

ing trestle. A survey was run to show a possible new location for present main line railway tracks.

LAKE MINE.

Monthly surveys were made until May 31st when the mine was abandoned.

MAAS MINE.

Weekly surveys were made and the geology noted and mapped. Several sub-level development schemes were submitted and approved. Drawings of a plan to concrete the present shaft, replacing the wooden sets with steel, together with an estimate of the cost of the same, was prepared. A report was prepared on the mining of the Maas ore body Westward to the West limit of the Race Track, together with surface map of this territory showing all lots with assessed valuation.

MORRIS-LLOYD MINE.

Monthly surveys were made and geology noted. The 6th level Morris was driven West across Lease No.26 and 500' into Lease No.27. The 7th level Morris drift was driven West, encountering the ore body, and was stopped in jasper. The sump for the 7th level was completed. On the surface additional rock and ore trestles were laid out.

NEGAUNEE MINE.

Weekly surveys were made and lines given for drifts in the sub-levels. All geology on the sub-levels was noted and mapped. The skip runners were gauged and the results submitted to the Superintendent. Some time was spent in constructing and trying out the MacCarthy-Moulton ore loader.

REPUBLIC MINE.

Monthly surveys were made and all diamond drill holes located. Lines were given for sinking the Pascoe Shaft and surveys run from the 2370' to the 2470' level Pascoe Shaft. Surface surveys were made and considerable work done in connection with the division of Smith's Bay. Together with the Ford representatives ^{office a} this made ~~the~~ division satisfactory to both parties. Documents and maps have been prepared showing this division.

SALISBURY MINE.

Monthly surveys were made. This mine was closed on March 5th.

SOUTH JACKSON MINE.

The extension of the ore mined was surveyed after a small tonnage was mined by the steam shovel.

SPIES MINE.

Monthly surveys were made and all drill holes were located. The mine was closed on May 31st.

VIRGIL MINE.

Maps were prepared of work which was done from the Spies Mine for the fee owners.

MISCELLANEOUS.

SECTIONS 1, 2, 3, 4 and 6, 47-27.

Some work was done in the office on maps of these sections.

SECTION 11, 47-27 CONTOURS.

Survey lines were run and contour data secured in the field for the entire South half of this section. In the office maps and tracings were completed.

SECTION 12, 47-27 CONTOURS.

Survey lines were started for contouring part of this section. This work had to be stopped when reduction in working force was made.

SECTION 13, 47-27.

A small amount of work was done on the maps of this section.

SECTION 14, 47-27 CONTOURS.

Survey lines were run and contour data secured of the $N\frac{1}{2}$ of the $N\frac{1}{2}$ and the $S\frac{1}{2}$ of the $NW\frac{1}{4}$. Maps have been completed of the $N\frac{1}{2}$ of the $N\frac{1}{2}$.

SECTION 15, 47-27.

Some work was done on maps of this section.

SECTION 21, 47-27.

A few days were spent on maps of this section.

SECTION 22, 47-27 CONTOURS.

Contour data which was secured on the $NE\frac{1}{4}$ of this section in 1920 was all plotted and the maps completed this year.

DEAD RIVER STORAGE DAM.

Considerable work was done in the field and in the office in connection with lands in the storage basin.

BARNES-HECKER DIVERSION DITCH.

The line of the ditch was surveyed and lines and grades given for excavating the same. After the completion of the ditch, an estimate was prepared showing the yardage removed.

NEELY EXPLORATION.

All diamond drill hole locations were surveyed.

ABSTRACTS.

Maps and abstracts were prepared in connection with Dead River Storage Basin, transmission lines, City of Ishpeming, Dead River water power and general.

REPORT ON THE ABSTRACT DEPARTMENT FOR THE YEAR 1921.

Documents received here have been recorded and copies made when necessary. The abstract of the Minnesota mines and the water power lands are incomplete.

OPTIONS FOR MINING LEASES.

No options for mining leases have been acquired during the year.

MINING LEASES.

The following mining leases have been surrendered:

No.43 - Meadow Mine.

No.45 - Fowler Mine, surrendered as of November 30, 1921.

Both of these mines are at Aurora, St. Louis County, Minnesota.

No new mining leases were taken out during the year.

DOCUMENTS RECORDED.

The following list of documents is a summary of those placed on the records in the files during the year 1921:

	<u>NO. RECEIVED.</u>	<u>LAST FILE NO.</u>
Land offers - - -	36	1301
Authorizations - -	0	116
Deeds and Miscellaneous	30	713
Easements - - - -	2	136
Rights of Way - - -	0	172
Water rights - - -	2	17
Surface leases - -	106	1937
Applications for Sale -	14	56
Sales - - - -	91	292
Tax Histories - -	0	506
Legal Opinions - -	2	138

LAND OFFERS.

Among the land offers were the Section 30 Mine on the Vermilion Range, Minnesota, the American-Boston Mine on this Range and the mineral lands of the D. M. & M. Railway. In Canada, iron explorations were offered including the Josephine Mine of the Michipicoten District, several other explorations near the Algoma Central Railway and also a few near the boundary and West of Port Arthur. For the most part, the rest consisted of lots in Negaunee and scattered lands in Marquette County.

AUTHORIZATIONS.

No authorizations for diamond drilling were recorded during the year.

ENGINEERING DEPARTMENT.

DEEDS AND MISCELLANEOUS DOCUMENTS.

These included deeds to this Company and also a number of documents for which there was no other place provided and which convey interests in to this Company.

EASEMENTS.

These include an easement to the Marquette County Gas & Electric Company for a pole transmission line to the Ishpeming City Crusher.

RIGHTS OF WAY.

There were no rights of way granted and recorded during the year.

WATER RIGHTS.

The Company entered into an agreement with the Lake Superior Iron Company on the drainage of the Lake Angeline basin. The other water right obtained was on the Spies Mine water discharge ditch.

SURFACE LEASES.

These were leases granted by this Company on farms and lots.

APPLICATION FOR SALE.

Applications for sale, which were sent to this office by the Land Department for approval, were entered.

SALES.

The sales which were entered conveyed miscellaneous parcels by this Company to various parties; also a number of sales of land owned by Mr. W. G. Mather at Michigamme were entered.

LEGAL OPINIONS.

The legal opinions entered were relative to special descriptions of land.

LAND OFFER PLAT BOOK.

The information contained in the land offer plat book has been posted, more particularly as regards explorations.

ABSTRACTS.

Some work has been done on the water power land abstracts which are being obtained upon additional lands acquired. In Minnesota the abstracts of the mines are being prepared by Mr. Carl Brewer in the form of a book similar to those he made of the lands in Michigan. A copy of this book is for the Cleveland office and another for the Land Department.

ENGINEERING DEPARTMENT.

SUNDRY ITEMS BY J. E. JOPLING.

PYRITES.

The following offers of pyrites were received during the year:

No.159, Saint Antonio Mining & Exploration Company, at Goudreau in the Michipicoten District of Canada. This property was offered on August 18th.

No.160, Julian Cross through J. E. Marks of Port Arthur, offered an old exploration with 1500 tons of ore on the dump near Schrieber, North of Lake Superior on September 29th.

Neither of these offers were examined and both were declined.

MICHIGAN STATE TAX COMMISSION.

Mr. L. P. Barrett, Appraiser of Mines for the Michigan State Tax Commission, was here in January and February to investigate the mines of the Company. He was given the information as shown on the reports. The maps for the year 1920, upon his request, were made on the reduced scale of 200' to the inch and upon them was shown the main geological boundaries. Copies are retained here in a binder for 14" x 17" sheets.

LAKE SUPERIOR IRON COMPANY.

An examination was made in February by Messrs. Eaton, Derby and myself of the lower workings in Section 16 Mine of the Lake Superior Iron Company, being its only mining operation. A report and map was made.

A special report was made of the Lake Superior Iron Company's lands with regard to explorations and developments of iron ore.

INTERSTATE IRON COMPANY.

The Interstate Iron Company purchased on January 12, 1921 the Breitung properties in Negaunee, except the Mary Charlotte Mine. A map of these holdings accompanied my letter dated July 15th. Surveys by the Interstate Company were made during 1920 on the same coordinates as those of this Company with the intention of establishing boundaries between their properties and those of this Company.

REDUCTION OF FORCE.

During June a reduction of the number of men in the Engineering Department was made according to the above report by Mr. Chenneour. The men laid off obtained employment with the Marquette County Road Commission. They were

given to understand that they might regain their positions with this Company as opportunity offered.

MOORE & CHASE LEASES.

On August 10th Messrs. G. W. Moore and P. P. Chase examined the maps of the underground workings on their properties and later received copies of blue prints. Mr. Chase went underground with me at the Morris Mine on November 30th to see the developments in ore upon the 7th level.

IMPERIAL MINE.

Engineers of the Michigan Land, Iron & Lumber Company came to the Ishpeming office in August in order to copy necessary data for maps of the Imperial Mine, now being reopened.

DIVISION OF SMITH'S BAY, REPUBLIC.

The agreement on the division of the mineral rights under Smith's Bay, Republic, by the Michigan Iron, Land & Lumber Company with this Company was signed September 26th. Mr. E. G. Kingsford of Iron Mountain, representing the Lumber Company, appointed Mr. W. C. Gordon, who is a geologist for the Oliver Iron Mining Company, to confer with the engineers of this office upon this boundary question. After making surveys at Republic in July, maps were made of Section 7 showing the shore line of Smith's Bay according to the state survey of 1870 and a boundary line was agreed upon by the engineers between the mineral rights of the companies under the lake. This agreed boundary line was embodied in the above mentioned document.

MARQUETTE COUNTY HISTORICAL SOCIETY.

During the year, this office furnished information to Rev. C. J. Johnson of Marquette, who is employed by Mr. J. M. Longyear, the President of the Marquette County Historical Society. This included a map of the Village of Gwinn, together with photographs of the principal buildings, photographs of old and modern mine building construction and appliances, ore and rock samples and maps of Marquette County showing location of mines and the representative outcrops.

A marker was erected in October near the County Road opposite the site of the oldest mining operations of the Company bearing this inscription:

"Upon this site the Cleveland Iron Mining Company began its first mining operations in 1850. It was the second company to engage in iron mining in the Lake Superior region".

OLD RECORDS.

The old records which had been stored in the upper floor of the Hard Ore office were sorted and examined. In company with men from other departments, the valuable books and papers were selected and stored. Correspondence dating back to 1849 was preserved and is being arranged.

SPIES AND VIRGIL MINES.

On September 1st, in company with Messrs. Stakel and Derby, I examined the Bates Mine and also the maps of the Osana Mine with reference to further developments at the Spies and Virgil.

MICHIGAMME COMPANY.

On September 30th, I accompanied Mr. C. V. R. Townsend to Iron Mountain where he made an offer of Mr. Mather's lands at Michigamme to Mr. E. G. Kingsford, representing Mr. Henry Ford.

DEAD RIVER WATER POWER.

Mr. O. D. McClure and I examined the dam constructed some years ago by the City of Marquette at Silver Lake on Dead River, on October 10th.

CANADIAN IRON ORE.

Mr. Derby and I examined an iron exploration recorded under offer No. 1291 situated 25 miles East of Sault Ste. Marie, Ontario, on October 19th.

ASHLAND MINE.

Mr. M. C. Lake, geologist for M. A. Hanna & Company, came to this office on November 7th to examine the records of the Ashland Mine, more particularly those of drill hole No. 11 relative to the ore there discovered and the agreement as to certain repayments to this Company.

BLUE MINE.

Reports and maps were made in November and December relative to the ditch which carries the water of Partridge Brook across the Blue Mine property.

THE CLEVELAND CLIFFS IRON COMPANY.

REPORT OF THE GEOLOGIST FOR THE YEAR ENDING DECEMBER 31, 1921.

STAFF.

The staff of the Geological Department for 1921 is given in Table I below. Mr. Pinger resigned June 25th and returned to his home at Fallon, Nevada. He went back to Harvard in the fall to take up graduate work in geology and allied subjects. On account of the general curtailment in ore production the first of June, no one was engaged to succeed him. Mr. Denn was laid off June 5th coincident with the laying off of several members of the Engineering Department staff on account of the general curtailment.

TABLE I.

<u>NAME.</u>	<u>OCCUPATION.</u>	<u>DURATION OF EM- PLOYMENT IN 1921.</u>	<u>DAYS LOST. SICKNESS.</u>	<u>VACATION.</u>	<u>% OF WORKING DAYS WORKED.</u>
E.L.Derby, Jr.	Geologist in charge of Department.	Entire year	0	0	100.0
A.W.Pinger	Assistant Geologist	6 months	0	2	98.5
E.A.Allen	Assisting Geologists, testing diamond drill holes, collecting and labeling core, etc.	Full time for 10½ months, ¼ time for 1½ months.	6	4½	93.9
Gustav Afuhs	Draftsman	Entire year	3½	4½	97.1
P.N.Denn	Collecting core, etc.	Full time for ¾ of a month, ¼ time for 4½ months.	0	0	100.00

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

TABLE II.

Total days of eight hours worked -	-	276½ days.
Sundays -	-	52 "
Days resulting from Saturday afternoons	-	26½ "
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 last five years:

TABLE III.

<u>YEAR.</u>	<u>AVERAGE NUMBER OF MEN.</u>
1917	3.35
1918	4.85
1919	5.44
1920	4.06
1921	3.56

DIVISION OF WORK AMONG THE MEMBERS OF THE DEPARTMENT.

H. L. SMYTH. The work of the Geological Department continued under the direction of Mr. H. L. Smyth as Consulting Geologist.

E. L. DERBY, JR. The major part of my time during the past year was taken up with the general oversight and supervision of the work of the Department. This included, besides the usual routine office work, surface drilling explorations in the Ishpeming, Dead River, Crystal Falls and Gwinn Districts; underground drilling in the Holmes, Morris, Republic and Spies Mines; and the underground surveys in the Athens, Barnes-Hecker, Cliffs Shaft, Francis, Gwinn, Holmes, Maas, Morris-Lloyd, Negaunee, Princeton, Republic, Salisbury, Spies and Stephenson Mines. I have accompanied the men making these surveys frequently and have kept in touch with and supervised their detailed studies of the results of these surveys constantly. After Mr. Pinger left I made all the underground surveys of the new development work in the mines.

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

In January, I accompanied Mr. Elliott in an examination of the workings of the Baraga ore body on Arctic Parcel No. 1 of the Breitung-Hematite Mine and made an estimate of the ore for his report. I also made a geological survey of the Section 16 Mine workings, adjacent to the Holmes Mine boundary.

In February, I made a special report on the so-called South Deposit of the Meadow Mine in connection with an anticipated surrender of the lease on this property. I also made a joint examination of and submitted a joint report on the Section 16 Mine with Messrs. Jopling and Eaton, including an estimate of the ore remaining in the property.

I left for Washin^{ton}, D. C., March 20th as a member of this Company's Committee which submitted the valuations of all the Company's mines to the Metals Valuation Section of the Internal Revenue Department for the purpose of depletion. I spent the greater part of the time until May 30th in Washington in company with the other members of this Committee, Messrs. Geffine and Jaynes of the Cleveland office, negotiating with the Government officials to establish these valuations, estimates of tonnage and depletion factors.

In August, I went again to Washington where, with Messrs. Geffine, Jaynes and Bush, we practically finished establishing with the Government the valuations, rates of depletion, etc, on the Company's mines. Mr. Bush and myself spent several days at the Cleveland office in preparation for this work on our way to Washington. I returned August 21st and made a new estimate of the ore in the Athens Mine. I also made a joint examination and report with Mr. Jopling of the Copps Feldspar Quarry, three miles South of the Barron Mine and just East of the County Road to Republic.

In September, I made joint examinations and reports with Messrs. Jopling and Stakel of the maps of the Osana Mine, formerly known as the James Mine, lying directly North of the Virgil property at Iron River and of the underground workings of the Bates Mine, also at Iron River.

In October, and in company with Mr. Jopling, I made an examination of and reported on the Bar River iron property in Ontario, about 25 miles East of the Canadian Soo, which was offered to the Company by the Saint Antonio Mining & Exploration Company of the Canadian Soo.

In November, I made a special ^{estimate} ~~report~~ of the ore in the Lloyd and East Lloyd Mines and the Company's fee interest in the Morris Mine; also an estimate of the ore discovered by drilling in Section 3 at Ishpeming.

A. W. PINGER. Mr. Pinger continued as an assistant geologist until he resigned June 25th. He made regular underground geological surveys at all the Company's operating mines in Michigan and posted these surveys on the geological maps and cross-sections. He usually assisted in all such surveys made by me. He assisted in taking water samples for the determination of the sulphur content of the ore when these tests were made at the Section 3 exploration at Ishpeming. He also geologized the outcrops located by the engineers on their topographical surveys in Sections 11 and 14, 47-27 and made a geological survey of the E $\frac{1}{2}$ of the SE $\frac{1}{4}$ of Section 24, 46-27, about four miles South of Palmer, in connection with land offer No. 1277. He did a small amount of surface geological work in Section 2, 47-27. He also made the daily reports of diamond drilling while I was in Washington from March 20th to May 30th.

E. A. ALLEN. Mr. Allen continued as an assistant in the Department throughout the year. During November, he spent approximately half his time and in December about two thirds of his time driving the Ford truck for the Engineering Department and assisted the engineers in their surveys. This was after the discontinuance of most of the drilling to which he previously gave considerable time. After Mr. Denn was laid off, Mr. Allen collected, labeled and filed all drill core and sludge samples from the explorations. He assisted in taking the water samples for sulphur determinations at the Section 3 exploration. He made the regular monthly carbon report and the annual inventory of all diamond drill equipment. He frequently assisted both Mr. Pinger and myself in the underground geological surveys and laid out many of the tracings which later were used as new geological maps and cross-sections of extensions and new levels at the various mines. He assisted in geologizing the outcrops located by the engineers in Sections 11 and 14, 47-27 and mentioned above in connection with Mr. Pinger. He also assisted Mr. Pinger in the survey of the E $\frac{1}{2}$ of the SE $\frac{1}{4}$ of Section 24, 46-27. Finally Mr. Allen made all the Maas Compass surveys where necessary of the diamond drill holes drilled during the year.

GUSTAV AFUHS. Mr. Afuhs continued as a draftsman throughout the year. His work, as in former years, has consisted chiefly in preparing cross-sections of drilling, monthly drill reports and geological maps and cross-sections but he has frequently assisted in making ore estimates. He colored all the annual report sheets of the Company's drilling during the year. The rest of his time was occupied with the routine work of the office.

P. N. DENN. Mr. Denn was a full time member of this Department only from January 17th to February 7th, inclusive. During the rest of the period until he was laid off on June 7th, due to the general curtailment, only one quarter of his time was in this Department, the remainder being occupied as a chauffeur for the Engineering Department. His time credited to Geological Department was completely taken up with collecting, labeling and filing of diamond drill core and sludge samples from current drilling and in looking after the core room.

SURFACE GEOLOGICAL SURVEYS.

ISHPEMING DISTRICT.

The principal surface geological work done during the year was the survey of the S $\frac{1}{2}$ of Section 11, 47-27 and the N $\frac{1}{2}$ of the N $\frac{1}{2}$ and the unflooded portion of the S $\frac{1}{2}$ of the NW $\frac{1}{4}$ of Section 14, 47-27 at Lake Sally. The rock outcrops, test pits and contours were located by the members of the Engineering Department, and the rock determinations and geological notes were made by Messrs. Pinger and Allen of the Geological Department. This survey has not been completed, nor have all the maps of the portions already surveyed been posted.

PALMER DISTRICT.

Messrs. Pinger and Allen also made a geological survey of the E $\frac{1}{2}$ of the SE $\frac{1}{4}$ of Section 24, 46-27, about four miles South of Palmer, in connection with land offer No.1277.

UNDERGROUND GEOLOGICAL SURVEYS.

Until Mr. Pinger resigned in June, we were able to keep the geological surveys of the current mines work up to date in all mines except the Cliffs Shaft and Republic, which are hard ore mines and readily accessible and can be caught up as the opportunity arises. Since then, however, we have had to have the assistance of several engineers at their respective mines but have been able in this way to keep the work pretty well caught up on account of the few mines operating following the general curtailment of production.

