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19. WASHING PLANT OPERATIONS:

Washing operations were started on May 3rd and finished for the season on October 15th. The working schedule was two 8-hour shifts, five days per week. There were some variations from the schedule, due to boat dispatch requirements.

Generally speaking, operations were very satisfactory; a good average production maintained and a high grade of concentrates secured.

There were times when the operations were slowed down on account of handling lean ore or rocky material.

A break occurred in the dyke on the West side of the lower tailings basin on August 23rd. The water and mud rushing through the break, sprung the 20" pipe line and caused leaky joints. The tailings were turned into the upper basin until the break was repaired.

On September 17th, the East dyke of the lower tailings basin was washed out for a distance of 100 feet. The lower basin was about filled and the top of the dyke, which is comparatively narror, became weakened from saturation. The tailings were diverted from the break by a temporary dyke and the South basin was used for the remainder of the season.

The stockpiling equipment was put into service on June 24th and thereafter no delays were occasioned on account of an inadequate car supply. The equipment worked very satisfactorily and gave no trouble of any nature.

The 481 Marion electric shovel was moved to the plant on October 14th and loaded out this ore as cargo accumulations required until November 5th. The shovel operated intermittently.

During the year 1937, 952,417 tons of wash ore was treated. The concentrates produced in 1937 amounted to 606,143 tons.

The rejects from the mill during 1937 amounted to 17,304 tons, averaging 24.88% Iron.

The gross recovery for the year was 63.64%, and the iron unit recovery was 91.18%.

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

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19. WASHING PLANT OPERATIONS: (Continued)

	TONNAGE	% IRON DRIED	TONNAGE RECOVERY	IRON UNIT RECOVERY.
Crude Ore and Rock Mined,	968,014	41.13		
Less;Rock removed in mining,	2,970	34.30		
Crude ore transported to Mill,	965,044	41.15		
Less;Rock rejects in Crusher House,	12,627	26.15		
Crude ore entering Mill,	952,417	41.35	63.64%	91.18%
Concentrates produced,	606,143	59.24		
Rock Rejects on Mill Picking Belt,	4,677	21.44		
Tailings (by Deduction)	341,597	9.88		
Total Heads, as above,	952,417	41.35		

The analysis of the product from the various machines for 1937 were as follows:

	IRON	PHOS.	SILICA
Logs, ----------	59.99	.052	5.78
Classifiers, ----------	56.42	.046	11.74
Picking Belt Concentrates, ----------	58.65	.051	7.52
Tailings, ----------	16.12		

The analysis of the plant rejects for the year 1937 were as follows:

	TONS	IRON	PHOS.	SILICA
Hill, ----------	114	27.62	.053	53.38
Trumbull, ----------	17,190	24.86	.034	57.85
Total, ----------	17,304	24.88	.034	57.82

The rock removed from the pit and placed on the dumps during 1937, together with the analysis, follows:

	TONS	IRON	PHOS.	SILICA
Hill, ----------	1,755	38.75	.053	39.79
Trumbull, ----------	1,215	27.87	.058	54.72
Total, ----------	2,970	34.30	.055	45.89

During mining operations, 7,842 cubic yards of Trumbull waste ore was removed and placed on the waste dump, and 7,290 cubic yards of Trumbull lean ore was placed on the lean ore dump.

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19. WASHING PLANT OPERATIONS: (Continued)

The weight recovery realized during the 1937 season was 63.64%, which compares with 66.70% in 1930, the last year that the Hill-Trumbull operated on a normal basis. The iron content in the crude ore was about one and one-half points higher in 1930.

The iron unit recovery for 1937 was 91.18%, against 92.91% in 1930, the higher grade crude ore treated in 1930 explaining the difference.

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11. ACCIDENTS AND PERSONAL INJURY.

a. Fatal Accident.

The Mining Department sustained one fatal accident in 1937. It occurred at the Negaunee Mine on May 21.

The fatality rate for the year, based on 300 man-days worked per 1000 men employed, was .40. The average fatality rate for the seven-year period from 1930 to 1936, inclusive, was 1.74 per thousand men employed.

Description of Fatal Accident

Charles Kangas and his son, miners, worked on the 450 foot sub-level of the Negaunee Mine, which was 40 feet above the 11th level. The working place was operated day and night shifts, with an interval of four hours between shifts. On the night shift of May20 the miners had extended a slice drift to the hanging wall. They blasted and then found lean material running in on top of the blasted ore pile. This run of rock came in on the side of the adjacent slice, at the upper side close to the breast. To stop the run of rock five large forepoles were placed over the cap of the last set of timber. Four of the forepoles were set in close together under the rock run. The fifth pole was placed on the opposite side and the gap between was covered cross wise with short lagging. This work ended the shift.

During the interval between the two shifts the short pieces of lagging were loosened by rock which dribbled over them from the forepoles on the left side of the slice. In addition, ground fell away directly above the lagging and developed a small opening.

On arriving for their day's work on the morning of the 21st, the younger Kangas approached the dirt pile to inspect the condition of the back. His father ordered him to step to one side and permit him to look it over. He crawled up on the pile and projected his head into the opening between the fourth and fifth forepoles. As he did this ground fell from the back, catching him in a position where he was helpless. The son immediately summoned miners who were passing by, on their way to other working places in the same vicinity. It was necessary to saw through several pieces of lagging to free Kangas from the trap-position into which he had projected himself. It was apparent that he had met death instantly.

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11. ACCIDENTS AND PERSONAL INJURY.

a. Fatal Accident. (Continued)

Great care must be used in properly forepoling the back in order to avoid danger by falls of ground. In this instance, one or two more forepoles would have prevented loose ground falling and developing a dangerous condition. The accident occurred in a comparatively safe working place and should have been avoided.

Kangas was an experienced miner. He was 49 years old and is survived by a wife and three adult children. The coroner jury's verdict was: "Charles Kangas came to his death as a result of an accident."

b. Non-Fatal Accidents.

It can be accepted as a reasonable summary of the accident frequency in underground mining that during the course of a year one workman of every three or four employed will sustain an accidental injury that should receive a doctor's treatment. It is almost equally true that the element of chance very frequently explains the difference between an accident that only causes a slight injury or one of a more serious nature. While luck is supposed to be out of the field of endeavor in accident prevention work he is blind to the facts in the situation who is unwilling to recognize the important role it plays in human activities when associated with danger.

The extraction of ore in our large soft ore mines was speeded up during the course of the year to a daily product beyond the tonnage ever reached in the past. This increased many of the hazards incidental to mining as it entailed (1) the hiring of new employees who were inexperienced miners; (2) it accelerated ground movement in the miners' working places which were occupied twenty-four hours daily; (3) it required more rapid and heavier traffic in the transportation of men, ore and supplies; and (4) it increased the use of explosives.

A total of 58 compensable non-fatal accidents occurred, which resulted in higher frequency and severity accident rates compared with the record in 1936. The frequency rate in 1936 was .59 and the severity rate was 5,80 per 1000 man days worked. In 1937 the

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11. ACCIDENTS AND PERSONAL INJURY.

b. Non-Fatal Accidents. (Continued)

rates were .076 and 6.08 respectively. Including the number of compensable days chargeable to fatalities, the severity rate in 1937 was 8.41 as compared with 12.15 in 1936, or a reduction of 30 per cent. The number of man days worked was about 33 per cent higher and there was one less fatality in 1937, which account for the reduction.

There are injuries that cause loss of members of the body which call for an exact amount of compensation. For instance, 600 days were charged against the Maas Mine because of an eye injury and 360 days against the Spies-Virgil Mine because of a thumb injury. In both of these cases the actual time lost by the injured men will be far less than the number of days for which they will receive compensation payments.

There is no evidence of any workmen being guilty of malingery after suffering accidental injury. On the other hand, they evince much concern in maintaining good accident records and indicate their displeasure in no uncertain terms when a fellow workman meets with an accident due to negligence. Many men after sustaining an injury, even of a serious nature, plead for an opportunity to remain on the job by being given lighter work. The lowering of a safety flag because of the occurrence of a lost-time accident is a matter of much regret.

From the data appearing in Table II it is difficult to appraise the value of age and experience as factors in preventing accidents. The number of compensable accidents that occurred to older workers with years of experience in their favor indicates that other factors are of vital importance. Most of these accidents occurred in working places which were comparatively safe. All of which goes to prove that the personal element as a factor in the prevention of accidents is most important and that there is no substitute for it.

Herewith is a brief description of the lost-time accidents.

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11. ACCIDENTS AND PERSONAL INJURY.

b. Non-Fatal Accidents. (Continued)

Mine	Number of Accidents	Description	Days Lost
Athens	7	1. Ore fell from back of working place. Dislocation of ankle.	202
		2. Fall of ore from breast of drift. Fractured fibula, right leg.	63
		3. Ore fell from side of drift. Fractured ulma, right arm.	39
		4. Timber rolled off truck. Fractured maleolus, right foot.	43
		5. Fell off stage, against a piece of lagging. Fractured rib and collapsed lung.	73
		6. Pulling empty truck off cage in tunnel. Slipped and truck wheel ran over his foot. Fractured toe.	48*
		7. Boring machine twisted from his grip and struck his leg. Fractured left fibula.	36*
Canisteo	1	1. Camel back fell off running board of locomotive as it was being transported. Fell on man's foot. Fractured phalanx.	72*
Cliffs Shaft	10	1. Erecting smokestack at dry. It swung around and caused injured man to slide off roof. Fractured right tibia.	67
		2. Barring ground, standing on ladder. Chunk of ore broke ladder and he fell on the ore pile, 14 feet. Sprained ankle and lacerated face.	79
		3. Handing plank to man standing on stage. Plank slipped and fell on his foot. Lacerated foot.	13
		4. Attempted to reach through guard to pick out a large piece of ore in the rolling machine of sample crusher. Crushed thumb, index and middle fingers, left hand.	690**

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11. ACCIDENTS AND PERSONAL INJURY.

b. Non-Fatal Accidents. (Continued)

Mine	Number of Accidents	Description	Days Lost
Cliffs Shaft	10	5. Loading at chute, chunk fell on his foot. Fractured 4th & 5th right metatarsals.	18
		6. Threw end of air hose across top of raise and fell with it. Fractured left clavicle.	42
		7. Standing, watching his partner bar at the top of 20-foot ladder. Small piece of ore fell and bounded, striking his leg. Contusion of left thigh.	27
		8. Loading ore at chute, chunk caught his finger.	61
		9. Stumbled over pole. Infected wound.	12
		10. Pulling wire rope, steel sliver in thumb. Infected thumb.	18
C. P. & L. Co.	1	1. Auto truck rear wheel dropped in a hole in the woods at Tilden mine, causing man and a large reel to drop off the truck. Fracture of right ankle bone.	42
Gardner-Mackinaw	2	1. Picking back in stope and chunk of ore fell on his foot. Fractured ankle.	36
		2. Riding in skip, his arm outside and squeezed between skip and wall plate. Contused arm and elbow.	98
Hill-Trumbull	2	1. Jumped from one railroad car to another. Fractured malleolus and right tibia.	45
		2. Unloading tractor from flat car. Crane tipped over and in jumping away, injured ankle. Fractured left ankle.	48

