 170 feet long driven near the dividing line of the properties. There are in addition several shallow workings including a 30-foot shaft at a point 75 feet higher than level 1 and 270 feet above the main level of the Umpqua Consolidated Mining Co. Comfortable camps have been built on both properties, and at the Silver Peak Copper Co.'s mine a No. 10 Ingersoll-Rand compressor and a Fairbanks-Morse 120-horsepower engine, both new, were installed in 1930.

"Orebodies: The ore minerals occur as massive tabular bodies and disseminated in highly foliated schist. The two principal workings expose a zone of mineralized schist more than 100 feet wide. Across most of this zone sulphide minerals are rather sparsely distributed, but in at least two places bodies of nearly solid sulphide ore occur. One of these, in the main crosscut of the Silver Peak Copper Co., the "northwest band", is about 15 feet wide and another, the "southeast band", is over 20 feet wide. Both pinch out to the northeast, one within a distance of 200 feet and the other within 60 feet. Two sulphide bodies are exposed also on the main level of the Umpqua Consolidated mine, but there the northwest body is only about 10 inches wide, whereas the southeast body is about 10 feet wide. Normally the massive ore grades into schist with disseminated sulphides, but in some places, especially where the massive ore pinches, one or both walls are slickensided fault surfaces commonly lined with several inches of gouge.

"The massive sulphide ore is distinctly banded, probably in part because the ore minerals have replaced schistose rocks and in part because the minerals were introduced along parallel fractures in the rock. The sulphides include pyrite, sphalerite, chalcopyrite, bornite, galena, tennantite, chalcocite, and covellite, named in the relative order of their abundance. The last four mentioned occur in relatively small amounts. In addition the occurrence of native copper is reported by Mr. Reeves. The gangue minerals are principally quartz, barite, and sericite. Epidote was seen in one thin section of the ore.

"At the surface oxidation is almost complete. Level 1, for example, follows a porous, iron-stained, and greatly leached gossan in which no sulphides are visible. A short distance from the portal sulphides become visible and are abundant near the face. Sulphides were struck also in the 30-foot shaft on the Umpqua Consolidated property. Traces of oxidation extend as deep as the lower levels, as shown by thin films of oxide minerals along fractures.

"Quartz was the first gangue mineral to be deposited. It is everywhere fine grained but tends to be coarser in the fractures along which it was introduced. Barite was introduced next, then fracturing occurred, and pyrite was deposited. After a second fracturing sphalerite, tennantite, chalcopyrite, bornite, galena, and chalcocite were deposited as an overlapping series and probably in the order named, although the relation of galena and chalcocite was not well established.

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"The mineral composition differs in the different orebodies and within the layers of a single orebody, as shown for example by the northwest and southeast orebodies in the Umpqua Consolidated mine. The sulphides of the northwest orebody are associated with abundant quartz but very little barite, whereas the southeast orebody contains much barite and small amounts of quartz. The southeast orebody contains much barite and smaller amounts of quartz. The southeast body in the stopes above the level consists of nearly solid sulphides with some layers of barite. The barite is lenticular in outline, and any one layer does not persist very far. The sulphides are distinctly banded. One stope shows seven distinct bands with parallel structure. The composition of the northwest orebody resembles that of layers 3 and 6 of the southeast orebody as shown in the illustration. The ore exposed on the Silver Peak Copper level more nearly resembles the ore of the southeast orebody of the Umpqua Consolidated level. However, in some places - for example, near the top of the connecting raise - the copper sulphides are less abundant and the proportion of barite is greater than normal. At the turn in the drift, 30 feet northwest of the raise, the rocks are largely replaced by very fine grained silica that has irregular red jasperlike streaks.

"Four carefully cut samples taken at selected places serve to show the relative proportions of the metals to one another but do not necessarily illustrate the average metal content of the ore, which may be more closely determined from the production figures that follow. Analyses of the samples made in the chemical laboratory of the United States Geological Survey are given below:

Analyses of ores from the Silver Peak district, Oregon
(E. T. Erickson, analyst)

Sample No.	Silver (ounces per ton)	Gold (ounces per ton)	Copper (percent)	Zinc (percent)
8	0.59	0.09	4.05	5.5
9	.30	.01	.90	.9
10	4.58	.03	5.13	7.5
11	.46	.01	.93	.6

"8. Silver Peak Copper tunnel, northwest orebody. Sample taken in stope 33 feet above tunnel level across 5½ feet of massive sulphide ore.

"9. Umpqua Consolidated tunnel, main crosscut immediately northwest of massive sulphide band. Sample taken across 9 feet of schist with disseminated sulphides.

"10. Umpqua Consolidated tunnel. Sample taken across 7 feet of massive sulphide ore in stope along line A-A', plate 4.

"11. Silver Peak Copper tunnel, 30 feet northwest of top of connecting raise. Sample taken across 6 feet of intensely silicified rock containing some visible sulphides.

"The results show that copper and zinc increase and decrease together, but indicate no similar relations between those metals and gold and silver or between the gold and silver themselves.

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....."Origin of the ore: The mineralogy of the ores described above is evidence of their hypogene (deep-seated) origin - that is, the mineral assemblage as shown by the careful observations of many geologists belongs to Lindgren's mesothermal type, deposited at moderate depths by hot solutions. The source of the solutions is not evident from the geology in the immediate vicinity of the deposit, but quartz diorite and related rocks, which are believed to be the sources of many ore deposits in southwestern Oregon, are exposed a few miles distant and are probably not far below the surface at Silver Peak.

"The ore-bearing solutions, whatever their source, deposited gangue and sulphide minerals as they moved through the schistose rocks. The solutions apparently rose along planes of schistosity and replaced the adjoining material. Certain beds in the schist were apparently either more susceptible to replacement or were more readily penetrated by the solution than others, because solid sulphides occur interbedded with schist in which sulphides are sparsely distributed. The composition of the ore-bearing solutions probably changed during the period of deposition, because minerals of different composition have been deposited in an overlapping succession. Movements occurred within the rocks during the mineralization, once after the gangue minerals were deposited and again after the deposition of the pyrite. The later sulphides were deposited as a continuous series. After the deposition of the sulphides, strains within the rocks were relieved along faults, some of which have displaced the ore. More recently the sulphides near the surface have been oxidized, and much of the metal content of the outcrops has been removed by leaching. Erosion has kept pace fairly well with the oxidation, for at no place in the vicinity are oxide minerals known in abundance very far beneath the surface.

"Economic Aspects: The orebodies at the Silver Peak Copper and Umpqua Consolidated mines have not been sufficiently developed to permit exact tonnage estimates, nor has the ground in the immediate vicinity been sufficiently explored to indicate the probability of undiscovered orebodies nearby, but enough work has been done to demonstrate that fairly large bodies of good-grade massive sulphide ore are present. Also sampling shows that there is a possibility, when metal prices recover, of mining and milling lower-grade disseminated ore along with the higher-grade material.

"Only a very small percentage of the sulphides found on the lower levels are supergene (descended from above), and therefore it follows that there is not much likelihood of any material change in the metal content of the ore for some little distance below the present deepest level. However, owing to the fact that the outcrop has been almost entirely oxidized and much of the metallic content removed, more or less sulphide enrichment is to be expected immediately below the zone of oxidation.

"The facts available permit some conclusions as to the probable vertical and horizontal content of the ore. Foliated schists similar to those containing the ore are exposed at the surface for some distance north and south of the known orebodies. In places they are mineralized - for example, at the Golden Gate mine, to the north. Some mineralization was also noted in a schist of similar appearance about half a mile to the southwest. Underground the ore has been followed along the strike for a total distance of over 450 feet, and in at least two places it continues beyond the present workings. Both bodies of solid sulphide ore were sheared off in the northeast drifts of the Silver Peak Copper Co.'s main level but continue into the walls to the southwest of the present workings.

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"The southeast orebody on the Umpqua Consolidated level appears to turn into the southeast wall of the drift about 50 feet from the face. It appears also to have undergone shearing, and further work may prove that it is displaced. At the south end of the same drift the ore appears to end against an east-west, southward-dipping fault. Sulphide ore interlayered with barite is exposed on one side of this drift about 20 feet from the face, and it seems likely that the orebody may continue southwestward from this point. Thus the evidence underground does not suggest that the horizontal limits of the orebodies have been reached. Even where the ore is sheared off by faulting there is no known reason why the segments may not be recovered. Outcrops of partly oxidized sulphide ore occur 140 and 270 feet above the ore bodies found on the two main levels. No raises have been driven through to the surface to prospect the ground between these outcrops, although at one place ore has been stopped above the Silver Peak Copper Co.'s level for a vertical distance of about 90 feet. It seems reasonable, however, to expect the ore to continue to the surface, though not necessarily as one continuous body, because of the possibility of fault displacement. It is generally recognized that there is usually a relationship between the horizontal extent of an ore body and its downward extension, and as the ore bodies under discussion are exposed on the lower levels over a horizontal distance of 450 feet without having ended, they can reasonably be expected to extend for some distance below the present workings."

ESTIMATION OF RESERVES:

Definition of Terms: For the purposes of this report, one drift of ore in a hillside, together with a fairly well-exposed outcrop, will establish "proven" ore in the included vein when vertical distances are less than 100 feet. "Probable" ore is here regarded as ore that is outlined by development on only one or two sides. "Possible" ore is that ore that may possibly be mined before the entire ore-reserves of the mine are exhausted. Calculations of these "possible" reserves, the continuity of the known ore bodies, the type of ore, and the structural conditions, are all factors which have been taken into account.

Development: On the Silver Peak--Umpqua Consolidated Property--development has been insufficient, as can be seen on the accompanying map, to block out the ore bodies. However, certain estimations can be made with the above assumptions well in mind.

The two levels are over 200 feet below the outcrop, and the upper is 50 feet above the lower. The aggregate length of the ore exposed on both levels is nearly 700 feet with thicknesses varying from one to two feet up to over 15 feet. At the junction of the upper crosscut with the two ore bodies, the total thickness of both lenses is over 25 feet of solid sulphide; but usually the thickness is between 5 and 10 feet.

Correlation even between the two developed levels is very difficult since although the ore bodies are similar in strike and dip, they are offset both along their length and across their strike.

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Production and Assays:

Production Figures from Smelter Returns

Silver Peak Mine

	Width	Zn.	Au.	Ag.	Cu.
1926	389		.12	7.3	6.0
1928	937		.044	2.7	6.6
1929	1666		.07	3.6	5.6
1930	264		.057	3.0	4.4
1936	1001	6.88	.128	4.23	6.07
1937	2328	5.13	.058	2.34	5.13

Umpqua Consolidated

1930	38		.24	2.2	3.9
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Assays

Silver Peak Mine

Z1	From S.E. Drift:Stope, 100' N. of main Xcut, up 15' S side	5'	1.3	.04	0.4	2.5
Z2	From S.E.Drift: 25' S. of S. crosscut near raise	5'	0.6	.02	Tr.	1.1
Z3	From S.E.Drift: Stope, 100' N. of main Xcut, up 15', N. side	5'	9.2	.01	1.1	2.5
Z4	From S.E.Drift: E. end of main crosscut	15'	1.2	.03	0.8	2.1
Z6	From S.E.Drift: 35' from S end	6'	0.8	Tr	Nil	0.1
8	From N.W.Drift: Stope, 35' up, near main Xcut	5'6"	5.5	.09	.59	4.05
10		7'	7.5	.03	4.58	5.13

Estimates:

A block of massive ore 8 feet wide, 300 feet long, and 200 feet high (entirely above the lower tunnel level) gives, on a basis of 8 cubic feet of massive sulphide ore to the ton, 60,000 tons which at 6% should yield 3600 tons of metallic zinc. The entire length of the zone would give over 100,000 tons; and if another 100 feet of depth below the lower level were taken, the total tonnage should be over 200,000 tons of ore to yield 12,000 tons of metallic zinc. The type of ore suggests that ore bodies may continue to depths of many hundreds of feet, so the amount of "possible" ore may be as much as 500,000 tons.

ZINC RESERVES IN THE NORTH SANTIAM DISTRICT

On the north fork of the Santiam River there are a number of mines with ore containing an important zinc content. Of these the Amalgamated Mine (Pacific Smelting and Refining Co.) is by far the best developed. Details concerning this property are given in reports by Merritt and Rosenberg. The vein has been proven for a mile and a half on the surface, and has been developed underground for a horizontal distance of 1500 and a vertical distance of 480 feet. The vein has an average width of 12 feet, and an average of many assays gives 7.96% zinc, 1.14% lead, 0.36% copper, 0.033 ounces gold, and 0.404 ounces silver. Most engineers would give

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this property about 200,000 tons of "developed" ore, that is, ore reasonably well blocked out on two, three, or four sides by drifts and raises. The "probable" ore reserves amount to about 200,000 tons; and the "possible" reserves will be four or five times this amount, based on the statement above as regards surface exploration of the vein, vertical extent of known ore bodies, and our knowledge of the habit of mineralization in this area.

