SCREEN ANALYSIS

MATERIAL Tamarack Reclamation January 1958

TABLE V

Name of Company Mr. L. C. Klein

Location

Size of Crusher

Feed to Crusher

Crusher Setting

Moisture

Specific Gravity

Hardness

Remarks

Form 71

Screen Analysis made with Tyler Test Sieves

Through	On	Weight on Screen	% on Screen	% Cumulative	% Copper	% Copper
		General Tails				
	28	.70	.35	.35		
	35	4.50	2.25	2.60	.218	.0056680
	48	17.00	8.50	11.10	.199	.0169150
	65	27.70	13.85	24.95	.187	.0258995
	100	39.20	19.60	44.55	.177	.0346920
	150	27.40	13.70	38.25	.165	.0226050
	200	17.60	8.80	67.05	.143	.0125840
200		65.90	32.95	100.00	.129	.0425965
Totals		200.00	100.00			.1608690

Head Assay .152% Copper

By Screen Analysis .161% Copper

W. G. Gagnon 2-13-58
wgg/gws

SCREEN ANALYSIS

TABLE VI

MATERIAL Tamarack Reclamation April 1959

Name of Company Mr. L. C. Klein

Location

Size of Crusher

Feed to Crusher

Crusher Setting

Moisture

Specific Gravity

Hardness

Remarks

Form 71

Screen Analysis made with Tyler Test Sieves

Through	On	Weight on Screen	% on Screen	% Cumulative	% Copper	% Copper
		General Feed				
	28	1.2	.60	.60		
	35	6.3	3.15	3.75	.190	.0071250
	48	24.6	12.50	16.05	.182	.0223860
	65	31.6	15.80	31.85	.202	.0319160
	100	35.3	17.65	49.50	.249	.0439485
	150	24.8	12.40	61.90	.275	.0341000
	200	14.4	7.20	69.10	.250	.0180000
200		61.8	30.90	100.00	.260	.2378155

Head Assay .232% Copper

By Screen Analysis .238% Copper

SCREEN ANALYSIS

C O P Y

MATERIAL **Tamarack Reclamation** **April 1959**

TABLE VII

Name of Company **Mr. L. C. Klein**

Location

Size of Crusher

Feed to Crusher

Crusher Setting

Moisture

Specific Gravity

Hardness

Remarks

Form 71

Screen Analysis made with Tyler Test Sieves

Through	On	Weight on Screen	% on Screen	% Cumulative	% Copper	% Copper
		General Tails				
	28	.9	.45	.45		
	35	1.9	.95	1.40	.211	.0029540
	48	17.1	8.55	9.95	.179	.0153045
	65	23.8	11.90	21.85	.162	.0192780
	100	33.7	16.85	38.70	.145	.0244325
	150	27.6	13.80	52.50	.142	.0195960
	200	17.7	8.85	61.35	.141	.0124785
200		77.3	38.65	100.00	.127	.0490855
Totals		200.0	100.00			.1431290

Head Assay .144% Copper

By Screen Analysis .143% Copper

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Report on

THE LEACHING OF AHMEEK MILL CONCENTRATES

by

L. C. Klein

November 5, 1958

FC/39

INTRODUCTION

This report will attempt to give answers to several questions that have been raised concerning the possibility of leaching certain Ahmeek Mill Concentrates to produce 25,000,000 pounds of copper per year in copper oxide, for production of copper powder. In addition to this, about 3,600,000 pounds of copper oxide would have to be produced to supply the regular demand for industrial and agricultural oxide, this material to be produced from either primary or secondary copper sources.

This report will cover the capacities of present leaching and distillation facilities; changes in leaching and distillation equipment necessary to adapt this equipment to the leaching of concentrates and distillation of the rich solutions produced; material handling; changes in leaching techniques; leaching solution control; types of concentrates that can be leached; and the control of impurities in the oxide produced. A rough estimate is also given for capital expenditures necessary and the cost of oxide production.

CONCLUSIONS

Certain of the Ahmeek Mill Concentrates can be leached to produce copper oxide. "Rich" and "Poor" can be leached with minor modifications to the present 54 ft. diameter leaching tanks and piping, although smaller diameter tanks would be more efficient. "Heading" can be leached in special tanks providing faster solution turnover. The Lake Linden Leaching Plant has tank capacity to leach three or more times the required amount of copper from high grade concentrates.

With the present distillation facilities at Lake Linden, about 1,300,000 pounds of copper as copper oxide can be produced per month consistently. The Tamarack Leaching Plant can produce an average of about 750,000 pounds of copper as oxide per month.

To produce 2,000,000 pounds of copper per month for copper powder, and 300,000 pounds per month of industrial and agricultural demand, it will be necessary to do one of the following:

1. Operate both the Tamarack and the Lake Linden Leaching Plants at near capacity, or

2. Install two additional stills and accessory equipment at Lake Linden.

Plan 1 requires a capital expenditure of about $30,000 at Tamarack, and $25,000 at the Lake Linden plant. Oxide produced at Tamarack would cost from 4.0 to 4.5¢ per pound of copper processed, and at Lake Linden the cost per pound would be about 2.75¢.

Plan 2 requires a capital expenditure in the order of $225,000, of which $25,000 would be spent in the Leaching Plant, and $200,000 in the Still House. With this plan, the cost of producing a pound of copper, as oxide, would be about 2¢.

The extent to which impurities in the concentrates, particularly arsenic and silica, will contaminate the oxide, and the possibility of the arsenic being evolved on reduction with hydrogen will have to be determined experimentally. These impurities can be precipitated from the leaching solutions if it is necessary. ?

Plan 2 = 225,000
Plan 1 = 30,000
195,000

% of difference feeds -?

AHMEEK MILL CONCENTRATES

The grades of concentrates produced at the Ahmeek Mill are as follows: Heading, Rich, Poor and Flotation.

Rich is a more or less ideal material for ammonia leaching. The assay of this grade is about 90% copper, and the individual particles are not too large to be dissolved in a reasonable leaching cycle, nor is much of the copper likely to be entrapped in the gangue. The 10% of the gangue in the material is not enough to stop permeation of the solutions through the material, and slimes are not present in sufficient quantity to create a problem.

Poor, assaying about 70% copper, is more difficult to leach. The copper particles are smaller, but the increased amount of gangue and the finer texture of the gangue inhibits the solution percolation to some extent, and creates a greater problem with slimes.

Heading, which is relatively pure copper, but large in size, can be leached in a special tank, such as rectangular tank, with rapid circulation of solutions. Leached in the conventional tanks this material would take from six to eight months to dissolve. In the rectangular tank it could probably be leached in two weeks. COST-?

Mill mass is not considered a good leaching material. It would take a period of years to leach some of the larger pieces of mass, and then any copper entrapped in the ore would not be recovered.

Flotation concentrates can be leached if special equipment were used. Something on the order of an enclosed thickener, or counter-current decantation unit could be used to leach this material, so that rakes would continuously turn over the material and expose the copper to the leaching solutions. Percolation leaching would not work on this material because of the very fine nature of both the copper and the gangue. Before leaching this material, it would be necessary to determine whether the flotation reagents and oils would contaminate the leaching solutions and show up in the copper oxide as carbon and sulfur compounds.

It is safe to assume that Rich, Poor, and Heading can be leached with no particularly difficult troubles developing. An experimental lot of mixed Rich and Poor is now being leached at the Lake Linden Leaching Plant and is progressing satisfactorily. This test is being made in a 15 ft. diameter tank with reverse flow of solutions.

LEACHING OF CONCENTRATES

The large, 54 ft. diameter leaching tanks at Lake Linden and Tamarack are not ideally suited to the leaching of mill concentrates. Small diameter tanks, about 16 ft., would be much better because less trouble would be experienced with the solutions working through the area of least resistance in the charged tank, or "channeling". By reversing the flow of solutions on the large tanks and installing porous filter bottoms, no great trouble with leaching concentrates should be experienced. It may be necessary to drain a tank once or twice during the leaching cycle and turn over the material with a clam to counteract the effect of channeling. This can be done by one man in an hour or so.

Reversing the flow of solutions in the tanks will eliminate the problem of slimes plugging up the filter bottom and cutting off the flow of solutions. Any slimes in the effluent solutions can be removed by filtering, if these solutions are sent to distillation, or by settling if they go to the leach storage tanks. Slime settling in the storage tanks could be removed by flushing the tanks periodically.

Four of the large leaching tanks will be needed to leach 2,000,000 pounds of copper per month. About 1,000,000 pounds of copper would be charged in each tank, and the leaching cycle should take from six to eight weeks.

How many small tanks? Cost

It will be simple to produce a consistently high cuprous oxide by leaching concentrates, that is a cuprous oxide content in the order of 70-75%. If a higher cuprous oxide content is desired, a small tank charged with copper shot or other pure copper material could be placed in the rich line between the stills and the preheaters in the Still House. This should boost the cuprous content of the oxide to about 90%, and would cut to less than half the theoretical amount of hydrogen necessary for reduction of the oxide to copper powder. XXX

Careful control of the leaching solutions will be necessary if high grade concentrates are to be leached, since supersaturation of the solutions results in the precipitation of basic cuprous carbonate in the tanks with resulting high copper losses. Controlling the solutions is not difficult and the possibility of supersaturation of solutions occurring should cause no great concern if the concentrations of copper, ammonia, and carbon dioxide in the leach storage are kept in proper balance.

All equipment in the leaching plant is adequate for leaching the required tonnage of concentrates, the only expenditures necessary will be for tank bottoms and repiping. A pressure filter for rich solutions must be obtained. — ? This could be located either at the Leaching Plant or Still House.

If maximum production of cuprous oxide is to be maintained with the present facilities, it will not be possible to operate two leaching circuits at Lake Linden. If different grades of oxide are to be produced at Lake Linden, it will involve a considerable expansion of still house facilities. This will be taken up in more detail later in this report.

IMPURITIES IN COPPER OXIDE PRODUCED FROM PRIMARY

Analysis of solutions obtained from leaching Ahmeek Mill concentrates indicate that arsenic in the mineral is being dissolved by the ammoniacal solutions, presumably forming ammonium arsenate or ammonium arsenite depending on the valence of the arsenic in the ore.

The ammonium arsenates would normally break down to form the respective arsenic oxides at distillation temperatures, but other reactions can take place. If chlorides are present in the solutions being distilled, the cuprous copper reduces the arsenates forming arsenious chloride which is quite volatile. Arsenic has been detected in the distillate from the decomposition of solutions containing arsenic, so this reaction may be taking place to some extent. Since Torch Lake water is used for leaching, chlorides are present in considerable quantity. If any amount of arsenic goes into the distillate, it will be returned to the leaching plant and eventually build up quite high in the solutions.

Since arsenic has a great affinity for sodium, and is readily dissolved by alkaline sodium compounds, it is quite possible that the introduction of a small quantity of a sodium compound, preferably sodium carbonate, to the still feed will result in the arsenic forming the sodium compound. Since the sodium arsenates or arsenites do not decompose at distillation temperatures, the arsenic would be eliminated in the still waste. There is also the possibility of precipitating the arsenic from leaching solutions with small amounts of magnesium compounds or other chemicals.

There is a strong possibility that if the oxide is reduced with hydrogen at temperatures over 1300°F., the arsenic compound will be sublimed, or that it will be evolved as arsine. Arsine, if it is formed, decomposes freeing metallic arsenic at elevated temperatures, which should sublime under the right conditions.

It is likely that the silica content of the oxide made from concentrates will be a little higher than in that made from secondary, because silica is very slightly soluble in the alkaline leach liquors. ?

There is a possibility that calcium and magnesium might be a little higher in oxide made fromprimary because of the presence of the chlorides of these two metals present in the ore. The Torch Lake water also contains a high percentage of these compounds. The presence of carbon dioxide in the leaching solutions precipitates both of these metallic ions as insoluble carbonates, and calcium and magnesium getting into the oxide is carried in the solutions as fine suspensions. It is likely that filtering the solutions to remove slimes will also effect the removal of most of these compounds.

The effect of the above impurities on the quality of oxide, and copper powder produced from it, can only be determined by distilling solutions made from concentrates in a large scale test, and reducing the oxide obtained. -?