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11. ACCIDENTS AND PERSONAL INJURY.

b. Non-Fatal Accidents. (Continued)

Mine	Number of Accidents	Description	Days Lost
Lloyd	7	1. Chunk of ore fell from off stope. Fractured left tibia and fibula. (Injured man in poor physical condition.)	312*
		2. Movement of ground at working place. In running back, fell and injured ankle. Sprained ankle.	41
		3. Lighting a round of holes and remained longer than allotted time. Hole exploded before reaching safe zone. Punctured wounds of face, neck, hands, and body.	15
		4. Placing dynamite by hand in mill raise instead of using blasting stick. Ground fell. Fractured left fibula.	73
		5. Same as above. Injury - Separation of symphysis.	76
		6. Sheave block came off sling and fell on his right foot. Fractured metatarsal.	24
		7. While sledging ore junks, ore fell down mill raise, bounded and struck his foot. Pott's fracture, left foot.	80*
Maas	15	1. Ore fell off breast of working place and pinned him against timber and ground. Fracture of four ribs, right side.	46
		2. Barring loose ground, chunk fell and broke. Piece rolled on him before he could avoid it. Fractured right forearm.	67
		3. Picking ore pile, chunk fell from back. Contused right shoulder.	38
		4. Caught between ventilation door and locomotive. Bruised hip and thigh.	10
		5. Jumped back to avoid fall of ground. Slipped and fell on axe. Incised wound, left knee.	16

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11. ACCIDENTS AND PERSONAL INJURY.

b. Non-Fatal Accidents. (Continued)

Mine	Number of Accidents	Description	Days Lost
Maas	15	6. Rushing from shower bath to locker, slipped and fell. Bruised right elbow.	29
		7. Repairing raise and chunk fell on his leg. Fractured fibula.	94
		8. Operating scraper hoist, brake band broke and handle struck his foot. Loss of third toe, left foot.	60
		9. Struck by ore falling from back of working place. Contusion of back.	19
		10. Charging holes and struck by chunk of ore falling from inside of cap. Fractured rib and 6th cervical vertebrae.	53
		11. Pulling down a sawed pole with pick. Pole fell, bounded and struck his foot. Fractured 3rd and 4th metatarsals.	45
		12. Picking back and splinter into his eye. Did not lose right eye but sight badly impaired.	600**
		13. Cutting bark off cap and piece of bark struck his right eye. Eye became infected.	60*
		14. Rush of wet ore and water caused haulage car to dump over. Pinned between car and timber. Contusions both knees.	75*
		15. Same as above. Injury, bruised right and left knees and legs.	8
Negaunee	11	1. In stepping back to avoid a chunk of falling ore he fell and broke his leg. Fractured fibula, left leg.	88
		2. Unloading 18-foot logs in timber yard. Log struck his arm. Fractured arm.	58
		3. Charging holes in raise. Fall of ore broke stage and man fell 100 feet. Bruises, hemorrhage and cerebral irritation.	112

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11. ACCIDENTS AND PERSONAL INJURY.

b. Non-Fatal Accidents. (Continued)

Mine	Number of Accidents	Description	Days Lost
Negaunee	11	4. Struck by glancing rope. Fractured pelvis bone.	37
		5. Ground fell off side of drift and caused cap to drop on his leg. Bruised leg.	9
		6. Caught fingers in snatch block, as he attempted to take it down. Timber moved the rope. Lost top of 3rd.& 4th fingers, right hand.	105
		7. Hit by ventilation door. Contusion of chest.	21
		8. Struck by timber which was moved by scraper in motion.	100*
		9. Stepped on pole over raise, pole broke and he fell down raise. Fractured right wrist.	72*
		10. Ore fell from breast and knocked cap off legs. Struck by cap. General contusions.	36*
		11. Moved back to avoid junk rolling down ore pile and struck himself against timber.	30*
Spies-Virgil	1	1. Attempted to couple haulage cars with his hand. Loss of thumb phalanx.	360**
Storehouse & Shops	1	1. Painting ceiling, lost balance and fell off ladder. Fell 8 feet. Fracture small bone in ankle.	38
Miscellaneous	1	1. Working on scaffold and piece of lumber fell on his right thumb. Sprain.	60

* - Estimated lost time.
** - Compensation payments.

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11. ACCIDENTS AND PERSONAL INJURY.

TABLE I.

1937 ACCIDENT RECORD

Number of Accidents.

Mine or Plant	Slight Accidents	Lost-time Non-Compensable	Compensable
Athens	125	1	7
Canisteo	21	0	1
Cliffs Shaft	94	0	10
C. P. & L. Co.	5	0	1
Gardner-Mackinaw	25	0	2
Hill-Trumbull	39	1	2
Lloyd	72	1	7
Maas	167	3	15
Negaunee	143	2	11
Spies-Virgil	2	0	1
Shops & Storehouse	16	0	1
Tilden	6	0	0
Miscellaneous	2	0	1
	717	8	59

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11. ACCIDENTS AND PERSONAL INJURY.

TABLE II.

AGE, YEARS OF EXPERIENCE, AND OCCUPATION OF INJURED WORKERS.

Age	No.	Experience	No.	Occupation	No.
Under 20 years	1	Less than 1 month	4	Miner	34
20 to 25 years	8	1 to 6 months	7	Trammer	8
25 to 30 years	7	6 months to 1 year	8	Timberman	4
30 to 40 years	14	1 to 2 years	7	Foreman	2
40 to 50 years	13	2 to 5 years	4	Samplers	2
50 to 60 years	13	5 to 10 years	8	Motor & chutemen	2
50 to 70 years	3	10 to 20 years	14	Machine runners	3
		20 Plus	7	Surface men	4
	59		59		59

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11. ACCIDENTS AND PERSONAL INJURY.

TABLE III.

COMPARATIVE ACCIDENT RECORD
1936 and 1937
COMPENSABLE ACCIDENTS

	1936			1937		
Mine or Plant	Number of Accidents	Days Lost	Days lost per 1000 worked	Number of Accidents	Days Lost	Days Lost per 1000 worked
Athens	7	589	10.77	7	504	6.32
Canisteo	4	120	1.95	1	72	1.63
Cliffs Shaft	2	77	.76	10	927	8.18
C. P. & L. Co.	1	38	2.40	1	42	2.42
Gardner-Mackinaw	0	0	0	2	134	3.36
Hill-Trumbull*	-	--	----	2	93	2.18
Lloyd	8	657	12.40	7	621	8.00
Maas	7	1540	16.10	15	1221	9.03
Negaunee	4	214	3.24	10	568	2.00
Shops & Storehouse	0	0	0	1	38	1.40
Spies-Virgil*	-	--	----	1	360	23.20
Tilden	0	0	0	0	0	0
Miscellaneous	1	64		1	60	---
All Properties	34	3299	5.80	58	4640	6.08
	Fatal Accidents			Fatal Accidents		
Canisteo	1	1800		Negaunee		
		2002**	31.30	1	1800	
Cliffs Shaft	1	1800			2368**	22.30
		1877**	18.84			
All Accidents	36	6899	12.15	59	6440	8.41

* - Idle in 1936.
** - Total days lost.

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11. ACCIDENTS AND PERSONAL INJURY.

TABLE III-A

COMPARATIVE RECORD OF COMPENSABLE ACCIDENTS

	5 years 1930-1934	1935	1936	1937
Number of man days worked	1,963,767	393,967	567,880	763,000*
Number of fatal accidents	13	2	2	1
Fatality rate per 1000 men	1.98	1.52	1.06	.40
Number of compensable accidents not including fatalities	125	37	35	58
Number of days lost by compensable accidents not including fatalities	12,703	3,192	3,299	4,640*
Number of days lost per 1000 days worked not including fatalities	6.46	8.10	5.80	6.08
Number of days lost by compensable accidents including fatalities**	36,103	6,792	6,899	6,440*
Number of days lost per 1000 days worked Compensable accidents including fatalities	18.38	17.25	12.15	8.41

* Estimate
** 1800 days lost per fatal accident

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Year 1937.

11. ACCIDENTS AND PERSONAL INJURY.

TABLE IV.

Classification of Fatal Accidents 1911 to 1937, inclusive by the Central Safety Committee.

I	Trade Risks		108
II	Negligence of the Company:		
	Violation of Rules.....	4	
	Failure to Provide Safety Devices.....	5	
	Improper Method of Doing Work.....10		
	Failure to Provide Tools or Safe Place to Work....	3	
	Failure to Instruct men.....	4	26
III	Negligence of Workmen:		
A	Injured Men-		
	Improper Method of Work.....	18	
	Violation of Rules.....	7	
	Failure to use Tools or Appliances Provided.....	4	
	Failure to use Safety Devices.....	2	31
B	Other Workmen:		
	Improper Method of Work.....	14	
	Violation of Rules.....	4	
	Failure to Use Tools or Appliances Provided.....	1	19
	Total.....		184

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11. ACCIDENTS AND PERSONAL INJURY.

TABLE V.

Classification of Causes of Fatal Accidents
From December 1st, 1898 to December 31st, 1937.

A	Fall of Ground or Timber	96	
	Run of Mud or Sand	60	
	Fall of Chunk of ore from chute	2	
	Stray Chunk or Stick down Raise or Stope	3	161
B	Shaft Accidents:		
	Falling down shaft	14	
	Rock or Timber falling down shaft	2	
	Struck or Caught by Cage, Skip, Bucket, or Tool.	8	
	Falling from Cage, Skip, or Bucket	11	
	Falling from Ladder in Shaft	5	
	Carried or Pushed into shaft by car	3	
	Jumping on or off Cage, Skip, or Bucket	3	
	Struck by Crosshead	5	51
C	Use of Explosives:		
	Explosion of Powder	16	
	Premature Blast	3	
	Fall of Ground or Timber Due to a Blast	4	
	Overcome by Gas	3	
	Miscellaneous Causes	1	27
D	Mine and Railroad Cars:		
	Caught by Haulage Cars	12	
	Riding or attempting to Ride cars	6	
	Falling with car from trestle	4	
	Run over by railroad car	7	
	Miscellaneous Causes	1	30
E	Miscellaneous Causes:		
	Falling in Raise, Stope or Pocket	8	
	Contact with Electric Wire	8	
	Falling from ladder, stage, or trestle	7	
	By Moving Machinery	5	
	Mine Fires	3	
	Stockpile Slide	2	
	Miscellaneous Causes	3	36
	Total		305

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11. ACCIDENTS AND PERSONAL INJURY.