Other mines in the district contain zinc ore assaying as high as 25%; but development does not permit tonnage estimates.

The Blue Jay is a part of the Amalgated Group, lying half a mile to the east of the main tunnel. The vein is said to have been traced for over 2000 feet on the surface. One 400 foot drift shows that the average width of the vein approaches 4 feet, carrying up to 16% zinc.

The Blende Ore vein is proven by tunnels and open cuts for a horizontal distance of 1000' and a vertical distance of over 300'. In the lower 200-foot drift the vein averages 3 feet wide, and an ore shoot 100 feet long in the vein shows massive sphalerite lenses several feet long up to six inches wide in a zone of altered andesite from 12 to 65 inches wide which contains much disseminated sulfide. An assay of this latter material gave 4.6% zinc; .09 oz. Au.; 2.6 oz. Ag.; and 4.3% Cu. The average value of the ore should be considerably higher than this.

The Busche Group shows development on two veins totalling 100 feet and proving the vein for several hundred feet. The vein varies from one to six feet in width; one sample across four feet assaying 3.4% zinc.

The King #4 - A 40-foot tunnel on the King #4 claim shows a one foot vein of massive sulphide assaying 6.5% Zn and 0.2% Cu.

The Capitol, Mineral Harbor, and Silver King properties were also visited, but development was insufficient to determine any values.

ZINC RESERVES IN THE BOHEMIA DISTRICT

Although many properties in the Bohemia district have showing of zinc ore, only three show developed and unmined reserves. The most extensively developed of these is the Champion Mine (now being developed by the H & H Mines). Details concerning this property are given in reports by Higgins and Hinsdale. The vein has been developed over a vertical distance of 600 feet on 7 levels for over 1600 feet laterally. The average width is 26 inches. Assays average 7% zinc along the western 400 feet of the vein, and 3% or less along the eastern 1000 feet. Gold averages over half an oz. for the eastern part of the vein, less for the western. There is an ore reserve of probably close to 100,000 tons of ore classed as "probable" with possibilities of four or five times that much, especially as development on the western end of the vein, which is highest in zinc, has not reached the point where tonnages can be estimated. This mine has not been developed as a zinc mine but rather only for its precious metals content. If there should be a local smelter where zinc concentrates could be sold the mining policy would be changed somewhat

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and instead of this mine producing 5 to 8 tons per day of zinc concentrates-- as it will be within a few months, smelter or no smelter - it might produce several times this quantity of zinc.

The Musick vein has been proven for a distance of 1800 feet by development on four levels giving a vertical distance of 400 feet. The ore shoots which total about 900 feet in length, have been largely mined for 200 feet of this distance. The vein averages over 18 inches wide and assays from 6% to 8% zinc with usually at least 0.2 oz. of gold, 2 oz. of silver, 3% lead, and 0.5% copper. The unmined ore reserves are estimated at 30,000 tons "proven" and at greater depth will possibly reach four times that amount.

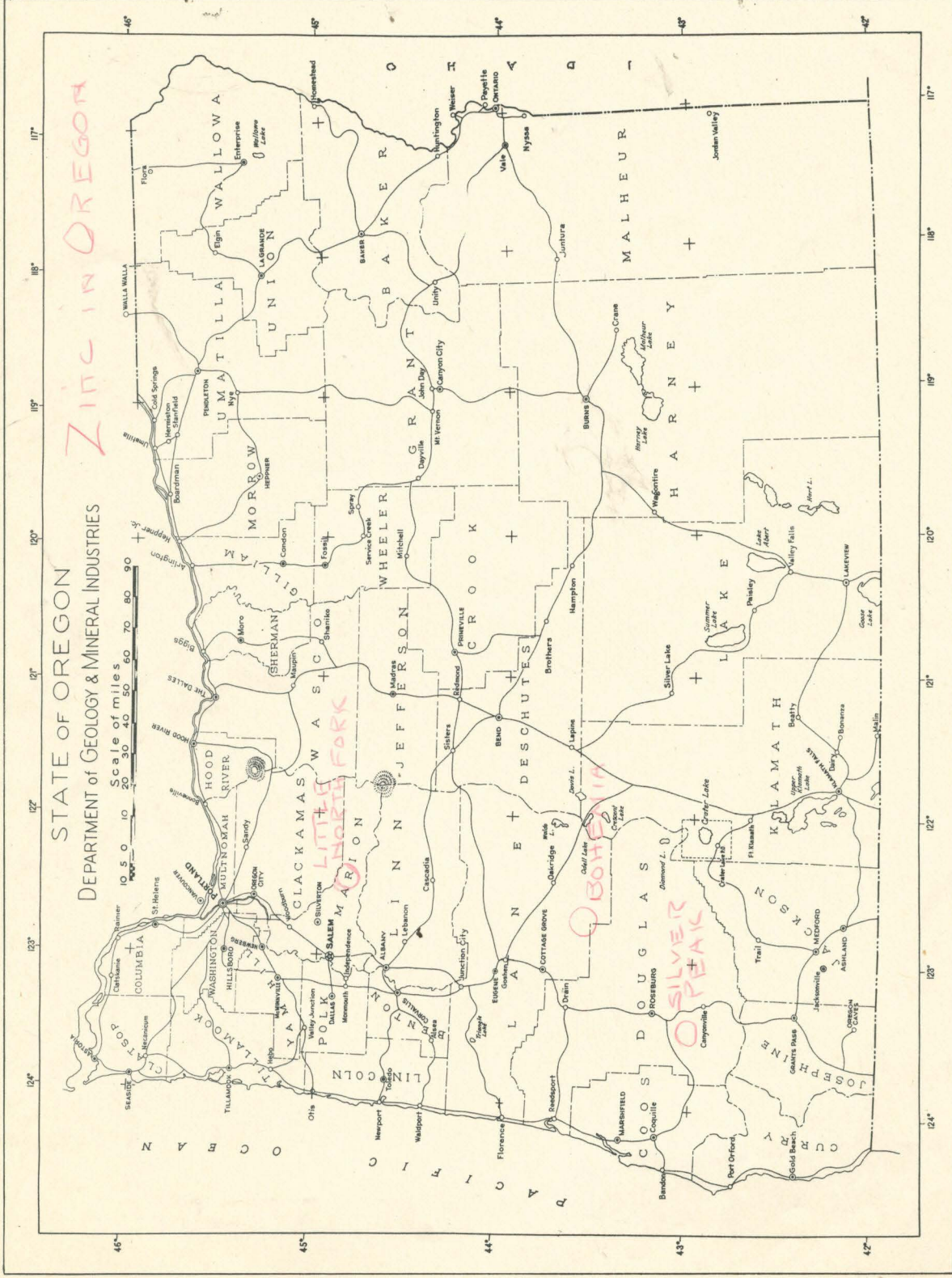
Helena Mine - The Helena vein has been proved for a distance of 3,000 feet in length and developed on 5 levels with a differential elevation of over 300 feet. The lowest or working tunnel runs for 750 feet along the vein, averages at least 5 feet in width with nearly half its length definitely in ore. The zinc content of sorted ore has in the past averaged nearly 3½%, with gold up to 2.0 ozs., as well as silver and copper values.

Assays taken across the vein gave values as follows:

<u>Width</u>	<u>Zn</u>	<u>Au</u>	<u>Ag</u>	<u>Cu</u>
4' gouge and quartz	1.3	Tr.	Nil	
8½' qtz. & sulphide	1.9	.02	0.4	
3' sulphide	2.4	.03	0.6	
Sorted ore from dump	4.7	2.58	5.5	0.2

The Sultana vein has been proved by two drifts, 650 and 850 feet long from crosscuts, by a 20-foot shaft, and by numerous shallow cuts for a horizontal distance of more than 2500 feet. The vein is mostly 3 to 4 feet wide containing shoots of quartz and sulphides; sphalerite, and galena being most abundant. One sulphide shoot is reported to be 80 feet long and from 6 inches to 2 feet wide. Panned concentrates from the ore assayed 40% Zn.; .02 oz. Au.; and .4 oz. Ag. The lead content is said to be frequently very high, running the silver up to 20 or 30 ounces.

The Grizzly, Leroy, Sunset, and War Eagle were also visited, but development was insufficient to determine values.



STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

Scale of miles
0 10 20 30 40 50 60 70 80 90

ZINC IN OREGON

LITTLE FORK
MARION

BOHEMIA

SILVER PEAK

UNITED STATES
DEPARTMENT OF THE INTERIOR
BONNEVILLE POWER ADMINISTRATION

PORTLAND, OREGON
October 16, 1942

IN REPLY REFER TO:

Mr. Earl K. Nixon, Director
Geology & Mineral Industries
702 Woodlark Building
Portland, Oregon

Dear Mr. Nixon:

Enclosed is a copy of report on zinc-lead mines which I pass on to you with the hope that it may be of some assistance in your work. This report, of a preliminary and "confidential" nature, was prepared by Mr. Harold L. Gage, Associate Mining Engineer of the Market Development Section. The information contained in the report was taken from standard reference books well known in the mining industry and does not attempt to include many properties which have not been publicized. The accuracy of the data, therefore, is no greater than that of the sources from which they were drawn. However, the information was carefully checked, and it is believed that the picture of each property is fairly represented up to the year 1940. Of course, since that time, exploration and development of zinc ore properties has been greatly accelerated, and the condition of some of the properties mentioned may have changed. The report is in loose-leaf form so that you may be able to add to it such properties as you may re-check or receive information thereon.

I hope that this report will be of some value to you, and I would greatly appreciate such comments as you may wish to make.

Sincerely yours,

SYSTEM PLANNING & MARKETING DIVISION

Ivan Bloch

IVAN BLOCH, Chief
Market Development Section

RECEIVED
OCT 19 1942
STATE DEPARTMENT OF GEOLOGY
& MINERAL INDS.

B. M. C.

Mr. H R Goss

There is no simple way to separate the lead and silver from the sulphide ore you have. Assuming that most of your ore is in the form of Galena, a lead sulphide containing small amounts of silver, you could roast it in a vessel which permitted free access of large quantities of air. ~~which~~ This would remove the sulfur and leave a mixture of lead and silver. Industrially silver is removed from lead by a repeated melting and partial crystallization, ~~followed by cupellation of the enriched lead~~ of the melt. Crystals containing appreciably less lead than the original mixture tend to form before the silver-rich fraction solidifies. By repeating this process many times the silver content is raised a great deal. The enriched fraction is then cupelled and the lead removed, mostly in the form of litharge.

From the foregoing you can see that the separation of silver and lead is an expensive and time-consuming operation and is not readily accomplished outside of a regular smelter.

The Department issues a monthly organ, the Ore Bin. We will be happy to place your name on our subscription list upon receipt of 50 cents for a one year's subscription.

DISCUSSION OF A PROPOSAL

TO ESTABLISH AN ELECTROLYTIC ZINC PLANT AT

BONNEVILLE POWER DEVELOPMENT

In considering the economics of zinc production in the United States, it is necessary to bear in mind that the Tri-State district of Missouri, Kansas and Oklahoma, which has been the dominant factor in tonnage, has passed its peak, and will play a decreasing role in the future. An extensive campaign of drilling failed to disclose any substantial extensions beyond the present productive area. This district will continue to produce for a long time to come, but the future zinc market in the United States will depend more and more on the complex ores of the western States, and this will involve adjustments in smelting locations and methods.

