22. REPORT OF THE GEOLOGIST FOR THE YEAR ENDING DECEMBER 31, 1931.

A. STAFF.

The staff of the Geological Department for the year 1931 is shown in Table I below. The only change in the personnel for the year is the transfer of Mr. Allen to the Engineering Department, which was effected September 1st. This change was made for the benefit of both Departments in as much as all drilling at our Michigan properties was discontinued and Mr. Allen's services could be used to greater advantage in the Engineering Department. It is anticipated that the transfer is temporary only:

TABLE I.

NAME.	OCCUPATION.	DURATION OF EMPLOYMENT IN 1931.	DAYS LOST. SICKNESS.	VACATION.	% OF WORKING DAYS WORKED.
E.L.Derby,Jr.,	Chief Geologist	Entire year	0	0	103.6#
A.H.Tillson,	Assistant Geologist,	" "	17½	10	89.5
Gustav Afuhs,	Draftsman,	" "	25 5/8	6 2/3	87.7
E. A. Allen,	Assistant	8 months	0	10	94.5

Represents 75 hours net overtime after cancelling 5 days vacation and ½ day illness.

The year was divided into the factors shown in Table II below:

TABLE II.

Total days of eight hours worked, $\left(\frac{2104}{8}\right)$ -	263 days
Sundays, - - - - - - - - - -	52 "
Full days resulting from Saturday afternoons,	12 "
Full Saturdays not worked, - - - - -	28 "
Holidays, - - - - - - - - - -	10 "
Total,	365 days

Table III, below, shows the average number of men regularly employed on the staff of the Geological Department during the first five years:

TABLE III.

YEAR.	AVERAGE NUMBER OF MEN.
1927	4.0
1928	4.0
1929	4.0
1930	4.0
1931	3.7

B. DIVISION OF WORK AMONG THE MEMBERS OF THE DEPARTMENT.

The division of time actually consumed by the members of the Department is shown in Table IV below:

TABLE IV.

ITEMS.	HOURS WORKED. DERBY.	TILLSON.	AFUHS.	ALLEN.	TOTAL DAYS.
MINES:-					
Athens,	0	28	60	0	88
Bingham-North Star,	261	16	248	0	525
Canisteo,	188	0	1	0	189
Cliffs-Shaft,	41	733	201	516	1491
Corrigan, McKinney Mines,	0	7	20	0	27
Dean-Itasca,	36	0	1	0	37
Drew,	0	0	12	0	12
Gardner-Mackinaw,	0	102	12	0	114
Hill-Trumbull,	53	0	0	0	53
Holman-Brown,	231	0	25	0	256
Maas,	8	259	14	44	325
Morris-Lloyd,	89	533	213	375	1210
Neely Lease,	0	0	10	0	10
Negaunee,	6	142	31	4	183
Sherwood,	9	0	0	0	9
Tilden,	0	0	19	0	19
Virgil,	101	0	156	0	257
MISCELLANEOUS ITEMS:-					
Annual Report,	55	0	0	0	55
Appraisal of C.C.I.Co. Mineral Properties,	167	0	0	0	167
Appraisal of St.Paul Mine (Corrigan McKinney),	4	0	0	0	4
Assisting Engineering Department,	0	4	41	148	193
Cliffs Power & Light Company,	0	14	0	0	14
Driving Engineering Department Truck,	0	0	0	59	59
Federal Taxes (C.C.I.Co. Mines),	115	0	16	0	131
Federal Taxes (Rep.Steel Corp. Mines),	233	0	0	0	233
General Department,	339	36	194	211	780
General Research (Iron Ores),	133	0	0	0	133
Investigating Mineral Land Offers,	57	2	33	4	96
Investigating Outside Explorations,	20	0	4	3	27
Michigan Mineral Land Company,	24	0.	502	0	526
Minnesota Research Company,	13	0	0	0	13
Munising Silica Sand Exploration,	40	0	32	0	72
Total Hours Worked,	2223	1876	1845	1364	7308

E. L. Derby, Jr. I continued to have charge of the Geological Department as Chief Geologist. A large part of my time, as formerly, was taken up with the general oversight and supervision of the work of the Department. This has included, besides the usual routine office work, surface explorations at the Bingham, Canisteo and Holman-Brown properties on the Mesaba Range in Minnesota; the underground drilling in the Cliffs-Shaft and Morris-Lloyd Mines; and the geological surveys in the Athens, Cliffs-Shaft, Gardner-Mackinaw, Maas, Morris-Lloyd, Negaunee and Virgil Mines.

My time not taken up with these duties was spent chiefly as follows:

In January, I was at our Hibbing office twice, once the first part of the month and again at the end of the month. While there I supervised and participated in the preparation of revised estimates of ore reserves and stripping at the Holman-Brown Mine, occasioned by structure drilling done during 1930; also a revised stripping estimate of the Canisteo and stripping amortization estimates on the Bingham, Canisteo, Holman-Brown and North Star properties. I spent two days in Chicago at a conference held between Messrs. S. L. Mather, V. P. Geffine, H. A. Raymond, S. R. Elliott and M. H. Barber, representing the Company, and Messrs. E. C. Congdon, Harvie Garver and T. Field, representing the Canisteo Mining Company, on Holman Mine estimates, both ore reserves and stripping. At Ishpeming I worked up a revised estimate of ore reserves as of March 1, 1913 on the Holman Mine for depletion purposes.

In February, I spent two days in Minneapolis with Mr. McMorris, of our Research Department, observing jig tests being made at the University of Minnesota Experimental Station on rocky wash ores from the Hill-Trumbull and Holman-Brown Mines. I attended conferences in Chicago and Cleveland, at which I made revised appraised valuations of the Company's entire mineral estate. I also spent one day at the Internal Revenue Department in Washington, D. C., in the interest of revised depletion estimates covering the Holmes and Morris-Lloyd Mines. At Ishpeming I did considerable work in preparation for my final report on the Munising Silica Sand proposition.

Early in March, I went to Hibbing and went over all of the work of the Research Department with Mr. McMorris, including the results of his tests made at the Experimental Station in Minneapolis in February. I then went to the Corrigan, McKinney office at Bessemer where I secured complete detailed information on the 1930 operations of the mines of this company. Later in the month I went to our Cleveland office and made an appraisal of the iron ore properties of both the Corrigan, McKinney Company and the Republic Steel Corporation in conjunction with Mr. Geffine. At Ishpeming I continued to work up data for my report on the Munising Silica Sand proposition.

In April, I went to our Hibbing office and was met there by Mr. W. L. Remick, General Manager of the Hydrotator Company, and with him and Messrs. Moore and McMorris went over the final plans which we had worked up for installing two Hydrotator units in the Holman washing plant for an anticipated test on fine ores during the operating season of 1931. I spent several days at our Cleveland office going over the Form D Income Tax reports of the Republic Steel Corporation in conjunction with Messrs. Geffine and T. F. Veach, the latter of Mr. Belden's office. We started to revise the valuation estimates for the various Republic mining properties. To carry on this work, I then went to Duluth to consult Messrs. F. J. Webb and E. W. R. Butcher of the Republic Company, going over various ore estimates of their properties and compiling additional data. At Ishpeming I completed my general report on the Munising Silica Sand proposition and made reports on the lands of the Michigan Mineral Land Company that were being offered for sale at the spring tax sale for delinquent taxes.

In May, about one half my time was taken up with the work which Mr. Geffine and I did jointly in connection with the revaluation of the mines of the Republic Steel Corporation for Federal Income Tax purposes. In this connection, I spent a week at our Cleveland office and two days at the Republic Company's office in Duluth. On my trip to Duluth, I also went to Hibbing and went over the work of the Research Department with Mr. McMorris, including the preparations being made for the installation of the Hydrotator equipment at the Holman washing plant and the Bingham drilling which had been started in April. At Ishpeming I continued to spend some time reviewing the tax situation on the Michigan Mineral Land Com-

pany's property, particularly in regard to the purchase of tax titles to protect their mineral interests. This included a consultation with Mr, R. S. Archibald, representing the Inland Steel Company, half owners of the Michigan Mineral Land Company.

In June, about a third of my time was spent in the revaluation work that I had been doing for the Republic Steel Corporation in connection with their Federal Income taxes. This necessitated a conference in Chicago with Messrs. Geffine and Saddler and also three days at our Cleveland office. At the latter place, a conference was held between Messrs. Geffine, Saddler, Webb, Butcher and myself, after which we were in consultation with Mr. Gordon, Government Engineer. I spent two days at the Experimental Station of the University of Minnesota in Minneapolis with Mr. McMorris of our Research Department at a sintering test made on Dean Mine painty lean ore. Later I went to the Mesaba Range with headquarters at Hibbing, spending ten days there. I classified the drill samples of approximately 80 old drill holes on the Holman-Brown property which we had not had an opportunity to examine previously. This came to a head when we received advice that the engineers of the State Tax Commission would review the valuation of the Holman-Brown property together with the North Star during the summer. I also classified approximately 20 old drill holes located on the East forty of the North Star property which we were requestedto do by the Great Northern engineers in connection with what they believed to be a body of mineable ore lying beneath the present approach tracks to the Holman-Brown pit and adjacent to the latter on the North. I went over with Mr. E. G. Sterling recent estimates that he had made on the Holman-Brown and North Star properties which were to be submitted to the engineers of the Tax Commission in their review of the valuation of these properties.

In July, I spent two weeks on the Mesaba Range with headquarters at our Hibbing office, most of the time being consumed in supervising new estimates of ore possibilities on all of our Western Mesaba properties. That is, the parcels comprising the Canisteo-Cliffs, Holman-Cliffs and Mesaba-Cliffs holdings. This work was done more especially in connection with Mr. S. L. Mather's suggestion that a merger of these interests be consummated. Mr. Barber and I also went to Minneapolis where we held a conference with Professors Lambert and Heilig, of the University of Minnesota, in connection with a review by the Minnesota State Tax Commission, and these engineers, of the Holman-Brown and North Star properties. At this conference we submitted our estimates of ore remaining in these properties, together with all supporting data. I joined with Mr. Barber in a report on the valuation of the St. Paul Mine of the Corrigan, McKinney Steel Company, particularly in reference to negotiations for the sale of the fee of this property to the Oliver Iron Mining Company. I spent two days in Iron County examining the surface of land offer No.1331 in Section 13, 43-35, North of our Virgil Mine, and visiting and acquiring data on several outside explorations. These results were embodied in several reports.

In August, I spent two weeks on the Mesaba Range, most of the time at the Hibbing office working up operating plans at the Canisteo Mine covering a period of the next three years and reconciling this program with ore reserves on the various parvels constituting the mine which I had previously prepared. I also did the same thing for the Holman-Cliffs Mine for the period of one year, 1932. I prepared a report covering the sintering test on the Dean Mine lean ore made at the Mines Experimental Station, Universityw of Minnesota, in June. During all of my visits to the Range, I classified jointly with a representative of the Great Northern samples from the current drilling at the Bingham Mine. I attended, in Duluth, an organization meeting forming the Minnesota Research Company and was elected a Director and Vice President of the company. This company is sponsored by most of the iron ore companies of the Lake Superior District and includes in its scope of activity the entire field of beneficiation of the leaner iron ores of the district. I went to Minneapolis and spent one day in conference with

Messrs. Lambert and Heilig, Engineers for the Minnesota State Tax Commission on their revaluation and estimates of reserves in the Holman-Brown and North Star properties. In Ishpeming I started to prepare a revised estimate of the ore reserves and ultimate possibilities for ore extension in the Morris-Lloyd Mine in connection with the negotiations then pending with the Inland Steel Company, anticipating that they might purchase an interest in this property.

In September, I spent the latter half of the month at our Hibbing office. Again, the major portion of my time on the Range was spent in supervising the work of preparing maps and cross-sections in connection with the revised tonnage reserve estimates of the West end properties in anticipation of a consolidation. This entailed a large amount of work bringing our information up to date for an examination by the engineers of the other partners involved. I spent some time going over with Mr. McMorris the testing and other work being done by the Research Department. I attended a meeting in Duluth of the Board of Directors of the Minnesota Research Company. At Ishpeming I completed the new reserve estimate on the Morris-Lloyd Mine and prepared a similar estimate of the Virgil Mine. The latter was in connection with negotiationsw with the Jones & Laughlin Ore Company for an interest in the Virgil Mine. Mr. C. O. Swanson, Geologist for the J. & L. Company, spent one day at my office going over the geological maps and cross-sections, and my tonnage estimate. Mr. Stakel and I spent two days conducting Messrs. Wearne, Archibald and Satterley, representing the Inland Steel Company, through the principle underground workings at the Morris-Lloyd Mine, and another two days going over with them the maps, cross-sections and tonnage estimates in connection with the anticipated purchase, by the Inland Company, of an interest in the Morris-Lloyd Mine.

In October, I made two trips to the Mesaba Range with headquarters at Hibbing, dividing my time between the continued supervision of the work being done on reserve estimates of the Minnesota Cliffs Companies in anticipation of the merger, and with Mr. McMorris in the preparation of a proposed flow sheet for a fine ore plant being designed at the Holman washing plant as a result of tests conducted there during the summer. Mr. McMorris and I spent one day at the Mines Experimental Station at Minneapolis, submitting our data to Messrs. Davis and Wade of the Experimental Station staff for their approval and advice. At Ishpeming I prepared a supplemental report on the estimated ore reserves in the Morris-Lloyd Mine in connection with the proposed partnership in this operation with the Inland Steel Company.

In November, I spent a week on the Mesaba Range with headquarters at Hibbing. I went over, with Mr. McMorris, all of the data he had collected during the past season's experimental work at the Holman plant and assisted him in preparing his report on the treatment of fine ores and made recommendations for the construction of a fine ore plant at each of our three washing plants, Hill-Trumbull, Holman and Canisteo. A joint meeting was held at our Hibbing office, our own representatives, Messrs. Barber, E. G. Sterling and myself, meeting with officials from the other partnership companies involved in the anticipated merger of our Minnesota Cliffs Companies. We went over with them our estimates of developed and prospective ore reserves and the maps and cross-sections supporting these estimates; also, all of the main general features entering into a joint operation of these properties. This conference consumed three days. I spent three days at our Cleveland office in connection with the revaluation, for depletion purposes, of the Morris-Lloyd Mine. Messrs. Geffine, Saddler and I conferre d with Mr. Gordon, of the income Tax Unit of the Federal Internal Revenue Department. While in Ishpeming I also spent considerable time working up additional data for this Morris-Lloyd revaluation. I examined and prepared a memorandum on the Robinson report of oil and gas possibilities in the Upper Peninsula, which was sent to me for perusal by Mr. Bush, of the Land Department.

In December, I spent four days on the Mesaba Range, going over all of our exploration work, more particularly that being conducted at the Bingham and Canisteo properties. I classified all of the current Bingham ~~box~~ samples jointly with

a representative of the Great Northern. I also worked up a plan for sampling, by structure drilling, several areas in our West end properties which must be included in our 1932 operating program with anything like a normal production. I spent one day at Minneapolis in attendance at the annual meeting of the Minnesota Section of the American Institute of Mining & Metallurgical Engineers. This was the fifth annual meeting of this group and by far the most interesting. The morning was given over to a discussion of geologic theories covering the oxidation and concentration of the Lake Superior iron ores brought about by the new hot water theory advanced by Dr. John W. Gruner, Professor at the University of Minnesota. Dr. C. K. Leith, of the University of Wisconsin, supported the old cold water or weathering theory. In the afternoon two very interesting speakers covered the subject of the Gold Standard and its workings, one a professor who spoke on the theoretical aspects and the other a bank official who explained the practical side of the question. These meetings are particularly valuable in bringing together responsible representatives of the various iron companies of the Lake Superior District in a pleasant informal way and establishing personal relationships which go far toward ironing out many controversies that arise between companies from time to time in the operation of the various properties. I spent one day at Iron River, going over the maps, sections and other data of the old Riverton Mine, which has been offered to us.

A. H. Tillson. Mr. Tillson continued as Assistant Geologist throughout the year. He made regular underground geological surveys in the Cliffs-Shaft, Gardner-Mackinaw and Morris-Lloyd Mines and occasional surveys in the Athens, Maas and Negaunee Mines. He posted all these surveys on the geological maps and cross-sections of the several properties. The new sub-levels opened up in a number of these properties necessitated making new geological tracings to cover this development work. Mr. Tillson checked over the plotting of all of our current drilling on both maps and drill sections and checked the plotting of all the drilling information for our outside exploration files which came to the office during the year in the form of land offers, outside explorations, etc. He assisted Mr. Afuhs in the preparation of a new set of geological cross-sections of the Morris-Lloyd Mine which I used in my revised depletion estimate on this property. He made several trips to the Gwinn District to assist the Engineering Department in locating property corners on account of his familiarity with the District where he served a good many years as District Engineer. This work was more particularly in connection with the Cataract Water Power project developed on the Escanaba River by the Cliffs Power & Light Company.

Gustav Afuhs. Mr. Afuhs continued as our Draftsman throughout the year. His work, as heretofore, has, in part, consisted in preparing cross-sections of all current drilling done by, or for, the Company and of all the drill results that have been submitted to this office in the form of land offers, outside explorations, etc.

In January, the early part of the month was spent completing the posting of the previous year's current extensions on the geological maps and crosssections of the Athens, Cliffs-Shaft, Holmes, Morris-Lloyd and Virgil Mines. The cross-sections of several of these properties are photographed for our annual report. He spent several days on a new set of geological cross-sections of the Morris-Lloyd Mine, which I used in a revised estimate, for depletion purposes, of the ore reserves in this property as of March 1, 1913.

In March, he prepared several white print maps and drill sections of the Munising Silica Sand exploration for my report on this project. He also prepared white print maps of the Holmes Mine for my depletion estimate. He calculated the average analysis of the ore shown in drill hole No.10 at the Tobin Mine for use in my appraisal of the Corrigan, McKinney mineral properties.

In June, he spent a considerable time making up ideal cross-sections for all of our operating mines in Michigan to be used in connection with a display

of typical ore and rock specimens from these mines being made up by Mr. Brewer for the Company's Club Room. He started to make up several white prints of a new geological map of Iron County, showing the lands and mineral interests owned by the Michigan Mineral Land Company. This latter job is a large one and he spent practically all of his spare time the balance of the year preparing a number of these maps. These are to be used in a special report to be made by Mr. Archibald, representing the Inland Company, and myself in which we will classify all of the Michigan Mineral Land Company's surface and mineral interests with the anticipation that some of the parcels on which taxes are now being paid will be abandoned as of comparatively small value not warranting the continued investment of taxes to hold title to them.

In September, a considerable amount of his time was consumed in preparing three sets of white print maps and cross-sections of the Morris-Lloyd Mine to accompany my estimate of September 1st in connection with the negotiations then pending with the Inland Steel Company for an interest in this property. He posted the current extensions on the geological maps and cross-sections of the Virgil Mine. This included the extension of the 6th level over on to the Sherwood property. This Company is doing the work for the Republic Steel Corporation, who owns the lease on the Sherwood. He spent some time almost every month keeping the results of drilling at the Bingham property on the Mesaba Range posted on our regular drill sections. This consumes considerable time on account of the large amount of analytical data in connection with this structure drilling.

In November, he prepared for me three sets of white prints of the main levels of the Morris-Lloyd Mine, showing on them the outlines of all the known ore areas which I used in my conferences with Mr. Gordon, Government Engineer, in our anticipated revaluation of this property for depletion purposes.

Much of his time during December was consumed in posting the geological cross-sections and drill sections of the Athens, Bingham, Cliffs-Shaft, Morris-Lloyd and Negaunee Mines to be used in the annual report. As mentioned above, all of his available time,after the first of June, not spent in regular routine work, or the things referred to in particular in these paragraphs, was taken up in the preparation of the white print geological maps of Iron County showing the lands and mineral interests owned by the Michigan Mineral Land Company. At various times during the year he also assisted Mr. Tillson in posting the current extensions on the geological maps and cross-sections of our several mines. The rest of his time was spent on the routine work of the office.

E. A. Allen. Mr. Allen continued as an Assistant in the Department until September 1st when he was transferred to the Engineering Department because of the completion of all drilling operations at our Michigan properties and the absence of work in the Department for which he is equipped. At times, during the eight months of employment in the Geological Department, he assisted several of the engineers with their underground surveys. He also drove the Engineering Department truck at various times. The major part of his time, however, was spent in collecting, sampling, labeling and filing diamond drill samples from the current explorations and making tests for the dip and bearing of drill holes with the Maas Compass whenever this data was required.

Mr. Allen also classified and reported on the core and sludge samples from the current explorations and made all of the necessary thin sections of rocks for examination under the microscope. He made the regular monthly carbon reports and assisted Mr. Tillson in a number of his underground geological surveys. Usually, he joins with Mr. Kalm in making an annual inventory of the diamond drill equipment but so little drilling was done during 1931 that this inventory was omitted. He made several field examinations of outside explorations during the year, covering them with special reports.

C. SURFACE GEOLOGICAL SURVEYS.

No detailed geological surveys were made during the year.

D. UNDERGROUND GEOLOGICAL SURVEYS.

D-1. ATHENS MINE.

The Athens Mine worked five days, single shift, to March 1st, at which time the schedule was reduced to four days per week, continuing to June 8th. From this date to November 15th the schedule was three days a week, after which, for the balance of the year, only two days a week were worked. Geological surveys were made periodically by Mr. C. W. Allen, Engineer at the property. We have kept this information posted on both the geological maps and cross-sections.

A horse of jasper was encountered just South of and in contact with the main East-West dike between the 4th and 6th levels, very similar to that found between the 6th and 8th levels, referred to in my reports for 1928-1929-1930. The former may have some connection with the latter but so far development work on the 6th level has not demonstrated it.

The raises started in 1930 from the hanging wall drift on the South side of the fault dike on the 6th level are now up to the 4th level and are being connected preparatory to the opening up of this territory for mining. In developing the sub-levels above the 8th level on the North side of the fault dike decomposed slate or dike stringers were encountered interbedded with the ore to such an extent that it is unmerchantable which seems to indicate that the footwall is coming in to cut out the ore and contract considerably its limits in this territory. A mining limit has been established on the -470' sub-level, South of the fault dike to prevent under-cutting the ore developed by underground diamond drill hole No.11 drilled from the -480' sub-level.

The principle mining during the year was confined to stoping between the 4th and 6th levels and the 6th and 8th levels.

D-2. CLIFFS-SHAFT MINE.

The Cliffs-Shaft Mine worked six days per week, single shift, to April first; then five days to May first; four days to June 4th; three days to November 12th and then two days per week for the balance of the year. Mr. Tillson has kept the Cliffs-Shaft geology up to date by making surveys each month coincident with those made by the engineers. He has also made surveys of small portions of the mine more frequently where extra detail was necessary. Both the geological maps and cross-sections were posted regularly.

The principle development in "A" Shaft continued to be in the main, or so-called, Bancroft vein on the North side of the mine. Part of this work was located on Lot 2 Section 3, or the Bancroft lease from the Oliver Company, and the balance along the Eastern extension of this ore body on Cleveland-Cliffs Iron Company land. Work was carried on from levels 1 to 10, inclusive, and on the 15th level, but a large part of the ore came from the stopes on the 10th level. The work on the 15th level consisted of the continuation of a footwall drift started in 1930 to get under this Bancroft ore which is mined from the 10th level. Work also continued developing and stoping ore bodies in the ground between the old Cliffs-Shaft workings and the Incline and No.3 Mines. The ore from this territory was obtained chiefly from the advancement of stopes on the 6th level.