HANDLING OF CONCENTRATES

Up to 100,000 pounds of concentrates will have to be handled per day from the Ahmeek Mill to the Lake Linden Leaching Plant, and into the tanks. There are at least two ways of doing this. If no expenditure of money is to be made, the concentrates would have to be loaded into gondola cars, or into pans on gondola cars, at the mill, so that they could be transferred into the leaching tanks either with a clam, or by picking up pans of concentrates with the crane and dumping into the leaching tanks. By either method, this material could be put into the tanks in about four hours a day by the regular scrap-handling crew. The mineral would then have to be leveled off in the tanks, when a tank is completely charged.

The alternative would be to use the present mineral cars, and build a pit under the leaching plant tracks from which an elevator would take the mineral to a storage silo, from which it could be dumped into pans for transporting to the leaching tanks, or a system of movable conveyors could be used for this purpose. This method of handling the concentrates would involve a considerable outlay of capital.

HANDLING OF LEACHING RESIDUES

The handling of the residues left from the concentrates after leaching will present two problems: 1. Removal of soluble copper and ammonia, and 2. Removal of the residue from the tanks and recovery of the silver contained therein.

1. The test now being run on the leaching of Rich and Poor minerals will provide information on how well ammonia and soluble copper can be removed from the residue by washing with ammonium carbonate "distillate" and water. It is assumed that sufficiently good washing can be attained, since the volume of residue is small in comparison to the initial tank charge.

It will not be economical to steam the residue for ammonia recovery if it can be reduced to below about ten pounds to the ton.

2. Because a considerable value of silver will remain in the residue, it is assumed that some effort will be made to recover it if the cost is not too great. This will rule out the use of conventional flushing methods for eliminating the residue from the leaching tanks. If the silver particles are not too fine, it may be possible to install riffles in the tailings launder, or a settling area in which the silver can be trapped. If half of the silver could be recovered by this method it will probably be worth doing, since flushing would be by far the cheapest way of getting rid of the residue. The alternate method would be to clam and shovel the residue from the tanks, or to flush them out into a settling tank or thickener, for dewatering, and then recover the silver by flotation, cyanidation, or pyrometallurgical means, or selling the residues as such. Tests will be made with the residue from the leaching test now in progress to determine the nature of the silver particles, and to determine the best way of handling the residue.

DISTILLATION

While the Leaching Plant has capacity to leach considerably more copper from concentrates than required for this program, the capacity of the distillation facilities is definitely limited.

With the three distillation units now at Lake Linden, the maximum copper that can be produced in a seven day week, with ideal conditions, is about 1,500,000 pounds. A comfortable average production is in the order of 1,300,000 pounds per month. If a fourth still were installed at Lake Linden, maximum production would approach 2,000,000 pounds per month, with a consistent average not much above 1,600,000 pounds per month.

The production figures shown above could only be met if only one grade of oxide--high cuprous--was produced. If high cupric oxide is to be made, or agricultural grades of oxide, the production figures would be reduced considerably. This would rule out use of two circuits at Lake Linden unless additional distillation and drying facilities are installed.

The Tamarack plant has on occasion produced 1,000,000 pounds of copper in oxide per month, however, an average production of 750,000 pounds per month is all that can be produced consistently.

COPPER OXIDE DRYING, BAGGING, AND HANDLING

The drying equipment at Lake Linden will handle up to 50,000 pounds of high cuprous oxide per day. Other oxides, higher in cupric oxide content, reduce the capacity of the dryer because they contain more moisture. If production in excess of 50,000 pounds of oxide per day is expected, new drying equipment must be purchased. Drying 50,000 pounds of oxide per day will require some departures from the normal way of operation, since heavy loads of oxide, as encountered when boiling out a still before shutting it down, would overtax the drying equipment. Controlling the flow of oxide from the dewatering cones to the filter should overcome this problem.

The drying of chippings will have to be spread over a longer period of time, so as not to overload the drying equipment when it is carrying its regular load. It is possible that this operation can be mechanized to eliminate the need for a man to shovel the chippings into the drying system.

The bagging equipment at Lake Linden is adequate to handle 50,000 pounds of oxide per day, but bagging will have to be done on two shifts, rather than on one shift.

It is assumed that the oxide will be dried and bagged before reduction to copper powder. If wet oxide is to be reduced directly to powder, it will be necessary to do this with no intermediate storage, since storing the wet, high cuprous oxide for even a few hours would result in a hopelessly caked mass.

It is possible, if the oxide is not to be stored for too long a period before reduction, to eliminate the bagging operation, and transfer the oxide from the drying plant to storage bins in the reduction plant by a pneumatic or other type of conveying system. In this case, the copper powder would have to be used as a basing point for figuring costs rather than the oxide. This would eliminate the need for complete assays on oxide produced for reduction to powder. The only control needed would be the cuprous oxide content, which is a simple analysis, and could be run by plant personnel if necessary.

FACILITIES NEEDED TO MEET ALL OXIDE REQUIREMENTS

The Lake Linden Leaching Plant and Still House will not be able to produce, with present distillation facilities, the high tonnage of copper oxide required for the production of copper powder, and also make the various grades of oxide required for industrial and agricultural customers. Spray grade oxide could be made from the high cuprous oxide made for powder if it were reduced in size by some such fine grinding device as the Micronizer. To produce upwards of 2,000,000 pounds of copper per month for powder, and 300,000 pounds of copper for agricultural and industrial requirements, the following two plans are suggested:

1. <u>Reactivate the Tamarack Leaching Plant.</u>

All of the industrial and agricultural grades of oxide would be produced at the Tamarack Plant, from either Ahmeek Mill concentrates, or a combination of concentrates and pure copper scrap. The Lake Linden Leaching Plant would operate at its average capacity producing only high cuprous oxide for copper powder. The Tamarack Plant would have enough capacity, in addition to that required for special grades of oxide, to contribute about 400,000 pounds of high cuprous oxide for the manufacture of copper powder.

The advantages of this plan are as follows:

A. Lowest capital outlay.

The disadvantages of this plan are:

A. Steam costs, for distillation, are over 150% of the Lake Linden steam costs.
B. Cost of production would be about double Lake Linden costs.
C. Drying and bagging equipment would have to be purchased.
D. Oxide would have to be transported to Lake Linden for blending, or reduction to powder. Oxide handling setup at Tamarack is inefficient.
E. The Tamarack Plant is not serviced by a C&H railroad.
F. Duplication of labor when compared to Plan 2.

2. <u>Install Two New Stills, and Additional Drying and Bagging Equipment at Lake Linden.</u>

Using this plan, four stills would be used to produce oxide for powder, and the fifth still would be used for production of the various industrial and agricultural grade requirements. Total production of copper would be about 2,300,000 pounds per month. Additional drying and bagging equipment, and enlargement of the Still House building would be involved.

The advantages of Plan No. 2 are as follows:

A. Lower cost of production.
   (1) Few extra men needed.
   (2) Lower steam cost.
   (3) Lower Material costs. Two circuits could be used.
   (4) Lower oxide handling costs.

The disadvantages of this plan are as follows:

A. Large capital outlay.
B. Building would have to be enlarged.
C. Operating three stills at a time would require up to 45,000 pounds of steamper hour and making up 45,000 pounds of water at the boiler house per hour.

CAPITAL AND PRODUCTION COSTS

This report will not go into any detail on costs, however, reasonable estimates have been prepared.

To reactivate the Tamarack Leaching Plant, capital expenditures would include the purchase of drying and bagging equipment, and repairing tank bottoms. This would cost about $30,000. If 750,000 pounds of copper in oxide is produced per month at Tamarack, the treatment cost would be from 4.0 to 4.5¢ per pound.

To equip the Lake Linden Leaching Plant and Still House to handle all of the copper oxide production requirements for both copper powder and oxide sales would require an expenditure in the order of $225,000 of which $25,000 would be needed in the Leaching Plant to adapt the present tanks for concentrate leaching. This $25,000 expenditure would be necessary at Lake Linden under either plan. About $200,000 will be needed to add two distillation units and accessory equipment in the Still House, and to make the necessary building alterations.

Treatment costs at Lake Linden will vary from 2.75¢ per pound at a 1,300,000 pounds per month production basis, to 2.0¢ per pound at a production level above 2,000,000 pounds of copper per month.

MS-002
Box 40
Folder 2

INVESTIGATION REPORT
Copper Recovery Test - Tamarack Reclamation
Project No. 48.1.5
July 31, 1959

Introduction

Recovery of oxidized reclamation copper ore sands of the Copper Country has presented a problem that to date has not been solved. Much work has been done at the Copper Range, Quincy, and the Calumet & Hecla companies, as well as at the Michigan College of Mining and Technology of Houghton, Michigan. The Research Department of the Michigan College of Mining and Technology has explored the possibilities of lowering the tailing losses of the above locations, but have found no definite solution to date. Their report titled "Microscopic and Flotation Study of Tamarack Sands for Calumet & Hecla, Inc." was issued March 28, 1958 by M. E. Volin, Director. An Investigation Report, covering a Metallurgical Test for Copper Recovery of the Ahmeek Mill Reclamation Sand Bank, Processed at the Ahmeek Mill, No. 4 Unit of May 1958, Project No. 45.1.31, discloses no better copper recovery.

Object of This Test

The object of this test was to investigate if the tailings of the partially oxidized reclamation sands could be lowered in the Tamarack reclamation plant by use of Z-11 Xanthate No. 250 Dowfroth and No. 2 Fuel Oil; also to study the effect of higher plant tonnage on copper recovery and tailing losses; to obtain and study V-tank underflows for sizing and copper content. These are not ball mill ground prior to flotation.

Tamarack Reclamation Plant Flowsheet Employed - Product Treated

The Tamarack reclamation plant feed for this test was dredged and pumped from the Ahmeek Mill tailing deposits northeast of the Ahmeek Mill. These sands were secured in shallow water, close to the shoreline and, as a result, were highly oxidized.

The coarse fraction of the reclamation ore is dewatered by "Esparanza Type Classifiers" at the Tamarack shore plant and is delivered by conveyor belt to the ball mills and classifiers where it is ground, classified, and fed to Fagergren flotation machines. The Esparanza classifier overflows are dewatered and pumped to form a feed to the above Fagergren flotation machine. Thus, the ground coarse and fines combine to form a common feed to the Fagergren flotation machine. The coarse copper from the coarse fraction after grinding is removed by jigs and tables. The Fagergren flotation machine produces a rougher concentrate and a tail. The Fagergren flotation tails are discarded as waste, while the rougher concentrates are cleaned in a Fahrenwald flotation machine. The concentrates of the Denver machine and the coarser copper fractions from the jigs and tables are properly filtered and sent to the smelter.

Procedure - Equipment and Data

No. 2 Fagergren flotation machine was used for test purposes, taking the feed of two ball mill classifier overflows and a portion of the shore plant fines. The quantities of the ball mill tonnage of the belt coarse feed, being fed by launder dividers, varied from about 2,200 to 2,700 tons per 24 hours for the six ball mills, or 365 to 450 tons per hour per ball mill. See Tables No. I, II, and III for the daily feed rates. The "fines" varied considerably from time to time during the day, depending upon pumping areas in the pool and dredging area at the Ahmeek sand bank. The tonnage to the two grinding circuits can be varied to the requirement of each ball mill and has to be reduced at times when large amounts of "fines" are encountered.

Ore Sampling

The sampling was done hourly at the following points:

1. Belt feed to reclamation plant.
2. Flotation feed from two B.M. unit classifier overflows.
   Flotation feed from divided portion of shore plant "fines."
3. No. 2 Fagergren flotation tails.
4. General Tails.
5. Filter concentrates.

Reagents

In order to introduce No. 250 Dowfroth and No. 2 Fuel Oil, it was necessary to arrange two open drum containers and properly pipe them to the Clarkson feeders with a valve and pipeline system to permit feeding the regular reagents, Z-11, No. 5 P. O. and No. 11 P. O., or the new reagents required for the test.

Reagent Quantities - Regular Practice

1.	Z-11 Isopropyl Xanthate	240 cc./min., or .07 lbs./ton, 10% sol'n
2.	No. 5 P. O.	24 cc./min.
3.	No. 11 P. O.	Variable to suit requirement

Reagent Quantities - Test

1.	Z-11, Isopropyl Xanthate	240 cc./min., or .07 lbs./ton, 10% sol'n
2.	No. 5 P. O.	24 cc./min.
3.	No. 11 P. O.	Variable to suit requirement
4.	No. 250 Dowfroth (Dow Chem.)	25 cc./min.
5.	No. 2 Fuel Oil	6 to 8 cc./min.

