

HILL-TRUMBULL MINE
ANNUAL REPORT
YEAR 1940

8. COST OF
OPERATION:
(Continued)

d. Detailed Cost Comparison: (Continued)

(2) Open Pit Mining: (Continued)

levels in 1940 was more compact and could not be readily handled without shaking. Power Shovels Operating was \$.004 higher than the budget and \$.003 higher than the 1939 cost. The rocky conditions in the areas mined on the north side of the Hill pit were such that the shovel was unable to keep a sufficient quantity of ore moving to the mill, and it was necessary to work another shovel at the same time, to augment the supply. Power Shovels Maintenance was \$.003 higher than the estimate, but very close to the 1939 figures. More repairs were required than anticipated, when the budget was prepared. Track Expense was \$.003 under the budget and only \$.001 over 1939. More track work was provided for in the budget than was found necessary in actual operations. There was a cost item of \$.001 for Trucks Operating and a like amount for Pit Roads and Ramps included in the 1940 costs. These items were not set up in the budget and there were no trucks used in 1939. The total of these several items show a cost of \$.005 above the budget and \$.009 above the 1939 figure, while on a concentrated basis the difference is \$.014 under the budget and only \$.001 over 1939. This apparent inconsistency is explained by the fact that in calculating the crude ore costs on a concentrated basis, the percentage of tonnage necessary is an important factor, as it determines the quantity of wash ore required to produce the season's tonnage of concentrates. In preparing the budget estimate, a recovery factor of 54.00% - (based on hand-wash tests) was used, while that actually realized was 58.95%. In 1939, the recovery was 57.75%. The smaller tonnage of wash ore required with the higher recovery factors results in a lower cost per ton on a concentrate basis, except as it may be effected by the variations in the individual items.

(3) General Pit Expense:

Only three items materially effect the costs for 1940, as compared with the budget and 1939; the others being practically the same. Pumping and Drainage was \$.004 under the budget and the 1939 cost. There was a very small charge to this account in 1940, while in 1939, rather extensive repairs were made to the pumps and a heavier pumping schedule maintained after the 1938 shut-down. Less pumping was required than was provided for in the budget. Waste Pile Expense was \$.001 over the budget and \$.002 over 1939, there being no charge in the latter year. This item was higher in 1940 on account of the rock that was removed from the north Hill area and the lean material from the direct ore area. The largest difference is in Structure Drilling, which is \$.012 above the budget and \$.013 higher than in 1939. There was a deferred charge of \$28,659.97 as a result of the drilling program carried out in 1939 and, at the time the budget was prepared, only one-half of this money was provided for. Later, it was decided to take up the full amount and that accounts for the comparatively higher cost for this item. In 1939, a fixed charge was placed against production to take up a portion of that year's drilling expense and the residue remaining from 1937.

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8. COST OF OPERATION:
(Continued)

d. Detailed Cost Comparison: (Continued)

(4) Concentrating:

The 1940 cost per ton was \$.012 under the budget and \$.011 under that for 1939. Transportation to Mill and Washing were less by \$.007 and \$.005, respectively, than the budget and \$.002 and \$.001 lower than in 1939. These differences are explained, in both cases, by the fact that the wash ore treated was of better grade than estimated and also superior to that handled in 1939. Maintenance - Building and Machinery was \$.002 above the budget and \$.009 under the 1939 cost. The higher cost in 1939 is largely due to the extensive work done on the dikes in preparing the new tailings basin.

(5) General Mine Expenses:

A comparatively small difference is found in the numerous items under this caption, as between the 1940 costs, the budget and those for 1939. The accumulated differences, as carried into the totals, show the 1940 costs to be \$.016 under the budget and \$.012 under 1939.

Idle and Winter Expense was \$.013 over the budget and \$.038 above the 1939 figure. The low 1939 cost was realized because repair work was carried on in the shops and at the washing plant during 1938, although the mine was not operated in that year. This, together with the fact that stripping operations were conducted to the end of 1939 and the mine equipment was not overhauled in the fall, necessitated only a light repair program in 1939.

9. EXPLORATIONS:

No drilling campaign was undertaken during the past year. The tentative program laid out for the drilling of the bottom of the Hill pit in 1940 was postponed, because of uncertain conditions effecting the Hill-Trumbull lease, but it is now the intention to do this work in 1941.

There are two marginal areas that should receive attention in the near future. One on the north side of the Hill pit, west of the taconite island, and the other south of the Trumbull area which lies immediately east of the main approach. These pieces of ground have always been considered as possible extensions of the proven ore body, but, from the standpoint of taxes, it has not been deemed advisable to bring this ore into the picture. However, during 1940, the State Tax Commission engineers made a re-estimate of the property and included substantial tonnages in these areas, and the exploratory work could now be done without greatly affecting the taxable valuations.

Considering the comparatively heavy schedule of production applied to the Hill-Trumbull Mine during the past several years, and

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9. EXPLORATIONS
(Continued)

that anticipated for the future, it would be advisable to determine the tonnage, grade and character of the desirable ore, outside of the present pit limits, in order to properly place it in the general plan of operation during the remaining life of the property.

10. TAXES:

The following statement shows the taxes and average rate at the Hill-Trumbull Mine for the years 1940 and 1939:

	1940	1939	Increase	Decrease
Hill Mine,	\$56,314.60	41,595.53	14,719.07	
Trumbull Mine,	63,963.97	56,793.22	7,170.75	
Hill-Trumbull Shops,	833.10	824.71	8.39	
Hill-Trumbull W.P.Lands,	3,126.99	3,045.22	81.77	
Personal Property,	3,857.92	2,344.94	1,512.98	
TOTAL, -----	\$128,096.58	104,603.62	23,492.96	
Village Lots,	501.44	493.92	7.52	
GRAND TOTAL, -----	\$128,598.02	105,097.54	23,500.48	
Average Tax Rate,	90.05	85.96	4.09	

The increase in the taxes at the Hill-Trumbull Mine is accounted for, mainly by the fact that there was a substantial increase in tonnage as a result of a new estimate and a review of that property by the State Tax Commission's engineers.

The taxes on the shops and washing plant lands are higher than in 1939 due to an increased tax rate.

The Personal Property taxes were increased through the transfer of equipment from the Canisteo Mine and through a higher tax rate.

The tax rate on the village lots was also higher, with a resulting increase in the taxes.

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12. NEW CONSTRUCTION
AND PROPOSED
NEW CONSTRUCTION:

A "ramp" was built in the pit which will be used in connection with truck haulage for both direct and wash ore.

In anticipation of a more extensive use of trucks in the 1941 ore operations, it will be necessary to build a one unit repair garage in the vicinity of the ramp.

13. EQUIPMENT AND
PROPOSED
EQUIPMENT:

The following equipment was received during 1940:
One 5 x 14 double-decked Robins vibrating screen, to replace the old trommel in the washing plant. An Austin-Western road patrol and a second-hand power sprinkler for use on the pit roads. One second-hand 120-B - 4-yard electric shovel from the Canisteo Mine.

Provision has been made for the addition of three Euclid trucks and one RD-8 "Caterpillar" Tractor, to the pit equipment - and two Akins classifiers, one Koehring Dumptor truck and one second-hand dragline, to the washing plant equipment.

19. NATIONALITY
OF EMPLOYEES:

<u>NATIONALITY:</u>	<u>NO. OF MEN</u> <u>1940</u>	<u>NO. OF MEN</u> <u>1939</u>
English, -----	16	35
Jugo-Slav, -----	33	27
Swedish, -----	28	26
German, -----	19	25
Finnish, -----	29	30
Croatian, -----	-	19
Irish, -----	9	13
Norwegian, -----	7	11
French, -----	4	7
Italian, -----	5	6
Bulgarian, -----	4	4
Welch, -----	1	1
Bohemian, -----	-	1
Polish, -----	-	1
Swiss, -----	-	1
TOTAL, -----	155	207

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19. WASHING PLANT
OPERATIONS:

Operations at the washing plant were started on May 6th and completed for the season on September 30th. The working schedule was conducted on three 8-hour shifts, five days per week, throughout the season. Operations were quite satisfactory during 1940, with an average daily production of 7,152 tons of concentrates, which is the highest ever realized at this property.

On account of the limited number of cars furnished by the railroad company, it was necessary to place concentrates in stockpile quite frequently, from the latter part of June to the end of the season.

A total of 1,298,142 tons of wash ore was treated during 1940, yielding 765,330 tons of concentrates.

The complete washing plant data for the year was as follows:

	<u>TONNAGE</u>	<u>% IRON DRIED:</u>	<u>TONNAGE RECOVERY</u>	<u>IRON UNIT RECOVERY:</u>
Crude Ore and Rock Mined,	1,333,862	41.69		
Less: Rock Removed in Mining,	17,987	32.25		
Crude Ore Transported to Mill,	1,315,875	41.81		
Less: Rock Rejects in Crusher House,	<u>17,733</u>	<u>29.71</u>	-----	-----
Crude Ore Entering Mill,	1,298,142	41.98		
Concentrates Produced,	765,330	59.44	58.96	83.48
Rock Rejects on Mill Picking Belt,	2,460	23.76		
Tailings (By Deduction)	<u>530,352</u>	<u>16.87</u>	-----	-----
Total Heads (as above)	1,298,142	41.98		

The analysis of the product from the various machines for 1940, was as follows:

	<u>IRON</u>	<u>PHOS.</u>	<u>SILICA</u>
Logs, -----	60.56	.047	6.26
Classifiers, -----	55.82	.043	12.73
Picking Belt Concentrates, -----	59.13	.044	8.25
Tailings, -----	18.05		

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19. WASHING PLANT
OPERATIONS:
(Continued)

The analysis of the plant rejects for the year 1940 was as follows:

	<u>TONS</u>	<u>IRON</u>	<u>PHOS.</u>	<u>SILICA</u>
Hill, -----	16,005	29.43	.032	52.52
Trumbull, -----	4,188	27.27	.031	54.77
Total, -----	20,193	28.99	.032	52.98

The rock removed from the pit and placed on the dumps during 1940, together with the analysis, follows:

	<u>TONS</u>	<u>IRON</u>	<u>PHOS.</u>	<u>SILICA</u>
Hill, -----	17,987	32.25		
Trumbull, -----	-	-		
Total, -----	17,987	32.25	-	-

During mining operations, 113 tons of Hill lean ore were removed and placed on the lean ore dump.

The weight recovery realized during the 1940 season was 58.96%, as compared with 57.75% in 1939. The increase is due to the higher grade crude ore mined in 1940.

The iron unit recovery for 1940 was 83.48%. The decrease from 86.81%, realized in 1939, was due to the fact that the greater portion of the wash ore treated was quite fine and of a porous nature, resulting in a higher loss of iron in the tailings.

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11. ACCIDENTS
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INJURYa. Fatal Accidents

Accidents during the year caused five deaths. For the first time since 1910 and the second time since 1926 five fatalities occurred within a year.

Description of Fatal AccidentsFatal Accident No. I

Morris H. Strand, a laborer, was injured on May 27, 1940 at the Canisteo Mine and died in a hospital at Hibbing four days later.

A crew of men was engaged in getting the mill ready to operate when this accident occurred. Towards the end of the day's work, when the logs were turned over, a heavy grinding indicated something was wrong in the gear housings. Strand and several more men were called back after supper to adjust the gears. It was necessary to remove the lower housing of the south gear and, as the crew of four men were working there, the log paddles went into motion. Strand was pulled down between the paddles and, although prompt action was taken to stop the movement of the revolving log, his body was badly crushed.

The district electrician was working at the relay panel the same time as the mechanical crew was working on the logs. In some manner he made the electric contact that started the log. The failure to pull the switch and lock it made possible this very sad fatality.

Strand was married, age 30 years, and had been employed since 1930.

Fatal Accident No. II

Victor Vaisanen, a miner, was instantly killed on the 11th level, Negaunee Mine, at 5:45 P. M., May 31, 1940. His death was due to a chunk of ore falling on his head.

On reaching their working place on the afternoon shift, Vaisanen and his partner, Eino Kivisto, scraped some broken ore out from the breast to the chute and then set up a cap on the leg on the left hand side of the breast and rested it on broken ore. Forepoles and an "H" beam had been put in by the previous shift. When the shift boss, Abel Laitinen, reached this place about 5:00 o'clock he told Vaisanen to catch up the

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back above the forepoles with lagging, as there was a slab of ore left under the jasper hanging which looked as though it might fall. The jasper was showing in the back of the breast, pitching downward at a slight angle and only one more cut remained to be mined before reaching an old mined area.

The miners pulled some lagging into the breast and Vaisanen started to lag on top of the forepoles on the right side of the slice. The left side had been lagged by the previous shift. There was only about $2\frac{1}{2}$ feet opening above the broken ore, and Vaisanen, instead of inserting the lagging from the side, crawled into this narrow space and reached back over the forepoles to block up to the back. He gradually pulled himself above the forepoles directly under the ground in the back. His partner noticed that small pieces of ore were dribbling and called to him to get out. However, Vaisanen continued at the work and a piece of ore loosened from the hanging and fell, catching his head above the poles.

The conditions in the working place were the same as in all places in the mine. The miners were advancing under new ground and therefore were using forepoles and "H" beams for their protection should any material fall from the back. The distance above the forepoles was normal and there was no unusual hazard existing at the time of the accident.

Vaisanen had been employed at the Negaunee Mine since 1903. He was nearly 65 years of age and is survived by a son and daughter.

Fatal Accident No. III

John Vivian, a steam shovel craneman, was buried under a stockpile slide of ore at the Spies-Virgil Mine on September 20, 1940 and died before being extracted.

Prior to this accident there had been a slide of ore out of which three railroad cars had been loaded. As the shovel was swung around to the bottom of the stockpile for another dipper of ore the chain broke. The surface foreman looked the situation over and decided it was safe to repair the chain with the dipper at the foot of the stockpile. He proceeded to do so with the assistance of four men. The fireman stood

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on the shovel, watching the men at work and the stockpile. The top of the pile caved and the fireman shouted an alarm. A wave of ore, two to three feet in thickness, slid down catching the men before they could escape. The foreman was caught up to his hips in ore and Vivian was completely covered. The former was released in about fifteen minutes and shortly after Vivian's head was uncovered but it was evident that he was dead.

This fatality was preventable. It was possible to have moved the shovel back from the foot of the stockpile where the crew could have worked safe from a cave. More attention should have been given to the probability of a cave and the necessary precaution taken to eliminate it by blasting the top of the pile.

Vivian was a single man, 59 years old, and had worked at the mine since 1925.

Fatal Accident No. IV

John Battaglio, a miner, was injured at the Athens Mine on December 12, 1940 and died in the Ishpeming Hospital on January 4, 1941. His death was the result of a combination of a fractured skull and meningitis.

Battaglio and his partner were slicing along the side of a crushed traveling road on a sub above the 5th level. Due to the presence of loose ore, it was necessary to proceed slowly and carefully in setting up the timber. At the time of the accident a cap rested on one leg and was supported at the center by a prop. Battaglio watched the ground as his partner picked a hitch for the other leg. A piece of ore fell from the back and knocked out a sprag, which struck Battaglio on the side of the head. Battaglio saw the impending danger and called to his partner to look out. The sprag was knocked backward and although he was not as close to the breast as his partner and apparently in less danger, he did not move backward in time to avoid the accident himself.

Battaglio was married, 58 years of age, and had been employed thirty years.

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INJURYa. Fatal Accidents (Continued)Fatal Accident No. V

Albin Seppanen, a miner was instantly killed by a fall of ground at the Negaunee Mine on December 21, 1940.

Seppanen and his son were slicing ore above the 13th level. They were in the third cut on the sub and had passed from under the timber gob to the hanging wall. When the accident occurred Seppanen was at the breast attaching the scraper rope hook to the head block. He stood under forepoles and steel "H" beams. The hanging apparently settled without warning and the forepoles and steel yielded to its weight. They did not break but bent downward only on the side of the heading where Seppanen stood. He was struck on the back of the head.

The shift boss had inspected the place a few minutes before the accident and found conditions satisfactory. A repair miner stated that he had gone out of the place but a short time before and that when he had left there Seppanen was adjusting the blocking over the poles and everything appeared to be in safe condition.

Seppanen was 52 years of age and is survived by his wife and five children. He had worked at the mine 23 years.

b. Non-Fatal Accidents

Accidents caused 617 non-fatal accidents in addition to the five fatalities. Of this number 57 were accidents which resulted in injuries that required compensation payments, sixteen were lost-time accidents of one to six days, and 544 slight injuries which were reported for first aid treatment.

As usual each year the causes of the compensable accidents are various, but falls of loose ground heads the list. One of them occurred on surface at an underground mine and eight occurred at our open pit mines in Minnesota. Underground work at the Athens, Maas, and Negaunee mines must be charged with 42 of these accidents.

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b. Non-Fatal Accidents (Continued)

Accident Statistics

TABLE I

<u>Year</u>	<u>Number of Fatalities</u>	<u>Number of man-days Worked per fatality</u>	<u>Number of tons of Ore mined per fatality</u>
1931	3	165,137	529,680
1932	0	189,000*	486,750*
1933	2	94,689	398,357
1934	4	80,477	451,046
1935	2	196,883	1,136,215
1936	2	283,945	1,850,898
1937	1	765,702	5,216,879
1938	3	163,434	385,954
1939	1	564,433	3,713,389
1940	<u>5</u>	<u>142,870</u>	<u>1,156,387</u>
Average	2.3	196,068	1,216,019

* Total man-shifts worked or ore produced

An annual production of a million tons of ore per fatality is a favorable record when compared with the amount of ore produced per fatal accident in the years prior to special safety activities. During the thirteen years from 1898 to 1910, inclusive, the production was 172,131 per fatality. It may be pointed out that the records for the years 1937 and 1938 are indicative of the possible attainments in mine safety with respect to accidental deaths. We are, however, always confronted with the element of chance. Year in and year out, it is the most important factor that swings the accident record from success to failure. The relative position a man occupies with respect to an occupational hazard is often only the matter of a few seconds but it may result in death or exemption from an accident. If a record was available of all the narrow escapes from accidental accidents that might have had fatal or serious consequences, we would find that they are very numerous and that many of them occur when and where least expected.

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TABLE II

NUMBER OF ACCIDENTS

<u>Mine or Plant</u>	<u>Fatal</u>	<u>Compensable</u>	<u>Slight</u>	<u>Total</u>
Athens	1	10	68	79
Canisteco	1	4	38	43
Cliffs Shaft	0	2	84	86
C. P. & L. Co.	0	0	11	11
Holman-Cliffs	0	3	21	24
Hill-Trumbull	0	2	21	23
Lloyd	0	3	69	72
Maas	0	16	121	137
Negaunee	2	16	103	121
Spies-Virgil	1	1	1	3
Shops & Storehouse	0	0	17	17
Tilden	0	0	2	2
Miscellaneous	0	0	4	4
	<u>5</u>	<u>57</u>	<u>560</u>	<u>622</u>

TABLE III

FREQUENCY RATES*

All Compensable Accidents

<u>Year</u>	<u>Total Man Days Worked</u>	<u>Number of Compensable Accidents</u>		<u>Frequency Rate</u>
		<u>Non-fatal</u>	<u>Fatal</u>	
1935	393,967	35	2	.094
1936	567,891	33	2	.062
1937	765,701	58	1	.077
1938	491,303	46	3	.099
1939	564,542	44	1**	.078
1940	714,354***	57	5	.085

* Based on number of accidents per 1000 man-days worked.

** C. P. & L. Company fatality.

*** Approximately correct.

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TABLE IV

ACCIDENT CAUSES

<u>Cause</u>	<u>Fatal Accidents</u>	<u>Non-Fatal Compensable Accidents</u>	<u>Slight Accidents</u>
Falls of ground, including chunks	4	26	71
Handling or using tools, machinery and material	1	15	159
Falling or bounding objects	0	4	47
Flying objects	0	0	57
Falling, slipping, or stumbling of persons	0	4	71
Loading at chute or pocket	0	4	41
Haulage	0	2	9
Explosives	0	2	1
Handling wire rope	0	0	21
Miscellaneous	<u>0</u>	<u>0</u>	<u>83</u>
	5	57	560

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TABLE V

SHOWING WHERE ACCIDENTS OCCURRED

On surface at underground mines.....	50
Below surface at underground mines.....	449
Open pit mines.....	92
All other places.....	<u>31</u>
	622

TABLE VI

Severity Rates
All Compensable Accidents

<u>Year</u>	<u>Non-Fatal</u> <u>Days Lost</u>	<u>Rate</u>	<u>Fatal</u> <u>Days Lost*</u>	<u>All Accidents</u> <u>Days Lost</u>	<u>Rate</u>
1935	3,225	7.93	3,600	6,825	17.70
1936	3,509	6.16	3,600	7,109	12.67
1937	7,881	10.29	1,800	9,681	12.64
1938	6,290	12.80	5,400	11,690	23.66
1939	3,264	5.79	1,800	5,064	8.97
1940	3,222	4.50	9,000	12,220	17.00

* A fatality is charged with 1800 days loss regardless of the fact that no compensation payment is obligatory when there are no dependents. The Company pays compensation on two of the fatalities that occurred in 1940. Deducting 5,400 days loss for the other three fatalities from 12,220 and the actual number is 6,820, which gives a severity rate of 9.64.

The severity rates of the non-fatal compensable accidents for the past two years are the lowest recorded by the Company.

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b. Non-Fatal Accidents (Continued)

It is believed that the inexperienced man is more liable to injury than an experienced man and that an increase in accident frequency invariably accompanies an increase in work activity. These conclusions are supported by numerous tabulations of accident rates over periods of depression followed by periods of business activity. In all comparisons of accident records it must not be forgotten that while figures may represent the facts with mathematical accuracy they can not in the nature of the case make known the underlying industrial conditions controlling the facts. The figures may therefore appear arbitrary but they do not always make evident the presence and influence of some most important factors.