TABLE V.I.

Classification of All Compensable Accidents 1937
By the Central Safety Committee.

I	Trade Risk. (Incidental and Non-Preventable)	17	17
II	Negligence of Company:		
	1. Failure of Use Safety Devices Provided.....	2	
	2. Failure to use Proper Tools or..... Appliances Provided.....	0	
	3. Violation of Rules.....	0	
	4. Improper Act or Selection of Improper Method of Doing Work. (By Foreman).....	0	
	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.....	1	3
III	Negligence of Workmen:		
A	1. Failed to use Safety Device Provided.....	0	
	2. Failed to use Proper Appliances or Tools Provided.....	5	
	3. Violation of Rules.....	3	
	4. Improper Act or Selection of Improper Method of Doing Work.....	28	36
B	Other Workmen:		
	1. Failed to use Safety Devices Provided.....	0	
	2. Failed to use Proper Appliances or Tools Provided.....	0	
	3. Violation of Rules.....	0	
	4. Improper Act or Selection of Improper Method of Doing Work.....	3	3
	Total.....		59

Safety Department

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11. ACCIDENTS AND PERSONAL INJURY.

c. Safety Inspection

The local mines were inspected monthly, the Spies-Virgil Mine six times and the Canisteo and Hill-Trumbull twice. There is no unwillingness in correcting unsafe conditions or failures to comply with our safety standards when attention is called to the same.

G. R. Whittington, a chemist, whose service with our Company has been many years, was appointed safety inspector for the Canisteo and Hill-Trumbull mines in September. It was appreciated that he has tact and ability in contacting the workers and obtaining their cooperation in safety and welfare affairs and that he would render valuable service in his new capacity.

Erecting new fences around the shafts, pits, and caves on idle or abandoned mines was carried on during the mild season of the year. It was necessary to replace fences around many of the large surface openings that abound on these properties, in order to put them in safe condition. This repair work was not completed at the Republic and Empire mines and a number of scattered explorations. Two old men, former miners, were engaged in this work. They served faithfully and efficiently.

Central Safety Committee.

This Committee held five sessions. Lost-time accidents were discussed and classified and consideration was given to the following subjects:

Safety Standards	Mine Rescue Equipment
Shaft Runners	Mine Rescue Training
Fuse Lighters	Safety Belts
Bell Signals	Riding in Double Deck Cages
Wire Netting	New Types of Goggles
Cash Award Contest	Respirators.

Foremen Conferences.

In order to avoid unnecessary delays in holding conferences of foremen throughout the year the Manager stipulated definite times when they must be held. Two conferences are being held every quarter of the year. The superintendents and captains are expected to be present at each meeting and the foremen and bosses must attend at least one of the two meetings in each quarter. All accidents data

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11. ACCIDENTS AND PERSONAL INJURY.

c. Safety Inspection (Continued)

Foremen Conferences. (Continued)

available are presented at these conferences and the lost-time accidents are reviewed in a manner similar to the procedure followed by the Central Committee. Tables that summarize all slight accidents are given to each attendant. This affords opportunity to focus attention upon the principal causes of accidents. Other subjects bearing on safety or efficiency are discussed. Minutes of each conference are sent to the Manager.

Cleveland-Cliffs Club.

A meeting of this Club was held on the evening of December 11th. There were 144 members who participated in a supper served at six-thirty, after which the Manager reviewed the Company's labor policy and the writer discussed mine ventilation.

National Safety Council.

Membership in this organization was retained at a fee of $120. This is the source of our supply of safety posters, of which 1200 were used. 2900 1938 Safety Calendars were bought at a cost of 28 cents each, and were distributed to employees on the pay days before Christmas.

Lake Superior Safety Council.

This chapter of the National Safety Council held its first conference since 1931 on June 24th and 25th at Duluth, Minnesota. The conference was well attended by men from the mining and allied industries. Messrs. Stanford, Allen, Hill, Derby, and Conibear were present from our Michigan mines, and Messrs, Barber, Bolthouse, Sterling, Moore, Gaffney, Young, and Wivell from our Minnesota mines. Mr. Stanford presented a paper on "Underground Illumination in Metal Mines."

Discipline.

There were less men given lay-offs from work because of failures to conform to the Company's rules and regulations than in former years. The number suspended because of intoxication, however, increased.

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11. ACCIDENTS AND PERSONAL INJURY.

c. Safety Inspection (Continued)

Safety Flags

The practice of having a Safety Flag afloat at each mine, under the National Flag, is being continued. When a lost-time accident occurs at a mine or plant the Safety Flag is lowered for a period of two weeks. A Banner Flag was awarded the Tilden mine for a perfect record in 1936 and the same honor went to the Gardner-Mackinaw mine. Both mines retain these flags another year on the strength of their 1937 accident records; the Tilden for the best record for pits and plants and the Gardner-Mackinaw for the best underground record.

Miners' Safety Bulletin.

This bulletin was issued bi-monthly and approximately 15,600 copies were used.

Inspection Reports.

The number of inspection reports received from the mines and plants by this Department is given in the following table.

TABLE VII.

Hoisting cables	2051
Skip and cage roads	355
Ladderways	324
Hoists	80
Cage catches	79
Slack rope	58
Fire doors	27
Fire equipment	23
	3007

Safety Standards.

A new issue of Explosive Standards was printed and 425 copies of the same were distributed to the miners. A total of 159 copies of haulage, top slicing, and motor driver standards were given out to new employees.

Safety Devices.

Pocket men were supplied with a safety belt which was devised by the Canisteo mine mechanic. Attached to this belt is a chain for

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c. Safety Inspection (Continued)

Safety Devices (Continued)

the purpose of anchoring a man when he rides a railroad car. If it is used consistently by all our pocket men it should prevent a repetition of the fatal accident which occurred at the Canisteo mine in 1936.

A "Sigaphone" device was installed on the Athens mine cage in December. It consists of a small transmitter on the cage with an antenna wire outside of the cage. A pick-up wire in the shaft and a special amplifier and loud speaker in the engine house comprise the entire outfit. Bell signals can be given from inside of the cage when it is stationary or in motion. It is of particular value on double deck cages, and also in shaft inspections, repairs and other work.

Several new types of respirators were introduced which are meeting with the approval of the workers. We are experimenting with an improved type of goggles.

Cash Awards.

The distribution of cash awards as a means of stimulating interest in safety was continued for the second year in succession. The awards were given away in 1936 at the end of the year but in 1937 they were available monthly providing no compensable accident occurred at a unit during the month. Posters, outlining the contest for the awards, included the following information:

Prizes Will Be Awarded Monthly as Follows:

Number of Men	Number of Prizes			Total Monthly
	$10.00	$5.00	$2.00	
400 or over	5	6	10	$100.00
350 to 399	4	6	10	90.00
300 to 349	4	5	5	75.00
250 to 299	3	5	5	65.00
200 to 249	3	3	5	55.00
150 to 199	2	2	5	40.00
100 to 149	1	2	5	30.00
50 to 99	1		3	16.00

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c. Safety Inspection (Continued)

Cash Awards. (Continued)

Contest Rules

1. Cash Prizes will be awarded monthly at each Mine or Plant where no compensable accident has occurred.

2. A man must work one half of his allowable time in a month to receive a chance in that month.

3. Men on salary will not be eligible.

4. Drawings for the prizes will be conducted on the pay day which follows the first of each month.

TABLE VIII.

Showing the number of prizes awarded and the value of the same.

Mine or Plant	Number of Months Won	Number of Months Lost	Number of Prizes $10	$5	$2	Total Value
Athens	7	5	24	35	35	$ 485
Canisteo*	10	1	23	26	50	460
Cliffs Shaft	6	6	24	36	60	540
C. P. & L. Co.	11	1	11	0	33	176
Gardner-Mackinaw*	9	2	18	16	46	352
Hill-Trumbull*	9	2	14	12	39	278
Lloyd	7	5	21	35	35	455
Maas	2	10	11	13	25	225
Negaunee	5	7	23	28	40	450
Tilden	12	0	12	0	36	192
Shops	11	1	17	16	49	348
Spies-Virgil**	7	1	7	0	21	112
	96	41	205	217	469	$4073

* Participated 11 months.
** Participated 8 months.

The awards in 1936 cost $3676.70, which was an expenditure of $1.85 per man, as compared to about $1.50 per man in 1937.

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d. First Aid Work.

No instruction in first aid methods was rendered during the year but arrangement was made with the U. S. Bureau of Mines to have its instructors train our men employed at the Canisteo and Hill-Trumbull mines in January, 1938.

To the list of first aid supplies was added sodium chloride or salt tablets. They are for the prevention of heat sickness during the hot days in summer and also for miners working in hot places underground. These tablets act to replace the salt loss from the muscular tissue, caused by excessive sweating.

Regularly each week first aid cabinets are replenished. The amount of supplies thus distributed is tabulated in the following table.

TABLE IX.

First Aid Supplies Distributed

Material	Number distributed
Mercurochrome Compresses	7,419
Ounces of Mercurochrome	191
1" Roller Gauze	720
3" Roller Gauze	320
Rolls of Adhesive Tape	71
Packages of Picric Gauze	84
Packages of Plain Gauze	528
Leather Finger Cots	300
Mercurochrome Applicators	526
Tubes of Ointment	24

e. Mine Rescue Work.

With the re-opening of the Spies-Virgil mine foul air was encountered, pouring out from an abandoned stope through the fourth level, and from thence through the second outlet to surface. Its menace was cutting off the second outlet to surface. Four investigations of this poor air situation were made by crews of men wearing mine rescue apparatus. Analyses of the impure air revealed a depletion in oxygen and a corresponding increase in carbon

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e. Mine Rescue Work. (Continued)

dioxide that would not sustain life. A new outlet from the 6th to the 4th level was being driven at the close of the year, with the object of getting located to overcome the passage of the foul air from the 4th level to surface.

In July ten new McCaa rescue apparatus were bought at a cost of $1937.43 and turning in our old apparatus. In 1912, we acquired the Draeger apparatus, which served us about eleven years, and it was replaced by the Paul machine. Two rescue stations are maintained; one at the Negaunee mine and the other at the Cliffs Shaft mine.