Note: The above reagents were varied to some degree from figures shown, but no better results were obtained. See Table I-A to I-F, inclusive, for reagents used for various test periods.

Density of B.M. Classifier Overflow - B.M. Tonnage

The ball mill tonnage varied from 365 tons per hour to 450 tons per hour and the ball mill densities ranged from 40 to 45% solids. The "fines" varied considerably, ranging from 1½% solids to 20% solids, or 250 tons per hour to 2,500 tons per hour, respectively, for plant tonnage. Fluctuating quantities of "fines" with fixed reagent quantities can create higher tailing losses.

V-Tank Underflows - "Fines"

The V-tank underflows sampled hourly for 24 hours were sent to the Lake Linden laboratory for copper and screen analysis (refer to Table VIII). Contrary to favorable results shown, it was predicted that larger amounts would be found coarser than 28 mesh. This eliminated the chance of higher flotation machine tailing losses from this source unless too large tonnages of "fines" would be pumped.

Tables - Summary of Results

1. A summary of results of Table I-A to I-F, inclusive, shows averages for test periods and reagents used.

2. Table No. II summarizes tests shown by Table I-A to I-F, inclusive, with various reagents used, assay values and plant tonnages.

3. Table No. III summarizes average test results of Table No. II with plant belt tonnage arranged in increasing order. As the tonnage increases in the ball mill units, the tailing also rises. The test III-A, using Z-11, #250 D.F., and No. 2 Fuel Oil, indicates, considering higher tonnage and higher feed, that the results are about equal to those of the regular practice. Hence, use of Z-11, plus No. 250 Dowfroth and No. 2 Fuel Oil, cannot be justified due to higher cost of these reagents.

4. Tables No. IV and V represent Tamarack average monthly general feeds and general tails, respectively, for January 1958, indicating appropriate grind with copper values on various screen meshes.

5. Tables VI and VII, represent Tamarack average monthly general feeds and general tails, respectively, for April 1959, indicating appropriate grind with copper values on various screen meshes. Here the tailings are considerably reduced because the feed is not as oxidized as in 4 above.

6. Table No. VIII represents underflows from the Tamarack V-tanks; 24 hourly composite sample. The material as shown is practically all -28 mesh and is adequate for flotation. The copper values are higher than the coarse feed and oxidation of the copper prevents proper flotation recovery.

Conclusion

1. From the foregoing tests, it is indicated that no better recovery was possible with the various tests applied.

2. A report by the Research Department of the Michigan College of Mining and Technology, issued March 28, 1958, titled "Microscopic and Flotation Study of Tamarack Sands" disclosed that the ore was highly oxidized and no real accomplishment resulted from the standpoint of better copper recovery.

3. Increased plant tonnage exceeding ball mill capacity effects proper ore reduction, producing higher tailings.

4. Project No. 45.1.31 covering a Metallurgical Test for Copper Recovery of the Ahmeek Mill Reclamation Sands, disclosed no better copper recovery.

5. In the past years, many attempts to reduce the tailing losses were made on the native oxidized copper tailing deposits of the Copper Country. All attempts to date prove no improvement of copper recovery of these ores by means of flotation.

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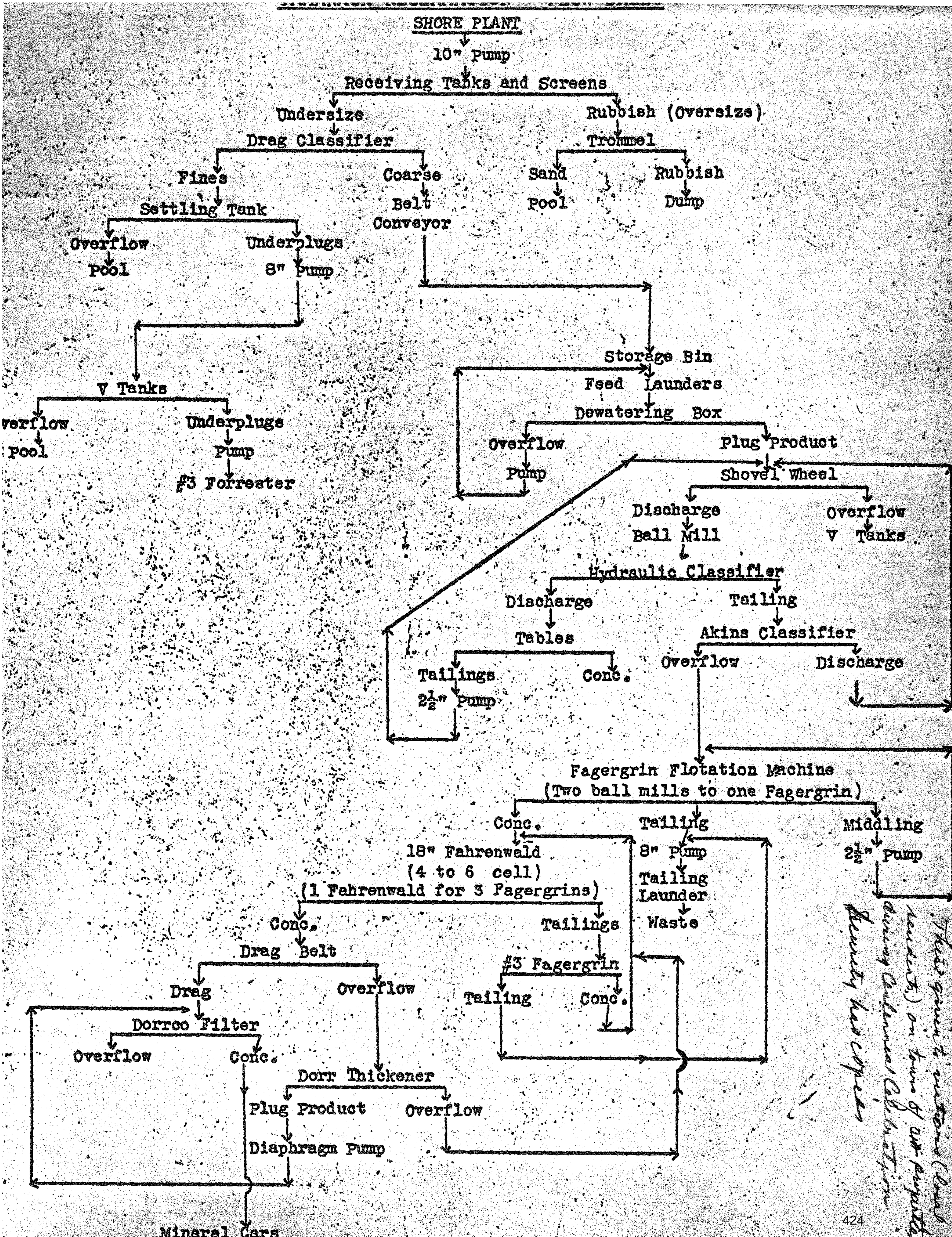
Assay Results of Tamarack Reclamation Plant - Test - 1957-1958
Project No. 48.1.5

TABLE I

Part	Date	Belt Reg. Feed	Belt Tons	Plt. Fines	Gen. Feed	Gen. Tail	Shifts: Day	Shifts: Aft.	Shifts: Nite	Test No.2 Flot.	Remarks
	1957										
	12/5	.291	2,643	.260	.277	.154	.154	.149	.158	.151	Reg. practice, Z-11, #5 P.O. & #11 P.O.
	12/6	.295	2,463	.261	.260	.150	.143	.155	.151	.147	Same as above
"A"	12/7	.319	2,636	.261	.254	.150	.139	.152	.158	.179	" " " "
	12/8	.319	2,552	.261	.254	.150	.139	.152	.158	.162	" " " "
	12/9	.279	2,536	.241	.263	.151	.145	.145	.163	.160	" " " "
	12/10	.258	2,518	.270	.247	.141	.147	.149	.126	.168	" " " "
	12/11	.258	2,325	.270	.247	.141	.147	.149	.126	.134	" " " "
Total		2.019	17,673	1.824	1.802	1.037	1.014	1.051	1.040	1.101	
Average		.288	2,525	.260	.258	.148	.145	.150	.149	.157	
	12/12	.305	2,512	.266	.259	.146	.135	.151	.151	.151	Z-11 ∱ #250 Dowfroth ∱ #2 Fuel Oil
	12/13	.257	2,313	.265	.258	.144	.145	.149	.139	.175	Same as above
	12/14	.242	2,543	.259	.231	.143	.134	.143	.151	.139	" " "
	12/15	.242	2,394	.259	.231	.143	.134	.143	.151	.151	" " "
"B"	12/16	.267	2,282	.268	.272	.137	.143	.147	.121	.138	" " "
	12/17	.252	2,234	.239	.238	.134	.138	.137	.126	.135	" " "
	12/18	.252	1,683	.239	.238	.134	.138	.137	.126	.151	" " "
	12/19	.279	2,271	.285	.268	.146	.147	.149	.142	.160	" " "
	12/20	.278	2,422	.264	.246	.153	.145	.158	.157	-	" " "
Total		2.374	20,654	2.344	2.241	1.280	1.259	1.314	1.264	1.200	
Average		.264	2,295	.260	.249	.142	.140	.146	.140	.150	
	12/21	.297	2,653	.258	.241	.149	.161	.140	.147	-	Z-11 ∱ #5 P.O.
	12/22	.297	2,535	.258	.241	.149	.161	.140	.147	-	Same as above
	12/23	.274	2,549	.267	.269	.157	.159	.147	.164	.156	" " "
"C"	12/24	.276	1,560	.260	.237	.151	.154	.149	.147	.153	" " "
	12/26	.276	2,447	.260	.237	.150	.154	.149	.147	.142	" " "
	12/27	.267	2,286	.250	.266	.150	.157	.154	.139	.157	" " "
	12/28	.285	2,464	.267	.216	.142	.138	.137	.150	.138	" " "
	12/29	.285	2,317	.267	.216	.142	.138	.137	.150	.140	" " "
Total		2,257	18,811	2.087	1.923	1.190	1.222	1.153	1.191	.886	
Average		.282	2,351	.261	.240	.149	.153	.144	.149	.148	