During the year it was necessary to employ many young and untrained workers. The result of this employment is quite different from the experiences of activity in steel plants and factories when labor recruiting became active and large numbers of inexperienced men were introduced to occupational hazards. Examination of the following table shows that in the age groups, instead of being higher with respect to "green" workers, accident frequency was in fact lower than that for the skilled workers.

TABLE VII

SHOWING GROUP AGES OF INJURED WORKERS

<u>Age</u>	<u>Number injured</u>
Under 20 years of age.....	0
20 to 25 years of age.....	4
25 to 30 years of age.....	12
30 to 40 years of age.....	10
40 to 50 years of age.....	14
50 to 60 years of age.....	21
60 to 65 years of age.....	<u>1</u>
	62

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INJURYb. Non-Fatal Accidents (Continued)

TABLE VIII

SHOWING SEVERITY OF ACCIDENTS ACCORDING TO AGE GROUPS

<u>Age</u>	<u>Number of Accidents</u>	<u>Average loss of Time per Accident</u>
20 to 25	4	30
25 to 30	12	40
30 to 40	9	47
40 to 50	14	31
50 to 60	18	101

The five fatalities are not included in Table VIII. The ages of the men killed were 30, 52, 58, 59, and 64. The young man of this group did nothing in the combination of circumstances which resulted in his death, other than was expected of him in the discharge of his duties. The same cannot be said of the other men.

Many instances could be cited to illustrate that the element of human imperfection was the chief contributing cause of many of the severe accidents, including the fatalities. It is also true that in some of these cases the acceleration in the extraction of ore which took place was another contributing factor. This is particularly evident in a review of the accidents which occurred underground at mines in the Negaunee district, where 42 of the compensable non-fatal accidents and three of the five fatal accidents occurred. However, the presence of human fault or occupational hazards must not be permitted to obscure the fundamental causes which can be reached by the reformation of wrong conditions. What we must have is more intelligent supervision. Unless we bring to our aid every resource of mechanical, engineering, and educational advantages for the control of accidents, the end of progress is in sight.

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TABLE IX

Classification of Fatal Accidents 1911 to 1940, inclusive,
by the Central Safety Committee

I	Trade Risks.		111
II	Negligence of the Company:		
	Violation of Rules	4	
	Failure to Provide Safety Devices.	5	
	Improper Method of Doing Work.	12	
	Failure to Provide Tools or Safe Place to Work . . .	4	
	Failure to Instruct Men.	4	29
III	Negligence of Workmen:		
	A Injured Men:		
	Improper Method of Work	19	
	Violation of Rules.	8	
	Failure to Use Tools or Appliances Provided	4	
	Failure to Use Safety Devices	3	34
	B Other Workmen:		
	Improper Method of Doing Work	14	
	Violation of Rules.	4	
	Failure to Use Tools or Appliances Provided	1	19
	Total		193

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TABLE X

Classification of Causes of Fatal Accidents
From December 1, 1898 to December 31, 1940

A	Fall of Ground.	100	
	Run of Mud or Sand.	60	
	Fall of Chunk of Ore from Chute	2	
	Stray Chunk or Stick down Raise or Stope.	<u>3</u>	165
B	<u>Shaft Accidents:</u>		
	Falling down Shaft.	14	
	Rock or Timber Falling down Shaft	2	
	Struck or Caught by Cage, Skip, Bucket, Tool.	8	
	Falling from Cage, Skip, or Bucket.	11	
	Falling from Ladder in Shaft.	5	
	Carried or Pushed into Shaft by car	3	
	Jumping on or Off Cage, Skip, or Bucket	3	
	Struck by Crosshead	<u>5</u>	51
C	<u>Use of Explosives:</u>		
	Explosion of Powder	16	
	Premature Blast	3	
	Fall of Ground or Timber Due to a Blast	4	
	Overcome by Gas	3	
	Miscellaneous Causes.	<u>1</u>	27
D	<u>Mine and Railroad Cars:</u>		
	Caught by Haulage Cars.	13	
	Riding or Attempting to Ride Cars	6	
	Falling with Car from Trestle	4	
	Run over by Railroad Car.	7	
	Miscellaneous Causes.	<u>1</u>	31
E	<u>Miscellaneous Causes:</u>		
	Falling in Raise, Stope or Pocket	8	
	Contact with Electric Wire.	9	
	Falling from Ladder, Stage, Trestle, etc.	8	
	By Moving Machinery	6	
	Mine Fires.	3	
	Stockpile Slide	3	
	Miscellaneous Causes.	<u>3</u>	40
	Total.		314

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TABLE XI

Classification of All Compensable Accidents in 1940
By the Central Safety Committee

I	Trade Risk (Incidental and Non-preventable)	25	25
II	<u>Negligence of Company:</u>		
	1. Failure to Use Safety Devices Provided.	0	
	2. Failure to Use Proper Tools or Appliances Provided. . .	1	
	3. Violation of Rules.	0	
	4. Improper Act or Selection of Improper Method of Doing Work (By Foreman)	4	
	5. Failure to Instruct Men as to Method of Doing Work and Hazards Incident Thereto	0	
	6. Failure to Provide Safety Devices	0	
	7. Failure to Provide Proper Tools, Appliances, or Place of Work.	0	5
III	<u>Negligence of Workmen:</u>		
A	I. Failed to Use Safety Device Provided.	0	
	2. Failed to Use Proper Appliances or Tools Provided . .	0	
	3. Violation of Rules.	1	
	4. Improper Act or Selection of Improper Method of Doing Work.	30	31
B	<u>Other Workmen:</u>		
	1. Failed to Use Safety Devices Provided.	0	
	2. Failed to Use Proper Appliances or Tools Provided . .	0	
	3. Violation of Rules	1	
	4. Improper Act or Selection of Improper Method of Doing Work.	0	1
	Total.		62

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INJURYc. Safety Inspection

Operating our soft ore underground mines on a working schedule of three shifts per day presents more serious and difficult safety problems than those presented by most industrial activities. It is not unusual to have ore slices advance three or even four cuts in twenty-four hours, which produce an opening from 2,000 to 2,400 cubic feet or larger. In the best working places and with the most efficient of miners working this process goes on from Monday morning until Saturday morning and the miners are in these places all this time excepting blasting periods. Hence we are contending with the forces that keep destroying safe working conditions much more frequently than in the past. Opportunities for miners to expose themselves to hazards have increased, and the desire on their part to keep up a fast pace and earn high wages is natural. Their security depends largely upon a job that is strong and settles down on the timber slowly and uniformly. When a gob holds up the timber sets do not become secure and solid. When it breaks, runs of rock may occur. Danger and inefficiency are the consequences of these conditions.

New shift bosses were added to the supervisory force at each of our five large underground mines. Some of them give promise of developing into capable foremen. Others have not been tested sufficiently to determine their executive capacities. This much is certain, the superintendents and captains should exert much personal attention in directing all of these men along the direction that will train them to become competent supervisors. This is our greatest requirement at the present time from the safety angle in the operation of our mines. In the course of events men vary in their capacity or ability to direct workers, and likewise with respect in training men to leadership. Regardless of the size of a mine or the nature of its ore and mining conditions, we shall always depend upon the judgment and the leadership of the bosses in the elimination of accidents. The miners work many hours a day free of contact from supervision. They must have a thorough understanding of all occupational hazards and the safe methods of avoiding them. These responsibilities are ours and as we measure up to them so shall be the measure of success that will be ours in accident prevention.

Underground headings in the Athens, Negaunee, and Maas mines were the places where most of our serious accidents occurred. Most of these accidents occurred on the afternoon and night shifts. We are

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told that workers are not at their best during the hours of these two shifts. But we recognized that the day shift workers received much more supervision than was given the workers on the other shifts. To remedy this situation the day foremen were transferred to the afternoon and night shifts.

H. F. Rogers, safety inspector, spent most of his time underground. It has been found advantageous to have him in a mine when the captain happens to be absent due to illness or vacation period. The record of his various inspections is compiled in the table that follows. While the number of infractions, unsafe practices, and recommendations may seem to be many, they number 195 less than he reported the previous year. Mr. Rogers is rendering very satisfactory services. He is conscientious in the discharge of his duties and works in harmony with the officials and workmen.

TABLE XII

<u>Mine or Plant</u>	<u>Violation of Standards</u>	<u>Safety Suggestions</u>	<u>Recommendations</u>	<u>Total</u>
Athens Mine	12	8	6	26
Cliffs Shaft Mine	15	19	11	45
Lloyd Mine	32	5	4	41
Maas Mine	38	19	21	78
Negaunee Mine	56	32	13	101
Spies-Virgil Mine	6	2	2	10
Tilden Mine	1	3	4	8
Shops	1	1	4	6
C. P. & L. Company	1	0	2	3
Miscellaneous	<u>0</u>	<u>2</u>	<u>6</u>	<u>8</u>
Totals	162	91	73	326

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INJURYc. Safety Inspection (Continued)

G. R. Whittington, safety inspector at our Minnesota mines, works directly under the instruction of the District Superintendent. The number of inspections he made was as follows:

TABLE XIII

<u>Mine</u>	<u>Pit</u>	<u>Shops</u>	<u>Washing Plant</u>	<u>Surface</u>	<u>Total</u>
Canisteco	32	40	45	18	135
Hill-Trumbull	20	41	39	16	116
Holman-Cliffs	22	40	36	22	120
	<u>74</u>	<u>121</u>	<u>120</u>	<u>56</u>	<u>371</u>

Mr. Whittington reported he submitted 125 recommendations, of which 105 were in writing to the District Superintendent. He inspected and recharged all fire extinguishers, visited all employees who were unable to work due to accidental injuries, and represented the Company at the various safety conferences held in that mining district. He is secretary of the Cliffs Club, which held seven conferences during the year.

Idle and Abandoned Properties

These were inspected and fences placed in safe condition. Repairs were required at the Lake, Angeline, Salisbury, Cleveland, Nelson, Hard Ore, Jackson, Empire, and Republic pits. New fences had to be erected around caved areas on the old East New York mine. Attention was given to numerous test pits and old shafts. Each winter drifting of snow and the wanton work of men and boys bring destruction to the protection that we maintain at these places. A new cave developed at the old Michigamme mine and in compliance with a request of the Land Department, it was enclosed with a strong fence. Mr. Mather paid for this work.

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The number of inspection reports recorded at this office exceeded the number received in 1939 by several hundred, most of which were hoisting rope inspections. It is very gratifying to state that the men responsible for these various inspections are prompt in making inspections and also efficient.

TABLE XIV

Hoisting Ropes.	Daily Report.	1723
Skip Roads.	Weekly Report	344
Ladder Roads.	" "	345
Skip and Cage Hoists. . .	Monthly Report.	111
Cage Safety Catches . . .	" "	81
Slack Rope Alarm.	" "	59
Underground Fire Doors. .	" "	24
Mine Rescue Apparatus . .	" "	24
Fire Extinguishers. . . .	Semi-Annual Report. . . .	37
Fire Hose	" "	32
Fire Prevention	Annual Report	152
Total		2932

The number of individual inspections of fire extinguishers is given in Table XV.

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TABLE XV

NUMBER OF FIRE EXTINGUISHERS INSPECTED

	<u>2½ Gallon Soda Acid Type</u>	<u>3 Gallon Carbon Tetrachloride</u>	<u>1 Quart Carbon Tetrachloride</u>	<u>Foam Type Non- Freezing</u>
Athens Mine	5	4	26	0
Canisteo Mine	8	0	20	0
Cliffs Shaft Mine	10	4	48	0
Central Office	7	0	12	0
Gardner-Mackinaw	4	2	38	0
Gwinn District	2	0	18	0
Hill-Trumbull	0	0	30	0
Holman-Cliffs	0	0	42	0
Hibbing Office	0	0	0	0
Ishpeming Hospital	9	0	20	0
Ishpeming Residences	0	0	30	0
Lloyd Mine	3	6	22	0
Maas Mine	5	10	38	0
Negaunee Mine	5	6	30	0
Negaunee Hospital	0	0	0	0
North Lake Residences	2	0	18	0
Spies-Virgil	3	8	40	0
Spies Location	0	0	34	0
Shops, Storehouse, & C. P. & L. Company	14	0	52	11
Section 2	4	0	3	0
Tilden Mine	<u>1</u>	<u>2</u>	<u>56</u>	<u>1</u>
Totals	82	42	577	12

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INJURYc. Safety Inspection (Continued)Bonus for Foremen

The writer is uncertain as to the effectiveness of paying cash awards to foremen and bosses as an added incentive to accident prevention efforts. It is one of many activities whose value cannot be determined. Among others are safety posters and the distribution of the Miners' Safety Bulletin. They are regarded as educational and doubtless should be carried on. From observation one would conclude that the surface foremen have yielded more cooperation than many of the underground bosses. The accident records appear to confirm what one senses when contacting the surface foremen. The Negaunee Mine had one accident on surface and that resulted in a loss of 24 days. The other local mines have the following records:

TABLE XVI

NUMBER OF CONTINUOUS DAYS WITHOUT A LOST-TIME ACCIDENT

<u>Mine</u>	<u>Years</u>	<u>Months</u>	<u>Days</u>
Lloyd	10	2	14
Tilden	5	3	27
Shops & Storehouse	3	9	26
Maas	23	9	24
Cliffs Shaft	1	7	27
Athens	1	5	26

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Bonus for Foremen (Continued)

TABLE XVII

Safety Bonuses Paid to Foremen

<u>Mine or Plant</u>	<u>Amount</u>	<u>Men Participating</u>
Athens	\$ 834.54	12
Cliffs Shaft Mine	995.61	12
Lloyd Mine	594.77	13
Maas Mine	929.37	15
Negaunee Mine	841.53	12
Spies-Virgil Mine	168.57	4
General Storehouse	140.36	4
C. P. & L. Company	<u>154.24</u>	<u>5</u>
Total	\$ 4,658.99	77

TABLE XVIII

Occupations of Men Participating in Bonus

<u>Title</u>	<u>Cliffs</u>						<u>Gen. Sthse.</u>	<u>C.P.& L. Co.</u>
	<u>Athens</u>	<u>Shaft</u>	<u>Lloyd</u>	<u>Maas</u>	<u>Neg.</u>	<u>S.V.</u>		
Shift Boss	8	7	9	10	8	2	-	-
Electrician	1	1	1	1	1	1	-	3
Mechanic	1	1	1	1	1	-	4	-
Timber Foreman	1	1	1	1	1	1	-	2
Surface Foreman	1	1	1	1	1	-	-	-
Track Boss	-	-	-	-	-	-	-	-
Scraper Foreman	-	1	-	-	-	-	-	-
Carpenter Foreman	-	-	-	1	-	-	-	-
Totals	12	12	13	15	12	4	4	5

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INJURYc. Safety Inspection (Continued)Rules and Regulations

Only two new rules were adopted that apply to underground work. One stipulates placing primer cartridges in the bottom of bore holes when blasting a round of holes, but blasting in open stopes is excluded. The object in view is the elimination of unexploded dynamite. The other rule was put into effect to safeguard men who lash and send timber up raises. The puffer man is required to pull the slack and then wait for a second signal before hoisting the timber through to the landing.

At a conference held at the Hill-Trumbull Mine in December, which was attended by Messrs. Elliott, Barber, Sterling, Bolthouse, Whittington, and Conibear, safety rules and standards for open pits, washing plants, shops and surface operations were drafted. These went to press at the end of the year but were not printed in time for distribution.

TABLE XIX

RULE BOOKS DISTRIBUTED

<u>Mine or Plant</u>	<u>Foremen</u>	<u>Haulage</u>	<u>Explosions</u>	<u>Top Slicing</u>	<u>Total</u>
Athens	4	22	0	0	26
Cliffs Shaft	0	29	0	0	29
Lloyd	3	35	14	10	62
Maas	1	22	9	9	41
Negaunee	3	37	0	0	40
Spies-Virgil	<u>0</u>	<u>4</u>	<u>0</u>	<u>0</u>	<u>4</u>
Totals	11	149	23	19	202

A total of forty-four workers were given a three-day suspension for failures to conform to rules and regulations. There were thirty-six in 1939.

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TABLE XX

NUMBER AND CAUSES OF LAY-OFF PENALTIES

<u>Causes</u>	<u>Number</u>
Violation of safety rules.....	19
Losing too much time due to excessive liquor drinking.....	14
Reporting to work under influence of liquor.....	6
Violation of working standards.....	6
	45

Central Safety Committee

This committee met once each quarter of the year. Messrs. F. J. Haller and Onni Marjamaa became members. The captains were present at the meetings and the surface bosses were present once. Minutes of the proceedings were sent to interested parties.

Safety Conferences

No general safety conference with all foremen and bosses present was held during the year. Two were conducted for the captains, foremen, and bosses of the Negaunee district mines. The superintendents held a number of mine meetings with the men of the supervisory force.

Lake Superior Chapter of the National Safety Council

The Annual Safety Conference of this Chapter was held at Duluth on June 21 and 22, and was attended by 375 men. Our Company was represented by Messrs. Barber, Bolthouse, Allen, Derby, Gaffney, Rogers, Whittington, Haller, and Conibear. The writer read a paper entitled, "Discipline in Mine Safety."

A Quarterly meeting of this organization was held at the Mather Inn, Ishpeming, on September 12 and 13. There were 43 men in attendance.

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Two sessions were devoted to discussions of mine safety subjects and lost-time accidents. An inspection underground at the Cliffs Shaft Mine was taken in by 23 delegates from other companies. Our Company entertained to the extent of providing a banquet at the Mather Inn and granting the visit underground. This conference was voted the most profitable meeting of its kind.

National Safety Council

We retained membership in this organization and received in return the safety literature which is issued for mining companies. Much of this literature is given to the city schools and libraries in Ishpeming and Negaunee.

Safety Devices

No new devices were introduced. Safety glass goggles are now extensively worn by the workers with good results. Constant observation of the various devices is always in order to make certain that they are used and kept in serviceable condition.

Safety Flags

Banner Flags, which signify the best accident records for the previous year, flew at the Cliffs Shaft Mine for our underground properties, at the Tilden Mine for the open pits, and the Shops for the independent surface units. They will continue to fly during 1941 at the Tilden and Shops but the Lloyd Mine will take the Cliffs Shaft flag, as its severity rate was lowest for the underground mines. The standard Safety Flag flew at the other mines, excepting the two weeks following the occurrence of every compensable accident.

Miners' Safety Bulletin

This Bulletin was issued bi-monthly with 2,450 copies of each number being distributed. Mr. Gries edited the Health Department and this writer took care of the rest of the details.

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A microprojector for casting dust slides on a screen was received in March and installed in the Engineering Building of the Central Office. This apparatus makes comparatively easy dust counts and eliminates the eye strain that came with extensive counting through the microscope. Together with the midget impinger, our T. W. Hill finds his work less strenuous than formerly.

In compliance with recommendations offered by Mr. Cummings and approved by Mr. Elliott, we discontinued the counting of dust particles in dark field projection and rescinded the rule that limited men to six months' time of rock work at one period. These changes in standards are in conformity with the practices in vogue elsewhere in mining. The elimination of the time limit to workers in rock will be advantageous in rock drifting at the Cliffs Shaft mine and in shaft sinking at Section Two.

Mr. E. C. Urban has been the field representative of the Trudeau Foundation for this district since June, 1940, in place of Mr. Cummings. He was unfamiliar with the mining of iron ore but by giving attention and study to our ventilation conditions he has succeeded in fitting himself into his new situation very favorably from a personal viewpoint.

What are to be the permissible limits of the hematite and silica dust particles in mine atmospheres of the future? The answer to this question determines the necessity for the guidance of outside assistance in our dust prevention work. If the limitations that were set up seven years ago are not to be reduced, we shall have little difficulty in the maintenance of satisfactory ventilation. However, if the counts are to be reduced to a considerable extent, the investigation work will call for changes. This is particularly true with respect to dry drilling in ore and the movement of air circuits through restricted passageways in crushing ground.

A total of 387 dust samples were collected and counted. Besides covering all rock work many other operations were included in the collections. The various cycles in the mining of ore were taken at all of the local mines with the exception of the Cliffs Shaft mine where it will be done early in 1941. It is pleasing to report that the dust particles per cubic foot of air for both rock and ore operations can be pronounced good when interpreted by our present

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d. Ventilation (Continued)

standards. In several instances, however, they were too high but they were the consequence of failures to apply preventive measures, without which many of the places would always be unsatisfactory in so far as freedom from excess dust is concerned.

The distribution of the various places where the dust counts were taken are given in the following tables.

TABLE XXI

NUMBER OF DUST SAMPLES COLLECTED

<u>Mine</u>	<u>In Rock</u>	<u>In Ore</u>	<u>Totals</u>
Negaunee	60	46	106
Athens	41	36	77
Cliffs Shaft	60	13	73
Lloyd	30	35	65
Maas	10	53	63
Spies-Virgil	-	3	3
Totals	201	186	387

TABLE XXII

VARIOUS OCCUPATIONS WHERE DUST SAMPLES WERE COLLECTED

	<u>Cliffs</u>						<u>Totals</u>
	<u>Negaunee</u>	<u>Athens</u>	<u>Shaft</u>	<u>Lloyd</u>	<u>Maas</u>	<u>Spies Virgil</u>	
Drilling	48	18	67	32	25	-	190
Scraping	34	25	1	20	18	-	98
Blasting	8	9	3	5	9	-	34
Timbering	9	14	-	5	6	-	34
Hand Shoveling	1	2	1	-	2	1	7
Barring Back	1	-	1	-	-	-	2
Charging Holes	-	1	-	3	-	-	4
Blowing Cars	5	5	-	-	3	-	13
Blowing Pocket	-	3	-	-	-	-	3
Loading cars from chute	-	-	-	-	-	2	2
Totals	106	77	73	65	63	3	387

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A representative of the U. S. Bureau of Mines was with us in March and trained 132 men in first aid and 20 men in oxygen breathing apparatus. By mines these men were from the following mines:

TABLE XXIII

<u>Mine</u>	<u>First Aid Men</u>	<u>Mine Rescue Men</u>
Negaunee	36	4
Athens	34	4
Cliffs Shaft	30	4
Maas	12	4
Lloyd	8	4
Tilden	3	-
C. P. & L. Company	3	-
Shops	2	-
Central Office	<u>4</u>	<u>-</u>
Totals	132	20

In addition to the mine rescue training given by the Bureau of Mines, Mr. Rogers held training practices in which thirty-one men participated.