Speaking before the American Zinc Institute at St Louis on April 26, 1937, Walter Renton Ingalls, Director of the American Bureau of Metal Statistics, and recognized as a foremost authority on Zinc, said:

"America is not so rich in zinc ore resources as are other parts of the world, and the ores we mine average lower in lead and zinc. In my survey as of the end of 1930, I computed 179 million tons of lead-zinc ore in foreign countries showing an average grade of about 13% zinc and 7.3% lead, while the tabulation of about 180 million tons in the United States showed an average of 5% zinc and 1.25% lead. The latter tabulation included the great tonnage in the Tri-State District The time draws nearer every year when we shall be confronted with shortage in our domestic supply of zinc ore. Our old mines are becoming exhausted; we have but few that are being held in reserve. We do not discover many new mines, although I am not unmindful of the recent developments in the Bunker Hill & Sullivan, and at Pioche although the Morning Mine has but a few more years of life, some increase in zinc may come from the Coeur d'Alene We divert a considerable proportion of our sulphide concentrates (about 100,000 tons per year) and electrolytic dross to the direct manufacture of zinc oxide and lithopone. These substances come into increasing competition with other substances, and it is possible that the process of production of spelter may re-capture that supply or part of it"

From Mr. Ingall's remarks it is plain that he anticipated a shortage of zinc in this country in the not distant future. Word has now come from the Defense Commission at Washington, that they expect a shortage of 35,000 - 40,000 tons and they are already urging producers to step up their output.

A plant in the Bonneville area which can be on deep water, will be advantageously located to handle supplies from Alaska, or from British Columbia, and there are known to be promising deposits that have not been developed because there was no reduction plant to which zinc concentrates could be shipped without excessive freight charges. Peru in South America and the west coast of Mexico both have large undeveloped resources which would be within the Bonneville orbit if supplies have to be imported to supplement domestic supplies.

The present defense program makes it desirable to utilize as far as possible sources of zinc which are now lying dormant. There are within the range of Bonneville, such sources which can make a substantial contribution to current supplies.

A Report is available by Mr. Wm. L. Merritt of Acme Engineering Service, 637 Railway Exchange Building, Portland, which gives total reserves as 315,587 tons. These are tabulated as follows:

Blocks	Zinc %	Lead %	Copper %	Gold oz	Silver oz	Tonnage proven and in sight.
"A"	8.1	0.95	0.36	0.02	0.60	5,745 tons
"B"	4.9	0.80	0.90	0.02	0.30	18,763 "
"C"	10.45	3.075	0.175	0.022	0.90	23,272 "
"D"	8.045	.64	0.305	0.025	0.22	109,145 "
"E"	7.80	.50	0.31	0.02	---	25,822 "
"F"	5.86	.605	0.212	0.03	0.47	32,130 "
"G"	10.30	.45	.40	0.04	0.60	15,680 "
"H"	6.00	1.75	.14	0.02	0.20	4,200 "
"J"	10.92	1.31	.365	0.115	0.40	13,070 "
"K"	<u>7.23</u>	<u>1.30</u>	<u>.448</u>	<u>0.021</u>	<u>0.35</u>	<u>67,760 "</u>
Average	7.96	1.138	.361	0.0333	0.404	315,587 "

While these reserves are developed on three levels -(two sides only)- the sampling indicates that all the blocks except "K" may be safely taken as developed ore although the raises necessary to bring them fully into the standard position for such classification, are lacking. Block "K" covers the developed length on the lower tunnel level to a depth of 50 feet below that level. Block H, while exposed only on level No 4, can be safely included as developed ore.

The development on the bottom level shows that two ore shoots on the level above have extended laterally until they form a continuous ore body. This is a favorable indication for the next block below.

As regards possible ore, Mr. Merritt is of the opinion that driving the middle level ahead for 150 feet will reach an undeveloped ore shoot, with backs above the lowest level of 780 feet. Arbitrarily assigning a length of 100 feet to this shoot, -this being the shortest length of any of the exposed shoots, and an average width of 8 feet would give 45,800 tons in such a block of ground.

Mr. Merritt is of the opinion that geological conditions indicate that the ore shoots may be expected to continue to very considerable depths.

Other undeveloped veins in the same area are reported to indicate distinct possibilities of the existence of commercial ore shoots, so that, given an outlet for the zinc concentrates, this area should be able to supply larger tonnages than the existing development justifies.

Present exposures justify an initial production of 250 tons per day from which there would be produced 280 tons of concentrates, which in turn would yield 14 tons of metallic zinc.

Bohemia District - This district is being developed primarily for precious metals, and there are reliable reports that a production of 5 to 6 tons of zinc concentrates per day would be made if there were any place to market them.

This tonnage would yield 2.5 tons of zinc per day.

Metaline Falls District - This district in northeastern Washington is a producer and is now shipping 60 tons of high grade zinc concentrates to the reduction plant at Great Falls Montana. Most of these concentrates move over the Milwaukee road and the distance is 806 miles. Over the Great Northern the distance would be 653 miles. The distance via Great Northern to Portland is 499 miles which might result in a lower commodity rate than that now in force to Great Falls. The present rate is a smelting in transit rate and it is therefore doubtful whether the concentrate hauling end would be reduced, even in face of competition.

A plant at Portland could meet present schedules, and even lower them slightly to get this business, and tentative inquiries have indicated that the shippers, - the Pend Oreille Mines & Metals Co. would be open to discussions. These concentrates are high in zinc, but have only traces of gold and silver. The average content, as given by the shippers is:

Zn	Pb	Cu	Fe	Insol	Sb	Cd	As	S	Ag	Au	CaO	MgO
61.6	0.70	0.05	0.55	4.3	tr	0.27	tr	30.4	tr	tr	0.80	0.36

Sixty tons of such concentrates would yield 30 tons of zinc per day.

There are reports that certain mines in the Coeur d'Alene District are unable to market their zinc concentrates locally. The Haley District of Southern Idaho also has deposits carrying zinc, but this latter metal is of no interest now due to lack of a shipping point. A plant at Portland would be within the necessary distance to enable shipments to move.

CALIFORNIA

Shasta County - The copper-zinc mines of the Bully Hill and Afterthought districts have been operated at various times with indifferent success, largely because of lack of a suitable outlet for zinc concentrates. The records of the U. S. Bureau of mines give a total production of sulphide ores of 578,332 tons. Data on zinc is incomplete as in early years no record of assays was kept.

The largest developed properties are now held by the California Zinc Co. controlled by Mr. A. D. Joyce of the Glidden Paint Co.

THE RISING STAR MINE is reported to have produced 100,000 tons of ore oer level, or 500,000 tons for the five levels developed at 100 foot intervals. The ore occurs in lenses which average 20-30 feet wide and 250 feet long. Rogers, Mayer & Ball report that only 10% of the promising ground at this mine has been developed.

Up to 1920, this mine had an approximate production of 175,000-200,000 tons of selected copper ore, the zinc being avoided as far as possible. In 1924, 1925, 1926 and 1927, the California Zinc Co mined 81,072 tons of

ore from this mine. The average content was:

Cu. - 2.03% ; Zn.-19.64% ; Au 0.02 oz. ; Ag 2.00 oz.

The ore reserves in this mine we were estimated to be:

Date of Estimate	March 12, 1920	May 1, 1920
Estimate by	Rogers & Ball	Beals & Nowland
Developed Ore	126,300 tons	212,625 tons
Probable Ore	71,000 "	37,650 "
Total developed & Probable	197,300 "	250,275 "

It is reported that California Zinc did no development work so, based on Rogers & Ball estimate, there are now available:

Developed Ore	45,228 tons
Probable Ore	71,000 "
Total	116,228 "

BULLY HILL MINE From 1910 to 1910, a total of 22,946 tons of copper ore was produced. Full assay plans were kept, showing copper gold and silver values, but zinc was determined only irregularly. In 1920, Mr. R. L. Beals, on behalf of the Jackling interests, estimated the reserves in this mine at 124,000 tons averaging:

Cu.- 2.8 % ; Zn 12.0% ; Au 0.06 oz and silver 5.1 oz.

As no mining has been done since that time, these reserves are intact.

COPPER CITY MINE The recorded production is given as 16,850 tons mined for copper. No figures are available as to average content. Zinc was said to be too high for profitable exploitation as a copper producer.

AFTERTHOUGHT MINE - The U. S. Geological Survey has a record of production of:

1917 - 2,605 tons with 4.3% Zn ; 4.2% Cu ; 5.2 oz Ag
1918 -14,996 " " 7.2% " ; 9.5% " ; 2.6 " "
1919 - 6,000 " " 24.0% " ; 4.2% " ; 4.9 " "

From 1925 to Aug 1927 the California Zinc Co. produced 38,062 tons of ore with average content:

Cu - 2.65% ; Zn 15.85% ; Au 0.02 oz ; Ag 4.5 oz.

The lowest or 800 foot level is not completely developed. Present drifts show good ore in seams, and it is the opinion of the last operators that its possibilities are not exposed.

There are probably not large ore reserves that could now be taken out. The foremen during the last operations believes that a mill could be kept going with 125 tons per day for 6 months during which active development would be necessary.

THE DONKEY MINE adjoins the Afterthought on the south east. A considerable number of surface workings are all said to have shown ore too zincy to make it suitable for copper smelting. This property could be efficiently developed through the Afterthought tunnel, and is considered to offer prospects of a considerable tonnage of high zinc ores with proper development.

The Afterthought and Donkey mines are available. Mr. Joyce's asking price is a total of \$200,000, and terms can be arranged by which the bulk of the payments can be made as royalty as ore is extracted.

The Bully Hill and Rising Star groups are not on the market at present. These two groups will be affected by the lake formed behind the Shasta Dam now under construction, and negotiations are now progressing with the Interior Department regarding possible damage to the mines from the water.

The Glidden Company is interested in a Lithopone Plant at Oakland, and considers that its mines in Shasta County are potential sources of zinc for that plant. Considering the quantity of zinc which can probably be marketed for making lithopone, it is probable that ultimately the bulk of production would come within the orbit of a plant at Bonneville.

The cadmium content of the Shasta County ores is unusually high. The Manager of the California Zinc Co. gives the cadmium content of bulk concentrates with 47% Zn as 16 lbs or 0.8%.

OTHER OCCURRENCES There are other prospects along this belt of alaskite porphyry which show the characteristic type of ore. Between Copper City and the Rising Star mine, are partially developed prospects showing ore high in zinc. Between the Afterthought and Bully Hill is a slightly developed prospect showing ore with copper and zinc. Work is too slight to give any real idea as to size or grade. It is, however, a favorable prospect. About 7-8 miles south east of Afterthought is a group of prospects on which some superficial work has been done. The surface is largely obscured by a thin lava flow. Assays from shallow pits gave:

Cu. - 1-2% ; Zn. - 6-12% ; Au 0.10 oz and some silver and lead.

The freight to Bonneville of concentrates would be about \$4.75.

FOOTHILL COPPER-ZINC BELT

This belt of copper zinc ores extends from Salmon Falls, just south of the American River in Eldorado County, through Copper Hill, Ione, Campo Seco, Jennie Lind, Telegraph City to the vicinity of Blanchard in Tuolumne County, a distance of some 85 miles. There are 24 known copper-zinc mines along this belt which were worked for the rich secondary copper ores that occurred along or near the bottom of the oxidized zone. This work was done some 75 years ago and at that time but feeble attempts were made to treat the underlying sulphide ores. These were evidently unsuccessful.

PENN MINE. This mine near Campo Seco, in Amador County was opened in 1910 and extensively worked. At this point, one of two lenses was found to be relatively high in copper and low in zinc. From 1910 to 1918 it produced 428,720 tons of ore which was profitably smelted for copper. With the fall in copper prices after 1918, it could not be operated at a profit. A report made for the American Smelting & Refining Co. by J. Kruttschnitt Jr. in 1926, gives present reserves as 175,000 tons. The most of these reserves are in the west or zinc lense. The reserves as reported by Kruttschnitt are:

<u>Location</u>	<u>Sampled</u>	<u>Probable</u>	<u>Prospective</u>	<u>Total</u>
No 2 Lense	68,643	30,000	35,000	133,673
No 3 "	32,713	10,000	-----	42,713
	<u>101,360</u>	<u>40,000</u>	<u>35,000</u>	<u>176,368</u>

Regarding the prospective ore, this was in the No 2 lense between the deepest workings and the Campo Seco fault. Mr. A. P. Busey, who was manager during the years 1910-1918, states that the No 2 lense, after showing some broken ground, had again developed into a solid lense, and he believes it will continue down to the fault. The 35,000 tons are therefore probably there.

This mine showed two lenses, one in each of two veins about 300 feet apart horizontally. Each of these lenses was practically continuous from the surface to the Camp Seco fault which cuts the west vein at 1100 feet and the east vein at 1400 feet. This fault has a horizontal displacement of 1100 feet. The east lense which contained the better copper ore, was developed below the fault by an internal shaft to 3400 feet. Below the 2800 foot level, while ore continued it was only 2 feet wide, which was not commercial. The ore reserves sampled by Kruttschnitt are between the 1900 and 2800 foot levels.