Rescue apparatus training was carried on at all the local mines from August 15 to October 15, by Captain H. F. Rogers, who had been unable for several months to climb the high raises in the Athens mine, where he had been in charge of underground operations. The names of the men who received this training were posted in the offices of the mining captains. An opportunity was given to train men at the Spies-Virgil mine but the superintendent reported that the time was not favorable because of the rather complex situation prevailing there due to re-opening and getting the mine on a production basis.

f. Ventilation.

The volume of air entering each mine was measured and its distribution throughout the mine was mapped twice during the year. The supply of fresh air at the Cliffs Shaft mine was doubled by connecting a second drift from the east side of the present workings to the incline shaft. The supply at the Lloyd mine also was increased. These improvements have brought all the large underground mines to a pure air volume that meets the requirement considered satisfactory.

Forcing an ample allowance of fresh air to every heading in a mine is an ever-present problem. This has been accomplished many years at the Athens, Negaunee, and Maas mines by the use of many small booster fans. The same method is in vogue at rock headings in the Cliffs Shaft and Lloyd mines. Natural ventilation takes care of the air movements in the stopes of the Cliffs Shaft. The fresh air downcast in the Lloyd, Gardner-Mackinaw, and Spies-Virgil mines is increased by using large booster fans.

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f. Ventilation. (Continued)

The sources of dust in the mines and crusher plants were given special study. Air samples were collected regularly and the dust particles counted. The application of dust preventive methods was carried on vigorously.

In order to keep abreast of the times in this work the writer spent two days inspecting the Montreal and Eureka mines, where much rock work accompanies the mining of ore. The progress being made at these mines was discussed with our mine superintendents and several changes in our ventilation standards resulted therefrom.

TABLE X.

NUMBER OF AIR ANALYSES

Mine	Oxygen	Carbon Dioxide	Humidity	Temperature	Dust Counts in Millions Light Field	Dust Counts in Millions Dark Field
Cliffs Shaft	2	2	2	2	130	130
Lloyd	18	18	18	18	22	22
Spies-Virgil	15	15	15	15	8	8
Gardner-Mackinaw	2	2	2	2	3	3
Athens	-	-	-	-	32	32
Negaunee	-	-	-	-	31	31
Maas	-	-	-	-	20	20
Tilden	-	-	-	-	7	7
Brownstone Shops	-	-	-	-	4	4
Hill-Trumbull	-	-	-	-	4	4
Canisteo	-	-	-	-	3	3
Totals	37	37	37	37	264	264

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11. ACCIDENTS AND PERSONAL INJURY.

g. Department Expenses

Salaries	$ 4,565.00
Auto Expense	187.72
Heat, Light & Power	16.72
Insurance	.42
Postage	9.40
Stationery and Printing	254.00
Supplies	900.56
Traveling and Entertaining	296.87
Telephone and Telegraph	46.86
Personal Injury Expense	87.85
Accrual for Unemployment Ins. Tax	87.85
General Unclassified	168.13
Old Age Benefit Tax	48.38
Total	$ 6,669.76

Respectfully submitted,

William Conibear

Assistant Superintendent

22. REPORT OF THE GEOLOGIST FOR THE YEAR ENDING DECEMBER 31, 1937

A. STAFF

The staff of the Geological Department for the year 1937 is shown in Table I below. The personnel has remained unchanged throughout the year.

TABLE I

Name	Occupation	Hours Lost Sickness	Hours Lost Absence	Hours Overtime	Net % Hours Worked
E.L.Derby,Jr.	Chief Geologist	32½	152 3/4	72¼	94.6
Stanley W. Sundeen	Asst. Geologist	11	76½	3½	95.8
Gustav Afuhs	Draftsman	67¼	113 3/4	-	91.0
E. A. Allen	Assistant	-	56¼	7	97.6

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

TABLE II.

Total Working Days	277 days (2010 3/4 hours)
Sundays	52 "
Full days resulting from Saturday afternoons	26 "
Holidays	10 "
	365 "

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
1933	1.0
1934	1.0
1935	1.0
1936	2.4
1937	4.0

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

ITEMS	HOURS WORKED	PERCENT
MINES		
Athens	44	.6
Canisteo	274 1/2	3.5
Cliffs-Shaft	1871 1/2	24.0
Hill-Trumbull	118 3/4	1.6
Jackson Lease	19	.2
Lloyd	66	.8
Maas	235 1/4	3.0
Mackinaw	131	1.7
Morris Lease	57 1/2	.7
Negaunee	321 1/2	4.1
Pontiac	146 1/2	1.9
Ravenna-Prickett Lease	6 3/4	.1
Tilden	39 1/2	.5
Virgil	9 1/2	.1
Total Mines	3341 1/4	42.8%
EXPLORATIONS		
Cliffs-Shaft Mine	428	5.5
Section 1, 47-27	249	3.2
Section 2, 47-27	1158	14.8
Tilden	311 3/4	4.0
Total Explorations	2146 3/4	27.5%
MISCELLANEOUS		
Annual Report	41 1/2	.5
Depletion Estimates	268 1/4	3.4
Engineering Department	8 3/4	.1
General Departmental	1652 1/4	21.2
Geological Surveys on Company's Mineral Estate	94 1/2	1.2
Gold Leases on Company's Estate	12 1/2	.2
Investigating Mineral Land Offers	90 3/4	1.2
Investigating Outside Explorations	13 3/4	.2
Tax Commission Estimates	22 3/4	.3
Witherbee-Sherman Examination for Republic Steel Corporation	113	1.4
Total Miscellaneous	2318	29.7%
GRAND TOTAL	7806	100.0%

Approximately sixteen percent of my time during the year was taken up with the routine work of the office and the numerous miscellaneous duties peculiar to the Geological Department. I continued to spend a considerable amount of time,-- about fourteen percent,-- in connection with the Canisteo Mine. This consisted, principally, in the ad valorem tax problem on which we have been working with the State authorities for the past several years. I also made frequent trips to the Mesaba Range in connection with the structure drilling carried on at the Hill-Trumbull Mine, and plans to open the Pontiac Mine. Preparing estimates of all of our properties, including those in Minnesota, for Depletion valuations required about thirteen percent of my time. In this connection, Mr. W. C. Gordon, Engineer in the Metals Section of the U. S. Internal Revenue Department, who is handling our mineral valuations for the U. S. Government, spent several days in Ishpeming going over our valuations and I made two trips to Cleveland for conferences with him. This work was done under the supervision of Mr. Geffine and I worked very closely with both him and Mr. Sadler in all my conferences with Mr. Gordon. Nearly seventeen percent of my time was spent in planning and supervising the diamond drilling in the Cliffs-Shaft Mine and in the Section 1 and Section 2 surface explorations together with the final drilling we did at the Tilden Mine the early part of the year.

My activities, in addition to the regular routine work and to the geological surveys and explorations which are treated separately in this report, may be summarized as follows:

In January, I went to the Mesaba Range and prepared figures and miscellaneous supporting data for a conference which Mr. Barber and I then had with Mr. Johnson in St. Paul on the ad valorem tax valuation of our Canisteo Mine. Mr. Johnson is the Engineer for the Minnesota State Tax Commission. We, previously, had submitted our revised estimates to Mr. Lambert, the State's Estimator of iron ore reserves, as of May 1st, 1936 and which Mr. Lambert refused to accept. His own tonnage estimate, we feel, is unjustly out of line as based on any known information.

In February, Mr. Barber and I had our second conference with Mr. Johnson in St. Paul on our Canisteo tax problem. We made some progress but were unable to bring the matter to crystallization. I had several conferences with Messrs. Greene, Brown, S. L. Mather and Geffine, while they were in Ishpeming, relative to inaugurating a campaign of surface diamond drilling in Sections 1 and 2, 47-27. We had to purchase a large number of diamond drill carbon which required close supervision. We found it difficult to get the highest grade carbon, consequently our selection activities extended over several weeks

Mesaba

In March, I went again to the Range and then to Minneapolis where I had a conference with Mr. Lambert further in regard to our Canisteo ad valorem tax problem. Little or no progress was made with him but it helped to crystallize the policy which we followed, with success, later in the year.

In April, I accompanied Messrs. Geffine, Elliott, Jackson, and Adams on a trip to Lansing where we had our annual conference with Mr. Pardee, State Appraiser of Mines, and went over the tentative valuations on the Company's Michigan properties.

In May, I attended the Occupational Tax hearing held before the members of the State Tax Commission of Minnesota at the State Capitol in St. Paul. Messrs. Geffine and Barber also attended this hearing. I also spent a day at the Mines Experiment Station, University of Minnesota, in connection with the possibility of jigging Pontiac Mine ore and to get data for a report by Mr. Barber on the opening of this property. I then went to Hibbing and went over the structure drilling program and work being done on it at the Hill-Trumbull Mine. I conferred with Mr. Barber on Pontiac and Canisteo matters and had a conference with Mr. Matson, Research Engineer for Butler Brothers, also in connection with the concentration of our Pontiac ore. Butler Brothers, recently, had put into operation a combined washing and jigging plant on the Cuyuna Range to treat ore similar to the Pontiac from their Merritt Mine. I went over the possibility of jigging lean ores in the bottom of the Trumbull Pit and delegated one of our men to cooperate with the Great Northern people by observing and assisting in their laboratory experiments on this material. This work continued throughout the operating season and arrangements were made to set aside several carloads of this material, as it became available, to be shipped to the Mines Experiment Station in the fall for commercial size experiments to be conducted during the winter months.

In June, at the request of the Republic Steel Corporation and our Cleveland office, I spent a week examining the properties of the Witherbee-Sherman Corporation at Mineville, New York. I returned to Cleveland and estimated the reserves in these properties and prepared a report on the same for Mr. D. B. Gillies, Vice President. Later in the month, I went to the Mines Experiment Station at Minneapolis for a conference with Mr. Wade, Metallurgist, on the results he had obtained from the classifier tests made on the diamond drill core from our Pontiac Mine. I then went to Hibbing and went over the structure drill work at the Hill-Trumbull and conferred with Mr. Concklin of the Great Northern on the laboratory tests for jig possibilities of the lean material in the bottom of the Trumbull Pit. Mr. Barber and I spent one day on the Cuyuna Range and went through the nearly completed plant of the Butler Brothers for concentrating lean ore mentioned above. We went over the whole Pontiac question together in the preparation of his report of June 24th.

In July, my work was largely of a routine nature, including the supervision of our current drilling campaign. I did, however, go to the Ropes Gold Mine and examine the results of exploring by the Calumet & Hecla people on Company lands leased by them during the six months period ending July 1st and reported on the same to Mr. Bush.