The number and variety of first aid articles distributed appear in the following table.

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e. First Aid and Mine Rescue Work (Continued)

TABLE XXIV

FIRST AID SUPPLIES DISTRIBUTED

<u>Material</u>	<u>Number Distributed</u>
Mercurochrome Pads	18,074
Ounces of Merthiolate	238
One-inch Roller Bandage	509
Three-inch Roller Bandage	305
Rolls of Adhesive Tape	58
Pads of Picric Acid Gauze	221
Pads of Plain Gauze	437
Leather Finger Cots	226
Antiseptic Applicators	828
Tubes of Unguentine	30
Ounces of Aromatic Spirits of Ammonia	22
Pairs of Scissors	4
Ounces of Absorbent Cotton	30
Triangular bandages	70
Splints for fractures	25
Hot Water Bottles	2
Total items	21,079

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f. Department Expenses

TABLE XXV

Salaries	\$7,320.00
Auto Expense	409.20
Heat, Light, and Power	6.32
Insurance.	5.16
Postage.	6.61
Repairs.	22.60
Stationery & Printing.	----
Supplies	116.19
Taxes	----
Traveling and Entertaining	598.41
Telephone and Telegraph	43.61
Papers and Periodicals	----
Personal Injury Expense.	146.42
Unemployment Insurance Tax	218.91
General - Unclassified	372.37
Old Age Benefit Tax.	66.33
Depreciation	199.84
Equipment.	<u>275.00</u>
Total	\$9,806.97

Respectfully submitted,

William Corcoran
Assistant Superintendent

22. REPORT OF THE GEOLOGIST FOR THE YEAR ENDING DECEMBER 31, 1940

A. STAFF

The staff of the Geological Department for the year 1940 is shown in Table I below.

I regret to report that Mr. Afuhs passed away on August 9th, 1940, after several months illness. Mr. Afuhs joined the Company on December 27th, 1910 as a Draftsman in the Geological Department. With the exception of a leave of absence from February 1st, 1932 to August 8th, 1936, due to the major depression, he served continuously in this capacity with efficiency and faithfulness until his demise.

Mr. Archie Minnear, who for a number of years served as an engineer's assistant in the Engineering Department, was transferred to the Geological Department as Draftsman on September 24th, 1940. He continues to be employed in this capacity although he does some work for the Engineering Department.

TABLE I

Name	Occupation	Hours Lost		Hours Overtime	Net % Hours Worked
		Sickness	Absence		
E. L. Derby, Jr.	Chief Geologist	12 1/2	189	132 3/4	96.5
Stanley W. Sundeen	Asst. Geologist	36 1/4	113 3/4	5 1/2	92.7
Gustav Afuhs	Draftsman	651	-	-	46.5
Archie Minnear	Draftsman	-	-	-	100.0
E. A. Allen	Assistant	7 1/4	72 1/4	-	99.1

The year 1940 was divided into the factors shown in Table II, below:-

TABLE II

Total Working Days	275 days (1987 hours)
Sundays	52 "
Full days resulting from Saturday afternoons	26 "
Holidays	13 "
Total	<u>366 days</u>

Table III, below, shows the average number of men regularly employed on a full time basis on the staff of the Geological Department during the past five years.

TABLE III

Year	Average Number of Men
1936	2.4
1937	4.0
1938	4.0
1939	4.0
1940	3.9

B. GENERAL DESCRIPTION OF THE WORK OF THE DEPARTMENT

The work of the Geological Department was divided between the various mines, explorations and miscellaneous items shown in Table IV, below:-

TABLE IV

<u>ITEMS</u>	<u>HOURS WORKED</u>	<u>PERCENT</u>
<u>MINES</u>		
Athens.....	40 1/4	0.6
Canistota.....	77 1/2	1.1
Cliffs-Shaft.....	920 1/2	13.6
Hill-Trumbull.....	290 1/4	4.3
Holman-Cliffs.....	92	1.4
Jackson Lease.....	32 1/2	0.5
Lloyd.....	156	2.3
Maas.....	398	5.9
Mackinaw.....	9 1/4	0.1
Morris Lease.....	106	1.6
Negaunee.....	124 1/2	1.8
Pontiac.....	244 1/4	3.6
Section 2.....	546 3/4	8.1
Tilden.....	135 1/4	2.0
Virgil.....	16 1/4	0.2
Total Mines.....	3189 1/4	47.1
<u>EXPLORATIONS</u>		
Cliffs-Shaft Surface.....	66 1/2	1.0
Cliffs-Shaft Mine.....	418	6.2
Lloyd Mine.....	241 1/2	3.6
Maas Mine.....	241 3/4	3.6
Section 2, 47-27.....	713 3/4	10.5
Total Explorations.....	1681 1/2	24.9
<u>MISCELLANEOUS</u>		
Annual Report.....	39 3/4	0.6
Beneficiations of Iron Ores.....	7	0.1
Depletion Estimates.....	5 1/4	0.1
Engineering Department.....	578	8.5
Experiments and Investigations.....	9	0.1
Geological Surveys on Company's Mineral Estate.....	186 1/4	2.7
Gold Leases on Company's Mineral Estate...	2	-
Investigating Mineral Land Offers.....	71 1/2	1.1
Investigating Outside Explorations.....	45 1/4	.7
Lake Superior District Reserve Estimate...	2 1/4	-
Michigan Mineral Land Company.....	4	.1
Miscellaneous Geological.....	905	13.4
Reserve Mining Company.....	3 3/4	.1
Tax Commission Estimates.....	32 1/4	.5
Total Miscellaneous.....	1891 1/4	28.0
GRAND TOTAL.....	6762	100.0

B-1. DESCRIPTION OF WORK BY THE STAFF MEMBERS

E. L. DERBY, JR. Approximately 66% of my time during the year was spent in connection with the geological work at the Company's active mines. About 12% of my time was spent in planning and supervising diamond drill explorations in the Cliffs-Shaft, Lloyd and Maas Mines and on the Cliffs-Shaft Mine surface and the Section 2, Golf Club, Area. The balance of my time, or approximately 22%, was taken up with the routine work of the office and the numerous miscellaneous duties peculiar to the Geological Department. The geological surveys and explorations are treated separately, and in more or less detail, later in the report. My activities, in addition to the strictly routine work of the office, may be summarized as follows:

In JANUARY, two weeks of my time was spent at the Cleveland office and in New York City in connection with negotiations for a lease by the Negaunee Mine Company on Sections 1 and 2, 47-27 and a portion of the Maas Mine containing an estimated 1,600,000 tons of ore to augment the rapidly depleting reserves at the Negaunee Mine. I went to New York, from Cleveland, with Messrs. Greene, Brown, Elliott and Raymond, where a conference was held with Messrs. Buck, Merryweather and Cumings, officials of the Bethlehem Steel Company. I spent the last week of the month on the Mesaba Range in connection with the Canisteo, Hill-Trumbull and Holman-Cliffs properties and in St. Paul and Minneapolis in connection with plans for a retreatment plant proposed for the Hill-Trumbull Mine.

In FEBRUARY, I went to the Mesaba Range, Minneapolis and St. Paul. On the Range, I joined with Messrs. Barber and Moore in completing plans for the new machinery to be used to rehabilitate the Holman washing plant and went over the structure drilling being done at the Holman-Cliffs and Hill-Trumbull Mines. In Minneapolis and St. Paul, I consulted with Messrs. Davis and Wade at the Mines Experiment Station, and with Mr. Holt of Butler Brothers, on our concentrating plans and related matters.

In MARCH, I spent one week on the Mesaba Range. During this time I assisted Mr. Barber in preparing data which he presented later at a meeting in Cleveland of the Mesaba-Cliffs partners. This data related to proposed operating schedules and plans of the Hill-Trumbull and Holman-Cliffs Mines during the present and near future seasons. I also classified samples from the current structure drilling and laid out additional work for our drill crews and went over plans for an augmented drilling campaign at the Holman-Cliffs property.

In APRIL, I spent three days at the Mines Experiment Station, University of Minnesota, Minneapolis, going over the final results of the last jig test made on lean ore from the Hill-Trumbull Mine and witnessed the first of a series of table tests on finely ground Tilden Mine ore. I went to Hibbing where I spent some time on the new estimates being made by Mr. Everett Sterling on the reserves in the Canisteo and Hill-Trumbull Mines to be submitted during the summer to the Minnesota Tax Commission. I also accompanied Messrs. Geffine, Jackson and Adams to Lansing, Michigan, for our annual conference with Messrs. Pardee and Eddy, Appraisers of Mines for the State Tax Commission. At this conference, we discussed and considered the first tentative valuations placed by these appraisers on all

of the Company's active mines in Michigan. I made a joint report with Mr. Archibald on all of the tax delinquent lands in which the Michigan Mineral Land Company has a mineral interest.

In MAY, I went again to the Mines Experiment Station in Minneapolis and to Hibbing. At the Mines Experiment Station I went into a detail of the results of our numerous jig tests on Hill-Trumbull lean ore and the work being done in developing a possible flow sheet for the concentration of Tilden Mine Siliceous ore to a high grade product. In Hibbing, I went over, with Mr. Everett Sterling, the work he had completed to date on the new Canisteo and Hill-Trumbull reserve estimates to be submitted to the Tax Commission with special attention being given to the so-called jig ore developed by our latest drilling. Heretofore, the Tax Commission has placed no value on this material but gave notice that it would begin to do so in their 1940 appraisals. I joined Mr. Geffine in conducting Messrs. Willensec and Guches, Government Engineers, around the Company's property and particularly the water power development on the Dead River. I also spent one day in St. Paul in attendance at the annual public hearing on Occupational taxes. Messrs. Geffine, Barber and MacPherran also were present with me.

In JUNE, I made one trip to the Mesaba Range with headquarters at Hibbing, and went over the current structural drilling being done at the Canisteo and Holman-Cliffs Mines and went into the problem of opening the Pontiac Mine in considerable detail with Messrs. Barber and Moore. In the latter connection, we went to the site of the Pontiac and to Crosby, on the Cuyuna Range, where we conferred with Messrs. Whitney, Mollard and Matson of the Butler Brothers organization relative to ways and means of re-opening the old Clark shaft on the Pontiac. This was in case it was decided to sink this shaft a short distance and cross-cut the ore body, from foot to hanging wall, in order to obtain a three or four railroad-car sample of the mangiferous iron ore for testing purposes. Professor Lambert, Engineer for the State Tax Commission, was in Crosby and I availed myself of the opportunity, while there, to discuss with him our new estimate of the reserves in the Hill-Trumbull Mine. I left with him a map and complete set of cross-sections, together with detailed figures and factors supporting the estimate. Mr. Lambert agreed to grant another conference with him after completing his own estimate and before reporting it to the Tax Commission.

I spent two days at the Mines Experiment Station in Minneapolis with the continued experimental work being done on the Tilden Mine siliceous ore and the possible tests to be made on Pontiac ore. Messrs. R. C. Allen and Harry Taylor of the Oglebay-Norton Company spent a day in Ishpeming and we discussed a number of problems in connection with the Reserve Mining Company's property on the Eastern end of the Mesaba Range in which the Company owns an interest. Mr. Elliott and I had a conference with Mr. William H. Schacht, President of the Copper Range Company at his office in Painesdale. We discussed with him the general geological information he has collected and from which he has formulated certain large scale structural theories relating to the Lake Superior District in general.

In JULY, about 22% of my time was taken up with matters relating to the Pontiac Mine. In this connection I went to Anniston, Alabama, with Mr. E. W. Davis, Director of the Mines Experiment Station, at Minneapolis, and Messrs. Hazen Butler and Grover Holt of Butler Bros., where we visited the pilot plant of the Anniston Manganese Company. This plant produces about 25 tons of manganese sulphate per day of three eight-hour shifts, operating seven days per week and uses the so-called SO₂ leaching process. A special report was written to cover this examination. Messrs. Jacobs, Merryweather and Cumings of the Bethlehem Steel Company spent two days in Ishpeming and I went over with them in detail the various phases of the Section 2 Exploration. About 26% of my time during the month was spent in connection with this exploration and development.

In AUGUST, I spent about 22% of my time in connection with the Section 2 Development besides the time spent on the actual drilling itself. This included conferences with Messrs. Greene, Brown, S.L. Mather, Elliott and C. W. Allen in connection with the early opening and development of the ore encountered here and a field examination in Sections 1 and 2, 47-27 with Mr. Day, Chief Engineer of the Lake Superior & Ishpeming Railroad, going over the proposed location of a railroad spur into the property. I also spent about 38% of my time in connection with matters relating to the Pontiac Mine. I made two trips to the Mesaba Range with regard to current explorations at the Canisteco and Holman-Cliffs Mines and in preparation for a report to be made later by Mr. Barber and me on the Pontiac Mine. In the latter connection, Mr. Barber and I had a conference with Mr. Holt of Butler Brothers at Hibbing and I spent one day with Mr. E. W. Davis at his office in the Mines Experiment Station at Minneapolis.

In SEPTEMBER, I spent two days on the Mesaba Range going over the exploration work being done at the Canisteco and Holman-Cliffs Mines and on Pontiac Mine matters. I spent three days at our Cleveland office principally on plans for the possible opening of the Pontiac Mine in connection with a proposed sale to the Government of a supply of ferromanganese ore for war purposes. From Cleveland, I went to Bethlehem, Pennsylvania, spending one day there with Messrs. Brown and Allen in conference with Messrs. Jacobs, Merryweather and Bourlier, in connection with plans for the immediate opening and development of the ore discovered by drilling in Section 2, 47-27.

In OCTOBER, It was necessary to make three short trips to the Mesaba Range, principally in connection with the revised estimate and valuation set up on the Hill-Trumbull ore reserves by the State Tax Commission engineers, Messrs. Lambert and Heilig. On two of these occasions, I went to St. Paul and Minneapolis and conferred with these engineers at their office. Due to an excessive appraisal, I arranged to have these engineers go through the Hill-Trumbull Pit. Messrs. Barber and Bolthouse accompanied me in conducting them through the Pit. As a result of these conferences and pit inspection, we were able to get a reduction of 2,800,000 tons from their first tentative estimate which resulted in an appraisal figure that could be justified. Together with Messrs. Barber and Donovan, I attended the annual public Ad Valorem tax hearing in the State office building.

During these trips to Minnesota I also went over Pontiac Mine estimates and data with Mr. Davis at the Mines Experiment Station, with Mr. Emmett Butler and his staff in St. Paul, and with Mr. Barber. I made a classification of all the drill samples obtained during the current season's drilling to that date from the work done at the Canisteo and Holman-Cliffs Mines. About 75% of my time during the month was spent on the Mesaba Range matters. The month of October usually requires more of my time in this respect than any other month of the year. At one of my conferences with Mr. Davis at the Mines Experiment Station, I went over with him his final report on the concentration of Tilden Mine siliceous ores. I prepared a summary and comments on this work in transmitting copies of Mr. Davis' report to Mr. Elliott.

In NOVEMBER, I had conferences in Ishpeming with Messrs. Greene and Brown on matters relating to our current exploring program and the proposed opening and operation of the Pontiac Mine in connection with the U. S. Government policy of developing domestic manganese reserves.

In DECEMBER, I went to Minneapolis and had a conference with Mr. Davis at the Mines Experiment Station, further in connection with the Pontiac Mine and the report prepared by Mr. Davis on Cuyuna Range manganiferous possibilities for the Commission of National Defense in Washington. I attended the annual Minnesota Sectional meeting of the American Institute of Mining and Metallurgical Engineers, held at the Kaufman Memorial Union at the University of Minnesota. I went from Minneapolis to the Mesaba Range where I classified the balance of the samples from the current year's structural drilling at the Canisteo and Holman-Cliffs Mines.

STANLEY W. SUNDEEN. Mr. Sundeen continued as Assistant Geologist throughout the year. About 61% of his time was spent on the geological surveys and maps of our operating mines; 5% with the drilling explorations; 9% on surface geological surveys; and 25% on miscellaneous duties included in the routine work of the Department. He made periodic underground geological surveys and posted this information on the geological maps of the Athens, Cliffs-Shaft, Jackson Lease, Lloyd, Maas and Negaunee Mines. The Cliffs-Shaft Mine continues to be our biggest and most important underground geological problem. This property alone required about 37% of Mr. Sundeen's entire time.

Mr. Sundeen made all of the calculations to determine the sulphur content of the drill water which had to be sampled whenever the drills encountered ore in the Section 2 Exploration and in the Maas Mine. This requires a lot of time. He continued to work on the general surface geological map of the Marquette Range, filling in as many gaps as the time and information at hand would allow. In this connection, we exchanged information with Mr. E. A. Kronquist, Geologist for the Interstate Iron Company, who has spent the last year or two on surface geological surveys on that Company's Marquette Range mineral estate. As a result, we are getting our geological map of the Marquette Range in fairly good shape. The rest of his time was spent on the voluminous routine work of the Department.

GUSTAV AFUHS. Previous to the time Mr. Afuhs had to give up work on account of the illness which caused his death, he continued as our Draftsman. From the middle of May to the end of June, he was able to work only about half time and none at all thereafter. About 97% of his time was spent directly in connection with the geology of the current operating mines, posting the information on our geological maps and cross-sections and making new maps where necessary. He prepared cross-sections of all our current drilling, recorded the drill data in our files and copied all exploration data submitted to this office in the form of land offers, outside explorations, etc. Also, he posted the extensions on our set of geological tracings of the Morris Mine, operated under lease by the Inland Steel Company. This information was copied from the geologic records of the Inland Company. It is hoped, later, that an opportunity will be had to make our own independent underground geological examination at least once or twice each year.

ARCHIE MINNEAR. Mr. Minnear, following his connection with the Department in September, 1940, carried on in the same capacity as Mr. Afuhs. However, about 47% of his time continued to be spent assisting the Engineering Department, due to shortage of help and emergencies that arose. This condition largely has been corrected and it is expected that he will spend practically all of his time in the future on Geological Department work. He was trained almost immediately to check over the calculations made from drill water samples in Section 2 and the Maas Mine to determine the soluble sulphur. As stated in discussing Mr. Sundeen's work, this requires considerable time.

E. A. ALLEN. Mr. Allen spent about 70% of his time during the year collecting, sampling, labeling and filing diamond drill core and sludge samples from the current explorations and in making tests for the dip and bearing of all current drill holes with the Maas Compass wherever this data was required. He made thin sections of rock samples and drill core whenever necessary for microscopic study by Mr. Sundeen and me. He assisted Mr. Sundeen in a surface geological survey at the Tilden Mine in connection with the campaign of churn drilling in Section 27, 47-27 to the West of the West Pit. About 17% of his time was charged to the Engineering Department for the weekly observations he made throughout the year of the water levels in the various deep well holes at the Maas and Negaunee Mines. These wells were drilled for the purpose of observing and plating the activity and draining of the surface water over the ore bodies in these mines. The rest of his time was spent on routine office duties.

C. SURFACE GEOLOGICAL SURVEYS

The surface geological surveying during the year was confined largely to a detailed study of the outcrops in the N¹/₂ of Section 27, 47-27 West of the West Pit at the Tilden Mine. This was done in preparation for the campaign of shallow churn drilling in which twenty holes were put down hoping to locate an area favorable for another siliceous ore pit. Mr. Sundeen conducted this survey during the late summer, assisted by Mr. Allen. Also, some field observations were made by Mr. Sundeen in connection with the exchange of geologic information with Mr. Kronquist, Geologist of the Interstate Iron Company. This field survey was conducted only in areas

where the geologic data of the two companies overlapped and showed an inconsistency. As previously mentioned, Mr. Sundeen continued to spend some time during the year on the new surface geological map of the Eastern and more important portion of the Marquette Range. A brief field examination and study was made with Dr. Ayres, Professor of Geology at the Michigan College of Mining & Technology, of the Basal Metamorphic Complex in the area just South of the Tilden Mine and the granite area South of the Republic trough.

D. MINE GEOLOGICAL SURVEYS AND OPERATIONS

With minor exceptions, underground geological surveys of all current mining extensions and development work, were made during the past year, in all of our operating mines. Complete geological surveys were made regularly of all current workings in the Cliffs-Shaft Mine and surveys of the new development work, principally on the main levels in the other underground mines. Geological information was supplied to us by the Engineer at each of the various soft ore properties within the area of actual stoping operations and all of this data was posted on the geological maps and cross-sections.

With the exception of the Virgil, all active mines operated throughout the year on a five day schedule and each employee received five days per week. Until sometime in October, the mines were operated two eight hour shifts per day. At the Virgil Mine the operation was on a two eight hour shift, four day per week schedule until November 16th, after which the mine operated five double shifts per week. Beginning in October, additional men were added to the crews at all mines, with the exception of the Cliffs-Shaft and Virgil, filling the three shift crews until by January 1st, 1941, they were working five days per week, three eight-hour shifts per day.

The Tilden open pit operations began May 3rd and continued quite steadily to and including November 16th. Operations were geared to the schedule of boat shipments.

D-1. - ATHENS MINE

Most of the production from the Athens Mine came from blocks of ore between the 4th and 6th Levels South of the fault dike and from Block 3 above the 7th Level North of this dike. The remaining production came from Block 2 above the 8th Level.

On the 9th Level, No. 1 cross-cut, driven Southeasterly and started in 1939 from the main level drift, was completed early in 1940. Six additional raises were completed from the 9th Level, two of which had been started late in 1939. On the 7th Level, two additional raises were put up. One of these was located in No. 3 cross-cut and the other in the main ore drift. During the year, approximately 191,000 tons of additional ore, not previously included in our reserve estimate, was developed in sub-level operations between the 6th and 7th Levels in Block No. 3.