As all the equipment has now been removed from the East shaft it is probably wise to leave these reserves out of consideration. The cost of unwatering would be high. However a long drift to prospect the west lense on the 1800 foot level from the No 3 shaft had reached within 800 feet of its objective and might be an inducement for re-opening the shaft and putting in enough equipment to take out the known reserves. Much would depend on copper prices as these reserves have only about 5% zinc, but are relatively high in copper.

The content of the 68,643 tons sampled in the No 2 - (west) workings was:

Cu . - %	Zn %	Au oz/ton	Ag oz/ton
3.2	11.01	0.071	3.06

If the ore in the No 2 lense continued below the fault to the same depth as it did in the No 3 or east lense, then there would be an additional 350,000 tons. Appearances are said to indicate a reasonable expectation of this.

I have one analysis of zinc fume made from zinc middlings running 28.6% zinc. This fume contained 1.1% Cadmium. Using this ratio, 55% zinc concentrates would contain 0.7% or 14 lbs per ton. This is about in line with the content of the Shasta County ores.

The distance to Stockton is about .35 miles and trucking should not cost over \$1.25. Ocean freight of \$3.50 and .50 at the Bonneville end would make a total charge for freight to plant of \$5.25.

Assuming a production of 125 tons per day, the estimated reserves would last 3 years and there is excellent prospect of 8-10 years after that from reserves below the fault.

CONSTELLATION Adjoins the Penn on the south. The Reports of the State Mineralogist state that a shaft was sunk to a depth of 200 feet on the continuation of the east vein from the Penn Mine. At this depth a crosscut cut 7 feet of sulphides assaying 3.00% Cu. ; 9.5% Zn. ; 0.13 oz/ton Au.; and 3.0 oz/ton Ag. Ore from this shaft could be delivered to a mill on the Penn property.

Adjacent to the Penn mine on the north are surface showings of gossan which the latter were anxious to develop, but the price at which they were held was so high that no agreement was ever reached.

The Penn mine is now idle, and has been offered to me at a price of \$50,000 payable from royalty of 50¢ per ton of ore.

Concentration tests made in the laboratory of the Combined Metals Reduction Co. at Bauer, Utah, showed that copper concentrates with 20 - 25% Copper with 85-90% recovery could be made, carrying a maximum of 5% Zn and zinc concentrates with 55% Zn with recovery above 70%. Gold and silver recoveries of 80% can be made if a little iron is allowed to float.

TELEGRAPH HILL GROUP. Centered around Telegraph City within a distance of $2\frac{1}{2}$ miles along the belt, are 4 deposits which have been worked in the past. Two of them, the Quail Hill, and the Napoleon, have a record of a considerable production of rich copper ores from the zone of secondary enrichment. In the others, such ores seem to have been lacking.

QUAIL HILL A shaft has been sunk to a depth of 300 feet with levels in sulphides at 70, 170, and 270 feet. A report by Hershey indicates that this was a chimney associated with a cross fault and was not in the main fissure. Reports are that the chimney had bottomed above the 270 foot level. The ore shipped from it was very good grade. Available data as to shipments to Tacoma smelter has been assembled by Mr. W. G. Swart, E. M. as follows:

Tons	Au oz/ton	Ag oz/ton	Cu %	Zn %
2,622.1	0.400	6.51	5.58	15.60

I found some ore remaining in the corners of the shipping bins which assayed

Au oz/ton	Ag oz/ton	Cu %	Zn %
.41	10.69	5.6	25.3

This ore had been exposed for some years and was certainly somewhat oxidized. Flotation tests showed that a copper concentrate of over 24% Cu with between 6 and 9% Zn with recovery of 70-75%, and a zinc concentrate of 50-55% with a recovery of 85% could be made. Gold and silver recoveries were erratic which may have been due to semi-oxidation.

The distance to Stockton would be about the same as from the Penn mine and cost of freight about the same.

NAPOLEON Mine The owner, Mr. E. H. Nutter of Minerals Separation Co. believes that there is somewhere between fifteen and forty thousand tons of zincy ore above the 250 foot level. He gets this information from conversation with a lessee who opened up the property some years ago. He places the probable assay as based on some crude concentrate attempts, at:

Au oz/ton	Ag oz/ton	Cu %	Zn %
0.24	3.6	3.2	8.0

COLLIER The Collier is about a quarter of a mile south of the Napoleon, and has a shaft about 70 feet deep. There appear to have been no secondary ores at this point. A sample from about 5 tons of recently mined ore lying on the dump assayed:

Au pz/ton	Ag oz/ton	Cu %	Zn %	Pb %
0.10	11.40	2.3	22.4	1.28

A line of shallow pits showing gossan extends well along toward the Napoleon.

GOPHER HILL This occurrence lies 4000 feet south east of Quail Hill in the direction of the Napoleon. A sketch signed by Mr. W. G. Swart E. M. shows two levels in the oxidized zone outlining ore 110 feet long and 75 feet wide. Neither copper nor zinc percentages are given, as gold seems to have been the attraction.

There is a paragraph in the Reports of the State Mineralogist saying that an ore body 230 feet long and 5 feet wide was opened at this point which averaged:

Au oz/ton	Ag oz/ton	Cu %	Zn %
0.32	5.0	2.0	10.0

Such maps and sections as are now available do not show that such a length is actually opened. The 78 foot level is marked as in sulphides.

COPPER HILL This deposit, located some 10 miles north of Ione, on the south bank of the Cosumnes River, shows evidences of considerable past work. There are evidences of heap roasting and considerable slag shows that smelting was conducted there. There are two parallel veins about 50 feet apart. These might be the same two veins which exist at The Penn Mine, but there they are 300 feet apart. Most of the work has been done on the west, or Cosumnes vein, on which a shaft has been sunk to 250 feet. According to the Reports of the State Mineralogist, most of the ore smelted came from the bottom level of this shaft, which has a drift north for 328 feet and south for 228 feet, a total length of 558 feet. On the Cosumnes vein there is a shaft 90 feet deep located 1500 feet south of the main shaft, and on the east vein a shaft of similar depth called the zinc shaft, 900 feet to the north. This indicates ore over a length of 2400 feet. The State Report speaks of wide lenses in a vein 2-4 feet wide.

No definite data as to the assay of the sulphide ore is available.

IONE COAL & IRON CO. This occurrence is about 2 miles north of Ione, and about 8 miles south of Copper Hill. There are four shafts covering a length along the strike of about 1000 feet. Ore was found in each of these. The State Repors give the width of vein as four feet, and sulphide ores were heap roasted and smelted. No definite data is available. A few pieces of ore lying on one of the dumps gave:

Au oz/ton	Ag oz/ton	Cu %	Zn %
0.78	8.98	5.1	Not run

JENNIE LIND - No definite data is available as to the occurrences near this town. It is about 7 miles south of the Penn Mine, and surface indications are fairly extensive.

BIG BUZZARD - This occurrence near Salman Falls close to the south fork of the American River, appears to be the most northerly occurrence of importance along the fracture. In 1928, one shaft was still open and samples at 10 foot intervals along a drift for fifty feet, gave an average width of 6 feet with content:

Au oz/ton	Ag oz/ton	Cu %	Zn %
0.7	15.0	3.4	17.10

While only fifty feet could be sampled, surface workings point to ore over a considerable distance. As ore of that character had no market, development was evidently dropped.

BLANCHARD - In Tuolumne County, just north of the Stanislaus River, a deposit was opened a few years ago, showing sulphide ore high in zinc and gold. This is apparently on the same fracture, and probably marks its southern extent.

The Foothill copper-zinc belt is the locus of important ore bodies, as shown by the results at the one point where development has been carried to any depth. At this point, the Penn Mine, there are two parallel veins about 300 feet apart. Further north, at Copper Hill, there are two veins, but the distance between them is only 50 feet. This indicates that they are converging. The Nassau mine, about 7 miles east of Telegraph City has developed a considerable amount of zinc ores high in gold. This might be on the east of the two veins, if they are converging or rather diverging toward the south.

The east vein at the Penn mine was commercial to a depth of 2800 feet. Ore continued to the bottom of the internal shaft at 3400 feet, but widths below 2800 feet averaged only 2 feet which could not be mined. The grade was the same.

The length of the fracture in which the ore bodies occur, its location in the same type of rocks in which the mother lode fracture occurs about 12 miles east, where workings are down over 6000 feet, makes it reasonable to expect that other occurrences comparable with the Penn mine exist along the fracture.

Any attempt to designate definite tonnage at present must be only a guess. The lengths reported in the Reports of the State Mineralogist at Copper Hill and Ione would, if the lenses persisted to depths comparable with those demonstrated at the Penn Mine, yield a million tons at each occurrence. The four deposits around Telegraph City may have a similar tonnage. Taken altogether, it is not a wild guess to assume that this channel will produce several million tons of ore which can be treated at a satisfactory profit if the zinc contributes its fair share of the revenue.

NASSAU MINE. This mine attempted recently to ship ore or bulk concentrates to the U. S. Smelting Co. at Salt Lake where it was planned to separate the zinc from the lead in their concentrator. It is reported that it failed to yield enough returns. I have no definite data, beyond favorable reports as to its being a potential shipper of concentrates.

THE MARKET FOR ZINC ON THE PACIFIC COAST

A fairly complete inquiry a few years ago with the aid of the Chamber of Commerce of San Francisco and Los Angeles, indicated that actual consumption was not far from 75 tons per day. This estimate was confirmed by personal contact with representative of a large metal selling group.

A considerable part of the consumption is in the form of oxide, and the high purity of electrolytic zinc guarantees a product at least equal to that of the New Jersey Zinc Co.

Die casting is a growing industry on the Pacific Coast, and for this electrolytic zinc purity is essential.

The bulk of the zinc used for galvanizing is at present supplied by the retort plant at Amarillo, Texas. There has been complaint regarding the lead, iron, and cadmium content of the Amarillo zinc, and one large producer stated that they had at times to stretch specifications.

The survey, conducted by the Chambers of Commerce, which covered only large consumers, showed:

		<u>Annual Consumption</u>	
<u>Slab Zinc</u>			
Los Angeles Area		4,000	tons metal
San Francisco Area		5,880	" "
<u>Brass</u>			
Los Angeles	4,000 tons containing	1,600	" "
San Francisco	1,250 " "	500	" "
<u>Zinc Oxide</u>			
Los Angeles - Tires	4,980 tons containing	3,980	" "
	Paint 2,400 " "	1,920	" "
	Ceramics 500 " "	400	" "
San Francisco-	2,125 " "	<u>1,700</u>	" "
	TOTAL	19,980	

EASTERN MARKETS

In addition to the market on the Pacific Coast in which a plant at Bonneville would have a freight advantage, freight rates via Panama Canal will enable the product to reach Atlantic Coast markets on a freight par with zinc produced at East St. Louis. The differential in prices between New York and St. Louis is the actual amount of the freight or 0.3¢ per pound.

The steamships are ready to apply the existing copper rate of \$4.00 which has now been in force for a long time, to zinc. The total delivery charges will be

Delivery to steamer, including dock & harbor dues	\$1.00/ton
Ocean Freight	4.00 "
Atlantic terminal charges inc. local freight	.50
Insurance, interest, contingencies	.50
TOTAL	<u>\$6.00</u>

The principal factors which enter into a discussion of the commercial aspects of a proposal to construct a plant near Bonneville Dam, are:

- 1 - The available sources of zinc concentrates.
- 2 - The market for the product, the prices at which it can be sold, and the possible competition with other producers.
- 3 - The cost of production
- 4 - The Capital required and the returns which may be expected for its use

A plant in the Bonneville area will have power rates considerably lower than those now enjoyed by any electrolytic zinc plant.

1 - SOURCES OF ZINC CONCENTRATES

OREGON & WASHINGTON & IDAHO

A map issued by the Pacific Northwest Regional Planning Commission, lists seven known zinc occurrences in Oregon, west of the main divide of the Cascade range, and five in Washington.

The nearest zinc reduction plants are at Kellogg, Idaho, in the Coeur d'Alene District and at Great Falls and Anaconda, Montana. The nearest plant, -that at Kellogg has large reserves of zinc ore in its own mines, and has accepted only small amounts of custom concentrates. Freight rates to Montana plants have been too high to induce development, in most cases.

There are in northeastern Washington, important zinc occurrences which have been shipping regularly to Montana plants, but in actual rail distance, they are nearer Bonneville than to either Great Falls or Anaconda.