ANGELINE MINE.

Practically all the ore that could be profitably recovered from this mine was removed and the property abandoned May 31st. The last geological survey was made the first of April and very little mining was done afterwards.

ATHENS MINE.

The Athens Mine continued to be a steady producer, although the operations were reduced to five shifts per week March 26th and to six half shifts per week May 17th. Regular geological surveys were made and the geological maps and cross-sections posted. The only development work accomplished was the extension of the 6th level Southwesterly. Mining was confined to four areas, namely, above and just below the 8th level, above the 6th level, all near the

West end of the property, and a small area above the 4th level near the East end.

BARNES-HECKER MINE.

Very little work was done at this property due to the large volume of water encountered when the three main levels cut into the ore formation. Two of these levels, the 1st and 3rd, were being extended at the beginning of the year but soon after this time it was decided to seal all levels with concrete dams and they were finished and all work stopped on March 17th. A drainage ditch on the surface was dug from the mine around North Lake to a swamp Southeast of the lake as it was thought the water being pumped from the mine was finding its way back into it through the North Lake drainage. After this ditch was completed the dams on the three levels of the mine were opened and a vigorous campaign of pumping waged the balance of the year. The last geological survey was made February 18th.

CLIFFS SHAFT MINE.

This mine continued to produce steadily until the general curtailment took place March 26th. Following this, production was cut down to five shifts per week until the property was closed May 31st. The only geological surveys made, with the exception of the 8th level drift in "A" Shaft connecting with the old Incline Mine, were of the "B" Shaft workings and were accomplished the latter part of February. The connection with the Incline Mine and all the accessible workings of both the Incline and No.3 Mines were geologized the latter part of April.

FRANCIS MINE.

The Francis Mine produced continuously throughout the year but curtailment to five shifts per week took place March 26th and to ^{six half} ~~six~~ shifts per week June 6th. Geological surveys were made quite regularly and the geological maps and cross-sections posted. A small amount of ore was removed above the 4th level but the remainder came from between the 4th and 5th levels. Considerable ~~amount~~ additional ore was developed on the South side of the basin and towards the West end of the mine at the elevation of the 4th level and above it. For some time we have anticipated a fold over to the South of

this side of the basin with a possible repetition of this basin which may be ore bearing. The developments on the 4th level in this vicinity show the beginning of this folding so that during the next year development work will be pushed to prove up this ground. The connection by drift and raise between the 5th level Francis and 10th level Gwinn, which started in 1920, was accomplished early in 1921 and the ventilation thereby much improved.

GARDNER-MACKINAW MINE.

This property was closed November 30, 1920 and no work has been done since.

GWINN MINE.

Production at this property was placed on a five shift per week basis March 26th and on May 31st it was closed entirely. The 11th level development was continued and ore had just been cut at the South end when operations ceased. Most of the ore continued to be mined between the 9th and 10th levels, practically all of the balance coming from higher elevations but with a small amount from new sub-levels between the 10th and 11th main levels. As explained in the case of the Francis Mine, the 10th level connection with the 5th level Francis was made by a raise and the ventilation greatly improved. The last geological surveys were made January 20th.

HOLMES MINE.

The Holmes Mine was a continuous producer throughout the year, although production was first reduced to ten shifts per week March 5th and to six shifts per week June 1st. Geological surveys were made regularly and the geological maps and cross-sections posted. During the year the 3rd and 4th level developments were practically completed and the development on the sub-levels half way between the 2nd and 3rd levels and half way between the 3rd and 4th levels were nearly completed. Practically all the ore mined came from above the 1st level and between the 1st and 2nd levels. All ore is now completely mined out above the 1st level.

MAAS MINE.

This property continued to be one of the large producers, although operations were reduced to five shifts per week March 26th and to ^{six half} ~~five~~ shifts per week June 1st. No new main level development work was done but mining was carried on over a very wide area, extending all the way from a little

below the 1st level to the territory between the 3rd and 4th levels. Until Mr. Pinger left, regular geological surveys were made and the geological maps and cross-sections posted. Since then this work has been done intermittently by Mr. Hayden, Engineer.

MORRIS-LLOYD MINE.

Mining was continuous at this property but production was cut to ten shifts per week March 5th and to ^{six half} ~~six~~ shifts per week June 1st. The principal new development has been on the 7th level Morris Mine, which is located 250' below the 6th level. Several important ore bodies are being developed on this level on No.9 lease, one of which extends East on to this Company's land. This latter is the ore discovered by diamond drill holes Nos.29, 32 and 34 drilled several years ago from the 6th level. Geological surveys were made and the geological maps and cross-sections posted regularly until Mr. Pinger left. Since then I have kept the Morris Mine development up to date and have had Mr. Trosvig, Engineer at the property, get the remaining information, which has been posted on the maps of this Department.

NEGAUNEE MINE.

The Negaunee Mine continued to be one of the largest producers on the Range, although production was curtailed to five shifts per week March 26th and to ^{six half} ~~six~~ shifts per week May 17th. The only main level development was on the 11th level, which was practically completed during the year. Most of the ore mined came from the territory between the 9th and 11th levels. As in the Maas Mine, geological surveys were made and the geological maps and cross-sections posted regularly until Mr. Pinger left. Since then this work has been done intermittently by Mr. Moulton, Engineer.

PRINCETON MINE.

This property produced continuously until August 27th when it was closed. Production was reduced, however, to a five shift per week basis March 26th and to ^{six half} ~~six~~ shifts per week June 1st. Geological surveys were made and the geological maps and cross-sections posted regularly until Mr. Pinger left. The last survey was made June 15th.

REPUBLIC MINE.

The Republic Mine produced continuously but was reduced to ten shifts

per week March 5th and to three shifts per week June 1st. Practically all the ore mined has come from the Pascoe Shaft workings and principally from the large stopes on the 2370' and 2470' levels. The latter level, which was just being started at the beginning of the year, was considerably developed and disclosed the continuation of the large ore body on the 2370' level in even larger proportions than on the latter level. No regular geological surveys were made during the year but all extensions were posted on the geological maps.

SALISBURY MINE.

This property was worked in a small way until it was closed March 5th. Practically all the ore removed was taken from the South Deposit above the 14th level. No regular geological work was done.

SPIES MINE.

The Spies Mine operated steadily until it was closed May 31st in accord with the plan of general curtailment. No new development work was done and practically all the ore in the main stope had been mined at the time of closing. There is a relatively small amount of ore remaining in the North lens. The last geological survey was made on January 10th.

STEPHENSON MINE.

This property produced continuously but production was reduced to five ^{six half} ~~six~~ shifts per week March 26th and to ~~six~~ shifts per week June 1st. Some new ore was developed at the Southeast end of the mine on the 4th level and below. The majority of ore mined came from between the 4th and 5th levels, although considerable was mined between the 5th and 6th levels. Geological surveys were made and the geological maps and cross-sections posted regularly. Mr. Sterling, Engineer at this mine, has assisted in this work materially since Mr. Pinger left.

EXPLORATIONS.

Drilling explorations were carried on during 1921 in the following districts and mines:

FROM SURFACE.

<u>DISTRICT.</u>	<u>RANGE.</u>
Ishpeming,	Marquette.
Gwinn,	Swanzey.
Crystal Falls,	Menominee.

FROM UNDERGROUND.

<u>MINES.</u>	<u>DISTRICT.</u>
Holmes,	Ishpeming.
Morris,	North Lake.
Republic,	Republic.
Spies,	Iron River.

No options for exploring and no mining leases were acquired during the year.

Mining Leases Nos. 43 and 45, covering the Meadow and Fowler Mines, respectively, were surrendered.

Table IV, which follows, gives the footage drilled, the ore encountered and the cost per foot of drilling for both surface and underground explorations: It will be noted that the average cost of surface drilling was \$4.76 per foot, excluding certain items which are not actually drilling expenses but are charged to explorations. By including these items the average cost was \$5.97 per foot. This large differential is due mainly to the taxes on the Neely property of \$6858.06, which are charged to the exploration but clearly is not an item of drilling expense. It is also to be noted that the costs of the Stephenson drilling include part of the drifting expense in connecting the 6th level with drill hole No. 66. The average cost of underground drilling in the same way was \$3.78 and \$3.90, respectively. The average cost of all drilling was \$4.37 and \$5.14, respectively. These costs are less than those of last year by 12.7% and 6.9%, respectively, in spite of the fact that there was more than 1600' less drilling in 1921 than in 1920, resulting in a corresponding increase in the overhead expense for 1921.

TABLE IV.

SUMMARY OF DRILLING FOR 1921.

EXPLORATION.	DESCRIPTION. SEC. T. R.	STAND- PIPING FT.	CHURN DRILLING FT.	DIAMOND DRILLING FT.	TOTAL 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".
<u>SURFACE DRILLING.</u>												
Dead River Hoist	17, 48-26	96			96				\$526.48	\$5.48	\$526.48	\$5.48
Ishpeming Section 3	3, 47-27	165		8391	8556	285	60	181	44,811.37	5.24	40,285.71	4.71
Neely Lease	12, 42-33	167	2	726	895	70	60	90	11,007.87 *	12.30	3,948.61	4.41
Stephenson Mine	22, 45-25		32		32	0	0	0	853.67 *	26.68	853.67 *	26.68
Total surface drilling		428	34	9117	9579	355	120	271	\$57,199.39	\$5.97	\$45,614.47	\$4.76
<u>UNDERGROUND DRILLING.</u>												
Holmes Mine	9, 47-27			967	967	17	12	0	2,603.23	2.69	2,569.14	2.66
Morris-Lloyd Mine	1, 47-28			1445	1445	38	61	151	5,869.79	4.06	5,655.37	3.91
Republic Mine	7, 46-29			2525	2525	102	20	81	10,882.74	4.31	10,474.72	4.15
Spies Mine	24, 43-35			1495	1495	20	125	25	5,724.91	3.83	5,589.52	3.74
Total underground drilling				6432	6432	177	218	257	\$25,080.67	\$3.90	\$24,288.75	\$3.78
Grand total drilling		428	34	15549	16011	532	338	528	\$82,280.06	\$5.14	\$69,903.22	\$4.37

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

The contract drilling for the year comprises the surface drilling on the Neely Lease and was done by the Cole & McDonald Exploration Company.

* Includes taxes - \$6858.06.

* Includes part of drifting on 6th level to connect hole No.66.

SURFACE EXPLORATIONS.

MARQUETTE RANGE.

ISHPEMING DISTRICT.

SECTION 3, 47-27.

All drilling from surface in the Ishpeming District was confined to the explorations on Section 3, 47-27. Holes Nos. 3, 29 and 30, which were started in the latter part of 1920, were completed, and holes Nos. 31 and 32, also drilled and completed. All of these holes were drilled to explore and extend the limits of the ore South of the main East-West fault, which was first discovered in 1920 by hole No. 24.

Hole No. 3, which was located 400' South of No. 24, did not encounter ore. After correcting for the deviation in each of these holes, the former encountered the slate about 250' South of the corresponding contact in No. 24 and at a relative elevation that indicates another fault. Apparently this fault dips to the North at a steep angle and has displaced the slate foot upward on its South side, forming, with the Southerly dipping slate to the North, a crotch which very likely explains the localization of the ore in No. 24. Evidence higher up in hole No. 3 indicates a third fault. This dips steeply to the South and the movement of the South side has been down relative to the North side.

Hole No. 29 was located 400' East and 200' South of No. 24 and encountered 135' of good ore from 2525' to 2660'. On account of deviation this ore is approximately 200' South and 100' West of the collar of the hole.

Neither holes Nos. 30 or 31 encountered ore. The first was located 300' East of No. 29 and 200' South of No. 26 and the second 400' West and 75' North of No. 3. The latter, No. 31, encountered the footwall slate on the South side of the Northerly dipping fault mentioned in connection with No. 3 and at practically the same elevation as it was encountered in the latter hole.

The results of this drilling^{ing} proved very conclusively that the ore body first discovered in No. 24 and cut again in No. 29 lies in a Southeasterly and Northwesterly trending crotch formed by a fault throwing the slate footwall

up on the South side. This crotch has a general pitch to the Southeast. Accordingly, No.32 was located 300' South and 300' East of No.29, being also 300' South of No.30. This location, it was estimated after taking into account an expected Southerly deviation, should encounter the Southeasterly extension of this ore body if it continued this far. We were successful in this supposition since the hole encountered no less than 140' of good ore between the depths of 2555' and 2705', being 5' more than encountered in any of the other successful holes.

A very conservative estimate of the ore in this South body yields practically two million tons and it is more than likely that there is several times this amount in the deposit. At all events, the tonnage disclosed is enough to encourage and warrant its development, consequently further exploring was deemed unnecessary.

DEAD RIVER DISTRICT.

DEAD RIVER HOIST, SECTION 17, 48-26.

A series of standpipes were sunk late in 1920 Southwest of the main Dead River on the site of the proposed new storage dam at the Hoist to determine the depth to ledge and ascertain its character. The last of this series of pipes was sunk in January 1921 and the information compiled for Mr. McClure's use.

GWINN DISTRICT.

STEPHENSON MINE SURFACE, SECTION 29, 45-25.

An 8" standpipe was sunk to ledge at the center of the ledge basin over the Section 29 ore body during 1920, the plan being to drill to the elevation of the 6th level and drain this basin through the mine with its pumping equipment. During 1920, also, a 7 5/8" hole was chopped in the ledge with the Keystone outfit to a depth of 358' where, on account of the difficult and slow progress, the hole was reduced to 6". During January 1921 the hole was extended from its depth of 482' at the beginning of the year to a depth of 514'. The hole deviated ~~to 35'~~ about 35' in this distance but it was finally holed into by a crosscut from the objective point on the 6th level of the mine.

After holing, a great deal of difficulty was experienced in pulling back the standpipe to allow the basin water to drain into the mine; in fact, the hole became so badly plugged with boulder material at the ledge surface that a raise is now being put up from which this ground will be thoroughly blasted. It is hoped this will cause a steady flow of water until the basin is drained.

CRYSTAL FALLS DISTRICT.

NEELY LEASE, SECTION 12, 42-33.

Drilling on this lease was commenced in August 1920 and continued to the first part of March 1921. The purpose of this work was to explore for an ore connection between the main Neely ore bodies and the ore developed on the Oliver property just South of the boundary between these two properties. All told, nine holes were drilled aggregating 2600'. Six of these, Nos. 37 to 42, inclusive, were completed in 1920.

Although the results of this drilling do not definitely prove there is continuous ore between the two deposits on account of the irregular character of the ore encountered, it is quite likely that such does exist. To prove it, however, would entail an unwarranted amount of drilling. On the other hand, we did develop an appreciable extension of this Oliver ore on to the Neely property as our estimate shows a total (developed by this drilling) of 122,400 tons of recoverable ore averaging 60.04% iron and .201% phosphorus and all lying within 285' of surface.

UNDERGROUND EXPLORATIONS.

HOLMES MINE.

Drilling was resumed in the Holmes Mine early in January. A series of six horizontal holes, Nos. 12 to 17, inclusive, were drilled from the main West drift on the 3rd level. Three of these were drilled to the Northeast to locate the true greenstone footwall and explore for possible ore extensions on the foot. The other three were drilled to the Southwest to locate the quartzite hanging wall and possible ore extensions in this direction. Hole No. 13, which was drilled Northeast, was the only one to encounter any appreciable ore. In this case, the hole started in ore and continued in it to a depth of 15'.

Damascus Bond

A series of three holes, Nos. 18 to 20, inclusive, was then drilled horizontally from the West end of the 4th level. The drift at this point was in massive greenstone, which was apparently the footwall, but Mr. Eaton desired to test it further by drilling these holes. One was drilled Northwesterly in the line of the drift and the other two at right angles, one Northeasterly and the other Southwesterly. The Northeasterly hole encountered nothing but greenstone footwall and the other two passed from this footwall into hanging slate and quartzite without encountering iron formation. This completed the drilling at the Holmes Mine for the year.

MORRIS-LLOYD MINE.

Drilling was carried on in this property intermittently during the year.

Hole No. 64 was being drilled horizontally and S. 25° E. from the 3rd level East Lloyd Mine the first of January, 1921. The purpose here was to try and develop a lens of ore in this vicinity in which a raise could be located to tap the working sub-levels above so that the ore could be handled directly on the 3rd level without a previous transfer, as at present. The attempt was unsuccessful, the only ore encountered being a skin on the side of an old stope on the South side of the level.

A second hole, No. 65, was then drilled horizontally from approximately the same position but on a course of S. 47° E. No ore was encountered. A third hole, No. 66, was also drilled horizontally from this level but from the South end of the main South crosscut. It was drilled S. 10° E. to cross the main East Lloyd fault, penetrate the slate on the South side of the fault and into the iron formation beyond to test the latter for possible ore lenses. The hole was bottomed without finding an ~~enrichment~~ enrichment at a depth of 405' after drilling through 179' of iron formation South of the fault.

Drilling was then resumed from the West end of the main West drift on the 6th level Morris Mine. It has been the plan here to crosscut the formation for 200' or 300' with ~~a~~ horizontal holes spaced at intervals of from 300' to 400' as drifting progressed. Three such holes were drilled, Nos. 67 to 69, inclusive. Nos. 67 and 69 were drilled South. No. 68 was drilled North to locate the footwall, which was encountered at a depth of 26'. No. 69 en-

countered three narrow seams of ore, two of which are of mineable width. This drilling was then temporarily discontinued to allow a further advancement of the main level drift.

Later in the year one hole, No.70, was drilled with a dip of $-65^{\circ}\text{N}.10^{\circ}\text{W}$. from the end of the Southwest crosscut through the West ore body on lease No.9. The purpose here was to explore for the downward continuation of this ore body, which, from the 4th level down to the 6th level, had been continuous with a Westerly pitch. The hole was planned to locate the footwall of this ore, if extension was found, somewhere near the 7th level elevation, 250' below the 6th level, in order to plan the lay out of the former level to develop this ore.

Strangely enough no merchantable ore was encountered in No.70 but at about this time ore was cut in the 7th level drift, the development of which may solve the problem of the downward extension of the 6th level ore. Consequently, further drilling was given up to await these developments.

REPUBLIC MINE.

Drilling in the Republic Mine was continuous throughout the year. During that time 22 holes, Nos.467 to 488, inclusive, were completed, one old hole, No.465, was deepened and hole No.489 was drilled to a depth of 95'. The total footage amounted to 2525'.

All holes were drilled horizontally from current working levels, or levels immediately adjacent to them, according to a plan of systematic exploration which may be divided into three parts. In the first place, an attempt was made on all new levels to locate the downward extension of known ore lenses immediately above where they are not found by drifting along the quartzite hanging contact but have probably dropped back into ^{the} jasper footwall. Secondly, the hanging contact ~~shown~~ zone is explored for new ore bodies by drilling in cases where rock drifting is unwarranted until a discovery of ore is made. Lastly, a systematic exploration of the jasper formation is made back to a horizon 100' to 200' from the hanging contact as it has been the experience in this mine that all ore bodies of any consequence occur within this zone.

Three holes, Nos.477, 478 and 479, were drilled from the 2370' level No.9 Winze. All the rest were drilled from Pascoe Shaft levels as follows: No.465 from the 2270' level; Nos.467 and 468 from the 1710' level; No.469 from the 1950' level; Nos.470, 471 and 472 from the 2070' level; No.473 from the 2370' level; No.474 from the 2470' level, and Nos.475 and 476 and 480 to 489, inclusive, from the 2370' level.

Two of these holes, Nos.467 and 469, discovered new merchantable ore lenses. The first is on the 1710' level and the second on the 1950' level, both in the Pascoe Shaft, and they open up possibilities for considerable additional ore in their probable extensions.

SPIES MINE.

Six holes, Nos.8 to 13, inclusive, and aggregating 1495', were drilled from the bottom or 3rd level of the Spies Mine. The work began early in March and was completed the last of May.