In August, I went to the Mesaba Range and examined the current samples and results of the structure drilling at the Hill-Trumbull Mine and the laboratory experiments on jig material. I went over all of the drilling and mine data on the Pettit, Schley and Hobart Mines, offer of which properties recently had been made. I also assisted Mr. Barber in the preparation of another report on the Pontiac Mine and spent considerable time going over the ad valorem tax problem of the Canisteo. In the latter connection I wrote a complete memorandum which, later, we used at a conference with Mr. Johnson, State Tax Commission Engineer. This memorandum is explicit in our protest on the tonnage estimate placed on this property by Mr. Lambert and sets forth our reasons of protest in each controversial area in the property.

In September, I went to St. Paul with Mr. Barber where we held a conference with Messrs. Geffine and Holten on our Canisteo tax problem. Plans for handling this problem in the immediate future were discussed and tentatively agreed upon. Mr. W. C. Gordon, Government Engineer, and Messrs. Geffine and Sadler came to my office toward the end of the month and we spent several days in conference on the estimates and valuations of our mines and mineral estate for Depreciation and Depletion purposes.

In October, I spent the last half of the month at our Cleveland office in connection with these Depletion estimates and valuations. We had done very little directly with the Government engineers on this work for some 10 or 12 years and a thorough job was done in 1937. I went to the Range earlier in the month and went over all of the same problems which have been current during the past several months. In addition to this, I prepared estimates and other data which I used in my Depletion work at Cleveland in amortizing the stripping at our Mesaba Cliffs properties. I went to Iron Mountain and examined the records and the surface, including outcrops, formerly operated open pits, test pits, etc., on the land offered to us by Mr. John T. Spencer. This property is known as the old Cornell-Clifford, except that an irregular area approximating 30 acres has been sold to the Globe Iron Company from which they are producing siliceous ore from an open pit. The question of acquiring an option for lease on the Spencer property is before us for decision at the present time.

In November, I had a conference with Messrs. Davis and Wade at the Mines Experiment Station in Minneapolis in connection with jig tests to be made on three carloads from our Trumbull Pit. I attended the Public ad valorem tax hearing at the State Capitol in St. Paul in company with Messrs. Geffine, Barber and Donovan. Messrs. Raymond and Barber and I had a conference with Mr. Emmett Butler at his office in St. Paul on our Pontiac Mine. It was decided that Mr. Butler's engineers

would examine all of our drill records and samples of this property together with our tonnage estimates and submit two propositions,--one, to mine and treat this ore in their new Concentrator,--the other, only to treat the ore. I went to the Range and went over our Pontiac data in detail with Messrs. Whitney and Matson of the Butler Bros. organization. While on the Range I went over all of the work being done under my supervision and mentioned previously in this report.

In December, I spent several days the first of the month and the end of November at our Cleveland office completing our current conferences with Mr. Gordon, Government Engineer, on Depletion valuations. As stated previously, in all of this work I was in frequent conference with Messrs. Geffine and Sadler. Mr. Matson, Research Engineer of Butler Brothers, spent two days at my office going over the drill core and other data which he needs in connection with the work he is doing on our Pontiac concentrating problem. This is in connection with the possibility of treating our Pontiac ore in the Butler Brothers' Concentrator.

STANLEY W. SUNDEEN. Mr. Sundeen continued as Assistant Geologist throughout the year. His time was divided 67% directly connected with the geological surveys of our operating mines; 3% with the drilling explorations; and 30% on miscellaneous duties covered by the routine work of the Department. He has made periodic underground geological surveys and posted this information on the geological maps of the Cliffs-Shaft, Maas, Negaunee, Athens, Lloyd and Mackinaw-Gardner Mines, and the Jackson Lease. The Cliffs-Shaft Mine continues to be our biggest and most important underground geological problem. This property alone required about 41% of Mr. Sundeen's time. I am happy to report that, with the exception of a little work to be done at the Virgil Mine, the geological surveys and corresponding maps and cross-sections are posted right up to date. We had not been able to do this since the beginning of the depression and, in the case of the Cliffs-Shaft Mine, for a number of years before that time. He has also posted the current extensions on our geological maps and cross-sections of the Morris Mine and I think he will have the time during the coming year to make an occasional trip through the underground workings and examine the geology. We have been forced to accept all of this data from the Inland Steel Company since the latter assumed the operation of this property.

GUSTAV AFUHS. Mr. Afuhs continued as our Draftsman throughout the year. His work, as in the past, has, in part, consisted in preparing cross-sections of all of our current drilling and copying all exploration data submitted to this office in the form of land offers, outside explorations, etc. On account of the new campaign of drilling in Sections 1 and 2, he has had more work on drill sections than for a number of years. This required about 35% of his total time. He started work in 1936 on a new set of geological maps and cross-sections of the Cliffs-Shaft Mine to take the place of the old ones which are in very bad shape after thirty years of constant handling. He has continued this work as he could. During the latter part of the year it became more important to make up

a new set of geological cross-sections through the Maas-Negaunee ore body and he has worked on these all of his spare time since. About 48% of his time was spent on the Cliffs-Shaft tracings and 9% of his time on the Negaunee tracings. The rest of his time has been spent in general drafting work, making exploration tracings, maps and prints for my various reports and with a variety of smaller jobs comprising the routine work of the Department.

E. A. ALLEN. Mr. Allen spent 88% of his time collecting, sampling, labeling and filing diamond drill samples from the current explorations and making tests for the dip and bearing of the several drill holes with the Maas Compass as this data was required. He made a large number of thin sections of rock samples and diamond drill core for microscopic study by Mr. Sundeen and me. Occasionally, he has assisted Mr. Sundeen in some of his underground geological survey work. The rest of his time was taken up with office routine duties.

C. SURFACE GEOLOGICAL SURVEYS

No important nor appreciable surface geological surveys were made during the year. Mr. Sundeen and I examined the surface of the old Cornell-Clifford property near Iron Mountain which is being offered to us by Mr. John T. Spencer. I have mentioned this previously in somewhat more detail. He also investigated a report of the finding of an important lead of high grade ore on the surface at the old Republic Mine. It proved to be only a skin of ore left on the side of an old open pit operated many years ago by the old Republic Company. He has started work on a new surface geological map of the Eastern and more important portion of the Marquette Range. He has completed a basic tracing and we have had several printed copies made of it. In the continuance of this work, the next step will be to post on one of these tracings all of the surface geological information that has been acquired by the Company from its various surface surveys over the years of its existence, reconcile their overlaps, and fill in the gaps after a very detailed geological survey has been made of these areas.

D. UNDERGROUND GEOLOGICAL SURVEYS

All of the underground mines of the Company were very active during the year although somewhat curtailed at the end of the year. The Virgil Mine, which was closed at the end of April, 1933, was reopened on March 23rd.

From January 1st to February 23rd, all mines operated three 8 hour shifts, five days per week. From February 23rd to March 8th, all except the Mackinaw were increased to three 8 hour shifts six days per week. From March 8th to April 6th, the mines returned to a five day per week schedule except the Cliffs-Shaft which continued six days per week. From April 6th to October 3rd, the mines went back to a six day per week basis except the Mackinaw. The latter property was idle from July 9th to August 30th and the men employed at other Company mines. From October 3rd to December 6th, all mines were worked five days per week except the Cliffs-Shaft which continued on a six day basis. The third daily shift was eliminated at the Mackinaw. From December 6th to

December 31st, all mines except the Mackinaw were worked two shifts per day, six days per week, but the work was so staggered that each man was employed only four days per week. The Mackinaw continued on a two shift basis five days per week with each man on a four day per week basis. This was the schedule in force at the end of the year.

The Tilden Mine open pit began operations on April 7th and closed down November 3rd. Generally speaking, only five single shifts per week were worked. A few exceptions to this occurred when boats were waiting for ore. Only eighteen shifts were worked in June and eight in July. After seven single shifts had been worked the first of October, operations were placed on a two shift per day basis for the balance of the season.

D-1. - ATHENS MINE

We have mapped the geology, in the Athens Mine, of the new development work on the main levels and have kept the geological maps and cross-sections posted to date.

All of the Athens production continued to come from the blocks of ore between the 4th and 6th Levels. All of the ore above the 4th Level and North of the Northeast-Southwest dike now has been mined. Mining continues in this area below the 4th Level.

The development of the new 7th Level continued throughout the year. First the rock drift driven from the shaft holed into the drift driven from the main transfer raise inside the mine. Following this, three cross-cuts were completed and a fourth is being driven across the ore body. Three raises, put up from this level, were completed during the year and mining started from the tops of them. Six other raises have been started also from this level. A rock transfer raise was put up at the shaft plat from the 7th to the 6th Level. Late in December, a new drift was started on the 9th Level to take the place of the old main level drift which has caved. Also, the transfer raises at the shaft plat between the 9th and 10th Levels were stripped to eliminate the trouble of ore hanging up in them. All ore mined on the 9th Level is transferred to the 10th for hoisting. A new cross-cut is being driven Southeasterly on the -550' Sub-Level which will act as a transfer in mining the ore in Block 4 below the 4th Level.

D-2. - CLIFFS-SHAFT MINE

As stated before, the geology of the Cliffs-Shaft Mine is one of the most important problems of the Department. By continuing the intensive work through the past year, which was started in 1936, we have brought the geological survey work at this property up to date for the first time in a number of years. With our present organization we will be able to continue to keep this work up to date. These surveys together with the diamond drilling are more necessary than ever in discovering and developing new lenses of hard ore within the property. This becomes increasingly necessary as time goes on. Mr. Sundeen has made regular underground geological surveys during the past year and

has posted this information on the geological maps and cross-sections. He continues to make more detailed studies of areas requiring this extra attention. I have kept in very close touch with this work, personally, and have looked after the diamond drilling program. Mr. Afuhs is still working, as he has time, on the new set of geological maps and cross-section tracings to replace the old ones. It will be noted, by examining Table IV that 24% of the total time of the Department was spent on the Cliffs-Shaft Mine and I don't think a single hour of this was spent injudiciously.

In "A" Shaft, the production continued to come chiefly from the Bancroft Lease on the North; the main deposit, both the central part and the area adjacent to the old Incline and No. 3 Mines on the East; and from the Southeast Deposit. About 66% of the total mine production was mined from "A" Shaft deposits.

The important developments in "A" Shaft during the year were as follows:

The development drift driven Northeasterly from the East end of the 6th Level holed into the 429' Sub-Level of Old No. 3 Mine workings and furnished drainage from the latter to this elevation. This drift will be continued Northeasterly to get under ore pillars which are below the 4th Level of No. 3 Mine. The West drift on the South side of the 8th Level was extended Westerly and one raise put up to the 6th Level through which ore is now being mined.