In the Jordan Valley of southwestern Idaho, close to the Oregon line there are 318,000 tons of zinc-silver ores developed with prospects of a much larger tonnage This assays:

<u>Au - oz</u>	<u>Ag-oz</u>	<u>Cu-%</u>	<u>Pb-%</u>	<u>Zn-%</u>
.026	10.19	0.62	0.88	14.56

This ore is tributary to Bonneville, and could probably be most economically treated through a reduction plant there.

In the Hailey District of southern Idaho, are considerable reserves both in mines and dumps, which could be brought into production with the necessary reduction plant so that the zinc concentrates could be profitably shipped.

Columbia Mines Development Co. - This Company has developed an occurrence on the Santiam River, about 100 miles from Portland, and now has a substantial reserve ready for stoping. The property is at an elevation of 3000 feet, where operations can be maintained without difficulty throughout the year. Only occasionally is a snow plow required to maintain communications. At present but one vein system has been explored, but it is reported that there are other parallel systems of promise.

A plant at Bonneville would have some protection against competitive shipments from the east, by higher westbound freight rates. Present rates are:

On Spelter	\$ 7.00/ton by slow steamer
	8.00/ " " fast "
On Slab Zinc (Specified as not spelter)	10.00 " " slow "
	11.00 " " fast "

Electrolytic or other high grade zinc would take the last classification.

METAL PRICES

The bulk of the zinc used for galvanizing at California Plants comes from the retort plant at Amarillo, Texas. The freight rate to Los Angeles or San Francisco is 60¢ per hundred pounds. The smelter is at present absorbing 17½¢ of these charges, billing to large consumers at 42½¢ per hundred over St Louis base prices. Small consumers are, however, paying up to \$1.05 per hundred over St. Louis base. The freight rate from Amarillo to St Louis is 19½¢ per hundred pounds, so the Amarillo plant could bill to Pacific coast consumers at 60-19½¢ - 40½¢ and still be on an equal footing in either market. This latter figure has therefore been used in the following calculations.

Electrolytic zinc is nominally quoted at 1¢ above St Louis base prices for spelter. There is a growing market on the Pacific Coast for metal for die-casting, and only zinc comparable in purity with electrolytic zinc can enter this market. Recent inquiries indicate a consumption of 200 tons per month in the die casting plants at Los Angeles and San Francisco, and there is no doubt but that part of this market could be obtained. The production of electrolytic zinc has now reached such proportions that it should not be expected that the total output of a plant could be sold at a premium. Although there is no question but that the resistance to corrosion of electrolytic zinc is much greater than of spelter, it makes a dull grey coating instead of the pretty spangles, and galvanizers will not pay any premium for it.

The product of the Amarillo plant, made by retort process from impure ores has considerable percentages of iron and cadmium, both of which are objectionable in galvanizing, and one at least of the large consumers on the Pacific Coast reports trouble with peeling and that they had frequently to stretch their specifications to enable the Amarillo product to pass. Asked whether at the same price, they would prefer a spelter made from electrolytic zinc with the exact addition of lead to give them their conditions, they said there would be no doubt about it. From this it is safe to infer that at equal prices an electrolytic plant could expect to gain practically this whole market on the Pacific Coast.

Ocean freight from plant to Los Angeles should not exceed \$3.50 and to San Francisco \$2.50 per ton. Harbor dues on coastal shipments are 5¢ per hundred. The maximum charge from steamship to consumer should not exceed \$1.00. If we assume 50¢ trucking at the Bonneville end and 5¢ wharfage, the total delivery charges on zinc sold in the San Francisco Bay area would be not over \$4.20 or 0.21¢/lb. Local delivery charges at Los Angeles would not exceed 60¢ per ton so that total delivery costs would be about \$4.80 per ton or 0.24¢/lb.

SCALE OF OPERATIONS

Speaking before the American Zinc Institute at St Louis, on April 26, 1937, Walter Renton Ingalls, Director of the American Bureau of Metal Statistics, and recognized as a foremost authority on Zinc, said:

"America is not so rich in zinc ore resources as are other parts of the world, and the ores we mine average lower in lead and zinc. In my survey as of the end of 1930, I computed 179 million tons of lead-zinc ore in foreign countries showing an average grade of about 13% zinc and 7.3% lead, while the tabulation of about 180 million tons in the United States showed an average of 5% zinc and 1.25% lead. The latter tabulation included the great tonnage in the Tri-State District The time draws nearer every year when we shall be confronted with shortage in our domestic supply of zinc ore. Our old mines are becoming exhausted; we have but few that are being held in reserve. We do not discover many new mines, although I am not unmindful of recent developments in the Bunker Hill and Sullivan and at Pioche although the Morning mine has but a few years more of life, some increase in zinc may come from the Coeur d'Alene We divert a considerable proportion of our sulphide concentrates, (about 100,000 tons per year), and electrolytic dross to the direct manufacture of zinc oxide and lithopone. Those substances come into increasing competition with other substances, and it is possible that the process of production of spelter may recapture that supply, or part of it."

From Mr. Ingalls' remarks it appears plain that there is a probability of an underproduction of zinc in the near future, and it might even be necessary to bring in supplies from abroad. A plant in the Bonneville area will be advantageously located to handle supplies which are now dormant. It can receive concentrates by steamer direct at the plant, and it is known that there are large reserves in Alaska and British Columbia which are lain undeveloped because of lack of market facilities for production of metal. There are also large resources in Peru and the west coast of Mexico which would be tributary to Bonneville if it becomes advantageous to import zinc. The probabilities are for insufficient reduction capacity for home needs, and this situation is now aggravated by the demands for the defense program.

The following concentrate supplies would be immediately available, so can be brought into production within the time required to get an electrolytic plant into operation.

Location	Daily Tonnage Concentrates	Daily Yield Zinc
Pend Oreille Mines & Metals	Washington 60	34.5
Columbia Mines Dev. Co	Oregon 28	14.0
Bohemia District	" 5	2.5
Penn Mine	California 19	9.5
	Totals	60.5

There are developed reserves in the Penn mine for 3 years, with a certainty that further development will add to these reserves within that time, possibly enough for another 6-8 years. Other occurrences along the Foothill Belt would certainly develop to take care of the tonnage figured from the Penn when that is exhausted, and probably much more than that.

The Columbia Mines have 5 years ore developed above the tunnel levels, and sinking will without question add appreciably to this. Other veins in their own ground as well as neighboring claims, also give definite promise.

The Bohemia District is just being developed and should operate for many years.

The Pend Oreille Company have large reserves both in the operating property, and one which has never yet been developed.

The potential supplies of zinc within the orbit of a reductio plant at Bonneville which would be developed if the owners were given incentive by provision of a market for concentrates within a reasonable distance, taken together with supplies which can be brought direct to the plant by steamer, lead definitely to the conclusion that within a few years, there will be a sound basis for a considerable increase in the size of the reduction plant, which would make for lower costs.

For the following calculations, three St Louis base prices are assumed, and a division of markets between the Pacific Coast and Atlantic Seaboard has been taken, based on 50% of the Pacific Coast market, for both galvanizing and die casting. On this basis, the average prices received for zinc would be:

Los Angeles Sales		<u>St Louis Price</u>	<u>4.5¢</u>	<u>5.5¢</u>	<u>6.5¢</u>
Los Angeles Sales	-3000 tons (900 tons Die Casting)		4.965	5.965	6.965
San Francisco "	3100 " (300 " " ")		4.950	5.950	6.950
Atlantic Coast	<u>15075</u>		<u>4.500</u>	<u>5.500</u>	<u>6.500</u>
	21175		4.631	5.631	6.631

METAL RECOVERIES

One electrolytic zinc plant made an actual recovery of 93.7% of the metal in calcines averaging 61% Zn. Such a grade of calcines would be made from concentrates averaging 54.5% Zn. One large operating plant reported for a 3 months period an average recovery from calcine to cathode of 97%. This included zinc in purification residue at 100%. There should be deducted a small amount for this item, as the copper sponge shipped carries about 15% Zn. This however is so small in weight that the actual zinc lost is very small. They had the zinc down to 4.6% in the residue.

Experiments have shown that concentrates from the Foothill Belt in California will run 54-56% Zn. Work to date on Shasta County ores shows that the mixture of sulphides is so intimate that only very fine grinding will effect a separation. Bulk concentrates of 47% zinc have been made. Preliminary calculations indicate that the largest return from Shasta County ores would come by making a bulk concentrate, treating this by Waelz kilns to recover a zinc fume, and shipping the copper residue to smelter.

From the potential sources of supply in Oregon and Washington, concentrates of 54% to 61% Zn are being made.

For purposes of calculation, an average recovery from calcine to saleable zinc is taken as 93.5%.

POWER COSTS

The Bonneville Power Administration have filed 4 power schedules as follows:

- A-2 Covers power taken from bus bars of the Bonneville Project Plant which is taken as meaning within a circle having a radius of 15 miles. The rate is \$14.50 net per kilowatt year of billing demand. The weighted monthly average power factor to be .85 or more. It is based on maximum demand for any 30 minute period. This rate figures out at 1.67¢ per KWH. A ratchet clause provides that billing for any month shall not be less than the highest billing demand which occurred during the immediately preceding eleven months.
- C-2 Covers power at locations on the transmission lines, approved by the Administrator, and is to be billed at \$17.50 net per year per kilowatt of billing demand, which is based on maximum demand for any 30 minute period. It also has a ratchet clause similar to that in A-2
- F-1 Covers optional wholesale power and provides for:
 - a- Demand charge of 75¢ net per month per kilowatt of billing demand.
 - b- Energy Charge of 2½ mills net per kilowatt hour of current delivered

It also has a ratchet clause but limited to 75% of the billing demand in any of the preceding eleven months.

All of these Schedules require firm contracts, and billing demand is to be either actual demand or contract demand, whichever is greater. This wording indicates that while firm contracts are required, it would be possible to make this slightly under expected demands, so that actual demand would be always

slightly over contract figures. That is, a little flexibility is indicated.

H-1 Covers DUMP ENERGY, and is to be billed at 2.5¢ per KWH of energy delivered. This Schedule requires that purchaser have either a stand-by contract or generating facilities satisfactory to the Administrator. This would practically rule out its application by a proposed electrolytic zinc plant as the Capital tied up in an idle generating plant of the size required would be a heavy burden.

The hardships of the ratchet clause to an enterprise which may be subject to considerable variations in production rates to conform to market prices and demands, have been pointed out to the Power Project Administration, and it may be possible to work out some arrangement by which slightly greater flexibility is achieved.

There are available sites both within the 15 mile limit of the power project, and further down the river. Questions of transportation, sulphur disposal etc. will require study in order to arrive at the best average solution. In absence of this detailed study the C-2 schedule is selected as basis for power costs. An electrolytic zinc plant has a power factor of about 95%. Adjusting for this would bring the billing rate up to 2.12¢ per KWH.

To cover the contingency arising from the ratchet clause and from the stipulation that billing demand shall be contract demand or actual demand, whichever is the greater, a reserve fund should be set up from operating profits.

BY-PRODUCTS

There are by-products of the normal procedure in preparation of pure solution of zinc sulphate for electrolysis which add to the revenue from operations. These are:

Sulphur

Sulphur costs \$24.00 per ton delivered at paper mills in the Pacific Northwest, and the amount consumed in the area contiguous to Bonneville is more than the output of the proposed zinc plant.

After allowing for the sulphate sulphur purposely left in the calcines to make up plant losses of sulphuric acid, average zinc concentrates will give about .27 tons of sulphur in roaster gases per ton of concentrates. Sulphur as SO₂ and other losses may reduce this to a recoverable figure of .24 tons. The average content of flash roaster gases is 9% S.

Sulphur is being commercially recovered from roaster gases by several methods based on the coefficient of absorption of certain solutions.

Imperial Chemical Industries in England have developed a process using basic aluminum sulphate. It has been successfully applied to power plants in the London area to remove Sulphur from very dilute boiler flue gases for reasons of hygiene. It has also been applied at Outokompu in Finland for recovery of Sulphur from copper smelter gases, and its sale to paper mills. It is now recovered and sold as liquid SO₂ but plans were being made for the next step of reduction to elemental sulphur by either coke or charcoal.

Consolidated Mining & Smelting Co. at Trail B.C. use ammonium sulphite-ammonium bisulphite cycle, recovering the sulphur as sulphate fertilizer for which they have developed a market. This process is in successful commercial use.

German interests developed a process using Xylidine as the absorption agent. This is open to a possible objection at Bonneville of the cost of reagent. Braun Knecht Heimann were unable to give any quotation, but it is known that while the loss is small, the cost per pound of reagent will be high.