TABLE I contd

Part	Date	Belt Reg. Feed	Belt Tons	Flt. Fines	Gen. Feed	Gen. Tail	Shifts Day	Shifts Aft.	Shifts Nite	Test No.2 Flot.	Remarks
	1957										
	12/30	.261	2,406	.268	.225	.150	.158	.148	.145	.144	Z-11 ≠ #5 P.O. ≠ #11 P. O.
	12/31	.260	1,481	.255	.221	.138	.147	.125	-	.133	Same as above
	1958										
	1/2	.260	1,641	.255	.221	.138	-	.125	.143	.143	" " "
	1/3	.270	2,523	.259	.219	.156	.173	.140	.154	.156	" " "
	1/4	.291	2,391	.255	.220	.139	.134	.135	.147	.134	" " "
	1/5	.291	2,185	.255	.220	.139	.134	.135	.147	.134	" " "
	1/6	.267	2,237	.253	.226	.145	.139	.147	.148	.145	" " "
	1/7	.309	2,188	.241	.230	.141	.139	.143	.142	.151	" " "
	1/8	.309	2,206	.241	.230	.141	.139	.143	.142	.151	" " "
	1/9	.263	2,300	.260	.242	.147	.157	.144	.145	.147	" " "
	1/10	.257	2,452	.248	.242	.149	.149	.154	.144	.156	" " "
"D"	1/11	.268	2,322	.263	.236	.148	.139	.154	.151	.147	" " "
	1/12	.268	2,310	.263	.236	.148	.139	.154	.151	.147	" " "
	1/13	.304	2,425	.251	.237	.150	.152	.160	.137	.149	" " "
	1/14	.274	2,260	.245	.247	.142	.138	.143	.145	.144	" " "
	1/15	.274	1,705	.245	.247	.142	.138	.143	.145	.144	" " "
	1/16	.251	2,381	.277	.226	.142	.137	.149	.141	.145	" " "
	1/17	.274	2,739	.265	.234	.156	.157	.153	.157	.162	" " " High tonnage
	1/18	.245	2,551	.276	.284	.144	.150	.142	.139	.139	" " " " " "
	1/19	.245	2,480	.276	.284	.144	.150	.142	.139	.139	" " " " " "
	1/20	.273	2,656	.261	.253	.158	.165	.154	.154	.152	" " " High Tonnage
Total		5.714	47,839	5.412	4.980	3.057	2.934	3.033	2.916	3.062	
Average		.272	2,278	.258	.237	.146	.147	.144	.146	.146	
	1/21	.267	2,780	.273	.287	.162	.173	.154	.160	.167D .148A .176N	(High tonnage) Z-11 = 240 cc./min. or .077 lbs./ton #5 P.O.=24 cc./min. #11 P.O.= 5 to 10 cc./min. Z-11 Prepared at Ahmeek Mill
	1/22	.267	2,662	.273	.287	.162	.173	.154	.160	.180D	" " " " " "
Total		.534	5,442	.546	.574	.324	.346	.308	.320	.671	
Average		.267	2,721	.273	.287	.162	.173	.154	.160	.168	
	1/23	.253	2,541	.276	.255	.157	.166	.154	.152	.154	Z-11 ≠ #250 D.F. ≠ #2 F. O.
	1/24	.267	2,458	.277	.254	.162	.172	.147	.166	.158	Same as above
	1/25	.281	2,604	.279	.242	.152	.148	.145	.162	.150	" " " "
	1/26	.281	2,601	.279	.242	.152	.148	.145	.162	.159	" " " "
"F"	1/27	.306	2,532	.260	.242	.144	.147	.136	.148	.157	" " " "
	1/28	.288	2,283	.268	.270	.157	.164	.144	.162	.157	" " " "
	1/29	.288	1,816	.268	.270	.157	.164	.144	.162	.157	" " " "
	1/30	.278	2,372	.270	.244	.154	.152	.152	.157	.143	" " " "
	Total	2.242	19,207	2.177	2.019	1.235	1.261	1.167	1.271	1.235	
	Average	.280	2,400	.272	.252	.154	.158	.146	.159	.154	


SHORE PLANT
10" Pump
Receiving Tanks and Screens
Undersize
Rubbish (Oversize)
Drag Classifier
Trommel
Fines
Coarse
Sand
Rubbish
Settling Tank
Belt Conveyor
Pool
Dump
Overflow
Underplugs
Pool
8" Pump
Storage Bin
V Tanks
Feed Launders
Dewatering Box
verflow
Underplugs
Overflow
Plug Product
Pool
Pump
Pump
#3 Forrester
Shovel Wheel
Discharge
Overflow
Ball Mill
V Tanks
Hydraulic Classifier
Discharge
Tailing
Tables
Akins Classifier
Tailings
Conc.
Overflow
Discharge
2½" Pump
Fagergrin Flotation Machine
(Two ball mills to one Fagergrin)
Conc.
Tailing
Middling
18" Fahrenwald
(4 to 6 cell)
(1 Fahrenwald for 3 Fagergrins)
8" Pump
2½" Pump
Tailing Launder
Conc.
Tailings
Waste
Drag Belt
#3 Fagergrin
Drag
Overflow
Tailing
Conc.
Dorrco Filter
Overflow
Conc.
Dorr Thickener
Plug Product
Overflow
Diaphragm Pump
Mineral Cars

LAKE CHEMICAL COMPANY

CALUMET AND HECLA CONSOLIDATED COPPER COMPANY

For Inter-Office Correspondence Only.

To Mr. A. E. Petermann
E. R. Lovell

Date March 21, 1944

Form A10-250-6-43

SUBJECT

No Reply Necessary ☐

Please Reply ☐

The question of the corporate setup which will be used is one which does not need to be determined at the present time. It seems to me the first step is to develop the process to a point where it is demonstrated to be commercially possible. This can be done without any definite commitment as to future arrangements except for a general agreement to divide cost and profit.

If Calumet and Hecla decides to participate in this operation the next step is to design the necessary furnace equipment, install it at Hubbell and try to work the bugs out of the process. The Harshaw Company will make available one of its chemists and its designing staff for this part of the job. We explained to Mr. Harshaw the possibility that it would be necessary to produce oxide from scrap of various kinds, in which case the oxide would contain zinc. He promised to start his research staff working on our Lake Linden oxide to see what happens to the zinc.

While we have made no investigation of the Harshaw Company's financial status, both Mr. Craig and I were impressed with the people that we talked to there. We think they are our kind and that a hookup with them would probably be beneficial to Calumet and Hecla. Everyone with whom we talked told us that the Harshaw Chemical Company has a very good reputation and is a good company to do business with.

Yours truly

A. E. Petermann Jr.

A. E. Petermann, Jr.
General Counsel

P2:RA

ms-002 Box 58 Folder 29

CALUMET AND HECLA CONSOLIDATED COPPER COMPANY

For Inter-Office Correspondence Only.

To Mr. A. E. Petermann
E. R. Lovell

Date March 21, 1944

Form A10-2M-9-43

SUBJECT

No Reply Necessary ☐

Please Reply ☐

With Mr. George B. Craig, Research Director, I spent several hours talking to Mr. W. D. Harshaw, President, and Mr. G. J. Hall, Vice President of the Harshaw Chemical Company at Cleveland, Ohio.

The Harshaw Chemical Company has developed a method of producing cuprous oxide from Calumet and Hecla Consolidated Copper Company's zinc free mixed copper oxide. This method was disclosed to Mr. Craig and appears to be entirely different from any of the methods now used and protected by patents held by others. The Harshaw Co. is having a patent search made to confirm this opinion.

The method has been proved in laboratory practice and the Harshaw Company has carried it beyond that stage and has demonstrated the possibility of using it on batches of 25 pounds at a time. Mr. Craig's report will undoubtedly cover this phase of the matter fully.

It seemed to be the consensus of opinion that the next step would be to set up a pilot plant large enough to permit the development of a commercial practice. The chief item of equipment necessary would cost in the neighborhood of $7000.00. Other preliminary work in developing a commercial practice would probably bring the cost of this stage up to about $15,000. The cost beyond that stage should not be more than another $20,000 or $25,000, making a probable ultimate total investment in equipment and research of about $40,000.

The Harshaw Company's proposal generally was that Calumet and Hecla join with it in development of the process and in conducting a business of manufacturing cuprous oxide. Nothing very definite in the nature of the proposal for dividing costs and profits was made but Mr. Harshaw indicated that his Company would be willing to pay half the cost and I therefore assume that he intends to divide the profit equally also. The logical place to build a plant would be near the source of supply, of course, and it was thought that operations might be conducted either at our smelter or an adjoining building. Calumet and Hecla would do the operating and producing and the Harshaw Company would take care of the selling.

CALUMET AND HECLA CONSOLIDATED COPPER COMPANY

For Inter-Office Correspondence Only.

To Mr. *Date*

Form A10-2M-9-43 Page 2 SUBJECT

No Reply Necessary ☐

Please Reply ☐

Some discussion was had of the manner in which the entire operation should be conducted. The Harshaw Company is now paying excess profits taxes and it is probable that any additional earnings from this process, if coming to it direct, would result in an 80% federal tax. For that reason the Harshaw Company would like to see the business conducted through a subsidiary with each Company receiving its share of profits in dividends. Such a subsidiary would undoubtedly be subject to excess profits taxes also but probably means could be found to secure credits which would reduce the overall tax to something less than 80%, and 85% of Harshaw's receipts would be non-taxable. The Harshaw Company's attitude is that earnings are of no consequence to it at the present time, that it would rather build for the future and be in a position to benefit after the tax rate has declined. Mr. Harshaw indicated that if the process became successful his Company would like to devote substantially all of its earnings to further research in an attempt to develop other copper chemicals so that the investments would bring a benefit at a later date.

Calumet and Hecla Consolidated Copper Company is not subject to an excess profits tax at the present time and I cannot see how earnings from this operation would ever be great enough to make us subject to excess profits taxes. Therefore, operations through a subsidiary would result in Calumet and Hecla Consolidated Copper Company receiving a return substantially less than it would have in a direct operation. These two viewpoints do not necessarily seem irreconcilable. It may be possible, for example, to utilize one of the Calumet and Hecla subsidiaries having an invested capital which would reduce excess profits taxes, or it might be possible to set up a subsidiary wholly owned by Harshaw giving Calumet a management contract with its fee calculated at 50% of the profits.

MS-002
Box 58
Folder 29

Mr. Lovell

G. L. Craig October 12, 1944

Before starting my analysis of the suitability for the installation of a COC$ process in either the Lake Linden or the Tamarack leaching plants, I think it would be well to give a short review of the COC$ process as practised by Harshaw today. The first step in the operation is the loading of the reaction tank with copper wire. This reaction tank is about 6' 6" in diameter, and about 10' high, and has a capacity of from 12 to 14 thousand pounds of wire. After the tank is loaded a few bags of sodium chloride are added and the tank filled with water. A weighed amount of 26° Be' ammonium hydroxide is also added to the tank, and the batch is started by blowing through compressed air. From time to time as the batch progresses 98% sulphuric acid is added in order to keep the pH of the solution around 4.0. The air agitation is kept up from 12 to 14 hours, at the end of which time the batch is finished. It is then pumped over to a storage tank, which is about 10' in diamter and 12' high, and agitated by a sweep agitator. It is allowed to age in here for another period of time, and is then filtered through a wooden plate and frame filter press. After thoroughly washing the press cake, the presses are dumped and the cake is loaded on trays and put into truck and tray driers. When the cake is dry it is removed from the drier and ground in a Raymond Impact Mill. After grinding the product is bagged in paper bags, and is ready for shipment.

There are a number of improvements we contemplate in the setting up of this new plant, of which the substitution of a continuous type of filter rather than the plate and frame presses is one. We have already sent some samples of our slurry to Oliver United Filters for test runs on their type of filter. The analysis of the cake from this filter shows it to be high in both ammonia and sodium, and for that reason we are not sure whether or not this type of filter can be applied to the process. However, more samples will have to be sent to these people and to manufacturers of other types of continuous filters before we reach a final decision on this point.

Another improvement we contemplate is the use of a continuous type of drier rather than the use of the very laborious truck and tray driers which we are using at present. The type of driers that may be used on this product are (1) Raymond Kiln Mill, (2) spray drying, (3) Aeroform Drier, manufactured by Proctor and Schwartz, and (4) a rotary drier such as manufactured by Louisville. The advantage of using either the Raymond Kiln Mill or spray drying over any of the other methods is that the product would not have to be ground after drying. Again, before we make a final decision on the type of drier to be employed, a thorough investigation of all these different types must be made.

So, as you see, at the present time the type of equipment for the COC$ process has not been fully determined. It therefore is in order to analyze the space available by comparing space requirements using an Oliver Continuous Filter followed by either Kiln milling or spray drying; and by using plate and frame filter presses followed by an Aeroform Drier and grinding and bagging machinery.

The main items of equipment needed in the first case are (1) 4 reaction tanks, approximately 7' diameter by 10' high, (2) 3 storage tanks, approximately 10' diameter by 12' high, (3) 4 BCM reaction tanks, approximately 8' diameter by 9' high, (4) 1 Oliver Filter, (5) 1 spray drying or Kiln milling setup followed by a Bates Valve Bagger. For the second case, the equipment needed is (1) 4 reaction tanks, approximately 7' diameter by 10' high, (2) 3 storage tanks, approximately 10' diameter by 12' high, (3) 4 BCM reaction tanks, approximately 8' diameter by 9' high, (4) 3 42" wood plate and frame filter presses, approximately 30' long, (5) 1 Proctor and Schwartz Aeroform Drier, approximately 60' long, (6) grinding equipment followed by a Bates Valve Bagger. In addition, sufficient space must be provided for the storage of raw and finished materials. The raw materials consist of (1) briquetted copper wire, (2) 26° Be' ammonia storage, (3) 66° Be' sulphuric acid storage, (4) liquid caustic soda storage (At Elyria we are using the supplier's tank car. Perhaps the same arrangement can be utilized here), (5) sodium chloride storage. The finished goods storage, which consists of 56% COCS, 44% COCS, and BCM, should be stored in an ammonia free location. Also, since the sales of these items are seasonal, sufficient space must be allotted to store approximately 200 tons of product.