In "B" Shaft, drifting was started on the 6th level to the Northwest following the North limb of the main fold. Later this area will be completely explored by drilling. Thus far the drift itself has been mainly in the softer hanging wall rock, both slate and quartzite, but a crosscut is now being driven North to the footwall, hoping that ore in commercial quantities will be encountered at the hanging contact. This work constitutes an entirely new development in this section of the mine. Drifting was also started Westerly from the Southwest end of the 10th level to explore and develop the ore encountered many years ago in the old drilling from surface in the W½ of Section 9. Two hundred and fifty feet of drift had been driven up to the end of the year. In the Southwest ore body on the 13th level, the large stope raise, which I reported last year as having followed ore to a point above the 12th level, was stopped as the ore narrowed down to an unimportant seam. A small raise, however, was carried up to the 10th level as a connection. This seam continued in the raise for a part of the distance and then petered out. Drifting in the rock drift running Northeasterly on the 15th level toward the Section 3 ore body was resumed the end of March and continued for the balance of the year. The work had been discontinued in October 1930 in order to construct a concrete dam for the protection of the mine in case unusual amounts of water are encountered in this work.

D-3. GARDNER-MACKINAW MINE.

The Gardner-Mackinaw Mine worked five days a week, single shift, until May 8; then four days to June 1st; three days to November 15th and two days a week for the balance of the year. Mr. Tillson has made regular underground geological surveys and has kept the geological maps and cross-sections posted regularly.

The underground inclined shaft, which was started from the 5th level in 1930, was extended to the 7th level, 250' vertically below the 5th. Both the 6th and 7th levels were opened up, the 6th half way between the 7th and most of the available lower sulphur ore was stoped out between the 6th and 5th levels. On the 6th level most of the ore Northwest of the shaft is too high in sulphur to be mined by itself and must be mixed with the ore located Southeast of the shaft which has a much lower sulphur content; also, the ore body Northwest of the shaft varies in width from 20'to 65', whereas Southeast of the shaft the average width is not much over 10'. There is, however, Northwest of the shaft, a zone along the hanging wall of variable width, from a seam to 20', that carries much less sulphur and also is lower in phosphorus. This is being mined, leaving in place the higher sulphur ore on the footwall. Because of the general high sulphur and phosphorus content of the ore Northwest of the shaft, its Northwest limit has not been reached on the 6th level.

The 7th level, to the Southeast of the shaft, was quite completely developped. The ore continued narrow but of the lower sulphur variety. To the Northwest of the shaft this lower sulphur continued for about 100' and then gave way to ore very high in sulphur and also in phosphorus, except for the narrow irregular zone along the hanging similar to that mentioned on the 6th level. Development is only partially complete Northwest of the shaft since the ore that can be removed in this high sulphur area is limited by the amount that can be mixed in with the lower sulphur product mined elsewhere.

About the middle of the year, an incline winze was started in the ore body on a dip of 45° from the 7th level and about 200' Northwest of the incline shaft. At the start the sulphur content was about 1% and the phosphorus correspondingly high. At the end of the year this winze had reached a depth of 160' on the incline. The last 50' was a high grade Bessemer ore with the sulphur content less than .500%. This is very encouraging and the 8th level will be opened from this winze 150' vertically below the 7th, and the incline shaft will be raised between these levels.

D-4. MAAS MINE.

The Maas Mine operated five days per week, single shift, up to May 1st; four days to June 8th; three days to November 16th and two days per week the balance of the year. Mining continued throughout the year in the territory between the 2nd and 3rd levels on the footwall side of the deposit. This part of the mine has been somewhat behind the balance of the operations and all possible speed has been made in its mining in order to catch up with the other operations.

The development work during the year in the new riser of ore, which was first encountered on the 4th level on the footwall side of the Race Course property in 1929, demonstrated the ore to extend to a point at least 130' above the 3rd level. Raises are being put up on the footwall side of the ore from the 405' sub-level and the ore mined above this elevation by a room and pillar system. On the 405' sub the ore is triangular in shape, having a base East and West about 250' long and an altitude North and South of about 200'. This ore has also been fairly well outlined on the 3rd level. Here, however, it is nearly crescent shape with its long dimension, East and West, and about 380' with a maximum width of 80'.

On the 4th level, the No.3 crosscut East was extended Northwesterly for 80' in ore. This will become the main haulage way through the ore body since the drift along the East boundary of the Race Course will soon crush due to the constant approaching of mining operations immediately above it.

Development work continued throughout the year on the new 5th main level. The main North-South drift from the shaft through the footwall was completed and one crosscut was started to develop the ore body on the Race Course. It had encountered 15' of good ore at the end of the year.

D-5. MORRIS-LLOYD MINE.

The Morris-Lloyd Mine operated five days per week, single shift, to April 30th; four days to June 8th; three days to November 15th and two days per week the balance of the year. Mr. Tillson has made geological surveys regularly and has kept the geological maps and cross-sections posted to date.

Developing on the 8th level Morris, in the main deposit, continued for the first six months of the year. The footwall drift also was extended Westerly in slate across lease No.24, a total distance of 1500'. Four drill stations were cut at 200' intervals in the first 600'. Good ore was encountered in the breast of one of these stations. One crosscut was driven Southwesterly from the East-West drift in ore on the South side of No.9 lease for a distance of 300' to the South boundary of this lease. The breast was in dike but developments in sub-levels above demonstrated that ore exists South of this dike. Ore was mined during the year in the main deposit on No.9 lease between the 7th and 8th levels, both by top slicing and sub-level stoping. On the 7th level two drifts were driven West in deposit "B", each about 300' in length and 60' apart, all in ore. This ore body had been located previously by underground diamond drill hole No.110. The ore has been followed up for a distance of about 140' above the 7th in one raise and development work started at the top of this raise.

In Lloyd East territory, all of the known ore in the numerous fingers extending up from the main Section 6 ore body was exhausted during the year. All work is now confined to the main Westerly pitching ore body and mainly to sub-level stoping between the 3rd and 4th levels. One sub-level stope is being developed above the 3rd level. Development in this ore body on the 6th level was confined to two horizontal diamond drill holes, Nos.107 and 108, drilled South from the main drift. Both holes crosscutted the ore from foot to hanging and with hole No.106, drilled the latter part of 1930, quite completely outlined the main ore body at this elevation. This 6th level drift was extended on a curve for a short

distance and a raise is being put up to the 4th level. The only work done during the year in the old Lloyd Mine was a crosscut which is being driven North from the 6th level drift, connecting the Morris and Lloyd East areas, to a point beneath the Lloyd shaft. Later this shaft will be raised from the 6th to the 4th.

D-6. NEGAUNEE MINE.

The Negaunee Mine operated four days a week, single shift, to April 13th; three days to November 16th and two days a week the balance of the year. Mr. Tillson has made periodic geological surveys and has kept the geological maps and cross-sections posted to date. He was materially assisted in this work by Mr. Pellow, Engineer at the property.

The principle mining was conducted between the first sub below the 10th level and the first sub below the 11th. The work of developing the ore from this latter sub to the 12th level was continued throughout the year, and particularly in the vicinity of the Maas boundary. Several raises were put up into this territory from the 12th.

Additional raises were put up during the year from the East-West drift on the 11th level between dikes 1 and 2 to further develop the ore in this territory. The drift East and West between No.1 dike and the footwall, which was started in 1930, was completed and two raises put up to develop the ore above it.

D-7. TILDEN MINE.

The Tilden Mine worked intermittently during the shipping season of 1931 and continued to produce an excellent grade of hard siliceous ore. The shipments from the West pit were 123,413 tons of standard grade siliceous and from the East pit 13,597 tons of low phosphorus siliceous and 3,028 tons of standard siliceous. All of the ore from the West pit was mined from the top bench, having been blasted late in 1930. The East pit was a new operation in 1931.

The East pit was opened by an approach from the West end. In drilling blast holes for this approach, samples from them showed a low phosphorus siliceous ore in an area that originally had been considered waste material. As the ground was opened up, the ore proved to be even better than the blast hole samples indicated. It is from this operation that the 13,597 tons of low phosphorus siliceous ore was shipped, as well as the 3,028 tons of standard grade material. After cleaning up this ore, the material in contact with it, which was expected to be a good grade low phosphorus siliceous ore, was found to be badly mixed with dike and had to be wasted. It is anticipated, however, that one more blast will remove the last of this mixed material and expose a full face of the low phosphorus siliceous ore developed by diamond drill hole No.18. Geological data was collected and mapped by Mr. Allen, Engineer at the property.

D-8. VIRGIL MINE.

The Virgil Mine was operated six days per week, double shift, to May 25th; six days per week, single shift, to November 15th and four days per week, single shift, the balance of the year. I have made periodical geological surveys at this property during the year and the geological maps and cross-sections have been posted to date.

Stoping in the main ore body above the 6th level continued at a reduced scale. It was impeded considerably by the failure of portions of two main supporting pillars due to the swelling of slate seams interbedded with the ore on continued exposure to the air. It is likely that this caving will continue until finally stoping in the North portion of this main deposit above the 6th level will have to be abandoned.

The new development work during the year continued mainly to be the further opening up of the 8th level ore body between the 6th and 8th levels. This ore now has been completely outlined on the -75', -100', -130' and -150' sub-levels. Stoping has been carried on during the year from the -25', -50', -75', -100' and -130' subs. The high sulphur portions of this ore body are being left intact and occur principally on the foot side and in the Northeast end of the ore body.

Drifting from the Northwest side of the 6th level on to the Sherwood property, for the account of the Republic Steel Corporation, was commenced the latter part of July. The drift is being driven Southwesterly and will cross the Sherwood and be extended on to the Aronson property. It had progressed about 400' on to the Sherwood from the Virgil boundary at the end of the year and a crosscut was being started to the South on the coordinate line 200' West of the Virgil property at the end of the year. This crosscut will explore the ore on the South limb of the fold, which from surface drilling, extends above this elevation. Later on it is planned to crosscut North to the proposed shaft location and raise the shaft from this elevation.

E. OPTIONS AND LEASES.

No new options to explore or leases were taken during the year.

F. EXPLORATIONS AND COSTS.

Drilling explorations were carried on during 1931 in the following districts and mines:

F-1. FROM SURFACE.

DISTRICT.	RANGE.
Taconite	Mesaba

F-2. FROM UNDERGROUND.

MINE.	DISTRICT.
Cliffs-Shaft	Ishpeming
Morris-Lloyd	North Lake.

Table V, which follows, gives the footage drilled, the ore encountered and the cost per foot of drilling for both the surface and underground explorations. It will be noted that the average cost of surface drilling was $3.33 per foot, excluding certain items which are not actual drilling expense but which are charged to explorations. By including these items, the average cost was $3.86 per foot. The average cost of underground drilling in the same way was $2.51 per fot and $3.07 per foot, respectively.

Table VI, also shown below, gives a comparative cost per foot of total drilling for the past five years.

It will be noted that the total cost per foot of drilling, both including the several items of overhead expense and excluding the same, was the lowest for the past five years with one exception, 1928, which I think is a commendable record. In 1928 we had some very cheap drilling in the Holmes and Virgil Mines; also the cost of drilling in the Cliffs-Shaft Mine that year was the lowest we had ever had.

These were the determining factors in making 1928 a record year. In 1931 the cost at the Cliffs-Shaft Mine is a record low for all time, even including 1928. The 1928 costs were $2.86 per foot, including the overhead, and $2.50 per foot, excluding the overhead, whereas in 1931 they were only $2.69 and $2.16 per foot, respectively. This factor, together with the reduction in drilling price that I was able to secure from Mr. Schultze, who is doing the drilling on the Bingham lease, accounts for the low total drilling costs:

TABLE V.

SUMMARY OF DRILLING FOR 1931.

EXPLORATION.	DESCRIPTION. SEC. T. R.	STAND-PIPING FT.	CHURN DRILLING FT.	DIAMOND DRILLING FT.	TOTAL DRILLING. FT.	FIRST CLASS ORE FT.	SECOND CLASS ORE FT.	LEAN ORE FT.	TOTAL COST "A".	COST PER FT. "A".	TOTAL COST "B".	COST PER FT. "B".
SURFACE DRILLING.												
Bingham Lease,	21, 56 - 24, Minn.	1900	3157	234	5291	196	0	1548*	$20,405.56	$3.86	$17,635.24	$3.33
Total Surface Drilling		1900	3157	234	5291	196	0	1548	$20,405.56	$3.86	$17,635.24	$3.33
UNDERGROUND DRILLING.												
Cliffs-Shaft Mine,	3,9 & 10,47-27, Mich.			1730	1730	239	80	41	$ 4,647.18	$2.69	$ 3,738.00	$2.16
Morris-Lloyd Mine,	6,47-27 & 1,47-28, Mich.			1010	1010	348	54	92	3,775.43	3.74	3,152.02	3.12
Total Underground Drilling,				2740	2740	587	134	133	$ 8,422.61	$3.07	$ 6,890.02	$2.51
Grand Total Drilling,		1900	3157	2974	8031	783	134	1681	$28,828.17	$3.59	$24,525.26	$3.05

* This is Crude Wash Ore, all of which can be concentrated to High Grade Ore.

NOTE: Cost "A" includes office expense, engineering, analysis, legal, personal injury, etc.
Cost "B" excludes " " " " " " " " (to compare with contract prices).

The drilling on the Bingham Lease was done under contract by J. S. Schultze of Grand Rapids, Minn.

TABLE VI.

SUMMARY OF FOOTAGE DRILLED AND COST PER FOOT OF DRILLING FOR PAST FIVE YEARS.

YEAR.	TOTAL FEET DRILLED.	COST PER FOOT "A".	COST PER FOOT "B".
1927	20,169	$3.88	$3.30
1928	4,770	3.00	2.63
1929	13,190	3.75	3.36
1930	14,656	4.15	3.61
1931	8,031	3.59	3.05

F-3. DIAMOND DRILL CARBON.

We had on hand, January 1st, 1931, a total of 397.91 karats of diamond drill carbon which inventoried at $48,933.20. We consumed, in 1931, a total of 17.01 karats in our drilling at a cost of $2377.14. We had on hand, December 31, 1931, a total of 380.90 karats which inventoried at $46,556.06.

F-4. DRILL SECTIONS.

Cross-sections showing a detailed report of the drilling on the Bingham lease, Mesaba Range, will be found in the Annual Report Book labeled: "The Cleveland-Cliffs Iron Company - Minnesota Districts, December 31, 1931". Cross-sections showing a detailed report of the drilling in the Cliffs-Shaft and Morris-Lloyd Mines will be found in the Annual Report Book labeled: "The Cleveland-Cliffs Iron Company - Ishpeming, North Lake and Iron River Districts, December 31, 1931". These books are submitted as a part of the Annual Report of the Engineering and Geological Departments.

G - SURFACE EXPLORATIONS.

G-1. BINGHAM MINE LEASE, NW¼ OF SE¼ OF SECTION 21, 56-24, MINNESOTA.

Drilling was commenced the middle of April on the Bingham lease of the Holman-Cliffs Mine to check-drill the old exploratinge done many years ago by antiquated churn drill methods, and to more completely outline the limits of the deposit of merchantable and wash ore which continues Southward from the Brown No.1 parcel along the West side of this property. The drilling is being done under contract by J. S. Schultze of Grand Rapids, Minnesota, using two churn drill rigs. The holes put down are of large diameter and called "structure holes" since the large size makes it possible to recover pieces of sample large enough to determine accurately the structure of the formations, including the ore. The holes were all put down vertically, using a 3" pipe.

Up to the end of the year, 24 holes had been completed and hole No.25, the last one which we plan to drill in the present program, was standpiping in surface at a depth of 68' on December 31st. The holes have ranged from a depth of 120' to 294' and were laid out in more or less of a checker-board pattern but located on East-West cross-sections and in the W½ of the property. There is a relatively deep channel of good ore extending Southward along the West boundary of both the Brown No.1 and Bingham parcels. A total of 5291' has been drilled, made up of 1900' of standpiping through surface, 3157' of churn drilling (with structure bit) and 234' of diamond drilling.

We have made no revised estimate of the ore encountered by this drilling but will do so when it is completed. We have encountered 196' of merchantable, or direct shipping ore, and 1548' of washable ore which will make high grade concentrates. Our original estimate, based on the old drilling, showed a total of 1,398,800 tons, made in September 1925 and comprising 532,000 tons of direct shipping ore and 866,800 tons of wash ore concentrates. Our present drilling has been quite satisfactory in that it has, we believe, shown up more tonnage than our first estimate. We believe also that the results indicate a smaller ratio of stripping per ton of shipping ore. Previously we had estimated 2,316,700 cu. yds. of surface stripping and 80,000 cu. yds. of paintrock stripping.

The principal variation between the old drilling and the present work is what might be expected from the inaccurate methods in sampling of a great deal of the churn drilling done on the West end of the Mesaba Range years ago. That is, that there is less direct shipping ore than indicated by the old drilling. In a number of cases we have found a high grade wash ore where the old drilling showed

direct shipping ore. This was our experience, to even a greater degree, in our drilling during 1930 on the West forty of the North Star parcel, also of the Holman-Cliffs Mine. In other words, many of the samples in these wash ore areas were concentrated by the drill water in catching the samples by inaccurate methods at the time the old drilling was done.

H - UNDERGROUND EXPLORATIONS.

H-1. CLIFFS-SHAFT MINE.

One diamond drill was operated continuously in the Cliffs-Shaft Mine from the beginning of the year to the middle of June. Drilling was then discontinued for the balance of the year due to depressed conditions in the iron ore market and the reduction of working time at the mine. Hole No.418 was completed and four additional holes drilled during this time, Nos.419 to 422, inclusive. The holes were all in "A" Shaft and included a total of 1730' of drilling. Of this total footage, 239' was first class ore, 80' second class ore, and 41' lean ore, a very satisfactory result.

Hole No.418, drilled horizontally and due North from the North side of the 9th level "A" Shaft, was 562' deep at the beginning of the year and had encountered several runs of good ore. It was bottomed at a depth of 601' in mixed hanging slate and ore material without any additional footage of clean ore. Hole No.419 was drilled horizontally and S. 17° E. from the East end of the 9th level "A" Shaft to explore for an ore connection between the old Incline Mine and the main South vein of ore on this level, also to explore all of the formation to the greenstone footwall on the Moro side of the mine. It encountered 20' of good ore from 34' to 54' which probably represents an ore connection with the old Incline. Beyond this point, however, the hole was almost entirely in footwall dike with an occasional narrow band of hard ore jasper and finally was bottomed in siderite at a depth of 438'. The siderite exhibited considerable folding and brecciation and, because of this, was partly oxidized. This structure indicates a fault zone at this point which may have an important bearing on the allocation of ore in the vicinity.

Two holes, Nos.420 and 421, were next drilled horizontally from the Northwest end of the 10th level "A" Shaft. Hole No.420 was drilled due South to crosscut the downward extension of the Bancroft fault vein which carried ore on the two levels above. Except for an unimportant seam of high grade magnetite from 102' to 106', the hole was practically all in footwall greenstone and finally bottomed in siderite at a depth of 300'. Hole No.421 was drilled due North to explore the North side of the Bancroft fault and the main Bancroft ore body which had been cut here and there at higher elevations but in what we believe to be a faulted position with respect to its anticipated position on this meridian. The hole passed North of the fault at 21', where 4' of high grade ore was encountered. After passing through some hanging slate followed by slate mixed with seams of good ore, indicating the hole was close to the contact between the slate and ore, the main Bancroft ore body was encountered at a depth of 117'. From this point high grade ore was continuous for 163', to a depth of 280', averaging practically 62% in iron. This ore is the richest ever found in the mine in any large quantity and is the largest footage, with one exception, that has ever been cut by a drill hole in this mine. The hole was bottomed in hanging wall slate and quartzite at a depth of 353'.

Hole No.422 was drilled horizontally and due North from the North side of the 15th level "A" Shaft to explore for the downward continuation of the ore encountered in hole No.421 and to plan the lay-out of a drift on the 15th from which raises may be put up to develop and mine this ore. Unfortunately, the hole, except for a few narrow seams of brecciated magnetite ore, encountered little else than footwall material, siderite and dike. Apparently the hole is very close to the contact between the

iron formation and the footwall dike. The seams of magnetite ore, which probably are droppers into the footwall from above, may or may not connect with the main faulted Bancroft ore body encountered above.

H-2. MORRIS-LLOYD MINE.

One drill was operated continuously in the Morris-Lloyd Mine from the beginning of the year to the latter part of May. Drilling was then discontinued for the balance of the year on account of the depressed condition of the iron ore market and the reduction in working time at the mine. During this time, four holes were drilled, Nos.107 to 110, inclusive, aggregating 1010'. Of this footage, 348' was high grade ore, 54' second class ore, and 92' lean ore, an excellent record.

Holes Nos.107 and 108 were drilled horizontally and due South from the East end of the 6th level in the Lloyd East property to continue outlining the foot and hanging limits of the main Section 6 ore body at this elevation, which had been cut in hole No.106 completed in December 1930. Hole No.106 was at the extreme East end of the level, No.107 about 400' to the West and No.108, 250' West of No.107. Both of these holes cut the main ore body and located its foot and hanging on their respective meridians. The ore in No.107 extended from 65' to 134' with an additional 9' from 180' to 189'. The ore body was cut in No.108 from 30' to 110', from 119' to 164' and from 170' to 180'. The results of this drilling exceeded somewhat our expectations in the size of the 6th level contours of this ore body.

Hole No.109 was drilled horizontally and due South from the -110' sub-level but located just above the 7th main level on No.9 lease in the Morris Mine. The object of this hole was to crosscut the iron formation on the hanging side of this sub-level and explore for the upward extension of ore just previously encountered and being developed below the 7th level. Except for a 2' seam of good ore, from 123' to 125', the hole was all in rich soft ore jasper and was bottomed at a depth of 168'.

Hole No.110 was drilled horizontally and due South from the 7th level on lease No.9 in the Morris Mine to continue crosscutting and exploring the iron formation on the hanging side of the level for the upward continuation of ore discovered in drilling and being developed between the 7th and 8th levels. The results in this hole were quite successful since good ore was cut from 189' to 260', 280' to 320' and from 345' to 367', where the hole was bottomed. Drilling was stopped in ore because of caving ground and the proximity of the bottom of the hole to development work being carried on and therefore did not warrant the expense of casing the hole to continue drilling.

I - EXPLORATIONS AND NEW DEVELOPMENTS BY OTHER COMPANIES.

I-1. MARQUETTE RANGE.

The Inland Steel Company, who started to sink a shaft on their hard ore prospect in Section 23, 47-28, South of Greenwood, in 1930 continued their sinking operations throughout the year. The property is called the Greenwood Mine. At the end of the year they had bottomed their shaft at a depth of approximately 1150'. Shaft plats were cut at depths of 850' and 1100', respectively. They are now drifting due South on the 1100' level and are now in approximately 100' from the shaft. The shaft was all in hanging wall material, principally quartzite, and the drift on the 1100' level is still in quartzite, which is dipping approximately 70°to the North.

During the first part of the year, the Oliver Iron Mining Company drilled a series of five holes along the hard ore contact just South of the East-West center

line of Section 23, 48-31, West of Michigamme. These holes were inclined to the North, dipping from 50° to 70°, and were located on a line starting about 1000' South of the East quarter corner and extending to a point approximately 300' South of the West quarter corner. The first hole was near the East line of the section and the last hole about 500' East of the West line. No commercial ore was encountered.

Also, during the spring some Chicago interests unwatered the old Spurr Mine, just North of the Imperial. It was reported that they were to conduct some explorations here but after a short time all activity stopped and I do not believe any exploring was actually undertaken.

I-2. MENOMINEE RANGE.