D-2. - CLIFFS-SHAFT MINE

In "A" Shaft, the production for the year continued to come chiefly from the Bancroft Lease on the North; the main deposit, in both the central part and areas adjacent to the old Incline and No. 3 Mines on the East; and from the Southeast Deposit. Approximately 67.4% of the total mine production was mined from "A" Shaft deposits. The important developments in "A" Shaft during the year may be summed up as follows:

On the Bancroft Lease, the ore in the large stope on the 10th Level, was followed from the 7th to the 5th Level, where it seemed to pinch out. However, a cross-cut East on the 5th Level and to the South of this location encountered ore again which may be a part of the same deposit. It is just being opened up at the present time.

Stoping continues in comparatively large volume on the fee property to the East of the Bancroft Lease at several elevations.

"B" Shaft deposits produced 32.6% of the total mine production. This was slightly less than in 1939 but still more than in other recent years. The ore in this shaft continued to come mainly from the floors, raises and stopes in the ore areas already developed on the main levels. On the 1st Level, the drift driven Southwesterly, and started in 1939, to intercept the ore encountered in Drill Hole No. 467, West of the Lake Superior Iron Company's forty, reached its objective. A stope is being opened in this ore with the advance heading West just Northwest of the Lake Superior property corner. The ore body at this point, combining the width of the stope with the holes drilled from the sides of the stope, is approximately 40' wide. In the Section 9 Deposit, at the West end of the 10th Level, the Western limit of ore apparently was reached in the main drift. Stoping in this ore above the level, started in 1939, continued throughout the year. It has reached a height of 225' above the level.

To the East of this deposit, a raise has been started from the South side of the main drift heading toward the ore encountered in surface drill holes 34 and 35, approximately 360' vertically above the 10th Level. Good ore was encountered 80' above the level. This is very encouraging as it is more than likely continuous ore will be found all the way to the ore in the drill holes. A second raise is being started for a traveling road to this deposit. A cross-cut also is being driven on the 10th Level to reach the ore encountered in horizontal drill hole No. 472, drilled North from the main drift.

D-3. - JACKSON LEASE

Operations in the Jackson Lease were carried on continuously during the year from the Cambria Mine by the Republic Steel Corporation. Two eight-hour shifts, five days per week, continued until the middle of January when the working schedule was reduced to two shifts, four days per week. In May, operations were increased to two eight-hour shifts, five days per week. In August, the schedule again was stepped up, this time to three shifts per day, five days per week and continued as such the balance of the year. Production from the Lease during the year amounted to 92,669 tons, all Cambria (non-Bessemer) grade. The production came entirely from above the 6th Level.

A total of thirteen diamond drill holes were drilled during the year,- eleven of them from the 6th Level and two from the 7th Level. These holes have aided materially in planning and executing development work during the year particularly on the 6th Level. A new deposit was uncovered in Drill Hole No. 122 lying East and South of the so-called East Deposit. This ore is being opened by development cross-cut at the present time.

The main drift on the 7th Level was extended on to the Jackson Lease and for a distance of 884' on this Lease. It was just getting into high grade ore at the Southwest end at the end of the year. Two raises were being put up from this drift from which development work will be conducted. One of them had been put up 94' and the other 89' at the end of the year.

The operations on this Lease are disappointingly slow but the outlook for increased ore reserves is very bright.

D-4. - LLOYD MINE

Practically all production from the Lloyd Mine came from three areas in the Lloyd-East ore body,- namely, from the East end above the 4th Level; the central area between the 615' and 650' Sub-Levels; and the stopes under the hanging wall in the West end of the ore body above the 6th Level. The ore from these stopes ran nearly 80% of Silica grade, which continued to be somewhat disappointing. It is expected the grade will improve with depth. A little mining was done in the very bottom of the old Lloyd Deposit just below the 3rd Level. This work was disappointing, however, because of the contamination of the ore by intersecting fault dikes forming the bottom limits of the ore body.

Five new raises were put up from the main drift on the 6th Level, Nos. 604 to 608, inclusive. A drift was driven East on a low incline from No. 608 Raise starting on the 515' Sub and extending to the East point of the ore body. From this point, a raise was put up to the 5th Level. This development will act as a transfer for stoping operations above and under old slicing areas. A main sump and pump house have been completed at the shaft on the 5th Level. In the future all mine water will be handled from this point. Preparations were being made at the end of the year for sinking the shaft below the 7th Level from which all of the known ore below the 7th may be developed and mined.

D-5. - MAAS MINE

Production from the Maas Mine continued to come principally from three areas,- namely, from the East and West footwall pillars above the 3rd Level; the main deposit above the 4th Level, both to the East and South of the Race Course; and from the main deposit above the 5th Level on the Race Course and to the South and Southwest of it. An area adjacent to the Negaunee Mine boundary was leased to the Negaunee Mine Company in the middle of the year. This incorporates some of the ore on the Maas South of the Race Course so that operations were discontinued in the last half of the year. The limits of the ore West of the Southwest

corner of the Race Course and under the hanging wall, were extended further during the year. This encouraging extension first was mentioned in my report for 1939. The amount of Bessemer ore produced continued to decline until during 1940 only $4\frac{1}{2}\%$ of the production was of this grade as against $10\frac{1}{2}\%$ in 1939 and 16% in 1938. This ore, almost entirely, is confined to the horizon immediately below the hanging wall.

The transfer system of mining the ore in the West footwall pillar on and above the 3rd Level, was extended somewhat to the West on the 200' Sub-Level and preparations made for stoping the ore above. One additional raise was put up, making a total of three. A cross-cut was driven on the 3rd Level and two raises put up from it to the East footwall deposit. One additional raise has been planned.

On the 5th Level, the North footwall drift was extended and No. 8 cross-cut driven due South on the 1800 W. meridian. Ore was encountered for about 360' of this cross-cut and it was stopped in the South footwall jasper approximately 45' North of the Pioneer & Arctic South boundary of the property. Unfortunately, all of the ore in this drift was high in Sulphur and cannot be used as a standard grade ore. One raise was put up from the North drift and a second is in progress. Also, one raise was put up and two are in progress from the No. 3 cross-cut in the main deposit. These will take ore from the 4th Level raises just East of the Race Course east boundary.

D-6. - MORRIS MINE

The Morris Mine continued to be operated under lease by the Inland Steel Company. Mining was on a basis of five double shifts per week throughout the year. Mr. Sundeen, in company with Mr. Satterley, Superintendent at the time (now Superintendent in the Iron River and Crystal Falls District), and Mr. Pearson, Engineer and Geologist, made one geological inspection through the mine during the year. He directed his attention chiefly to the geology of the new development work and to the more important stoping and slicing areas with the view of ascertaining whether or not the geological mapping by the lessees was substantially correct. Mr. Sundeen and I went over the geological and operating maps with Mr. Allen, present engineer, and Mr. Braund, present Geologist, after the close of the 1940 operating season.

The production during 1940, amounting to 312,910 tons, continued to come principally from No. 9 Lease and the Cleveland-Cliffs Iron Company's fee land to the East and South of this lease. Some ore, however, was mined from Lease No. 24 located immediately to the West of Lease No. 9. Production from this lease probably will increase from now on. Due to the ore on the Company's fee land pitching Westerly, the known ore to the East of No. 9 Lease soon will be exhausted and that to the South of this lease will decrease steadily. A request has been made for diamond drilling on this fee land in areas where no exploring has been done and where there are possibilities for the discovery of new ore bodies. This plan was agreeably received by Mr. Fritz Olson, the present Superintendent of the mine.

About 89% of the production from the mine came from top slicing operations and 11% from stoping. The topmost workings were on the +160' elevation and in No. 21 deposit. This is 80' above the 7th Level. The lowest workings were on the -110' elevation in the No. 33 or main deposit. This is 15' above the 8th Level.

During the year an ore connection was developed between No. 75 deposit and No. 77 deposit, the combined deposit now being called No. 75. Development continued to the West in No. 75 deposit on the +20' Sub-Level and a transfer sub-level was opened on the 00' elevation. The ore will be mined by slicing on the West end of the deposit above the +20' sub-level and by stoping on the East end from the 00' elevation to the +100' Sub. This deposit is now open for a distance of about 400' on the West end of the +20' Sub-Level. All of this development is on No. 9 Lease.

The ore from the Company fee land mainly came from the +30' Sub-Level to the East of No. 9 Lease and the -50' and -80' sub-levels South of this lease, all in No. 33 or the main deposit.

On the 8th Level, a full size cross-cut was driven South a distance of about 500' on Lease No. 24 approximately 100' West of Lease No. 9. One raise was put up from this cross-cut in No. 75 deposit ore to the 00' Sub. Ore was first encountered in this raise at the -20' elevation.

The 9th main footwall drift was extended Westerly in slate for about 1000'. One cross-cut was driven South from this drift for 200' on the 2050 W. meridian. The first hundred feet was in footwall slate and the balance in footwall jasper. The purpose of this cross-cut is to get under No. 33 and No. 75 deposits. The footwall drift will be extended West and a cross-cut driven to the South along the East side of the West boundary of No. 9 Lease as the next development on this level.

No additional high sulphur ore was encountered during the year in No. 33 and 79 deposits, the sulphur condition remaining the same as previously reported.

D-7. - NEGAUNEE MINE

The production from the Negaunee Mine in 1940 came from four localities, - namely, the main deposit between the 12th and 13th Levels; the footwall pillar above the 12th Level; the area between the two South dikes above the 12th Level; and the shaft pillars above the 9th Level around old No. 1 and No. 2 shafts.

Two additional raises were put up from the 9th Level into the No. 1 Shaft Pillar area. Ore was developed on and from the 12th Level South of the two South dikes and mining started. On the 13th Level, three raises were put up from the second cross-cut through the South dikes to develop the main ore body adjacent to the Maas boundary and under the hanging wall. On the 14th Level, drifting in rock was started from the shaft plat to open the new main haulage drift leading to the ore body. At the end of the year it had reached the main dike and was turned to follow Southwesterly along this dike.

The shaft passes through high sulphur ore just above the 13th Level elevation. This ore is formed in a fault crotch with the South side being displaced downward against the Siamo slate on the North. A 65° raise was put up from the shaft flat until it encountered the ore. From this point, an incline drift or raise at an inclination of 25° was extended a little South of East following this ore to the 250' sub-level elevation, or a distance of 126'. It was all very high sulphur and could not be mixed with standard grade ore. At the top of this incline, cross-cuts were driven at right angles in both directions to determine the width of the ore but this work was not completed when operations were stopped in order to concentrate all possible activity on the production of standard ore. It is anticipated this exploration will be continued sometime in the future and the ore followed to its limits.

D-8. - TILDEN MINE

The 1940 production continued to come from the East and West Pits. The total production was 205,612 tons, of which 78,589 tons was mined from the East Pit and 127,023 from the West Pit. Of the East Pit production, 19,107 tons was a special Low Phos. grade, averaging .013% Phos. A total of 4,385 cubic yards of stripping were removed from the North and East sides of the East Pit to prevent contamination with the breaking of ore below and to prepare for the coming season's production.

Up to the present time, Tilden Mine production has been intermittent because it had to be geared to the schedule of boat shipments. In order to provide a steadier program of production, stockpile grounds were constructed during the past season just South of the crusher pocket. In this way ore can be stocked in periods between shipments and the property kept in continuous operation. It is estimated the savings in a steady operation will more than off-set the cost of handling the ore in stock.

D-9. - VIRGIL MINE

Approximately three-quarters of the year's production from the Virgil Mine came from the Southwest area between the 6th and 8th Levels. The balance came principally from the Northwest ore body although some ore was drawn from the middle stope above the 6th Level. This constituted ore that had been broken some time ago together with additional ore that had caved into this stope since active mining ceased. A new cross-cut was driven on the 8th Level North along the Sherwood boundary at the West end of the property and two raises put up. These raises were connected for a transfer drift at the -100' elevation. The ore is being prepared for stoping. A small amount of exploratory drifting was done in the high sulphur ore body to the East of the Northwest stope to determine how much of it can be mined and mixed with the standard ore. Water is being pumped from the old Virgil shaft to drain the old workings (drifts and stopes on the old 1st and 2nd Levels) as much as practical and thus minimize the existing water hazard. The current workings in the Virgil are directly below this area.

E. OPTIONS AND LEASES

No new options to explore, nor mining leases, were taken by the Company during the year.

F. EXPLORATIONS AND COSTS

Drilling explorations were carried on in 1940 in the following districts and mines:

F-1. - FROM SURFACE

<u>DISTRICT</u>	<u>RANGE</u>	<u>MINE</u>
Coleraine	Mesaba	Canisteco
Marble	Mesaba	Hill-Trumbull
Taconite	Mesaba	Holman-Cliffs
Ishpeming	Marquette	Cliffs-Shaft
Ishpeming	Marquette	Section 2
Tilden	Marquette	Tilden

F-2. - FROM UNDERGROUND

Ishpeming	Marquette	Cliffs-Shaft
North Lake	Marquette	Lloyd
Negaunee	Marquette	Maas

Table V, which follows, gives the footage drilled, the ore encountered, and cost per foot of drilling for both surface and underground explorations. It will be noted that the average cost of surface drilling was \$4.05 excluding certain items not actual drilling expense but which customarily are charged to these explorations. By including these items, the average cost of surface drilling was \$4.86 per foot. The cost of underground drilling in the same way was \$3.42 per foot and \$4.07 per foot, respectively. By comparison with 1939, the cost of drilling was approximately the same with the exception of the underground drill cost including the extraordinary items. In this case the 1940 cost includes a very much larger amount of office work in connection with the calculations of soluble sulphur in the drill water samples. This occurred at the Maas Mine and explains the entire increase over 1939 cost. The cost of drilling in 1940 as a whole, however, was slightly less than in 1939.

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

TABLE V.
SUMMARY OF DRILLING FOR 1940

PROPERTY	DESCRIPTION			STAND- PIPING FT.	CHURN DRILLING FT.	DIAMOND DRILLING FT.	TOTAL DRILLING FT.	FIRST CLASS ORE FT.	SECOND CLASS ORE FT.	LEAN ORE FT.	TOTAL COST "A"	COST PER FT. "A"	TOTAL COST "B"	COST PER FT. "B"
	SEC.	T.	R.											
<u>SURFACE DRILLING</u>														
Canisteo Mine	30 & 31	56	24 Minn.	891	3,198½	-	4,089½	-	-	* 1,473	\$ 16,760.02	\$4.10	\$ 13,440.59	\$3.29
Hill-Trumbull Mine	17	56	24 "	-	300	-	300	-	-	* 201	1,461.04	4.87	847.09	2.82
Holman-Cliffs Mine	21	56	24 "	121	3,720½	-	3,841½	-	-	* 1,937	14,581.84	3.80	10,884.13	2.83
Cliffs-Shaft Surface	9	47	27 Mich.	123	5½	754½	883	-	-	-	2,784.51	3.15	2,651.67	3.00
Section 2 Exploration	2	47	27 "	116	472	2,976	3,564	291	49	22	29,837.28	8.37	26,360.93	7.40
Tilden Mine	27	47	27 "	357	1,436	-	# 1,793	-	-	592	4,932.04	2.75	4,392.06	2.45
TOTAL SURFACE DRILLING				1,608	9,132½	3,730½	14,471	291	48	4,225	\$ 70,356.73	\$4.86	\$ 58,576.47	\$4.05

* This is Crude Ore, which, when concentrated, becomes First Class Ore.

This includes 101' of standpiping and 270' of churn drilling done in January, 1941, which completed the drilling program.

UNDERGROUND DRILLING

Cliffs-Shaft Mine	3 & 9	47	27 Mich.	-	-	2,442	2,442	40	84	141	\$ 9,106.79	\$3.73	\$ 8,001.02	\$3.28
Lloyd Mine	6	47	27 "	-	-	1,685	1,685	30	92	105	6,217.50	3.69	5,624.19	3.34
Maas Mine	6	47	26 "	-	-	916	916	650	117	63	5,183.15	5.66	3,620.54	3.95
TOTAL UNDERGROUND DRILLING				-	-	5,043	5,043	720	293	309	\$ 20,507.44	\$4.07	\$ 17,245.75	\$3.42
GRAND TOTAL DRILLING				1,608	9,132½	8,773½	19,514	1,011	341	4,534	\$ 90,864.17	\$4.66	\$ 75,822.22	\$3.89

Note: Cost "A" includes office expense, engineering, analysis, legal, personal injury, etc.

Cost "B" excludes " " " " " " " " " " (To compare with contract prices)

At the Canisteo Mine, 1,665' were drilled by contract for \$3.50 per foot, and at the Holman-Cliffs Mine 1178' were drilled by contract for \$3.00 per foot. (both by J. S. Schultze of Grand Rapids, Minnesota.)

TABLE VI.

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

YEAR	TOTAL FEET DRILLED.	COST PER FOOT "A"	COST PER FOOT "B"
1936	12,094	\$ 3.46	\$ 3.00
1937	21,008	5.32	4.69
1938	15,744	6.16	5.38
1939	19,926	4.70	3.96
1940	19,514	4.66	3.89

ELD:DWG
2-12-41

F-3. - DIAMOND DRILL CARBON

We had on hand, January 1st, 1940, a total of 465.95 carats of diamond drill carbon which inventoried at \$46,886.65. We purchased, during the year, sixteen stones having a weight of 57.96 carats, at a cost of \$5,216.40. We consumed, during the year, a total of 90.66 carats, having a value of \$9,046.36. This left on hand December 31st, 1940, a total of 433.25 carats which inventoried at \$43,056.69. In addition to this carbon, we used 1.40 carats of Bortz at a cost of \$4.55, leaving a balance on hand December 31st, 1940 of 11.22 carats. Bortz is used in the place of chipped carbon when we encounter soft ore or real soft ground in our surface drilling. It is carried separately and not inventoried with the carbon.

F-4. - DRILL SECTIONS

Cross-section tracings of all drilling, showing analyses and classification of material encountered during the year, have been made up. Photographic copies, showing the work done during the year on the Marquette Range, in colors, will be found in the Annual Report books of maps of the Michigan Ranges which are submitted as a part of the Annual Report of the Engineering and Geological Departments.

G. SURFACE EXPLORATIONS

G-1. - EXPLORATIONS IN SECTION 2, 47-27, MICHIGAN

Diamond drilling in the Golf Club area, which was discontinued on June 8th, 1939 because of discouraging business conditions, was resumed early in March, 1940. Holes 44 and 45 were the ones being drilled when work was stopped. Drilling was resumed in Hole 44 at a depth of 1975' on March 8th and at a depth of 1355' in Hole 45 on March 7th. Both these holes were located on the 11400 W. meridian and drilled vertically at points about 950' apart, Hole 44 being South of Hole 45. They are located in the E $\frac{1}{2}$ of the SE $\frac{1}{4}$ of Section 2 at some distance South and East of the main body of ore which was encountered and developed in the NE $\frac{1}{4}$ of the Section by Holes 16, 27A, 37, 38, 39 and 40.

High grade ore was encountered in Hole No. 44 at a depth of 3234'. The ore extended for a thickness of 216' to 3450'. The top 26' was of Bessemer grade, having an analysis of 65.75% Iron, .022% Phos. and .024% Sulphur. From 3260' to 3450', 190' of ore averaged 62.62% Iron, .124% Phos. and .017% Sulphur. This high grade ore was followed by considerable second class ore, averaging over 50% Iron until the foot-wall slate was encountered at 3505'. The hole was finally bottomed in this slate at 3523' on August 8th. This proved to be by far the most important run of high grade ore in the entire Golf Club area drilling. I don't believe it has any ore connection with that in the North half of the Section mentioned above and it is from 500' to 900' deeper. It is probably a part of a large body located in a separate geologic structure.

High grade ore was encountered in Hole No. 45 at a depth of 2515'. With the exception of 2' of dike from 2573' to 2575', this ore was continuous to a depth of 2590'. All of the ore is of Bessemer grade

which is exceptional at this depth and in this locality. From 2515' to 2573', the ore analyzed 65.69% Iron, .014% Phos. and .021% Sulphur. From 2575' to 2590', the ore below the dike, the analysis was 65.69% Iron; .013% Phos. and .018% Sulphur. Dike again was encountered below this ore extending from 2590' to 2666'. Typical soft ore jasper followed this and extended to the footwall Siamo slate at 2735'. The hole was bottomed in the latter at a depth of 2783' on August 16th. It is our opinion, at present, that this ore is in still another geologic structure and has no direct ore connection with either the developed ore body in the $N\frac{1}{2}$ of the Section or the deep ore in Hole No. 44 described above.

All drilling was again discontinued at this exploration upon the completion of Holes 44 and 45. It is estimated that enough ore already has been developed by the drilling in the $N\frac{1}{2}$ of the Section to warrant its opening and development. This is underway at the present time. Ground was broken for a shaft on Monday, January 6th, 1941. This shaft is located in the Northeast portion of the $SW\frac{1}{4}$ of the $NW\frac{1}{4}$ of Section 2. It is anticipated that drilling again will be resumed in the vicinity of Holes 44 and 45 during 1941 in an attempt to unravel the several geologic structures and their relation to one another. This is necessary for the efficient future drilling to follow up possible extensions of the ore encountered in these two holes.

Before starting to sink the new shaft mentioned above, the depth of overburden on the ledge was tested at all four corners of the proposed shaft site by sinking a small pipe at each location. It was then decided to put down a 9" churn drill hole into ledge and carry it as deep as practical to drill and ability to keep the hole from deviating beyond the limits of the proposed shaft. The object of this drilling was to provide an opening approximately on the center line of the proposed shaft to break to in blasting the first round of holes in each cut. It should result in saving of both powder and time.