It is probable that at Bonneville either ammonium sulphite or basic aluminum sulphate will be the favored agents. I am indebted to a Report by Mr. Raymond M. Miller, Senior Industrial Engineer of the Market Development Section of the Bonneville Project for some cost figures applying to the Xylidine process. These figures indicate that that costs using either of the above processes will not exceed:

Labor - (Included in electrolytic plant costs. App. A)	--	
Absorption reagent	\$1.10	
Dryer	.15	
Soda	.80	
Fuel	.85	
Power	.10	
	<hr/>	
	Total	\$3.00
	Add Freight	2.00
		<hr/>
	Cost per ton liquid SO ₂	\$5.00
	" " " Sulphur content	2.50
REALIZATION	\$24.00 - \$2.50 =	\$21.50 per ton Sulphur
	= \$ 5.16 " " concentrates	

Cadmium

About 85% of the cadmium content of calcines is normally recovered as metallic cadmium for which there is an active market. New uses are being found and the market is strong. It is separated from the zinc in the normal process of preparing the zinc solution, and is recovered by an electrolytic procedure analagous to that used for the zinc. On the scale of operations of the proposed plant, which would produce about 500 pounds per day, the costs would be about:

Labor	3.57¢	per	pound	of	Cadmium
Maintenance	.15¢	"	"	"	"
Power 1 KWH	.22¢	"	"	"	"
	<u>3.94¢</u>				
Total	3.94¢				

Cadmium is now seeling at 75¢ per pound, but has been as low as 52¢. The latter figure is therefore used in present calculations.

Copper Sponge.

About 80% of the copper in average calcines is recovered as a copper sponge in the normal process of purification of zinc solutions prior to electrolysis. This sponge is saleable to copper smelters or for making copper sulphate. Its value may be taken as about the same as scrap copper or 9¢ per pound of copper content.

Residues

The residues from the leaching plant contain the gold and silver and lead which was in the concentrates, and because of the smaller bulk, these metals are present in amount to usually make their sale to smelters a profitable procedure. The actual value varies with each concentrate.

COST OF PRODUCTION

		<u>Per Ton</u>	
		<u>Zinc</u>	
1 - <u>Labor</u> - See Appendix A			\$ 8.78
2 - <u>Maintenance</u>			
Roasters	Labor	.45	
	Supplies	<u>.40</u>	.85
Leach Plant	Labor	1.19	
	Supplies	<u>.80</u>	1.99
Tank House	Labor	1.44	
	Supplies	<u>1.49-</u>	2.93
Casting Plant	Labor	.10	
	Supplies	<u>.08</u>	.18
Absorption Plant	Labor	.30	
	Supplies	<u>.40</u>	.70
			6.65
3 - <u>Fuel</u> - (Oil)			
Roasters	4 gals		
Leaching	4 "		
Melting	5 "		
Residue Drying	3 "		
Misc	<u>8 "</u>		
	24 " @ 3 $\frac{1}{4}$.88
4 - <u>Power</u> -			
3680 KWH @ 2.12 mills			7.81
5 - <u>Plant Overhead</u> - See Appendix B			<u>1.60</u>
			25.72
Contingencies 10%			<u>2.58</u>
			Total
			\$28.30

Per Pound of zinc this is 1.415¢

MARGIN CALCULATION

PENN MINE ORES

In 1931 I had a series of tests made by flotation on ores from the Penn Mine and four other properties along the Foothill Belt. In all cases high grade copper and zinc concentrates were made as well as a shipping copper concentrate. Using the tests on Penn Mine ore, and adjusting for the average content as determined by Kruttschnitt, the profit from these ores would be:

Products	Wt	Au	Ag	Zn	Cu	Recovery - %			Cu
		oz	oz	%	%	Au	Ag	Zn	
Crude Ore	100	.071	3.06	11.01	3.2				
Copper Concts	13.6	.30	15.2	5.9	20.0	57	67		85
Zinc "	14.7	.064	1.46	56.0	.8	13	7	75	
Zinc Calcines	12.94	.073	1.66	63.6	.9				
Residue	3.26	.292	6.64	9.0	.9				

REVENUES

Copper Concentrates (Shipped to Tacoma)

Payments

Gold	.30 x \$31.816	\$9.54	
Silver	15.2 - 0.5 @ 70 5/8	10.38	
Copper	400# x 95% x (11-2.5)	32.00	\$51.92

Deductions

Treatment	4.25	
Freight to Stockton	1.25	
Ocean freight to Tacoma	3.00	
Freight on moisture	.45	8.95
Net smelter return per ton concentrates		<u>\$42.97</u>
" " " " " ore		5.84

Copper Sponge

80% of the copper in calcines is recovered as a sponge which is usually shipped to copper smelters. It contains 40-60% Cu. There would be 14.4 lbs of copper content which would be worth 8¢ per pound.

$$14.4 \times .08 = \$1.15 \text{ per ton calcines.}$$

Cadmium

I have one cadmium analysis on Penn Mine material. This was of a zinc oxide fume made from zinc middlings, and it assayed 79% Zn and 1.1% Cd. This ratio would give .88% Cd as the content of calcines with 63.6% Zn. This figure is above the average cadmium content reported for concentrates at existing electrolytic zinc plants but there is corroboration of the high content of California copper-zinc ores in the Report of the Manager of the California Zinc Co., who gave the average content of bulk concentrates made from a considerable tonnage of ores from the Afterthought mine, which contained 47% Zinc and 1.8% Cd.

Penn Mine Margin Calculation - Cont'd.

Residue

<u>Payments</u>			
Gold	.292 @ \$31,816	\$9.19	
Silver	6.64 - 0.5 @ 70 5/8¢	4.33	
Copper	Below limits	--	\$13.52
<u>Deductions</u>			
Freight (wet wt.)		2.80	
Treatment		4.25	7.05
Net realization per ton Residue			\$6.47
" " " " Calcines			\$1.62

SUMMARY

	Zinc Prices	4.5	5.5	6.5
<u>Credits</u>				
Value of 1156 lbs. Zinc		\$53.53	\$65.09	\$76.65
Copper Sponge		1.15	1.15	1.15
Cadmium		7.16	7.16	7.16
Sulphur		5.88	5.88	5.88
Residues		1.62	1.62	1.62
		<u>69.34</u>	<u>80.90</u>	<u>92.46</u>
<u>Debits</u>				
Freight on concts.				
Truck to Stockton	\$1.25			
Steamer to Bonneville	3.50			
Moisture	.45			
	<u>5.20</u>			
Production cost 1156# @ 1.415¢	16.36	21.56	21.56	21.56
Net Return per ton calcines		47.78	59.34	70.90
" " " " ore		6.18	7.67	9.17
<u>ADD</u> - Returns from copper concts		5.84	5.84	5.84
		<u>12.02</u>	<u>13.51</u>	<u>15.01</u>
<u>Deduct</u>				
Mining & Development - Appendix D	- 3.30			
Milling	" E - 1.80			
Mine General	" F - .30			
Overhead	" G - .40	5.30	5.30	5.30
Net Realization per ton ore				

Columbia Mines Development Company

MARGIN CALCULATION

Products	Wt	Au-oz	Ag-Oz	Zn-%	Pb-%	Cd-%	Cu-%
Crude Ore	100	.035	0.40	8.0	1.5		
Lead Concts	1.85	.65	13.5		60.0		
Zinc "	11.2	.145	.9	54.0	1.15	.10	.50
Calcines	9.82	.163	.9	61.56	1.31	.10	.57
Residue	2.85	.563	3.1		4.8		

REVENUES

Lead Concentrates (Shipped to Selby) - Lead @ 5¢

Payments

Gold	0.65 @ 31.816	\$20.71	
Silver	13.5 x 95% x 70 5/8	9.05	
Lead	2000 (60.0 - 1.5) x 90% @ 5.0-1.5)	36.83	
Iron	2.75 x .06	.16	\$66.73

Deductions

Base Charge	\$2.50 - (58.5 - 30) x .10		
	add	.35	
Insoluble	15 x .10	1.50	
Sulphur		2.50	3.65

Realization per ton concts	63.08
Freight to Selby	9.55

Net Realization \$ 0.99

Copper Sponge - 9¢ @ .09 .81

Cadmium .1.7¢ @ .48 .82

Sulphur 5.88

Residues - Lead content is too small to pay charges to Selby, hence based on Tacoma Schedule

Payments

Gold	.562 x 31,816	17.88	
Silver	3.1 oz - 0.5 @ 70 5/8	1.83	19.71

Deductions

Freight	2.50	
Treatment	4.25	6.75
Net realization per ton residue		12.96
" " " " calcines		3.76

Margin Calculation - Columbia Mine Devel. Co. Cont'd.

SUMMARY

Zinc prices 4.5¢ 5.5¢ 6.5¢

Credits

Value 1145# Zinc	\$53.02	\$64.47	\$75.92
" Copper Sponge	.81	.81	.81
" Cadmium	.82	.82	.82
" Sulphur	5.88	5.88	5.88
" Residue	3.76	3.76	3.76
	<u>64.29</u>	<u>75.74</u>	<u>87.19</u>

Debits

Freight on concts - Truck	\$1.50		
" moisture	.15		
Production Cost - 1145# x 1.415¢	16.20	17.85	17.85
Net Return per ton calcines	46.44	57.89	69.34
" " " " ore	4.56	5.68	6.80
<u>ADD - Returns from lead concentrates</u>	<u>.99</u>	<u>.99</u>	<u>.99</u>
Total Returns per ton ore	5.55	6.68	7.79
<u>DEDUCT</u>			
Mining, Milling, Overhead	4.22	4.22	4.22
Net Realization per ton ore	\$1.33	\$2.46	\$3.57

MARGIN CALCULATION

PEND OREILLE MINES AND METALS CO.

Purchased Concentrates

Average Assay -	Zn-%	Pb-%	Fe-%	CaO-%	Cd-%	Au-oz	Ag-oz
	61.6	0.70	0.55	0.80	0.27	tr	tr

Proposed Schedule

<u>Payments</u>	<u>St Louis Base price</u>	<u>4.5¢</u>	<u>5.5¢</u>	<u>6.5¢</u>
Zinc - 2000 x .616 x .87 $\frac{1}{2}$ = 1178#		\$53.01	\$64.79	\$76.57
Lead - No payment				
Silver - No payment				
Gold - No payment				
Total		<u>\$53.01</u>	<u>\$64.79</u>	<u>\$76.57</u>
 <u>Deductions</u>				
Treatment charge - Base	18.00			
Add- \$2.50 x 65-60	<u>1.25</u>	<u>18.00</u>	<u>18.00</u>	<u>19.25</u>
Pay for concentrates -(per ton)		35.01	46.79	57.32

METALLURGICAL BALANCE

Product	Wt	Au oz	Ag oz	Zn %	Pb %	Cu %	S %	Cd %
Zinc Concentrates	100	tr	tr	61.6	0.70	tr	30.4	0.27
Calcines	87			70.2	0.80			0.307
Residue	24.1			9.0	2.9			

<u>Realization</u>	<u>St Louis Prices</u>	<u>4.5¢</u>	<u>5.5¢</u>	<u>6.5¢</u>
<u>Credits</u>				
Value of 1313 lbs Zinc		\$60.80	\$73.93	\$87.06
Cadmium- 5.22#		2.40	2.40	2.40
Sulphur		5.88	5.88	5.88
Residues - No value		--	--	--
		<u>\$69.08</u>	<u>\$82.21</u>	<u>\$95.34</u>
 <u>Debits</u>				
Cost production 1313# Zinc @ 1.415¢		18.58	18.58	18.58
Realization per ton calcines		<u>50.50</u>	<u>63.63</u>	<u>76.76</u>
Realization per ton concentrates		44.30	55.81	67.33
<u>DEDUCT</u> - Cost of concentrates		<u>28.35</u>	<u>36.21</u>	<u>44.82</u>
Freight		<u>15.95</u>	<u>19.60</u>	<u>22.51</u>
		<u>4.50</u>	<u>4.50</u>	<u>4.50</u>
MARGIN		\$11.45	\$15.10	\$18.01

MONEY REQUIRED

RUTH MINE - COLUMBIA MINES & DEVELOPMENT PROPERTY

Preliminary discussions with the administration of this property indicate willingness to combine it with the reduction plant. It is developed sufficiently to justify a scale of operations of 250 tons of ore per day. The money required will be:

250 ton differential flotation mill	\$125,000	
Steam power plant	50,000	
Tram road equipment	20,000	
Misc. Mine equipment	10,000	
Miscellaneous	10,000	\$215,000

PENN MINE

This property can be acquired for a purchase price of \$50,000 payable from royalty at 50¢ per ton of ore. The money required to put it in operation will be:

Pumping out mine	\$10,000	
125 ton differential flotation mill	85,000	
General rehabilitation and misc. mine equip	50,000	145,000
Total for Mines		<u>360,000</u>

ELECTROLYTIC ZINC PLANT

Cost ready to operate	850,000
TOTAL PLANT COST	\$1,215,000

WORKING CAPITAL

Breaking in fund	80,000
Reduction Plant - 60 days	125,000
Mines - 60 days	110,000
Concentrate purchase fund	70,000
TOTAL WORKING CAPITAL	\$385,000

TOTAL MONEY REQUIRED \$1,600,000

STATE TAXES

Plant Located in Washington

1 - Property Tax

Investment		% Depreciation	Probable Appraised Value	Ratio of Assessment-%	Probable Assessed Value
a-Land	\$10,000	--	\$10,000	50	\$5,000
b-Buildings	185,000	15	170,000	40	68,000
c-Machinery-Equip.	665,000	25	500,000	40	200,000
d-Working Capital & Inventory	205,000	33 1/3			
		Inv.	10,000	40	6,000
	<u>1,065,000</u>		<u>690,000</u>		<u>279,000</u>

	Assessment	Rate	Taxes
Real Property	\$ 73,000	.034	\$3,482
Personal Property	206,000	.034	7,004
	<u>279,000</u>	<u>.034</u>	<u>\$10,486</u>

2 - Sales Tax

	Amount	Rate	Tax
1 - Material for repairs and replacements	\$68,000		
2 - Misc Tools, supplies etc.	12,000		
	<u>80,000</u>	.02	\$1600

3 - Business and Occupation Tax

	Zinc prices	4.5¢	5.5¢	6.5¢
Gross Value of products		\$1,961,229	\$2,364,729	\$2,808,2
Tax Rate .0025		\$4,904	\$5,962	\$7,021

4 - Corporation License Tax - \$300.

SUMMARY

	Zinc Prices	4.5¢	5.5¢	6.5¢
Property		\$10,486	\$10,486	\$10,486
Sales Tax		1,600	1,600	1,600
Business & Occupation		4,904	5,962	7,021
Totals		<u>\$16,990</u>	<u>\$18,048</u>	<u>\$19,107</u>

STATE TAXES Cont'd.

OREGON

1 - <u>Property Tax</u>		Depreci- ation %	Probable Appraised Value	Ratio of Assess- ment -%	Probable Assessed Value
Investment					
a-Land	\$ 10,000	-	\$ 10,000	75	\$ 7,500
b-Buildings	185,000	15	170,000	35	65,500
c-Machinery & Equip.	665,000	25	500,000	50	250,000
d-Work Capital & Inventory	205,000	33 1/3 Inv.	10,000	50	5,000
	<u>1,065,000</u>		<u>690,000</u>		<u>328,000</u>

	<u>Assessment</u>	<u>Rate</u>	<u>Taxes</u>
Real Property	\$ 73,000	.0352	\$ 2,570
Personal Property	255,000	.0352	8,976
	<u>328,000</u>	<u>.0352</u>	<u>11,546</u>

2 - Corporation Excise Tax

	<u>Zinc Prices - 4.5¢</u>	<u>5.5¢</u>	<u>6.5¢</u>
Net Income	\$386,400	552,602	725,526
Add back Personal Prop. Tax	8,976	8,976	8,976
	<u>395,376</u>	<u>561,578</u>	<u>734,502</u>
Tax 8%	31,630	44,927	58,740
Less Offset of 50% for personal property tax paid	15,815	22,464	29,370
Total Excise Tax	<u>15,815</u>	<u>22,464</u>	<u>29,370</u>

SUMMARY

	<u>Zinc Prices - 4.5¢</u>	<u>5.5¢</u>	<u>6.5¢</u>
Property	\$11,547	\$11,547	\$11,547
Excise	15,815	22,464	29,370
Corporation Tax	<u>200</u>	<u>200</u>	<u>200</u>
Totals	\$27,562	\$34,211	\$41,117

CONCLUSIONS

The Tax position seems to be more favorable in Washington than in Oregon.

FINANCIAL SUMMARY

ANNUAL OPERATING PROFIT

A - COMPANY ORES

Mine	Location	Tons	St. Louis Base Zinc Prices		
			4.5	5.5	6.5
RUTH	Oregon	87,500	\$116,375	\$215,250	\$312,375
PENN	Calif.	43,750	294,000	359,187	424,812
Totals		131,250	410,375	574,437	737,187

B - PURCHASED CONCENTRATES

Bohemia District, Oregon	1,750	47,530	58,432	69,387	
Pend Oreille M. & M. Co.	21,000	240,500	317,100	378,210	
Totals		22,750	288,030	375,532	447,597

Total Plant Realization \$698,405 \$949,969 \$1,184,784

DEDUCT

Administration, Selling Commission - (5%), legal, etc.		120,000	140,000	161,000
		578,405	809,969	1,023,784
Taxes		22,990	24,048	25,107
		555,415	785,921	998,677
Bank Interest on metal carrying loans		10,000	12,500	15,000
		545,415	773,421	983,677
Reserve Fund against ratchet provision of Power Schedule 15% = 32¢ per 1000 KWH		23,186	23,186	23,186
		522,229	750,235	960,491
Mine Exploration		50,000	50,000	50,000
		472,229	700,235	910,491
Breaking in cost - 1st year only		50,000	50,000	50,000
		422,229	650,235	860,491
Depreciation - 10% \$100,000				
Depletion - 40¢/ton ore 52,480		152,480	152,480	152,480
		269,749	497,755	708,011
Federal Income Tax - 25%		67,438	121,939	177,003
		202,311	375,816	531,008
On total money used this is		12%	23%	33%

1st Year

Cash Gain before Fed. Taxes	422,229	650,235	860,491
Federal Taxes	67,438	121,939	177,003
NET CASH GAIN 1st YEAR	\$354,791	\$528,296	\$683,488

BASIS "B"

No Mine Development - All concentrates to be purchased

There are reliable reports that as much as a carload per day of zinc concentrates can be contracted in the Coeur d'Alene District, and there are also idle properties in the Hailey District of Idaho, which are dormant because of lack of market for zinc concentrates, and the lead alone will not carry the operation. The Bunker Hill & Sullivan plant at Kellogg is not a regular buyer of concentrate as they have very large reserves in their own mines.

By working on this basis, it would be possible to defer opening up the Penn Mine and taking other steps to acquire a supply under Company control, until these steps could be paid for from plant earnings. The Columbia Mines Development Co. state that they can easily finance mill construction if they have a market for concentrates.

Generally speaking, an electrolytic zinc plant ought to have 50% of its supplies under its own control, but if contracts could be made for three years, conditions now are favorable enough so that there would not be any risk in basing operations initially on purchased concentrates.

To carry out this program, it would be necessary to enter into a contract for a three year period with Pend Oreille Mines & Metals, The Columbia Mines Development Co. and the producers in the Bohemia District in Southern Oregon. The balance could be contracted for in several places as a balance wheel. Perhaps the Jorday Valley could join on a contract basis. In three years it will be possible to develop enough reserves under Company control to ensure safety of the position.

The Capital needed on this basis would be appreciably less, especially if the Banks would make loans for concentrate purchase. Tentative inquiries indicate that they would do this. The results shown by such a program are:

<u>CONCENTRATE SUPPLIES</u>	Tons	Daily Yield Zinc
Columbia Mines Devel. Co.	28	14.0
Pend Oreille Mines & Metals Co.	60	34.5
Bohemia District	5	2.5
Coeur d'Alene	20	10.0
	<u>113</u>	<u>61.0</u>

MONEY REQUIRED

(Based on assumption that banks will loan for concentrate purchase)

CONSTRUCTION

Electrolytic Zinc Plant \$850,000

WORKING CAPITAL

Breaking in fund 50,000
Plant operation - 60 days 125,000

Total \$1,025,000

MARGIN CALCULATION

RUTH MINE - Columbia Mines Development Co. - Concentrates Purchased

Average Assay - Au-oz	Ag-oz	Zn-%	Pb-%	Fe-%	Cd-%
0.143	0.80	54.0	1.15	4.0	0.09

Proposed Schedule

Payments	St Louis Base Price	4.5¢	5.5¢	6.5¢
Zinc - 2000 x .540 x .80		\$38.88	\$47.52	\$56.16
Lead - No payment				
Silver - No payment				
Gold - .143 x .80 x \$31.816		3.65	3.65	3.65
		<u>\$42.53</u>	<u>\$51.17</u>	<u>\$59.81</u>
<u>Deductions</u>				
Treatment - Base Charge		\$16.00		
Add - \$2.50 x (65-60)		1.25	16.00	17.75
			<u>16.00</u>	<u>17.75</u>
Pay for Concentrates per ton		\$26.53	\$35.17	\$42.06

* * * * *

METALLURGICAL BALANCE

Product	Wt	Au oz	Ag oz	Pb %	Zn %	Cd %
Zinc Concts	100	.143	0.80	1.15	54.0	0.09
Calcines	87.7	.163	0.91	1.31	61.5	0.10
Residue	25.5	.562	3.1	4.50	9.0	

RESIDUES - Shipped to Tacoma

Payments

Gold	0.562	31.817	\$17.88
Silver	3.1 - 0.5 Oz @ 70 5/8¢		<u>1.84</u>
Lead No payment			<u>\$19.72</u>

Deductions

Treatment		5.25
Zinc penalty - 2%		.30
Freight		<u>3.00</u>
		<u>7.55</u>

Returns per ton Residue	\$11.17
" " " Calcine	3.13

CADMIUM - 1.65 # @ 48¢ - Returns per ton calcine \$ 0.78

COPPER SPONGE - 10# @ 8¢ " " " " \$ 0.80

Margin Calculation - Cont'd - RUTH MINE

<u>SUMMARY</u>	<u>St Louis Base Prices</u>	<u>4.5¢</u>	<u>5.5¢</u>	<u>6.5¢</u>
Value of 1131# Zinc		\$52.37	\$63.68	\$74.99
" Copper Sponge		.80	.80	.80
" Cadmium		.78	.78	.78
" Sulphur		5.88	5.88	5.88
" Residues		3.13	3.13	3.13
		<u>\$62.96</u>	<u>\$74.27</u>	<u>\$85.56</u>
<u>Deduct</u>				
Production Cost 1131# Zinc @ 1.415		<u>16.01</u>	<u>16.01</u>	<u>16.01</u>
Realization per ton calcines		46.95	58.26	69.57
" " " concts		41.18	51.05	61.02
Pay for Concentrates		<u>26.53</u>	<u>35.17</u>	<u>42.06</u>
MARGIN		\$14.65	\$15.88	\$19.96

FINANCIAL SUMMARY

Annual Operating Profits

<u>Purchased Concentrates</u>	<u>Tons</u>	<u>Zinc Prices --</u>	<u>4.5</u>	<u>5.5</u>	<u>6.5</u>
Columbia Mines Development Co.	9800		143,570	156,624	195,608
Bohemia District	1750		42,280	54,057	65,012
Pend Oreille	21000		240,500	317,100	378,210
Coeur d'Alene (or others)	<u>7000</u>		<u>169,120</u>	<u>216,230</u>	<u>260,050</u>
			595,470	744,011	898,880
 <u>Deduct</u>					
Administration, Selling commission (5%) Legal, etc.			<u>120,000</u>	<u>140,000</u>	<u>161,000</u>
			475,470	604,011	737,880
Taxes			<u>16,990</u>	<u>18,048</u>	<u>19,107</u>
			458,480	585,963	718,773
Bank Interest on revolving fund for concentrate purchase			<u>3,000</u>	<u>3,500</u>	<u>4,000</u>
			445,480	569,963	699,773
Reserve fund against ratchet clause of power schedules 15% = 32¢ per 1000 kw			<u>23,186</u>	<u>23,186</u>	<u>23,186</u>
			422,294	546,777	676,587
Mine exploration and development			<u>50,000</u>	<u>50,000</u>	<u>50,000</u>
			372,294	496,777	626,587
Breaking in cost (1st year only)			<u>50,000</u>	<u>50,000</u>	<u>50,000</u>
			322,294	446,777	576,587
Depreciation -- 10% on \$850,000			<u>85,000</u>	<u>85,000</u>	<u>85,000</u>
			237,294	361,777	491,587
Federal Income Tax -- 25% Available for distribution			<u>59,324</u>	<u>90,445</u>	<u>122,897</u>
			177,970	271,332	368,690
On Total Money Used			25%	27%	36%
 <u>1st Year</u>					
Cash gain before Federal Taxes			322,294	446,777	576,587
Federal Taxes			<u>59,324</u>	<u>90,445</u>	<u>122,897</u>
			262,970	356,332	453,690