I hope the foregoing has given you an idea of the problems we must consider in choosing a suitable location for the installation of a 1000 ton per year unit of COCS, keeping the thought in mind that it very probably will be expanded to 2000 tons per year, and possibly to 3000 tons per year.

Installation of Process at Tamarack

Equipment installed at the present time in the process building at Tamarack consists of six 54' diameter by 12' deep steel leaching tanks, four 44' diameter Dorr Classifiers, and miscellaneous equipment. One of the proposals submitted by G. & H. is to remove two of the Dorr Classifiers and some of the miscellaneous equipment, and install the COCS process in the vacated area. The geometry of this area is approximately 61'-0" by 85'-0", or approximately 5200 square feet. Using the equipment cited in the first case above, it would be possible to make a satisfactory installation in the 61'-0" by 85'-0" area allotted. However, it would be necessary to erect a storage shed, preferably in the area directly south of the present Dorr Classifiers. This storage shed could be of light steel truss construction with corrugated steel siding, and should be of sufficient size to allow ample storage space for both raw materials and finished goods. A railroad spur could be brought into this building by cutting into an existing plant track a short distance away.

If it was decided to substitute plate and frame filter presses instead of the Oliver Filter it still would be possible to install the equipment in this location; although it would seriously cut down the working area necessary for dismantling and cleaning out the spray drier between runs of the various products.

Using the equipment cited in the second place, it would not be possible to make a satisfactory equipment installation in the 61'-0" by 85'-0" area. Since this is a fairly high building (about 28' below truss) it may be possible to put in another floor and erect the reaction tanks, the storage tanks, the BCM tanks, and the filter presses on the second floor; while the drying and grinding equipment could be installed on the first floor. This would give enough room to allow a railroad spur to be run into the building, and would also allow a limited storage space for raw materials.

In my opinion, the choice of this area for the installation of a COCS process is not a very good one. The reasons are that, although it is possible to install a 1000 ton per year unit in this area, there would be no place to go if it is ever decided to install a second or third 1000 ton unit. Even if it developes later on that additional equipment can be moved by C. & H. from this area, the original layout necessary for the thousand ton unit would be such that considerable rearrangement of equipment would result if it was ever decided to install another unit in this location. Of course, this unit can be installed with the idea in mind that if it is ever necessary to increase productive capacity the equipment would be moved to a new location along with the additional equipment necessary to meet the new production requirements. Such a procedure is, of course, expensive and one to be avoided if at all possible. Again, if it is necessary to erect a second floor in this area to accommodate all the equipment, the expense involved would be considerable.

<u>Installation of Process at Lake Linden</u>

If it is decided to install the COCS process in the Lake Linden sand leaching plant, ample space could be provided for the process by pulling two of the 54' diameter sand leaching tanks from either the north or the south end of the building. In either case, this would give a working area of approximately 60' wide by 125' long, or equivalent to 7500 square feet. In the use of this area the best possible layout for this equipment can be obtained. Perhaps the north end of the building would be a better location than the south for it would be more isolated, and the workmen would not be bothered by the Crane traffic, which I understand at times is very heavy. If it was ever decided to install another 1000 ton per year unit all that would be necessary would be to pull the two adjacent 54' diameter tanks and install the necessary additional equipment. This could all be done without disturbing or rearranging the initial equipment installation, and for this reason this area is to me the most logical and the most appealing of the two areas proposed.

A good location for the necessary raw material storage, with the exception of the sodium chloride, would be in the area directly east of the two leaching tanks and occupied at present by solution tanks. If it was not deemed feasible by C. & H. to remove these tanks, the next best thing would be to construct a small lean-to on the west side of the building for the necessary raw material storage. If it were possible to open up a portion of the north flotation plant for storage it would be an ideal location for storage of both finished COCS and salt. This building is free from ammonia fumes and, therefore, well suited for long period storage of COCS. Also this building has railroad facilities, which would help facilitate the shipment of the product.

In addition to these two areas it has been suggested as a possibility that the vacant smelting plant at the Lake Linden Works could be utilized. This building is divided into four sections, each approximately 60' wide by 120' long, and each one of these areas would be suitable for a 1000 ton unit. The geometry of the equipment layout is such that about the most efficient equipment installation would be in area approximately 60' wide by 120' long, and so if C. & H. has any other locations available the COCS process could be installed in them if the space available would approximate these dimensions.

Before we can make a final complete layout of the equipment for this process, and before it is necessary to make a final decision as to the area in which the equipment is to be installed, it will be necessary for us to determine the exact type of filter and drying equipment to be used. When this is done, and the location decided upon, an accurate, detailed estimate of the cost involved in the construction of a 1000 ton unit can be drawn up.

R. A. Lucht

RAL:JMA

CALUMET AND HECLA CONSOLIDATED COPPER COMPANY

CALUMET, MICHIGAN

MS-002
Box 60
Folder 4

July 16, 1945

Mr. W. J. Harshaw, President
The Harshaw Chemical Company
1945 East 97th Street
Cleveland 6, Ohio

Dear Mr. Harshaw:

The Board of Directors of the Calumet and Hecla Consolidated Copper Company has authorized me to negotiate an agreement with your Company leading to the joint production and sales of copper chemicals substantially along the lines we have discussed, such agreement to be subsequently ratified by the Board of Directors of Calumet and Hecla before becoming effective. The details of our joint arrangement, of course, must be worked out, and we hope that this may be done promptly.

We understand that a new corporation will be formed with an authorized capital of about $300,000. This new corporation will lease from Calumet and Hecla such space as is necessary for production. Equipment will be provided by purchase, either from Calumet or from Harshaw. Capital will be furnished by sales of stock to Calumet and to Harshaw, either for cash or for equipment, etc., so that each Company always owns 50 per cent of the stock. The amount of capital needed cannot be determined at present, but can be adjusted from time to time to meet the Company's requirements.

At present there are two products which will be produced, COCS and Cupric Hydrate. Other products may be added later by mutual agreement, and it is understood that we will both attempt to develop such additional products. We now have a process for making Cuprous Oxide, which looks as though it might be ready very soon.

It is understood that our present mixed oxide is not to be put in the pool. Also, we can produce Cupric Oxide direct in our leaching plant, and are now preparing to do so, and will therefore retain this product for ourselves, at least for the present, although we will be glad to make a sales arrangement with you if you wish.

Both Cupric Hydrate and Cuprous Oxide (if we can make it) will start with our present leach solution, which is the basis for our present mixed oxide. Production of these materials may displace our own product to some extent, either by taking some of our capacity, or by taking some of our market. The price that we charge for the solution, delivered to the new plant, should therefore include our normal profit on our own operation. In other words, the price will be determined by deducting from the market price of mixed oxide (13.6 cents per pound of contained copper at present) the normal cost of operations not performed; such as, distillation, packaging, etc.; and by adding the cost of solution not returned to the circuit.

We are to manage the operation and will charge the new Company all of our real costs, including applicable overhead items.

Your Company will sell the products of the plant, and will receive a commission of 5 per cent of the sales price. In this connection, as long as we are selling mixed oxide and possibly Cupric Oxide we feel that it would be advantageous to be able to make sales of the other products also. We have no intention of creating a sales force or of trying to make sales, but feel that some of our own customers might prefer to buy from us, at least at first. Harshaw would receive its regular commission on any such sales, and we would get none.

Will you please ask Mr. Perry to send us a copy of your agreement with the Stauffer Chemical Company, to be used as a starting point for a contract between us.

At an early date another conference should be arranged to work out the details of the arrangement so that we may proceed as rapidly as possible. I suggest that this time you come to Calumet.

Sincerely yours,

President

ERL/P
C-A.D.N.

OK
H G Kenny

OK

OK
A. H. Wohlrab

A. H. Wohlrab, General Manager

August 27, 1945.

Dear Sir:

With reference to the charge out price of electric power for the new chemical plant at Tamarack Reclamation:

From the data we have at the present time, it appears that the requirements at this plant would be in the neighborhood of 200 Kw. demand, with a probable consumption of 50,000 Kw-H per month.

Under these conditions, if power was purchased from the Houghton County Electric Light Company, the unit cost would be approximately 1.65¢ per Kw-H.

At the present time we must assume that any additional power furnished will be generated at the Lake Linden Plant. The average cost of producing power from this plant for the past 6 months has been 1.07¢ at the switchboard, as shown by the monthly cost sheet, but under our present operating condition the increment cost of any additional power developed by this plant will be in the neighborhood of .7¢ per Kw-H. (just the coal cost).

The power used at the new chemical plant will be metered at 440 volts and in order that this plant stand its share of line and transformer losses, I would suggest that we establish a rate of 1.00¢ per Kw-H.

Yours truly,

s/ Carl L. Fichtel

Electrical Superintendent

CLF/G

August 27, 1945.

Mr. E. R. Lovell, President
Mr. A. H. Wohlrab, General Manager
Calumet, Michigan

Dear Sirs:

Steam and Water for Chemical Plants
at Tamarack Reclamation

Steam for use in the processes does not appear to be required.

Building Heating

A fair charge may be arrived at by comparison with Calumet heating plant experience where the condensate is metered and charges are proportioned to radiation and other factors.

For example, the Hecla machine shop, a building of similar height, used 934,000 lbs. of steam in January 1945, which is 43.6 pounds per square foot ground area.

Allowing space for the proposed plant, 104' x 81', or 8420 sq. ft. and 43.6 lbs. per sq. ft., steam chargeable to this portion of the building would be 338,000 lbs., worth about 50¢ per thousand pounds at Tamarack, or $169 for one winter month.

Using seasonal factors of 3 months at 100%, 2 months each at 75%, 50% and 25%, and 3 months at zero, the annual charge would amount to about $1,000.

This would appear to be a fair charge unless it becomes advisable to maintain a higher temperature in the building because of the new operation. Present requirements are to safeguard against frost.

Two furnaces will contribute to the heating, possibly enough to point to less heating charge.

Water Supply

Three sources of water are available, Lake Superior, mill supply from Torch Lake, and fire system, also from Torch Lake.

Lake Superior water costs around 8¢ per thousand gallons without overhead on labor, depreciation, etc.

The cost for power only for mill supply water is about 6 tenths of a cent, and for water from the fire system 2½ to 3 cents.

Fair rates to cover the full cost would be 10¢ per thousand gallons for Lake Superior, 1¢ for mill supply, and 4¢ for fire system.

Lake Superior water may be required for process work except cooling. 131 batches per month at 1800 gallons and 10¢ per 1000 gallons, would cost under $25 per month. Amount of wash water is not known, probably would be Lake Superior.

Water from the mill supply or the fire system may be used for cooling, according to the pressure needed for circulation through the coils.

Meters in the water supply lines would appear desirable.