Three of these holes, Nos.8, 9 and 10, were drilled from the North end of the hanging wall crosscut along the Virgil boundary to explore for a downward continuation of the ore in the East-West drift on the 3rd level in this vicinity, also to follow up the indications of an ore body disclosed by the ore encountered in holes Nos.1 and 3 drilled in 1920. No.8 was drilled with a dip of -45° S, $55^{\circ}46'$ W. on to the Virgil property; No.9 was vertical and No.10 had a dip of -45° S. 45° E. The results were disappointing, although it is possible that No.10 was stopped too soon. Holes Nos.11, 12 and 13 were all drilled horizontally from the Northwest end of the 3rd level to explore along the North footwall. These results were also disappointing except for a 10' seam of good ore in No.12 in its extension on to the Virgil and near the Northeast corner of this property. This may lead to something more encouraging when the opportunity for following it up is at hand. On account of the unfavorable position of this ore with respect to drilling for its extension from the present 3rd level workings in the Spies Mine, this part of the Virgil property should be explored by drilling from surface. It is likely this will be done in connection with the general exploration of the Virgil property.

EXPLORATIONS BY OTHER COMPANIES.

Mr. Ernest Allen, who heretofore has made periodic visits to the explorations of other companies on the Michigan and Wisconsin iron ranges, did not visit any such explorations during 1921. Very little drilling was done by other companies and on account of the business depression and resulting curtailment, Mr. Duncan thought it inadvisable to send Mr. Allen out.

The only new outside exploration which came to our attention was that instituted by the Palms-Book Land Company, three or four miles Southeast of Amasa, Michigan, on the Menominee Range. Two holes were drilled on Section 26, 44-33 on the Michigan Mineral Land Company's property, in which this Company has an interest. A third hole is now being drilled just to the North of Section 22.

Mr. Afuhs has copied for our files outside exploration results of any importance which have come to this office in the form of land offers, etc.

EXAMINATIONS OF MINERAL LAND OFFERS.

Two mineral land offers were examined and reported on during the year as follows:

Mrs. Anna Cornish's property, No. 1277.

Bar River property, No. 1291.

The Cornish property is located about four miles South of Palmer in Section 24, 46-27. There is a small remnant of a basin of iron formation lying on the granite on this property but nothing to warrant further investigation so the offer was declined.

The Bar River property is located in Ontario, Canada, about 25 miles East of the Canadian Soo, and is controlled by the Saint Antonio Mining & Exploration Company of the Canadian Soo. Mr. Jopling and myself both examined the property and found only lean ferruginous decomposed quartzite, which the Saint Antonio people had evidently mistaken for a favorable iron formation. This offer was also declined.

Tables No.V and No.VI, 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 V.

DETAILED STATEMENT OF CHARGES TO GEOLOGICAL EXPENSE FOR YEAR 1921.

GEOLOGICAL DEPARTMENT.

<u>Salaries.</u>	<u>Travel.</u>	<u>Operating Autos.</u>	<u>Supplies.</u>	<u>Office Expense.</u>	<u>Total.</u>
\$16,643.16	\$552.25	\$1,075.18	\$1,190.29	\$ 45.91	\$19,506.79

DETAIL OF LARGEST ITEMS GROUPED AS TRAVEL, OPERATING AUTOS AND SUPPLIES.

TRAVEL.

Rail travel, - - -	\$234.11
Horse maintenance, -	318.14

OPERATING AUTOS.

Tires and new parts for Buick - - -	\$146.31
Depreciation on Buick, - - - -	190.00
" " auto for Eng. & Geol. Depts. - -	45.18 (Geol prop.†)
" " truck for Eng. & Geol. Depts. - -	67.58 " "

SUPPLIES.

Rental of Maas Compasses, - - -	\$100.00
Tracing cloth, - - - -	62.09
Annual report negatives and paper -	489.44

EXPENSES OF H. L. SMYTH.

<u>Travel.</u>	<u>Supplies.</u>	<u>Misc.</u>	<u>Total.</u>
\$588.12	\$35.44	\$150.00	\$773.56

SUMMARY.

Expenses of Geological Department, -	\$19,506.79
" " H. L. Smyth, - - -	773.56
Grand total	<u>\$20,280.35.</u>

TABLE VI.

COMPARATIVE STATEMENT OF CHARGES TO THE GEOLOGICAL DEPARTMENT FOR

LAST THREE YEARS.

	<u>1921.</u>	<u>1920.</u>	<u>1919.</u>
Salaries, - - - -	\$16,643.16	\$18,846.76	\$18,890.02
Travel, - - - -	552.25	412.74	839.03
Operating autos, - -	1,075.18	1,189.45	1,000.09
Supplies, - - - -	1,190.29	1,365.96	1,309.03
Visiting Outside Explorations,	0	197.66	72.41
Miscellaneous, - - -	45.91	199.30	5.61
Total	\$19,506.79	\$22,211.87	\$22,116.19
Expenses of H. L. Smyth, i.e., travel, supplies and miscellaneous, - - -	773.56	686.19	642.52
Grand total	\$20,280.35	\$22,898.06	\$22,758.71

ANGELINE MINE

All mechanical equipment at this mine operated in a satisfactory manner during the year,

Mining operations were stopped on May 31st, but the underground pump was kept in operation for the Oliver Iron Mining Company.

Arrangements have been completed for the installation of pumping equipment by the Oliver Iron Mining Company.

CLIFFS SHAFT MINE

It was necessary to operate the steam pumps and air compressor from October 12th, 1920, to March 21st, 1921, on account of the shortage of water at the Water Power Plants.

Mining operations were suspended on May 31st, but the underground pumps are being operated.

A 15 H.P. locomotive boiler was installed in the basement of the Laboratory for heating purposes. This boiler was formerly located at the Gwinn Mine change house.

A 50 H.P. boiler, secured from the Wade-Helmer Mine, was installed in the Change House. This boiler is used as a heating plant for the Change House and General Offices. In connection with this heating plant a 2 $\frac{1}{4}$ " x 2 $\frac{1}{2}$ " Aldrich vertical triplex electric belt driven pump was installed to return the condensation from the heating system to the boiler. This plant was completed in September.

The main boiler plant was closed down on August 28th.

Electric heating equipment was installed in the Laboratory for sample work.

There were no further additions or changes at this mine and all mechanical equipment operated satisfactorily.

HARD ORE SHOPS

The only new equipment added during the year was machinery for forming motor coils.

There were no other additions or changes and all equipment operated in a satisfactory manner.

HOLMES MINE

The 800 G.P.M. Cameron centrifugal pump was sent to the Barnes-Hecker Mine in February to be used in case the flow of water continued to increase. However, it was not necessary to use this pump and it was returned to the Holmes and re-installed.

There were no other changes and no additions made at this mine. All mechanical equipment operated in a satisfactory manner.

LAKE MINE

The steam driven air compressor was shut down in March and this mine was supplied with compressed air from the Holmes Mine until May 31st, at which time mining operations were suspended. The underground pumps have been operated for the Oliver Iron Mining Company since June 9th.

The two De Laval centrifugal pumps, together with motors, etc., located in the pump station at the east end of the lake bottom, were sold to the Oliver Iron Mining Company; also one of the centrifugal pumps in the lake bottom.

In November the #6 McCully crusher and motor was dismantled and shipped to the Athens Mine.

There were no other changes and all mechanical equipment is in very good condition.

SALISBURY MINE

Mining operations at this mine were suspended on March 5th. The only mechanical equipment now in operation is the underground pumps.

ATHENS MINE

The cage hoist was equipped with a "Lilly" Hoist Control and it is giving entire satisfaction.

A #6 McCully crusher and motor, transferred from the Lake Mine, was installed near the shaft house and was placed in operation December 6th.

All mechanical equipment operated satisfactorily during the year.

MAAS MINE

The skip roads in the shaft house, which were in very poor condition, have been repaired. There is considerable more repairing to be done on the dumps and the skip roads should be repaired to the collar of the shaft. This work will be taken care of as soon as weather conditions are favorable.

The steam turbine was in operation up to March 19th.

The boiler plant was shut down March 28th.

A new 50 H.P. locomotive type boiler, purchased from The Brownell Company, was installed in an addition to the Change House for heating purposes.

A hot air heating plant was installed in the basement of the Power House.

A steam heating plant was installed in the Office.

The mine buildings are now heated from individual plants, so that it is now unnecessary to operate the main boiler plant as was formerly done.

The Prescott pump on the 2nd level has been equipped with a new Falk herringbone gear; also a gear guard. This pump should not need any repairs for some time, as it is now in good condition.

A new pyrobar roof was placed on the Power House building, making

Bond

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MAAS MINE (Cont'd)

this building fireproof, the only wood in the building being the doors and windows.

There were no further changes or additions and all mechanical equipment operated in a satisfactory manner.

MAAS CRUSHING PLANT

This plant was in operation but a short time. All mechanical equipment operated satisfactorily.

NEGAUNEE MINE

A new "Lilly" hoist control was installed on the skip hoist. This is the first installation on a direct current motor. The control operates very satisfactory in every way.

There were no other changes or additions at this mine and all mechanical equipment operated in a satisfactory manner.

SOUTH JACKSON CRUSHING PLANT

There was a little mining done in the pit, but not enough to cause any trouble with the equipment. The crusher was not operated.

BARNES-HECKER MINE

At this mine we have encountered considerable water trouble. In February the 1,000 G.P.M. Allis-Chalmers centrifugal pump on the second level burned out some coils in the motor. It was then necessary to get an 800 G.P.M. Cameron centrifugal pump from the Holmes Mine to replace the above pump until it could be repaired.

It was decided to dig a drainage ditch from the Morris Mine to Barnes-Hecker. We met with considerable difficulty. In some places it was necessary to make five cuts to complete the ditch to grade. As this work was done in the winter time the ground was badly frozen, and in the swamps the

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BARNES-HECKER MINE (Cont'd)

water and mud added to the difficulties of making headway. During the time the ditch was being dug the drifts on the three levels at the mine were bulkheaded with concrete to hold the water under control until the ditch was completed. The ditch was completed in July. The dams underground were then opened and pumped out.

In December it was decided to pump out North Lake. We started a 4,000 G.P.M. centrifugal pump at the Lake on December 24th. It is operating very well. We also expect to put a 2,000 G.P.M. pump in operation about Jan. 1st. This will give a pumping capacity of between 6,000 and 7,000 G.P.M. for the first 20 ft. After the first 20 ft. the pumping capacity will be reduced to about 2,500 G.P.M.

There were no further changes or additions at this mine and all mechanical equipment operated in a fairly satisfactory manner.

LLOYD MINE

A plunger pump, capacity 150 G.P.M., is being installed on one of the upper levels to supply water for the Location houses. This pump was formerly used at the Barnes-Hecker Mine.

There were no other additions or changes and all mechanical equipment operated satisfactorily.

MORRIS MINE

During March a new 4" six stage Allis-Chalmers centrifugal pump, capacity 500 G.P.M. against 750 ft. head, driven by an Allis-Chalmers 125 H.P. motor, was installed on the 7th level; also an Aldrich vertical triplex pump, size 7 $\frac{1}{2}$ " x 16", capacity 500 G.P.M. against 550 ft. head, driven through a set of herringbone gears by a Westinghouse Type "CW", 100 H.P., 2200 volt motor. The Aldrich pump was secured from the Mackinaw Mine. Both of these pumps are used to pump the water from the 7th level to the main pump station on the 4th level.

MORRIS MINE (Cont'd)

On August 31st a serious overwind occurred on the skip hoist. The overwind attachment had not been operating satisfactory on the morning of the accident. The hoisting engineer saw the electrician going through the engine room and stopped the hoist to tell him about it. The electrician went over to look it over. The engineer then went back to his hoist and started the skip, which was about 70 ft. from the dump, in the reverse direction. The skip went through the dump, breaking the head sheave and also the rope. The skip did not drop back in the shaft, which usually occurs, because it was wedged tight in the steel work of the shaft house. The overwind did operate, but at what point we are unable to state. This same overwind was tested on August 26th by Mr. Keast and it was O. K. at that time. There is only 3 ft. of clearance between the skip and sheave when the skip is in the dumping position. Had this hoist been equipped with a "Lilly" hoist control the accident probably would not have occurred.

There were no other changes or additions at this mine during the year and all mechanical equipment operated satisfactorily.

SECTION 6 SHAFT

There were no changes or additions to the mechanical equipment and operation was very satisfactory.

AUSTIN MINE

This mine was idle the entire year.

FRANCIS MINE

The mechanical equipment at this mine has given excellent service during the year, there being no delays of any importance.

During the summer the Ingersoll-Rand air compressor cylinders were opened up and the pistons and valves all removed and given a thorough cleaning

FRANCIS MINE (Cont'd)

and examination. The compressor is now in first class shape.

During the fall a concrete dam was built on the 1060 ft., or bottom level of the Francis Mine. This level connects with the bottom workings of the Gwinn Mine, and the purpose of the dam is the segregating of the two mines in case of a run of water or a fire in either. The dam is designed for a head of 1060 ft. of water and contains two 30" air ducts for ventilation and passage through from one mine to the other. The ducts have heavy cast iron heads that may be bolted in place to close them up in case of emergency.

GWINN MINE

Mining operations were suspended on May 31st.

Previous to the above date the mechanical operation had been satisfactory in all respects.

As the amount of water had been steadily increasing on the 11th level it was decided to install a pump on this level to throw the water up to the main pumps on the 1,000 ft. level. For this purpose the old Deane plunger pump from the Princeton Mine was installed in June.

When the Gwinn Mine was shut down the ventilation in the Gwinn and Francis mines, which had been maintained by discharge from the air compressors, became so poor that some other means of maintaining this ventilation became imperative. The pumpmen, timber and repair men could not remain underground. To provide fresh air a 38" x 48" Sirroco electric driven fan was installed at the collar of the Gwinn Mine shaft, and the shaft above the fan discharge was bulkheaded off. The fan has a capacity of 40,600 cu. ft. of air per minute, and gives excellent ventilating conditions in both the Francis and Gwinn; in fact, the air is much better in both places than ever before.

GWINN CRUSHING PLANT

This plant was operated intermittently during the months of July, August, September and October, during which time the mechanical operation was entirely satisfactory.

In August the old 36" conveyor belt became so badly worn and weakened that it was necessary to replace it with a new one. This old belt was installed when the plant was built in 1916 and had given approximately $5\frac{1}{2}$ years service, during which time over 1,238,000 tons of ore passed over it.

GARDNER MINE

This mine was idle the entire year.

MACKINAW MINE

This mine was idle the entire year. The underground pumps, however, are still in operation.

PRINCETON MINE

This mine was shut down on August 27th.

Prior to shutting down a new hoist was authorized for #2 Shaft, and also the raising of the shaft house a height of 21 ft. to secure a more rapid and safer hoisting condition.

As no work had been done toward raising the shaft house up to the time of closing down the mine, this improvement was deferred until a later date, it being desirable to curtail expenses as much as possible.

The hoist, however, had been received and its installation was practically completed at the time of closing down the mine. The designs for this hoist were worked out to incorporate the use of the 7' dia. x 8'8" face drum, the auxiliary air brake engine and indicator discarded on the old Allis-Chalmers steam driven cage hoist at the Maas Mine. The new hoist is equipped with single reduction herringbone gears, which are enclosed in an oil tight gear case. It has a hand brake for hoisting operation and an air power brake

PRINCETON MINE (Cont'd)

operated through a "Lilly" hoist control, which incorporates all of the safety features of the better and most up-to-date hoists. The motor and switchboard of the old hoist will be used on the new hoist. The design of the hoist is neat and pleasing and it is amply strong for all future hoisting operations at #2 Shaft. As a considerable saving in the price was realized by the use of the discarded parts from the Maas hoist, it is a very satisfactory job.

PRINCETON CENTRAL POWER PLANT

Service at this plant has been continuous and very satisfactory. There were no delays of any importance at any time and the operation was practically routine.

During the summer the steam turbine was given a complete overhauling, and the electrical end in particular was dismantled and thoroughly cleaned. In its present condition with proper operating care it should be good for several years service.

The boiler room equipment has all been thoroughly overhauled and put in good operating condition. The arches of the furnaces have been put in good shape, the piping all repaired and made tight and the economizer thoroughly cleaned and overhauled.

The new coal handling apparatus is all installed. It has been tested and operates satisfactorily.

The new scales for weighing coal have yet to be installed, and some of the asbestos covering remains to be put on the steam pipes.

The new pyrobar roof was completed, making this building absolutely fireproof.

PRINCETON PUMP STATION

This plant operated very satisfactory throughout the year.

The pumping has practically all been done at a very considerable saving with the new Allis-Chalmers electric driven centrifugal pump installed in December 1920.

MADE IN U.S.A.

STEPHENSON MINE

During the month of October a run of water approximating 500 G.P.M. took place on the 5th level. This water came from a drift leading to the old workings of the Austin Mine and was probably caused by some settlement in these old workings. A concrete dam was built in the drift on the 5th level of the Stephenson Mine to hold back and control this water in case the flow should continue to increase. However, after several weeks the amount of water materially decreased, while at the same time it was noticed that the amount of water pumped from the 6th level to the 5th level decreased quite appreciably. Thus the condition worked out to the advantage of the pumping operations in the Stephenson Mine by the amount of the decrease in the water pumped from the 6th to the 5th level, a distance of 60 ft.

BOEING MINE

As all machinery was installed before January 1st, the mechanical work consisted of repairs to breakdowns. The top tram car went over the trestle in January and had to be overhauled. The underground tram cars also needed some attention. The rotary dump gave trouble due to pocket timbers not being anchored solid and moving slightly.

The only trouble on compressor was with the high pressure relief valve, which leaked slightly. A new valve was supplied by the manufacturers in April to be tried out, but when the mine was shut down May 1st no further tests were made on it.

When mining operations were discontinued on May 1st all motors were removed from underground and stored on surface, with the exception of pump motors. All surface machinery was drained and greased in preparation for an indefinite shut-down.

It was necessary to take two transformers from the Substation at this mine and send them to the Hill-Trumbull Mine to replace two 150 K.V.A. transformers which were struck by lightning. Two 50 K.V.A. transformers were

MADE IN U.S.A.

BOEING MINE (Cont'd)

secured from the Great Northern Power Company for use at the Boeing Mine until repairs could be secured for the burned out transformers at the Hill-Trumbull. Repairs were received for one in August and the pumping load since then has been carried by two 150 K.V.A. transformers. Repairs for the third transformer will be purchased as soon as mine is placed in operation again.

In August the Winston-Dear Company encountered more water in stripping pit than they could handle. It was decided to put down stand-pipes and drain the water to the underground pumps. The first pipe was finished in September and since then most of the water has drained to mine. It is being handled much cheaper in this manner than with steam pumps in the pit.

CROSBY MINE

During the year only two repair jobs of any size were made. A broken right side frame on #2 locomotive was replaced, a new deck casting put on and new crank pin added to one set of wheels. In August this locomotive was moved to the Hill-Trumbull Mine to replace #19 locomotive and is still there.

After the mine was shut down on May 7th repairs were received for the Substation, which was damaged by fire the year before. Substation was rebuilt and is now in good condition, with a substantial wire fence around it.

After the machinery was drained and greased in May no further mechanical work was done at this mine.

HILL-TRUMBULL MINE

The installation of motor-generator set at the Washing Plant was completed in the spring. This is used to secure a variable feed on the pan conveyor and to drive, through belt, the rock haulage generator. This

HILL-TRUMBULL MINE (Cont'd)

set consists of a 2200 volt, 80 K.V.A., synchronous motor direct connected to a 240 volt, 55 K.W., shunt wound direct current generator. On the same shaft is a 4 K.W., 125 volt, direct current exciter. The end of this shaft is equipped with pulley to drive by belt the 25 K.W., 250 volt, 950 R.P.M., direct current generator used to operate the rock haulage electric locomotive. The only trouble experienced was with the belt drive, which was too light for the electric locomotive. This will be corrected by replacing the belt pulleys with larger ones, which will double the belt speed.

It was found necessary to rebuild the Merrick weightometer for a heavier load. Tests showed that the maximum load the belt would carry was 175 lbs. per ft., and the weightometer is now designed to carry this load.