The Jones & Laughlin Ore Company continued their active drilling campaign in the Iron River and Crystal Falls Districts throughout the year but were expecting to stop all work as the year closed because of business conditions. For more than half the year they employed six drills and were employing four drills as the year closed. Near Crystal Falls they drilled an area Northwest of the Great Western Mine. This comprises the SW¼ of the NW¼ of Section 21, 43-32, or the forty North of the old Lincoln Mine. Some good ore was encountered but so far they have not developed an ore body of commercial importance. Other drilling was done in the SW¼ of the SE¼ of Section 1, 42-33, South of the old Dunn Mine. The results were very disappointing. In the Iron River District, drilling was carried on Southeast of the Zimmerman Mine in 42-34; in the SW¼ of Section 13, 43-35, the so-called Barnett option, and on the NW¼ of the NW¼ of Section 24, 43-35, the forty just North of the Virgil. The results of all this work so far have been negative in that no commercial ore in quantities has been discovered. The work, however, has aided in their geological study of the District and undoubtedly when business conditions improve, the J. & L. Company will continue a search for a new ore body in the Iron River-Crystal Falls District. J. & L. also had a crew of six men actively engaged in magnetic survey work during a greater part of the summer North and West of Crystal Falls. This work was done with the Hotchkiss Super-dip needle under the immediate direction of Mr. C. O. Swanson, Professor of Geology at the Michigan College of Mining & Metallurgy, Houghton, who is retained in a consulting capacity by J. & L.

Pickands, Mather & Company were also quite active in Iron County with one drill in a more or less wild-cat territory on the Northwest extension of the Negaunee formation, North and West of Crystal Falls. This formation has produced such ore bodies as the Amasa-Porter and Warner Mines; also, the new ore body found in Section 26, 43-32 in 1930 by J. & L. Pickands, Mather also has done some test pitting and exploration shaft work in the same locality. I have been unable to get any detailed information of this work to date, except that in a number of places, where ore formation was expected, they were unable to find even unoxidized cherty iron formation and in no place did they encounter ore in commercial quantity.

The Oliver Iron Mining Company had two men from their Duluth office scouting over all of their mineral holdings in Iron and Dickinson Counties. This field examination covered some 28,000 acres and a rough magnetic survey was made in connection therewith. The object of this examination was to compile information, preparatory to allowing all that part of their acreage to be relinquished for taxes which this survey might show to have little or no value. This is, by the way, quite a decided step for the Oliver to take in comparison with their former policy of hanging on to all of their lands, regardless of apparent value. I was told, authoritatively, that this is but a beginning of their activities in this respect and that the surveys will continue until all of the mineral lands held by the Oliver in the entire Lake Superior District are covered and so classified.

I-3. GOGEBIC RANGE.

On the Gogebic Range the only event of importance that has come to my attention the past year was the purchase, by the M. A. Hanna Company, of the fee of the Chicago Mine. This comprises the E½ of NE¼ of Section 8, the NW¼ of NW¼ and the mineral rights to the SW¼ of NW¼ of Section 9, all in T. 47 N. R. 45 W. The purchase price was reported to be $35,000. This property was offered to us in February 1930, land offer No.1798; I examined the same in the spring of 1930 and reported on it in my letter to Mr. Elliott of July 9, 1930, strongly recommending that the offer be accepted and the property purchased. The first price given was for $44,000 but I later got this reduced to $35,000, the price paid for it by the Hanna Company.

I-4. MINNESOTA RANGES.

I have no definite knowledge as to the actual descriptions of mineral lands involved in acquisitions by mining companies in the Minnesota Ranges. I do know, however, that a number of properties, particularly on the Mesaba Range, were optioned or leased by the Oliver Company and a lesser number by Pickands, Mather and M. A. Hanna. The great scramble, however, for iron ore properties on Minnesota Ranges, which was in full swing in 1929, has just about spent itself.

J - EXAMINATION OF MINERAL LAND OFFERS.

Twenty mineral land offers were received and reported on during the past year as follows:

NUMBER.	DESCRIPTION.	REMARKS.
1847	Various in Cass and Crow Wing Counties, Minnesota,	Declined
1848	Delta County, Michigan, - - - - - - -	"
1849	NE¼ & SE¼ of NW¼ of Sec.1, 46-29, Minnesota, -	"
1850	Various in Crow Wing County, Minnesota, - -	"
1851	Copper, nickel and chromium in Montana, - -	Pending
1854	SW¼, NW¼ of SE¼ & S½ of SE¼ of Sec.32, 138-26, Minn.,	Declined
1855	Various in Aitkin County, Minnesota, - - -	"
1857	W½ of SE¼ & E½ of SW¼ of Sec.22, 47-29, Minnesota,	"
1858	E½ of SW¼ & W½ of SE¼ of Sec.2, 55-25, "	"
1859	Various in Sections 11 and 12, 58-19, "	"
1860	Various in 45-29 and 45-30, Michigan, - - -	"
1861	Various in Sections 14 and 15, 42-33 and various in Section 14, 43-33, Michigan, - - -	"
1864	Copper, nickel and chromium in Montana, - -	Pending
1865	W½ of SE¼ of Section 24, 58-17, Minnesota, -	"
1866	Wabasha County, Minnesota, - - - - -	Declined
1867	Ontario, Canada, - - - - - - - -	"
1868	N½ of NW¼ of Section 4, 47-28, Michigan, - -	"
1869	N½ of SW¼ & SE¼ of SW¼ of Sec.36, 43-34, Michigan,	Pending
1870	Various in Sections 2 and 11, 46-29, Minnesota,	"
1871	Various in 59-25 and 59-26, Minnesota, - -	Declined.

K. EXPENSE STATEMENTS.

Tables VII and VIII, which follow, show a detailed statement of charges to geological expense for the year and a comparative statement of these charges for the last three years. They are self-explanatory:

TABLE VII.

STATEMENT OF CHARGES TO GEOLOGICAL EXPENSE FOR YEAR 1931.

Salaries, - - - -	$12,994.58
Travel and Entertainment,	2,244.77
Operating Automobiles, -	451.81
Supplies and Office Expense,	1,094.39
Unclassified, - - -	119.86
Total,	$16,905.41

TABLE VIII.

COMPARATIVE STATEMENT OF CHARGES TO GEOLOGICAL DEPARTMENT FOR LAST THREE YEARS.

	1931.	1930.	1929.
Salaries, - - - - - -	$12,994.58	$15,495.00	$13,754.60
Travel and Entertainment, -	2,244.77*	100.33	343.52
Operating Automobiles, - -	451.81	852.90	1,018.25
Supplies and Office Expense,	1,094.39	1,537.74	1,127.77
Unclassified, - - - -	119.86	295.00	-
Total,	$16,905.41	$18,280.97	$16,244.14

* Previously all Travel and Entertainment expense charged against any particular mining operation was not included in this statement.

L. RESEARCH DEPARTMENT.

The Research Department throughout the year 1931 continued to be under the immediate supervision of Mr. W. L. McMorris, Jr. In addition to experimental work of a reaearch nature which has been carried on, the Research Department has looked after the drilling on the Bingham property and the drilling and test pitting program at the Canisteo to prove ~~kx~~ up operating areas for the first year's operations, and small exploration campaigns carried on in the Hill-Trumbull and Holman-Cliffs Mines.

A very extensive program of experimental research was carried out. Early in the year the Canisteo and Trumbull ores were tested at the Mines Experimental Station, University of Minnesota, at Minneapolis, in a Hancock jig. Additional tests were made of Dean Mine ore at the Station to determine the possibility of concentrating or sintering this ore. Brief reports covering this work were submitted. During November and December, additional jig tests were made on Canisteo and Brown No.1 ores at the Experiment Station, and tests, using the Symons-Carve jig, were made on Canisteo, Brown No.1, Hill and Trumbull ores at the Link Belt plant in Chicago, where this latter jig is manufactured. None of the tests in November and December have, as yet, been correlated in a formal report. This will be done, however, as soon as the test is completed early in ~~the~~ 1932.

The Research Department also carried on, at the Holman-Cliffs plant, a test program, continuing throughout the operating season, to prove the desirability of retreating fine ore, thus increasing the recovery of this fine ore by more advance methods of concentration. In this work there were tested the Newton By-Pass, which is an auxiliary appliance to the Dorr bowl classifier; the Hydrotator, which is a thickening device somewhat similar in application to the Dorr bowl; the Fahrenwald Sizer, which is used for classifying lean bowl classifier concentrates; and concentrating tables for retreating lean products from the Fahrenwald Sizer. In addition to these tests, a start was made on testing the possibility of the application of oil flotation to the recovery of fine iron oxide ore particles. A complete report covering all the tests made at the Holman plant has been submitted by Mr. McMorris with recommendations for the construction of a fine ore treatment plant at each of our three washing plants.

During the year the Research Department maintained a minimum organization of four men, including Mr. McMorris. This was augmented in June by an additional engineer and two additional helpers. From time to time during the operating season, one or two additional men were used to assist in the work. At the close of the year, the organization had been reduced to three engineers and three helpers.

The samples from all the explorations were delivered directly to the laboratory of the Research Department where they were classified and prepared for analysis at our Central Laboratory. Hand washed tests were made on all wash ores before classification. The Central Chemical Laboratory, which came into being during 1930, proved a very satisfactory arrangement, as well as economical in comparison with the previous arrangement of having analyses made by Lerch Brothers, independent chemists. The Research Department, in all of their work, has kept abreast of the timesin adopting the latest approved methods for all classes of work within its field of activity. I feel that the year 1931 has been one of great accomplishment in this Department and that future developments and operations will definitely prove this. A free hand was given and unstinted cooperation was had from all departments of our organization.

Respectfully submitted,

E. L. Derby, Jr.

Geologist

GEOLOGICAL DEPARTMENT

Safety Department

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Year 1931

11. ACCIDENTS AND PERSONAL INJURY

a. Fatal Accidents:

There were three men accidentally killed at the mines in 1931. They occurred underground at the Maas, Morris-Lloyd and Cliffs Shaft mines. Two of them were classified preventable accidents and one as a trade risk.

There have been only two years since 1898 when the number of fatalities were less. For the year 1922 there was one and there were two during 1925.

DESCRIPTION OF FATAL ACCIDENTS

Fatal Accident No. 1.

August Kahaliin, a timberman, was fatally injured at the Maas Mine, 11:35 A. M. January 5th, 1931. He died at the Ishpeming Hospital about 7:30 o'clock in the evening of the same day.

A two-compartment raise, extending 170 feet above the 3rd level, had been completed in December, and it was decided to plank the dirt compartment before putting it into service. The timber foreman, Peter Bessola, was instructed to have his crew plank the raise. Before permitting his men to enter the dirt compartment, Bessola first made an inspection to ascertain if it was in safe condition. He climbed the ladder road to the top of the raise and found that this compartment was completely covered. There was double cribbing dividing the two sections of the raise. The foreman found narrow openings between these cribbings and made his inspection of the top and foot of the dirt compartment by peeping through them. On reaching the bottom of the ladder road, he told his men to go ahead and put in the plank, as the raise was safe to work in.

Three members of the timber crew started on the job. They first placed two ladders in the dirt compartment and then hung a block above these ladders, to pull up the planks. Walter Warren and Kahaliin worked in the raise and Sam Tripp supplied them with plank. After completing the first row of planks they started on the next layer. About 11:30 Warren, hearing blasting, asked Kahaliin if they should stop work and start for the shaft, but the latter replied they had time to put in one more plank. Shortly after this conversation some fine dirt came down the raise. In a few seconds, a chunk of ore fell, striking Kahaliin on the side of the head. His hard hat was broken but it did not afford ample protection to avoid a fractured skull. Apparently the chunk of ore was loosened by the blasting on the sublevels. An investigation later showed that the covering at the top of the dirt was not sufficient to prevent small chunks of ore from falling into the raise.

Kahaliin was a Finn, 56 years of age, and is survived by a widow and seven children, the youngest of whom is sixteen years old. The Coroner's Jury verdict was: "Death was the result of a falling chunk of iron ore and that the same was an unavoidable accident."

Safety Department

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11. ACCIDENTS AND PERSONAL INJURY

a. Fatal Accidents (continued)

Fatal Accident No. 2.

Joseph Bussona, a miner, was injured in a blasting accident at the Morris Mine at 10:30 P. M., January 27th, 1931, which resulted in his death at the Ishpeming Hospital on February 1st.

Bussona and partner, Heltzy Oesti, were miners working 50 feet above the 7th level. They had finished a sub-level and had started a new sub, with four sets of timber placed over the raise. They then started to drift over the ladder road side of the raise in order to make room for their scraper hoist. On the night of the accident, they drilled 17 holes in the breast, a few feet off the top of the ladder road, and at 10:30 o'clock they were ready to blast these holes. One of the holes, located in the upper left hand corner of the breast, was quite wet, as water came through there from the sub-level above that had been mined and caved. The other holes were dry. Bussona, being an old miner, took the lead. He started to light the fuses, telling Oesti to stand by with his light. After lighting 16 fuses, Bussona had trouble in lighting the one that was wet. He took out his knife and cut off a few inches of the fuse, at which time Oesti said, "I think we should get out; we have been here too long," Oesti climbed down the ladder but held up his light for his partner to see in case his light went out. Bussona replied to the effect that they had plenty of time and that he was going to light the last fuse. While he was doing it, one of the holes exploded. Oesti stepped down under a sollar, near the top of the raise, where he remained in darkness while the other holes exploded. He then climbed down to the main level, where he found Bussona lying on the track. The latter was conscious and able to talk. It was thought at first that he would recover but his death came as the result of internal injuries.

Bussona was an Italian, 42 years of age, and is survived by a widow and five children. An inquest was not considered necessary by the Coroner.

Fatal Accident No. 3.

Jacob Pihlaja, a miner, was instantly killed about 3:00 P. M., July 8th, 1931, at the Cliffs Shaft Mine, due to an explosion of powder that was left in the bottom of a drill hole from a previous blast.

This man and two trammers were driving a rock drift on the 11th level of "A" shaft when the accident occurred. On July 6th, a cut was blasted and the next day the two trammers mucked the dirt and the miner helped them in the morning, after which he rigged up his machine and started to drill. During the morning of the 8th, Pihlaja finished all the holes except the three bottoms. He had started to drill the center bottom hole when his first drill struck some concealed powder.

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11. ACCIDENTS AND PERSONAL INJURY

a. Fatal Accidents (continued)

Fatal Accident No. 3. (continued)

The explosion threw back several chunks of rock, one of which struck his head, causing instant death.

When mucking, the trammers found several pieces of powder in the dirt pile, which they handed over to the miner. The three men then kept a close inspection for a missed hole but found no evidence to indicate that there was one. Between the time of the blast on July 6th and the time of the accident, ten men had inspected the place. These men were the miner and two trammers who were working there, the mine superintendent, the County Mine Inspector, Captains John Olds and William Nault, Foreman John Bredeson, Shift Boss Matt Renowden and myself. Pihlaja was then drilling his first bottom hole and we had no idea as we left that there was powder hidden in the bottom of an old hole.

The concealment of the powder was due to the fact that the bottom holes were drilled at an inclined angle from the horizontal, so that the floor of the drift would be easier for placing track ties. When the blast was fired on the 6th of the month, the right bottom hole probably shattered the upper part of the center hole. The stick of powder that carried the cap exploded because the trammers claimed that all the holes were counted when the blast was made. Two sticks were thrown to the left side of the drift and one stick was left intact at the bottom of the hole, slightly below the level of the drift. The ground is very hard and the floor of the drift was covered with water. The holes broke irregularly, and hence nobody paid particular attention to an uneven surface in the starting of new holes. The center bottom hole was started against a hard face of rock that completely hid the powder resting beneath it.

Pihlaja was a Finn, age 48 years, and is survived by a widow and five children. The verdict at the Coroner's Jury was "Accidental death from premature blast; the reason unknown and no one to blame."

This fatality was accepted as a trade risk accident.

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11. ACCIDENTS AND PERSONAL INJURY

TABLE I

Classification of Fatal Accidents 1911 to 1931, inclusive.
By the Central Safety Committee

I	Trade Risks		107
II	Negligence of the Company		
	Violation of Rules	4	
	Failure to Provide Safety Devices	4	
	Improper Method of Doing Work	7	
	Failure to Provide Tools or Safe Place to Work	3	
	Failure to Instruct Men	3	21
III	Negligence of Workmen:		
A	Injured Men		
	Improper Method of Work	10	
	Violation of Rules	7	
	Carelessness	6	
	Failure to use Tools or Appliances Provided ...	4	
	Failure to use Safety Device	1	28
B	Other Workmen:		
	Improper Method of Work	9	
	Violation of Rules	4	
	Carelessness	3	
	Failure to use Tools or Appliances Provided ...	1	17
	Total		173

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11. ACCIDENTS AND PERSONAL INJURY

TABLE II

Classification of Causes of Fatal Accidents
From December 1st, 1898 to December 31st, 1931.

A	Fall of Ground or Timber	92	
	Run of Mud or Sand	60	
	Fall of Chunk or Ore from Chute	2	
	Stray Chunk or Stick down Raise or Stope	3	157
B	Shaft Accidents:		
	Falling down shaft	14	
	Rock or Timber falling down shaft	2	
	Struck or caught by Cage, Skip, Bucket or Tool	8	
	Falling from Cage, Skip or Bucket	11	
	Falling from Ladder in Shaft	5	
	Carried or pushed into Shaft by Car	3	
	Jumping on or off Cage, Skip or Bucket	3	
	Struck by Crosshead	5	51
C	Use of Explosives:		
	Explosion of Powder	16	
	Premature Blast	3	
	Fall of Ground or Timber due to a Blast	4	
	Overcome by Gas	3	
	Miscellaneous Causes	1	27
D	Mine and Railroad Cars:		
	Caught by Haulage Cars	12	
	Riding or attempting to ride Cars	6	
	Falling with Car from Trestle	4	
	Run over by Railroad Car	6	
	Miscellaneous Causes	1	29
E	Miscellaneous Causes:		
	Falling in Raise or Pocket	7	
	Contact with Electric Wire	7	
	Falling from Ladder, Stage or Trestle	6	
	By Moving Machinery	4	
	Mine Fires	3	
	Miscellaneous Causes	3	30
	Total		294

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11. ACCIDENTS AND PERSONAL INJURY

TABLE III

Showing number of fatalities and rates per 1000 employees for 13 years prior to Safety work and for 21 years of Safety work

Year	Fatalities	Rate	Year	Fatalities	Rate
1898	6	5.63	1915	5	2.17
1899	4	3.41	1916	8	2.61
1900	4	2.80	1917	6	1.73
1901	9	6.83	1918	13	3.45
1902	8	5.38	1919	11	2.79
1903	8	5.15	1920	5	1.21
1904	4	2.97	1921	6	2.60
1905	12	5.88	1922	1	.45
1906	10	4.13	1923	6	2.19
1907	18	6.33	1924	5	1.88
1908	6	2.57	1925	2	.81
1909	13	5.15	1926	55	23.90
1910	20	6.52	1927	4	1.82
	122 Avg.	5.03	1928	4	2.00
1911	5	1.89	1929	4	1.91
1912	4	1.71	1930	5	2.25
1913	11	4.19	1931	3	1.40
1914	10	4.10		173 Avg.	3.13

TABLE IV

Comparison of Fatality Rates for Coal Mines, Metal Mines, Etc.

Year	U.S. Coal Mines	U.S. Metal Mines	Minn. Metal Mines	Mich. Metal Mines
1911	4.97	4.45	5.46	4.28
1912	4.46	4.09	3.15	3.22
1913	4.70	3.72	3.16	3.12
1914	4.66	3.92	2.93	3.97
1915	4.44	3.89	2.71	3.74
1916	3.94	3.62	2.59	3.76
1917	4.25	4.44	3.04	3.40
1918	3.94	3.57	3.25	3.31
1919	4.27	3.43	3.09	2.99
1920	3.62	3.16	2.61	3.25
1921	4.11	3.09	2.51	3.63
1922	4.89	3.54	3.03	2.17
1923	4.39	3.01	2.08	2.03
1924	4.80	3.51	5.61	2.30
1925	4.65	2.99	2.16	2.33
1926	4.50	3.47	1.67	5.79
1927	4.43	3.10	2.55	2.62
1928	4.64	2.50	1.25	2.82
1929		3.03	2.88	2.29
1930		2.92	2.41	3.02
	4.41	3.48	2.96	3.20

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11. ACCIDENTS AND PERSONAL INJURY

b. Non-Fatal Accidents:

A total of 24 lost time accidents, other than fatalities, occurred at the mines. There were 78 in 1930. As the number of operating days was reduced the reduction in severity rate does not show the same improvement as would seem to be indicated by the difference existing in the number of accidents for the two years.

The records of the various units with respect to these accidents were as follows:

TABLE V

Mine or Plant	Number of Non-Fatal Accidents
Gardner-Mackinaw	0
Holman-Cliffs	0
Hill-Trumbull	0
Tilden	0
C. P. & L. Co.	0
General Shops	0
Republic	1
Alexandria	1
Wade	1
Cliffs Shaft	1
Athens	2
Canisteo-Cliffs	2
Spies-Virgil	2
Morris-Lloyd	4
Negaunee	5
Maas	5
Total	24

TABLE VI

Classification of all accidents by causes - 1931

By falls of ground from back or side of drift, stope, etc....	6
By finger or foot being caught between objects	5
By flying, glancing or bounding objects	3
By explosion of powder	2
By chunks rolling down piles	2
By haulage operations	2
By stumbling or slipping	2
By miscellaneous causes	5
Total	27

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11. ACCIDENTS AND PERSONAL INJURY

TABLE VII

b. Number of Compensable and Non-Compensable Accidents

Mine	Received Compensation	No Compensation	Total
Athens	2	0	2
Cliffs Shaft	2	0	2
Holmes	0	0	0
Maas	5	1	6
Morris-Lloyd	5	0	5
Negaunee	5	0	5
Gardner-Mackinaw	0	0	0
Spies-Virgil	1	1	2
Miscellaneous	0	1	1
C. P. & L. Co.....	0	0	0
Alexandria	1	0	1
Hill-Trumbull	0	0	0
Holman-Cliffs	0	0	0
Canisteo-Cliffs	2	0	2
Wade	1	0	1
Total	24	3	27

TABLE VIII

Number of Accidents, number per 1000 Men employed and Percentage Classified Preventable - 1912 to 1931.

Year	Number of Accidents	Number per 1000 Men Employed	Percentage Classified Preventable
1912	207	88	25
1913	316	120	24
1914	443	181	37
1915	427	185	23
1916	592	193	20
1917	639	184	23
1918	590	156	21
1919	670	172	22
1920	708	175	19
1921	351	170	18
1922	344	168	26
1923	453	166	23
1924	407	152	23
1925	363	152	27
1926	426	185	33
1927	211	90	43
1928	123	77	62
1929	85	40	66
1930	82	37	70
1931	27	13	74

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11. ACCIDENTS AND PERSONAL INJURY

TABLE IX

b. Classification of All Accidents 1931
By the Central Safety Committee

I	Trade Risk. (Incidental and Non-Preventable)		7
II	Negligence of Company:		
	1. Failure to use Safety Devices Provided	0	
	2. Failure to use Proper Tools or Appliances Provided	0	
	3. Violation of Rules	0	
	4. Improper Act or Selection of Improper Method of Doing Work (By Foreman).....	2	
	5. Failure to Instruct Men as to Method of Doing Work and Hazards Incident Thereto	0	
	6. Failure to Provide Safety Devices	0	
	7. Failure to Provide Proper Tools, Appliances or Place of Work	0	2
III - A	Negligence of Workmen:		
	1. Failed to use Safety Device Provided	0	
	2. Failed to use Proper Appliances or Tools Provided	0	
	3. Violation of Rules	1	
	4. Improper Act or Selection of Improper Method of Doing Work (By Foreman)	17	18
III - B	Other Workmen:		
	1. Failed to use Safety Devices Provided	0	
	2. Failed to use Proper Appliances or Tools Provided	0	
	3. Violation of Rules	0	
	4. Improper Act or Selection of Improper Method of Doing Work (By Workmen)	0	0
	Total		27

Safety Department

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11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection:

A safety inspection of the Company's mines in Marquette County was made each month by the writer. The Spies-Virgil was inspected four times and our mines in Minnesota twice. All important subjects of safety were submitted either to the General Superintendent or the Manager. There were no inspections by committees of foremen or workmen.