The first hole, No. 47, reached diorite at ledge at a depth of 72'. The hole was discontinued at 124' when it was decided that a shaft located at this point would not be as desirable as a point some 60' to the Northeast. *where the ledge would be nearer the surface.*

Hole No. 48 was put down at this new location and encountered diorite at ledge at a depth of 44'. The hole continued in diorite to a depth of 448' where it encountered soft ore jasper. After drilling in the latter to a depth of 464', a survey of the hole showed that its deviation had taken it out of the limits of the proposed shaft and further drilling was discontinued.

G-2. - EXPLORATIONS ON CLIFFS-SHAFT MINE SURFACE IN SECTION 9, 47-27, MICHIGAN.

Drilling from surface near the Northeast corner of the $SE\frac{1}{4}$ of $NE\frac{1}{4}$ of Section 9, 47-27, was commenced the middle of November with Hole No. 52. This hole was drilled vertically to explore for the downward extension of a strong ore body being mined on the South side of the 1st Level, "B" Shaft. The next tramming level to the shaft below the 1st is the 5th Level and it was hoped to develop the downward extension of this ore the 250' intervening in order to drift into it and raise up below the ore being mined on the 1st Level. Hole 52 drilled through the

quartzite hanging and cut 13' of hard blue jasper breccia and then went into the footwall without having encountered first class ore. For this reason, a second hole, No. 53, also drilled vertically, was located 50' North of No. 52. It was still drilling in hanging wall slate at a depth of 402' on the last of the year.

G-3. - EXPLORATIONS NEAR TILDEN MINE IN SECTION 27, 47-27, MICHIGAN

A total of twenty relatively shallow churn drill holes, Nos. 1 to 20, inclusive, were drilled in the $N\frac{1}{2}$ of the $NE\frac{1}{4}$ of Section 27, in an area roughly 1400' East and West by 600' North and South, lying approximately 1500' West of the West Tilden Pit. The drilling was done by two rigs, a Cyclone and an Armstrong, using 6" bits. Because of the difficulties encountered in casing some of the holes, the accuracy of the sampling in these was somewhat doubtful. In several of the holes the water level was struck in standpiping above ore near the ledge surface. In such cases and where it was difficult to seal the standpipe into ledge, sand from the overburden was washed into the hole contaminating the sample. An examination of the sludge samples with a binocular microscope showed much sand contamination particularly in Holes No. 4 and No. 12. An estimate of siliceous ore developed by Holes 1, 5, 12, 13 and 14 totals approximately 900,000 tons above the elevation of the present West Pit bottom limits (+1430') and approximately the same grade as the ore produced from this pit. The overburden on this ore is estimated at approximately 100,000 cubic yards.

G-4. - HILL-TRUMBULL MINE, SECTION 17, 56-23, MINNESOTA.

The only drilling at the Hill-Trumbull Mine during 1940 was the completion of two holes in the Trumbull Pit early in January and the drilling of two additional holes in the same area also completed early in January. These were structure drill holes and they completed the program covered in my report for 1939. A total of 300' was drilled and 201' of wash ore encountered. The work was done by the Mesaba-Cliffs Mining Company's own men and equipment.

G-5. - HOLMAN-CLIFFS MINE, SECTION 21, 56-24, MINNESOTA.

A total of 52 structure drill holes was drilled in the Holman-Cliffs Pit during the year 1940. Forty-six of these holes, with a total of 3,086' 6" were drilled in the bottom of the Brown No. 1 Pit and in the neck between this Pit and the Holman Pit. A total of 1,392' of wash ore and jig material was encountered. The remaining six holes were drilled on the North Star lease just North of the Brown No. 1 Pit to limit the Northerly extension of the ore to be mined from this pit operation. A total of 755' was drilled encountering 545' of wash ore and jig material. This completes the program of drilling in connection with the Brown No. 1-North Star Pit operations. Most of the drilling was done by the Mesaba-Cliffs Mining Company's own men and equipment, the balance by J. S. Schultze of Grand Rapids, Minnesota, under contract.

G-6. - CANISTEO MINE, Section 29, 56-24, MINNESOTA.

A total of 34 structure drill holes were drilled in the Canisteo Pit and around its perimeter during the operating season of 1940. Five of

these holes were located in the West Bovey Lease on the North side of the Pit; twenty-four of them were located on the East Bovey also on the North side of the Pit; three holes were drilled in the South Bovey Lease on the South side of the Pit; and the remaining two holes from the East Snyder forty along the South side of the Pit. The total drilling amounted to 4,089' 5" and 1,473' of wash ore was encountered. Most of the work was done by Cleveland-Cliffs Iron Company men and equipment, the balance by J. S. Schultze of Grand Rapids, Minnesota, under contract.

H. UNDERGROUND EXPLORATIONS

H-1. - CLIFFS-SHAFT MINE

One diamond drill operated continuously in the Cliffs-Shaft Mine throughout the year. During this time, seven holes were completed and the 8th started, for a total of 2,442'. These holes were numbered from 472 to 479, inclusive, and all were drilled horizontally.

Holes 472 to 477, inclusive, all were drilled from near the West end of the 10th Level, "B" Shaft, in the so-called Section 9 Deposit and vicinity, in order to thoroughly explore this area for the continuation of the ore encountered in the development work and to discover any additional ore bodies. Holes 472, 474, 475 and 477 were drilled to the North. Hole No. 473 was drilled S. 48° W. and Hole No. 476 due South.

A new lense of ore was encountered in Hole 472 from 184' to 195' at the end of 1939. The hole was drilling in hard ore jasper at a depth of 224' on January 1st, 1940. It was continued North without encountering additional ore and finally bottomed in the North footwall greenstone at a depth of 815'. Hole No. 473, drilled to the Southwest to explore an indicated synclinal fold in the formation, encountered a new ore lense at the quartzite-hanging contact from a depth of 440' to 455'. This ore averaged 57.26% Iron and .132% Phos. This was most encouraging as it demonstrated the existence of hard ore in a virgin area hitherto unexplored and indicates possibilities of important extensions along this fold. Although the other holes drilled during the year in this area did not encounter high grade ore, nevertheless they assisted materially in outlining the geologic structure, and in directing future drilling and exploring.

Drilling in the Section 9 area was discontinued temporarily in order to drill several holes in parts of the mine where the information is needed as soon as possible. Accordingly, Holes 478 and 479 were drilled due North from the East drift on the 15th Level, "A" Shaft. The object of these holes was to explore for the downward continuation, in an Easterly pitch, of the strong ore body on the 10th Level elevation and above. Both the ore body and the drill holes are on the Bancroft Lease. Second class ore was encountered in a brecciated zone from 35' to 60'. From 35' to 49' the ore averaged 56.49% Iron and .092% Phos. and from 49' to 60', it averaged 51.25% Iron and .123% Phos. Although this grade is lower than the standard grade of Cliffs-Shaft ore, it can be mined, mixed with and graded as standard ore. Additional mineable ore was encountered from 131' to 140' but with a 3' seam of slate mixed in

from 133' to 136'. This rock can be picked out during the stoping operations. From 131' to 133', the ore averaged 62.75% Iron and .210% Phos. From 136' to 140', the ore averaged 59.90% Iron and .154% Phos.

Hole No. 479, located about 300' East of Hole 478, also encountered mineable material, some of which was not of shipping grade direct but can be mixed as in the case of Hole 478. These ore runs occurred as follows:

<u>From</u>	<u>To</u>	<u>Feet</u>	<u>Iron</u>	<u>Phos.</u>
15'	23'	8	57.05	.036
23	25	2	52.80	.062
28	32	4	53.87	.027
94	102	8	55.00	.120
187	200	13	55.35	.143

This hole actually had reached a depth of only 170' at the end of the year and was drilling in slate at that point.

The results of these two holes constitutes a most encouraging and important discovery. It is the first time we have found ore extending as deep as the 15th Level in "A" Shaft. The ore soon will be opened by development drifting and raising from the 15th Level.

H-2. - LLOYD MINE

Toward the end of January, 1940, it was decided to explore, by drilling, an area on the 6th Level, Lloyd Mine, to the South of the main footwall drift and West of the main Lloyd-East ore body. The main Lloyd fault, having a strike Northwest and Southeast and a dip to the Northeast, cuts this level and forms, with the slate footwall, a structure favorable for concentration of ore. This ore naturally would pitch to the East and would, in depth, join with the main Lloyd East ore body which is pitching West. Four holes, Nos. 111 to 114, inclusive, were completed from this level during the balance of the year.

Hole No. 111 was drilled horizontally on a course of S. 45° W. to cut the main Lloyd fault, penetrate the faulted footwall slate on the South side, and explore the adjacent soft ore jasper to the South. Twenty-five feet of good ore was encountered near the fault contact at a depth of 95' to 120'. This undoubtedly is the ore body anticipated as the first objective in this drilling. This ore averaged 59.65% Iron and .047% Phos. The jasper to the South of the faulted slate showed some enrichment carrying, in places, more than 51% in Iron, but no first class ore was found. Drifting and raising in this new ore was carried on later in the year. Its outlines above the 6th Level are quite limited but should increase materially as the ore pitches to the East in depth.

Holes 112 and 113 were drilled horizontally and to the South to explore the iron formation South of the main Lloyd-East ore crotch in hopes of finding one or more additional fault crotches in which ore

concentration may have taken place. Drilling a number of years ago on the South side of the upper levels of the mine indicated such structure. These holes demonstrated the continuation of this fault structure but did not encounter merchantable ore at this elevation.

Hole No. 114 was drilled with a dip of -62° to the South directly under Hole No. 112 to get down deeper into this fault structure. Some enrichment of the formation was found but no first class ore. This fault crotch pitches Westerly and there seems to be no geologic reason why it shouldn't carry ore somewhere down the pitch. It will be explored at a lower elevation, probably from the 7th Level when the possibility is provided. Hole No. 114 was completed at the end of the year.

H-3. - MAAS MINE

Diamond drilling in the Maas Mine from the 5th Level to determine the limits of the ore in its pitch to the West below the level, and more particularly its sulphur content, was started in December, 1939 with Hole No. 30 and continued until the end of May, the last hole being No. 33. Hole No. 30, which was drilled horizontally and S. 45° W. from the 200' Sub-Level, was drilling in soft ore jasper at a depth of 212' on the first of the year. This hole was testing the North deposit. It had encountered good ore from 50' to 140', previously discussed in my report for 1939. No additional ore was encountered and the hole was bottomed at 309'.

Holes 31, 32 and 33 were drilled from the 5th Level with dips of -30° , S. 59° W.; -59° , S. 59° W., both from the same location; and -45° S. 35° W. These holes all were carried down ^{to} the footwall slate or the ferruginous transition material lying on the slate. All three of these holes penetrated the ore body and found it to be abnormally high in Sulphur content. Unless some improvement is found in later drilling, it looks very much as though the ore below the 5th Level elevation cannot be mined and mixed with standard grade ore because of this high sulphur content. Occasional 10' to 25' seams of ore average from .039 to .050% in Sulphur, but most of the ore will average from .133% to as high as 1.836% in Sulphur. Additional drilling below the 5th Level was started in January, 1941, and will be continued until all possibilities of finding standard grade ore below this elevation have been exhausted.

I. EXPLORATIONS AND NEW DEVELOPMENTS BY OTHER COMPANIES

The following activities on the Iron Ranges, that may be of especial interest, have come to my attention during the past year:

I-1. - MARQUETTE RANGE

The Inland Steel Company, at its Greenwood Mine, continued to produce a limited tonnage of hard ore, both magnetite and hematite, found in stringers along the quartzite hanging wall, extending between the 1st and 4th Levels. The year 1940 was the best in the mine's history and a production of 103,638 tons was realized. This compares with 72,360 tons in 1939, the next largest year. Shipments from the mine during 1940 were 102,602 tons, made up of 68,246 tons of lump and 34,356 tons of Junior (crushed). New stringers of ore were encountered in extending several of

the levels to the West and stoping followed up on them to their termination at the hanging wall contact. It is anticipated sinking will be resumed during the current year to open up the new 5th Level 200' below the 4th. Before this work can be started, however, a new headframe and hoisting equipment will be installed. Work is underway on this installation at the present time.

No changes occurred during 1940 in the status of either the Ropes or Michigan Gold Mines which were discussed in my report for 1939. Both properties have been kept unwatered and mining activities are anticipated during the current year.

I-2. - GOGEBIC RANGE

Effective January 15th, 1941, the Oliver surrendered the lease on the Puritan Mine, reporting the exhaustion of the ore reserves. This leaves the Oliver with only one operation, the Geneva-Davis. At the Newport, a new level is being opened but so far is still in rock. Pickands, Mather & Company put down a 17" churn drill hole in the old Tilden Mine property in which a pump has been installed to catch the water before its natural drainage takes it into the Palms-Anvil workings. At the Carey Mine, Pickands-Mather is opening the 29th and 31st Main Levels. Ore recently was encountered on the 31st. It is a high grade Bessemer ore, lying on the Easterly extension of an ore-bearing dike from the Montreal property to the West. The Republic Steel Corporation reopened the Ironton Mine and ore production was resumed the latter part of the year.

I-3. - MENOMINEE RANGE

At Iron River, the M. A. Hanna Company continued drifting to connect the Minkler and Homer Mines and were forced to unwater the old Wauseca workings as a safety precaution due to the high water pressure encountered in the Homer drift heading toward the Minkler. A 30" churn drill hole was sunk 1000' at the No. 1 Hiawatha Mine to be used as a ventilating shaft and later as a means for conveying filling to stopes. The Inland Steel Company is well underway with its shaft sinking on the Sherwood Lease. The Pittsburgh Coke & Iron Company acquired the stock of the Davidson Ore Company and assumed operation of the mines at Mineral Hills on December 1st. The same operating personnel is in charge. They also acquired the old Forbes property to the North, exhausted by the North Range Iron Company in 1939. It is rumored a shaft will be sunk here to serve the Davidson No. 1 Mine, the shaft of which is in bad condition and the stockpile ground endangered by mining.

At Crystal Falls, the Inland Steel Company practically completed stripping the open Pit ore at the Ravenna-Prickett and shipped 62,081 tons from the Pit. This work was done under contract by the Evergreen Mines Company of Crosby, Minnesota. Work soon will start in sinking a shallow shaft outside of the pit limits through which the underground ore will be mined. The Republic Steel Corporation reopened the Tobin Mine and was preparing it for production at the end of the year. The stockpile was cleaned up and shipped, a total of 24,681 tons.

On the old Menominee Range, the Globe Iron Company continued to operate its siliceous ore pit on the Cornell property near Iron Mountain and shipped 57,486 tons during 1940. At the Bradley Mine, near the old Ludington shaft of the Chapin Mine, Mr. Bradley, under contract, mined and delivered to the Jackson Iron & Steel Company a total of 31,409 tons of siliceous ore. Mr. John T. Spencer of Iron Mountain shipped 1,337 tons of self-fluxing lean ore from stockpile at the Matilda Mine (Old Davidson) at Commonwealth, Wisconsin. This ore was trucked to Florence and shipped from there by rail to the Wells Furnace Company.

I-4. - MESABA RANGE

A number of improvements were made by Butler Brothers at its new cone heavy density concentrating plant located at the Harrison Mine in Cooley, Minnesota, and simplified the flow sheet somewhat, resulting in a material saving and increased satisfactory operation. At the Danube Mill of Pickands, Mather & Company, a new jig unit was completed and went into full production during the middle of the shipping season. Some mechanical trouble was experienced but was ironed out before the close of the season. However, a number of alterations will be made in the mill. A new jig unit is being designed by them and will be constructed during the current season for treatment of jig ores at the Majorca Mine which is to be reopened. Numerous idle open pits either were reopened during 1940 or will be opened in the current season with anticipated shipments breaking all previous records. One of the principal changes under way in many of the open pit mines is the substitution of truck for rail haulage.

I-5. - CUYUNA RANGE

Butler Brothers revamped their concentrating plant at Crosby and substituted ferro-silicon as a heavy density medium in the place of galena which proved unsatisfactory at the time this plant was closed down several years ago. The new flow sheet is very similar to that used at its Harrison plant at Cooley, Minnesota, and referred to above.

I-6. - WISCONSIN

The Inland Steel Company purchased all of the stock of the Jackson County Iron Company, owner of approximately 85% of the siliceous ore lands near Black River Falls, and ^{purchased} the balance of these lands from smaller individual owners. Some surface exploring has been done and a tunnel is now being driven into the hillside of one of the deposits to get a large size sample. In my Annual Report for 1938, I mentioned that magnetic concentration tests were made on ores from these properties at the Mines Experiment Station, University of Minnesota, Minneapolis. I have learned that the crude ore of the samples tested analyzed approximately 35.63% Iron. Most of the iron is in the form of magnetite which averaged 33.28% Iron in the crude. Crushed through 100 mesh and subjected to magnetic concentration, a concentrate was obtained with an average of 62.73% Iron and 11.73% Silica, yielding a 50% weight recovery. Mr. Wahl tells me that experimental work is being done on this ore at present at the laboratory of the Battelle Memorial Institute, Columbus, Ohio, and that the results so far are very encouraging.

J. EXAMINATION OF MINERAL LAND OFFERS

A total of 48 land offers were received by this office during the year 1940. Thirty-six of these were mineral land offers. Of the remaining twelve offers, nine were of surface property and real estate in the City of Negaunee, two of surface property and real estate in the City of Ishpeming, and the remaining offer was the surface of the old St. Lawrence Mine in Section 5, 47-27. The offers and their numbers are as follows:

Offer No.	Description	Remarks
2084	Iron ore lands in the Vermillion Range District, Minnesota.	Declined
2085	Magnetite iron lands in New Jersey	"
2086	Molybdenum property in Arizona	"
2087	Residence of F. H. Berg, Ishpeming	Purchased
2088	Silica Deposit on Island in Lake Huron	Declined
2089	Manganese property in New Mexico	"
2090	Quartz-silica deposit North of Sault Ste. Marie, Ontario	"
2091	Iron lands in Iron County	"
2092	Lot 8, Block 14, Pioneer Iron Co. Plat, Negaunee	"
2093	Lot 6, Block 33, Pioneer Iron Co. Plat, Negaunee	Pending
2094	Family home at 108 E. Main St., Negaunee	Declined
2095	Iron ore lands in Iron County	"
2096	Armour No. 2 Mine, Cuyuna Range, Minnesota	"
2097	Various lands in several Upper Peninsula counties	"
2098	Gold prospect in Arizona	"
2099	Tin and pumice prospect (a wildcat) Baraga County	"
2100	Berkshire Mine, Iron River, Michigan	"
2101	Iron lands in Crow Wing County, Minnesota	"
2102	Various lands on the Gogebic Range	"
2103	House on Lot 1, Block 4, Pioneer Iron Co. Second Addition, Negaunee	"
2104	House at 435 Cherry St. and Lot 20, Block 2, Corbit's Addition, Negaunee	Pending
2105	Property at 819 N. Fifth Street, Ishpeming	Declined
2106	Lands North of Wausau, Wisconsin	"
2107	Limestone and dolomite lands on Drummond Island	"
2108	Manganese iron deposit in Arizona	"
2109	N $\frac{1}{2}$ of Lot 14, Block 27, Pioneer Iron Co. Plat, Negaunee	"
2110	Copper and gold in Ontario	"
2111	Mineral rights of old St. Lawrence Mine, Sec. 5, 47-27	"
2112	House and lot at South end of Harvey Lot 8, Negaunee	Pending
2113	Pyrite property in Michipicoten District, Ontario	Declined
2114	Copper property in Ontario	"
2115	Mathisen property Southwest of Pontiac Mine, Cuyuna Range, Minnesota	"
2116	Various lands in 47-26, 47-28 and 47-29, Marquette County Michigan	"
2117	15 claims on Mississagi Reserve, Ontario	Pending
2118	Iron ore in New Mexico	Declined
2119	Brule Mine, Iron River District	"
2120	Crystal Falls and Dunn Mines, Crystal Falls District	"
2121	Surface of St. Lawrence Mine, Section 5, 47-27, Michigan	"
2122	NE $\frac{1}{4}$ of SW $\frac{1}{4}$ of Sec. 2, 45-26, Marquette County, Michigan	"

Offer No.	Description	Remarks
2123	Lot 3, Block 12, Pioneer Iron Co. Plat, Negaunee	Declined
2124	Manganese property in Virginia	"
2125	Iron and manganese property in North Carolina	"
2126	Large acreage of lands in Cass and Crow Wing Counties, Minnesota	"
2127	Iron Ore in Arkansas	"
2128	Magnetic ore in Ontario, Canada	Pending
2129	House and Lot 26, Block 4, Jackson Iron Co. Addition, Negaunee	Recommended
2130	Iron and manganese lands near Parkersburg, West Virginia	Declined
2131	Manganiferous iron ore property on Cuyuna Range	"

K. RESEARCH AND EXPERIMENTS

One additional jig test was made early in the year on lean ore from the Trumbull Pit at the Mines Experiment Station, Minneapolis, Minnesota, supplementing similar tests made in 1939. This last test was made on a washed sample crushed to a maximum size of $\frac{1}{2}$ " in order to compare the results with jig tests made on material whose maximum size was both larger and smaller than this. The Wade-Gleason pneumatic pulsating jig, now called the "Conset" jig, was used and the work done by the regular staff at the Station. The results of this test are covered in a special report.

Exhaustive investigations and concentration tests were made on a carload of Tilden siliceous ore, also at the Mines Experiment Station, in order to determine whether a high grade concentrate could be made economically. Both magnetic and gravity concentration methods were used. The work was under the immediate direction of Mr. E. W. Davis, Director of the Station, and his results are set forth in detail in a special report dated October 7th, 1940. This report also goes into the detail of plant construction for making concentrates, including cost of both plant and operation. In a few words, the results of these tests demonstrate that a high grade concentrate and sinter can be produced from Tilden Siliceous ore by the gravity method of concentration in common metallurgical practice and with machinery units of current design and accepted use. The cost, however, is estimated at approximately \$6.40 per ton of sinter delivered at Lower Lake ports. With a 63.30% Iron natural and with no credit for a low phosphorous content, this would amount to \$1.011 per unit of iron. This would not be a profitable operation at the present time but is information which may be valuable in years to come.