The seasons operation wore out one set of grizzly bars, and it was also necessary to patch the picking belt in order to make it last to the end of the season.

A fish screen was added to intake at pump station, but when a section of retaining wall of storage basin was washed out the rush of water upset the screen and it will have to be rebuilt.

One bad accident occurred on the pan conveyor. A chunk of rock wedged at receiving pocket opening and broke a 14" supporting roller and tension take-up castings. The pocket opening was changed to correct this trouble.

At the Shops the new work left over from last year was completed. Connecting tracks from locomotive house to main line were put in. In January the 2,000 lb. steam hammer was operated by steam, but as soon as the electric driven compressor was started in February the hammer was changed over to air. The compressor is an Ingersoll-Rand machine, size 12 $\frac{1}{4}$ " x 12", Class NE-1, secured second hand from the South Jackson Mine. It has a piston displacement of 290 cu. ft. per minute, and is belt driven by a 50 H.P., 900 R.P.M., General Electric motor.

Repairs to shovels and locomotives were as follows:

On the 85-C Bucyrus, besides a general overhauling, the flues

HILL-TRUMBULL MINE (Cont'd)

were removed and cleaned, an asbestos covering was put on the boiler, a new house built over shovel and one leg of "A" frame replaced. This leg broke as the shovel finished up its winter work in January. The dipper sticks were also rebuilt.

The "36" Marion shovel was given a thorough overhauling, as it was in bad condition. A new house was built over it.

Most of the work on the 88-C Bucyrus shovel was on account of boom engine trouble. This was traced to a mistake in manufacture and the Bucyrus Company, when notified, sent a new boom engine cylinder casting to replace the old one.

It was necessary to re-tube the boilers on the three American locomotives.

The #19 locomotive was used until the #17 was thoroughly overhauled, then the #19 was put through the Shop. Both of these Baldwin machines were in bad condition, but were rebuilt all through and should give little trouble for some time.

At the Substation two 150 K.V.A. transformers were burned out by lightning during the summer. These were replaced with two transformers from the Boeing Mine Substation and only short delays resulted. To correct this trouble a lightning arrester was added to the secondary side and since then no further trouble has been experienced.

MEADOW MINE

A blister occurred on #2 boiler in January, but this was pounded back and no patch was needed.

After June 3rd, when production ceased, all equipment, with exception of pumps, was removed from underground. When pumping was discontinued on August 31st all pumps were removed from underground with the exception of the old Prescott compound, which was not considered worth removing, and all pipes taken from shaft. All boiler and engine house equipment was left in place.

MEADOW MINE (Cont'd)

The #20 Bucyrus shovel was moved from the Wade Mine to Meadow stockpile in July and after loading out the required tonnage was stored there, ready to remove the remainder of stockpile in 1922.

WADE-HELMER MINE

After stripping was stopped on January 12th the work of repairing the different machines was started. This work was completed and machines ready for operation in the spring.

The cab on #28 shovel in Helmer Pit caught fire in February and had to be replaced.

In March a one car rotary dump, built by the Car Dumper Equipment Co., was installed over storage pocket on 1st level, but was never used as the mine was shut down on May 28th.

In April an accident occurred to compressor, causing a 24 hr. delay. Machine was repaired and gave no further trouble.

In June one 50 H.P. locomotive type boiler from the Helmer incline boiler house was loaded on flat car and shipped to the Cliffs Shaft Mine for heating system.

With the exception of changing the three poles on the Aldrich pump, which were badly worn, no work has been done since the mine was shut down. The pumping load remains almost constant and is taken care of by the Aldrich triplex underground pump.

The central heating system was thoroughly drained and a baseburner stove set up in the Office, this being the only heater operated in November and December.

REPUBLIC MINE

The 48-cell storage battery ordered in 1920 from the Electric Storage Battery Company was received in January and installed in one of the underground locomotives.

No other equipment was received and no new work was done at this mine.

Mining operations were curtailed on May 31st, since which time mine has been working three days a week.

SPIES MINE

There were no changes or additions to the mechanical equipment at this mine.

Mining operations were suspended on May 31st, but the underground pumps are still in operation.

ELECTRICAL DEPARTMENT

The past year has been very quiet as compared to the activity which characterized the years immediately preceding and our annual report reflects this condition.

Early in the year the new high tension line from the McClure Plant to the Maas Mine was put in service, adding to our reserve capacity and insuring greater continuity of service.

With the completion of this line we have revised our switching rules and have made up new switch charts for all Substations.

The organization which we now have is well trained in caring for transmission line trouble and shows excellent co-operation with quick response.

A number of electrical storms occurred during the year, with resultant transmission trouble. An unusually severe sleet and wind storm developed in February, causing seven cases of breakdown on our transmission system. This storm caused an appreciable interruption at Republic Mine, but we were able to give service at all other points with only short interruption and had the Republic service re-established before the close of the day. There were no other interruptions which caused any appreciable delay in mining operations during the year.

The reliability of electric service for mine operation is thoroughly established.

The circuit breakers at the Carp Plant, which were destroyed by lightning in July 1920, were replaced by new ones of larger capacity and better design. We think our station equipment at the Carp Plant is now equal to that at the McClure Plant, which has proven entirely satisfactory and very reliable. As far as possible the new equipment added has been duplicate of apparatus which we have found to be reliable.

The only additions to our lines, other than the new McClure line, are a short circuit from the Holmes Mine to surface pumping station at Section 16 Mine, a line and cable from Munising to Grand Island and a short

ELECTRICAL DEPARTMENT (Cont'd)

line from the North Lake Substation to North Lake to serve pumps used in draining the lake. These lines were built largely with material on hand, which had been salvaged from temporary and discontinued circuits.

Systematic and periodical inspection of transmission lines was put into effect with our regular men and we think it a very desirable arrangement. The more important lines are patrolled every two weeks and the less important circuits monthly and reports of same tabulated and filed. A total of 42 cases of transmission line trouble occurred, about 90% of which were due to shattered insulators and apparently half of these were mechanical breakage, such as shooting or breaking with rocks by trespassers.

Our transmission losses are 1.5% less than last year and when we consider that our fixed losses, such as transformer core loss and line charging current, are unchanged under reduced load we think this is a very good record.

We have maintained a thorough and systematic testing of meters and checking of losses, and while occasional errors have appeared, as a whole the results are satisfactory.

Considerable repair work was done on the stave pipe of the Carp Plant pipe line, and this now seems to be in practically as good condition as when first built.

The McClure Plant pipe line is in good condition, also the short pipe lines at the Hoist and Au Train plants.

A new heater was installed in the surge tank at the Au Train Plant.

The Carp and McClure dams are as good as ever, with no apparent depreciation of any kind. New stop logs were provided where required.

New parts have been secured for changing the main valve at the Hoist Plant so that it may be operated by one man. This work will be undertaken as soon as weather conditions are favorable.

Considerable time has been spent and experiments made in electrifying our Laboratories. We now think we have the matter of drying and evaporating samples pretty well worked out and are making the installations necessary.

ELECTRICAL DEPARTMENT (Cont'd)

The class work among employees was expanded into a Club and the results tabulated and forwarded in a separate report.

At the close of the year the condition of stored water, and the prospects for carrying our load through the winter without the aid of steam generated current, seems very good.

Our output in 1921 shows a decided drop from last year, this being due, of course, to the curtailed operations at the mines. We have, however, disposed of considerable excess power to outside parties.

Very little new work has been done at the mines and this is covered by the individual mine reports.

The usual tables and graphic charts are appended.

During the year the following addition was made to pole lines and circuits:

<u>NEW LINE BUILT</u>	<u>POLE LINE</u>	<u>CIRCUIT</u>	<u>WIRE</u>
McClure Plant to Maas Mine - #00	39,700 ft.	39,700 ft.	119,100 ft.

Total miles High Tension 3 phase line	-	113.
" " " " " " wire	-	458.
" number " " Towers	-	377.
" miles 3 phase Primary Line	-	39.
" " " " " Wire	-	119.
" " Primary Pole Line	-	37.

ELECTRICAL DEPARTMENT (Cont'd)

SUMMARY OF OPERATING CONDITIONS - 1921.

Month	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Precipitation	0.78	0.70	3.34	5.22	1.34	2.30	4.17	2.22	5.64	1.86	1.56	1.25
Total Precipitation for 1921 (Ishpeming)	- 30.38 inches.											
Average " at Marquette	- 32.8 " (46 years record)											

CARP RIVER HYDRO-ELECTRIC PLANT

Drainage area above Intake Dam,	66.66 sq. mi.
Cubic feet Precipitation in 1921,	4,758,006,500
K. W. Hrs. generated at Carp River Plant in 1921,	11,490,910
Cubic feet water utilized (90 cu. ft. = 1 KWH)	1,034,181,900
" " " in Storage Basin Jan. 1, 1921,	204,682,000
" " " " " " Dec.31, "	273,920,000
" " " gained in 1921,	69,238,000
" " " wasted over Intake Dam in 1921,	341,236,800
Total run-off for the year 1921,	1,444,656,700
Run-off per sq. mile of drainage area,	21,672,000
Total Precipitation,	<u>1913</u> <u>1914</u> <u>1915</u> <u>1916</u> <u>1917</u> <u>1918</u> <u>1919</u> <u>1920</u> <u>1921</u> 30.11 26.53 38.4 36.83 25.46 31.05 29.50 27.40 30.38"
Second ft.per sq.mile,	1.03 .67 .93 1.29 .70 .79 .83 .73 .68

McCLURE HYDRO-ELECTRIC PLANT

Drainage area above Intake Dam,	140.52 sq. mi.
Cubic feet Precipitation in 1921, (Ishpeming 30.38")	10,028,696,800
K. W. Hrs. generated at McClure Plant in 1921,	19,493,000
Cubic feet water utilized (125 cu. ft. = 1 KWH)	2,436,625,000
" " " wasted over Intake Dam in 1921,	2,126,491,000
Total run-off for the year 1921,	4,563,116,000
Run-off per sq. mile of drainage area,	32,473,000
Second ft. per sq. mile,	<u>1920</u> <u>1921</u> 1.22 1.02

ELECTRIC POWER SYSTEM

SUMMARY OF OPERATIONS - 1921.

	KILOWATT HOURS GENERATED						TOTAL	Used by Auxiliaries	Delivered to Line	K. W. H. Sold	Losses	Cost Per K. W. H. (Incl. Depr.)
	McClure	Carp	Hoist	Au Train	Maas	Princeton						
Jan.	1,517,800	1,121,800	340,000	237,760	492,200	512,150	4,221,710	71,534	4,150,176	3,465,490	16.49%	\$.01282
Feb.	1 626 600	1 046 530	359 000	175 800	244 000	530 450	3 982 380	79 116	3 903 264	3 324 563	14.82	.01103
March	1 723 700	924 190	391 000	208 100	359 900	423 500	4 030 390	79 251	3 951 139	3 431 250	13.16	.01181
April	1 632 000	917 440	616 000	439 470	0	0	3 604 910	8 141	3 596 769	3 052 510	15.13	.00635
May	1 443 500	1 257 950	496 000	450 730	0	0	3 648 180	7 836	3 640 344	3 093 006	15.04	.00605
June	1 314 100	963 900	380 000	275 040	0	0	2 933 040	7 794	2 925 246	2 436 640	16.70	.00694
July	1 413 700	899 900	291 000	103 480	0	0	2 708 080	7 841	2 700 239	2 271 451	15.88	.00740
Aug.	1 733 100	1 061 000	334 000	53 350	0	0	3 181 450	8 346	3 173 104	2 660 972	16.14	.00601
Sept.	1 209 800	1 298 900	316 000	44 590	0	0	2 869 290	8 333	2 860 957	2 402 485	16.02	.00640
Oct.	2 052 700	545 700	396 000	95 450	0	0	3 089 850	8 816	3 081 034	2 578 734	16.30	.00640
Nov.	1 878 500	734 800	341 000	95 310	0	0	3 049 610	8 835	3 040 775	2 552 755	16.04	.00632
Dec.	1 947 500	718 800	411 000	130 910	0	0	3 208 210	9 680	3 198 530	2 681 419	16.16	.00914
TOTALS	19,493,000	11,490,910	4,671,000	2,309,990	1,096,100	1,466,100	40,527,100	305,523	40,221,577	33,951,275	15.58%	\$.00830

Note:-

Decrease in output due to curtailed operations at mines.

ELECTRICAL DEPARTMENT (Cont'd)

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

	INSTALLED TO JAN. 1, 1921	INSTALLED IN 1921	TAKEN OUT IN 1921	CONNECTED JAN. 1, 1922 TOTALS
CARP RIVER POWER HOUSE -				
Auxiliaries - 2 - 15 HP pump motors	30 HP.			
Water Supply Pump	<u>1</u>			31 HP.
ANGELINE MINE -				
Hoist	250			
Underground Haulage Set	150			
Top Tram (Stored at Mine)	10		10	
Underground Centrifugal Pump	100			
Surface Drainage Pump - East End (Sold)	<u>15</u>		15	500
CLIFFS SHAFT MINE -				
Shop	25			
No. 8 Crusher	125			
No. 5 Crushers - 2 - 25 HP motors	50			
Screens	15			
Top Tram	50			
Lower Tram #1	35			
Underground Haulage Set	100			
Hoist for "A" Shaft	500			
Underground Plunger Pump No. 1	180			
" Centrifugal Pump	250			
Compressor - Allis-Chalmers	175			
Hoist for "B" Shaft	500			
Underground Plunger Pump No. 2	200			
Laboratory Crusher	5			
Coal Crushing Plant	15			
" " " Exhaust Fan	$\frac{1}{2}$			
Lower Tram #2 (Burned up)	50		50	
Cooling Water Pump for Compressors	10			
Ingersoll-Rand Compressor #1	400			
" " " #2	<u>400</u>			3,035 $\frac{1}{2}$
HARD ORE -				
Machine Shop	7 $\frac{1}{2}$			
Carpenter Shop	25			
Blacksmith Shop Punch	3			
Winding Machine	2			
Armature Banding Machine	2			
" " "	$\frac{1}{2}$			
" " "	$\frac{1}{8}$			
Lathe Grinder	1			
Portable Drill	$\frac{1}{4}$			
" " - Large	$\frac{1}{4}$			
Commutator Slotter	$\frac{1}{8}$			
Air Compressor	10 $\frac{1}{2}$			
Water Supply Pump			<u>7$\frac{1}{2}$</u>	59 $\frac{3}{4}$
BROWNSTONE SUBSTATION -				
Test Set	$\frac{1}{2}$			
Oil Filter Press	$\frac{1}{4}$			
Battery Charging Motor-Generator Set	<u>3</u>			3 $\frac{3}{4}$
fwd.	<u>3,697$\frac{1}{2}$</u> HP.	<u>7$\frac{1}{2}$</u> HP.	<u>75</u> HP	<u>3,630</u> HP.

ELECTRICAL DEPARTMENT (Cont'd)

	INSTALLED			CONNECTED
	TO JAN. 1, 1921	INSTALLED IN 1921	TAKEN OUT IN 1921	JAN. 1, 1922 TOTALS
HARD ORE #3 SHAFT -	brt. fwd.			
Hoist	3,697½ HP.	7½ HP.	75	3,630 HP.
Underground Centrifugal Pump (Stored)	50		50	
Sinking Pump - from Gardner-Mackinaw (Stored)	35		35	
U.G. Plunger Pump - from Spies (Sent to North)				
(Lake)	<u>125</u>		125	
				25
HOLMES MINE -				
Air Compressor	340			
" " Cooling Water Pump	3			
Skip Hoist	400			
Cage "	400			
Underground Haulage Converter	150			
Machine Shop	7½			
Top Tram	25			
No. 8 Crusher	100			
No. 6 Crushers - 2 - 40 HP. motors	80			
Screens	20			
Laboratory Crusher	2			
Underground Plunger Pump	250			
" Centrifugal Pump	<u>400</u>			
				2,177½
LAKE MINE				
Underground Haulage Set	215			
Surface Drainage Pumps - 2 - 30 HP. motors	60 (Sold)		60	
" " Pump	50 (Sold)		50	
" " (Stored at Hard Ore)	20		20	
" " (Sent to Salisbury)	5		5	
Underground Plunger Pump	75			
" Centrifugal Pump	125			
U.G. Ventilating Fan (to Hard Ore for repairs)	40		40	
Ore Crusher (Sent to Athens)	25		25	
Coal Crushing Plant	<u>15</u>			
				430
SALISBURY MINE				
Hoist	400			
Underground Centrifugal Pump	400			
" Plunger Pump	100			
" Ventilating Fan	7½			
Compressor Cooling Water Pump	2			
Surface Drainage Pump	30			
Compressor	150			
Water Supply Pump (from Lake Mine)		<u>5</u>		
				1,094½
	fwd.	7,829½ HP.	12½ HP.	485
				7,357 HP.

Warranted
Bond

MADE IN U.S.A.

ELECTRICAL DEPARTMENT (Cont'd)

	INSTALLED			CONNECTED	
	TO JAN. 1, 1921	INSTALLED IN 1921	TAKEN OUT IN 1921	JAN. 1, 1922 TOTALS	
	brt. fwd.	7,829 $\frac{1}{2}$ HP.	12 $\frac{1}{2}$ HP.	485	7,357 HP.
ATHENS MINE					
Cage Hoist		400			
Compressor		325			
" Cooling Water Pump		3			
Auxiliary Compressor for Hoist Brakes		5			
Underground Ventilating Fan		15			
Sinking Pump - 1080 ft. Station		35			
" " - 2400 " "		50			
Skip Hoist Set		850			
" " " Oil Pump		1			
Shop		10			
Underground Haulage Converter		150			
Skip Pit Pump		2			
Laboratory Crusher		5			
Underground Plunger Pump #1		400			
Top Tram - 2 - 50 HP. motors		100			
Carpenter Shop		20			
Underground Ventilating Fan		15			
" Plunger Pump #2		4400			
U.G. Ventilating Fan (from Lake Mine)			40		
Ore Crusher " " "			25		
Battery Charging Motor-Generator Set (not reported previously)			$\frac{1}{4}$		
					2,851 $\frac{1}{4}$
MAAS MINE					
	(Circulating Pump	40 (to North Lake)		40	
Turbine Auxiliaries (Injection Pump		25			
(Exciter		33			
Underground Haulage Set		215			
Shop		10			
Underground Centrifugal Pump		350			
" Hoist		50			
" Plunger Pump #1		320			
Winze Pump - 4th Level		15			
Compressor Cooling Water Pump		5			
Skip Pit Hoist		15			
Top Tram - 2 - 50 HP. motors		100			
Coal Crushing Plant		15			
" " " Exhaust Fan (burned out)		$\frac{1}{2}$		$\frac{1}{2}$	
Underground Plunger Pump #2		250			
Ingersoll-Rand Air Compressor #1		400			
Small Air Compressor for U.G. Pumps		2			
Ingersoll-Rand Air Compressor #2		400			
Compressor Cooling Water Pump		3			
Rock Tram		50			
Skip Hoist		700			
Cage " "		400			
Boiler Room Fan			$\frac{1}{2}$		
Skip Hoist Rheostat Pump			2		
					3,360 $\frac{1}{2}$
MAAS CRUSHING PLANT					
Crusher		100			
Pan Conveyor		50			
Belt " "		50			
					200
	fwd.	14,214 HP.	80 $\frac{1}{4}$ HP.	525 $\frac{1}{2}$	13,768 $\frac{3}{4}$ HP.

MADE IN U.S.A.