Yours truly,

s/ R. McIntosh

Mechanical Superintendent

RM/G

LEASE

DRAFT – September 6, 1945

THIS INDENTURE, Made and entered into this ____________ day of ____________, 1945, between Calumet and Hecla Consolidated Copper Company, a corporation organized and existing under the laws of the State of Michigan and having its principal office in Michigan at Calumet, Michigan (hereinafter referred to as "Lessor"), party of the first part, and Lake Chemical Company, a corporation organized and existing under the laws of the State of Michigan and having its principal office at Calumet, Michigan (hereinafter referred to as "Lessee"), party of the second part, WITNESSETH:

That the Lessor, in consideration of the rents herein reserved to be paid by the Lessee, and of the conditions and covenants herein contained to be observed and performed by the Lessee, does hereby demise and lease unto the Lessee the following described property (hereinafter called the "leased premises"), to wit:

Parcel "A"

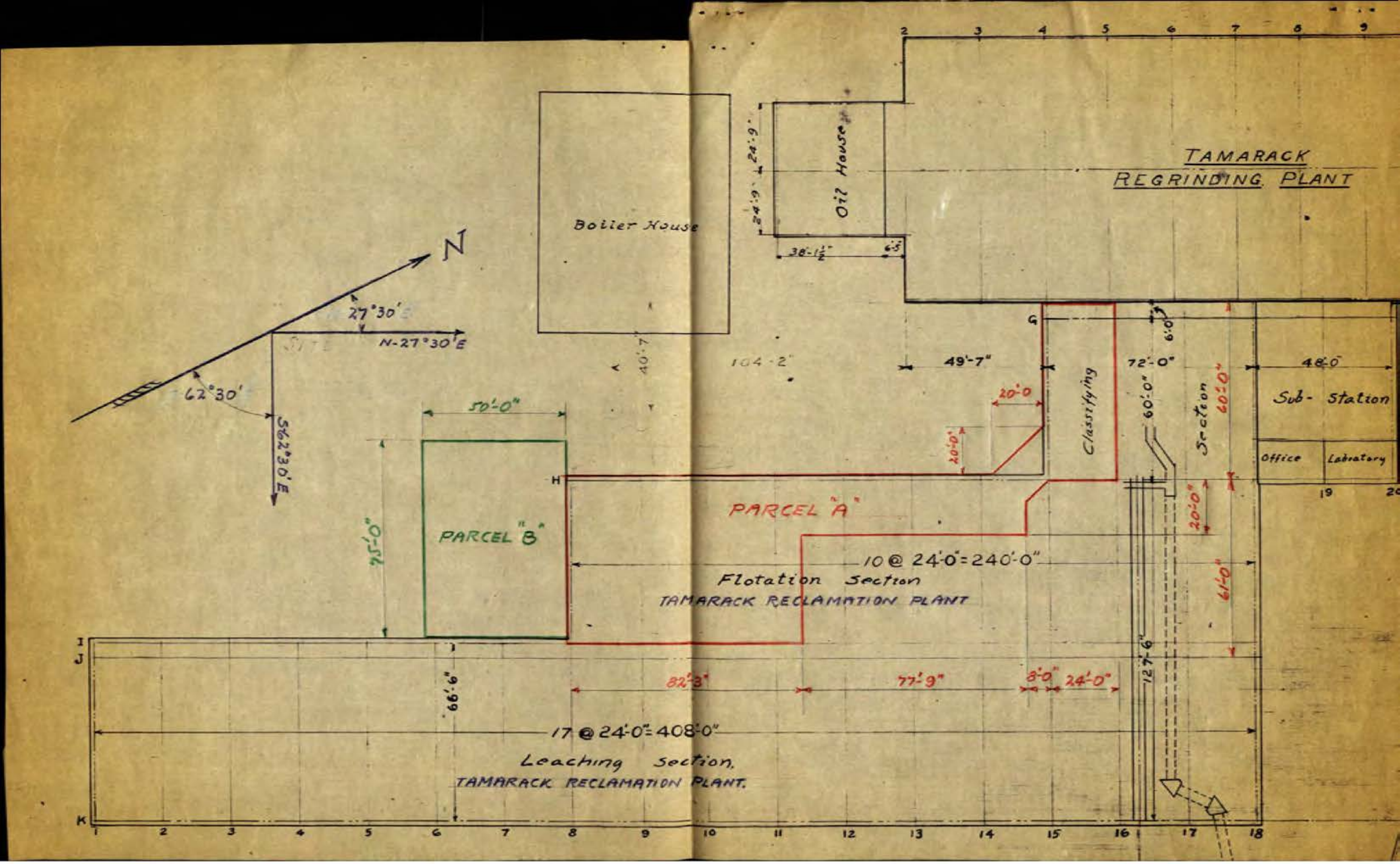
That part of the Tamarack Reclamation Building owned by Calumet and located in Osceola Township, Houghton County, Michigan, which is enclosed in red lines and marked "Parcel A" on the print attached hereto, comprising Eight Thousand Two Hundred Twelve and Twenty-five Hundredths (8,212.25) square feet of floor space, more or less.

Parcel "B"

A piece or parcel of land located in Osceola Township, Houghton County, Michigan, known and described as follows:

> Starting at the Southwest (SW) corner of the flotation section of the Tamarack Reclamation Building (which point is indicated by the letter "H" on the attached print); thence North sixty-two degrees, thirty minutes West (N 62° 30' W) fourteen (14) feet; thence South twenty-seven degrees, thirty minutes West (S 27° 30' W) fifty (50) feet; thence South sixty-two degrees, thirty minutes East (S 62° 30' E) seventy-five (75) feet; thence North twenty-seven degrees, thirty minutes East (N 27° 30' E) fifty (50) feet; thence North sixty-two degrees, thirty minutes East (N 62° 30' E) sixty-one (61) feet to the point of beginning.

Together with the right of ingress and egress to and from the leased premises through, over, and across lands and premises owned or controlled by Calumet, which right shall be exercised at places mutually agreeable to the parties, and without undue interference to Lessor's use and occupancy of the lands and premises crossed.


TAMARACK REGRINDING PLANT
Oil House
Boiler House
N
27°30'
N-27°30'E
62°30'
S62°30'E
50'-0"
75'-0"
PARCEL "B"
PARCEL "A"
49'-7"
72'-0"
48'-0"
Classifying
Section
Sub- Station
Office
Laboratory
10 @ 24'-0" = 240'-0"
Flotation Section
TAMARACK RECLAMATION PLANT
82'-3"
77'-9"
8'-0"
24'-0"
17 @ 24'-0" = 408'-0"
Leaching section.
TAMARACK RECLAMATION PLANT.

SALES CONTRACT

DRAFT – September 6, 1945

THIS AGREEMENT, Made and entered into on ______________________, 1945, between Lake Chemical Company, a corporation organized and existing under the laws of the State of Michigan, and having its office at Calumet, Michigan (hereinafter referred to as "Lake"), party of the first part, and The Harshaw Chemical Company, a corporation organized and existing under the laws of the State of Ohio, and having its principal office at 1945 East 97th Street, Cleveland, Ohio (hereinafter referred to as "Harshaw"), party of the second part, WITNESSETH:

WHEREAS, Calumet and Hecla Consolidated Copper Company and Harshaw have caused Lake to be organized, and each is the owner of one-half of its capital stock, under the terms of an agreement between them, dated ______________________, and

WHEREAS, Lake was organized for the purpose of engaging in the manufacture and sale of Copper Oxychloride Sulphate and Cupric Hydroxide, and such other copper chemicals as may be determined upon at a later date, and desires to secure the services of Harshaw in the installation of machinery and equipment for manufacturing such chemicals and in the sale of such chemicals, and

WHEREAS, Harshaw has had extensive experience and special knowledge in the installation of machinery and equipment for manufacturing chemicals and the sale of such chemicals, and is willing to devote such experience and knowledge in assisting in the installation of the manufacturing plant of Lake and in selling its products;

NOW, THEREFORE, in consideration of the premises and of the sum of one dollar ($1.00) paid by each of the parties hereto to the other, the receipt of which is hereby acknowledged, it is mutually agreed as follows:

1. As soon as reasonably possible, Lake will install in the building leased from Calumet and Hecla Consolidated Copper Company the proper machinery and equipment for the manufacture of Copper Oxychloride Sulphate and Cupric Hydroxide, and will commence and carry on the manufacture thereof.

2. Harshaw will furnish Lake with its best designs and with such technical knowledge as it may possess and such assistance as may be required by Lake to complete said plant.

3. Upon completion of said plant, Harshaw will assign to Lake the exclusive right to make, use, and sell Copper Oxychloride Sulphate under all formulas and processes owned or controlled by it for the sum of one dollar ($1.00). Harshaw

will communicate to operating personnel such information as may be necessary to permit the manufacture of Copper Oxychloride Sulphate by Lake.

4. Lake hereby grants to Harshaw the sole and exclusive right to sell chemical products manufactured by Lake during the continuance of this agreement, and Lake shall supply Harshaw such of said products as Harshaw may require from time to time to supply its customers. Lake shall fix the price at which its products shall be sold, but Harshaw shall sell the same to its own customers in its own name, bill such customers direct, make all collections, and assume all credit risks. Lake will make shipments to Harshaw or direct to Harshaw's customers as instructed by Harshaw. Lake will bill Harshaw promptly after shipment, allowing Harshaw a five per cent (5%) seller's discount from the invoice price established for sales of Copper Oxychloride Sulphate and Cupric Hydroxide to Harshaw's customers, and any cash discount allowed to such customers, and Harshaw will pay such bills promptly. The amount of such seller's discount shall be reviewed and revised annually to cover the succeeding year.

It is understood that this exclusive grant is subject to the right of Lake, which is hereby reserved, to permit Calumet and Hecla Consolidated Copper Company to make sales of Lake's products to its customers on the same terms and conditions as Harshaw, except that Calumet and Hecla Consolidated Copper Company will receive no seller's discount and the amount of any such discount attributable to sales by Calumet and Hecla Consolidated Copper Company will be paid by Lake to Harshaw.

5. During the continuation of this agreement, Harshaw will not manufacture, sell, deal in, or in any way handle Copper Oxychloride Sulphate or Cupric Hydroxide, except such as is supplied by Lake under the terms of this contract, so long as Lake is able to furnish such chemicals to the extent necessary to supply Harshaw's customers.

6. Harshaw agrees to furnish Lake from time to time with such technical knowledge and services as it may possess, and to make available to Lake its personnel and facilities for the purpose of conducting such research as Lake may wish to engage in. Harshaw will also cooperate with Lake in making purchases of raw material for Lake's account, and will bill any such purchases from others to Lake at Harshaw's cost thereof. Harshaw will also make available for purchase by Lake materials manufactured or dealt in by it at prices not in excess of the lowest market price at which such materials are then being sold by Harshaw to other customers.

7. For any services which Harshaw may perform for Lake, whether provided for herein or not, for which payment or method of payment is not provided herein, Lake shall pay Harshaw such reasonable charges as may hereafter be mutually agreed upon.

8. This Agreement shall continue in force and effect during the entire term of the lease of even date herewith, wherein Calumet and Hecla Consolidated Copper Company has leased plant space to Lake for the purpose of engaging in the manufacture of chemicals.

9. Neither of the parties hereto may assign this agreement or its rights hereunder except in connection with a sale of all of its assets and business, or except to a successor corporation in a consolidation, merger, or other corporate reorganization, without the written consent of the other party. Subject to the limitations of this paragraph, the terms and conditions hereof shall inure to the benefit of and be binding upon the respective successors and assigns of the parties hereto.

IN WITNESS WHEREOF, etc.

OPERATING CONTRACT

DRAFT - September 6, 1945

THIS AGREEMENT, Made and entered into as of ______________________, 1945, between Lake Chemical ~~Corporation~~ Company, a corporation organized and existing under the laws of the State of Michigan, and having its office at Calumet, Michigan (hereinafter referred to as "Lake"), party of the first part, and Calumet and Hecla Consolidated Copper Company, a corporation organized and existing under the laws of the State of Michigan, and having its principal place of business in Michigan at Calumet, Michigan (hereinafter referred to as "Calumet"), party of the second part,

WITNESSETH:

WHEREAS, The Harshaw Chemical Company and Calumet have caused Lake to be organized, and each is the owner of one-half of its capital stock, under the terms of an agreement between them, dated ______________________, and

WHEREAS, Lake was organized for the purpose of engaging in the manufacture and sale of Copper Oxychloride Sulphate and Cupric Hydroxide, and such other copper chemicals as may be determined upon at a later date, and desires to secure the services of Calumet in the installation of machinery and equipment for manufacturing such chemicals and in the conduct of its manufacturing operations, and

WHEREAS, By instrument of even date herewith Calumet has leased to Lake space in one of its buildings for the purpose of installing such machinery and equipment and is willing to assist in the installation of machinery and equipment and in the conduct of the business of manufacturing such chemicals;

NOW, THEREFORE, in consideration of the premises and of the sum of one dollar ($1.00) paid by each of the parties hereto to the other, the receipt of which is hereby acknowledged, it is mutually agreed as follows:

1. As soon as reasonably possible, Lake will install in the building and premises leased from Calumet, at its own cost and expense, machinery and equipment necessary for the manufacture therein of Copper Oxychloride Sulphate and Cupric Hydroxide.

2. Calumet will assist Lake in designing and installing said machinery and equipment by furnishing technical knowledge, supervision, and direction, and such labor and facilities as may be required, and Lake agrees to pay Calumet therefor as provided hereafter for the payment for other like services to be rendered in connection with the manufacturing of such chemicals.

3. Upon completion of said plant, Calumet will assign to Lake the exclusive right to make, use, and sell Cupric Hydroxide under the process owned by Calumet, for the sum of one dollar ($1.00). Calumet will also communicate to operating personnel such information as may be necessary to permit the manufacture of Cupric Hydroxide by Lake.