Central Safety Committee:

This Committee held six sessions during the year. The reduction in the number of accidents made unnecessary a regular monthly meeting, as has been the custom in past years.

Safety Inspection Reports:

The various reports and the number of the same that were made at the mines and were forwarded to the Safety Department are listed in the following table:

TABLE X

Cage Riders	Daily	2000
Hoisting Ropes	"	1881
Ladderways	Weekly	348
Skip and Cage Roads	"	362
Cage Safety Catches	Monthly	116
Hoists	"	188
Mine Rescue and First Aid	"	187
Fire Doors	"	49
Fire Equipment	Quarterly	74
Electrical Equipment	"	14
		5219

Safety Standards:

The formulation of safety standards covering the various operations which experience has proven to be responsible for most accidents is almost completed. These standards have been made available in printed form. The number distributed, including copies of the General Rules, was as follows:

TABLE XI

Rule Books	94
Standards for Shops, Boiler and Engine Rooms	168
Standards for Handling and Use of Explosives	59
Standards for Top Slicing System of Mining	35
Standards for Installation of Haulage	10
Standards for Open Pit Mining	56
Standards for Washing Plants	2
Total	505

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11. ACCIDENTS AND PERSONAL INJURY

c. Safety Activities:

Safety Conferences:

A conference of the Company's foremen who are employed in Marquette County was held monthly at Ishpeming, with the exception of December. Mr. Graff presided as chairman at these conferences, which were held for the purpose of educating the foremen in safety activities. All standards were reviewed and a solution reached whenever a misunderstanding or a difficulty existed. Mine conferences of foremen were held both locally and in Minnesota from time to time throughout the year, when study was given to the problems arising at each individual property.

Penalties:

A total of fifteen employes were suspended or laid off from work because of failures to comply with established safety practices. The penalty usually inflicted is three days, but if a violation resulted in an accident or is one that is deliberately committed, it is made more severe. No employe has been reported a second time for an infraction of safe conduct.

Safety Awards:

The Joseph A. Holmes Certificate of Honor, which is distributed annually by the U. S. Bureau of Mines for unusually good accidents records, was awarded to the Tilden and Gardner-Mackinaw mines in June for establishing perfect records for a year or longer. The Negaunee Mine was given a certificate in 1928 because it had the unique record of having been operated ten years without a fatality. These three mines are the only ones on the Marquette range to receive this recognition.

The Holman-Cliffs, Hill-Trumbull, Cliffs Shaft "A" and Cliffs Power & Light Co. were operations which completed a year each with a perfect accident record and Gold Buttons were distributed for the same.

The Gardner-Mackinaw has suffered but one accident the past two years and in token of this record each employee of this mine was awarded a 50 pound sack of flour two days before Christmas. On the same day turkeys were given to the men of the Tilden Mine for establishing a two year perfect record.

There are now employed by the Company 37 men who have records of 30 to 49 years without sustaining a lost time accident. This list includes only those men who have perfect records during the entire duration of employment. There are many more men who have worked 30 years or longer without being injured, whose entire records are not exempted from lost time accidents. The 37 men on the all time honor roll were also given turkeys for Christmas and their records have been given to the Joseph A. Holmes Association in response to a request received from the Bureau of Mines.

Safety Department

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11. ACCIDENTS AND PERSONAL INJURY

c. Safety Activities:(continued)

Safety Bulletin:

A monthly bulletin, dealing entirely upon subjects of safety, was issued and mimeographed copies were distributed to superintendents, captains anf foremen.

First Aid Work:

A total of 145 men were given lessons in first aid education under the direction of Thomas Guy. Of these men, 52 are now working at the Company's Michigan mines, 86 were employed in 1931 at our Minnesota mines and 7 were men working in October at the logging camp of the Land Department.

The number of men employed by the Company has dropped off in recent years and as a consequence, we have lost many first aid men. Many of them worked at mines which became depleted of ore, such as the Lake, Salisbury, Stephenson, etc. With the transfer of the Holmes Mine to the Oliver Mining Co. in 1930, we lost a considerable number. In the following table is given the figures that tell the situation.

TABLE XII

Mine	Total Number of Men Trained	Number Now Employed
Athens	50	35
Negaunee	89	59
Maas	77	37
Cliffs Shaft	82	63
Morris-Lloyd	102	63
Gardner-Mackinaw	48	30
Spies-Virgil	22	18
Tilden	0	11
Holman-Cliffs	8	24
Hill-Trumbull	0	25
Alexandria	0	32
Canisteo-Cliffs	0	7
Shops	8	16
Abandoned Mines	362	
Total	848	420

Safety Department

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11. ACCIDENTS AND PERSONAL INJURY

e. Department Expense

Salaries and expenditures for this department, as tabulated by our Cleveland Office, appear in the following table:

TABLE XIV

Salaries	$ 5,023.46
Auto Expense	275.20
Donations	35.00
Furniture and Fistures	1.52
Heat, Light and Power	6.62
Janitor and Cleaning	2.40
Postage	18.00
Repairs	1.79
Stationery and Printing	122.75
Supplies	44.14
Travel and Entertainment	583.63
Telephone and Telegraph	75.50
General - Unclassified	229.71
Total	6,419.72

Respectfully submitted,

William Coubrough

Assistant Superintendent

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CLIFFS SHAFT MINE:

On Sunday, May 17th, a fire occurred in the underground pump station, cause unknown. Indications were that the fire may have been caused from smoking. This fire caused considerable damage to the pump and electrical equipment. The thrust bearing was damaged and one shaft bearing burned out on the pump. Two oil switches and one starting compensator of the electric equipment were burned.

The #5 McCully crusher in the crusher building was dismantled to make room for an ore chute. This crusher has not been in service for several years. It is stored at the mine.

The hot well in the change house was repaired by placing an old steel tank inside the concrete tank. We expect no more trouble with this tank.

In October the lump ore tram plant was moved to a position near the crusher plant, which is a much better arrangement as all the control equipment can be inspected much easier than in the old location.

All the mechanical equipment at this mine is in very good condition and operated satisfactorily during the past year.

TILDEN MINE:

Loading was started at this mine on April the 16th and finished on October the 21st.

A new main journal bearing was installed in the #2 Locomotive to replace one that was worn out.

There were no changes made to the mechanical equipment at this mine during the year. All mechanical equipment operated in a very satisfactory manner.

There is some repairing to take care of before the Plant is put in operation again. Most of this is replacing worn out parts. The #31 shovel boom needs considerable re-riveting and the crowding machinery needs some attention. The locomotive water tanks are leaking and should be repaired. There is not a very great amount of repair work to do to put the Plant in first class condition.

ATHENS MINE:

On January 11th new weight arms were installed on the skip hoist to replace the old arms, which did not have the proper angle. This change improved the brake on this hoist so that it will hold the loaded skip without slipping.

The cage hoist drum became loose on the shaft. This was repaired on January the 17th by burning a clearance space between the halves of the drum spiders, fitting new keys and shrinking in the spider hub bolts.

On January 24th new cylinder head gaskets were put in the Nordberg air compressor to replace the old gaskets that were leaking.

On the steel stocking trestle several tension channels were found

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ATHENS MINE: (Cont'd)

broken. New and heavier steel was ordered and the necessary repairs were made.

On October 20th the piston rings in the high pressure cylinder of the Ingersoll-Rand air compressor broke. New rings were made at the Hard Ore Shops to replace the broken rings and installed on October 21st. This machine is now in good condition.

All the mechanical equipment at this mine was in good condition at the end of the year.

MAAS MINE:

On January 7th some trouble developed with the crossheads on the third level Prescott pump. New pins and shoe adjusting bolts were made and installed. This repair put the crossheads in good condition again. New pinion shaft bearing shells were installed in this pump to replace the old shells, which were badly worn.

On January 26th a new "Vim" double leather belt, 38'0" x 11", was put on the 4th level Aldrich pump to replace a worn out canvas belt. This "Vim" leather belt is giving very good service and will outwear two canvas belts.

A new nest of tubes was installed in the intercooler on the Ingersoll-Rand compressor to replace a nest that was badly pitted and leaking.

Considerable experimenting has been done with underground pump plungers. The mine water is very dirty and causes a lot of wear on the plungers and packing. We have developed a porcelain plunger that appears to do the trick. This plunger is made up by placing a porcelain sleeve on a cast iron core, with concrete between the sleeve and core. We have at the present time a porcelain plunger in use in an Aldrich pump at this mine that was installed in April, 1927, which shows very little wear, and it was operating on Jan. 1st, 1932, in good condition. Another advantage in using porcelain is that there is less friction and the packing cost is about 50% less than on cast iron plungers.

A small crack developed in the crankshaft of the Aldrich quintuplex pump and this was repaired by electric welding.

The new pump station on the 5th level is almost completed.

All mechanical equipment is in good condition.

NEGAUNEE MINE:

A small air compressor was installed in the Sample Crusher Room so that it will not be necessary to operate the compressor in the engine room on days when the mine is idle.

New type oilers were installed on the 11th level Aldrich pumps, saving about 50% on the oil consumption.

The intercooler on the Ingersoll-Rand air compressor developed a leak. Several of the tubes were badly pitted and the ends of the tubes were completely

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NEGAUNEE MINE:

gone. These tubes were made from 1" galvanized pipe, with the ends turned and a copper ferrule fitted over the end. They were rolled tight in the heads with a boiler tube roller. We tried to use 1" black pipe to replace these tubes, using the same method of fitting them in the heads, but the pipe split in the seams. They would not stand the rolling. We then purchased a complete set of 115 - 1¼" x 12', #13 gauge seamless steel boiler tubes with copper ferrules, 1¼" inside dia., 1-3/8" outside dia., 5/8" wide. These ferrules were placed on the ends of the tubes in the usual manner and rolled tight with a tube roller. It was not necessary to turn the tube ends as they were the proper size when using the copper ferrules. This method of re-tubing the intercooler worked out much better than the old method and is a far better job when finished.

LLOYD MINE:

The grooves in the skip hoist drum were turned as they were badly worn.

All mechanical equipment at this mine is in good condition and operated satisfactorily during the year.

MORRIS MINE:

There were no changes or additions to the mechanical equipment at this mine. Operation was very satisfactory and the equipment is in good condition.

SECTION 6 SHAFT:

All mechanical equipment at this mine operated satisfactorily during the year. No changes or additions.

GARDNER-MACKINAW MINE:

On January 12th the air receiver caught fire, caused by thawing out the blow-off with oiled waste. It was necessary to replace several tubes to put the receiver in good condition again.

A new Allis-Chalmers centrifugal pump was installed on the 5th level. This pump has a capacity of 300 G.P.M. at 165 ft. head.

Several old Diamond Drill holes were encountered in the different stopes in this mine, increasing the flow of water about 200 G.P.M. It was decided to try and stop this flow of water by concreting or grouting the holes. The static pressure on these holes varied from 125 to 470 lbs. per square inch. This pressure was too high to use a regular grouting machine. A machine was built up at the mine by using a piece of 6" extra heavy pipe for a mixing chamber and a boiler test pump to get the required pressure. The holes were completely sealed in the regular manner and the water decreased to normal flow.

All mechanical equipment is in good condition.

SPIES-VIRGIL MINE:

A new Chicago Pump Company bilge pump was installed in the skip pit, size 3", capacity 50 G.P.M., 50 ft. head.

A leak developed between the cylinder and water jacket on the air compressor. New gaskets were put on the heads to repair the leak. In February the main bearing on the low pressure side of the air compressor burned out. This bearing was repaired by re-babbitting.

New oil rings were installed on the pinion shaft of the hoist to replace the old rings, which were badly worn.

New plungers were installed in the No. 208 pump on February 11th. The pinions on both underground pumps were repaired and set in closer to the gears.

The hoist gear became loose on the drum shaft. It was necessary to pull the gear off the shaft and recut the keyway and make a new key. This repair was a temporary job. A new shaft will have to be installed to complete this job.

ALEXANDRIA MINE:

This mine operated four days per week, single shift, from January 1st to August 15th, when it was shut down, and no additional work was carried on except stockpile loading and underground pumping.

Few changes were made to equipment. Two safety features added were a slack rope alarm for skip cable, and a lubricator attachment to main compressed air line leading underground so the miners could be notified quickly through an Ethyl Mercaptan stench if a mine fire occurred.

In March the steam shovel front end was overhauled and should give no trouble for several years. A new 1-1/4" hoisting chain was added in October.

During the summer new ground wires were added to Substation, guard wires were placed over 2200 volt line where it crosses the 22,000 volt system and a new Thyrite lightning arrester was installed in the Substation.

All electric equipment, excepting pumps, was removed from underground in August and stored in the shops. At this time automatic electric starting equipment was installed on the two underground pumps.

In December the power contract was changed from Schedule P-6 to P-7, the minimum charge reduced from 300 to 50 horsepower, and two 50 K.V.A. transformers were installed in the Substation by the Minnesota Power & Light Co. to replace the three 200 K.V.A. transformers.

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BOEING MINE:

Additional equipment was removed during the year as follows:

MONTH	EQUIPMENT	SHIPPED TO
March	50 HP. Motor from top tram.	Canisteo for shop compressor.
May	Two rotary dump cars.	Wade Mine.
July	One " " car.	Holman discharge weir.
September	Three " " cars.	Canisteo for scrap iron storage.
August	Change House lockers.	Village of Hibbing.
August	" " "	Canisteo shops.

The Sullivan compressor with motor and receiver, several rotary dump cars, Change House heating boiler and top tram engine are still stored at this mine.

CANISTEO-CLIFFS MINE:

Stripping was carried on five days each week, double shift, for three and one-half months, and single shift for six months, the months of May and December being used for repairs to equipment.

Changes were made to pit pump installation. As the mine makes 2,000 G.P.M. it was decided only one 7,000 G.P.M. pump was needed. The second pump was removed and stored in warehouse. Two of the three 16" discharge water lines were removed for washing plant. Using only one line increased the friction head approximately 15 lbs. per sq. inch.

At the shops the following machines were installed in addition to those listed in the report for 1930:

1 - 11"x10" Class ER-1 Compressor - new.	from Ingersoll-Rand Co.
1 - 60" Vertical boring mill - second hand.	from Northern Pacific Ry.
1 - Wheel Press, 42" opening, 100 ton/sq.in. Second hand.	from General Wrecking & Equipment Co.
1 - Portable Grinder - new.	
1 - Punch & Shear Machine - second hand.	from Holman Mine shop.
1 - Hydraulic Pit Jack - " "	from Emerman & Co.
1 - 220 cu. ft. Portable Gas Driven Compressor - new.	from Ingersoll-Rand Co.
1 - 20" Upright Drill Press - second hand.	from Pontiac Mine.
1 - 350 G.P.M., 160' head, Centrifugal Fire Pump - new.	from Cameron Ingersoll-Rand Co.

In February two carloads of second hand mine equipment was transferred from the Pontiac Mine at Crosby and stored or used here.

Additional pit equipment purchased during the year was a 1-1/4 yd. gas driven Northwest shovel which was received in February, started in April, used as a shovel all summer and changed to a dragline in November to clean out and dig ditches. It was closed down about December 15th.

Some troubles were experienced with the second hand locomotives purchased from the Oliver Iron Mining Co. In January a new axle was added to rear set of drivers on locomotive #156. In March a new axle on rear drivers was added to locomotive #128. In May it was necessary to add a new wheel center and axle to locomotive #128 and new side sheets to locomotive #176.

CANISTEO-CLIFFS MINE: (Cont'd)

In October a new axle was needed on locomotive #152 due to loose wheel center. In December a main crank pin let go on right side of locomotive #146, breaking the piston, both cylinder heads and bending connecting rod.

The 220 cu. ft. portable gas driven compressor was used at the Holman washing plant all season on bowl classifier hydraulic lift.

Only one breakdown occurred on 120-B electric shovel when a shipper shaft pinion lost a tooth in September. New pinions were put on and a spare set ordered for the four machines in this district.

One churn drill took care of the blasting ahead of electric shovel all season. In August, when the shovel started on bank stripping, the second drill was transferred from the Holman and both machines put on structure drilling.

At the washing plant the Dorr washers were completed in January, and the 16" clean water line to tailings pond in February. It was then decided to keep the plant idle for 1931, so work was stopped and was not started again during the year.

HILL-TRUMBULL MINE:

Ore operations were started June 1st and finished September 30th, with a total of 181,345 tons of concentrates. Most of this was loaded with the 120-B electric shovel, but steam shovels #22, 26 and 27 were used at various rocky areas in east end of pit. Operations were kept on a five-day single shift schedule until August, when the time was reduced to four days per week.

During the spring locomotives #101, 102 and 103 were placed in the shops and new crown brasses installed, the first ones since the machines were bought new in 1920. Due to pit operations it was found necessary to move locomotive #128 from the Canisteo Mine to make up a fourth train. Locomotive #180 was also shipped from the Holman to the Hill-Trumbull, and after repairs were completed it was used as a spare until October, when it was shipped to the Canisteo Mine. No repairs were needed on the 120-B electric shovel, but all the steam machines required some attention. Worn parts on the 20-yd. dump cars were built up with electric welding and some reinforcing added. All pit equipment went through the season with practically no delays.

One improvement made in blacksmith shop during the Fall was bridging the steel work and removing supporting column to improve steam hammer operation.

At the washing plant the receiving pocket was rebuilt and is now long enough to dump a full 30-yd. car. The track at the pocket was raised 2-1/2 ft. and in May a new steel railroad bridge was installed to span the arterial highway in order to eliminate the possibility of auto accidents due to center post as used in the old timber bridge design.

On the tailings pond it was found necessary to add a second line of sprays across the center of the basin to stop all sand from blowing into Calumet. During the Summer the 3/4 yd. gas dragline built up the dykes around basin No. 1 and 2 sufficiently high to last for the next three years. In the Fall brush was placed on the dykes and some sand fences built in an attempt to

HILL-TRUMBULL MINE: (Cont'd)

stop sand from blowing during the Winter, when water is not available to hold it. Some tests were made with crude oil to hold these tailing sands from blowing, but they were not a success.

Few repairs were found necessary to Washing Plant equipment in the Fall. The head sprocket in 8 ft. pan conveyor was built up, a new bevel pinion added to revolving screen and the various motors overhauled and painted. The plant is now in shape for operation next season.

A 10 G.P.M. electric plunger clean water pump was installed in well at Caretaker's cottage, and a pipe line run to washing plant, with fountains installed on each floor to eliminate the use of drinking cups.

HOLMAN-CLIFFS MINE:

The shipping season started June 1st and ended October 16th, with a total of 296,166 tons of concentrates. Operations were on a five-day, single shift basis.

In the pit the sump was completed. A new barrel scow was built large enough to install two centrifugal pumps, one 1600 G.P.M., 200 ft. head, and one 1100 G.P.M., 325 ft. head. These were connected through two flexible rubber sleeves to a 12" discharge line running over the north bank. The pit makes about 1600 G.P.M. and keeps one pump running steady. No pumpmen are needed as a shop man inspects the pumps once every 24 hours to keep them in good condition. The 4200 G.P.M. pump was left on a scow ready for any emergency. A weir box made from a Boeing Mine rotary dump car was placed at pit pipe line discharge and check made weekly to note any change in mine flow.

The two electric shovels gave good service for the season. A steel clevis supporting boom through cables and attached to "A" frame broke on one machine and caused a 10 hour delay, the only delay due to shovel construction. After the season closed it was necessary to build up the links of the caterpillar treads on both machines with electric welder using Hascrome rod. This work was completed in December.

At the shops, in addition to the necessary repairs to our locomotives, the four machines used by A. Guthrie & Co. on stripping were overhauled in the Spring. One big job was rebuilding the pans of 8-ft. conveyor from the washing plant. These pans were badly worn and the links bent out of shape. A new 3/8" plate was welded to the top of the old pans and counter sunk head rivets used.

Some additions were made to the washing plant in the Spring due to research work carried on during the season. A timber structure was added to east side of plant to house a hydrotator equipment built by The Hydrotator Co. of Hazelton, Pa., which was tested during August and September. A six spigot Fahrenwald sizer was set up on log floor, also a Deister electric driven table, and a feed arranged for them through a bucket elevator which took part of the concentrate from one bowl classifier and elevated it to the log floor. In addition to these machines a laboratory size oil flotation equipment was installed on west side of rock bin in the plant and tests run on it during the season. A Newton hydraulic lift was installed on one bowl classifier by the Dorr Company, which required additional compressor capacity. A portable gasoline driven compressor was transferred from the Canisteo Mine to care for this. This testing on the various machines has proven to the research depart-

HOLMAN-CLIFFS MINE (Cont'd)

ment that large savings can be made by changing the present flow sheet and adding new machinery to this plant. This is covered in a separate report made by the research department.

The only change very much needed for next season is to replace the 6 ft. revolving screen, which is in poor condition, with two vibrating screens. A separate report was sent in covering this.

In the Spring the 3/4-yd. gas dragline was moved to the tailings pond from Hill-Trumbull and a dyke erected across the pond near the middle. This dyke gave the water a chance to settle before reaching the washing plant pump sump.

A 10 G.P.M. electric plunger clear water pump was installed in well near the Caretaker's house, a pipe line was laid underground to washing plant and drinking fountains installed for the workmen.

The jaws on 42" x 40" crusher were found badly worn when crusher was dismantled before the season started. These jaws were built up with Hascrome rod and are still in good condition after operating all season.

Some trouble was experienced due to poor mixing of the various ores in concentrator bins. This was corrected with deflecting troughs attached to log discharge.

WADE MINE:

Work was carried on at a four-day week schedule until May 4th, when the mine was closed down and all portable equipment stored on surface. Only pumping has been carried on since that date.

Due to the high temperatures in the air compressor cylinders, it was necessary to clean out the jacket water scale with a bath of muriatic acid. This improved conditions, but may have to be repeated when the mine starts again.

The change house heating boiler flues had to be replaced in February. This boiler is now in good condition. It was not started in the Fall as a coal stove set up in the office supplies all the necessary heat.

After the mine closed a high wind blew down the pulley stand next to the shaft. This was removed so that the hoist could be used in an emergency.

In June it was decided the electric wiring in underground pump station was not safe, and a complete overhauling was made. At the same time new timbers were installed and the ceiling lined with sheet iron. This pump station is now in first class condition.

In August the shaft sump pump motor, burned out and replaced with a spare, was rewound.

MECHANICAL DEPARTMENT
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ELECTRICAL DEPARTMENT:

Cliffs Power & Light Co. service in general has been good, with very few interruptions of any consequence. Our customers all seem to be well satisfied and we are of the opinion that there will be a gradual increase next year and thereafter as compared to the year just closed.

The year covered in this report of operation of The Cliffs Power & Light Co. has, in general, followed the adjustments due to business conditions, and we are fortunate in being able to show a reasonable profit.

Work covered by E. & A. #10, Au Train Storage Dam and Levee, was practically completed, giving us very appreciable increase in storage and an increase of nearly 50% in head. This more than doubles the capacity of this plant.

Work was continued on the repair of the Carp wood pipe line. This is a method developed whereby the wood pipe is encased with reinforced concrete. Collapsible forms are used and the work so systematized that one complete section of 12 feet is completed each day with a force of nine men. This method makes a very economical and permanent job, and, so far as known, is unique in this application.

Due to the favorable weather there was an unusual growth of foliage along our transmission lines and it was necessary to keep several crews busy clearing brush during the summer. These are now all in good condition and we anticipate only a nominal amount during the coming year.

A considerable amount of time has been expended in co-ordinating our regulation to meet the requirements of the Paper Mill connection. We have apparently solved this problem fairly well and think the Paper Mill people are quite well satisfied. Their generator burned out on March 29th, causing an interruption of one month; otherwise this has been continuous.

Our contract with the Munising Paper Company became effective the first of the year and we have received about the minimum each month, which is more than we required due to a reasonable rainfall and falling off in demand at the mines, but mostly because the amount used by the Inland Lime & Stone Co. was only one-half the amount they had estimated.