ELECTRICAL DEPARTMENT (Cont'd)

	brt. fwd.	INSTALLED			CONNECTED
		TO JAN. 1, 1921	INSTALLED IN 1921	TAKEN OUT IN 1921	JAN. 1, 1922 TOTALS
NEGAUNEE MINE					
Underground Haulage Set		14,214 HP.	80 $\frac{1}{4}$ HP.	525 $\frac{1}{2}$	13,768 $\frac{3}{4}$ HP.
"Ilgner" Hoist Set					
Top Tram - 2 - 50 HP. motors					
Laboratory Crusher					
Auxiliary Compressor for Hoist Brakes					
U.G. Plunger Pumps - 2 - 300 HP. motors					
" Centrifugal Pump					
" Suction Pumps - 2 - 15 HP. motors					
Compressor Cooling Water Pump					
Nordberg Air Compressor					
Shop					
Skip Pit Pump					
Ore Crusher					
Ingersoll-Rand Air Compressor					
Commutator Grinder					
12th Level Plunger Pump					
11th " " Pumps - 2 - 75 HP. motors					
Exciters for U.G. Pump Motors (2)					
Hoist at #2 Shaft					
Signal System Motor-Generator Set (not reported previously) $\frac{1}{2}$					2,757 $\frac{1}{2}$
SOUTH JACKSON CRUSHING PLANT					
Hoist					
Crusher					
Compressor					325
BARNES-HECKER MINE					
Cage Hoist					
Skip "					
Water Supply Pump					
Underground Haulage Converter					
U.G. Ventilating Fan (stored at Morris-Lloyd)				15	
Underground Centrifugal Pump - 2nd level					
Top Tram					
Underground Plunger Pump					
" Centrifugal Pump - 3rd Level					
LLOYD MINE					
Skip Hoist					
Cage "					
Top Tram - 2 - 40 H.P. motors					
Ore Crusher					
Water Supply Pump installed Underground (from Barnes-Hecker) <u>50</u>					955
MORRIS MINE					
Skip Hoist					
Cage "					
Shop					
Water Supply Pump					
" " "					
Ingersoll-Rand Air Compressor					
U.G. Plunger Pumps - 2 - 350 HP. motors					
7th Level Plunger Pump (from Mackinaw Mine)				100	
" " Centrifugal Pump				175	
Centrifugal Pump unwatering North Lake (from Maas)				40	
" " " " " (from Hard Ore #3)				125	
	fwd.	20,376 HP.	130 $\frac{3}{4}$ HP.	540 $\frac{1}{2}$	19,966 $\frac{1}{4}$ HP.

MADE IN U.S.A.

ELECTRICAL DEPARTMENT (Cont'd)

	INSTALLED			CONNECTED
	TO JAN. 1, 1921	INSTALLED IN 1921	TAKEN OUT IN 1921	JAN. 1, 1922 TOTALS
brt. fwd.	20,376 HP.	130 $\frac{3}{4}$ HP.	540 $\frac{1}{2}$	19,966 $\frac{1}{4}$ HP.
MORRIS MINE (Cont'd)	1,865	440		
Laboratory Crusher	5			
Carpenter Shop	25			
Underground Haulage Set	150			
Nordberg Air Compressor	325			
Compressor Cooling Water Pump	5			
Winze Plunger Pump (Stored)	50		50	
" Centrifugal Pump "	50		50	
Triplex Pump "	50		50	
Top Tram - 2 - 50 HP. motors	<u>100</u>			
				2,915
SECTION 6 SHAFT				
Hoist	200			
Water Supply Pump	<u>3</u>			
				203
AUSTIN MINE				
Laboratory Crusher	3			
Hoist	200			
Top Tram	<u>25</u>			
				228
FRANCIS MINE				
Underground Ventilating Fan	7 $\frac{1}{2}$			
Air Compressor	403			
Underground Centrifugal Pump	400			
Skip Hoist	400			
Compressor Cooling Water Pump	3			
Shop	5			
Top Tram	50			
Underground Haulage Converter	150			
Cage Hoist	400			
Underground Plunger Pump	350			
Rock Crusher	25			
Ore Tram	<u>37</u>			
				2,230 $\frac{1}{2}$
GWINN MINE				
Skip Hoist	400			
Cage "	400			
Underground Centrifugal Pump	400			
" Plunger "	350			
Ore Tram	37			
Rock "	10			
Underground Haulage Set	150			
Shop	5			
9th Level Pump	35			
11th Level Plunger Pump (from Princeton #1)		50		
Ventilating Fan on Surface		<u>100</u>		
				1,937
GWINN CRUSHING PLANT				
Crusher	85			
Fan Conveyor	50			
Belt "	<u>40</u>			
				175
GARDNER MINE				
Hoist	400			
Top Tram	<u>25</u>			
				425
fwd.	28,049 $\frac{1}{2}$ HP.	720 $\frac{3}{4}$ HP.	690 $\frac{1}{2}$	28,079 $\frac{3}{4}$ HP.

ELECTRICAL DEPARTMENT (Cont'd)

	INSTALLED		INSTALLED TAKEN OUT		CONNECTED
	TO JAN. 1,	IN 1921	IN 1921	IN 1921	JAN. 1, 1922
	1921				TOTALS
	brt. fwd.	28,049 $\frac{1}{2}$ HP.	720 $\frac{3}{4}$ HP.	690 $\frac{1}{2}$	28,079 $\frac{3}{4}$ HP.
MACKINAW MINE					
Hoist		400			
Compressor		325			
Shop		7 $\frac{1}{2}$			
Water Supply Pump		7 $\frac{1}{2}$			
Top Tram		25			
Underground Haulage Converter		150			
" Plunger Pump		350			
Compressor Cooling Water Pump		3			
Underground Triplex Pump (not previously reported)			75		
					1,343
PRINCETON MINE #2					
Hoist		200			
Top Tram - 2 - 50 HP. motors		100			
Underground Plunger Pump		150			
" Centrifugal Pump		125			
					575
PRINCETON MINE #3					
Hoist		75			
					75
STEPHENSON MINE					
Top Tram - Bessemer		50			
Aldrich 5th Level Plunger Pump		250			
Prescott " " " "		250			
5th Level Centrifugal Pump		275			
6th " " " "		50			
" " Plunger " (not reported previously)			50		
Top Tram - C. & N. W.		50			
" " " " #2 Bell (Not reported previously)			50		
Rock Tram			25		
					1,050
PRINCETON CENTRAL POWER PLANT					
(Circulating Pump)		50			
Turbine Auxiliaries (Injection ")		25			
(Exciter)		33			
Underground Haulage Set		215			
Compressor		625			
" Cooling Water Pump		7 $\frac{1}{2}$			
Boiler Room Fan (Sent to Athens Mine)		40		40	
" " " "			50		
Coal Handling Machinery			10		
" " " "			5		
					1,020 $\frac{1}{2}$
PRINCETON CENTRAL SHOPS					
Shop Motor		25			25
PRINCETON CENTRAL PUMP STATION					
Centrifugal Pump		100			100
McCLURE PLANT					
Water Supply Pump		2			2
HOIST PLANT					
Exciter Motor-Generator Set		20			20
	fwd.	32,035 HP.	985 $\frac{3}{4}$ HP.	730 $\frac{1}{2}$	32,290 $\frac{1}{4}$ HP.

ELECTRICAL DEPARTMENT (Cont'd)

	brt. fwd.	INSTALLED	INSTALLED TAKEN OUT	CONNECTED
		TO JAN. 1, 1921	IN 1921	JAN. 1, 1922
		32,035 HP.	985 $\frac{3}{4}$ HP.	730 $\frac{1}{2}$ HP.
				TOTALS
				32,290 $\frac{1}{4}$ HP.
ISHPEMING HOSPITAL				
Passenger Elevator		7 $\frac{1}{2}$		
Dumb Waiter		3		
Large Washer		2		
Small "		1		
Extractor		2		
Vacuum Cleaner		3		
" Pump (to Hard Ore Shop for repairs)		1		1
Dumb Waiter spare on Vacuum Pump			3	
				21 $\frac{1}{2}$
REPUBLIC MINE				
Crusher		25		
"		100		
Auxiliary Air Compressor for Hoist Brakes		5		
Pump in Engine House		75		
Centrifugal Pump in Engine House		20		
Coal Tram		7 $\frac{1}{2}$		
Pump		20		
Pascoe Shaft Tram		30		30
Machine Shop		5		
Pump - 4th Level		15		
" - 3rd "		50		
Pascoe Shaft Underground Pump		50		
" " Rock Tram		15		
Portable Hoist		7 $\frac{1}{2}$		
Laboratory Crusher		3		
Picking Belt		5		
Rock Tram - 7th Level Pascoe Shaft		7 $\frac{1}{2}$		
Screen		10		
Tram (spare)		15		15
Carpenter Shop		20		
#9 Shaft Hoise - 2 - 500 HP. motors		1,000		
Motor-Generator Set for Underground Haulage		30		
Underground Hoist		100		
9th Level Winze Hoist		50		
#9 Shaft Top Tram - 2 - 50 HP. motors		100		
Pump - 11th Level Pascoe Shaft			10	
				1,730 $\frac{1}{2}$
TOTAL MINING DEPARTMENT		33,820 HP.	998$\frac{3}{4}$ HP. (776$\frac{1}{2}$)	34,042$\frac{1}{4}$ HP.
PIONEER FURNACE				
Motor-Generator Set		750		
Sawmill (8 motors)		445		
				1,195
L. S. & I. RY.				
Shops)				
Ore Dock & Pumps)				
Sawmill)		800		800
MUNISING WOODENWARE COMPANY				
Veneer Mill (13 motors)		695		695
ELECTRIC LIGHT & POWER CO., MUNISING				
City Pumping		125		125
REPUBLIC TOWNSHIP				
Water Supply Pump		25		25
GRAND TOTAL CONNECTED LOAD		36,660 HP.	998$\frac{3}{4}$ HP. (776$\frac{1}{2}$)	36,882$\frac{1}{4}$ HP.

ELECTRICAL DEPARTMENT (Cont'd)

The following motors are not connected to our General Power System:

	INSTALLED TO JAN. 1, 1921	INSTALLED IN 1921	TAKEN OUT IN 1921	CONNECTED JAN. 1, 1922
SPIES MINE				
Hoist	200 HP.			
Triplex Underground Pump	50			
Crusher	50			
Air Compressor	200			
Grinder in Shop	<u>3</u>			
				503 HP.
MESABA RANGE				
BOEING MINE				
Sinking Hoist	35			
Air Compressor	200			
Underground Plunger Pump	100			
" Centrifugal Pump	125			
" Haulage Set	150			
Hoist	200			
Top Tram	50			
Compressor Cooling Water Pump	2			
Shop	10			
Sump Pump	<u>7½</u>			
				879½
CROSBY MINE				
Hoist	75			
Air Compressor	50			
Plunger Pump	50			
Centrifugal Pump	85			
Shop	3			
Conveyor Belt	40			
Screen	20			
Picking Belt	3			
Log Washer	20			
Turbo	20			
Chip Screen	3			
Tables	20			
Underground Haulage Set	150			
Feeder Motor	20			
Shop	5			
Centrifugal Pump	85			
Sump Pump	<u>5</u>			
				654
HELMER MINE				
Pump	20			
Hoist	200			
Sump Pump	<u>5</u>			
				225
WADE MINE				
Hoist	125			
Air Compressor	150			
" " Cooling Water Pump	2			
Underground Haulage Set	150			
Machine Shop	20			
Pump	50			
Centrifugal Pump	100			
Sump Pump	5			
Ventilating Fan	15			
Top Tram	50			
Locomotive Water Pump	5			
Clear " "	<u>15</u>			
				687
fwd.	<u>2,948½</u>	0	0	<u>2,948½</u> HP.

ELECTRICAL DEPARTMENT (Cont'd)

	INSTALLED TO JAN. 1, 1921	INSTALLED IN 1921	TAKEN OUT IN 1921	CONNECTED JAN. 1, 1922 TOTALS
HILL-TRUMBULL MINE				
brt. fwd.	2,948 $\frac{1}{2}$ HP.	0	0	2,948 $\frac{1}{2}$ HP.
Temporary on Feeder	50		50	
Log Washers - 2 - 25 HP. motors	50			
Turbos - 4 - 5 " "	20			
Picking Belt	2			
Chip Screens - 2 - 2 " "	4			
Crusher	100			
Screen	7 $\frac{1}{2}$			
Sand Pumps - 2 - 10 " "	20			
Prescott Plunger Pump	150			
Centrifugal Pump	150			
Conveyor	50			
Tables	20			
Shops	30			
Punch & Shear Machine in Shop	5			
Band Saw in Carpenter Shop	5			
Compressor in Shop	50			
Total	3,662 HP.	0	(50)	3,612 HP.

The following motors are on hand (Dec. 31, 1921), but are not installed:

CLIFFS SHAFT MINE		
Top Tram (stator only)	50	
Signal System Motor-Generator Set	<u>1$\frac{1}{4}$</u>	50 $\frac{1}{4}$ HP.
GENERAL STOREHOUSE		
Spare Motor-Generator Set	15	
" from Republic concrete mixer	5	
" General Electric Top Tram	50	
" " " Pump	50	
" Westinghouse Motor-Generator Set	220	
" Allis-Chalmers	30	
" " "	10	
" General Electric Hoist Motor	400	
" from Stephenson pump	250	
" " " "	275	
" " Salisbury compressor	150	
" McClure Plant centrifugal pump	50	
" " Lake Mine " "	20	
" " Hard Ore #3 Shaft " "	150	
" " " " " " plunger pump	35	
" " Mackinaw Mine plunger pump	35	
" Auxiliary Air Compressor	<u>2</u>	1747
NEGAUNEE MINE		
Flywheel Hoist Set		350
MORRIS-LLOYD MINE		
Underground Haulage Set Motor	150	
Winze Plunger Pump (stored)	50	
" Centrifugal " "	50	
" Triplex " "	50	
Ventilating Fan Motor from Barnes-Hecker	<u>15</u>	
	315	
fwd.		2462 $\frac{1}{4}$ HP.

ELECTRICAL DEPARTMENT (Cont'd)

Motors on hand.	brt. fwd.	2,462 $\frac{1}{4}$ HP.
AUSTIN MINE		
Laboratory Crusher Motor		3
GWINN MINE		
Plunger Pump (from Holmes)		50
PRINCETON CENTRAL POWER PLANT		
Rock Crusher from Francis	25	
U.G. Centrifugal Pump from Princeton	50	
Top Tram	<u>50</u>	
		125
STEPHENSON MINE		
Layne & Bowler Pump #2		350
REPUBLIC MINE		
Spare	15	
"	10	
"	<u>30</u>	
		<u>55</u>
TOTAL ON HAND 12/31/21		3,045 $\frac{1}{4}$ HP.

Motors sold:

Lake Mine surface drainage pump	50	
" " " " pumps - 2 - 30 HP.	60	
Angeline Mine surface drainage pump	<u>15</u>	
	TOTAL	125 HP.

Motors destroyed by fire:

Cliffs Shaft Mine lower tram #2	50	
Maas Mine boiler room fan	<u>$\frac{1}{2}$</u>	
	TOTAL	50 $\frac{1}{2}$ HP.

Spare motors on Mesaba Range:

CROSBY MINE		
Pump	20	
"	3	
Sump Pump	<u>3</u>	
		26 HP.
WADE MINE		
Pump		5
HILL-TRUMBULL MINE		
Spare Log Washer Motor	40	
Temporary on Feeder	<u>50</u>	
		<u>90</u>
	TOTAL	121 HP.

ELECTRICAL DEPARTMENT (Cont'd)

Total C.C.I.Co. load connected to General Power System -	34,042 $\frac{1}{4}$ HP.
" Outside " " " " " " -	2,840 "
" connected load at Spies Mine -	503 "
" " " Minnesota Mines -	3,109
" Spare Motors on hand 12/31/21, Ishpeming District-	3,045 $\frac{1}{4}$ "
" " " " " Minnesota Mines -	121 "
" Sold -	125 "
" Destroyed by Fire -	50 $\frac{1}{2}$ "

Damascus
~~and~~ Bond
MADE IN U.S.A.

ELECTRICAL DEPARTMENT (Cont'd)

Direct current generators and exciters installed up to
Dec. 31st, 1921:

AU TRAIN WATER POWER PLANT			
Exciters (2)			34 K.W.
CARP RIVER WATER POWER PLANT			
Exciters (2)			150
HOIST PLANT			
Exciter			17½
McCLURE PLANT			
Exciters (2)			110
MAAS PLANT			
Motor Driven Exciter	22½		
Turbo "	22½		
Compressor Exciters (2)	20		
	<hr/>		65
PRINCETON CENTRAL POWER PLANT			
Motor Driven Exciter	22½		
Turbo Exciter	22½		
Compressor Exciter	12		
	<hr/>		57
REPUBLIC MINE			
Exciter #5 Engine House	7½		
" Water Power Plant	17		
	<hr/>		24½
CLIFFS SHAFT MINE			
Compressor Exciters (2)			20
HARD ORE & BROWNSTONE SUBSTATION			
Battery Charging Set	2		
Line Testing Set	½		
	<hr/>		2½
HOLMES MINE			
Compressor Exciter			10
ATHENS MINE			
Compressor Exciter	10		
Flywheel Set Exciter	15		
Skip Hoist Generator	700		
Battery Charging Motor-Generator Set	½		
	<hr/>		725½
NEGAUNEE MINE			
Skip Hoist Generator	400		
Cage " "	150		
Flywheel Set Exciter	25		
Exciters for Underground Pump Motors (2)	28		
Ingersoll-Rand Compressor Exciter	10		
Nordberg " "	10		
Bell Signal Set	½		
	<hr/>		623½
MORRIS MINE			
Ingersoll-Rand Compressor Exciter	12		
Nordberg " "	10		
	<hr/>		22
FRANCIS MINE			
Compressor Exciter	10		
	<hr/>		10
	fwd.		1,871½ K.W.

ELECTRICAL DEPARTMENT (Cont'd)

Direct current generators and exciters. (Cont'd)

	brt. fwd.	1,871 $\frac{1}{2}$ K.W.
MACKINAW MINE		
Nordberg Compressor Exciter		10
	TOTAL	1,881 $\frac{1}{2}$ K.W.

Underground haulage generators installed up to Dec. 31st, 1921:

ANGELINE MINE		
Motor-Generator Set		100 K.W.
CLIFFS SHAFT MINE		
Motor-Generator Set		100
HOLMES MINE		
Converter		100
LAKE MINE		
Motor-Generator Set		100
ATHENS MINE		
Converter		100
MAAS MINE		
Motor-Generator Set		100
NEGAUNEE MINE		
Motor-Generator Set		100
BARNES-HECKER MINE		
Rotary Converter		100
MORRIS-LLOYD MINE		
Motor-Generator Set		100
FRANCIS MINE		
Converter		100
GWINN MINE		
Motor-Generator Set		100
MACKINAW MINE		
Converter		100
PRINCETON CENTRAL POWER PLANT		
Motor-Generator Set		100
REPUBLIC MINE		
Battery Charging Set for Storage Battery		
Locomotives		20
	TOTAL	1,320 K.W.

ELECTRICAL DEPARTMENT (Cont'd)

Direct current motors installed up to Dec. 31st, 1921:

AU TRAIN WATER POWER PLANT			
Governor Control Motors	(2)		$\frac{1}{4}$ H.P.
CARP RIVER WATER POWER PLANT			
Rheostat Control	(2)	$\frac{1}{4}$	
Governor "	(2)	$\frac{1}{4}$	
		<hr/>	$\frac{1}{2}$
McCLURE PLANT			
Valve Control	(2)	2	
Rheostat "	(2)	$\frac{1}{2}$	
		<hr/>	$2\frac{1}{2}$
CLIFFS SHAFT MINE			
Portable Hoist Motor			10
HOLMES MINE			
Sturtevant Fans	(2)		3
ATHENS MINE			
Skip Hoist Motor			900
MAAS MINE			
Timber Hoist - 2nd Level		10	
" " - 4th "		10	
Bilge Pump from Holmes Mine		<hr/> 5	
			25
NEGAUNEE MINE			
Skip Hoist Motor		500	
Cage " "		200	
Timber Hoist - 9th Level		10	
" " -10th "		10	
Fan Motor		<hr/> 15	
			735
MORRIS MINE			
Ventilating Fan		15	
Sturtevant "		$1\frac{1}{2}$	
Ore Loader		2	
" "		2	
" "		2	
" "		<hr/> 2	
			$24\frac{1}{2}$
GWINN MINE			
Hoist - 9th Level		15	
Ventilating Fan		15	
" "		<hr/> 15	
			45
PRINCETON MINE			
Bilge Pump		<hr/> 5	
			5
TOTAL			$1,750\frac{3}{4}$ H.P.