4. Calumet agrees to provide Lake's plant with water, power, heat, and process steam as may be necessary for its manufacturing operations. For the first year of this contract Lake agrees to pay Calumet One Thousand Dollars ($1,000) per year for heating its plant, Fifty Cents (50¢) per thousand pounds for process steam, One Cent (1¢) per Kilowatt Hour for power, Ten Cents (10¢) per thousand gallons for Lake Superior water, One Cent (1¢) per thousand gallons for Mill Supply water, and Four Cents (4¢) per thousand gallons for Fire Protection water. Process steam, power, and Lake Superior water will be metered, and Mill Supply and Fire Protection water will be estimated. Calumet will bill monthly, and Lake will pay monthly for such heat, steam, power, and water. Calumet will also permit Lake to use its present trackage facilities without charge, except that if Calumet shall render switching services for Lake, its charge therefor will be Two Dollars ($2.00) per car. The rates and charges provided for in this paragraph shall be reviewed and revised annually to cover the succeeding year.

5. Calumet will endeavor to furnish Lake with all labor, supervision, and services, and with such tools, appliances, and apparatus other than those installed or owned by Lake, as may be necessary for the manufacture of such chemical products. Duplication of facilities between Calumet and the new company is to be avoided wherever possible, but it is understood that Calumet is under no obligation to furnish apparatus equipment, or machinery, which it does not have or which it cannot spare from its own operations. Calumet will keep full, accurate, and current accounts and records of all of the labor, supervision, services, tools, appliances, apparatus, machinery, and equipment furnished to the new company, which records and accounts shall at all reasonable times be open to inspection by Lake, and Calumet will bill Lake monthly for the costs of all such items furnished to Lake during the previous month. Such costs shall include all direct charges, all proper overhead charges, the proper proportion of the cost of supervision, and other expenses incurred jointly for the benefit of Lake and Calumet. Lake will pay Calumet monthly the costs of such items as are billed to it for the previous month. In addition, Lake will pay Calumet an operating fee for its

services in operating and supervising the operations of such plant in the amount of Three Hundred Dollars ($300.00) per month, which amount shall be reviewed and revised annually to cover the succeeding year.

6. Calumet will keep Lake's books and records, and Lake will pay Calumet for such service the cost thereof, including the proper proportion of overhead and administration expense.

7. Calumet agrees to furnish Lake from time to time with such technical knowledge and services as it may possess, and to make available to Lake its personnel and facilities for the purpose of conducting such research as Lake may wish to engage in. Calumet will cooperate with Lake in making purchases of raw material for Lake's account, and will bill any such purchases from others to Lake at Calumet's cost thereof. Calumet will also make available for purchase by Lake materials manufactured or dealt in by it at prices not in excess of the lowest market price at which such materials are then being sold by Calumet to other customers. Calumet will also furnish to Lake leach solution (copper ammonium carbonate solution), which it now makes in the process of manufacturing mixed copper oxide. All or a part of the copper content of such solution will be utilized by Lake, and some of the ammonia and carbon dioxide may be used or lost, but the unused portion of such solution will be returned to Calumet. Calumet will charge and Lake will pay for such solution used or lost by it as follows:

1. For the portion of the copper content of the solution used by Lake, the price shall be the lowest market price to others of zinc-free mixed copper oxide (on the basis of copper content) less Calumet's normal cost of recovering such oxide from leach solution, and packing, selling, and shipping the same.

2. For other elements of the solution which are not returned to Calumet, the price shall be Calumet's cost thereof.

3. Lake will also pay Calumet any cost it may have in reconditioning such returned solution and returning it to the circuit.

The above formula for pricing leach solution is based on the present spread between the producer's price of refined copper, f.o.b. Connecticut Valley, (which is now twelve cents (12¢) per pound) and the lowest market price of zinc-free mixed copper oxide, reduced to a copper basis (which is now thirteen and six-tenths cents (13.6¢) per pound). Therefore, if the difference between the producer's price of refined copper, f.o.b. Connecticut Valley, and the lowest market price of zinc-free mixed copper oxide, f.o.b. Hubbell, (on a copper basis) varies from one and six-tenths cents (1.6¢) per pound by more than one-half cent (½¢) per pound, the above formula may be reviewed and revised at the request of either party.

8. For any services which Calumet may perform for Lake, whether provided for herein or not, for which payment or a method of payment is not provided herein, Lake shall pay Calumet such reasonable charges as may hereafter be mutually agreed upon.

9. This Agreement shall continue in force and effect during the entire term of the lease of even date herewith, wherein Calumet has leased plant space to Lake for the purpose of engaging in the manufacture of chemicals.

10. This Agreement is not assignable by Calumet except in connection with a sale of its Tamarack Reclamation Plant, or to a successor corporation in a consolidation, merger, or other corporate reorganization, except with the written consent of Lake. This Agreement is not assignable by Lake except in connection with a sale of all of its assets and business or to a successor corporation in a consolidation, merger, or other corporate reorganization, except with the written consent of Calumet. If assigned in any of the circumstances making such assignment permissible, the terms, conditions, and covenants hereof shall inure to the benefit of and be binding upon the respective successors and assigns of the parties hereto.

IN WITNESS WHEREOF, etc.

LAKE CHEMICAL

Fiscal Year 1945	C-O-C-S Produced	C-O-C-S Shipped	COPPER HYDRATE Produced	COPPER HYDRATE Shipped	T-B-C-S Produced	T-B-C-S Shipped
Jan.	-	-	4,525	3,025	-	-
Feb.	-	-	3,480	2,709	-	-
March	-	-	4,105	4,211	-	-
April	-	-	2,185	4,000	-	-
May	-	-	-	200	-	-
June	-	-	21,000	14,446	-	-
Totals	-	-	35,295	28,591	-	-
Fiscal Year 1946						
July	36,049	-	-	-	-	-
Aug.	97,576	100,576	-	-	-	-
Sept.	98,841	96,841	75,377	40,527	-	-
Oct.	126,100	101,100	6,991	34,331	-	-
Nov.	137,202	149,002	37,971	771	-	-
Dec.	143,430	98,660	39,339	57,789	-	-
Jan.	134,840	196,760	59,951	60,301	-	-
Feb.	129,150	150,700	71,660	51,260	-	-
March	149,890	103,090	51,190	51,040	-	-
April	140,365	153,965	101,700	103,500	-	-
May	140,320	163,020	30,900	-	-	-
June	131,723	111,719	-	-	-	-
Totals	1,465,486	1,425,433	475,079	399,519	-	-
Fiscal Year 1947						
July	137,795	161,149	-	-	-	-
Aug.	114,465	50,615	-	-	-	-
Sept.	200,801	1,001	-	1,022	-	-
Oct.	209,869	102,719	-	43,009	5,797	-
Nov.	47,367	101,167	-	12	-	-
Dec.	175,427	100,327	-	1,095	-	5
Jan.	152,401	205,001	-	12,002	-	-
Feb.	136,564	167,764	-	25	-	-
March	113,457	302,757	-	1	-	10
April	159,229	140,879	19,400	9,911	-	-
May	146,781	211,331	59,819	48,219	-	-
June	150,901	106,851	59,584	81,235	-	-
Totals	1,745,057	1,651,561	138,803	196,531	5,797	15

LAKE CHEMICAL

Fiscal Year 1948	C-O-C-S Produced	C-O-C-S Shipped	COPPER HYDRATE Produced	COPPER HYDRATE Shipped	T-B-C-S Produced	T-B-C-S Shipped
July	30, 750	112, 250	46, 010	40, 010	5, 782	-
Aug.	-	50, 000	55, 600	-	-	-
Sept.	-	50	-	3	-	-
Oct.	74, 200	50, 000	-	40, 002	-	-
Nov.	143, 850	150, 000	-	9	-	-
Dec.	162, 350	150, 000	-	23, 653	-	-
Jan.	200, 050	200, 000	16, 653	3	-	-
Feb.	221, 650	200, 000	65, 262	62, 012	-	-
March	262, 250	250, 200	78, 217	91, 306	-	-
April	152, 600	100, 250	-	6, 002	-	-
May	124, 961	140, 011	-	-	-	-
June	144, 550	106, 000	-	801	-	-
Totals	1, 517, 211	1, 508, 761	261, 742	263, 801	5, 782	-
Fiscal Year 1949						
July	121, 750	40, 000	21, 145	3, 153	-	-
Aug.	125, 950	-	45, 151	60, 051	-	-
Sept.	36, 350	50, 000	-	3, 100	-	-
Oct.	74, 150	150, 000	26, 525	25	-	-
Nov.	160, 000	100, 000	37, 950	20, 000	-	-
Dec.	198, 000	50, 000	-	40, 026	-	-
Jan.	146, 000	200, 000	-	-	-	-
Feb.	159, 000	200, 000	48, 126	50, 000	-	-
March	213, 350	200, 200	83, 558	84, 408	24, 050	-
April	86, 400	250, 400	30, 150	31, 600	83, 650	-
May	183, 250	90, 000	51, 650	50, 000	-	50
June	160, 750	206, 000	82, 100	50, 000	-	40, 170
Totals	1, 664, 950	1, 536, 600	426, 355	392, 363	107, 700	40, 220
Fiscal Year 1950						
July	6, 100	50, 050	32, 600	40, 025	18, 220	6, 600
Aug.	-	150, 000	69, 300	80, 000	29, 950	86, 400
Sept.	43, 250	-	44, 250	56, 000	33, 500	2, 400
Oct.	185, 350	100, 000	48, 050	45, 000	-	-
Nov.	228, 650	290, 000	58, 160	54, 010	-	-
Dec.	238, 250	210, 000	85, 750	94, 500	-	-
Jan.	212, 300	180, 000	72, 750	11, 600	-	50, 000
Feb.	242, 200	250, 000	85, 000	84, 000	-	-
March	65, 400	250, 000	100, 300	160, 150	311, 800	123, 050
April	189, 250	202, 350	-	2, 550	-	172, 050
May	251, 900	140, 000	-	2, 350	-	2, 000
June	60, 880	140, 200	-	-	54, 750	17, 500
Totala	1, 723, 530	1, 962, 600	596, 160	630, 185	448, 220	460, 000

LAKE CHEMICAL

Fiscal Year 1951	C-O-C-S Produced	C-O-C-S Shipped	COPPER HYDRATE Produced	COPPER HYDRATE Shipped	T-B-C-S Produced	T-B-C-S Shipped
July	220,020	150,000	-	-	-	23,450
Aug.	62,900	120,000	-	-	17,650	5,650
Sept.	173,050	114,000	32,850	-	1,000	750
Oct.	141,650	116,000	47,705	80,550	-	-
Nov.	114,550	100,000	43,705	40,000	-	-
Dec.	230,000	200,000	132,295	120,000	-	-
Jan.	254,000	250,000	113,495	120,000	-	-
Feb.	210,000	200,000	88,400	80,000	-	-
March	184,000	140,000	104,700	105,000	-	-
April	264,000	320,000	101,000	115,000	62,000	44,300
May	22,000	-	56,400	23,000	35,450	2,000
June	-	-	72,100	40,000	-	-
Totals	1,876,170	1,710,000	792,650	723,550	116,100	76,150
Fiscal Year 1952						
July	-	-	100,300	149,250	-	34,500
Aug.	-	-	36,150	40,750	-	3,250
Sept.	-	-	6,000	20,000	-	2,600
Oct.	-	-	-	-	-	-
Nov.	72,000	200,000	-	-	-	-
Dec.	240,000	200,000	23,250	23,000	-	-
Jan.	204,000	100,000	28,700	26,500	-	-
Feb.	200,000	250,000	7,450	3,000	-	6,100
March	192,000	340,000	63,450	39,800	-	3,000
April	248,000	20,000	125,050	113,000	-	-
May	65,550	150,000	56,300	-	-	3,000
June	-	50,000	-	40,000	-	30,000
Totals	1,221,550	1,310,000	446,650	455,300	-	82,450
Fiscal Year 1953						
July	-	50,000	10,050	50,000	40,000	2,250
Aug.	-	60,000	78,000	54,200	63,150	4,500
Sept.	134,450	-	29,800	2,100	-	-
Oct.	266,000	240,000	56,300	88,000	-	-
Nov.	111,150	150,000	43,360	5,010	-	-
Dec.	14,850	50,000	-	1,050	-	-
Jan.	205,000	250,000	-	43,500	-	-
Feb.	186,500	200,000	-	6,050	-	-
March	288,500	290,000	55,950	43,800	-	-
April	259,000	250,000	-	50	-	-
May	205,000	100,000	29,000	39,800	-	25,500
June	166,350	50,000	19,600	27,000	-	20,000
Totals	1,836,800	1,690,000	322,060	360,560	103,150	52,250