Mr. George H. Beasley continues to make glass classifier tests at our Hill-Trumbull research laboratory on all samples from our structure drilling on the Mesaba Range in possible jig ore horizons. This is necessary to aid in classifying jig material for future reserve estimates.

The ferro-silicon used in the heavy density method of concentration by Butler Brothers on the Mesaba Range costs approximately \$60.00 per ton. With a loss of one-half of one percent to three-fourths of one percent of medium per ton of concentrate recovered, this amounts to from three to four and a half cents per ton of concentrate. There is some chance of reducing

this loss slightly. Experiments are now being made using a mixture of ferro-silicon and roll scale. Roll scale is a waste product from the rolling of steel and can be purchased very cheaply (only a few dollars per ton). It is practically an artificial magnetite but is not quite as high in gravity as the ferro-silicon. If these products could be mixed in anything like equal parts, for example, and still have a satisfactory medium, the cost of this medium in concentrating might be reduced as much as 1¢ to 1¹/₂¢ per ton of concentrates. These tests will be watched with much interest as we may be considering an installation of this process in the near future.

L. EXPENSE STATEMENTS

Tables VII and VIII, which follow, show a detailed statement of charges to Geological expense for the year 1940 and a comparative statement of these charges for the last three years. They are self-explanatory.

TABLE VII

STATEMENT OF CHARGES TO GEOLOGICAL EXPENSE FOR THE YEAR 1940

Salaries	\$ 12,609.09
Travel and Entertainment	1,793.92
Operating Automobiles	854.21
Supplies and Office Expense	1,187.10
Personal Injury	251.14
Unemployment Insurance Tax	310.52
Old Age Benefit Tax	94.11
Unclassified	12.76
TOTAL	<u>\$ 17,112.85</u>

TABLE VIII

COMPARATIVE STATEMENT OF CHARGES TO GEOLOGICAL DEPARTMENT
FOR LAST THREE YEARS

	<u>1940</u>	<u>1939</u>	<u>1938</u>
Salaries	\$ 12,609.09	\$13,068.50	\$ 12,344.00
Travel and Entertainment	1,793.92	1,882.88	1,405.75
Operating Automobiles	854.21	683.81	438.44
Supplies and Office Expense	1,187.10	1,235.07	873.39
Personal Injury	251.14	262.16	258.15
Unemployment Insurance Tax	310.52	337.87	391.82
Old Age Benefit Tax	94.11	99.32	93.91
Unclassified	12.76	7.18	152.32
TOTALS	<u>\$ 17,112.85</u>	<u>\$17,576.79</u>	<u>\$ 15,957.78</u>

Respectfully submitted,

E. L. Derby, Jr.
Geologist

REPORT OF THE GEOLOGIST FOR THE YEAR ENDING DECEMBER 31, 1940

SURFACE EXPLORATIONS IN SECTION 2, 47-27, MICHIGAN

Diamond drilling in the Golf Club area, which was discontinued on June 8th, 1939 because of discouraging business conditions, was resumed early in March, 1940. Holes 44 and 45 were the ones being drilled when work was stopped. Drilling was resumed in Hole 44 at a depth of 1975' on March 8th and at a depth of 1355' in Hole 45 on March 7th. Both these holes were located on the 11400 W. meridian and drilled vertically at points about 950' apart, Hole 44 being South of Hole 45. They are located in the $E\frac{1}{2}$ of the $SE\frac{1}{4}$ of Section 2 at some distance South and East of the main body of ore which was encountered and developed in the $NE\frac{1}{4}$ of the Section by Holes 16, 27A, 37, 38, 39 and 40.

High grade ore was encountered in Hole No. 44 at a depth of 3234'. The ore extended for a thickness of 216' to 3450'. The top 26' was of Bessemer grade, having an analysis of 65.75% Iron, .022% Phos and .024% Sulphur. From 3260' to 3450', 190' of ore averaged 62.62% Iron, .124% Phos. and .017% Sulphur. This high grade ore was followed by considerable second class ore, averaging over 50% Iron until the footwall slate was encountered at 3505'. The hole was finally bottomed in this slate at 3523' on August 8th. This proved to be by far the most important run of high grade ore in the entire Golf Club area drilling. I don't believe it has any ore connection with that in the North half of the Section mentioned above and it is from 500' to 900' deeper. It is probably a part of a large body located in a separate geologic structure.

High grade ore was encountered in Hole No. 45 at a depth of 2515'. With the exception of 2' of dike from 2573' to 2575', this ore was continuous to a depth of 2590'. All of the ore is of Bessemer grade which is exceptional at this depth and in this locality. From 2515' to 2573', the ore analyzed 65.69% Iron, .014% Phos. and .021% Sulphur. From 2575' to 2590', the ore below the dike, the analysis was 65.69% Iron; .013% Phos. and .018% Sulphur. Dike again was encountered below this ore extending from 2590' to 2666'. Typical soft ore jasper followed this and extended to the footwall Siamo slate at 2735'. The hole was bottomed in the latter at a depth of 2783' on August 16th. It is our opinion, at present, that this ore is in still another geologic structure and has no direct ore connection with either the developed ore body in the $N\frac{1}{2}$ of the Section or the deep ore in Hole No. 44 described above.

All drilling was again discontinued at this exploration upon the completion of Holes 44 and 45. It is estimated that enough ore already has been developed by the drilling in the $N\frac{1}{2}$ of the Section to warrant its opening and development. This is underway at the present time. Ground was broken for a shaft on Monday, January 6th, 1941. This shaft is located in the Northeast portion of the $SW\frac{1}{4}$ of the $NW\frac{1}{4}$ of Section 2.

Before starting to sink the new shaft mentioned above, the depth of overburden on the ledge was tested at all four corners of the proposed shaft site by sinking a small pipe at each location. It was then decided to put down a 9" churn drill hole into ledge and carry it as deep as practical to drill and ability to keep the hole from deviating beyond the limits of the proposed shaft. The object of this drilling was to provide an opening approximately on the center line of the proposed shaft to break to in blasting the first round of holes in each cut. It should result in saving of both powder and time.

The first hole, No. 47, reached diorite at ledge at a depth of 72'. The hole was discontinued at 124' when it was decided that a shaft located at this point would not be as desirable as a point some 60' to the Northeast where the ledge would be nearer the surface.

Hole No. 48 was put down at this new location and encountered diorite at ledge at a depth of 44'. The hole continued in diorite to a depth of 448' where it encountered soft ore jasper. After drilling in the latter to a depth of 464', a survey of the hole showed that its deviation had taken it out of the limits of the proposed shaft and further drilling was discontinued.

C. W. Allen

Superintendent

E. L. Derby, Jr.

Geologist

ANNUAL REPORT OF THE MINING ENGINEERING DEPARTMENT FOR THE YEAR ENDING
DECEMBER 31, 1940

The usual books of photographic maps, showing the areas mined on the various levels and sub-levels in the operating mines during 1940, accompany this report. These books contain views of some of the properties and maps or sections of the different mines. These maps show, in red, the areas mined and development work since last year's report and the sections show, in color, the geological structure adjacent to the ore body. Books have been prepared for the different companies interested in the various mines, the following list showing the companies for which books have been prepared and the mines included therein:

Company	Mines
The Cleveland-Cliffs Iron Company	Athens, Canisteo, Cliffs-Shaft, Hill-Trumbull, Holman-Cliffs, Jackson Lease-Cambria Mine, Lloyd, Maas, Morris, Negaunee and Section 2, Spies-Virgil and Tilden.
Bethlehem Steel Company	Negaunee and Section 2.
Canisteo Mining Company	Canisteo.
Hanna Ore Mining Company	Hill-Trumbull and Holman-Cliffs.
Inland Steel Company	Hill-Trumbull and Holman-Cliffs.
Jones & Laughlin Steel Corporation	Hill-Trumbull and Holman-Cliffs.
Otis Steel Company	Hill-Trumbull and Holman-Cliffs.
Pickands, Mather & Company	Athens.
Pittsburgh Steel Corporation	Hill-Trumbull and Holman-Cliffs.
Republic Steel Corporation	Hill-Trumbull and Holman-Cliffs.
Wheeling Steel Corporation	Hill-Trumbull and Holman-Cliffs.

There were two bound volumes of The Cleveland-Cliffs Iron Company book made, one for the Cleveland office and one for the Engineering Department at Ishpeming. Six loose-leaf books were made of the Canisteo Mine for the Canisteo Mining Company. Four loose-leaf books were prepared for the Republic Steel Corporation, two of the Lloyd Mine and two as partners in the Mesaba-Cliffs Mining Company. One copy of the other books were made in loose-leaf form.

There were similar books prepared for the fee-owners and superintendents. Those for the Hibbing office were bound while the others were in loose-leaf form.

Person	Mines
Arthur Iron Mining Company	Hill-Trumbull and North-Star-Bingham Lease of Holman-Cliffs.
M.H.Barber, District Superintendent	Canisteo, Hill-Trumbull and Holman-Cliffs.
H.C.Bolthouse, Superintendent	Hill-Trumbull and Holman-Cliffs.
W.A.Sterling, Superintendent	Canisteo.
W.W.Graff, Superintendent	Maas, Negaunee and Athens.
H.O.Moulton, Superintendent	Maas.
F.J.Haller, Superintendent	Lloyd and Spies-Virgil.
C.J.Stakel, Superintendent	Cliffs-Shaft.

B. MAP REPORTS

Two sets of blue-prints of mine maps, scale 1" = 50', were prepared at the end of each month, showing in red the areas mined during that month. One of these sets was for the General Superintendent and the other set for the Mine Superintendent. Maps for the Cliffs-Shaft Mine were made at quarterly intervals as these workings are so extensive that it is impossible to make the surveys any oftener. These map reports to the General Superintendent are boxed and preserved for future use.

Besides the above map reports, other sets of maps were prepared for outside parties as follows:

ATHENS MINE

Two sets of monthly blueprints of the Athens Mine, showing in red the work done during that month, were sent to the Cleveland office for the Pickands, Mather & Company.

One set of blueprints, scale 1" = 50', showing in color the work done on the Mitchell Lease, Harvey Lots 8, 9 and 11, for the year, were forwarded to Dr. R. E. Drake, Ann Arbor, Michigan.

CLIFFS-SHAFT MINE

Two sets of blueprints, scale 1" = 50', of the geological maps of the Bancroft Lease, showing in red the work done since the previous report, were prepared after each quarterly survey of the mine. One set goes to the Ishpeming office of the Oliver Iron Mining Company and the other to our Cleveland office. At the end of the year, two sets of these geological maps of the Bancroft Lease are prepared, showing the work done for the year, one set going to the Duluth office of the Oliver Iron Mining Company and one to our Cleveland office. In addition, two copies of the estimate of ore reserves in the Bancroft Lease, as of December 31st, 1940 as prepared for the Michigan State Tax Commission, are sent, one to the Duluth office of the Oliver Iron Mining Company and one to our Cleveland office, together with a set of maps, scale 1" = 50', showing the location of the estimated reserves.

MAAS MINE

Blueprints of those portions of the Maas Mine workings in the Roman Catholic Cemetery Lease were sent monthly to Mr. R. S. Archibald, Negaunee, Michigan, showing in red, the areas mined during each month.

NEGAUNEE MINE

Sixteen sets of maps showing the development in the No. 3 Shaft ore deposit above the 13th Level were forwarded to the Cleveland office for fee-owners, showing in red the development and analyses during the last quarter of 1940.

At the end of the year, fourteen sets of Annual Report maps of the 4th, 6 $\frac{1}{2}$, 9th, 10th, 11th, 12th, 13th and 14th Levels were sent to the Cleveland office to be forwarded to the fee-owners.

A set of blueprints, scale 1" = 50', of the North-South cross-sections of the Negaunee Mine were sent at the end of the year to Mr. W. L. Cummings, Geologist of the Bethlehem Steel Company, Bethlehem, Pennsylvania. Only those sections were sent that were affected by mining operations during 1940.

SPIES-VIRGIL MINE

Five sets of blueprints, scale 1" = 50', were sent quarterly to the fee-owners of the Virgil property, showing in red the areas mined during the previous three months.

MICHIGAN STATE TAX COMMISSION

Estimates of ore reserves of the Athens, Cliffs-Shaft, Lloyd, Maas, Negaunee and Spies-Virgil Mines were made as of December 31st, 1940. These estimates were accompanied by a set of annual report maps showing, in color, the areas included in compiling these estimates and general geological features. One of these books were sent to the Michigan State Tax Commission through the Cleveland office in January, 1941, the other book remaining on file in the Engineering Department at Ishpeming.

C. REMARKS ON MISCELLANEOUS DOCUMENTS AND ABSTRACTS

All documents affecting lands and rights held by the Company or its subsidiaries passed through the Engineering Department for recording and approval irrespective of the Department in which they originate. These documents received the approval of both the Engineering and Geological Departments and are entered on the records and initialed by Mr. Brewer and also by Mr. Derby if necessary. Careful consideration of these documents are given from the standpoint of the Mining Department especially where the mineral or economic value is concerned. Copies of those documents which affect the mineral lands are kept on file in the Engineering Department.

The following table shows the number and classification of such documents as have passed through the Department during the year:

CLASSIFICATION	Number Received	Last File Number
Mining Leases	2	72
Miscellaneous Documents	14	1373
Easements	5	414
Rights of Way	1	222
Water Rights	0	59
Surface Leases	287	4997
Applications for Sale	3	177
Sales	263	1955
Tax Histories	0	702
Legal Opinions	0	195

The following comments cover the above classifications and the documents that were entered on the Department records during 1940:

MINING LEASES

There were two mining leases received during the year. One covered Sections 1 and 2, 47-27 to the Negaunee Mine Company. The other lease covers about five acres of the Maas Mine called the "Maas Area" lying adjacent to the Negaunee Mine, containing part of the Adams and C.C.I.Co. strips. Both these leases were dated January 2nd, 1940.

The lease of the Lloyd Mine to the Republic Steel Corporation, dated April 15, 1936, was cancelled as of November 30th, 1940.

MISCELLANEOUS DOCUMENTS

This classification covers all documents involving the transfer of rights on the mineral lands. Of those received during the year, two were copies of old documents for the files, two involved city lots in Ishpeming and Negaunee and five were rights of way and one was the purchase of the Minowan property at Palmer, and the others were Cliffs Power & Light Company rights.

EASEMENTS

These documents cover rights of way acquired by the Cliffs Power & Light Company. Three involved relocations of transmission lines and two were railroad crossings for service lines.

RIGHTS OF WAY

This file covers railroad and highway rights of way across mineral lands. There was one copy of an old document placed on file during the year.

WATER RIGHTS

These are permits granting rights for mine water discharge, etc., across lands adjacent to mines. There were no changes during the year.

SURFACE LEASES

These leases cover all sorts of permits for the use of Company lands and originate in the Land Department. There were 29 camp leases, and 12 for farms and gardens. The balance covered leases for residences. Most of these covered the lots where Company houses had been sold in the C. C. I. Co. Additions to the City of Negaunee, North Lake Location and Twenty Houses, City of Ishpeming.

APPLICATIONS FOR SALE

These also originate in the Land Department and are preliminary reports covering lands to be sold and are issued for the properties lying off the mineral formation.

SALES

This classification covers the transfer of rights of all kinds. Most of these originate in the Land Department. Most of these sales were contracts for the sale of Company houses in Negaunee, Ishpeming and North Lake. There were 10 various rights of way and 13 for lands off the mineral formation.

TAX HISTORIES

There were no tax histories added to the Engineering Department files during the year.

LEGAL OPINIONS

This file is for ready reference of legal opinions as to the title of various lands. There were no additions to the Engineering Department files during the year.

ABSTRACTS

There was no work done on abstracts during the year.

D. THE FORCE

The personnel of the Department was almost completely changed during the year. Messrs. F. J. Haller and O. Marjama left the Department to enter the operating end. Mr. Haller later became Superintendent at the Lloyd and Spies-Virgil Mines and Mr. Marjama Assistant Superintendent at the Negaunee and Athens Mines. Mr. W. A. Richards left for training camp with the Michigan National Guard when it was called into Federal service on October 15th. Mr. Minnear was transferred to the Geological Department. Messrs. Magnuson and Wilmot were employed during the summer. Mr. S. J. Richards was employed as a Draftsman to help in the place of Mr. Minnear and his place was taken later by Mr. Stannard.

The following table shows the personnel of the Department during the year, their position and period employed during 1940:

Name	Position	Entered	Left	1940 Employment
C. Brewer	Chief Mining Engineer			12 months
J. Trosvig	Engineer			12 "
F. J. Haller	"		Feb. 29	2 "
O. Marjama	"		Feb. 29	2 "
W. R. Atkins	"			12 "
W. A. Richards	"		Oct. 14	9 $\frac{1}{2}$ "
C. R. Sundeen	"	Feb. 20		10 $\frac{1}{2}$ "
J. S. Westwater	"	May 13		7 $\frac{1}{2}$ "
G. T. Hollett	"	Aug. 12		4 $\frac{1}{2}$ "
A. Minnear	Draftsman		Sept. 24	8 $\frac{1}{2}$ "
A. Koski	Helper			12 "
D. W. Carlson	Stenographer			12 "
S. J. Richards	Draftsman	Aug. 15	Oct. 31	2 $\frac{1}{2}$ "
H. Stannard	"	Nov. 1		2 "
R. E. Magnuson	Helper	June 25	Sept. 21	3 "
R. S. Wilmot	"	June 26	Sept. 7	2 $\frac{1}{2}$ "
D. Isaacson	"	Nov. 18		1 $\frac{1}{2}$ "

The next table shows the length of service in the Engineering Department of the present personnel:

Name	Date Entered	Length of Service
C. Brewer	August, 1906	22 years, 3 months
J. Trosvig	June, 1911	23 " 10 " (1)
W. R. Atkins	November, 1936	4 " 1 $\frac{1}{2}$ "
C. R. Sundeen	February, 1940	10 $\frac{1}{2}$ "
J. S. Westwater	May, 1940	7 $\frac{1}{2}$ "
G. T. Hollett	August, 1940	4 $\frac{1}{2}$ "
A. Koski	January, 1936	5 years,
D. W. Carlson	August, 1936	4 " 4 $\frac{1}{2}$ months
H. Stannard	November, 1940	2 "
D. Isaacson	November, 1940	1 $\frac{1}{2}$ "

(1) Not employed by Company from October 15, 1914 to December 1, 1915, also from June 1, 1932 to November 9, 1936.

The above "Length of Service" only covers the period that the men were employed in the Engineering Department and does not necessarily cover the entire length of service with the Company. Several of the men have been in other departments either before or at intervals since first entering this department.

The following table shows the total days worked, days sick and days absent for the year:

Name	Days Worked	Days Sick	Days Absent
C. Brewer	250 $\frac{1}{2}$	6	18 $\frac{1}{2}$
J. Trosvig	259		16
F. J. Haller	46		
O. Marjama	46		
W. R. Atkins	262 $\frac{1}{2}$		12 $\frac{1}{2}$
W. A. Richards	192	5 $\frac{1}{2}$	21
C. R. Sundeen	231	2 $\frac{1}{2}$	3
J. S. Westwater	171	3 $\frac{1}{2}$	
G. T. Hollett	103	2	1
A. Minnear	177	1	24
A. Koski	266	$\frac{1}{2}$	8 $\frac{1}{2}$
D. W. Carlson	263		12
S. J. Richards	60 $\frac{1}{2}$		
H. Stannard	42 $\frac{1}{2}$		
R. E. Magnuson, Jr.	68 $\frac{1}{2}$		
R. S. Wilmot	56 $\frac{1}{2}$		
D. Isaacson	31		

The distribution of the time spent underground, in the field and in the office during 1940 is shown in the following table, together with the total percentages.