ELECTRICAL DEPARTMENT (Cont'd)

Spare direct current motors on hand Dec. 31st, 1921:

CLIFFS SHAFT MINE		
Motor		6 $\frac{1}{2}$ H.P.
MORRIS-LLOYD MINE		
Fan Motor from Barnes-Hecker Mine	15	
Crane Motor	<u>10</u>	25
GWINN MINE		
Pump Motor	<u>20</u>	
TOTAL		51 $\frac{1}{2}$ H.P.

Spare underground haulage generators on hand Dec. 31st, 1921:

GENERAL STOREHOUSE		
Motor-Generator Set		150 K.W.
MORRIS-LLOYD MINE		
Motor-Generator Set	<u>100</u>	
TOTAL		250 K.W.

Spare generators and exciters on hand Dec. 31st, 1921:

CLIFFS SHAFT MINE		
Signal Set		$\frac{1}{2}$ K.W.
GENERAL STOREHOUSE & HARD ORE		
Old Hoist Exciter	22	
" " "	18	
Motor-Generator Set used for Battery charging in Hare Ore Shop	<u>10</u>	50
TOTAL		50 $\frac{1}{2}$ K.W.

ELECTRICAL DEPARTMENT (Cont'd)

MESABA RANGE

Exciters and generators installed up to Dec. 31st, 1921:

BOEING MINE
Compressor Exciter 6 K.W.

Underground haulage generators installed up to Dec. 31st, 1921:

BOEING MINE
Motor-Generator Set 115 K.W.

CROSBY MINE
Motor-Generator Set 125

HILL-TRUMBULL MINE
Motor-Generator Set 55

WADE MINE
Converter 100

TOTAL 395 K.W.

Direct current motors installed up to Dec. 31st, 1921:

BOEING MINE
Fan 15
" 15
30 H.P.

HILL-TRUMBULL MINE
Feeder Motor 60

TOTAL 90 H.P.

Total Exciters and Generators installed 12/31/21 6 K.W.

" Underground Haulage Generators " " 395 K.W.

" Direct Current Motors " " 90 H.P.

ISHPEMING DISTRICT

Total D.C. Generators and Exciters installed to 12/31/21 1,881½ K.W.

" Underground Haulage Generators " " " 1,320 K.W.

" Direct Current Motors " " " 1,750¾ H.P.

Total Spare D.C. Generators and Exciters on hand " 50½ K.W.

" " Underground Haulage Generators " " " 250 K.W.

" " Direct Current Motors " " " 51½ H.P.

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ELECTRICAL DEPARTMENT (Cont'd)

Substation transformers installed up to Dec. 31st, 1921:

<u>33,000/2300 Volts</u>	<u>NO.</u>	<u>K.V.A.</u>		<u>TOTAL K.V.A.</u>
Brownstone Substation	3	400	1 Phase	1,200
Cliffs Shaft-Holmes Substation	3	500	1 "	1,500
Morris-Lloyd Substation	3	590	1 "	1,770
Barnes-Hecker "	3	250	1 "	750
Republic "	3	400	1 "	1,200
Maas "	6	590	1 "	3,540
Princeton "	3	590	1 "	1,770
Gwinn "	3	625	1 "	1,875
Munising "	3	200	1 "	600
McClure Plant	2	5,000	3 "	10,000
Carp "	3	1,900	1 "	5,700
Au Train "	1	1,250	3 "	<u>1,250</u>
			TOTAL	31,155 K.V.A.
<u>13,000/2300 Volts</u>				
Maas Substation	1	1,250	3 Phase	1,250
Hoist Plant	1	1,250	3 "	<u>1,250</u>
			TOTAL	2,500 K.V.A.
<u>6,600/2300 Volts</u>				
Carp Plant	6	185	1 Phase	1,110
Gwinn Substation	3	350	1 "	1,050
Mackinaw "	3	350	1 "	<u>1,050</u>
			TOTAL	3,210 K.V.A.
<u>33,000/2300 Volts</u>				
Spare at Cliffs Shaft Substation	1	500	1 Phase	<u>500 K.V.A.</u>

Transformers used for Underground Haulage installed to 12/31/21:

Athens Mine converter	3	35	1 Phase	105
Francis " "	3	35	1 "	105
Holmes " "	1	100	3 "	100
Barnes-Hecker "	1	110	3 "	110
Mackinaw Mine "	3	35	1 "	<u>105</u>
			TOTAL	525 K.V.A.

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ELECTRICAL DEPARTMENT

(Cont'd)

Distribution Transformers installed up to Dec. 31st, 1921:

2300 to 220-110 Volts

	<u>NO.</u>	<u>K.V.A.</u>	<u>PHASE</u>	<u>TOTAL K.V.A.</u>
ANGELINE MINE				
Top Tram	1	5	1	
" "	1	$7\frac{1}{2}$	1	
Hoist Control	1	$7\frac{1}{2}$	1	
				20
CLIFFS SHAFT MINE				
Office Lights	1	$7\frac{1}{2}$	1	
" "	1	15	1	
Laboratory	1	5	1	
"A" Shaft Hoist	1	$7\frac{1}{2}$	1	
"B" " "	1	10	1	
Coal Crusher	2 ($7\frac{1}{2}$)	15	1	
Pump House Lights	1	1	1	
Crusher House Lights	2 (1)	2	1	
Crushers	3 (10)	30	1	
Laboratory Driers	1	<u>10</u>	1	
				103
HARD ORE & BROWNSTONE				
Light & Power	1	15	1	
Light	1	$\frac{3}{4}$	1	
Light & Power	1	$7\frac{1}{2}$	1	
Shop	1	<u>30</u>	3	
				53 $\frac{1}{4}$
HOLMES MINE				
Shop Power	3 (10)	30	1	
Engine House Lights & Power	1	5	1	
Skip Hoist Control	1	10	1	
Cage " "	1	10	1	
4th Level Pump House Lights	1	2	1	
Cage Bell Circuit	1	$\frac{3}{4}$	1	
Skip " "	1	$\frac{3}{4}$	1	
Shaft House Lights	1	$\frac{3}{4}$	1	
Pump House Lights	1	$\frac{3}{4}$	1	
Change House Lights	1	$\frac{3}{4}$	1	
Shaft House Lights	1	<u>$\frac{3}{4}$</u>	1	
				61
LAKE MINE				
Engine House Lights	2 (5)	10	1	
Underground Lights	1	$\frac{1}{2}$	1	
Shaft Lights	1	<u>$\frac{3}{4}$</u>	1	
				11 $\frac{1}{4}$
SALISBURY MINE				
Water Supply Pump	2 (2)	4	1	
Engine House Lights & Circulating Pump	1	5	1	
" " " " " "	1	2	1	
Ventilating Fan	2 ($7\frac{1}{2}$)	15	1	
Hoist Control	1	$7\frac{1}{2}$	1	
Lights	1	<u>$\frac{3}{2}$</u>	1	
				34
				<u>282$\frac{1}{2}$</u>
			fwd.	

ELECTRICAL DEPARTMENT (Cont'd)

Distribution Transformers. (Cont'd)

	<u>NO.</u>	<u>K.V.A.</u>	<u>PHASE</u>	<u>TOTAL K.V.A.</u>
			brt. fwd.	282½
ATHENS MINE				
Crusher	3 (7½)	22½	1	
Machine Shop	2 (10)	20	1	
Surface Lights & Lab. Hot Plates	3 (10)	30	1	
Pump House Lights	1	5	1	
" " "	1	2	1	
100 G.P.M. Pump	1	40	3	
Signal System	1	1	1	
Engine House Lights	1	5	1	
" " "	1	4	1	
				129½
MAAS MINE				
Lights & Injection Pump	3 (10)	30	1	
Coal Crusher & Shop	2 (10)	20	1	
Signal System	1	½	1	
Top Tram Control	1	2	1	
4th Level Pump	3 (5)	15	1	
3rd Level Pump House	2 (5)	10	1	
Bell Signal at 55 Winze	1	1	1	
Cage Hoist Control	1	10	1	
Skip " "	1	2	1	
" " "	1	3	1	
Rock Tram "	1	1	1	
Crusher Lighting	1	2	1	
				96½
NEGAUNEE MINE				
Shops Light & Power	1	7½	1	
" " " "	2 (10)	20	1	
Engine House Light & Power	2 (10)	20	1	
" " " " "	1	5	1	
Signal System	1	½	1	
No. 2 Shaft	3 (10)	30	1	
Pump House Lights, etc.	3 (7½)	22½	1	
12th Level Pump	3 (5)	15	1	
Barn	1	5	1	
				125½
SOUTH JACKSON CRUSHING PLANT				
Hoist Brake	1	5	1	
Lights	1	2	1	
				7
BARNES-HECKER MINE				
Lights	1	5	1	
"	1	7½	1	
Top Tram Control	1	1	1	
Skip Hoist Control	1	10	1	
Cage " "	1	10	1	
Pump House Lights	1	1	1	
				34½
LLOYD MINE				
Lighting	1	3	1	
Cage Hoist Control	1	7½	1	
Skip " "	1	7½	1	
				18
			fwd.	693½

ELECTRICAL DEPARTMENT (Cont'd)

Distribution Transformers. (Cont'd)

	<u>NO.</u>	<u>K.V.A.</u>	<u>PHASE</u>	<u>TOTAL K.V.A.</u>
				brt. fwd. 693½
MORRIS MINE				
Cage Hoist Control & Lights	2 (5)	10	1	
Skip " "	1	7½	1	
Signal System Lights	1	½	1	
Shop & Lights	3 (10)	30	1	
North Lake Pump & Lights	1	2½	1	
				50½
SECTION 6 SHAFT				
Hoist Control	1	7½	1	
Lighting	2 (2)	4	1	
				11½
AUSTIN MINE				
Lighting	1	10	1	
Top Tram	2 (10)	20	1	
				30
FRANCIS MINE				
Cage Hoist Control	1	10	1	
Skip " "	1	10	1	
Circulating Pump	2 (2)	4	1	
Lighting	1	5	1	
Shop	2 (10)	20	1	
Pump House Lighting	1	½	1	
				49½
GWINN MINE				
Substation Lighting	1	1	1	
Cage Hoist Control	2 (5)	10	1	
Skip " "	1	7½	1	
Engine House Lights	1	10	1	
Shaft " "	1	1½	1	
				30
GARDNER MINE				
Hoist Control	1	10	1	
				10
MACKINAW MINE				
Machine Shop	2 (5)	10	1	
Hoist Control	1	7½	1	
Signal System	1	1	1	
				18½
PRINCETON MINE				
Top Tram Lights	1	3	1	
#2 Pump House Lights	1	2½	1	
				5½
PRINCETON CENTRAL POWER PLANT				
Coal Crusher	3 (7½)	22½	1	
Power Plant Lighting	1	10	1	
Injection Pump	2 (15)	30	1	
Boiler Room Fan	2 (10)	20	1	
				82½
PRINCETON CENTRAL SHOPS				
Power & Light	2 (10)	20	1	
				20
PRINCETON DISTRICT LABORATORY				
Hot Plates	3 (10)	30	1	
				30
STEPHENSON MINE				
Rock Tram	3 (10)	30	1	
				30
			fwd.	1,061½

ELECTRICAL DEPARTMENT (Cont'd)

Distribution Transformers. (Cont'd)

	<u>NO.</u>	<u>K.V.A.</u>	<u>PHASE</u>	<u>TOTAL K.V.A.</u>
				1,061½
brt. fwd.				
REPUBLIC MINE				
G.E. Tram	2 (15)	30	1	
Lighting	3 (2)	6	1	
" & Pump	1	10	1	
" " "	1	10	1	
Engine House Lights	1	7½	1	
Hoist Control	1	25	1	
Top Tram Controls	2 (1)	2	1	
Office Lights	1	3	1	
Motor-Generator Set & Pumps	3 (7½)	22½	1	
Pascoe Shaft Hoist Control	1	7½	1	
#9 Shaft - 3rd & 4th Levels	3 (20)	60	1	
Power & Lights on Surface	3 (10)	30	1	
Water Power Plant Lights	1	1½	1	
Screen Motor & Lights	3 (3)	9	1	
Portable Hoist	1	<u>10</u>	1	
				234
AU TRAIN WATER POWER PLANT				
Power Plant Lights	1	1	1	
Operator's Dwelling Lights	1	2	1	
Power & Lights, Dixon Location	2 (5)	10	1	
" " " Grand Island	2 (5)	<u>10</u>	1	
				23
CARP RIVER WATER POWER PLANT				
Power & Light	1	10	1	
" " "	1	20	1	
Pump	2 (1)	<u>2</u>	1	
				32
McCLURE PLANT				
Power & Light	2 (10)	<u>20</u>	1	
				<u>20</u>
				GRAND TOTAL 1,370½ K.V.A.

MADE IN U.S.A.

J. G. ...

... ..

ELECTRICAL DEPARTMENT (Cont'd)

Spare Transformers on hand Dec. 31st, 1921:

	<u>NO.</u>	<u>K.V.A.</u>	<u>PHASE</u>	<u>TOTAL K.V.A.</u>
GENERAL STOREHOUSE				
General Electric	1	15	1	
Fort Wayne	1	5	1	
Westinghouse	2 (15)	30	1	
Allis-Chalmers (Lake Mine)	1	7 $\frac{1}{2}$	1	
General Electric " "	1	7 $\frac{1}{2}$	1	
" "	2 (5)	10	1	
Sinking Pump Transformers	3 (100)	300	1	
General Electric	5 (15)	75	1	
				450
MORRIS-LLOYD MINE				
General Electric	1	15	1	
" "	1	15	1	
" "	1	15	1	
" "	1	15	1	
				60
GWINN MINE				
General Electric (sump pump)	2 (3)	6	1	
				6
REPUBLIC MINE				
General Electric	3 (10)	30	1	
" "	1	4	1	
				<u>34</u>
				GRAND TOTAL 550 K.V.A.

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS of WATER PUMPED
<u>ANGELINE MINE</u>					
1916	----	5 772	6 128 112	1 060	
1917	----	38 310	23 257 417	607	
1918	442	57 814	79 443 122	1 374	
1919	423	48 580	89 137 049	1 834	57 792 500
1920	177	50 249	82 011 330	1 632	54 307 500
1921	101	23 670	50 150 525	2 118	
<u>CLIFFS SHAFT MINE</u>					
1907	8 880	302 924	692 018 970	2 239	242 599 222
1908	7 991	228 886	541 729 740	2 367	240 000 000
1909	7 328	242 573	680 932 960	2 796	166 079 249
1910	8 895	252 793	904 379 312	3 577	156 948 550
1911	8 095	246 334	898 424 112	3 647	165 101 640
1912	8 047	276 211	810 020 228	2 932	218 555 480
1913	8 027	295 105	833 987 419	2 826	276 582 240
1914	7 496	316 986	1 054 320 348	3 326	281 392 090
1915	5 181	347 955	889 280 382	2 555	283 489 900
1916	5 226	388 090	878 041 710	2 262	398 818 855
1917	4 500	377 177	885 993 944	2 349	345 847 725
1918	5 135	382 804	861 374 720	2 276	315 252 828
1919	3 494	377 901	907 895 024	2 402	298 889 689
1920	3 854	334 347	872 225 408	2 638	262 308 003
1921	2 094	67 454	273 648 228	4 057	274 901 402
<u>HOLMES MINE</u>					
1916	729	32 951	---	---	---
1917	739	90 225	425 227 500	4 712	---
1918	700	130 295	368 456 686	2 840	---
1919	947	173 178	521 145 000	3 009	(8 months) 25 471 515
1920	682	260 118	448 965 000	1 726	26 099 690
1921	832	191 147	275 057 000	1 439	38 456 053

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
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HARD ORE #3 HEATING PLANT

1913	729
1914	810
1915	883
1916	922
1917	1,038
1918	955
1919	970
1920	801
1921	1,014

LAKE MINE

1904	6 983	281 399	355 084 057	1 368	78 662 195
1905	10 346	505 321	885 737 363	1 753	77 492 105
1906	11 072	559 877	784 511 853	1 247	80 626 208
1907	10 934	549 449	773 662 287	1 410	90 105 988
1908	9 222	357 628	575 642 546	1 671	76 896 881
1909	9 640	381 060	826 433 227	2 245	81 268 184
1910	9 892	559 438	820 568 713	1 466	85 118 000
1911	7 558	309 519	583 930 820	1 886	93 643 210
1912	7 824	329 344	656 627 987	1 993	109 576 544
1913	8 059	473 848	962 459 483	2 031	95 007 553
1914	5 733	324 251	596 066 577	1 838	45 925 949
1915	6 019	359 185	586 965 354	1 634	96 375 565
1916	6 708	397 021	637 468 347	1 605	192 033 482
1917	7 181	497 272	782 431 925	1 573	134 142 986
1918	6 588	457 399	592 308 718	1 294	145 707 330
1919	5 884	334 419	510 718 170	1 527	192 626 467
1920	5 558	167 590	447 465 848	2 670	177 012 016
1921	1 804	36 772	94 270 771	2 563	203 677 901

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>SALISBURY MINE</u>					
1905	3 750	154 017	219 765 211	1 423	76 346 425
1906	3 909	152 034	219 345 241	1 461	77 100 543
1907	3 892	139 986	215 971 327	1 551	86 056 044
1908	3 606	116 724	218 591 828	1 895	66 957 839
1909	3 537	99 140	218 841 412	2 228	61 699 506
1910	3 308	113 574	162 828 098	1 433	63 430 079
1911	3 158	111 272	148 067 843	1 330	61 654 458
1912	2 788	118 635	154 493 210	1 301	55 855 799
1913	848	125 178	120 039 019	958	51 358 400
1914	583	97 318	94 530 000	971	56 786 400
1915	522	27 150	154 776 200	---	53 503 200
1916	496	100 803	273 558 000	2 713	126 831 364
1917	445	104 082	188 563 500	1 811	104 560 277
1918	436	113 073	166 455 000	1 472	100 958 079
1919	617	115 764	228 578 500	1 974	144 138 375
1920	482	112 603	216 351 000	1 921	152 694 797
1921	157	21 228	43 087 500	7 009	148 802 543
<u>ATHENS MINE</u>					
1914	231	7 404	120 048 750	---	---
1915	385	21 245	242 196 750	---	---
1916	419	26 930	2222840 000	---	---
1917	277	23 988	211 612 500	---	---
1918	609	101 394	498 600 000	---	---
1919	740	155 643	414 045 000	2 660	85 503 850
1920	593	214 601	505 035 000	2 353	82 794 824
1921	515	177 065	359 055 000	2 027	73 114 028

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>NEGAUNEE MINE</u>					
1908	10 294	300 007	210 799 982	696	638 488 540
1909	9 088	316 072	263 322 702	911	623 789 512
1910	7 913	364 111	361 923 373	993	610 209 058
1911	7 805	368 352	599 630 043	1 627	634 100 040
1912	8 003	298 308	825 468 516	2 767	696 210 397
1913	7 647	368 956	741 224 169	2 008	789 153 091 (#2 Shaft)
1914	5 269	337 792	613 144 000	1 798	395 877 353
1915	1 703	404 020	363 242 060	933	--- --- ---
1916	1 223	526 237	474 099 050	900	--- --- ---
1917	1 414	548 083	455 525 250	831	780 000 000
1918	1 293	524 869	443 996 750	845	828 575 874
1919	1 320	525 894	591 104 600	1 185	603 198 543
1920	1 095	569 895	729 139 000	1 279	610 132 854
1921	838	258 967	306 315 000	1 183	597 401 853
<u>MAAS MINE</u>					
1908	6 671	83 075	---	---	242 151 139
1909	6 494	141 510	291 338 833	2 095	231 101 590
1910	8 219	196 052	541 169 843	2 760	209 688 862
1911	7 252	---	646 245 479	---	---
1912	6 502	55 603	355 459 673	---	---
1913	8 903	287 784	915 881 473	3 182	---
1914	6 819	213 423	720 319 949	---	(3 Months) 8 336 357
1915	4 325	85 150	486 626 678	---	190 534 750
1916	8 062	272 802	763 134 066	2 797	363 273 050
1917	8 656	333 290	879 808 672	2 639	337 467 390
1918	9 351	312 634	935 128 335	2 991	510 265 180
1919	9 639	343 810	644 597 449	1 874	573 373 848
1920	5 097	351 521	571 224 659	1 625	513 176 403
1921	735	211 616	373 275 000	1 764	517 238 661