LAKE CHEMICAL

Fiscal Year 1954	C-O-C-S Produced	C-O-C-S Shipped	COPPER HYDRATE Produced	COPPER HYDRATE Shipped	T-B-C-S Produced	T-B-C-S Shipped
July	-	40,000	13,800	12,000	-	4,500
Aug.	-	-	49,100	50,950	-	1,750
Sept.	-	-	10,350	16,000	-	850
Oct.	155,650	250,000	14,000	2,100	-	-
Nov.	182,000	100,000	20,200	44,700	-	-
Dec.	252,000	100,000	46,900	45,950	-	-
Jan.	200,000	350,000	2,450	2,750	-	-
Feb.	214,000	50,000	16,600	15,800	-	-
March	135,800	140,000	67,350	56,300	-	-
April	-	310,000	17,950	32,600	-	-
May	-	-	-	-	-	-
June	-	-	-	-	-	-
Totals	1,139,450	1,340,000	244,900	279,150	-	7,100
Fiscal Year 1955						
July	-	-	-	-	-	-
Aug.	-	-	-	-	-	3,100
Sept.	38,900	50,000	53,800	53,150	-	-
Oct.	187,950	134,000	49,400	47,000	-	-
Nov.	169,350	220,000	17,850	2,300	-	-
Dec.	218,000	100,000	12,000	12,500	-	-
Jan.	150,000	150,000	-	3,000	-	2,000
Feb.	66,000	100,000	22,250	12,100	-	1,000
March	124,000	150,000	12,000	25,500	-	500
April	188,650	50,000	21,900	19,000	-	-
May	-	40,000	-	2,100	-	1,000
June	-	-	-	950	-	1,050
Totals	1,142,850	994,000	189,200	177,600	-	8,650
Fiscal Year 1956						
July	-	60,000	-	4,500	-	1,500
Aug.	-	-	5,000	11,600	-	1,000
Sept.	17,350	-	42,750	8,650	-	150
Oct.	144,000	250,000	24,400	52,400	-	-
Nov.	174,000	150,000	22,000	4,000	-	-
Dec.	222,000	-	13,100	13,150	-	-
Jan.	220,000	150,000	9,000	27,500	-	-
Feb.	160,000	150,000	29,450	21,850	-	-
March	110,000	50,000	35,900	20,150	-	700
April	22,930	137,380	5,350	30,150	-	-
May to date		100,000		32,600		
Fiscal Yr. to date		1,047,380		226,550		

Job C-1598 - Cupric Hydrate, Copper Oxide Drying, Secondary Copper
Labor and materials to provide Fuel Oil Storage Tank in Oil House at Tamarack Regrinding Plant, to include inlet piping from R.R. Switch west of Oil House, and discharge piping to west wall of Flotation Section of Tam. L.& F. Bldg.. Piping east of west wall to be charged to other Job Nos.

Oct. 1, 1945

Job Numbers for Cupric Hydrate & COCS Plants

Job C-1599 - Cupric Hydrate & COCS Plants

Labor and materials to remove concrete walls under both Flotation Machines, remove all portions of two thickener tank bottoms which project above concrete floor, provide doorway in south wall, make minor repairs, etc to prepare Leaching & Flotation Building for Cupric Hydrate & COCS Plants.

Job C-1599 to be charged to Calumet & Hecla.

Job LC-1600-A - Cupric Hydrate & COCS Plants

All Engineering, Developing, Drafting, Legal & Corporate Expenses.

Job LC-1600-B - Cupric Hydrate & COCS Plants

Labor and materials for grading, extending road to plant, ~~[illegible]~~, preparing storage space, etc outside of Tamarack L. & F. Bldg.

Job LC-1600-C - Cupric Hydrate & COCS Plants

Labor and materials to provide heating, lighting, electric and water services, etc in Tamarack L.& F. Bldg.

Job LC-1600-D - Cupric Hydrate & COCS Plants

Labor and materials to provide and install Bagging Machine, with Screw Feeders, V-belt Drives, Motors, Starters, etc.

Job LC-1600-E - Cupric Hydrate & COCS Plants

Labor and materials to provide and install Bag Storage Handling & Shipping Equipment. Tow Motor.

Job LC-1600-F - Cupric Hydrate & COCS Plants

Labor and materials to fabricate and erect Charging Floor complete, including all steel and concrete work above top of concrete piers at El. [illegible]'-0".

Job LC-1600-G - Cupric Hydrate & COCS Plants

Labor and materials to change the Gallery Floor above the present Office & Laboratory Section of the Sub-station into and Addition to the the Chemical Laboratory.

Job LC-1600-H - Cupric Hydrate & COCS Plants

Small Tools & Equipment

Job LC-1600-I - Cupric Hydrate & COCS Plants

Office & Office Equipment

Job LC-1600-J - Cupric Hydrate & COCS Plants
Labor and materials to build Concrete Ramp with side walls at doorway in South wall at Bent 8, provide Roadway from doorway to spur track scale, and provide Fill at spur track scale for loading railroad cars from trucks.

Job LC-1600-K - Cupric Hydrate & COCS Plants
Labor and materials to provide & install Laboratory Equipment

Oct. 1, 1945

Job Numbers for Cupric Hydrate Plant

Job LC-1601-A - Cupric Hydrate Plant

Labor and materials to engineer, develop and detail Cupric Hydrate Plant.

Job LC-1601-B - Cupric Hydrate Plant

Labor and materials for turning No.7 Leaching Tank into a Solution Preparation Unit, providing an additional Oxidizer, connecting No.5 Storage Tank, and auxiliaries.
Estimated cost $ 2,600.00

Job LC-1601-C - Cupric Hydrate Plant

Labor and materials to prepare Oil Storage Tank in Tamarack Regrinding Plant Oil House, for Caustic Soda Storage, by adding steam heating coils and necessary piping.
Estimated cost $ 2,000.00

Job LC-1601-D - Cupric Hydrate Plant

Labor and materials for Filters, Agitators, Proportioning, Pumps, Supports, etc, for Hydrate Precipitation & Filtering Section.

Job LC-1601-E - Cupric Hydrate Plant

Labor and materials to provide, install and connect Furnace, Pulverizer, Cyclone, Storage Bin, etc, with their foundations, supports, piping, conveyors, etc. oil piping

Oct. 1, 1945

Job Numbers for COCS Plant

Job LC-1602-A - COCS Plant
Labor and materials to engineer, develop and detail COCS Plant.

Job LC-1602-B - COCS Plant
Labor and materials to provide, install and connect Reaction & Storage Tanks, with their foundations, supports, piping, blowers, pumps, etc.

Job LC-1602-C - COCS Plant
Labor and materials to provide, install and connect Filter, Dryer, Pulverizer, etc with their foundations, supports, piping, conveyors, blowers, pumps, etc. Coarse Storage Bin

Job LC-1602-D - COCS Plant
Labor and materials for ~~Upper Floor~~, Stairs, Platforms, Ramps, Building Changes, etc. Frt. Elevator, 4T. Trolley + Beams, Copper Chute

Job LC-1602-E - COCS Plant
Labor and materials to provide and erect:
- Sulphuric Acid Storage Tank with foundations, piping, etc.
- Sulphuric Acid Measuring Tank with " , " , ".
- Piping between existing Ammonia Tank near north wall of building & COCS Plant.
- Storage & Distribution facilities for Salt.

Job LC-1602-F - COCS Plant
Labor and materials to construct 6 Steel Reaction Tanks, ~~lined with 12 lb. lead~~, as per drg. 10742 and Drafting Dept. Requisitions.

Job LC-1602-G - COCS Plant
Labor and materials to extend K.C.P.L.Co's.60 cyc. 3 ph., 2300 V. Circuit to Tan. Rec. Provide & Install 3 Single Fan & 1 Two Fan Dryers (Harshaw loan), includes cost or removal & return to Harshaw. — Bucket Elevator

Job LC-1602-H - COCS Plant
Labor and materials to line 6 Reaction Tanks with 12# sheet lead, including wood fillers for 4" I beams & angles in Tank floor, 1-1/2" lead pipe cooling coils, oxygen & hydrogen, etc to make a complete lining job.

Job Numbers for Cupric Oxide Plant

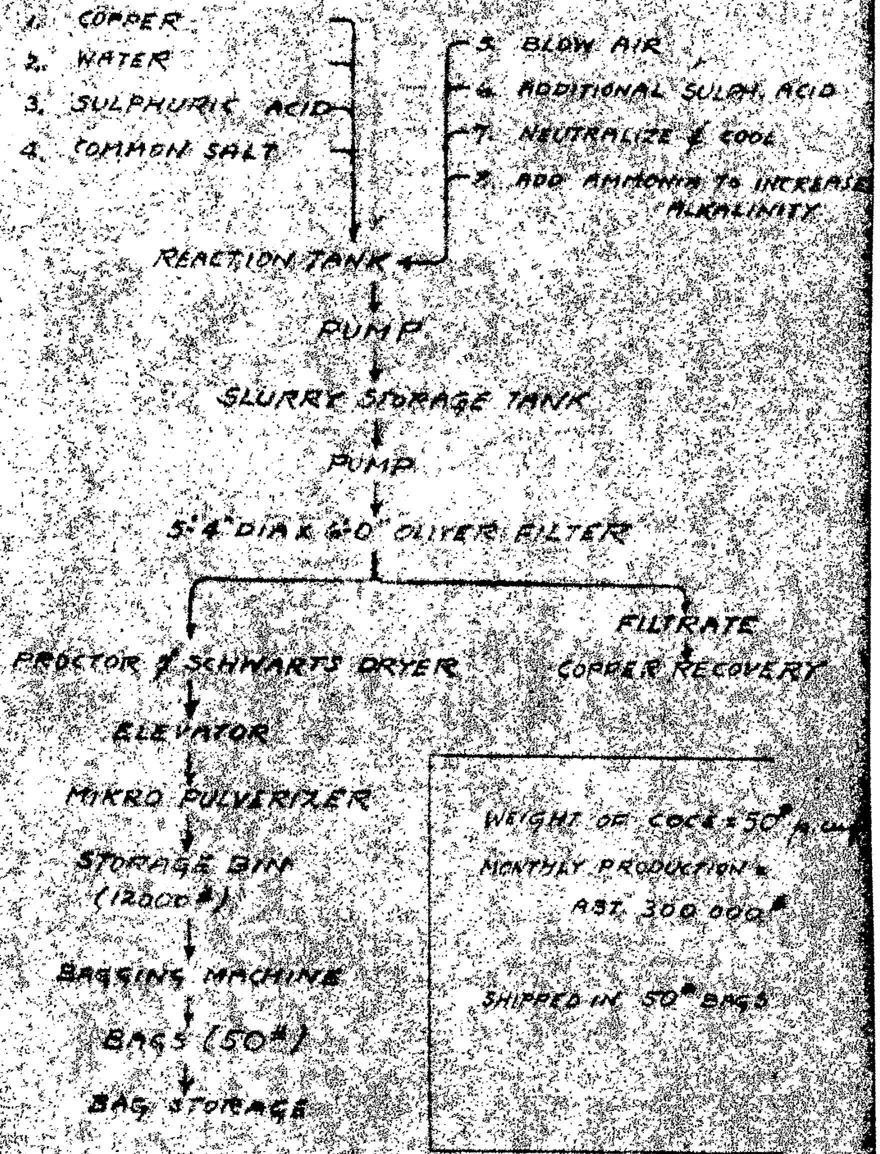
Job C-1597-A - Cupric Oxide Plant

Labor and materials to remove Oxidizer No.4 from Sand Leaching Plant, transport it to and erect it in Tamarack Leaching and Flotation Bldg., see drg. 10764. To include necessary piping, changes in building, etc to make a complete job.

COCS - PLANT

(COPPER OXYCHLORIDE SULPHATE PLANT)

FLOW SHEET



JAN. 15, 1946
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