The amount of current used by the Inland Lime & Stone Co. was practically the minimum under their contract and not sufficient by a half to entitle them to the special rate in the contract.

Sinking operations at the Greenwood Mine of the Inland Steel Co. are completed and we may reasonably expect an increase in revenue from this customer.

The Blueberry Mine of the Ford Motor Co. continued under two-shift operation up to about December 1st, then dropped to single shift. This will only slightly reduce their requirements for current.

The Michigan Gas & Electric Co. have continued as our best customer, but showed a decrease in December due to the Isabella Mine at Palmer shutting down.

Due to business conditions it seemed best to drop the negotiations which were underway to acquire the Village Plant at Newberry. This plant is still being operated by the Village, other interested purchasers having also dropped their negotiations.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1931

ELECTRICAL DEPARTMENT (Cont'd)

The Soo-Edison Company have acquired the St. Ignace Plant and the Manistique system, and are now completing the high tension lines connecting the three places.

The Wisconsin-Michigan Power Co. have made no extensions in the Upper Peninsula this year.

The Victoria Falls Plant is in operation, connecting into Houghton, and the Houghton company have completed and connected their Plant on the Sturgeon River near L'Anse.

An arrangement was made with the Department of Light & Power of the City of Marquette for a connection at our McClure Plant. This anticipates that they will take about 350,000 K.W.H. per month at off-peak periods. Practically all the expense of this connection is being borne by them. The connection is made through a 2,000 K.V.A. substation located near the McClure Plant power house. We hope this will prove quite profitable to us.

Only replacement maintenance in construction was done during the year. This included the following:

New feeder lines for Cliffs Shaft Mine.

New railroad cross-over at D. S. S. & A. tracks on Furnace Line.

Rebuilt Maas end of Negaunee-Athens feeders.

Lining tunnel at pressure tank in Escanaba Plant penstock.

Repair water wheel and intake basin at Republic Plant.

Re-wind one generator at McClure Plant. (Burned out Sept. 20th)

Repair 3 - 200 K.V.A. transformers at Au Train-Munising Substation. (Burned out July 27th)

Erect two steel towers blown over on North Lake line.

Repair gate valve #1 at McClure Plant.

MECHANICAL DEPARTMENT
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Electrical Department: (Cont'd)

Summary of Operation Conditions - 1 9 3 1 .

Month	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Precipitation -	1.01	1.24	1.79	1.89	2.35	4.86	5.93	1.71	6.34	4.38	4.11	1.09"

Total Precipitation at Ishpeming during 1931 - 36.70"
Average " " Marquette - 32.8" (46 year record)

CARP RIVER PLANT:

Drainage area above Intake Dam,	66.66	sq. miles
Cubic feet Precipitation in 1931,	5,686,624,900	
Kilowatt Hours generated in 1931,	9,257,900	
Cubic feet water utilized (90 cu. ft. = 1 KWH.)	833,211,000	
" " " in Carp Storage Basin Jan. 1, 1931,	215,812,400	
" " " " " " " Dec.31, "	416,495,300	
" " " stored in 1931,	200,682,900	
" " " wasted over Intake Dam in 1931,	712,764,000	
Total run-off for the year 1931,	1,746,657,900	cu. ft.
Run-off per square mile of drainage area,	26,189,000	" "

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
Total Precipitation,	30.11	26.53	38.40	36.83	25.46	31.05	29.50	27.40	30.38	33.67
Sec.ft.per sq.mi. run-off,	1.03	.67	.93	1.29	.70	.79	.83	.73	.68	1.06

	1923	1924	1925	1926	1927	1928	1929	1930	1931
Total Precipitation,	21.90	22.95	20.71	35.69	29.86	36.06	32.28	23.14	36.70
Sec.ft.per sq.mi. run-off	.59	.50	.25	.85	.98	1.11	.67	1.10	.83

McCLURE PLANT:

Drainage area above Intake Dam,	140.52	sq. miles.
Cu. ft. Precipitation in 1931, (Hoist Plant - 37.02")	12,065,816,100	
Kilowatt Hours generated at McClure Plant in 1931,	22,239,400	
Cubic feet water utilized, (125 cu. ft. = 1 KWH.)	2,779,925,000	
" " " wasted over Intake Dam in 1931,	559,872,000	
" " " in Hoist Storage Basin Jan. 1, 1931,	694,301,400	
" " " " " " " Dec.31, "	1,901,359,200	
" " " stored in 1931,	1,207,057,800	
" " " in Silver Lake on Jan. 1, 1931,	403,934,500	
" " " " " " " Dec. 31, "	746,194,000	
" " " stored in 1931,	342,259,500	
Total run-off for the year 1931,	4,889,114,300	cu. ft.
Run-off per square mile of drainage area,	34,793,000	" "

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
Sec. ft. per sq.mi. run-off	1.22	1.02	1.54	0.85	0.92	0.52	1.52	1.80	2.22	1.36	1.45	1.10

THE CLIFFS POWER & LIGHT CO.

SUMMARY OF OPERATIONS - 1931.

	KILOWATT HOURS GENERATED & PURCHASED								Used by Auxiliaries	Delivered to Line	KWH. Sold	Transmission Losses	
	McClure	Carp	Hoist	Au Train	Republic	Escanaba	Purchased	TOTAL				K.W.H.	%
Jan.	2,731,600	750,500	871,000	194,870	60,800	194,000	406,000	5,208,770	14,987	5,193,783	4,488,144	705,639	13.58
Feb.	2 556 900	659 700	783 000	152 460	54 200	174 000	712 000	5 092 260	15 226	5 077 034	4 432 175	644 859	12.70
March	2 135 000	975 600	697 000	157 170	49 900	172 000	658 000	4 844 670	12 540	4 832 130	4 194 980	637 150	13.18
April	1 784 600	1 623 900	545 000	488 280	178 400	599 000	121 000	5 340 180	12 134	5 328 046	4 627 586	700 460	13.14
May	1 355 900	770 000	414 000	634 320	404 200	648 000	552 000	4 778 420	9 330	4 769 090	4 045 916	723 174	15.16
June	1 532 800	569 400	524 000	647 000	303 800	63 000	720 000	4 360 400	12 483	4 347 917	3 780 722	567 195	13.04
July	1 605 200	658 800	552 000	425 880	238 100	83 000	624 000	4 186 980	10 226	4 176 754	3 530 086	646 668	15.48
Aug.	1 937 200	499 500	736 000	274 880	13 900	213 000	422 000	4 096 480	12 121	4 084 359	3 441 986	642 373	15.72
Sept.	2 294 400	378 700	773 000	146 550	10 000	140 000	441 000	4 183 650	13 186	4 170 464	3 510 257	660 207	15.83
Oct.	1 453 300	991 800	561 000	91 570	118 100	429 000	570 000	4 214 770	11 524	4 203 246	3 575 393	627 853	14.93
Nov.	1 509 700	788 900	614 000	63 400	227 700	322 000	653 000	4 178 700	11 705	4 166 995	3 551 603	615 392	14.76
Dec.	1 342 800	591 100	445 000	62 820	242 700	261 000	757 000	3 702 420	11 363	3 691 057	3 074 137	616 920	16.71
TOTAL	22,239,400	9,257,900	7,515,000	3,339,600	1,901,800	3,298,000	6,636,000	54,187,700	146,825	54,040,875	46,252,985	7,787,890	14.41

Republic Plant idle July 28th to Sept. 19th. Broken runner in large water wheel.

MECHANICAL DEPARTMENT

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MECHANICAL DEPARTMENT
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Electrical Department: (Cont'd)

The following alternating current motors are installed and operating as needed:

	INSTALLED TO JAN. 1, 1931	INSTALLED IN 1931	TAKEN OUT IN 1931	CONNECTED JAN. 1,1932 TOTALS
ANGELINE MINE:				
Hoist	250 HP.			250 HP.
CLIFFS SHAFT MINE:				
Shop	25			
No. 8 Crusher	125			
Screens	15			
Top Tram	100			
Hoist for "A" Shaft	750			
Underground Plunger Pump #1	180			
" Centrifugal Pump	250			
Allis-Chalmers Compressor	175			
Hoist for "B" Shaft	750			
Underground Plunger Pump #2	200			
Laboratory Crusher	5			
Coal Crushing Plant Exhaust Fan	1/2			
Cooling Water Pump for Compressors	10			
Ingersoll-Rand Compressor #1	400			
" " " #2	400			
Lower Tram #2	50			
Heating Plant Condensing Water Pump	2			
Underground Haulage Set #2	215			
Small Hoist in Crusher Building	15			
Conveyor Belt - New Crushing Plant - 1 motor	20		20	
Jaw Crusher - " " "	75			
Magnetic Separator " " "	1½			
Underground Scrapers - 50 - 25 HP. motors	1300		50	
Lower Tram #3	30			
Battery Charging Set, 2nd level "A" Shaft	7½			
Grinder in Drill Sharpening Shop	7½			
Rotary Screen	10			
Boiler Feed Pump at Central Office	3/4			
Undg. Haulage Set #1 (from Gen. Storehouse)	150			
Carpenter Shop	25			
Return Water Pump at Central Office	1			5,225¾
BROWNSTONE SUBSTATION:				
Test Set	1/2			
Oil Filter Press		1/4		
Battery Charging Motor-Generator Set	3			
Commutator Grinder	1			
Synchronous Condenser	80			
M.G. Set on Voltage Regulator Control	1/4			
Large Oil Filter Press	2			
Drill	1			88
fwd.	5,633½ HP.	1/4	70 HP.	5,563¾ HP.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1931

Electrical Department: (Cont'd)

	INSTALLED TO JAN. 1, 1931	INSTALLED IN 1931	TAKEN OUT IN 1931	CONNECTED JAN. 1,1932 TOTALS
brt. fwd.	5,633½ HP.	1/4	70 HP.	5,563¾ HP.
HARD ORE SHOPS:				
Machine Shop	10			
Carpenter Shop	25			
Blacksmith Shop Punch	3			
Armature Banding Machine	2			
" " "	1/2			
" " "	1/8			
Lathe Grinder	1			
Portable Drill - small (Stanley)	1/4			
" " - large	1/4			
Commutator Slotter	1/8			
Air Compressor	10½			
Water Supply Pump	7½			
Blacksmith Shop Blower	1/4			
Hacksaw	1/2			
Small Grinder	1/4			
Portable Drill (Stanley)	1			
Carpenter Shop Saw		25		
				87¼
ISHPEMING HOSPITAL:				
Passenger Elevator	7½			
Dumb Waiter	3			
Large Washer	2			
Small "	1			
Extractor	2			
Vacuum Cleaner	3			
Water Supply Pump	1			
Xray Machine	1/4			
Hot Water Circulating Pump	1/2			
" " Return - high pressure	5			
" " " - low "	1½			
Vacuum Pump	3			
				29¾
fwd.	5,725½ HP.	25¼ HP.	70 HP.	5,680¾ HP.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1931

Electrical Department: (Cont'd)

	INSTALLED TO JAN. 1, 1931	INSTALLED IN 1931	TAKEN OUT IN 1931	CONNECTED JAN. 1,1932 TOTALS
brt. fwd.	5,725½ HP.	25¼ HP.	70 HP.	5,680¾ HP.
TILDEN MINE:				
Compressor	150			
Centrifugal Pump	275			
Scraper on Coal Dock	15			
#29 Shovel - Motor-Generator Set	110			
" - Air Compressor	4½			
" - Oil Pump	1/4			
" - Trip Motor	2			
" - Exciter Motor	10			
Cyclone Drills - 1 - 10 HP.	20		10	
" " - 4 - 15 HP.	45	15		
Car Dumper	30			
Large Crusher	250			
Car Puller	10			
Sample Crusher	3			
Belt Conveyor	50			
Secondary Crushers - 2 - 100 HP.	200			
Small Hoist over Crusher	3			
#31 Shovel - Motor-Generator Set	110			
" - Exciter Motor	7½			
" - Trip "	1¼			
" - Air Compressor	5¾			
Drill Sharpener	15			
Pump for Drills	15			
Synchronous Condenser from P.C.P.Plant	625			
Shop Motor	5			
" " #2	3			
Scraper	50			
Armstrong Drill	15			
Blower Fan		1/2		2,035¾
ATHENS MINE:				
Cage Hoist	400			
Compressor - Nordberg	325			
Compressor Cooling Water Pump	3			
Auxiliary Compressor for Hoist Brakes	5			
Underground Ventilating Fan #1	15			
Sinking Pump - 2400' station	50			
Skip Hoist Set	850			
" " " Oil Pump	1			
Shop	10			
Underground Haulage Conveter	150			
Skip Pit Pump	2			
Laboratory Crusher	5			
Underground Plunger Pumps - 2 - 400 HP.	800			
Ore Tram - 2 - 50 HP.	100			
Carpenter Shop	20			
Ore Crusher	25			
Battery Charging Motor-Generator Set	1/4			
Underground Ventilating Fan #2	50			
Ingersoll-Rand Compressor	450			
Rock Tram	50			
Undg. Haulage Converter #2 (from Francis Mine)		150		3,461¼
fwd.	11,067 HP.	190¾ HP.	80 HP.	11,177¾ HP.

MECHANICAL DEPARTMENT
ANNUAL REPORT
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Electrical Department: (Cont'd)

	INSTALLED TO JAN. 1, 1931	INSTALLED IN 1931	TAKEN OUT IN 1931	CONNECTED JAN. 1,1932 TOTALS
brt. fwd.	11,067 HP.	190¾ HP.	80 HP.	11,177¾ HP.
MAAS MINE:				
Turbine Auxiliaries (Circulating Pump	40			
Turbine Auxiliaries (Injection "	25			
Turbine Auxiliaries (Exciter	33			
Underground Haulage Set	215			
Shop	10			
Underground Centrifugal Pump	350			
" Hoist (Stored in Ish. Barn)	50		50	
" Plunger Pump #1	325			
Compressor Cooling Water Pump	5			
Ore Tram - 2 - 50 HP. motors	100			
Coal Crushing Plant	15			
Underground Plunger Pump #2	250			
Ingersoll-Rand Compressors - 2 - 400 HP.motors	800			
Skip Hoist	700			
Cage "	400			
Boiler Room Fan	1/2			
Skip Hoist Rheostat Pump	3			
Carpenter Shop Saw	15			
Auxiliary Compressor for Hoist Brakes	7½			
4th Level Pump	50			
Cooling Water Pump	5			
Triplex Pump, 4th Level	50			
Centrifugal Pump, 4th Level	40			
Saw Gumming Outfit in Carpenter Shop	2			
Underground Haulage Set #2 (from Neg. Mine)	215			
Return Water Pump in Heating Plant	2			
Aldrich Pump, 4th Level (from Boeing Mine)	100			
Centrifugal Pump, 3rd Level (from Francis Mine)	400			
" " " " - primer	50			
				4,208
NEGAUNEE MINE:				
Underground Haulage Set #1	300			
"Ilgner" Hoist Set	450			
Top Tram - 2 - 50 HP. motors	100			
Laboratory Crusher	5			
Auxiliary Compressor for Hoist Brakes	3			
Udg. Plunger Pumps -2 - 300 HP. motors	600			
" Centrifugal Pump	350			
" Suction Pumps 2 - 15 HP. motors	30			
Compressor Cooling Water Pump	3			
Nordberg Air Compressor	325			
Shop	15			
Ore Crusher	25			
Ingersoll-Rand Compressor	400			
13th Level Plunger Pump	15			
11th " " Pumps - 2 - 75 HP. motors	150			
Exciters for 10th level Pump Motors (2)	40			
Signal System Motor-Generator Set	1/2			
Timber Hoist - #2 Shaft	25			
Ventilating Fan - " "	150			
Gravel Hoist	15			
Saw in Carpenter Shop	15			
Skip Pit Pump	3			
Underground Haulage Set #2	220			
fwd.	15,325 HP.	190¾ HP.	130 HP.	15,385¾ HP.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1931

Electrical Department: (Cont'd)

	INSTALLED TO JAN. 1, 1931	INSTALLED IN 1931	TAKEN OUT IN 1931	CONNECTED JAN. 1,1932. TOTALS
brt. fwd.	15,325 HP.	190¾ HP.	130 HP.	15,385¾ HP.
NEGAUNEE MINE: brt. fwd.	3,239½			
New Flywheel Set for Hoists	800			
Oil Pump on #2 Flywheel Set	1			
" " " " " "	1			
" " " Nordberg Compressor	1			
Hot Well Pump		2		
				4,044½
MAAS CRUSHING PLANT:				
Jaw Crusher	100			
Belt Conveyor	50			
Pan Conveyor Motor-Generator Set	50			
				200
SOUTH JACKSON CRUSHING PLANT:				
Hoist	75			
Crusher	150			
				225
BARNES-HECKER MINE:				
Skip Hoist	400			
				400
LLOYD MINE:				
Skip Hoist	400			
Cage "	400			
Top Tram	40			
Ore Crusher	25			
Water Supply Pump installed uhderground	50			
Concrete Mixer	5			
Top Tram	50			
				970
MORRIS MINE:				
Skip Hoist	600			
Cage "	400			
Shop	25			
Ingersoll-Rand Compressor #1	250			
4th Level Plunger Pumps - 2 - 350 HP. motors	700			
7th " " Pump	100			
" " Centrifugal Pump	175			
Laboratory Crusher	5			
Carpenter Shop	25			
Nordberg Air Compressor	325			
Carpenter Shop Boring Machine	5			
Top Tram - 2 - 50 HP. motors	100			
Underground Haulage Set #1	150			
Centrifugal Water Supply Pump	50			
Heating Plant Condensing Water Pump	2			
Ingersoll-Rand Compressor #2	500			
Planer in Carpenter Shop	15			
Crusher	25			
Underground Haulage Set #2	215			
Aldrich Triplex Pump	50			
8th level Pump	100			
Compressor Cooling Water Pump		3		
				3,820
SECTION 6 SHAFT:				
Hoist	200			
Water Supply Pump (to Morris Mine)	3		3	
				200
fwd.	25,182½ HP.	195¾	133	25,245¼ HP.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1931

Electrical Department: (Cont'd)

	INSTALLED TO JAN. 1, 1931	INSTALLED IN 1931	TAKEN OUT IN 1931	CONNECTED JAN. 1, 1932 TOTALS
brt. fwd.	25,182½ HP.	195¾ HP.	133 HP.	25,245¼ HP.
GWINN CRUSHING PLANT:				
Crusher	85			
Pan Conveyor	50			
Belt Conveyor	40			
Compressor	15			
" Cooling Water Pump	3			
				193
FRANCIS MINE STOCKPILE:				
Triplex Pump	7½			
				7½
GARDNER MINE:				
Hoist	400			
Top Tram	50			
Laboratory Crusher	3			
				453
MACKINAW MINE:				
Hoist	400			
Shop	7½			
Top Tram	50			
Underground Haulage Set	150			
Air Compressor	325			
Compressor Cooling Water Pump	7½			
Underground Quintuplex Pump	350			
" Triplex "	75			
5th level Pump (Automatic) from Stephenson	30			
Winze Hoist (From Morris Mine)	200			
				1,595
PRINCETON MINE #2:				
Hoist	200			
Top Tram	50			
Stockpile Loader	25			
				275
PRINCETON MINE #3:				
Hoist	75			
				75
STEPHENSON MINE:				
Skip Hoist	400			
				400
PRINCETON CENTRAL POWER PLANT:				
Turbine Auxiliaries (Circulating Pump	50			
(Injection "	40			
(Exciter	33			
Boiler Room Fan	50			
Coal Handling Machinery	10			
" " "	5			
				188
PRINCETON CENTRAL SHOPS:				
Shop Motor	25			
				25
PRINCETON CENTRAL PUMP STATION:				
Centrifugal Pump	100			
Automatic Pump	30			
				130
fwd.	28,524 HP.	195¾	133	28,586¾ HP.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1931

Electrical Department: (Cont'd)

	INSTALLED TO JAN. 1, 1931	INSTALLED IN 1931	TAKEN OUT IN 1931	CONNECTED JAN. 1, 1932 TOTALS
brt. fwd.	28,524 HP.	195¾ HP.	133 HP.	28,586¾ HP.
REPUBLIC MINE:				
Auxiliary Compressor for Hoist Brakes	5			
#9 Shaft Hoist Motors - 2 - 500 HP. motors	1,000			
" " Ore Tram - 2 - 50 " "	100			
Booster Compressor (Stored in Ish. Barn)	200		200	
				1,105
CARP PLANT:				
Auxiliaries - 2 - 15 HP. pump motors	30			
Water Supply Pump	1			
Air Compressor	5			
				36
HOIST PLANT:				
Exciter Motor-Generator Set	20			
Oil Pump	3			
Air Compressor	5			
Small Supply Hoist Motor		3		
				31
McCLURE PLANT:				
Water Supply Pump	2			
Exciter Motor-Generator Set	17½			
Air Compressor	5			
				24½
ESCANABA PLANT:				
Air Compressor	5			
Oil Pump	5			
Valve Operating Motor	1			
				11
AU TRAIN DAM: (Construction Job)				
Air Compressor (stored Ishpeming Barn)	50		50	
Centrifugal Pump " " "	100		100	
" " " " "	20		20	
Concrete Hoist " " "	50		50	
" Mixer " " "	10		10	
Centrifugal Pump " " "	125		125	
Water Supply Pump (stored at Au Train)	5		5	
				0
TOTAL MINING DEPARTMENT and CLIFFS POWER & LIGHT CO.	30,288½ HP.	198¾ HP.	693 HP.	29,794¼ HP.

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1931

Electrical Department: (Cont'd)

	INSTALLED TO JAN. 1, 1931	INSTALLED IN 1931	TAKEN OUT IN 1931	CONNECTED JAN. 1,1932 TOTALS
TOTAL MINING DEPARTMENT and CLIFFS POWER & LIGHT CO.	30,288½ HP.	198¾ HP.	693 HP.	29,794¼ HP.
PIONEER FURNACE:				
Furnace & Sawmill	1,195			1,195
L. S. & I. RR. CO.				
Shops, Sawmill, Ore Dock & Pumps	800			800
LAND DEPARTMENT:				
Grand Island - 3 motors	15½			15½
LUMBERING DEPARTMENT: (Dixon)				
Location Water Supply Pump	5			
Tie Mill Saw		75		
" " Conveyors	37			
" " Shop	10			127
MICHIGAN GAS & ELECTRIC CO:				
Ishpeming	2,170			
Munising	250			
Munising City Pumping	125			2,545
REPUBLIC TOWNSHIP:				
Water Supply Pump	25			25
OLIVER IRON MINING COMPANY:				
Pumps at Angeline & Sec. 16 Mines	525			
Air Compressor at Section 16 Mine	700		700	
Holmes Mine	2,552½			3,077½
CITY OF ISHPEMING:				
Booster Pump at Brownstone	15			15
CITY OF NEGAUNEE:	435			435
THE CLIFFS ELECTRIC CO.	100 Est.			100
PALMER MINING COMPANY:				
Volunteer Mine, Palmer	800			800
EMPIRE-QUINN MINING COMPANY:				
Archibald Mine, Gwinn	1,952		1,952	0
MUNISING WOODENWARE CO.	695			695
FORD MOTOR COMPANY:				
Blueberry Mine	1,165			1,165
INLAND STEEL CO., Greenwood Mine	400	50		450
INLAND LIME & STONE CO., Quarry & Dock	4,000			4,000
TOTAL OUTSIDE LOAD	17,972	125	2,652	15,445 HP.
GRAND TOTAL CONNECTED LOAD	48,260½ HP.	323¾ HP.	3,345 HP.	45,239¼ HP.