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>SOUTH JACKSON MINE</u>					
1912	381	42 790	---	---	---
1913	483	1 940	---	---	---
1914	0	15 281	---	---	---
1915	0	56 026	---	---	---
1916	0	0	(No ore taken out)	---	---
1917	0	46 994	---	---	---
1918	0	15 879	13 203 000	931	---
1919	0	56 840	---	---	---
1920	162	69 222	30 001 500	434	---
1921	48	5 051	1 935 000	383	---
<u>BARNES-HECKER MINE</u>					
1918	646	16 330	221 420 000	---	---
1919	603	29 731	---	---	(8 Months) 5 481 940
1920	410	62 426	(From Morris-Lloyd) 272 817 000	4 370	137 026 242
1921	120	3 712	38 406 000	1 034	585 904 565
<u>MORRIS-LLOYD MINE</u> (Including Sec. 6 Shaft)					
1911	---	88 792	---	---	---
1912	---	181 544	---	---	---
1913	726	209 667	---	---	---
1914	615	242 476	655 199 000	2 701	363 889 057
1915	533	298 816	722 622 750	2 418	322 295 660
1916	1 004	304 849	---	---	320 074 400
1917	886	296 589	667 908 000	2 370	319 198 700
1918	959	299 360	681 964 000	2 378	315 454 220
1919	1 132	313 887	936 264 700	2 982	340 883 140
1920	971	283 400	802 952 000	2 832	311 061 125
1921	848	234 809	681 918 000	3 067	321 064 176

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>AUSTIN MINE</u>					
1908	- - - -	204 769	- - - - -	- - - -	- - - - -
1909	- - - -	186 064	181 915 343	985	- - - - -
1910	- - - -	69 500	33 411 030	480	- - - - -
1911	- - - -	145 360	128 013 967	880	- - - - -
1912	- - - -	121 191	153 118 878	1 263	- - - - -
1913	- - - -	67 494	- - - - -	- - - -	- - - - -
1914			(Mine idle entire year)		
1915			(Mine idle entire year)		
1916	- - - -	23 697	- - - - -	- - - -	- - - - -
1917	- - - -	54 167	- - - - -	- - - -	- - - - -
1918	- - - -	759	(Mine flooded in January)		
1919	- - - -	19 212	- - - - -	- - - -	- - - - -
1920			(Mine idle entire year)		
1921			(Mine idle entire year)		
<u>FRANCIS MINE</u>					
1916	3 513	15 656	- - - - -	- - - -	- - - - -
1917	1 223	21 420	353 070 000	- - - -	66 723 400
1918	796	65 739	565 920 000	- - - -	49 625 600
1919	499	102 651	291 060 000 (Air used in Francis & Gwinn Mines)	- - - -	45 865 547
1920	479	93 548	420 340 000 (Air used in Francis & Gwinn Mines)	- - - -	45 855 040
1921	344	80 104	258 042 600	- - - -	39 415 502
<u>GARDNER & MACKINAW MINES</u>					
1916			(Mine idle entire year)		
1917	443	29 235	323 595 000	- - - -	- - - - -
1918	533	37 883	388 395 000	- - - -	- - - - -
1919	412	93 501	325 845 000	3 485	26 941 948
1920	387	139 057	367 830 000	2 645	36 770 855
1921	6	- - - -	- - - - -	- - - -	43 912 856

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>GWINN MINE</u>					
1909	2 022	---	60 638 452	---	---
1910	5 116	---	143 309 920	---	---
1911	3 400	2 548	136 216 025	---	---
1912	(Mine idle entire year)				
1913	1 583	14 376	---	---	---
1914	1 400	95 510	---	---	90 245 720
1915	807	151 474	---	---	131 676 720
1916	871	186 839	---	---	131 783 700
1917	976	191 080	---	---	148 022 900
1918	844	177 051	---	---	168 172 800
1919	1 132	154 002	---	---	199 404 200
1920	921	115 497	(Air supplied by Francis Mine)		165 004 020
1921	386	48 218	---	---	111 928 220
<u>PRINCETON MINE</u>					
1909	3 104	143 620	181 915 352	1 265	144 540 000
1910	2 582	126 047	226 054 113	1 793	138 556 000
1911	570	100 150	171 032 509	1 707	---
1912	184	22 639	48 083 876	2 123	107 537 270
1913	467	74 297	---	---	108 366 555
1914	64	772	---	---	99 939 295
1915	87	2 833	---	---	94 629 250
1916	105	2 636	---	---	136 569 170
1917	101	734	---	---	109 949 035
1918	334	182 760	---	---	112 926 605
1919	468	219 230	---	---	131 496 940
1920	476	184 912	---	---	129 512 469
1921	275	105 674	---	---	111 468 005

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
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PRINCETON CENTRAL POWER PLANT

		(Output)		
1909	4 630	606	384	494
1910	6 101	697	710	181
1911	7 493	819	304	399
1912	4 104	661	681	550
1913	2 360	---	---	---
1914	5 900	---	---	---
1915	7 092	---	---	---
1916	5 322	1 375	169	052
1917	2 121	1 051	739	302
1918	6 279	971	385	234
1919	3 614	1 236	341	627
1920	2 598	1 264	675	500
1921	3 754	839	610	000

PRINCETON PUMPING STATION

1909	598	137 037 480
1910	545	142 284 450
1911	497	153 854 205
1912	569	158 661 990
1913	633	172 438 180
1914	675	184 799 040
1915	794	202 554 240
1916	814	224 152 095
1917	986	275 717 100
1918	917	262 232 600
1919	920	237 147 315
1920	890	233 913 900
1921	259	309 992 940

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>STEPHENSON MINE</u>					
1911	4 182	239 991	384 041 898	1 600	625 253 183
1912	4 856	241 931	460 478 796	1 903	886 471 232
1913	3 420	283 146	---	---	1 028 287 849
1914	2 281	238 739	---	---	772 327 870
1915	2 220	230 575	---	---	763 638 450
1916	1 658	327 395	---	---	785 501 510 (11 Months)
1917	3 073	256 756	---	---	961 713 000
1918	1 560		(Mine flooded in December 1917)		
1919	724	1 662			
1920	2 064	205 366			1 381 633 440
1921	2 163	219 145			1 215 685 840
<u>CROSBY MINE</u>					
1911	1 493	80 976	---	---	---
1912	1 515	116 818	---	---	---
1913	3 305	207 728	---	---	---
1914	(10 Mo.) 2 151	(8 Mo.) 23 221	---	---	---
1915	250	---	---	---	---
1916	2 069	127 373	---	---	---
1917	2 504	300 142	---	---	---
1918	3 097	255 787	---	---	---
1919	2 578	208 449	---	---	---
1920	1 280	263 478	---	---	---
1921	72	89 754	---	---	---
<u>HELMER MINE</u>					
1918	3 125	216 428	---	---	---
1919	1 274	71 867	---	---	---
1920	(See Wade) (Wade-Helmer)	42 159	---	---	---
1921	855	70 578	---	---	---

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
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BOEING

1919	- - - -	2 048	- - - - -	- - - -	- - - - -
1920	491	34 428	- - - - -	- - - -	- - - - -
1921	212	26 190	- - - - -	- - - -	- - - - -

HILL-TRUMBULL

1920	7 670	191 927	- - - - -	- - - -	- - - - -
1921		333 595	- - - - -	- - - -	- - - - -

MEADOW MINE

1918	3 087	95 353	53 433 980	560	- - - - -
1919	3 247	101 113	49 352 710	488	- - - - -
1920	3 840	77 152	- - - - -	- - - -	- - - - -
1921	2 319	34 701	- - - - -	- - - -	- - - - -

WADE MINE

1918	3 820	72 305	- - - - -	- - - -	- - - - -
1919	5 516	238 644	- - - - -	- - - -	- - - - -
1920	4 095	200 254	- - - - -	- - - -	- - - - -
1921	855	70 578	(See Helmer Mine)		

REPUBLIC MINE

1917	8 755	196 996	1 582 113 000	8 031	- - - - -
1918	6 780	172 955	1 141 454 000	6 605	- - - - -
1919	5 709	185 383	1 228 202 000	6 625	34 770 380
1920	3 972	181 058	1 347 129 000	7 440	35 559 650
1921	1 436	79 761	954 242 000	11 964	35 132 398

SPIES MINE

1918	2 154	124 477	- - - - -	- - - -	- - - - -
1919	962	71 000	- - - - -	- - - -	- - - - -
1920	377	93 519	- - - - -	- - - -	- - - - -
1921	350	46 878	- - - - -	- - - -	- - - - -

COMPARATIVE TABLES (Cont'd)

Note:-

Angeline Mine - Abandoned May 31st. Underground pump operated for Oliver Iron Mining Co. since June 11th. Water pumped in 1921 not shown because pumpmen did not keep accurate record.

Cliffs Shaft Mine - Shut down May 31st.

Holmes Mine - Production curtailed May 31st.

Lake Mine - Abandoned May 31st, with exception of underground pumps, which have been operated for Oliver Iron Mining Co. since June 9th.

Salisbury Mine - Shut down March 5th.

Athens Mine - Working half time since May 17th.

Maas Mine - " " " " May 31st.

Negaunee Mine - " " " " May 17th.

Barnes-Hecker Mine - Mining operations suspended March 1st.

Morris-Lloyd Mine - Working half time since May 31st. Furnished air to Barnes-Hecker Mine.

Francis Mine - Working half time since May 31st.

Gardner-Mackinaw - Idle entire year.

Gwinn Mine - Shut down May 31st.

Princeton Mine - " " August 27th.

Stephenson Mine - Working half time since May 31st.

Boeing Mine - Shut down April 30th.

Crosby Mine - " " May 7th.

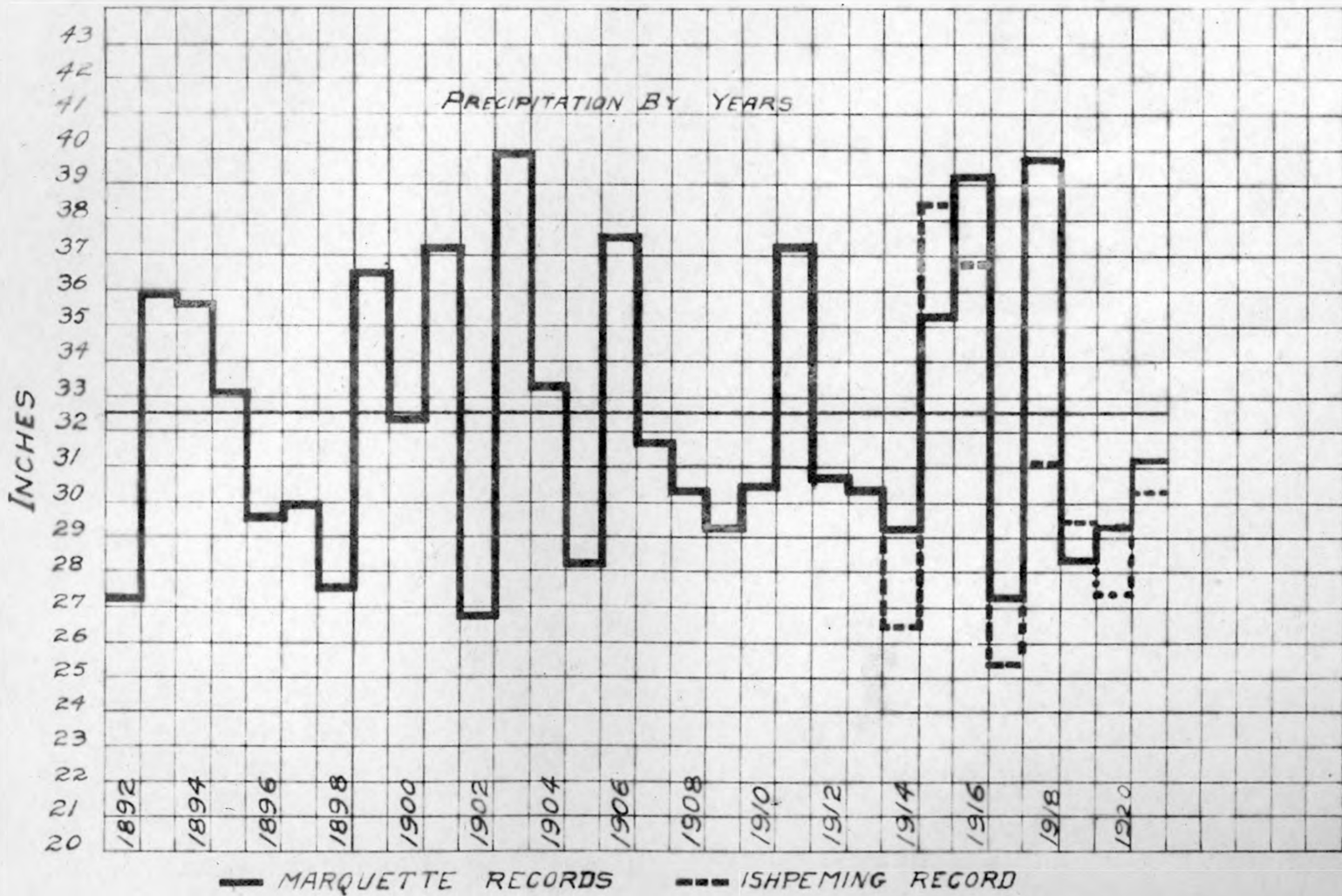
Meadow Mine - Shut down June 3rd. Abandoned entirely Aug. 31st.

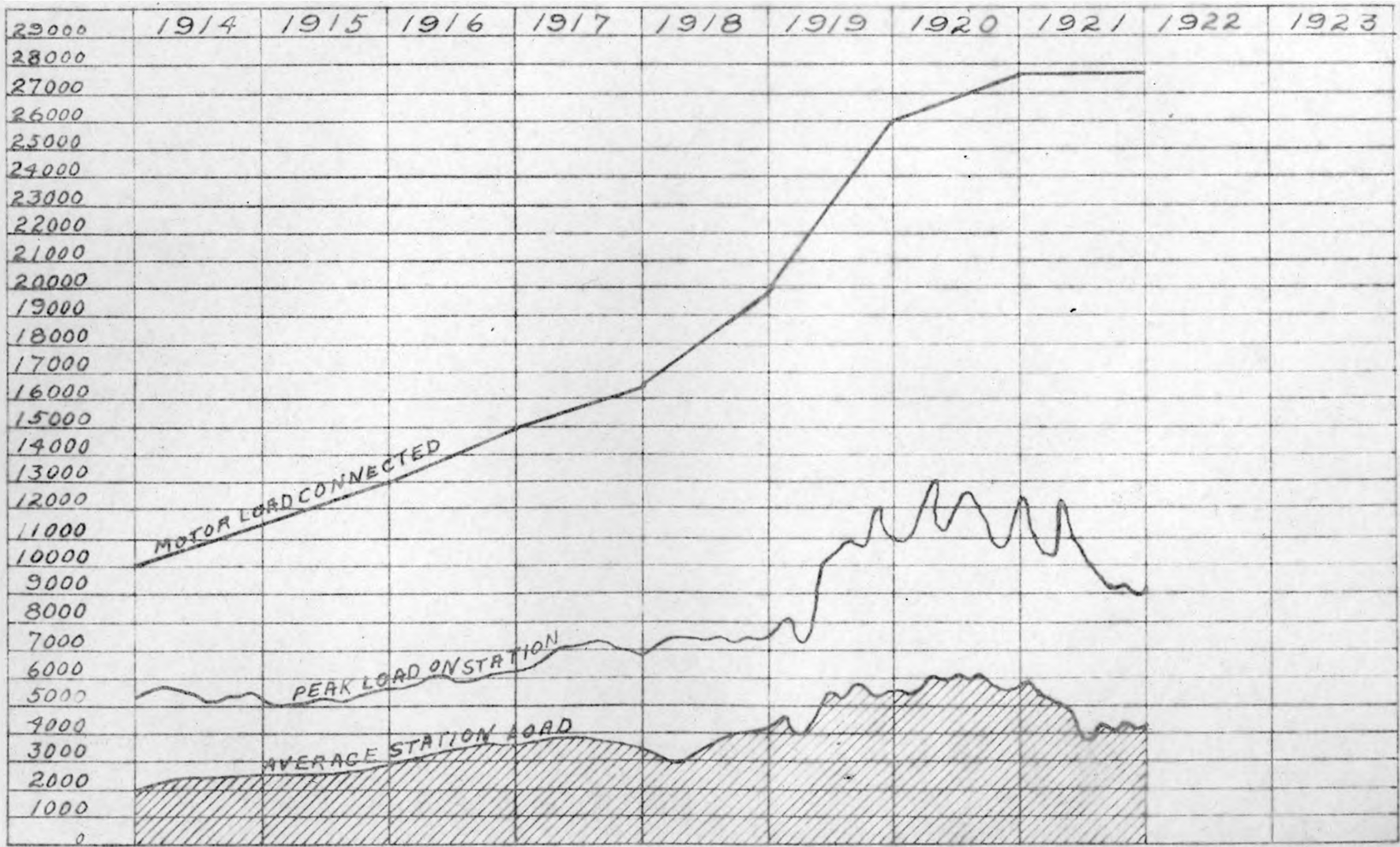
Wade-Helmer Mine - Shut down May 28th.

Republic Mine - Working half time since May 31st.

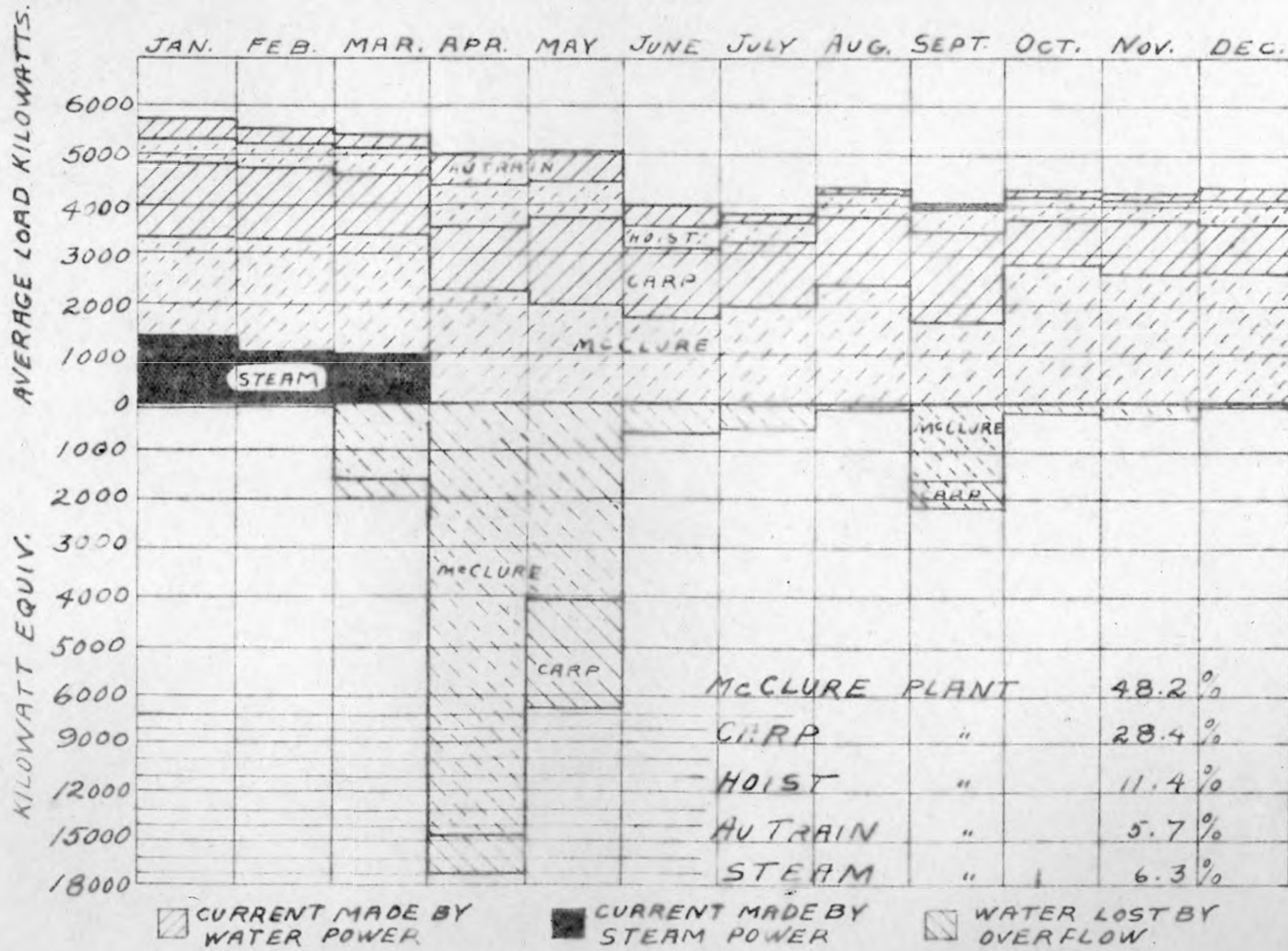
Spies Mine - Shut down May 31st.