The main East-West drift on the 10th Level South of the Bancroft Lease was extended about 240' East in footwall material. A series of holes will be drilled from this drift to completely explore the area. A cross-cut was driven South from near the end of this drift and cut 77' of good ore. Raises were put up from this cross-cut to mine ore on the 8th Level. Another drift to the North of this drift was driven Northeasterly and connected at its East end with an old stope. This drift followed ore practically all the way,-- the ore which was discovered in drill hole No. 431.

The drift which was started West last year from the main North-South cross-cut leading to the Bancroft Lease was extended 350'. Although a small amount of ore was encountered, it was mainly in footwall material and is opening up ground which will be more completely explored by diamond drilling and from which raises will be put up to mine the ore above.

On the Bancroft Lease, the main East-West drift was extended 300' Westerly. Ore was almost continuous in this drift but was narrowing. However, in putting up a raise to mine ore on the 6th Level, a good width of ore was found only 5' above the back of the drift. The main Bancroft ore body, which was crossed by the North cross-cut on the 1800 East meridian, was developed further by a stope drift driven to the West from this cross-cut, a distance of 150' until it hit jasper. Up to this point, the stope drift had ore along both ribs. A raise is being put up to the North a short distance from the breast of this drift and is all in ore.

On the 15th Level, raising which previously had been started from the North cross-cut under the Bancroft ore body, and from the East end, was completed. A new branch from this east end raise has been started to hole to the 10th Level.

"B" Shaft deposits produced about 34% of the total mine production. The ore continued to come almost entirely from the floors, raises and stopes in ore areas already developed on the various levels. The drift being driven Westerly from the Southwest end of the 10th Level to develop and mine the ore discovered by drilling from surface years ago on the West side of Section 9, was continued vigorously throughout the year with an advance of 640'. Previously, much of the drift had been in relatively soft greenstone but during the past year much hard cherty jasper was cut. At the very end of the year the ore was finally encountered and several cuts taken in it. The ore is of excellent grade and of the type found in the largest and most continuous of the Cliffs-Shaft ore bodies. Its development, during the coming year, by drifting, raising and diamond drilling, will be watched with keen interest. To augment the Cliffs-Shaft reserves by a large tonnage of ore in this area would be one of the most valuable assets added to the Company's mineral picture in a generation.

D-3. - JACKSON LEASE

We have made occasional geological surveys of the developments and the mining operations of the Republic Steel Corporation in the Jackson Lease. Three cross-cuts have been driven on to this lease from the 6th Level, Cambria Mine, and the ore bodies, already known to exist, further developed by drifts from these cross-cuts. Stoping is underway above this development on five sub-levels at elevations of +120'; +135'; +150'; +175'; and +200'. The production for the year was 66,116 tons.

D-4. - LLOYD MINE

We have kept the geology of the new development work in the Lloyd Mine and the geological maps and cross-sections up to date.

Except for a small tonnage of ore which was mined in the old Lloyd ore body on the 3rd Level elevation, the product of this property has come from the East Lloyd ore body and was divided between three principal areas,-- namely, from between the +940' and +830' elevations above the 4th Level; from between the +765' and +715' elevations, the lower part of which block is in new territory above the 5th Level; and from stoping under the West end hanging wall above the 5th Level.

Work was started during the year to open up and develop the new 6th Level which has an elevation half way between the 5th Level and the old 6th Level,-- the latter now called the 7th Level. The shaft plat on the new 6th Level was completed and some 330' of footwall drift, all in rock, advanced toward the ore body.

D-5. - MAAS MINE

Periodic geological surveys have been made in the Maas Mine during the year and the data posted on the geological maps and cross-sections.

The production during the year came 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 the main deposit above the 5th Level on the Race Course and South of it but all under the hanging wall. This area produced all of the Bessemer ore from the property. The West footwall pillar above the 3rd Level, in reality, is the upper part of the riser of ore which extends, and has been more or less developed, down as far as the 5th Level on the footwall side of the main deposit.

On the 4th Level a new drift was driven in ore to the East along the North footwall and a cross-cut turned off to the Southeast from this drift. The mining of the block of ore under the hanging wall above the 4th Level in this area, and developed from the 600 series of raises, was discontinued temporarily on account of the heavy flow of water.

On the 5th Level, the South footwall drift was extended Northeasterly, parallel with the boundary of the property, a distance of 270' and four raises put up into the block of ore above the 4th Level. Five new raises were put up into the same territory from No. 4 cross-cut along the East boundary of the Race Course. The South end of No. 7 cross-cut was extended about 250' Northwest from the South footwall drift and two raises put up to develop a newly found extension of the ore body under the hanging wall which was first encountered on the 90' Sub-Level.

D-6. - MACKINAW MINE

Geological surveys of all extensions and development work at the Mackinaw Mine were made during the year and the data posted on the geological maps and cross-sections.

The production for the year came from stopes above the 6th, 7th, 8th, 9th and 10th Levels but most of it from above the 7th, 8th and 10th Levels. Trouble continued to be experienced with the increasingly higher phosphorus content, which, so far, has eliminated as commercial, all of the ore in the areas developed during the year. These areas are centralized in the Northwest end of the ore body which is its widest part.

Development work progressed on the 7th, 8th, 9th and 10th Levels but most of it on the 10th Level. All of the development work was in the Northwest and wide portion of the ore body. On the 10th Level the main drift was extended in high phosphorus ore about 790' to the Northwest with the breast still in the same material. Several cross-cuts were driven to the foot and hanging walls to outline its width. The Northwest end of the ore body on this level has widened phenomenally,-- to a maximum of 247'. The tonnage reserve below the 9th Level, as a result of this development work, is as large as the total combined production to date from the

Mackinaw-Gardner Mine. It is truly unfortunate that this ore is unsalable by itself. If additional ore with relatively lower phosphorus and sulphur content can be discovered, as much of this new ore can be mined and graded with it as the combined analyses will permit.

D-7. - MORRIS MINE

The Morris Mine continued to be operated under lease by the Inland Steel Company. Mining was continuous throughout the year on the basis of five double shifts per week. It has been impossible for us to make our own geological surveys in this property. We hope to do this another year. I have, however, gone over the maps carefully with the Messrs. Satterly, Superintendent, and Pearson, Engineer and Geologist, and have the following to report relating to the production and new developments.

The production continued to come almost entirely from the No. 9 lease and the Cleveland-Cliffs Iron Company fee land to the East and South of this lease. A small amount of ore was mined from lease No. 24 lying directly West of lease No. 9. The production, the past year, was about evenly divided between sub-level stoping and slicing operations. The topmost workings are at the +170' elevation (B deposit) which is 90' above the 7th Level. The lowest workings remained on the -90' sub-level which is 35' above the 8th Level.

In continuing to develop the 8th Level, the South drift was extended about 200' West, the last 100' being on lease No. 24. From the end of this drift a cross-cut was driven just above the level both North and South of it. No ore was found, thus fixing the West limit, at this elevation, of the main or No. 33 deposit. Two raises were put up from the end of this drift and cut-outs made at several elevations, further delimiting the Westerly extension of this ore above the 8th Level and notably on the -50' and -90' Sub-Levels. A drift was driven Southwesterly 360' and then West about 300' starting from an old drift in C deposit (below No. 21 deposit). The last 380' of this drift was in ore of B deposit. Two raises were put up from the North side of this drift, both starting in ore. The East raise was in ore only about 20' then cut through dike and into jasper until within 20' of the 7th Level where it cut ore again and was stopped temporarily. The West raise, which is 75' high, is all in ore.

Development work on the -10' Sub, which is the timber handling sub-level 115' above the 8th and 85' below the 7th Levels, has reduced somewhat the anticipated ore area in B deposit as based on a former assumption of strict continuity of this ore between the elevations of the 7th and 8th Levels. Also from this sub-level, a cross-cut was driven Northeasterly to develop the downward extension of No. 61 deposit. The ore zone was crossed without finding high grade material.

Stoping in No. 21 deposit was completed above the 7th Level elevation during the year. In B deposit, slicing continues in the West end on the +100' Sub and in the East end on the +130' Sub. In No. 61 Deposit, slicing is being done in the West end of the ore body on the +110' Sub, and in the center of the ore body on the +150' Sub. Mining has stopped temporarily in the East end of this ore body on the +150' Sub-level.

D-8. - NEGAUNEE MINE

We did practically no underground geological survey work in the Negaunee Mine during the year. We have, however, posted the current extensions on all of the geological maps and cross-sections. Relatively little development work was done here but during the coming year we expect to resume our underground geological surveys and bring them up to date and keep them so as development progresses.

The production came, principally, from three localities; namely, from the main deposit above the 12th Level and from the footwall pillar and the area between the two South dikes, both above the 10th Level. A small production came from above the 11th Level South of these dikes and also from the main deposit above the 13th Level. Preparations were underway at the end of the year to mine the old No. 1 and No. 2 shaft pillars above the 9th Level.

Under the heading of development, about 675' of drifting was done on the 13th Level. Most of this was in the extension of two footwall drifts from which four raises were put up to develop the main ore body. The balance of this drifting was in a cross-cut to get under the ore South of the two main dikes. On the 12th Level, a footwall drift about 225' long was driven at the Northeast end of the level in rock from which two raises were put up to develop the bottom of the footwall pillar. Also, a hanging wall drift and cross-cut were put in to improve the ventilation in the Maas Mine. On the 9th Level, a 375' cross-cut was driven through the center of the old No. 1 shaft pillar from which three raises were put up to the top of the ore. Three other raises were put up into this same block from the old footwall drift. Mining operations in this block have been started from these raises since the first of the year. In the old No. 2 Shaft Pillar, old raise No. 17, which goes up in this pillar from the 9th Level, is being stripped to a two compartment raise in preparation for mining the ore in this pillar.

D-9. - TILDEN MINE

It was not necessary, from an operating standpoint, to make any detailed geological surveys at the Tilden property during the past year. A few observations, however, were made after the West Pit area was stripped, in mapping the outcrop of the interbedded dike which cuts through this ore body and dips to the North at about the angle of the general dip of the ore itself.

The production came entirely from the East and West Pits. Operations at the Summit Pit have been discontinued indefinitely because of the very irregular manner in which the phosphorus occurs, the lower iron content and the material increase in cost of producing ore from this pit. The West Pit produced 217,586 tons and the East Pit 87,832 tons making a total production of 305,418 tons. Three grades of ore were made and known as Tilden Silica, Tilden Silica No. 1 and Low Phosphorus. The Tilden Silica was a mixture of ore from both pits whereas the other two grades came only from the East Pit. The Low Phosphorus grade (.013 Phos.) amounted to a mere 469 tons and was made possible only after special pit selection.