Electrical Department: (Cont'd)

The following motors are not connected to our Power System:

	INSTALLED TO JAN. 1, 1931	INSTALLED IN 1931	TAKEN OUT IN 1931	CONNECTED JAN. 1,1932 TOTALS
MESABA RANGE:				
BOEING MINE:				
Air Compressor	225 HP.			
Top Tram (to Canisteo Mine)	50		50	
Blacksmith Shop Fan	1/4			
				225¼ HP.
CANISTEO MINE:				
Centrifugal Pumps - 1 - 600 HP. motors	1,200		600	
Priming Pump	3			
Shop	10			
Washing Plant Air Compressor	50			
Belt Conveyors 4 - 5 HP. motors	20			
Jaw Crusher	100			
Centrifugal Pumps 2 -125 "	250			
Symons Crushers 2 100 " "	200			
Belt Conveyor	75			
Dorr Washers 2 - 75 " "	150			
" " 2 - 30 " "	60			
Armstrong Drills 2 - 15 " "	15	15		
Centrifugal Pumps 2 - 25 " "	50			
Portable Drill	1/2			
Hacksaw	1/2			
Wood Planer	3			
Band Saw - replaced with 5 H.P.	3	5	3	
Circular Saw	5			
Shaper	3			
Dorr Classifiers 2 - 5 HP. motors	10			
Clear Water Pumps 2 - 3 " "	3	3		
Motor-Generator Set on Shovel	250			
Exciter Set " "	20			
Dipper Trip " "	2			
Fan	3			
Heater Motors 6 - 1/2 " "	3			
" " 8 - 1/8 " "	1			
Bolt & Pipe Machine		5		
Machine Shop Planer		10		
Boring Machine		15		
Pressure Pump in Boiler House		30		
Shop Air Compressor		50		
Portable Grinder		1		
Bench Grinders - 2 - 1 HP. motors		2		
Washing Plant Feed Water Pump (from Wade)		100		
Blacksmith Shop Forge		1/4		
Electric Welder		15		
				2,138¼
CROSBY MINE:				
Log Washer	40			
Screen	20			
Picking Belt	3			
Chip Screen	3			
Tables	20			
Stockpile	7½			
Centrifugal Pump	85			
#2 Turbo	20			
Feeder	20			
				218½
fwd.	2,983¾ HP.	251¼	653	2,582 HP.

Electrical Department: (Cont'd)

		INSTALLED TO JAN. 1, 1931	INSTALLED IN 1931	TAKEN OUT IN 1931	CONNECTED JAN. 1,1932 TOTALS
	brt. fwd.	2,983¾ HP.	251¼ HP.	653 HP.	2,582 HP.
HOLMAN-CLIFFS MINE:					
Layne & Bowler Pump		350			
Bench Grinder		1/4			
Portable Drill		1/4			
Belt Conveyor		75			
Symons Crusher	2 - 100 HP. motors	200			
Jaw Crusher		100			
Dorr Classifiers	2 - 10 " "	20			
Air Compressor		50			
Screen		25			
Centrifugal Pumps	2 - 125 " "	250			
Picking Belts	2 - 5 " "	10			
Centrifugal Pump		85			
Machine Shop		30			
Priming Pump		2			
Exhaust Fan		1/2			
Centrifugal Pump		275			
Blacksmith Forge Fan		1/2			
Motor-Generator Set		225			
Blacksmith Shop		10			
Undg. Haulage Set (from Boeing Mine)		150			
Locomotive Water Tank Pump (changed to 20 HP.)		3	17		
Clear Water Pump, Washing Plant		3			
Armstrong Drills	2 - 15 HP. motors	30			
Hummer Screen		5			
Bench Grinder		1/4			
Portable Grinder		1			
Shop Heaters	2 - 1/2 " "	1			
" "	10 - 1/8 " "	1¼			
Roll Motor in Main Laboratory		3			
Pulverizer in " "		1			
Fan " " "		1/8			
Ro-Tap " " "		1/2			
Air Compressor " "		1½			
Roll Motor in Washing Plant Laboratory		5			
Pulverizer " " " "		1			
Fan		1/8			
Motor-Generator Sets on Shovels	- 2 - 250 HP.	500			
Exciter Sets " "	- 2 - 20 HP.	40			
Dipper Trip " "	- 2 - 2 HP.	4			
Fans	- 2 - 3 HP.	6			
Laboratory Heater (from Hill-Trumbull)			1/8		
Portable Drill			1/4		
Flotation Machine	- 8 - 1/4 HP.		2		
Hydrotator			15		
" from Hill-Trumbull screen			20		
Centrifugal Pump at Pit			125		
Sump Pump			5		
					2,649½
	fwd.	5,449 HP.	435½ HP.	653 HP.	5,231½ HP.

MECHANICAL DEPARTMENT
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Electrical Department: (Cont'd)

	INSTALLED TO JAN. 1, 1931	INSTALLED IN 1931	TAKEN OUT IN 1931	CONNECTED JAN. 1,1932. TOTALS
brt. fwd.	5,449 HP.	435½ HP.	653 HP.	5,231½ HP.
HILL-TRUMBULL MINE:				
Log Washer	50			
" "	40			
Belt Conveyors - 4 - 5 HP. motors	20			
Crusher	100			
Sample Crusher	10			
Prescott Plunger Pump	125			
Centrifugal Pump	150			
Tables	20			
Shops	30			
Punch & Shear Machine in Shop	5			
BandSaw in Carpenter Shop	5			
Compressor in Shop	50			
Screen	20			
Conveyor	100			
Planer in Shop	2			
Variety Saw in Shop	5			
Electric Drill	1/4			
Motor-Generator Set	65			
Blacksmith Shop Fan	1/4			
Drill	1/4			
Keystone Drill (to Canisteo vert. boring mill)	15		15	
Washing Plant Laboratory Rolls	3			
Picking Belt	5			
Car Puller	7½			
Portable Grinder	1			
North Pit Pump	30			
Air Compressor at Washing Plant	25			
Churn Drill	10			
Boiler Feed Pump	5			
Chip Screens 2 - 2 HP. motors	4			
Layne & Bowler Pump	125			
Tool Post Grinder	1/4			
Electric Welder	15			
Armstrong Drill	15			
Clear Water Pump	3		3	
Rack Drives on Classifiers 2 - 10 HP. motors	20			
Hummer Screen	2			
Pulverizer in Laboratory	1			
Fan " "	1/8			
Symons Crushers 2 100 " "	200			
Bench Grinder	1/2			
Motor-Generator Set on Shovel	250			
Exciter " "	20			
Dipper Trip " "	2			
Fan	3			
Fan for Blacksmith Shop		5		
Clear Water Pump		3		
Flue Machine		5		
				1,555
fwd.	7,009 HP.	448½ HP.	671 HP.	6,786½ HP.

MECHANICAL DEPARTMENT
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YEAR 1931

Electrical Department: (Cont'd)

	INSTALLED TO JAN. 1, 1931	INSTALLED IN 1931	TAKEN OUT IN 1931	CONNECTED JAN. 1,1932. TOTALS
brt. fwd.	7,009 HP.	448½ HP.	671 HP.	6,786½ HP.
WADE MINE:				
Hoist	125			
Air Compressor	150			
Compressor Cooling Water Pump	2			
Underground Haulage Set	150			
Machine Shop	10			
Underground Triplex Pump	50			
" Centrifugal Pump (to Canisteo)	100		100	
Top Tram	50			
Clear Water Pump	15			
Blacksmith Shop Fan	3			
Sump Pump	7½			
Sinking Hoist	35			
Underground Centrifugal Pump	125			
" Fan	15			
				737½
TOTAL MESABA RANGE MINES	7,846½ HP.	448½ HP.	771 HP.	7,524 HP.
SPIES-VIRGIL MINE:				
Underground Triplex Pump	50			
Crusher	50			
Air Compressor	403			
Compressor Cooling Water Pump	3			
Hoist	400			
Boiler Feed Pump	2			
Circular Saw in Carpenter Shop	25			
Shop	5			
Compressor Cooling Water Pump	3			
Undg. Plunger Pumps, 8th level (2)	300			
Underground Haulage Converter	150			
Sump Pump		2		
TOTAL				1,393 HP.

MECHANICAL DEPARTMENT
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Electrical Department: (Cont'd)

The following A.C. motors are on hand, (Dec. 31, 1931) but are not installed:

CLIFFS SHAFT MINE:		
Top Tram (stator only)	50 HP.	
Spare Top Tram	50	
" " "	50	
Small Conveyor Motor	2	
Scraper Motors 8 - 25 HP.	200	
Crusher	25	
Battery Charger from Republic	30	
		407 HP.
GENERAL STOREHOUSE & BARN:		
Spare from Republic concrete mixer	5	
" General Electric pump	50	
" " " Motor-Generator Set (Morris-Lloyd)	150	
" from Hard Ore #3 plunger pump	35	
Bag Cleaner from D.R.Storage Dam	1/2	
Spare for Centrifugal Pump used at North Lake	200	
" Motor	40	
Portable Hoist from Republic Mine	7½	
Pump Motor " " "	10	
2 - 500 HP. Hoist Motors from Cliffs Shaft Mine	1,000	
Hoist Stator only " " " "	500	
Feeder Belt " " " "	5	
Conveyor Belt " " " "	20	
Motor-Generator Set from Tilden Mine	15	
South Jackson Compressor	100	
Pump from Au Train	125	
Concrete Mixer from Au Train	7½	
Picking Belt " " "	5	
Leach Concrete Mixer	10	
Air Compressor from Republic Mine	200	
Pump from 11th level Republic Mine	7½	
Carpenter Shop from " "	20	
Undg. Hoist " " "	50	
" " " Maas Mine	50	
Air Compressor " Crosby Mine	50	
Concrete Hoist " Au Train Dam	50	
Centrifugal Pump " " " "	20	
" "	2	
" " " Republic Mine	20	
Cyclone Drill " Tilden "	10	
Pump " Au Train Dam	100	
" " Republic Mine	50	
" " " "	7½	
		2,922½
LAKE MINE CHANGE HOUSE:		
Ventilating Fan from Salisbury Mine	7½	
		7½
ISHPEMING HOSPITAL:		
Spare for Dumb Waiter	3	
" " Hot Water Return	5	
		8
ATHENS MINE:		
Pump Motor	35	
Fan "	40	
		75
MAAS MINE:		
Winze Pump	15	
Pump (from Morris Mine)	50	
Hoist Motor from Stephenson Mine	75	
Pump Motor	75	
Rheostat Pump	2	217

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Electrical Department: (Cont'd)

		brt. fwd.	
			3,637 HP.
NEGAUNEE MINE:			
	Flywheel Hoist Set Motor	350	
	Top Tram	50	
			400
MORRIS-LLOYD MINE:			
	Centrifugal Pump Motor (from McClure Plant)	50	
	Top Tram	40	
			90
PRINCETON MINE:			
	Underground Pump	150	
			150
PRINCETON CENTRAL SHOPS & CENT. POWER PLANT:			
	Grinder	3	
	Austin Hoist Motor	200	
	" Top Tram	25	
	Fire Pump.from Mackinaw	20	
	Top Tram " Stephenson	50	
	Rock " " "	25	
	Ore " " "	50	
			373
GWINN STORAGE SHED & STEPHENSON TRANSFER:			
	Stephenson 5th level Plunger Pump	250	
	" " " " "	250	
	" 8th " " "	50	
	" 6th " Centrifugal Pump	125	
	Top Tram from Gardner	25	
	" " " Stephenson	50	
			750
GARDNER-MACKINAW MINE:			
	Prescott Centrifugal Pump	400	
			400
TILDEN MINE:			
	Conveyor Belt	50	
	Trip Motor for Shovels	1¼	
	Water Supply Pump	2	
			53¼
REPUBLIC MINE:			
	Spare	30	
	Screen from #9 Shaft	25	
	Crusher	100	
	Coal Tram	7½	
	Pump from bottom level #9 Shaft	20	
	" " 3rd level	50	
	Screen from Crusher	10	
	Underground Hoist	100	
			342½
	TOTAL		6,195¾ HP.

Spare motors at Spies-Virgil Mine:			
	Underground Haulage Set	150	
	Grinder Motor	3	
	TOTAL		153 HP.

MECHANICAL DEPARTMENT
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Electrical Department: (Cont'd)

Spare motors on Mesaba Range:

HILL-TRUMBULL MINE:		
Log Washer	25 HP.	
Pump	3	
Picking Belt	2	
Spare	3	
		33 HP.
CANISTEO MINE:		
Band Saw	5	
Crosby Mine Planer	3	
Spare Pump from Salisbury Mine	30	
		38
HOLMAN-CLIFFS MINE:		
Shaft Pump	150	
		150
TOTAL		221 HP.

Total C.C.I.Co. & C.P.&L.Co. load connected to Power System - 12/31/31 - 29,794¼ HP.

" Outside " " " " " " - 15.445 HP.

TOTAL CONNECTED LOAD 45,239¼ HP.

Total connected load at Mesaba Range Mines - Dec. 31st, 1931 - 7,524 HP.

" " " " Spies-Virgil Mine - " 1,393 HP.

Total spare motors on hand Dec. 31, 1931 - Ishpeming District - 6,195¾ HP.

" " " " " " " " - Spies-Virgil Mine - 153 HP.

" " " " " " " " - Mesaba Range Mines - 221 HP.

MECHANICAL DEPARTMENT
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Electrical Department: (Cont'd)

The following direct current generators and exciters are installed and operating as needed:

		INSTALLED TO JAN. 1, 1931	INSTALLED IN 1931	TAKEN OUT IN 1931	JAN. 1, 1932 TOTALS
AU TRAIN WATER POWER PLANT:					
Exciters	(2)	34 KW.			34 Kw.
CARP RIVER WATER POWER PLANT:					
Exciters	(2)	150			150
HOIST PLANT:					
Exciter		17½			
"		37			54½
McCLURE PLANT:					
Exciters	(2)	110			
M. G. Exciter		12			122
MAAS PLANT:					
Motor Driven Exciter		22½			
Turbo " "		22½			
Compressor Motor Exciters	(2)	20			65
ESCANABA PLANT:					
Exciter		28			28
PRINCETON CENTRAL POWER PLANT:					
Motor Driven Exciter		22½			
Turbo " "		22½			45
REPUBLIC MINE:					
Exciter in #5 Engine House	(Stored)	7½		7½	
" " Water Power Plant	"	17		17	0
REPUBLIC PLANT:					
Exciter		18			
"		15			33
CLIFFS SHAFT MINE:					
Compressor Motor Exciters	(2)	20			20
BROWNSTONE SUBSTATION:					
Battery Charging Set		2			
Line Testing Set		1/2			
Voltage Regulator Control		1/2			
Condenser Exciter		15			18
HOLMES MINE:					
Compressor Motor Exciter (Sold to O.I.M.Co.)		10		10	0
ATHENS MINE:					
Nordberg Compressor Motor Exciter		10			
Flywheel Set Exciter		15			
Skip Hoist Generator		700			
Battery Charging Motor-Generator Set		1/2			
Ingersoll-Rand Compressor Motor Exciter		10			735½
fwd.		1,339½ KW.	0	34½ KW.	1,305 K.W.

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Electrical Department: (Cont'd)

	INSTALLED TO JAN. 1, 1931	INSTALLED IN 1931	TAKEN OUT IN 1931	JAN. 1, 1932 TOTALS
brt. fwd.	1,339½ KW.	0	34½ KW.	1,305 KW.
MAAS CRUSHING PLANT:				
Pan Conveyor Generator	35			
" " " Exciter	1¾			
				36¾
NEGAUNEE MINE:				
Skip Hoist Generator	400			
Cage " "	150			
Flywheel Set Exciter	25			
Exciters for Underground Pump Motors (2)	28			
Ingersoll-Rand Compressor Motor Exciter	10			
Nordberg " " "	10			
Bell Signal Set	1/2			
Skip Hoist Generator #2	400			
Cage " " #2	200			
Exciter on New Hoist Set	35			
				1,258½
MORRIS MINE:				
Ingersoll-Rand Compressor Motor Exciter	12			
Nordberg " " "	10			
Ingersoll-Rand " " "	10			
				32
MACKINAW MINE:				
Compressor Motor Exciter	10			
				10
TILDEN MINE:				
Thrust Generator on Electric Shovel #29	15			
Hoist " " " " "	75			
Swing " " " " "	15			
Exciter " " " " "	5½			
" " " " " #31	5½			
Thrust " " " " "	15			
Hoist " " " " "	75			
Swing " " " " "	16			
Exciter for Synchronous Motor	15			
				237
TOTAL	2,913¾ KW.	0	34½ KW.	2,879¼ KW.

Electrical Department: (Cont'd)

Underground Haulage Generators:

	INSTALLED TO JAN. 1, 1931	INSTALLED IN 1931	TAKEN OUT IN 1931	JAN. 1,1932 TOTALS
CLIFFS SHAFT MINE:				
Motor-Generator Set #2	100 KW.			
" " Charging Set	5			
" " Set #1	100			
				205 KW.
ATHENS MINE:				
Rotary Converter #1	100			
" " #2 (from Francis Mine)		100		
				200
MAAS MINE:				
Motor-Generator Set #1	100			
" " " #2 (from Negaunee Mine)	100			
				200
NEGAUNEE MINE:				
Motor-Generator Set #1 (new)	200			
" " " #2	150			
				350
MORRIS-LLOYD MINE:				
Motor-Generator Set #1	100			
" " " #2	100			
				200
MACKINAW MINE:				
Rotary Converter	100			100
TOTAL	1,155 KW.	100 KW.	0	1,255 KW.

Direct Current Motors:

AU TRAIN WATER POWER PLANT:				
Governor Control Motors	(2)	1/4 HP.		
				1/4 HP.
CARP RIVER WATER POWER PLANT:				
Rheostat Control	(2)	1/4		
Governor "	(2)	1/4		
				1/2
McCLURE PLANT:				
Valve Control	(2)	2		
Rheostat "	(2)	1/2		
				2½
CLIFFS SHAFT MINE:				
Portable Hoist		10		
Car Puller		6½		
12 Scrapers		135	45	
				196½
fwd.		154½ HP.	45 HP.	0	199¾ HP.

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Electrical Department: (Cont'd)

		INSTALLED TO JAN. 1 1931	INSTALLED IN 1931	TAKEN OUT IN 1931	JAN. 1,1932 TOTALS
	brt. fwd.	154¾ HP.	45 HP.	0	199¾ HP.
TILDEN MINE:					
Hoist Motor on Electric Shovel #29		100			
Swing " " " " "		20			
Thrust " " " " "		20			
Swing " " " " #31		20			
Thrust " " " " "		20			
Hoist " " " " "		100			
					280
ATHENS MINE:					
Skip Hoist		900			
Ventilating Fans	7 - 5 HP. motors	30	5		
Sullivan Scrapers	2 - 6½ " "	13			
" "	10 -15 " "	150			
Ventilating Fan		15			
Sullivan Scrapers	2 20 " "	20	20		
I.-R. "	2 10 " "		20		
					1,173
MAAS MINE:					
Timber Hoist - skip pit		10			
" " - 4th level		10			
Bilge Pump (burned out)		5		5	
Ventilating Fan		15			
Sullivan Scrapers	12 - 15 HP. motors	165	15		
" "	7 - 6½ " "	45½			
Scraper Slide		15			
Ventilating Fans	7 - 5 " "	20	15		
Scrapers	2 - 25 " "	25	25		
Conway Loader		50			
I.-R. Scrapers	7 - 15 " "	60	45		
					515½
MAAS CRUSHING PLANT:					
Pan Conveyor		40			
					40
NEGAUNEE MINE:					
Skip Hoist		500			
Cage "		200			
Timber Hoist - tunnel		10			
" " - 10th level		10			
Ventilating Fan		7½			
Scrapers	12 - 7½ HP. motors	90			
Sullivan Scrapers	10 - 6½ " "	65			
" "	3 - 25 " "	75			
Ventilating Fan		5			
Denver Scrapers	3 - 10 " "	30			
Sullivan "	7 - 15 " "	105			
Ingersoll-Rand Scrapers	3 15 " "	45			
" " "	5 - 10 " "		50		
					1,192½
	fwd.	3,165¾ HP.	240 HP.	5 HP.	3,400¾ HP.

Electrical Department: (Cont'd)

		INSTALLED TO JAN. 1, 1931	INSTALLED IN 1931	TAKEN OUT IN 1931	JAN. 1,1932 TOTALS
	brt. fwd.	3,165¾ HP.	240 HP.	5 HP.	3,400¾ HP.
MORRIS MINE:					
Ventilating Fan, 4th level		15			
Sullivan Scrapers	7 - 6½ HP.	45½			
Denver Rock Drill Scrapers	7 7½ "	52½			
Sullivan Scrapers	2 - 10 "	20			
" "	5 - 7½ "	37½			
" "	7 - 15 "	105			
Scraper Slide		15			
Timber Hoist		7½			
Scrapers	3 - 25 "	75			
Ingersoll-Rand Scrapers	2 - 15 "	45		15	
					403
GARDNER-MACKINAW MINE:					
Ingersoll-Rand Scrapers	2 - 20 "	40			
Hoist		15			
					55
TOTAL D.C. MOTORS		3,638¾ HP.	240 HP.	20 HP.	3,858¾ HP.

Spare Generators and Exciters on hand December 31st, 1931:

CLIFFS SHAFT MINE:		
Motor-Generator Set for Battery Charging	20 KW.	
		20 KW.
GENERAL STOREHOUSE:		
Old Hoist Exciter	22	
		22
NEGAUNEE MINE:		
Skip Hoist (Armature only)	500 HP.	
TOTAL		42 KW.

Spare Underground Haulage Generators on hand December 31st, 1931:

GENERAL STOREHOUSE:		
Motor-Generator Set (from Morris)	100	
TOTAL		100 KW.

Spare Direct Current Motors on hand December 31st, 1931:

ATHENS MINE:		
Timber Hoist Motor	10 HP.	
Fan	15	
		25 HP.
MORRIS-LLOYD MINE:		
Crane Motor	10	
Ore Loader	2	
		12
GENERAL STOREHOUSE:		
Pump Motor	20	
Spare Hoist Motor for Shovel	105	
" Swing " " "	20	
Small Motor-Generator Set	10	
		155
TOTAL		192 HP.

Electrical Department: (Cont'd)

MESABA RANGE:

Exciters and Generators installed up to December 31st, 1931:

BOEING MINE:		
Compressor Motor Exciter	6 KW.	
		6 KW.
CANISTEO MINE:		
Hoist Generator on Shovel	137½	
Swing " " "	40	
Thrust " " "	39	
Washing Plant Generator	150	
Arc Welder	10	
Shovel Hoist Generator	150	
" Thrust "	39	
" Swing "	40	
" Exciter	12	
		617½
HILL-TRUMBULL MINE:		
Hoist Generator on Shovel	137½	
Swing " " "	40	
Thrust " " "	39	
		216½
HOLMAN-CLIFFS MINE:		
Hoist Generators on Shovels (2)	275	
Swing " " " (2)	80	
Thrust " " " (2)	78	
		433
TOTAL		1,273 KW.

Underground Haulage Generators installed up to Dec. 31st, 1931:

HOLMAN-CLIFFS MINE:		
Motor-Generator Set	115 KW.	
HILL-TRUMBULL MINE:		
Motor-Generator Set	55	
WADE MINE:		
Rotary Converter	100	
TOTAL		270 KW.

Direct Current Motors installed up to December 31st, 1931:

CANISTEO MINE:		
Rack Drives on Classifiers 4 - 5 Hp.	20 HP.	
Hoist Motor on Shovel	187½	
Swing " " "	40	
Thrust " " "	40	
Pan Conveyor	40	
		327½ HP.
HILL-TRUMBULL MINE:		
Feeder Motor	60	
Hoist Motor on Shovel	187½	
Swing " " "	40	
Thrust " " "	39	
Dorr Bowl Classifiers 2 - 5 HP.	10	
		336½
fwd.		664 HP.