Name	Underground	Field	Office	Total
C. Brewer	4	35½	211	250½
J. Trosvig	50½	50½	158	259
F. J. Haller	13½	½	32	46
O. Marjama	13½		32½	46
W. R. Atkins	109	15½	138	262½
W. A. Richards	52½	30	109½	192
C. R. Sundeen	86	12	133	231
J. S. Westwater	67½	33	70½	171
G. T. Hollett	21	32½	49½	103
A. Minnear	24	7½	145½	177
A. Koski	81	73	112	266
D. W. Carlson	1	3	259	263
S. J. Richards		18½	42	60½
H. Stannard			42½	42½
R. S. Wilmot	1	39	16½	56½
R. E. Magnuson, Jr.	6	44½	18	68½
D. Isaacson	4	9	18	31
TOTAL	534½	404	1,587½	2,526
%	21.2	16.0	62.8	100.0

The following is a resume of the work done by the various men in the Department during the year:

CARL BREWER, Chief Mining Engineer, had charge of the Engineering Department and exercised general supervision over all of the work done. All of the documents passed through his hands and were entered on the records. He initialed them and made such reports on the rights conveyed as were necessary. He compiled the Annual Report books, estimates of ore reserves and maps for the Michigan State Tax Commission, stockpile estimates, etc. He checked the published delinquent tax lists for both the Mining Department and the Cliffs Power & Light Company lands. With Mr. H. J. Adams, he visited some of the Boards of Review in the spring to correct certain descriptions on the tax rolls. He continued his study and tabulation of the surface water conditions at various properties. He supervised the triangulation surveys and calculations of mineral boundaries. A considerable portion of his time was spent in preparing lists and maps for the Cleveland office in regard to the Sections 1 and 2 Lease to the Negaunee Mine Company. He made the 1940 tax list for the Mining Department and the Cliffs Power & Light Company.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
General Engineering		20 $\frac{1}{2}$	206	226 $\frac{1}{2}$	90.4
Athens Mine		1 $\frac{1}{2}$	$\frac{1}{2}$	2	.8
Lloyd Mine		1		1	.4
Maas Mine		$\frac{1}{2}$		$\frac{1}{2}$	.2
Negaunee Mine	2	$\frac{1}{2}$		2 $\frac{1}{2}$	1.0
Spies-Virgil Mine	2	4	1	7	2.8
Tilden Mine		3	$\frac{1}{2}$	3 $\frac{1}{2}$	1.4
Sec. 2 Development		4 $\frac{1}{2}$	3	7 $\frac{1}{2}$	3.0
TOTAL	4	35 $\frac{1}{2}$	211	250 $\frac{1}{2}$	
%	1.6	14.2	84.2		100.0

JOHN TROSVIG, Engineer, had charge of the engineering work at the Cliffs-Shaft Mine during the entire year. He made quarterly surveys of the mine and prepared the quarterly maps showing the advance of mining and development. He planned development work with the Superintendent and Mine Captain and ran many surveys underground in connection with giving lines for raises and drifts. He located all the diamond drilling both on surface and underground at this property. He also made the monthly inspections and prepared maps of the Jackson Lease-Cambria Mine throughout the year and made a monthly written report thereon covering the grade of ore extracted as shown by mine samples. In May he made the estimate of ore in stock at the Otis Steel Company plant at Cleveland, Ohio. During the summer he did practically all of the triangulation surveys between Ishpeming and Negaunee. He made the annual estimate of ore reserves in the Cliffs-Shaft Mine for the Tax Commission and the annual estimate of ore in stock as of November 1st.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
General Engineering		28	22	50	19.3
Cliffs-Shaft Mine	41 $\frac{1}{2}$	9	108 $\frac{1}{2}$	159	61.4
Jackson Lease	9		27 $\frac{1}{2}$	36 $\frac{1}{2}$	14.1
Maas Mine		2		2	.8
Otis Steel Company		10 $\frac{1}{2}$		10 $\frac{1}{2}$	4.0
Sec. 2 Development		1		1	.4
TOTAL	50 $\frac{1}{2}$	50 $\frac{1}{2}$	158	259	
%	19.5	19.5	61.0		100.0

F. JOSEPH HALLER, Engineer, was in the Department until March 1st when he was transferred to the Lloyd and Spies-Virgil Mines, becoming Superintendent of these properties on October 1st. During January and February, he made the monthly map reports at the Maas Mine and assisted the Superintendent with

the written reports. After leaving the Department, he made the monthly map reports of the Lloyd and Spies-Virgil Mines until the middle of the year when other engineers took over this work at these properties.

The following table shows the distribution of his time during the two months he was in the Department:

Property	Underground	Field	Office	Total	%
Maas Mine	11 $\frac{1}{2}$		21 $\frac{1}{2}$	33	71.7
Tilden Mine		$\frac{1}{2}$	9 $\frac{1}{2}$	10	21.7
Lloyd Mine	1		1	2	4.4
Spies-Virgil Mine	1			1	2.2
TOTAL	13 $\frac{1}{2}$	$\frac{1}{2}$	32	46	
%	29.3	1.1	69.6		100.0

ONNI MARJAMA, Engineer, took care of the engineering work at the Athens and Negaunee Mines until he left the Department on March 1st, being transferred to the Negaunee District. He became assistant Superintendent of the Athens and Negaunee properties on December 1st. He continued to make the monthly map reports of the Negaunee Mine for several months until another engineer took over this work.

The following table shows the distribution of his time during the two months he was in the Department:

Property	Underground	Field	Office	Total	%
Athens Mine	7		15 $\frac{1}{2}$	22 $\frac{1}{2}$	48.9
Negaunee Mine	6 $\frac{1}{2}$		17	23 $\frac{1}{2}$	51.1
TOTAL	13 $\frac{1}{2}$	-	32 $\frac{1}{2}$	46	
%	29.3	0.0	70.7		100.0

WILLIAM R. ATKINS, Engineer, had charge of the engineering work at the Lloyd and Spies-Virgil Mines during January and February, changing to the Maas Mine after March 1st in place of Mr. Haller. He assisted Mr. Haller in becoming familiar with the former properties and had his help in becoming familiar with the latter. At the Maas Mine he continued making the weekly written reports as to underground conditions. He planned the stope development in the Race Course Lease adjacent to the 3rd Level and also the 5th Level exploration to the West. During the spring he made extensive tests with the use of various types of jack-bits for soft ore mines, working with the manufacturer's representatives. He made a few inspections at the Gardner-Mackinaw property and toward the end of the year made estimates etc., regarding the possibility of resuming mining prior to the decision to abandon this property. He made the estimate of ore in stock at the Maas Mine as of November 1st and the annual estimate of ore reserves.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
Maas Mine	89½	12½	98½	200½	76.4
Lloyd Mine	9½		16	25½	9.7
Spies-Virgil Mine	8		9½	17½	6.7
Gardner-Mackinaw Mine Sec. 2 Development	2	2½ ½	14	18½ ½	7.0 .2
TOTAL	109	15½	138	262½	
%	41.5	5.9	52.6		100.0

WILLIAM A. RICHARDS, Engineer, was in the Department until October 14th when he left the Company for the National Guard encampment, when it was enrolled in Federal service. He continued to look after the engineering work at the Athens Mine until his leaving, making the regular weekly inspections and monthly map and written reports. On March 1st, he took over the engineering work at the Tilden Mine from Mr. Haller. He supervised the blasts and general operations at this property and made the plans and supervised the construction of the stockpile ground. During August, he spent two weeks in Military Camp with the Michigan National Guard.

The following table shows the distribution of his time during the period he was in the Department:

Property	Underground	Field	Office	Total	%
General Engineering	1		4	5	2.6
Athens Mine	44½	4½	72½	121½	63.3
Cliffs-Shaft Mine	½			½	.3
Lloyd Mine			2	2	1.0
Maas Mine	3		8	11	5.7
Negaunee Mine	2½	1½	3½	7½	3.9
Tilden Mine		23	18½	41½	21.7
Jackson Lease	1			1	.5
Sec. 2 Development		1		1	.5
Morris Mine			1	1	.5
TOTAL	52½	30	109½	192	
%	27.4	15.6	57.0		100.0

CURTIS R. SUNDEEN, Engineer, entered the Department on February 20th, 1940. During the first few weeks he assisted in the Cliffs-Shaft surveys and other work in the office. In April, he took over the engineering work at the Spies-Virgil Mine and later assisted Mr. Marjama at the Negaunee Mine, taking over the full engineering work in October. During the absence of Mr. Richards in August, he looked after the work at the Athens Mine. He

made the estimate of ore in stock at the Lloyd and Spies-Virgil properties and the annual estimate of ore reserves at the Negaunee Mine.

The following table shows the distribution of his time during the period he was in the Department:

PROPERTY	Underground	Field	Office	Total	%
General Engineering			7	7	3.0
Maas Mine	$13\frac{1}{2}$	1	11	$25\frac{1}{2}$	11.1
Negaunee Mine	$24\frac{1}{2}$	1	27	$52\frac{1}{2}$	22.7
Cliffs-Shaft Mine	2	-	9	11	4.8
Spies-Virgil Mine	32	4	$45\frac{1}{2}$	$81\frac{1}{2}$	35.3
Jackson Lease			$\frac{1}{2}$	$\frac{1}{2}$	.2
Athens Mine	6		$1\frac{1}{2}$	$7\frac{1}{2}$	3.2
Tilden Mine		$1\frac{1}{2}$	2	$3\frac{1}{2}$	1.5
Lloyd Mine	8	$4\frac{1}{2}$	$29\frac{1}{2}$	42	18.2
TOTAL	86	12	133	231	
%	37.2	5.2	57.6		100.0

JAMES S. WESTWATER, Engineer, entered the Department on May 13th. The first month he helped with various surveys at the different properties and assisted in the preparations for the blast on June 19th at the Tilden. In July he took over the engineering work at the Lloyd Mine and continued on this for the rest of the year, making the monthly map reports, etc., at this property. He supervised the driving of the sump and pump house on the 6th Level and the pouring of the pump foundations, etc. After Mr. W. A. Richards left in October, he took over the engineering work at the Tilden mine, writing the monthly and annual reports of this property. During the fall of the year he did the engineering work in connection with the churn drilling on Section 27, 47-27. He made the estimate of ore in stock at the Negaunee Mine as of November 1st and the annual estimate of ore reserves at the Lloyd Mine.

The following table shows the distribution of his time during the period he was in the Department:

Property	Underground	Field	Office	Total	%
General Engineering		$1\frac{1}{2}$	$2\frac{1}{2}$	4	2.3
Athens Mine	1			1	.6
Cliffs-Shaft Mine	9	1	3	13	7.6
Lloyd Mine	48	3	$45\frac{1}{2}$	$96\frac{1}{2}$	56.5
Maas Mine	5	$5\frac{1}{2}$	5	$15\frac{1}{2}$	9.1
Mackinaw Mine	$\frac{1}{2}$		$\frac{1}{2}$	1	.6
Negaunee Mine	$2\frac{1}{2}$	$2\frac{1}{2}$	6	11	6.4
Spies-Virgil Mine	1		3	4	2.3
Tilden Mine		$19\frac{1}{2}$	5	$24\frac{1}{2}$	14.3
Jackson Lease	$\frac{1}{2}$			$\frac{1}{2}$	.3
TOTAL	$67\frac{1}{2}$	33	$70\frac{1}{2}$	171	
%	39.5	19.3	41.2		100.0

GRANT T. HOLLETT, Engineer, entered the Department on August 12th. He spent the first few months assisting in surveys and office work for the different properties, taking over the engineering work at the Athens Mine after Mr. W. A. Richards left. He also did the engineering work in connection with the preliminary construction at the Section 2 Development. He made the estimate of ore in stock at the Athens Mine as of November 1st and the annual estimate of ore reserves at this property.

The following table shows the distribution of his time during the period he was in the Department:

Property	Underground	Field	Office	Total	%
General Engineering		6½	6½	13	12.6
Athens Mine	11	7	24	42	40.8
Gardner-Mackinaw Mine		2	½	2½	2.4
Lloyd Mine		4	½	4½	4.4
Maas Mine	5	½	3	8½	8.3
Negaunee Mine	4	3	9½	16½	16.1
Spies-Virgil Mine	1	2		3	2.9
Tilden Mine		½	1	1½	1.4
Sec. 2 Development		7	2	9	8.7
Cliffs Power & Light Co.			2½	2½	2.4
TOTAL	21	32½	49½	103	
%	20.4	31.5	48.1		100.0

ARCHIBALD MINNEAR, Draftsman, was in the Engineering Department until September 24th when he was transferred to the Geological Department. Most of his time was occupied in making tracings and other office work. He also assisted in the underground and surface surveys at various times during the year, even after he entered the Geological Department.

The following table shows the distribution of his time for the period he was in the Engineering Department:

Property	Underground	Field	Office	Total	%
General Engineering		½	32½	33	18.6
Athens Mine	4		10	14	7.9
Cliffs-Shaft Mine		½	19½	20	11.3
Gardner-Mackinaw Mine		1		1	.6
Jackson Lease			14½	14½	8.2
Lloyd Mine	4		19½	23½	13.3
Maas Mine	4½		7½	12	6.8
Negaunee Mine	8½	1	16	25½	14.4
Spies-Virgil Mine	3		12½	15½	8.8
Tilden Mine		3	½	3½	2.0
Canistec Mine			1½	1½	.8
Hill-Trumbull Mine			1½	1½	.8
Morris Mine			8	8	4.5
Geological Dept.		1½		1½	.8
C. P. & L. Co.			1	1	.6
Sec. 2 Development			1	1	.6
TOTAL	24	7½	145½	177	
%	13.6	4.2	82.2		100.0

SAMUEL J. RICHARDS, Draftsman, entered the Department on August 15th and left on October 31st. Most of his time in the office was spent in connection with the preparation of the Sections 1 and 2 map for the Cleveland office. He also assisted in field work, especially in the stockpile and triangulation surveys.

The following table shows the distribution of his time during the period he was in the Department:

Property	Underground	Field	Office	Total	%
General Engineering			16	16	26.4
Cliffs-Shaft Mine		3	3 $\frac{1}{2}$	6 $\frac{1}{2}$	10.7
Maas Mine		6	1	7	11.6
Negaunee Mine		2 $\frac{1}{2}$	$\frac{1}{2}$	3	5.0
Spies-Virgil Mine		2		2	3.3
Tilden Mine		2 $\frac{1}{2}$	4 $\frac{1}{2}$	7	11.6
Sec. 2 Development		2 $\frac{1}{2}$	9 $\frac{1}{2}$	12	19.8
C. P. & L. Co.			7	7	11.6
TOTAL		18 $\frac{1}{2}$	42	60 $\frac{1}{2}$	
%		30.6	69.4		100.0

W. HARLOW STANNARD, Draftsman, entered the Department on November 1st, taking Mr. S. J. Richards place. All of his time has been spent in the office, making tracings and completing the Sections 1 and 2 Maps.

The following table shows the distribution of his time during the period he was in the Department:

Property	Underground	Field	Office	Total	%
General Engineering			18	18	42.4
Athens Mine			3	3	7.1
Maas Mine			1 $\frac{1}{2}$	1 $\frac{1}{2}$	3.5
Negaunee Mine			8	8	18.8
Sec.2Development			12	12	28.2
TOTAL			42 $\frac{1}{2}$	42 $\frac{1}{2}$	
%			100.0		100.0

DONALD W. CARLSON, Stenographer, has worked for both the Engineering and Geological Departments throughout the year. He also helped on some of the underground and surface surveys.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
Stenography			259	259	98.5
Maas Mine		3		3	1.1
Negaunee Mine	1			1	.4
TOTAL	1	3	259	263	
%	.4	1.1	98.5		100.0

ALFRED KOSKI, Helper, assisted in all the underground and surface surveys throughout the year. During May, he assisted Mr. Trosvig with the Otis Steel Company stockpile surveys in Cleveland. In the office he has done blueprinting and other work and looked after the automobiles of the Department.

The following table shows the distribution of his time during the year:

Property	Underground	Field	Office	Total	%
General Engineering		20	74 $\frac{1}{2}$	94 $\frac{1}{2}$	35.5
Athens Mine	4 $\frac{1}{2}$	4		8 $\frac{1}{2}$	3.2
Cliffs-Shaft Mine	37 $\frac{1}{2}$	6 $\frac{1}{2}$	4	48	18.0
Jackson Lease	6 $\frac{1}{2}$		2 $\frac{1}{2}$	9	3.4
Lloyd Mine	7	4 $\frac{1}{2}$	2	13 $\frac{1}{2}$	5.1
Maas Mine	9	4	5 $\frac{1}{2}$	18 $\frac{1}{2}$	7.0
Negaunee Mine	10	8	7	25	9.4
Spies-Virgil Mine	6	1	3	10	3.8
Tilden Mine		6 $\frac{1}{2}$		6 $\frac{1}{2}$	2.4
Canisteo Mine			7	7	2.6
Hill-Trumbull Mine			5 $\frac{1}{2}$	5 $\frac{1}{2}$	2.1
Holman-Cliffs Mine			$\frac{1}{2}$	$\frac{1}{2}$	.2
Otis Steel Company		11		11	4.1
Gardner-Mackinaw Mine	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1 $\frac{1}{2}$	.6
Sec. 2 Development		7		7	2.6
TOTAL	81	73	112	266	
%	30.5	27.4	42.1		100.0

RALPH E. MAGNUSON, JR., Helper, entered the Department on June 25th and left on September 21st to return to college. During most of the time he was employed, he was in the field or underground, assisting in the various surveys, triangulation, stockpile and other work.

The following table shows the distribution of his time during the period he was in the Department:

Property	Underground	Field	Office	Total	%
General Engineering		20	7 $\frac{1}{2}$	27 $\frac{1}{2}$	40.2
Athens Mine	1		1	2	2.9
Cliffs-Shaft Mine	4	$\frac{1}{2}$	2	6 $\frac{1}{2}$	9.5
Gardner-Mackinaw Mine		2	$\frac{1}{2}$	2 $\frac{1}{2}$	3.6
Jackson Lease	$\frac{1}{2}$			$\frac{1}{2}$	.8
Lloyd Mine		5 $\frac{1}{2}$		5 $\frac{1}{2}$	8.0
Maas Mine	$\frac{1}{2}$	1 $\frac{1}{2}$	$\frac{1}{2}$	2 $\frac{1}{2}$	3.6
Negaunee Mine		4	$\frac{1}{2}$	4 $\frac{1}{2}$	6.6
Spies-Virgil Mine		1		1	1.5
Tilden Mine		7 $\frac{1}{2}$	6	13 $\frac{1}{2}$	19.7
Geological Dept.		2 $\frac{1}{2}$		2 $\frac{1}{2}$	3.6
TOTAL	6	44$\frac{1}{2}$	18	68$\frac{1}{2}$	
%	8.8	64.9	26.3		100.0

ROBERT S. WILMOT, Helper, entered the Department on June 26th and left on September 7th to return to college. He assisted principally in the surface surveys, stockpile, triangulation, etc. He assisted the Geological Department part of his time, taking water samples at the surface diamond drilling.

The following table shows the distribution of his time during the period he was in the Department:

Property	Underground	Field	Office	Total	%
General Engineering		17	13 $\frac{1}{2}$	30 $\frac{1}{2}$	54.0
Lloyd Mine		1		1	1.8
Maas Mine	1	1		2	3.5
Negaunee Mine		$\frac{1}{2}$		$\frac{1}{2}$	.9
Spies-Virgil Mine		1		1	1.8
Geological Dept.		18 $\frac{1}{2}$		18 $\frac{1}{2}$	32.7
C. P. & L. Co.			3	3	5.3
TOTAL	1	39	16$\frac{1}{2}$	56$\frac{1}{2}$	
%	1.8	69.0	29.2		100.0

DANIEL ISAACSON, Helper, entered the Department on November 18th. He has assisted in the various surface and underground surveys and in the office, made blueprints, etc.

The following table shows the distribution of his time during the period he has been in the Department:

Property	Underground	Field	Office	Total	%
General Engineering		$\frac{1}{2}$	18	$18\frac{1}{2}$	59.7
Athens Mine	$\frac{1}{2}$	2		$2\frac{1}{2}$	8.1
Lloyd Mine	1	1		2	6.4
Maas Mine	1	$\frac{1}{2}$		$1\frac{1}{2}$	4.8
Negaunee Mine	$1\frac{1}{2}$	$\frac{1}{2}$		2	6.4
Tilden Mine		$1\frac{1}{2}$		$1\frac{1}{2}$	4.8
Sec. 2 Development		3		3	9.8
TOTAL	4	9	18	31	
%	12.9	29.0	58.1		100.0

E. DISTRIBUTION OF TIME

Practically all of the engineering work during the year had to do with the operation mines. The change in personnel among the engineers and the shifting around of duties made it especially hard to keep up the work required. All of the new men were inexperienced and it took some time for them to become familiar, not only with their duties, but with the mines where they were working. All of the work in connection with the various properties has been charged thereto while other work such as blueprinting, drafting, miscellaneous reports, etc., has been classified under General Engineering. For payroll purposes, the time under general engineering has been distributed proportionately to the various properties.

The following table shows the distribution of time for the Department divided between underground, field and office, at the various properties:

Property	Underground	Field	Office	Total	%
General Engineering	1	$114\frac{1}{2}$	428	$543\frac{1}{2}$	21.5
Athens Mine	$79\frac{1}{2}$	19	128	$226\frac{1}{2}$	9.0
Cliffs-Shaft Mine	$94\frac{1}{2}$	$20\frac{1}{2}$	$149\frac{1}{2}$	$264\frac{1}{2}$	10.5
Lloyd Mine	$78\frac{1}{2}$	$24\frac{1}{2}$	116	219	8.7
Maas Mine	$143\frac{1}{2}$	38	163	$344\frac{1}{2}$	13.6
Negaunee Mine	63	25	95	183	7.2
Spies-Virgil Mine	54	15	$74\frac{1}{2}$	$143\frac{1}{2}$	5.7
Tilden Mine		69	$47\frac{1}{2}$	$116\frac{1}{2}$	4.6
Jackson Lease	$17\frac{1}{2}$		45	$62\frac{1}{2}$	2.5
Gardner-Mackinaw Mine	3	8	16	27	1.1
Sec. 2 Development		$26\frac{1}{2}$	$27\frac{1}{2}$	54	2.1
Geological Department		$22\frac{1}{2}$		$22\frac{1}{2}$	.9
C. P. & L. Co.			$13\frac{1}{2}$	$13\frac{1}{2}$	.5
Otis Steel Company		$21\frac{1}{2}$		$21\frac{1}{2}$	.9
Morris Mine			9	9	.3
Canistota Mine			$8\frac{1}{2}$	$8\frac{1}{2}$	.3
Hill-Trumbull Mine			7	7	.3
Holman-Cliffs Mine			$\frac{1}{2}$	$\frac{1}{2}$	.1
Stenography			259	259	10.2
TOTAL	$534\frac{1}{2}$	404	$1587\frac{1}{2}$	2526	
%	21.2	16.0	62.8		100.0

F. COSTS

The next table shows a comparison of costs for the Engineering Department for the last three years:

	1938	1939	1940
Salaries	\$ 16,107.77	\$15,753.16	\$20,252.36
Auto Expense	460.07	680.87	934.43
Furniture and Fixtures	-	5.00	-
Heat, Light and Power	224.23	196.91	571.06
Insurance	99.54	145.85	112.22
Postage	24.05	28.08	30.18
Repairs	134.98	344.72	189.18
Stationery & Printing	58.14	92.27	57.42
Supplies	1,254.51	1,653.50	1,831.61
Taxes	47.52	45.82	45.27
Travel and Entertainment	119.52	60.28	68.10
Personal Injury Expense	326.45	317.52	410.97
Telephone and Telegraph	94.66	91.09	130.68
Papers and periodicals	1.30	3.83	17.00
Janitor and Cleaning	-	-	-
Unemployment Insurance Tax	536.40	521.36	660.47
General - Unclassified	59.69	20.54	32.69
Old Age Benefit Tax	155.24	157.74	204.47
Depreciation	-	-	84.96
TOTAL	\$ 19,704.07	\$ 20,118.54	\$25,633.07

H. AUTOMOBILES

The Ford Station Wagon and Chevrolet Coupe have been operated throughout the year. Both cars have given good service though they need replacement as they have served their term. The following table shows the mileage covered in 1940, the total mileage and the date purchased:

Car	Miles		Date Purchased
	1940	Total	
Ford Station Wagon	3,527	38,220	November 10, 1930
Chevrolet Coupe	6,994	27,340	July 1, 1937.