Four stripping operations were conducted during the year. These were at the West side of the West Pit (27,000 cu. yds); the lower bench of the West Pit (26,640 cu. yds); the East end of the East Pit (7,420 cu. yds) and the North side of the East Pit (2,375 cu. yds.). There remains to be stripped from the lower bench of the West Pit, 3,360 yards and when this is completed together with the stripping done the past year, the entire remaining reserves of the West Pit area limited by the dike on the North side, and down to the lowest bench, will be available. This amounts to 2,525,000 tons, of which 2,000,000 tons will come from the lower bench. The stripping on the East side of the East Pit makes available 227,000 tons. The stripping on the North side of this pit really uncovered no new ore. The area had been stripped before and the work done the past year was in the nature of a clean-up.

D-10. - VIRGIL MINE

The Virgil Mine, which was closed down on April 28, 1933, but since has been kept free of water, was reopened on March 23rd. After this relatively long shutdown, a considerable time was necessary to recondition the main levels and after production began it was interrupted frequently by breakdowns of timber in the old drifts which cut off ventilation. Since August, however, production has been continuous. The geological maps and cross-sections were posted practically to the date of shutdown in 1933. We have not had an opportunity since the mine reopened to do any work there but will soon resume periodic geological surveys and keep our maps and cross-sections posted currently. About 90% of the production has come from the stopes on the Northwest side of the deposit between the 6th and 8th Levels and the balance from the central pillar in the main portion of the ore body above the 6th Level.

A section of new rock drifting was driven along the North side of a caved portion of the 4th Level for a distance of about 630' for ventilation purposes. The 8th Level, main drift, was extended Southwesterly for about 150'. The last 70' had intermittent ore in the back of the drift. Two raises were put up and both encountered ore from the back of the level. One of these raises, to the South, encountered rock again at 17' and was stopped. The other raise, to the North, went 30' in ore where a sub-level was cut out from which to develop this ore. The remaining development work has consisted in completing the outline of the ore body at its Northwest end at the elevation of various sub-levels above the 8th Level.

E. OPTIONS AND LEASES

No new options to explore, nor leases, were actually taken by the Company during the year. However, negotiations for an option and lease were being carried on at the end of the year with Mr. John T. Spencer of Iron Mountain, Michigan on the old Cornell-Clifford property. This property lies to the North of Iron Mountain and is described as the $N\frac{1}{2}$ of the $NE\frac{1}{4}$; the $NE\frac{1}{4}$ of the $NW\frac{1}{4}$, and Lots 3, 4 and 5, all in Section 20, T. 40 N. R. 30 W, Dickinson County, Michigan, excepting the 30 acres, more or less, sold to the Globe Iron Company by Mr. Spencer.

The lease on the North 660' of the N½ of the NW¼ of Section 1, 47-27 and the North 660' of the NE¼ of the NE¼ of Section 2, 47-27, and dated April 15th, 1936, was finally executed by the Republic Steel Corporation on February 2nd, 1937. This is known as the Jackson Lease.

F. EXPLORATIONS AND COSTS

Drilling explorations were carried on in 1937 in the following districts and mines:

F-1. - FROM SURFACE

DISTRICT	RANGE	MINE
Marble	Mesaba	Hill-Trumbull
Ishpeming-Negauneee	Marquette	Secs. 1 & 2 Expls.
Tilden	Marquette	Tilden

F-2. - FROM UNDERGROUND

Ishpeming	Marquette	Cliffs-Shaft

Table V, which follows, gives the footage drilled, the ore encountered, and the cost per foot of drilling for both surface and underground explorations. It will be noted that the average cost of surface drilling was $4.97 per foot, excluding certain items which are not actual drilling expense but which are customarily charged to these explorations. By including these items, the average cost was $5.62 per foot. The cost of underground drilling in the same way was $2.93 per foot and $3.43 per foot, respectively. The drilling costs for 1937 were materially increased by the general wage increase the middle of March and the time and a half rate paid for work on Saturdays. In addition to this, we were unfortunate in hole No. 36, Section 2 Exploration, in sticking a bit which caused the breakage of several carbon. Such an accident has not happened before in my experience in the Department.

Table VI, also shown below, gives a comparative cost per foot of drilling for the past five years. The comparatively higher costs in 1937 are explained in the paragraph above. I might add, however, that although the total footage drilled is considerably more than in any of the past five years, by far the largest part of it, or more than 11,000 feet, was drilled in exceedingly hard ground as compared with drilling in the other years. Also, the holes have been much deeper which, of course, adds materially to their cost.

TABLE V.

SUMMARY OF DRILLING FOR 1937

PROPERTY	DESCRIPTION SEC.	T.	R.	STAND-PIPING FT.	CHURN DRILLING FT.	DIAMOND DRILLING FT.	TOTAL DRILLING FT.	FIRST CLASS ORE FT.	SECOND CLASS ORE FT.	LEAN ORE FT.	TOTAL COST "A"	COST PER FT. "A"	TOTAL COST "B"	COST PER FT. "B"
SURFACE DRILLING														
Hill-Trumbull Mine	17	56 -	23, Minn.	43	6,539	-	6,582	180	-	* 3,837	$20,452.18	$3.11	$17,043.57	$2.59
Section 1 Exploration	1	47 -	27, Mich.	13	11½	2,138½	2,163	-	2	5	14,253.89	6.59	12,714.37	5.88
Section 2 Exploration	2	47 -	27, Mich.	370	43	7,548	7,961	30	65	99	59,072.80	7.42	53,002.43	6.66
Tilden Exploration	26	47 -	27, Mich.	-	3	1,461	1,464	-	2	89	8,270.17	5.65	7,524.73	5.14
TOTAL SURFACE DRILLING				426	6,596½	11,147½	18,170	210	69	4,030	$102,049.04	$5.62	$90,285.10	$4.97
UNDERGROUND DRILLING														
Cliffs-Shaft Mine	3, 9 & 10	47 -	27, Mich.	-	-	2,838	2,838	209	85½	92	$ 9,733.68	$3.43	$8,309.32	$2.93
TOTAL UNDERGROUND DRILLING				-	-	2,838	2,838	209	85½	92	$ 9,733.68	$3.43	$8,309.32	$2.93
GRAND TOTAL DRILLING				426	6,596½	13,985½	21,008	419	154½	4,122	$111,782.72	$5.32	$98,594.42	$4.69

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

Note: Cost "A" includes office expense, Engineering, Analysis, Legal, Personal Injury, etc.
Cost "B" excludes " " " " " " " "

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"	
1933	4,939	$ 3.85	$ 3.01	
1934	8,230	2.01	1.64	Canisteo Structure drilling only.
1935	4,321	3.16	2.70	
1936	12,094	3.46	3.00	
1937	21,008	5.32	4.69	

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F-3. - DIAMOND DRILL CARBON

We had on hand, January 1st, 1937, a total of 329.23 carats of diamond drill carbon, which inventoried at $43,819.68. We purchased, during the year, 127 stones having a weight of 484.91 carats at a cost of $42,476.75. We consumed, during the year, a total of 205.99 carats having a value of $22,135.39. This left on hand, December 31st, 1937, a total of 608.15 carats which inventoried at $64,161.04. In addition to this carbon, we purchased 15.37 carats of Bortz at a cost of $49.95 to use in the place of chipped carbon when we encounter ore in our surface drilling. This is carried separately and not inventoried with our carbon.

F-4. - DRILL SECTIONS

Cross-sections of all diamond drilling, showing a detailed report of the work done during the year underground in the Cliffs-Shaft Mine and from the surface in the explorations in Sections 1 and 2, 47-27 and at the Tilden Exploration, will be found in the Annual Report Book of Maps of the Michigan Ranges which is submitted as a part of the Annual Report of the Engineering and Geological Departments.

Cross-sections of the structure drilling at the Hill-Trumbull Mine have been prepared in our Hibbing office for use on the Range. Copies of these sections will be sent to the fee owners, and to our Cleveland and Ishpeming offices.

G. SURFACE EXPLORATIONS

G-1. - HILL-TRUMBULL MINE, SECTION 17, 56-23, MINNESOTA

A total of 77 structure drill holes were drilled in the Trumbull Pit during 1937, with a total footage of 6,582'. This work had two objectives; one, to complete sampling ore layers being mined currently and to outline in greater detail their limits on the property; second, to determine the bottom limit of ore in the property and particularly to sample the so-called "Jig" ore horizon lying between the bottom of the regular wash ore and the taconite footwall.

This drilling was started coincident with the beginning of mining operations the first of April and continued until early in December. The holes were distributed between the NE¼ of the SW¼, and the NW¼ of the SW¼, both in Section 17, 56-23. Seventy-four of them were drilled West of the main approach and three East of it.

As a result of this drilling, the estimated developed reserves in the Trumbull Pit have been increased by 1,164,431 tons, all Wash Ore concentrates. In addition to this, there was developed a tonnage of so-called "Jig" ore between the bottom of the wash ore and the Taconite. Experimental work is being carried on at present to determine how much of this material can be treated and made in a commercial product. As soon as this is known, an estimate of the "Jig" ore developed by this drilling will be made.

G-2. - EXPLORATIONS IN SECTIONS 1 AND 2, 47-27, MICHIGAN.

In February, 1937, it was decided to inaugurate a comprehensive campaign of diamond drilling in Sections 1 and 2, 47-27, and more particularly in the so-called Jackson and Golf Club areas. With the rapid depletion of the ore reserves in our operating mines and the time necessary to discover, outline and open for production another high grade ore mine, it was realized we should start exploring at once. These areas were selected as being among the most attractive on the Company's mineral estate where ore might be expected at relatively moderate depths,--from 2,000 to 3,500 feet. From our limited knowledge, the geological structure in these areas appears to be exceedingly favorable for the concentration of high grade ore in the vicinity of the Siamo slate footwall.

Preparations of two drill sites were begun the last week in February in the Golf Club area, Section 2. Progress was hampered considerably by the heavy mantle of snow and additional storms coming at that time so that drilling did not commence until March 22nd with Hole No. 36 located just West of the Golf Club area at S. 1800' and 15,200 West. The second drill recovered and reclaimed old Hole No. 16 just North and East of the Golf Club at South 1200 and 12,000 East. This hole, originally was drilled to a depth of 421' in 1917, and its location was considered a good one for the initial test to the footwall in this area and thus making use of the footage already drilled. The work of reaming out the old hole to a larger size, in order that casing might be placed in the hole later, was commenced on March 22nd but new drilling from the bottom of this hole was not begun until April 15th.