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Electrical Department: (Cont'd)

	brt. fwd.		664 HP.
HOLMAN-CLIFFS MINE:			
Pan Conveyor		40	
Log Washers	3 - 40 HP.	120	
Hoist Motors on Shovels	2 187½ "	375	
Swing " " "	2 - 40 "	80	
Thrust " " "	2 - 40 "	80	
			695
	TOTAL		1,359 HP.

MESABA RANGE:

Total Exciters and Generators installed to December 31st, 1931 - 1,273 KW.

" Haulage Generators " " " " " - 270 KW.

" Direct Current Motors " " " " " - 1,359 HP.

SPIES-VIRGIL MINE:

Exciters installed to December 31st, 1931:

Compressor Motor Exciter - 10 KW.

Underground Haulage Generators installed to December 31st, 1931 - 150.KW.

Top Tram Larry Cars	2 - 20 HP. D.C. Motors	40 HP.
Fan		15
		55 HP.

ISHPEMING DISTRICT:

Total D.C. Generators and Exciters installed to Dec. 31st, 1931 - 2,879¼ KW.

" Underground Haulage Generators " " " " " - 1,255 KW.

" Direct Current Motors " " " " " - 3,858¾ HP.

Total Spare D.C.Generators & Exciters on hand " " " - 42 KW.

" " Underground Haulage Generators " " " " - 100 KW.

" " Direct Current Motors " " " " - 192 HP.

Electrical Department: (Cont'd)

Substation Transformers installed up to December 31st, 1931:

66,000/2,300 Volts	Phase	No.	K.V.A.	TOTAL K.V.A.	
Munising Substation	1	3	667	2,001	
Seney "	1	1	25	25	
Inland #1 "	1	3	500	1,500	
" #2 "	1	3	500	1,500	
					5,026 K.V.A.
33,000/66,000 Volts					
Gwinn Substation	1	3	1,250	3,750	
					3,750 "
33,000/13,200 Volts					
Clarksburg Substation	1	3	37½	112½	
					112½ "
33,000/6,600 Volts					
Eben Substation	1	1	25	25	
					25 "
33,000/2,300 Volts					
Brownstone Substation	1	3	400	1,200	
Cliffs Shaft-Holmes Substation	1	6	500	3,000	
Morris-Lloyd Substation	1	3	590	1,770	
Princeton "	1	3	250	750	
Republic "	1	3	400	1,200	
Maas "	1	6	590	3,540	
Escanaba Plant "	1	3	590	1,770	
Gwinn "	1	3	625	1,875	
Munising "	1	3	200	600	
McClure Plant "	3	2	5,000	10,000	
Carp " "	1	3	1,900	5,700	
Au Train " "	3	1	1,250	1,250	
Palmer "	1	3	625	1,875	
Hoist Plant "	1	3	667	2,000	
Greenwood "	1	3	150	450	
Chatham "	1	2	15	30	
Eben "	1	1	25	25	
					37,035 "
6,600/2,300 Volts					
Carp Plant Substation	1	6	185	1,110	
Gwinn "	1	3	350	1,050	
Mackinaw "	1	3	350	1,050	
Inland #1 "	1	3	25	75	
Blaney Park "	1	2	25	50	
" " "	1	1	15	15	
					3,350 "
6,600/115-230 Volts					
Germfask	1	1	15	15	
"	1	2	1.5	3	
"	1	2	3	6	
					24 "
			TOTAL		49,322½ K.V.A.

Transformers used for Underground Haulage installed to 12/31/31:

Athens Mine converters	1	6	35	210	
Mackinaw " converter	1	3	35	105	
					315 K.V.A.

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Electrical Department (Cont'd)

Distribution Transformers installed up to December 31st, 1931:

2300/220/110 Volts	PHASE	NO.		K.V.A.	TOTAL K.V.A.
ANGELINE MINE:					
Hoist Control	1	1		7½	
					7½
CLIFFS SHAFT MINE:					
Office Lights	1	1		10	
" "	1	1		15	
Laboratory	1	1		5	
"A" Shaft Hoists	1	2	(15)	30	
Pump Station Lights	1	1		3	
Crusher House Lights	1	2	(1)	2	
Crushers & Surface Lights	1	3	(10)	30	
Gravel Scraper	1	2	(37)	75	
Underground Scrapers	1	4	(50)	200	
" "	1	3	(25)	75	
Motor-Generator Set for Battery Charging and 1st Level A Scrapers	1	3	(15)	45	
Rectifiers	1	7	(5)	35	
Lights	1	34	(1½)	51	
Scraper Lights	1	1		2	
Signal in Engine House	1	1		5	
					581
HARD ORE, BROWNSTONE, ETC.					
Light & Power	1	1		15	
" " "	1	1		7½	
Shop	1	1		30	
Managers Residence	1	2	(10)	20	
" "	1	1		5	
F. C. Stanford & Testing	1	1		7½	
" " " " "	1	1		⅝ 5	90
LAKE MINE:					
Engine House Lights	1	1		5	
					5
TILDEN MINE:					
Pump	1	2	(10)	20	
Lights & Power	1	1		10	
" " "	1	2	(5)	10	
" " "	1	2		2	
Drills	1	3	(10)	30	
Shovel	1	3	(5)	15	
Crusher	1	3	(10)	30	
Synchronous Condenser	1	2	(7½)	15	
Scrapers	1	3	(15)	45	
					177
				fwd.	860½

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Electrical Department (Cont'd)

Distribution Transformers (Cont'd)

	PHASE	NO.		K.V.A.	TOTAL K.V.A.
brt. fwd.					860½
ATHENS MINE:					
Machine Shop	1	2	(10)	20	
Surface Lights & Lab. Hot Plates	1	3	(10)	30	
Pump Station Lights	1	1		5	
" " "	1	1		2	
100 G.P.M. Pump	3	1		40	
Signal System	1	1		1	
Engine House Lights	1	1		5	
" " "	1	1		4	
Top Tram	1	1		2	
" " Control	1	1		1	
					110
MAAS MINE:					
Lights & Injection Pump	1	3	(10)	30	
Coal Crusher & Shop	1	2	(10)	20	
Signal System	1	1		½	
3rd Level Pump Station	1	2	(5)	10	
Cage Hoist Control	1	1		10	
Skip Hoist Control	1	1		2	
" " "	1	1		3	
Rock Tram	1	1		1	
Heaters in Engine House	1	1		7½	
Top Tram	1	1		2	
Shop	1	1		15	
					101
MAAS CRUSHING PLANT:					
Lights	1	1		7½	
					7½
NEGAUNEE MINE:					
Shop Light & Power	1	1		10	
" " " "	1	1		7½	
Engine House Lights & Power	1	1		10	
" " " " "	1	1		5	
Signal System	1	1		½	
Pump Station Lights, etc.	1	3	(7½)	22½	
12th Level Pump	1	3	(5)	15	
Barn	1	1		5	
Gravel Pit	1	1		7½	
Hoist & Lights - #2 Shaft	1	3	(10)	30	
Laboratory Lights & Power	1	2	(15)	30	
Undg. Haulage	1	1		3	
					146
SOUTH JACKSON CRUSHING PLANT:					
Hoist Brake	1	1		5	
Lights	1	1		2	
					7
			fwd.		1,232

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Electrical Department (Cont'd)

Distribution Transformers (Cont'd)

	PHASE	NO.	K.V.A.	TOTAL K.V.A.
brt. fwd.				1,232
LLOYD MINE:				
Cage Hoist Control	1	1	7½	
Skip Hoist Control	1	1	7½	
Water Supply Pump House Lights	1	1	2	
Engine House Lights & Bell System	1	1	5	
Shaft House Lights	1	1	5	
Auxiliary Compressor	1	1	2	
Lights & Power	1	1	2½	
				31½
MORRIS MINE:				
Skip Hoist Control & Lights	1	1	10	
Cage " " " "	1	1	7½	
Signal System Lights	1	1	½	
Shop & Lights	1	3	(10) 30	
7th Level Pump Station Lights	1	1	2	
Location Lights	1	1	7½	
Club House Lights	1	1	10	
Laboratory	1	1	10	
"	1	1	15	
Elec. Room	1	1	1	
Engine House	1	1	1½	
				95
SECTION 6 SHAFT:				
Hoist Control	1	1	7½	
Lights	1	2	(2) 4	
				11½
REPUBLIC MINE:				
G. E. Tram	1	1	15	
Lighting	1	2	(2) 4	
Engine House Lights	1	1	7½	
Hoist Control	1	1	25	
Top Tram Controls	1	2	(1) 2	
Office Lights	1	1	3	
Water Power Plant Lights	1	1	1½	
" " " "	1	1	3	
				61
AUSTIN MINE:				
Shop	1	1	10	
				10
GARDNER MINE:				
Cage Hoist Control	1	1	10	
Top Tram	1	1	1	
Power & Lights	1	2	(10) 20	
				31
MACKINAW MINE:				
Machine Shop	1	2	(5) 10	
Hoist Control	1	1	10	
Top Tram	1	1	1	
				21
PRINCETON #2:				
Top Tram Lights	1	1	3	
Stockpile	1	2	(10) 20	
				23
PRINCETON MINE #3:				
Lighting & Bell System	1	1	1½	
				1½
			fwd.	1,517½

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Electrical Department (Cont'd)

Distribution Transformers (Cont'd)

	PHASE	NO.		K.V.A.	TOTAL K.V.A.
brt. fwd.					1,517½
PRINCETON CENTRAL POWER PLANT:					
Coal Crusher	1	3	(7½)	22½	
Power Plant Lights	1	1		10	32½
PRINCETON CENTRAL SHOPS:					
Power & Light	1	2	(10)	20	20
GWINN DISTRICT OFFICE:					
Lights	1	1		10	10
PRINCETON PUMP STATION:					
Power	1	3	(15)	45	
Lights	1	1		5	50
GWINN DISTRICT CRUSHER:					
Power & Lights	1	2	(10)	20	20
GWINN SUBSTATION:					
Lights	1	1		1	1
AU TRAIN WATER POWER:					
Operators Dwelling Lights	1	1		2	
Control	1	1		2	
Power & Lights, Dixon Location	1	2	(5)	10	
" " " Grand Island	1	2	(5)	10	
Lights, Forest Lake Location	1	1		10	
Chief Operator's Dwelling Lights	1	1	(5)	5	
Surge Tank Heaters	1	2	(5)	10	
Dixon Tie Mill	1	3	(3)	9	
Gravel Pit	1	2	(5)	10	
Camp Lights	1	1	(5)	5	73
CARP RIVER WATER POWER PLANT:					
Power & Lights	1	1		10	
" " "	1	1		20	
Pump	1	2	(1)	2	32
HOIST PLANT:					
Power & Lights	1	3	(10)	30	
" " "					30
MCCLURE PLANT:					
Power & Light	1	2	(10)	20	20
ESCANABA RIVER PLANT:					
Power & Light	1	3	(5)	15	15
GRAND TOTAL					1,821

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Electrical Department (Cont'd)

Distribution Transformers:

	PHASE	NO.		K.V.A.	TOTAL K.V.A.
THE CLIFFS ELECTRIC COMPANY:					
Austin Location Lighting	1	1		10	
Gwinn Street Lights	1	2	(1)	2	
" " "	1	1		2	
" Lighting - near Depot	1	1		½	
" " - Poplar Alley	1	1		30	
" Power - Club House	1	2	(5)	10	
" Lighting - " "	1	1		10	
" " - Mineral St.	1	1		10	
" " - Pine St.	1	2	(15)	30	
" Power - School	1	3	(5)	15	
" Lighting - "	1	1		10	
Cyr Location Lighting	1	1		2	
Princeton Upper Location Lighting	1	1		10	
" Lower " "	1	1		5	
New Swanzy " "	1	1		10	
Little Lake " "	1	1		5	
" " "	1	1		7½	
Chatham Lighting & Power	1	2	(7½)	15	
" "	1	1		10	
" "	1	1		5	
" "	1	1		1	
Eben Lighting - School	1	1		10	
Seney "	1	1		10	
" "	1	1		3	
Rumley Lighting	1	1		5	
Dorsey Farm Lighting	1	1		2½	
" " "	1	1		3	
Eben " "	1	1		3	
" " "	1	1		2½	
Blaney Lighting Extensions	1	1		3	
TOTAL					242

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Electrical Department: (Cont'd)

Spare Transformers on hand December 31st, 1931:

	PHASE	NO.	K.V.A.	TOTAL K.V.A.
ANGELINE MINE:				
General Electric	1	1	1	1
ATHENS MINE:				
Spare	1	1	3	
Spare	1	1	3	6
REPUBLIC MINE:				
General Electric	1	1	4	4
GENERAL STOREHOUSE & BARN:				
General Electric for 440 shaft pump	1	1	100	
" "	1	1	10	
" "	1	1	5	
" " from Republic	1	1	20	
" " " "	1	1	15	
" " " "	1	1	7½	
" " " "	1	1	10	
General Electric	1	3	(75) 225	
" "	1	1	10	
" "	1	1	10	
" "	1	1	10	
Western "	1	1	7½	
General "	1	2	(15) 30	
Allis-Chalmers	1	1	7½	
General Electric	1	1	10	
" "	1	1	3	
" "	1	1	5	
" "	1	1	2	
Western Electric	1	1	10	
General "	1	1	2	
Westinghouse Electric	1	1	5	
General Electric	1	1	5	
" "	1	1	1	510½
GWINN SUBSTATION:				
Spare	1	1	10	10
ESCANABA RIVER PLANT:				
Spare	1	1	10	10
PRINCETON MINE ENGINE HOUSE:				
Surface Lighting	1	1	5	5
PRINCETON CENTRAL POWER PLANT				
Spare	1	1	½	½
		TOTAL		547

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1931

COMPARATIVE TABLES.

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU.FT AIR USED	CUBIC FT.AIR PER TON HOISTED	GALLONS OF WATER PUMPED
CLIFFS SHAFT MINE					
1922	891	138,702	419,382,000	3,023	399,874,439
1923	2 359	305 727	734 645 710	2 403	377 383 675
1924	2 224	309 996	784 461 617	2 530	388 257 675
1925	2 900	322 928	824 005 547	2 551	327 655 585
1926	1 470	350 604	801 351 000	2 285	379 727 700
1927	957	426 830	766 647 000	1 796	440 517 425
1928	1 008	416 344	804 600 000	1 932	463 182 750
1929	934	451 334	853 572 500	1 891	461 403 025
1930	716	444 511	896 693 000	2 017	446 650 100
1931	560	315 492	592 506 000	1 878	350 061 000
ATHENS MINE					
1922	683	193,711	456,615,000	2,357	86,235,708
1923	971	246 704	635 535 000	2 576	103 329 157
1924	685	246 352	581 130 000	2 359	116 161 813
1925	789	214 510	468 900 000	2 186	131 715 395
1926	869	226 229	547 650 000	2 421	140 788 044
1927	790	233 221	679 815 000	2 914	127 086 869
1928	827	241 977	710 640 000	2 936	120 178 303
1929	767	344 534	1 154 380 000	3 350	117 645 969
1930	657	384 801	1 060 650 000	2 756	121 785 145
1931	621	254 660	686 750 000	2 696	136 215 501
MAAS MINE					
1922	628	219,676	458,010,000	2,083	516,431,109
1923	548	228 528	472 220 000	2 066	509 330 141
1924	682	224 291	470 880 000	2 099	522 683 088
1925	670	144 408	372 735 000	2 581	480 918 511
1926	829	245 992	420 930 000	1 711	508 242 996
1927	767	274 586	521 730 000	1 900	534 129 791
1928	657	272 740	679 005 000	2 489	553 419 346
1929	577	347 232	1 067 265 000	3 074	554 452 221
1930	606	443 504	1 374 390 000	3 098	577 702 994
1931	618	332 206	756 405 000	2 076	585 922 823
NEGAUNEE MINE					
1922	1,075	300 041	414,765,000	1,392	613,603,672
1923	996	383 914	655 695 000	1 708	582 912 109
1924	1 156	322 705	558 980 000	1 732	502 525 354
1925	1 100	342 824	660 600 000	1 927	436 422 253
1926	1 229	374 004	602 010 000	1 609	440 271 619
1927	1 139	501 516	895 680 000	1 785	603 746 976
1928	1 278	472 458	1 047 240 000	2 216	629 675 383
1929	1 410	569 489	1 123 840 000	1 973	648 591 436
1930	1 254	597 364	1 044 270 000	1 748	556 227 893
1931	885	346 533	620 641 000	1 791	482 294 599

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1931

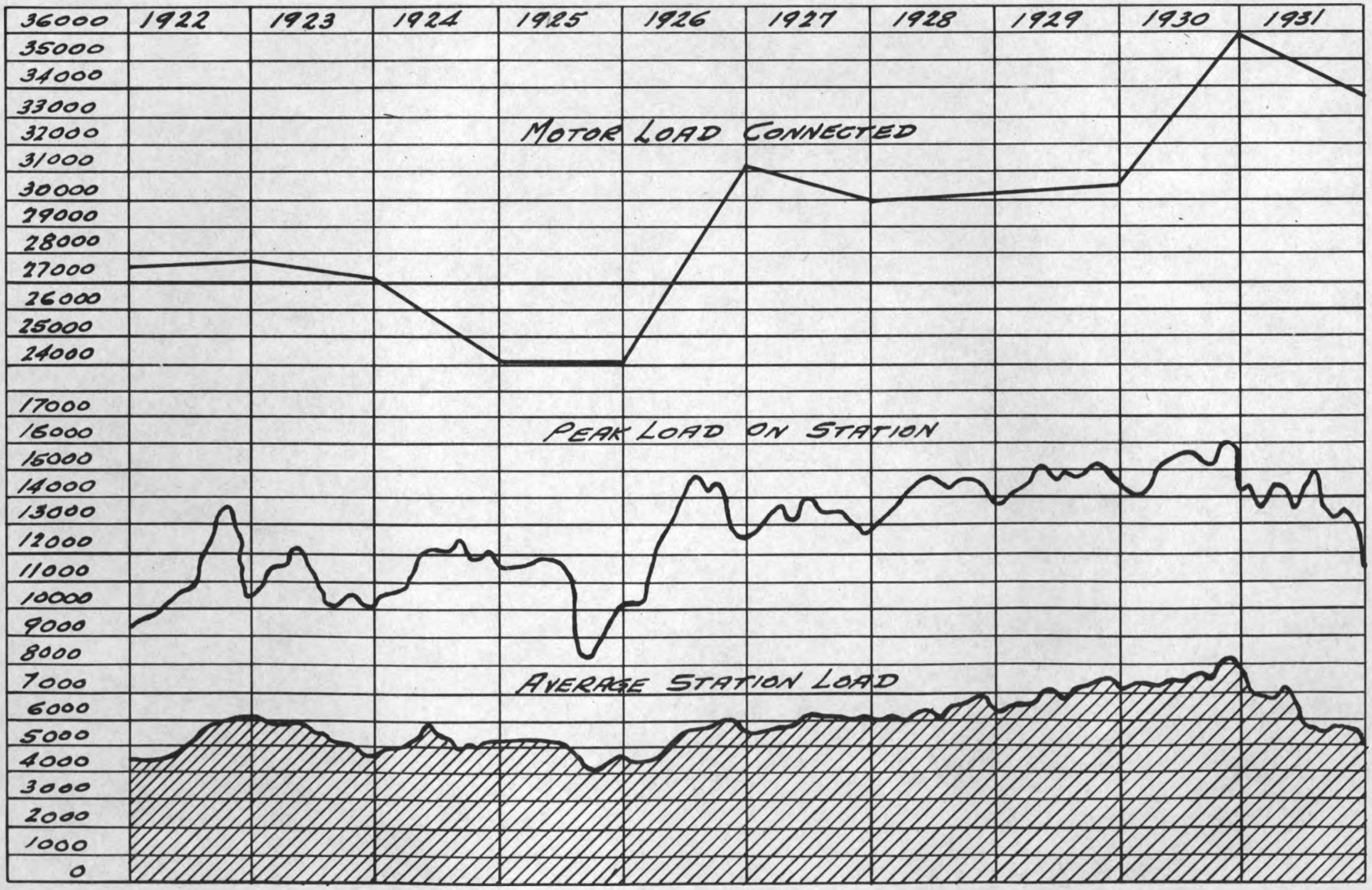
COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU.FT AIR USED	CUBIC FT.AIR PER TON HOISTED	GALLONS OF WATER PUMPED
TILDEN MINE					
1929	625	441,769	— — —	— —	— — —
1930	498	287 043	— — —	— —	— — —
1931	244	137 010	— — —	— —	— — —
MORRIS-LLOYD MINE					
1922	931	241,065	596,225,500	2,473	276,149,791
1923	1 031	273 124	826 038 000	2 460	267 210 477
1924	894	229 968	381 573 000	1 659	221 874 604
1925	919	258 062	611 836 920	2 371	172 168 518
1926	1 190	291 852	469 265 000	1 608	203 411 761
1927	1 096	333 736	688 545 000	2 062	223 631 596
1928	1 295	364 123	693 360 000	1 904	227 752 992
1929	1 243	456 119	947 560 000	2 077	236 012 174
1930	1 314	490 395	1 058 670 000	2 158	224 981 368
1931	795	364 591	660 645 000	1 812	205 406 448
GARDNER-MACKINAW MINE					
1928	336	91,293	214,020,000	2,344	52,760,063
1929	531	119 189	570 635 000	4 703	56,528 157
1930	316	129 321	621 450 000	4 805	74 823 761
1931	152	80,801	489 240 000	6 054	178 438 518
SPIES-VIRGIL MINE					
1922	192	5,432	— — —	— —	— — —
1923	495	19 732	— — —	— —	— — —
1924	272	55 953	— — —	— —	— — —
1925	313	72 542	— — —	— —	— — —
1926	392	92 407	— — —	— —	— — —
1927	424	163 911	— — —	— —	— — —
1928	366	184 141	— — —	— —	— — —
1929	292	168 913	— — —	— —	— — —
1930	318	146 027	— — —	— —	— — —
1931	256	97 371	— — —	— —	— — —
HILL TRUMBULL MINE					
1922	3,447	352,651	— — —	— —	— — —
1923	4 096	311 012	— — —	— —	— — —
1924	3 049	322 823	— — —	— —	— — —
1925	3 364	521 382	— — —	— —	— — —
1926	3 738	522 017	— — —	— —	— — —
1927	4 149	544 405	— — —	— —	— — —
1928	— —	495 748	— — —	— —	— — —
1929	— —	521 845	— — —	— —	— — —
1930	— —	392 598	— — —	— —	— — —
1931	— —	202 479	— — —	— —	— — —