I. MINES

The following summary covers the work done by the Department during the year:

GENERAL

Weekly inspections of soft ore mines were made by the engineer accompanied by either the Mine Captain or a shift boss, each working place being visited if it was practically possible. The advance of the various headings and general geological features were noted during these inspections and were included when the maps were posted at the end of the month for the monthly map report. The engineers have assisted the Mine Superintendents in writing their monthly and annual reports. The weekly inspections give excellent opportunities to discuss and plan future development.

ATHENS MINE

Studies were made for a plan of development above the 4th Level, both with the idea of starting at the top of the ore body and the development of a new block. Also, in connection therewith, the possibility of a 5th Level was considered.

On July 22nd, the 14th annual inspection of the experimental treated timbers was made by Mr. F. S. Crawford of the U. S. Bureau of Mines. These timbers were placed in the mine in 1926 and have been inspected annually ever since. It is possible that this inspection will be the last as there are only nine timbers left in the mine that can be seen, of the original 64. The remaining timbers are of very little value for mining purposes and are only of interest because of this experiment. The six timbers listed below as good are in an area where there is no weight and as there are lining sets adjacent, the fact that they are in place is due to the fact that they have not yet rotted sufficiently to fall down of their own accord. The summary of Mr. Crawford's report is as follows:

Preservative	Estimated Absorption of Dry Salt Lbs. per Cu. Ft.		Number of Timbers in Test.	Good		Partly Decayed		Badly Decayed		Removed				Eliminated
	Hard Maple	Soft Maple		No.	%	No.	%	No.	%	Acc't Decay		Acc't Crushing		
										No.	%	No.	%	
Borax	0.25	0.21	12			1	8.3	2*	16.6	6	50.0	3	25.0	3
Sodium Fluoride	.06	.07	27							21	77.8	6	22.2	-
Zinc Chloride	.54	.50	13	6	46.1					3	23.1	4	30.8	2
Untreated	-	-	12							12	100.0	-	-	3

* Decrease of one as reported in 1939.

The average life of sodium Fluoride treated timber was 7.7 years, untreated timber was 3.8 years.

In 1932, some twenty iron pins were placed across the Athens surface over the ore body and since then annually levels have been taken on these iron pins for the purpose of determining whether or not there is any surface subsidence. This year a slight subsidence was noticed about 400' East of the cave and during the fall monthly levels were run over these pins to determine the speed of subsidence. This subsidence was not very great, varying from about 2' near the cave to about .1' 400' East. Because of this subsidence, a plan of diverting the mine water discharge over to the Negaunee Mine was reconsidered and several profiles and plans were made before winter set in.

CLIFFS-SHAFT MINE

Quarterly surveys were made in February, May, September and November, from which map reports were made. Surveys were run for underground drill holes and such development work as was necessary during the year.

On surface, plans were made for permanent steel trestles to take the place of the present wooden ones. Grades and lines were given for the addition to the dry.

GARDNER-MACKINAW MINE

This property was idle throughout the year. In June, the underground traveling roads between the Gardner and Mackinaw shafts were inspected. In the fall, estimates of ore were studied in hopes that the property might be opened, but it was decided to abandon the property and, in November, instructions were given to remove the pumps and equipment. The mining lease will not be given up until all stockpile ore has been removed.

JACKSON LEASE-CAMERIA MINE

Regular monthly inspections of the operations on the Jackson Lease by the Republic Steel Corporation and monthly map reports were made showing the extension of workings. The analysis of ore mined by contracts was furnished and were tabulated by us to determine the iron content of the ore extracted by each gang. The 7th Level was opened up during the year and our engineers assisted in the plumbing to carry the surveys down to the new level through the winze.

LLOYD MINE

The 6th Level pumphouse and sump were planned and the excavations supervised during the time this work was in progress. Plans were prepared for shaft sinking below the 7th Level. This involves the 7th Level plat lay-out to include the hoist and dump arrangements as it will be necessary to conduct shaft sinking while the upper part is still in use.

On surface, lines and grades were given for the location of the discharge line Southwesterly from the shaft into the Carp River.

MAAS MINE

The principal development underground was in connection with the proposed stope in the Race Course between the 200' Sub and the 3rd Level. Plans were also made for the drilling below the 5th Level West of the present workings and lines and grades were given for the extension of the 5th Level drift.

MORRIS MINE

The Annual Report prints were posted from maps submitted by the Inland Steel Company and prints were included in the Annual Report.

NEGAUNEE MINE

The development of the 14th Level required lines and grades. The new development in the No. 3 shaft pillar above the 13th Level was surveyed. Plans were made for the development of the Maas Area, comprising part of the Adams Strip, Cleveland Iron Mining Company strip and Maas Mine, which was leased by the Negaunee Mine Company, dated January 2nd, 1940. In April, the surveys were carried to the 14th Level by plumbing in No. 3 Shaft.

SECTION TWO MINE

Grades and lines were given for the temporary buildings. Surveys were run for a possible mine water discharge to the West and muck soundings were made in the swampy area adjacent to Lake Bacon.

SPIES-VIRGIL MINE

The development of stopes between the 6th and the 8th Levels in the Southwest deposit required frequent surveys. After there was a connection between these levels in this area, a check survey was run from the 6th to the 8th Level, tying in exactly for course and by .08' in the Southings and by .27' in the Eastings. This was the first opportunity we have had to check the shaft plumbing below the 6th Level.

In June, a joint survey was run with the Inland Steel Company on surface to establish the West line of the Virgil property. The Inland Steel Company is opening the Sherwood property and will use our location of this line. This survey established this line as follows:

West Quarter Corner of Section 24, 43-35 (Southwest Corner of Virgil)
is S. 2654.40 and 4.91 West.

Sixteenth Corner to the North (Northwest corner of Virgil) is
S. 1328.51 and 3.82 West.

Course between quarter corner and 16th corner is N. 0° 2' 50" E.

Our surveys determined that the 16th corner North of the quarter corner as above located is not the same as was found by our original surveys in 1913. The above corner, however, has been accepted by Pickands, Mather & Company for 15 years as it was in place when they took over the James Mine in 1925, this 16th corner being the Southeast corner of the James property.

TILDEN MINE

The engineer did a good deal of the supervising in the pit operations during the year. The drill holes were planned and laid out and charges for the blasts were determined and the blasts supervised. During the summer, plans were made and grades given for the stocking ground. Several iron pins were concreted throughout the property and a check survey was run to tie them all in. The location of the drill holes in the $N\frac{1}{2}$ of the $N\frac{1}{2}$ of Section 27, 47-27 was planned and later surveyed.

J. MISCELLANEOUSCOAL

Estimates of coal in stock at the various mines were made in May.

SECTIONS 1 & 2, 47-27 LEASE

A summary index of all the outstanding surface rights on Sections 1 and 2, 47-27 was prepared grouped under (1) leases and (2) rights of way and other conveyances. Additional lists were prepared listing the grantors and grantees alphabetically. From these lists, three sets of four maps each were made up as follows: Map A, showing rights of way, highways, etc.; Map B, showing surface leases and outside ownerships; and Map C, showing rights for which there were no written agreements.

This work was started early in the spring and was not completed until late in the year. The lists and maps were revised from time to time during the course of compilation and were finally made up as of October 1st, 1940.

SHAFT GAUGING

The shaft mners at the various mines were gauged in May and again in November.

STOCKPILES

The ore in stock at the various mines was estimated and reported as of November 1st. The following table shows a comparison of ore in stock at the different mines between 1939 and 1940:

Mine	Nov. 1, 1939	Nov. 1, 1940	Difference
Athens	167,579	57,746	-109,833
Cliffs-Shaft	183,505	67,331	-116,174
Gardner-Mackinaw	127,251	51,301	-75,950
Lloyd	159,652	80,199	-79,453
Maas	388,141	125,763	-262,378
Negaunee	118,524	30,596	-87,928
Princeton	126,136	125,863	-273
Stephenson	60,035	29,831	-30,204
Spies-Virgil	210,558	168,353	-42,205
TOTAL	1,541,381	736,983	-804,398

During May, Messrs. Trosvig and Koski made the estimate of ore in stock at the Otis Steel Company plant in Cleveland. This was reported directly to the Cleveland office.

SURFACE SURVEYS

A survey was run to locate the Northwest corner of Section 31, 48-26 as this corner had never previously been located.

Contouring the $S\frac{1}{2}$ of $SE\frac{1}{4}$ of Section 34, 48-27 was started during the summer and it is hoped to be completed next spring.

The usual survey of mine surface caves was made in the fall.

TAXES

The usual tax list of Mining Department lands was prepared in the fall and also that of the Cliffs Power & Light Company.

MINERAL BOUNDARY LINES

Some work has been done on the calculations of the mineral boundary lines but this work has not been finished owing to the press of other work.

TRIANGULATION SURVEYS

The leasing of Sections 1 and 2 and the establishment of mineral boundaries in the Ishpeming and Negaunee districts, necessitated a study of the existing surface surveys. It was decided that before establishing any boundaries, a triangulation survey would be made between Ishpeming and Negaunee and tied in with the present triangulation survey of the Oliver Iron Mining Company. Triangulation stations were set in concrete on various knobs in Sections 1, 2, 3, 4, 9 and 10, 47-27 and Section 6, 47-26. A base line approximately 2400' long was laid out along the old Duluth, South Shore & Atlantic Railway Company grade in the $S\frac{1}{2}$ of $NE\frac{1}{4}$ of Section 10, 47-27, East of the Oliver Iron Mining Company's general office. Two attempts to accurately measure this base line were made but the results were not satisfactory. This will be accurately measured next spring. Many of the angles were turned in the triangulation system both between triangulation stations and to various section sub-division corners. This work will be finished next year and calculations made for determining the exact boundaries.

UNDERGROUND WATER

The elevation of the water in the various test holes at the Maas-Negaunee Mines was measured weekly during the year. The following table shows the drop in the surface water table between December 30th, 1939 and December 27th, 1940:

Test Hole	Elevation of Water		Difference
	12-30-39	12-27-40	
Maas Shaft	1291.1	1280.1	-10.0
W1	1267.8	1246.6	-21.2
W2	1287.8	1238.8	-49.0
W5	1323.1	1249.6	-73.5
W9	1282.4	1272.2	-10.2
W13	1343.0	1332.4	-10.6
W14	1319.8	1302.2	-17.6
W15	1328.0	1320.4	-7.6
W16	1294.2 (1-27-40)	1283.2	-11.0
W18	1257.0 (3-27-40)	1246.1	-10.9
6A	1189.1	1174.4	-14.7
7	1196.2	1179.7	-16.5

Test holes W-16, W-17 and W-18 were put down in Section 6, 47-26 East of the Maas cave and Test Holes 10 and 11 were put down in Section 32, 48-26 Northeast of the Negaunee Mine. Toward the end of the year plans were being made for additional holes Northwest of the Maas cave.

Negaunee Well No. 1 pumped throughout the year averaging about 250 G.P.M. This pumping had a marked effect on the flow of water into the Negaunee Mine especially on the 9th Level. This decrease is shown in the table below. The Maas Well No. 1 pumped about 350 gallons per minute throughout the year and No. 2 Well about 550 G.P.M. The pumping in the two Maas wells lowered the water table but did not have much effect on underground water. What reduction in water occurred at the Maas Mine was the result of pumping of the Negaunee well. The following table shows the average monthly gallons per minute flowing to the pumps on the various levels of the Maas and Negaunee Mines during the year:

Levels:	Maas Mine						Negaunee Mine					
	1st	2nd	3rd	4th	5th	Tot.	9th	10th	11th	12th	13th	Total
January	73	53	500	338	248	1212	482	172	73	35	13	775
February	73	53	500	324	247	1196	447	182	68	40	13	750
March	73	53	518	324	247	1215	353	182	62	44	13	654
April	73	53	482	310	252	1170	353	172	62	44	13	644
May	73	53	482	298	264	1170	324	162	29	73	13	601
June	73	53	423	290	241	1080	353	162	22	73	13	623
July	73	53	383	283	235	1027	353	128	22	73	13	589
August	98	53	368	271	252	1042	353	128	22	70	13	586
September	98	53	345	258	225	977	353	128	22	68	13	584
October	62	26	338	264	224	914	345	128	22	68	13	576
November	73	22	346	271	218	930	338	128	22	68	13	564
December	98	22	353	271	218	962	338	128	22	40	13	541

VENTILATION

The usual ventilation surveys were made in February and August showing the volumes and course of the air forced through the different mines. No survey was made at the Athens Mine in the fall due to the fact that the ventilation was interrupted by some cleaning on the 10th Level.

OFFICE HOURS

The office hours during the year were from 8:30 to 12:00 A.M. and 1:15 to 5:00 P.M. except for Saturday when there was no afternoon work.

HOLIDAYS

The following holidays were granted during the year:

January 1st	New Years Day
February 22nd	Washington's Birthday
March 22nd	Good Friday
April 1st	Election Day
May 30th	Memorial Day
June 24th	Midsummer Day
July 4th	Independence Day
September 2nd	Labor Day
November 5th	National Election Day
November 21st	Thanksgiving Day
December 24th	Christmas Eve ($\frac{1}{2}$ day)
December 25 and 26th	Christmas
December 31st	New Years Eve ($\frac{1}{2}$ day)

Carl Brewer

Chief Mining Engineer

CB:DWC
2-1-41

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CLIFFS SHAFT MINE:

In January the head on the #8 McCully crusher was cut down about 1" to get a larger percentage of lump ore. In October a bad crack developed in the upper shell and it was turned October 19th. to transfer the work to the opposite side. A new steel shell has been ordered and will be installed as soon as received.

A new cylinder was installed on the 6 $\frac{1}{4}$ x 24" Prescott pump in April to replace a cylinder that was cracked.

A new check valve was installed on the 15th. level centrifugal pump in November to replace one that was in too bad condition to repair. In December the thrust bearing was rebabbitted as it was in poor condition.

In May a new set of pans complete with rollers was installed on the picking belt to replace the worn out set which will be repaired and used as a spare set. In December the keyway in the propelling shaft stripped. A new shaft was made at the Hard Ore shops.

In June on inspection of the "A" and "B" shaft hoist drums it was found they were in very poor condition. In 1919 several cracks developed in the horizontal ribs and repairs were made at that time by installing a center hub on the drum shaft with jacks out to the inside of the drum shell to support it in the center. This repair has taken care of the drums up to the present. In June a very close examination showed that the cracks were getting a little longer and extending into the drum shell and it was decided to purchase new drum shells. The drums shells have been ordered and will be installed shortly after they are received.

All the mechanical equipment at this mine operated satisfactorily during the year.

The new 250 kw motor generator set was installed and is operating satisfactorily. This unit is of General Electric Company manufacture, 2300 volt, 300 H.P., motor driven, 250 kw, 275 volt D.C. This unit connects to the new feeder cable installed in "B" shaft, doubling the capacity of the previous installation.

TILDEN MINE:

This mine started loading ore on May 3rd. and completed shipments of 163,629 tons on November 16th.

In June it was necessary to repair the track on the D-8 caterpillar tractor. New grouser strips were welded on which put the track in good condition.

The #4 locomotive boiler mud ring was repaired by welding and building up the side plates.

A crankpin on the #3 locomotive became loose in August and a new pin was made at the Hard Ore Shops to make the necessary repairs.

In August the saddle block bolts broke on the #46 shovel and the unloading coil on the air compressor burned out. Repairs were made without any delay to shipments.

In September the ram on the drill sharpener broked and was repaired.

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TILDEN MINE: (CONT'D.)

In September the #29 shovel dipper sticks broke. These sticks will be repaired and used as spares. New sticks have been ordered as the old ones are in poor condition.

The boom foot on the #31 shovel broke on September 17th. Temporary repairs were made and a new foot ordered.

General repairs are being made to the equipment this winter to put it in good condition for next season's operations.

All equipment operated satisfactorily during the year.

The usual routine changes and extensions were made in the electric distribution lines.

ATHENS MINE:

On January 20th. a leak developed in the 10" pump discharge line in the shaft. As this pipe had developed several leaks 510 ft. of 10" pipe were ordered to replace the upper portion. This pipe was received and installation completed on May 1st.

New roller bearing rubber lined sheaves were installed on the skip hoist idler stands in April. This change has shown considerable increase in tonnage for skip ropes. Several dividers in the skip roads in shaft house were replaced in July due to poor condition.

The main header of the new heating system in the change house has been completed.

All mechanical equipment at this mine operated satisfactorily during the year.

New control equipment has been ordered from the General Electric Company for the skip hoist. The original control apparatus has reached an age that trouble is probable and it seemed wise to replace this with more modern equipment. The new control is to be Amplidyne, which is a recent development and used extensively in steel mills. It will be the first application to mine hoist controls and we believe will give a refinement and reliability not previously possible.

MAAS MINE:

In January a flange broke on the 10" pump discharge line in the shaft about 100 ft. above the 3rd. level. Repairs were made by electric welding the two pipes together.

The crankpin bearings on the Prescott pump on the 3rd. level burned out on April 22nd. and were repaired with a spare set. A crankpin on the 3rd. level prescott pump which was in poor condition was turned in place and new bearings fitted in October.

Considerable repairs were necessary to the steel in the head frame and pockets as some of the steel was in very poor condition, due to rust.

A few of the new type valves were installed in the Ingersoll-Rand compressor to try to eliminate breakage. Valve repair has caused considerable trouble and expense which it is hoped the new type valve will eliminate.

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MAAS MINE: (CONT'D.)

Repairs were made to the crusher plant in April. New plate liners were installed in the pockets and a new ring gear and spider were installed in the crusher. The thread on the mantle shaft was changed and the new type V-thread nut was used.

The brake band on the cage hoist broke in August and it was repaired by electric welding.

The heating boiler was in very poor condition. Repairs were made to the mud ring, new corners added in the fire-box and a new set of tubes installed. This boiler is now in first class condition.

Some of the unit heaters and the main steam header have been completed in the change house.

All mechanical equipment operated satisfactorily during the year.

NEGAUNEE MINE:

In February we started to move the 1000 G.P.M. Aldrich pump from the 11th. to the 12th. level to give us a spare unit. The pump drive was changed from a flat belt to a V-belt drive. This shortens the distance from motor to pump and makes the drive more positive. This work was completed in April.

An automatic stoker was installed in the heating boiler in the shops in February.

The weight levers on the cage hoist brake cracked on March 14th. New levers were made at the Hard Ore Shops and installed on March 16th.

A crankpin bearing on the #1 pump on the 10th. level broke on June 23th. Repairs were made and a new bearing purchased to replace the broken one.

The 6" air line in the shaft about 400 ft. below surface is in poor condition. A bad leak was repaired on June 16th. by using Dresser couplings. A portion of this line may have to be replaced sometime in the near future.

The skip hoist drum is in poor condition. About six years ago a crack developed in the drum shell. It was repaired and has operated satisfactorily up to the present time. In August of this year this drum showed signs of further weakening so an order was placed for a new drum which has been received and will be installed as soon as possible without interfering with the mine operations.

Work is progressing on the dry changes; the heating system is in operation and the shower baths are almost completed. The dirty clothes hangers are being installed and clean clothes lockers are being rearranged.

All mechanical equipment operated satisfactorily during the year.

LLOYD MINE:

New bearings were installed in the skip hoist motor to replace the old ones which were badly worn.

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LLOYD MINE: (CONT'D.)

An 8" pump discharge line was installed in the shaft in March for the Aldrich pump. This pump was formerly in service at the Stephenson Mine and stored in the Gwinn shed. It was changed from size 13 x 16", 1600 G.P.M., 530 ft. head to 9 $\frac{1}{4}$ x 16", 805 G.P.M., 1000 ft. head, the cost of this change being \$4,446.00. Installation was completed in December.

Considerable repairing is being done to the head frame as some of the steel is in very poor condition.

All mechanical equipment operated satisfactorily during the year.

A new motor generator haulage set was installed replacing obsolete equipment. This is a Westinghouse, 150 kw generator, 275 volts, driven by a 250 H.P. synchronous motor, 2300 volts, 80% power factor.

SECTION 2 MINE:

A 6'x0" x8'2" Ottumwa hoist formerly in service at Section 6 shaft was dismantled and moved to this mine. It has been erected and is ready to go into service sinking shaft.

An Allis-Chalmers 1000 cu. ft. air compressor at the Cliffs Shaft Mine was dismantled and moved to Section 2. This compressor will be ready to operate about January 27th.

A boiler for heating the buildings was taken from the old river pump station at Princeton and is now in service.

A cage and two cars for sinking are being built at the Hard Ore Shops and a rotary dump for the shaft cars has been ordered.

Preliminary electric wiring has been completed and the engineering studies and general layout are well underway. Electric equipment for the hoists should be under order by January 15, 1941.

SPIES-VIRGIL MINE:

In February the skip dumps were repaired and put in good condition.

The crank shaft bearings on the #2 pump were rebabbitted in February .

New steel liners were placed in the skip head frame sheave and the cage was overhauled and put in good condition in May.

The heating boiler has caused some trouble on account of leaks and fire cracks in the fire box. This boiler was retubed with a complete set of Electrunit seamless tubes. A new Iron Fireman automatic stoker was installed in the heating boiler and put in operation on September 12th.

In June a 5 H.P. fan was installed in the Virgil shaft to increase ventilation.

In July the intercooler on the Ingersoll-Rand air compressor was cleaned and repaired.

All mechanical equipment operated satisfactorily during the year.