APPENDIX - "A"

ELECTROLYTIC ZINC PLANT LABOR

	No. Men	Base	Total	per Day
<u>Yard - (Inc. unloading Conets)</u>	7	\$5.20	\$36.40	\$36.40
<u>Roasters</u>				
Operators	3	6.00	18.00	
" Helpers	3	5.20	15.60	49.20
Conveyor men	3	5.20	15.60	
<u>Cottrells & Absorption Plants</u>				
Operators	3	6.00	18.00	
" Helpers	3	5.20	15.60	33.60
<u>Leach & Purification</u>				
Operators	3	6.00	18.00	
" Helpers	15	5.20	78.00	96.00
<u>Cell Room</u>				
Testers	3	6.00	18.00	
Foreman	1	8.00	8.00	
Shift Bosses	2	6.00	12.00	
Clean Up gangs	4	5.60	22.40	
Strippers	16	5.60	89.60	
Brushing Cathodes	1	5.20	5.20	
Anode & Cathode Shop	3	5.20	15.60	170.80
<u>Melting Room</u>				
Operators	3	6.00	18.00	
Ladlers - Day only)	1	5.50	5.50	
Skimmers	4	5.20	20.80	
Dross Drum	1	5.20	5.20	
Zinc Dust	1	5.20	5.20	
Weigher	1	5.50	5.50	60.20
<u>Maintenance</u>				
Maintenance Engineer - \$250 per mo.	1		8.25	
Plant Electrician	1		7.25	
Repair crew	3 - Av 6.25		18.25	33.75
				5.06
Overtime maintenance crew - 15%				485.01
Compensation Insur @ 3.75%				18.19
Unemployment Funds @ 4.0%				19.40
				<u>522.59</u>

On 120,000 lbs zinc this is 0.439¢/lb = \$8.78 per ton

APPENDIX "B"

ELECTROLYTIC ZINC PLANT OVERHEAD

Office

Superintendent	\$500.00/mo.	
Assistant Superintendent	350.00 "	
Accountant	175.00 "	
Timekeeper-Storekeeper	150.00 "	
Metallurgical Bookkeeper	150.00 "	
Stenographer	85.00 "	1410.00

Laboratory

Chief Chemist	250.00/mo.	
Chemist	175.00 "	
Helper	125.00 "	<u>550.00</u>

Gateman

125.00

2085.00

Compensation Insur 37.65

Unemployment Funds - 4% 83.40

2206.05

Office Supplies

50.00

Postage & Telegrams

50.00

Laboratory Supplies

250.00

Travelling & Miscellaneous

127.95

2784.00

On 3,480,000 lbs Zinc this is 0.08¢ per lb. =
\$1.60 per ton.

APPENDIX "C"

PLANT COST

Basis - 60 tons Zinc per Day

CONCENTRATE HANDLING AND ROASTING

1 - Yard Tracks			\$1345	
2 - Track Scale			2325	
3 - Track Hopper			1534	
4 - Apron Feeder			3357	
5 - Belt Conveyor - 150' c/c			1255	
6 - Concentrate Storage Bins			3850	
7 - Belt Conveyor - 135' c/c			1255	
8 - 2 Raymond Mills, Cyclones, Furnaces			10000	
9 - 2 Flash Roasting Units			44610	
10 - Calcine Conveyor - 50'			2065	
11 - Bucket Elevator - lift 65'			1600	
12 - Surge Bin and Calcine Storage Bin			1800	
13 - Balcon Flue			4080	
14 - Power & Light Wiring			750	
			<u>79824</u>	
	Eng 5% - Cont 10%		11974	
			<u>91798</u>	
15 - Buildings - 40x60x40	4800			
	70x60x55	13860	18660	
			<u>110458</u>	
	Comp Insur - Fed & State		2410	
			<u>112868</u>	
16 - Cottrell Treater)			40000	
17 - Spray Tower) Western Precipitation		20000	Est
18 - Piping etc.)			6000	\$168,964
			<u>6000</u>	

ABSORPTION PLANT fpr SO₂

19 - Absorption Tower		20000	
20 - Vaporizer		5000	
21 - Compressor		6000	
22 - Piping wiring lighting		4000	
		<u>35000</u>	
	Eng 5% - Cont 10%	5250	
		<u>40250</u>	
23 - Building - 10000 cu. ft.		5000	45,250

LEACHING AND PURIFICATION

24- Belt Feeder	500
25 - Launder to Agitators	200
26 - 7 Batch Agitator Tanks	7028
27 - Launder - 50'	150
28 - Classifier	850
29 - Regrinding Mill	2025
30 - Wilfley Pump - 2" Rubber lined	785
31 - 4 Thickeners	9428
32 - Bucket Elevator for thickened pulp	1500
33 - Surge Tank & Agitator	700
34 - 2 Filters	3130
35 - Conveyor to hot acid leach	435
36 - Distributing Conveyor - 50'	700
37 - 6 Hot Acid Leach Agitators	5215

APPENDIX "C" - Continued

38 - Launder to elevator	150	
39 - Bucket Elevator	1500	
40 - Launder to Thickeners	150	
41 - Thickener	2357	
42 - Solution Pump	250	
43 - Three Filters with re-pulpers and pumps	15190	
44 - 2 Wash Solution tanks	500	
45 - Conveyor for calcines to hot acid leach	815	
46 - 2 Conveyors to Dryer - 145 & 80'	1430	
47 - Dryer and Building	6200	
48 - Piping	5000	
49 - Suction Equipment	6000	
50 - Bronze Pumps to Purification Agitators	1809	
51 - 3 Purification Agitators	3644	
52 - 2 Solution Pumps	410	
53 - Thickener	1000	
54 - Tilting Pan Filter	500	
55 - 2 Pressure Pumps	867	
56 - 2 Shriver Presses	3000	
57 - Piping	1100	
58 - Power & Light wiring	1000	
	<u>85518</u>	
Eng - 5%; Cont - 10%	12823	
	<u>98341</u>	
59 - Building: 160x75x40	28000	
Staging & Platforms	4000	
	<u>130341</u>	
Comp Insur - Unemployment	3859	
	<u>134200</u>	\$134,200

TANK HOUSE

60 - Tanks - 288 Prokorite	28800	
61 - Bus Bars and Jumping out Bar	18928	
63 - Cathodes - 78400# @ 26 $\frac{1}{2}$	20384	
64 - Anodes - 381,000# @ 6¢	22860	
65 - Copper Strips - 27,100# @ .15	4065	
66 - Cathode Handling Equip	2000	
67 - Anode Casting Equip	1944	
68 - Acid Electrolyte Tank - 30'x148	4132	
69 - Neutral Solution Tank	2440	
70 - Neutral Solution Lead Piping	9000	
71 - Sumps, surge Tanks launders	3682	
72 - Electrolyte Pumps and Piping	1322	
73 - Monorail Handling Equipment for cathodes	3500	
74 - Tracks to Casting Dept.	993	
	<u>119557</u>	
Eng 5% - Contin. 10%	17950	
	<u>137507</u>	
75 - Building 127x187x32	42000	
Comp Insur: Unemploy.	4000	
	<u>46000</u>	183,507

APPENDIX "C" - Continued

POWER PLANT

76 - Two 6500 Amp. Mercury Arc Rectifiers	175000	
77 - Erection	11000	
78 - Building 36x78x24'	<u>3500</u>	\$189,500

(General Electric Co. estimates based on a plant recently finished. Hence no engineering an contingency figures are added)

CADMIUM PLANT

79 - Five Agitator Tanks	3500	
80 - Thickener	1250	
81 - Four Shriver Presses	3000	
82 - Three Centrifugal Pumps	1325	
83 - Electrolytic Tanks	335	
84 - Anodes & Cathodes	828	
85 - Bus Bars etc.	1668	
86 - Piping	350	
87 - Melting & Casting Equip	1000	
	<u>13256</u>	
Engineering - 5%; Contingencies - 10%	1989	
88 - Buildings	3500	
Compen. Insur and Unemployment Funds	<u>650</u>	19,394

CASTING HOUSE

89 - Melting Furnace	6480	
90 - Ladles, Molds, Handling Equip	3600	
91 - Shipping Scale	700	
92 - Zinc Dust Blowing Equipment	2000	
93 - Dress Liquating Cylinder	1500	
94 - Storage Yard, racks etc.	500	
	<u>14780</u>	
Engineering - 5%; Contingencies - 10%	2220	
95 - Buildings 60x60x32'	6920	
Compen. Insur.; Unemployment	<u>756</u>	24,670

APPENDIX "C" Continued

MISCELLANEOUS

96 - Land Purchase - 20 acres @ \$500		10000	
97 - Oil Storage, pump and piping		800	
98 - Sewers and Drains		3000	
99 - Water Lines		1500	
100 - Automobile - Truck etc.		1500	
101 - Construction Tools		5000	
102 - Boiler Plant		1500	
103 - Office Building 2500 sq. ft.	8750		
Furniture	2000	10750	
104 - Laboratory - Building 3200 sq. ft.	<u>9600</u>		
Furniture	2500	12100	
105 - Warehouse - Building 1500 sq. ft.	3525		
Furniture	<u>600</u>	4125	
106 - Machine Shop - Building 3000 sq. ft.	6000		
Equipment	<u>6000</u>	12000	
107 - Gateman's House		800	
		<u>63075</u>	
Engineering 5%; Contingencies - 10%		9465	
Comp Insur and Unemployment		<u>1900</u>	74,440

* * * * *

S U M M A R Y

Concentrate Handling and Roasting	\$178,863
Absorption Plant fo SO ₂	45,250
Leaching & Purification	134,200
Tank House	183,507
Power Plant	190,000
Cadmium Plant	19,394
Casting House	24,670
Miscellaneous	<u>74,440</u>
TOTAL	\$850,324

The Daily News Congreew, MA 3/5/80

Bergsoe Metal Corp. set to build

By Richard Spiro
The Daily News

ST. HELENS — The construction start of a \$25 million lead recycling plant that Danish-based Bergsoe Metal Corp. officials say will be the most modern in the United States was marked by a groundbreaking ceremony in St. Helens Tuesday.

Taking note of Columbia County's 8.1 percent unemployment rate, one of the highest in Oregon, 87-year-old Svend Bergsoe told spectators his firm's first American plant will employ some 100 persons drawn mostly from the local labor pool.

"We will be an important industry for the United States," said Bergsoe, chairman of the board of the Bergsoe Group of companies, "because it is importing 250,000 tons of lead annually. In one year this plant will recycle 50,000 tons of pure lead in a year. Pure lead — all impurities are removed."

The lead will come from used storage batteries. "We don't chop them up," Bergsoe said, "but put them in a furnace so there is neither smoke nor pollution. It's a new principle, and we will be watched from all over the U.S."

A Burlington Northern rail spur will serve the new plant, and Bergsoe also explained that trucks will be loaded inside a building so no lead will be

scattered outside.

Oregon was chosen for the plant because "Its strict environmental regulations meant that if we can get in here we can get in any part of the U.S.," said Bergsoe Metals President Nils Jensen.

Of all Oregon cities a 50-acre site in St. Helens was selected because Bergsoe officials liked the quality of life here, and because of the support received on the local level from Port of St. Helens officials and Rep. Caroline Magruder, Jensen said. It also is close to the company's customers, battery manufacturers in the Willamette Valley.

Bergsoe Metals is a joint venture of the Bergsoe Group and East Asiatic Co., both based in Copehagen, Denmark. The St. Helens plant is to be similar in design to Bergsoe's plants in Sweden and Denmark.

The annual payroll will be about \$2 million for the 24-hour-a-day operation with three shifts. Property taxes should average \$300,000 annually.

Glenn Jackson, chairman of the Oregon Economic Development Commission, welcomed Bergsoe with the comment that "Yours is the type of industry Oregon aspires to attract."

CH2M Hill, of Portland, is designer and consulting engineer on the project, which is expected to be completed by late 1981.



Youthful Svend Bergsoe, 87, at groundbreaking