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1931

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU.FT AIR USED	CUBIC FT.AIR PER TON HOISTED	GALLONS OF WATER PUMPED
ALEXANDRIA MINE					
1930	—	322,102	— — —	— —	— — —
1931	105	141 385	— — —	— —	— — —
HOLMAN-CLIFFS MINE					
1930	—	673,048	— — —	— —	— — —
1931	—	296 414	— — —	— —	— — —
WADE MINE					
1929	—	162,595	— — —	— —	— — —
1930	—	165 853	— — —	— —	— — —
1931	—	54 057	— — —	— —	— — —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1922
1923
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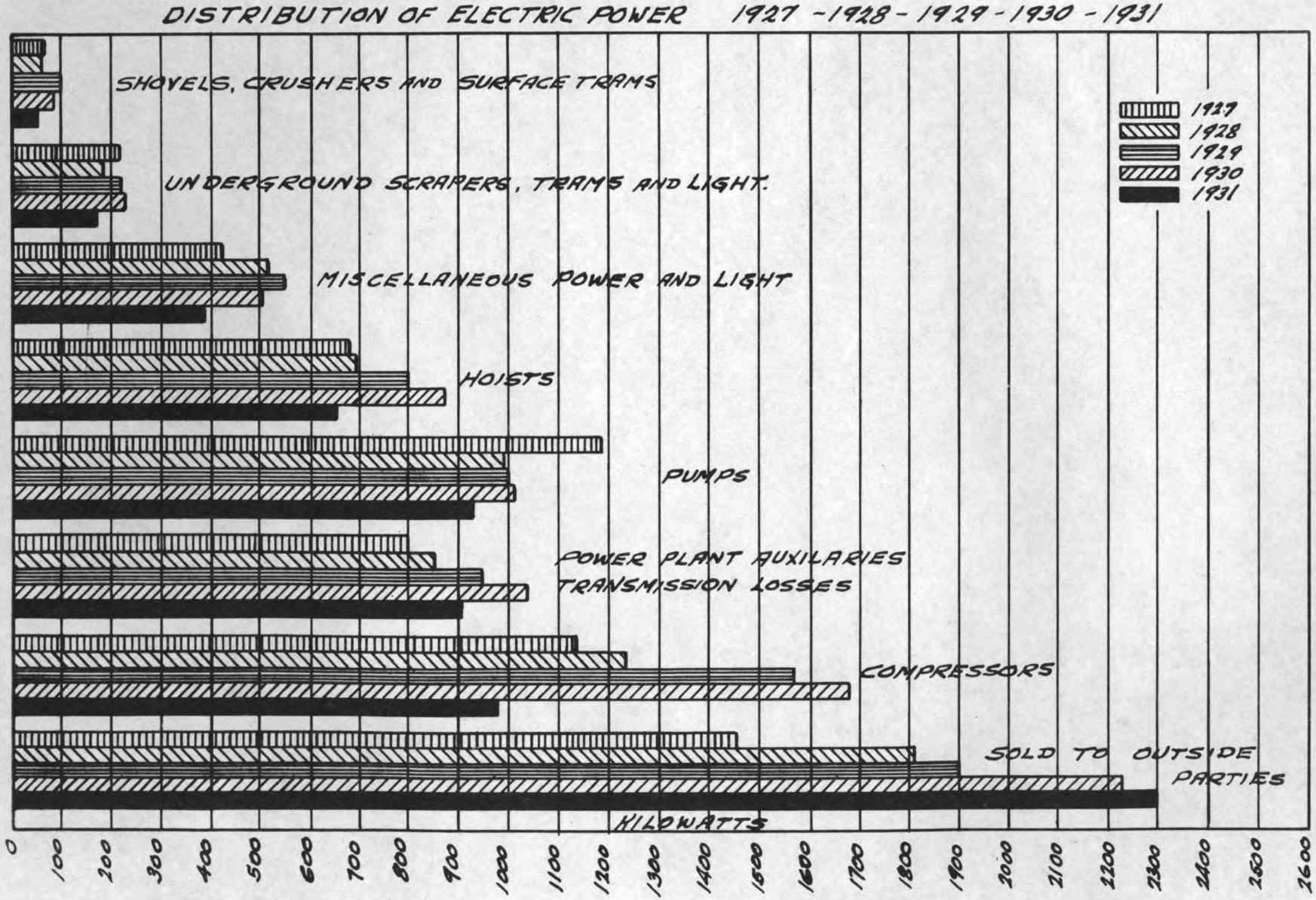
1926
1927
1928
1929
1930
1931
MOTOR LOAD CONNECTED
PEAK LOAD ON STATION
AVERAGE STATION LOAD


DISTRIBUTION OF ELECTRIC POWER 1927 - 1928 - 1929 - 1930 - 1931
SHOVELS, CRUSHERS AND SURFACE TRAMS
UNDERGROUND SCRAPERS, TRAMS AND LIGHT.
MISCELLANEOUS POWER AND LIGHT
HOISTS
PUMPS
POWER PLANT AUXILARIES
TRANSMISSION LOSSES
COMPRESSORS
SOLD TO OUTSIDE PARTIES
1927
1928
1929
1930
1931
KILOWATTS
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100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
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2100
2200
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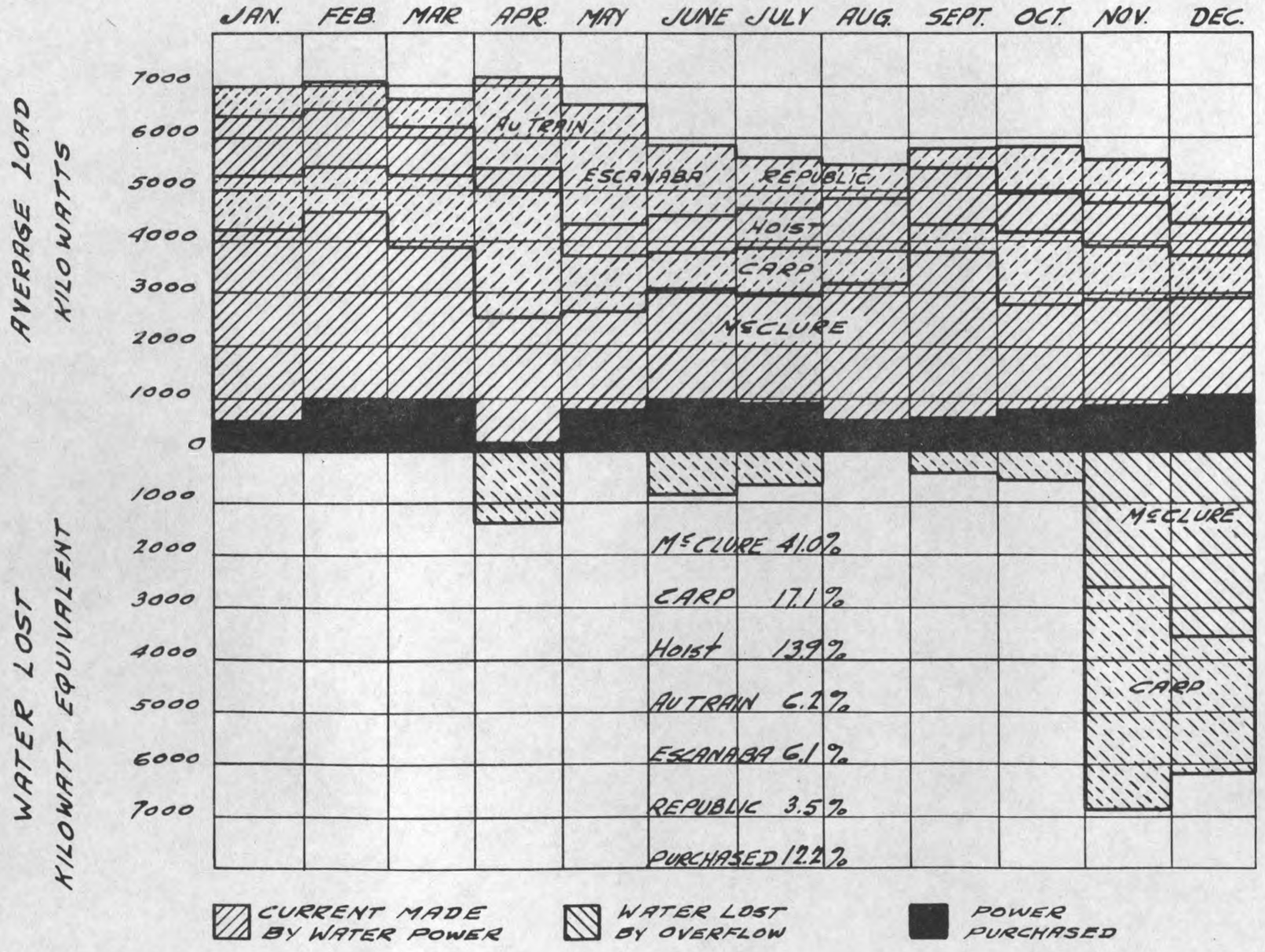
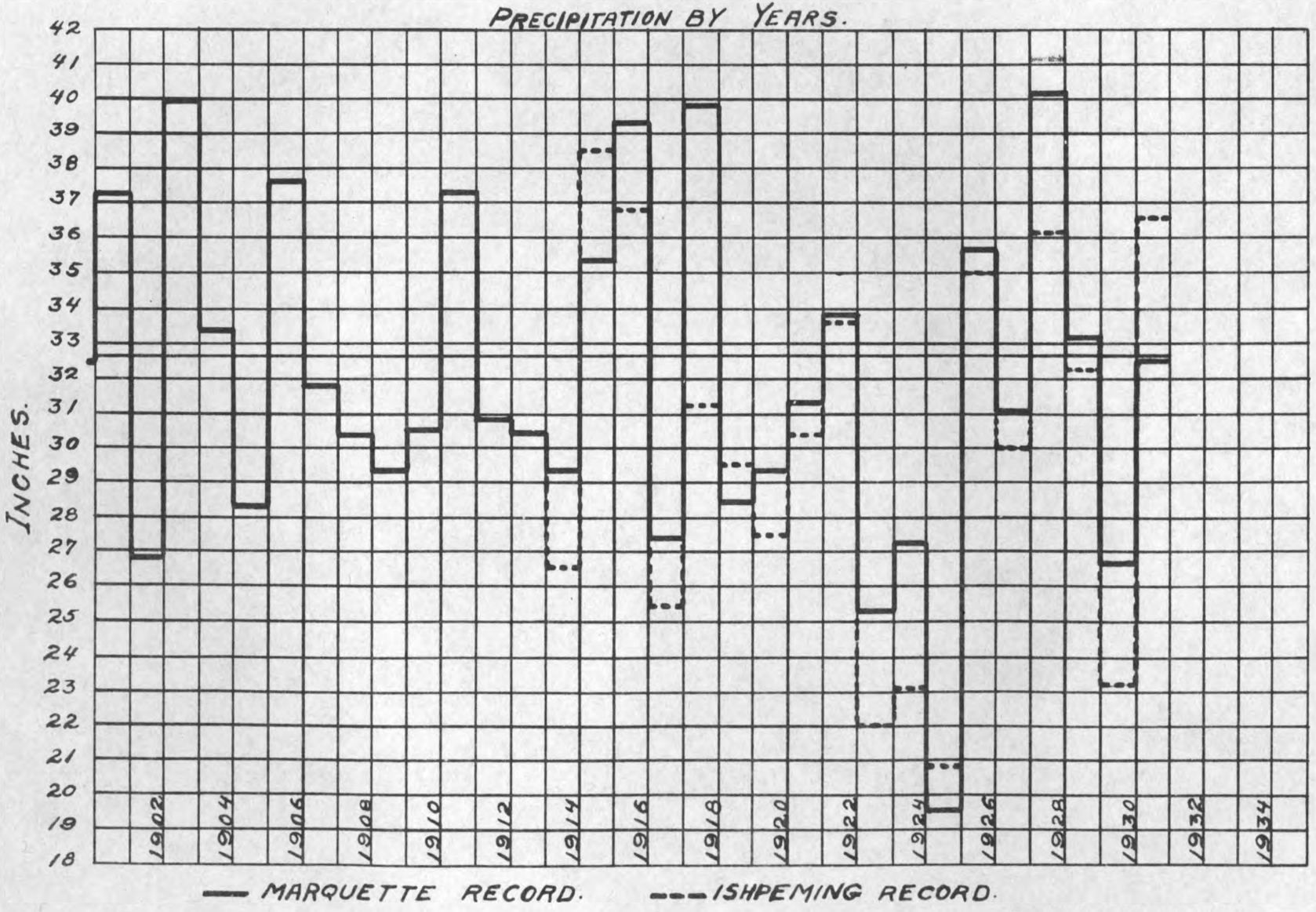
2500
2600

MECHANICAL DEPARTMENT
ANNUAL REPORT
YEAR 1931

1931




PRECIPITATION BY YEARS.
INCHES.
42
41
40
39
38
37
36
35
34
33
32
31
30
29
28
27
26
25
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22
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1914
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1922
1924
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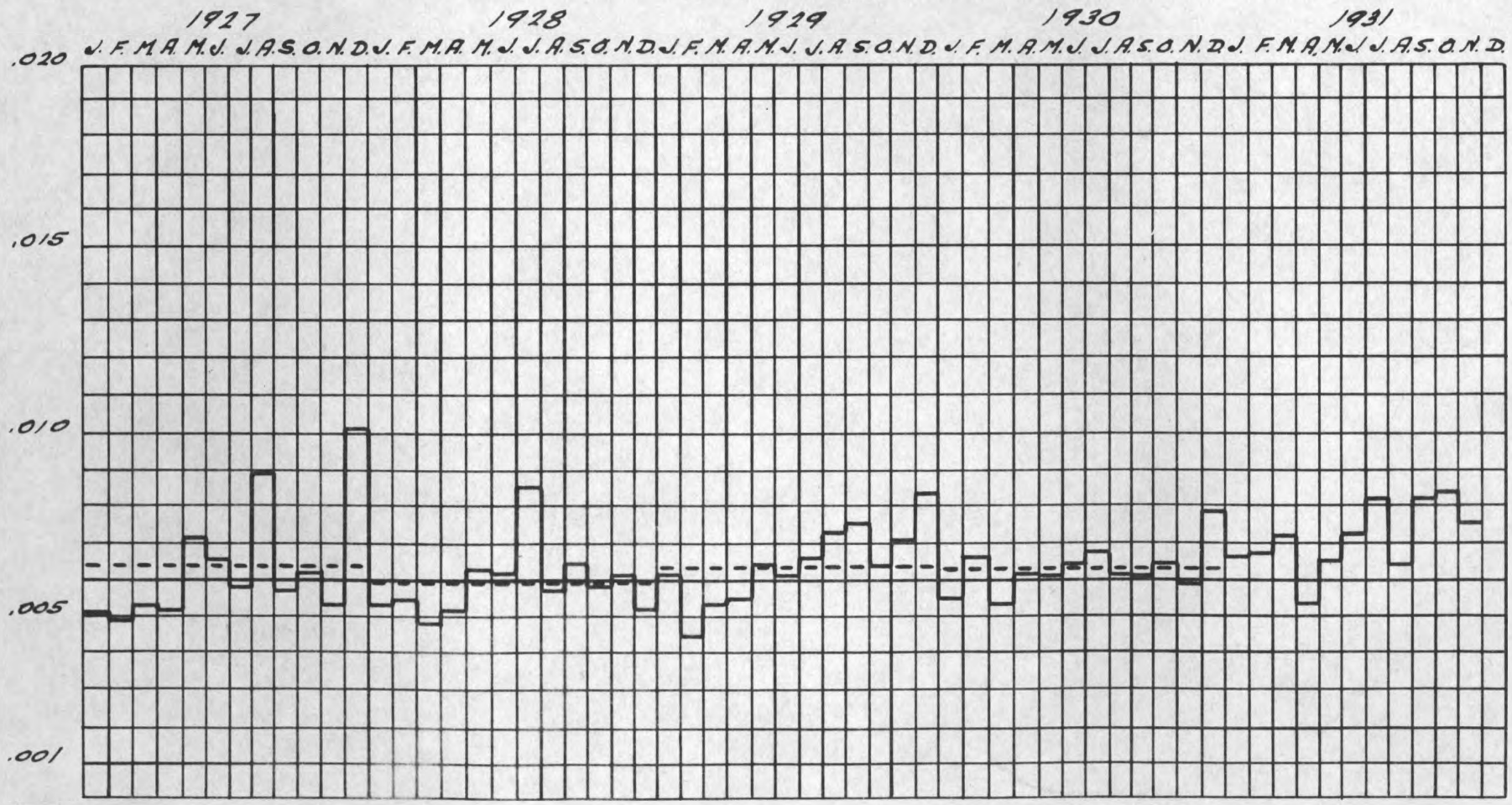
1928
1930
1932
1934
— MARQUETTE RECORD.
--- ISHPEMING RECORD.

COST DIAGRAM



21. ANNUAL REPORT OF THE MINING ENGINEERING DEPARTMENT FOR THE YEAR ENDING DECEMBER 31, 1931

The books of photographic maps and views of the Company's operations have been prepared as in former years. The following is a list of the books:

A. LIST OF ANNUAL REPORT MAP BOOKS FOR 1931.

The Cleveland-Cliffs Iron Company,
Ishpeming, North Lake and Iron River Districts.

The Cleveland-Cliffs Iron Company,
Negaunee and Gwinn Districts.

The Cleveland-Cliffs Iron Company,
Minnesota Districts.

The Cliffs Power & Light Company,
Hydro-Electric System.

The first three books contain the surface and underground maps of the mines operated by the Company, and the last book is made up of maps and views in connection with the operations of the Power Company. Two copies of each book were prepared, one for the Cleveland office and one to be kept in the Engineering Department at Ishpeming.

Special books have also been made for others interested in the Company's operations, as well as books and loose leaves for the various superintendents. These books, etc, are listed below:

BOOKS.

NO. OF COPIES.	MINE OR DISTRICT.	FOR WHOM.
1	Athens Mine,	Pickands, Mather & Company
1	Negaunee Mine,	Bethlehem Mines Corporation
5	Hill, Trumbull, North Star and Bingham Mines,	Partners - Mesaba-Cliffs Iron Mining Company
5	Holman-Cliffs Mine,	Partners - Holman-Cliffs Mining Company
5	Canisteo-Cliffs Mine,	Partners - Canisteo-Cliffs Mining Company
1	Alexandria Mine,	Donner Mining Company
1	Alexandria Mine,	A. C. Chisholm - Fee Owners
2	Alexandria, Hill, Trumbull, North Star, Bingham and Wade Mines,	Arthur Iron Mining Company
1	Hydro-Electric System,	O. D. McClure, General Manager
1	Negaunee and Gwinn Districts,	W. W. Graff, Superintendent
1	Cliffs Shaft Mine,	C. J. Stakel, Superintendent
1	North Lake District,	C. J. Stakel, Superintendent
1	Tilden and Spies-Virgil Mines,	W. R. Meyers, Superintendent
1	Minnesota Districts,	M. H. Barber, District Superintendent
1	Canisteo-Cliffs and Holman-Cliffs Mines,	E. C. Congdon - Fee Owners

LOOSE LEAVES.

1	Canisteo-Cliffs, Hill-Trumbull and Holman-Cliffs Mines,	H. C. Bolthouse, Superintendent

B. Mining leases on some of the properties require that map reports shall be sent at various times during the year to interested parties. These map reports consist of blue prints of the current mine maps. The following is a list of these reports that were sent out during the year:

ATHENS MINE.

Maps of the Athens Mine were sent monthly to the Cleveland office for Pickands, Mather & Company. Semi-annual letters were sent to the Agent representing the owners of the portion of the Athens Mine known as the Corbit Lease that no mining was done in this area during the year.

NEGAUNEE MINE.

Fourteen sets of the annual report prints of the 10th, 11th, 12th and 13th levels were sent to the Cleveland office for the fee owners of the Negaunee Mine.

MAAS MINE.

Monthly maps of the underground workings of the Roman Catholic Cemetery property were sent to Mr. R. S. Archibald, Negaunee, Engineer in charge.

MORRIS-LLOYD MINE.

Monthly maps of the underground workings of that portion of the Morris Mine on the Moore and Chase leases were sent to Mr. R. S. Archibald, Negaunee, Engineer in charge.

SPIES-VIRGIL MINE.

Five sets of maps of the mining operations of the Virgil Mine were sent to the lessors at the end of each quarter during the year. Since September 1st, three sets of analyses and two sets of level maps have been sent to the Republic Steel Corporation, showing the workings on the Sherwood property, besides three sets sent at the end of each quarter.

MACKINAW MINE.

One set of the monthly maps of the Mackinaw Mine have been sent to the lessors.

C. REMARKS ON THE ABSTRACTS AND VARIOUS SUBJECTS FOR THE YEAR 1931.

All documents involving the transfer of Company lands have been referred to the Engineering Department for approval before being executed. Prior to 1931, only such documents as affected the lands under the Mining Department were received but early in 1931 this ruling was changed to include all Company lands wherever situated. These documents have been entered on the records and descriptions and conditions checked before being sent to the Manager of the Mining Department for approval.

The following is a list of the various documents entered on the records of the Engineering Department during the year. Copies of some of these documents have been placed on file in the Department:

	NO. RECEIVED	LAST FILE NO.
Land Offers, - - -	26	1871
Deeds and Miscellaneous,	48	1182
Easements, - - -	61	338
Rights of Way, - - -	5	219
Water Rights, - - -	0	57
Surface Leases, - -	309	3438
Applications for Sale, -	9	117
Sales, - - - - -	22	500
Tax Histories, - - -	1	559
Legal Opinions, - -	0	193

LAND OFFERS.

Twenty one of the land offers received during the year were for mineral lands. These were referred to the Geological Department and reports made direct to the Manager. There was one offer of water power lands which was referred to the General Manager of the Cliffs Power & Light Company, and four offers of property in the City of Negaunee.

DEEDS AND MISCELLANEOUS DOCUMENTS.

The documents entered under this head involve the transfer of land on rights to or from the Company, or its subsidiaries, which are not filed elsewhere. Three of these consisted of copies of old transfers that were needed for the records of this office, while the others are new.

EASEMENTS.

These documents cover rights of way granted to the Cliffs Power & Light Company for transmission lines and are mostly in connection with the new line between Gwinn and the Inland Lime & Stone Company quarry.

RIGHTS OF WAY.

These covered various railway and public highway grants by the Company, both in Michigan and Minnesota.

SURFACE LEASES.

These leases all originated in the Land Department and were sent to the Mining Department for approval.

APPLICATIONS FOR SALE AND SALES.

The applications for sales and documents for sales of land were prepared by the Land Department and submitted to the Mining Department for approval.

ABSTRACTS OF TITLE.

There were no new abstracts entered during the year to the regular abstract books but a large amount of information has been collected in preparation for a complete revision of all the abstract books. This revision is such a large piece of work that it must necessarily wait until it can be put in the hands of one person. The checking up of the title of the Company lands has been continued throughout the year. Furthermore, a considerable amount of work was done with the Legal Department in obtaining rights of way for the Cliffs Power & Light Company's transmission lines across lands for which no permission had previously been obtained.

ENGINEERING DEPARTMENT

MICHIGAN STATE TAX COMMISSION.

Maps and estimates of the ore reserves at the various Michigam mines were prepared and sent to the State Tax Commission, as usual, during the year.

TAXES.

The tax lists of the Mining Department and Cliffs Power & Light Company were revised and copies were sent to the Land Department, the Tax Department and Mr. O. D. McClure. The delinquent tax lists of the various counties, in which the Mining Department and the Cliffs Power & Light Company are interested, were checked over and a report made on the delinquent lands. During the year quite a number of delinquent taxes were settled upon the approval of the Legal Department, these being mostly lands crossed by the Cliffs Power & Light Company transmission lines. Most of these delinquent parcels had been reported previously but a definite decision as to how the delinquency was to be handled had not been made until this year. Practically all of the delinquent descriptions have been cleared up.

LISTS OF LANDS.

During the year a list of the lands belonging to the Company under the jurisdiction of the Mining Department was prepared under the supervision of and submitted to the Legal Department. When this list was submitted, the Legal Department was informed that there were certain unsettled questions of title that should be passed upon by them before being submitted to the Cleveland office. A very complete list and check-up of the holdings of the Cliffs Power & Light Company is now being made and will be finished early in the year and submitted to the Legal Department.

MISCELLANEOUS.

The following are a few of the more important miscellaneous matters handled in the Engineering Department during the year that are not mentioned elsewhere in this report:

C.C.I.CO.'S SECOND ADDITION TO THE CITY OF NEGAUNEE.

The plat of this Addition was prepared and accepted by both the City of Negaunee and the Auditor General and was placed on record in the Register of Deeds office at Marquette.

ARCTIC IRON COMPANY.

A report was made in behalf of the Arctic Iron Company showing the portions of the surface owned by the Cleveland-Cliffs Iron Company in which the Arctic Iron Company has an interest.

AERIAL SURVEY.

There is a complete set of photographs on file in the Engineering Department of the aerial survey made over the Ishpeming-Negaunee District. A set of the Mosaic maps will be mounted and sent to the Cleveland office early in the year.

Carl Brewer

CHIEF MINING ENGINEER