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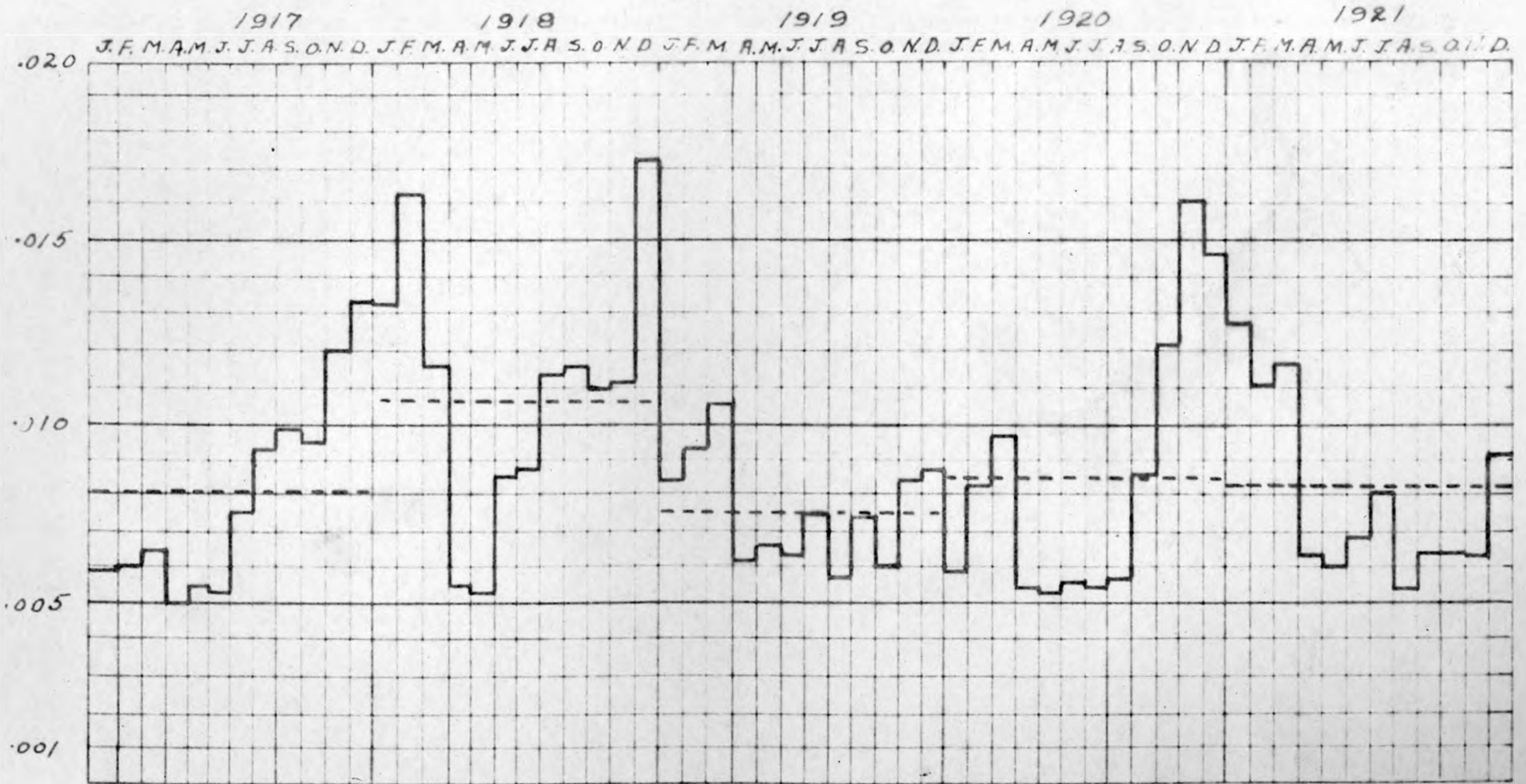


1921

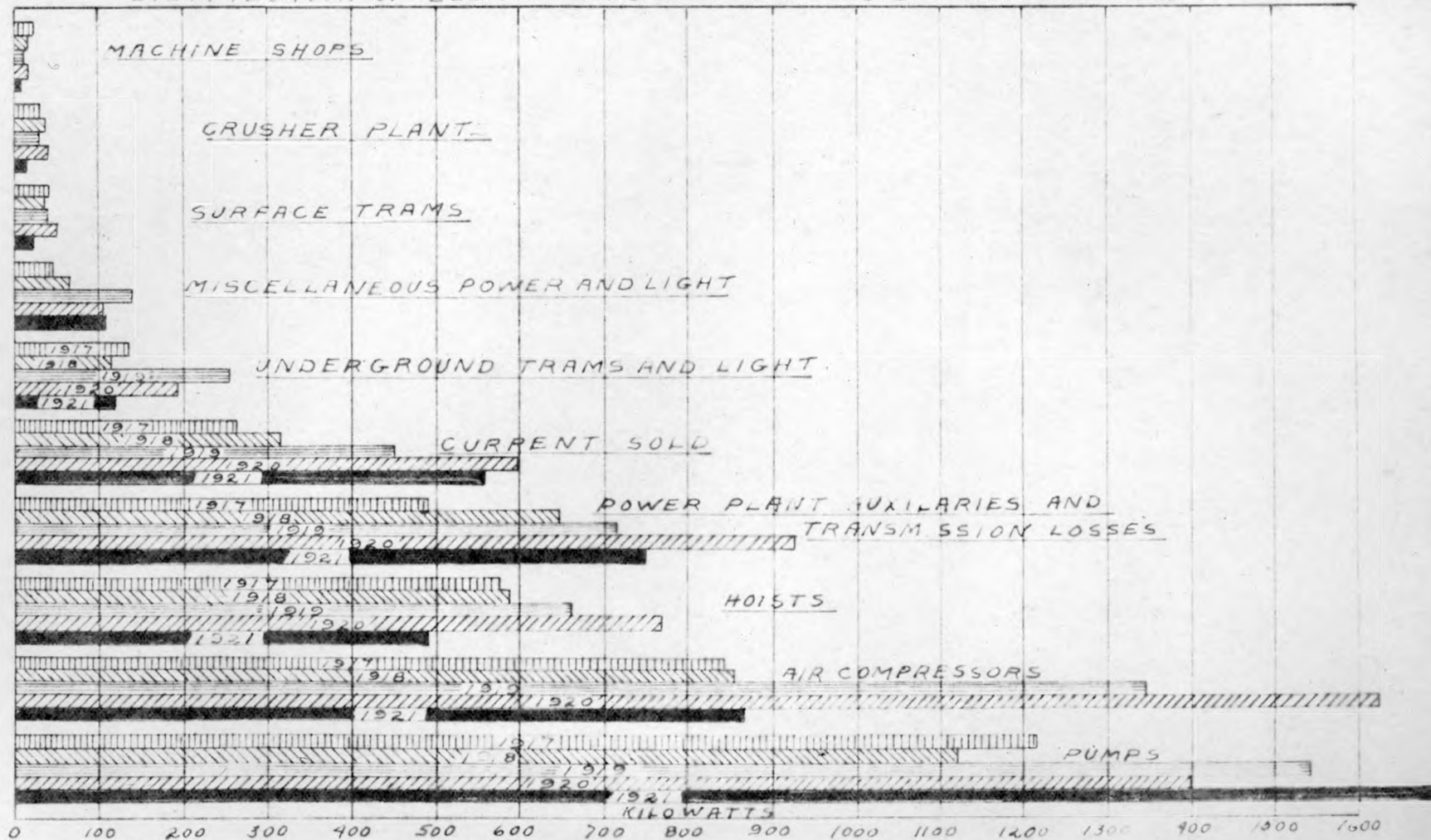


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COST DIAGRAM



DISTRIBUTION OF ELECTRIC POWER 1917-1918-1919-1920-1921



ANNUAL REPORT
OF THE (1921)
SAFETY DEPARTMENT

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The organization of the Safety Department was kept intact during 1921 notwithstanding the depression in the mining industry except to the extent that when the curtailment came in June it was necessary to lay off many men who were taking the company's regular annual course in first aid and mine rescue training. Safety inspection was conducted throughout the entire year similar as in previous years. It was directed by William Conibear, Safety Inspector, with the cooperation of the usual number of safety committees which have been utilized since the beginning of this work. J. H. Williams supervised the first aid and mine rescue training. As young men and new employees have not been available since June 1st, it has been necessary to use older employees, who were trained prior to 1921. The time of Miss Elsie Baker, stenographer, is divided between the Pension and Safety Departments.

In this report for 1921 the work of the Department is outlined under the following subjects: fatal, serious and slight accidents; safety inspection; general safety measures; first aid and mine rescue training and statistical tables.

Fatal Accidents

Six fatalities occurred at the mines last year. In the eleven years since the beginning of special safety activity there have been 84 fatalities, an average of 7.6 per year, but ^{the} fatality rate per 1000 men employed for 1921 is higher than the average annual rate since 1911. There were four years when the number of men killed was less than six and seven when it was six or more. On the basis of 300 working days per man there were employed approximately an average of 2,309 men last year, which gives a fatality rate of 2.60 per 1000 employees. The average annual rate of the past eleven years was 2.58.

Five of the fatalities were classified preventable accidents by the Central Safety Committee and one was classified a trade risk but by a divided vote, and a recommendation was adopted to prevent a repetition of a similar accident. Of the 84 fatalities which the Company sustained from 1911 to 1921, inclusive, 43, or more than one half of them, have been regarded as preventable accidents by the Central Safety Committee. The following table gives the classification of all fatalities since 1911.

TABLE I

I.	Trade Risk		40
II.	Negligence of Company:		
	Violation of Rules	4	
	Failure to Provide Safety Devices	4	
	Improper Method of Doing Work ..	3	
	Failure to Instruct Men	1	
	Failure to Provide Tools	1	
			13
III.	Negligence of Workmen:		
	Improper Method of Work.....	6	
	Carelessness.....	5	
A. Injured Men:	Violation of Rules	4	
	Failure to Use tools or applian- ces...	2	
	Failure to Use Safety Devices...	1	
			18
B. Other Workmen:	Improper Method of Work	8	
	Violation of Rules	3	
	Carelessness	2	
			13
			<u>84</u>

No fatality of last year was caused because of inexperience or unfamiliarity with their work on the part of the unfortunate men. Four were single and left no dependents and the other two were married, one was survived by a widow and the other by a widow and five small children.

With respect to causes, one man stepped or slipped into a shaft; another was thrown from a cage, falling 800 feet, and a third stepped into a shaft pocket, falling only 13 feet but was almost instantly killed. One fatality was caused by a slide of ore in a small stope and another one by the firing of a gopher hole. Both of these were due to lack of forethought on the part of fellow employees. Two occurred at the Maas Mine and one each at the Cliffs-Shaft, Stephenson, Spies and Hill-Trumbull mines.

DESCRIPTION of FATAL ACCIDENTS

Number One

Oscar Kivinen, a miner, was injured at the Cliffs-Shaft mine, January 27th, by being struck on the head by a small piece of ore which fell from the back of a stope. He did not regain consciousness and died before he was taken to the hospital.

Kivinen and his partner were mining the floor of a main level, and at 25 minutes to 5:00 o'clock of the day of the accident they blasted four holes, using fifty sticks of dynamite. They thought that the heavy blast would probably produce large chunks of ore and they returned to block-hole them. While examining the chunks a small piece of ore fell from the back, a distance of 13 feet, striking Kivinen on the head. The piece of ore was so small it could not be identified. It was classified a trade risk accident.

Number Two

Ben Lubowicki, a miner, was caught in a run of ore in a small stope at the Spies mine, March 2nd, which caused his death. This man and his partner were mining a strip of ore that extended from the 3rd level to the 2nd level. They had put up a raise in the ore from the lower level and were coning the raise upward. At the time of the accident, ore had been broken 35 feet above the 3rd level.

Several days previous to the accident trammers drew off several cars of ore from the raise, by order of the shift boss. On the day of the accident, the miners asked the boss if any dirt had been taken out of the raise.

The boss made an examination and when he found the chute was full he reported to the miners that no ore had been taken. The miners started to drill and the broken ore, upon which they stood, caved, drawing Lubowicki and partly burying him. He died before his partner and other miners were able to remove him. It was classified a preventable accident as the foreman had failed properly to instruct the men as to the hazard of their work.

Number Three

Edward Spencer, a cage rider, was killed at the Maas mine, March 14th, by falling from the cage when it was being hoisted from the 4th level to the 3rd

level. He fell to the bottom of the shaft, a distance of 200 feet.

The Masas mine cage has two decks; the lower one is used for timber, tools etc., and the upper one for men. On the morning of the day of the accident, Spencer first lowered the miners to the different levels and then went to the 4th level to send up trucks. He placed a truck on the lower deck, and after giving the signal to hoist to the 3rd level, he got on the same deck and also failed to throw the locking device, which has been provided on all cages to hold trucks in a stationary position. One end of the truck caught in the shaft timber and Spencer was thrown out of the cage. It was classified a preventable accident, due to a violation of rules on the part of Spencer.

Number Four

Frank Uitto, a surface timber trammer, stepped into the Stephenson mine shaft, at the timber tunnel, March 21st, and fell to the bottom of the shaft, a distance of 800 feet.

When the accident occurred the cage was at the collar of the shaft and the electric light at the tunnel entrance to shaft was not burning. Uitto and his partner had sent down three trucks of timber and had a fourth truck loaded, waiting to send down. Uitto walked through the tunnel to the cage to see if there was an empty truck in it. How he fell into the shaft is unknown, as the entrance is guarded by a heavy gate and an electric light within ten or twelve feet of the shaft was burning. The gate was found ajar about two feet and it is surmised that he may have been waiting for the cage, standing with the door open and accidentally slipped in the shaft, as the place was very slippery, due to a rain and hail storm, which had occurred the previous night. It was classified a preventable accident, caused by negligence on the part of Uitto because he failed to use a lantern which had been provided, in case the electric lights were out.

Number Five

Rade Blamisich, an open pit employee, was fatally injured at the Hill-Trumbull mine, July 22nd, death resulting about one week later. When the accident occurred this man and his partner, Nick Skorich, were springing a hole, using four buckets of water for tamping. Blamisich was pouring the water and Skorich

stood ready with the wires and dry cell, as it was necessary to act quickly before the water seeped away. While Blamisich was pouring the second bucket of water, Skorich evidently brought the wires in touch with the battery and exploded the charge. Skorich could offer no explanation. These men were brother-in-laws. It was classified a preventable accident, due to carelessness on the part of Skorich.

Number Six

Alfred Franzen, a timberman, was killed at the Maas mine, September 8th, by stepping into the 3rd level pocket and falling 13 feet. He was lowered to this level with the first cage load of men at 7:40 A. M. He then entered the pump station to fill his carbide lamp with water, After lighting his lamp, he returned to the shaft and started for the end of the drift, opposite the pocket, to get a drink, and walked directly into the pocket. In spite of the fact that he carried a lighted lamp in his hand and other workmen, who were near him, also had lights, it is surprising that this accident was possible, especially when he was known to be very familiar with the place. The accident was classified preventable because it is the usual practice to equip pocket openings with cables or bars, thus reducing the size of the openings and reducing the probability of workmen falling into the pockets. This device had been installed but had been taken out because the ore, being chunky, caught the pedestals of the haulage cars and ripped them off.

TABLE II

Showing number of fatalities and rates per 1000 employees for eleven years prior to safety work and also for eleven years of safety work.

Year	Fatalities	Rate	Year	Fatalities	Rate
1900	4	3.38	1911	5	1.89
1901	9	6.83	1912	4	1.71
1902	8	5.38	1913	11	4.12
1903	8	5.15	1914	10	4.10
1904	4	2.97	1915	5	2.15
1905	12	6.54	1916	8	2.81
1906	10	4.13	1917	6	1.73
1907	17	5.97	1918	13	3.45
1908	6	2.52	1919	11	2.79
1909	13	5.15	1920	5	1.21
1910	20	6.88	1921	6	2.60
	<u>111</u>	<u>4.98</u>		<u>84</u>	<u>2.58</u>

Tons of ore mined per fatality	176,684	335,813.
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SERIOUS ACCIDENTS

A total of 351 accidents, including fatal, serious and slight, were reported for the year, at this time of writing, January 5, 1921. This is at the rate of 152 per 1000 employees, which is the lowest rate since 1913, when the State Compensation Law went into effect in Michigan and since when accurate information has been recorded by all mines of its slight accidents. There were 145 serious accidents, or 62 per 1000 employees. This compares with a rate of 54 for 1920, 61 for 1918 and also 1919, and higher rates for the other years since 1913. Both the serious and slight accidents have diversified causes, so that it is practically impossible to select a few particular causes as responsible for them and to which concentrated effort might be made to reduce them.

The following list includes the very serious accidents, all of which incapacitated the injured men six months or longer.

TABLE 111

<u>Mine</u>	<u>Name</u>	<u>Date of Injury</u>	<u>Cause</u>	<u>Nature of Injury</u>	<u>Classification</u>
Angeline	Louis Farley	Feb. 2nd.	Lifting timber	Sprain, resulting in spinal tumor.	Trade Risk
Athens	Edward Prideaux	"	Struck head against drift.	Infected wound.	"
Francis	Andrew Pelki	Jan. 25th	Lifting weight	Fractured leg.	"
"	Ole Johnson	" "	Contact elec. wire	Burnt face	"
M-Lloyd	John Lehtimaki	July 15th	Fall of ground	Fractured leg	"
"	W. H. Quayle	" 21st	" " "	" "	Preventable
"	John Macki	" 8th	Riding Motor	" "	"
Negaunee	Samuel Sims	Aug. 27th	Ran wire in hand.	Infected wound	Trade Risk
Princeton	Battista Paris	Mar. 17th	Caught by motor car	Fractured foot.	"
"	Matt Melimaki	Aug. 21st	Fall of ground	" "	"
Republic	Alfred Power	Jan. 21st.	Caught in hoist brake.	Punctured elbow	Preventable
Stephenson	Battista Dell-angelo	Feb. 1st	Fell off ladder	Fractured leg	"
"	Gust Wirtanen	Feb. 14th	Fall of ground	" "	Trade Risk
"	James Possillippo	Apr. 19th	Lifting timber	Strained back	" "
Gwinn	Victor Salminen	Mar. 3rd	Fall of ground	Bruised leg	" "