Hole No. 16 encountered high grade ore at a depth of 2,095', which, except for 3' of dike, from 2,103' to 2,106', continued to a depth of 2,123'. Dike was encountered again below this ore at 2,123' and the hole continued in it until the footwall slate was cut at 2,168'. The ore from 2,095' to 2,103' averaged 58.92% Iron, .180% Phos., and .010% Sulphur. From 2,106' to 2,123', the ore averaged 60.03% Iron, .177% Phos. and .029% Sulphur. We took samples of the drill water to be sure that no soluble sulphur was lost. We were tremendously encouraged by encountering ore in the first hole to be drilled to the slate footwall. There was also a run of dike just above the ore, from 2,060' to 2,095'. It is my opinion that these three runs of dike represent a relatively narrow continuous and nearly vertical dike passing through the ore from foot to hanging and that the drill hole followed pretty closely one contact of this dike. If this is so, it is more than likely that, had the hole approached this horizon a few feet to the North or South, orewould have been continuous from some distance higher than 2,095' to the slate footwall contact. In other words, there is a possibility of ore with a thickness of as much as 100'.

In order to explore for the downward continuation of this ore along the footwall, we recovered old hole No. 27, drilled to a depth of 1047' in 1917 and 1918. It is located on the same meridian and about 750' South of Hole No. 16. Unfortunately, after recovering this hole,

we found the standpipe so much out of a vertical line that we could not ream the hole, and continue it, using our steel headframe which is quite essential for the economical drilling of deep holes. We, therefore, started a new hole, No. 27A, practically along side of No. 27. Hole No. 27A had reached a depth of 1561' at the end of the year. It ledged in broken dike at a depth of 49'. The main intrusive greenstone horizon was cut between the depths of 687' and 1199'. The balance of the hole was in typical Marquette Range soft ore jasper with here and there unimportant seams of enrichment. Near the contact with the first evidence of faulting we had 5' of first class ore running 58.55% Iron and .058% Phos., followed by 15' of second class material averaging 54.87% Iron and .068% Phos. This was between the depths of 1380' and 1400'. This appeared to be a relatively recent concentration along a water course in the brecciated zone and it contained visible sulphur in the form of gypsum. This is not unusual in such zones.

The favorable feature for the discovery of ore in this area is a fault basin. This is produced by a major East-West fault which outcrops approximately 300' South of this hole. The block on the North side has been dropped several hundred feet in relation to the block on the South side. This forms an impervious trap with slate below and iron formation butting up against the slate faulted up to the South. Usually these major faults are very steep. The limit of time is our principal handicap and, therefore, we did not take the time to drill inclined shallow holes to determine the dip of this fault. There is some evidence that we crossed this fault plane in hole No. 27A between depths of 1352' and 1490'. If such is the case, the fault dips steeply to the North and the hole is now drilling in the upthrust block to the South. This means that the hole would not get down to the favorable crotch or basin but would strike the slate several hundred feet higher in its faulted position and we would not expect any large amount of ore. On the other hand, we may have encountered the fault just as it is bending from a North dip to a South dip and still be on its favorable side. Furthermore, this fault evidence may be of minor magnitude and not the main fracture. In that case, also, we are on the favorable side. With no actual knowledge of this basin in depth, until the present hole is bottomed, it is difficult to determine its depth within one or two hundred feet. Our best information indicates we should encounter slate, if on the South side of the fault, not far from 2200'; and, if on the North side, somewhere between 2600 and 2700'.

Hole No. 36 was located to the West of the Golf Club area and about 3100' West of hole No. 27A. It was a vertical hole and located about 700' North of the surface outcrop of the main East-West fault. Greenstone ledge, representing the uppermost member of the main greenstone intrusive, was encountered at a depth of 104'. The principal intrusive horizon was cut between 274' and 886'. The hole encountered footwall slate at a depth of 2433' and was bottomed in it at 2460'. No commercial ore was encountered. Much of the

iron formation in this hole, unlike that in Holes 16 and 27A, was very hard until we got within a few hundred feet of the slate footwall. It was made up of blue hematite and magnetite seams laminated with white chert. It was almost like a hard ore jasper and probably represents an older oxidized horizon which has since been subjected to agents of metamorphism.

Hole No. 37 is being drilled vertically from the South shore of the Lily Pond Northeast of the Golf Club house and is located about 650' East and 250' North of 27A. The meridian passing through Holes 16 and 27A is a very promising one after encountering high grade ore in the bottom of Hole No. 16. It is, therefore, our plan to test this fault basin on meridians both East and West of this one. Hole No. 37 encountered broken soft ore jasper ledge at a depth of 10' and had drilled to a depth of 1750' at the end of the year. The upper member of the greenstone intrusive was cut between 336' and 460' and the lower member between 578' and 906'. A considerable footage of dike was cut between 1198' and 1290', and 1331' and 1360'. Except for minor unimportant dikes, the balance was in soft ore jasper. Some of this jasper shows signs of an older oxidation and subsequent metamorphism. Between the depths of 1268' and 1358' there were evidences of major faulting in this hole though not as pronounced as in Hole No. 27A. There is some indication that the main fault changes its direction and runs somewhat North of East to the East of Hole 27A. We may, therefore, have crossed this fault again though the evidence is not entirely convincing and the hole will continue to the footwall slate. If we are in the upthrust block to the South of the fault, we should encounter the slate footwall at a depth of between 2100' and 2200'. If we are in the basin to the North, the slate should be in the neighborhood of 2500' to 2600'.

Hole No. 38 is being drilled vertically on the meridian about 600' West of hole No. 27A and 150' North of it. It was moved to the North so that in case 27A has crossed the fault, No. 38 will be sure to stay within the basin to the North all the way to the slate footwall. It ledged in typical soft ore jasper at a depth of 128'. The upper member of the greenstone intrusive was cut between 177' and 360' and the hole was still drilling in the lower member of this intrusive, which it had encountered at 483', at a depth of 593' on the last of the year. The iron formation has been quite rich with 22' of it, from 390' to 412', averaging as high as 50.16% Iron and .100% Phos.

Soon after starting the drilling in Section 2, 47-27 with two drill rigs, it was decided to put a third drill to work in Section 1, 47-27. The thought was that, if our drilling in Section 2 proved unsuccessful, we would be saving time to get a hole down, if possible, along the Westerly extension of the ore encountered in Holes 67 and 68, Section 1. Accordingly, Hole No. 136 was located 1500' due West of Hole No. 67 with the realization that the footwall might be as deep as 3500'. This location is approximately 4300' East of the meridian passing through Holes 16 and 27A in Section 2. We

had no deep drilling in this area but, at the present writing, we think this hole will reach the ore horizon in the same fault block that controlled ore concentration in Holes 67 and 68.

Hole No. 136 encountered soft ore jasper ledge at a depth of 24½'. With the exception of several narrow dikes, typical soft ore jasper continued until the upper member of the main greenstone intrusive was cut at 962'. This member extended to a depth of 1281'. It was followed by soft ore jasper again and the lower member of the greenstone was cut between the depths of 1567' and 2088'. This in turn was followed by soft ore jasper in which the hole was temporarily bottomed at 2163' on August 31, 1937. The reason for stopping this hole was in order that the drill rig might be moved to Section 2, there to concentrate all our drilling capacity on the area in the vicinity of the original discovery of ore in Hole No. 16. This drill was moved to location No. 37.

G-3. - TILDEN MINE, SECTION 26, 47-27, MICHIGAN

Diamond drilling in the Tilden Mine area to the South and East of the West Pit, was being carried on at the beginning of the year with two drills. This drilling had been inaugurated in the middle of December, 1935 and continued uninterruptedly throughout 1936. I discussed the reason for this drilling and the results attained to the beginning of 1937 quite at length in my report for the year 1936 to which I refer for greater detail.

Hole No. 52 was drilling in cherty magnetite siderite at a depth of 1071' on the first of 1937. This was followed by an unoxidized clastic iron formation containing well rounded grains of glassy quartz in a ground mass of siderite and chloritic material with some magnetite. Here and there cherty siderite was interbedded. From 1444' to 1635', typical soft ore jasper was encountered followed by clastic iron formation, jasper again,and a small dike. This dike, depth 1685' to 1701', evidently marks the faulted contact between the Negaunee Iron Formation of the district on the North and the much older altered and decomposed Archean chloritic carbonate schist faulted up against the formation on the South side of the Range and outcropping in large areas. The hole was bottomed in this Archean schist at a depth of 1765'.

Hole No. 53 was drilling in clastic iron formation at a depth of 1475' on the first of 1937. Except for two narrow seams of soft ore jasper, drilling continued in this clastic formation until it, too, encountered the Archean faulted contact on the South side of the Marquette Range at a depth of 1617'. The hole was bottomed in it at a depth of 1638'.

Hole No. 54 started in January, 1937. It was drilled from practically the same location as No. 53 but with a dip of -70° due South toward hole No. 51, on the same meridian. This hole was drilled, principally, to determine the nature and attitude of the dike which was cut in Hole 53 between depths of 379' and 628'. From its appearance, it seemed to me that it must be a relatively thin, vertical or steeply

dipping dike. On the other hand, most of the dikes in this area have a relatively flat dip to the North and are interbedded with the iron formation instead of cutting across it. The future exploration of this area will be guided materially by the locations and attitudes of the various dikes which are known to exist. Hole 54 ledged in typical Tilden siliceous ore right at the start and continued in it for a depth of 200'. This was followed by magnetite sideritic chert, gruneritic chert, cherty magnetite and other various phases of the unoxidized or partly oxidized formation of the Range. From 511' to 566', typical soft ore jasper was cut with some enrichment of lean ore between 527' and 545'. This gave way to hard ore jasper at 566' and the hole was bottomed in it at a depth of 607'. At the latter point, we had drilled deep enough, without encountering any dike, to be satisfied that the dike in Hole 53 is a vertical or steeply dipping, relatively thin dike. This is quite important, structurally, as it very likely coincides with a plane or zone of faulting that may have an important bearing on the existence of a basin favorable for the concentration of a high grade ore body in depth.

With the completion of Hole No. 52 we moved that drill to Section 2, 47-27 the latter part of February. With the completion of hole No. 54, we decided to stop all exploring, temporarily, at the Tilden to concentrate our drilling expenditures in the Section 2 area. This drill was moved the latter part of March.

H. UNDERGROUND EXPLORATIONS

H-1. - CLIFFS-SHAFT MINE

One drill operated continuously in the Cliffs-Shaft Mine throughout the year. During this time, 14 holes were completed and the 15th started for a total of 2838'. These holes were numbered from 442 to 456, inclusive. Nine holes were drilled from the 14th Level, "B" Shaft, five from the 10th Level, "A" Shaft, and one from the 6th Level, "A" Shaft. All but one hole were drilled on Company fee property,--this one on the Bancroft Lease.

Hole No. 442 was drilled horizontally and due North from near the East end of the 6th Level, "A" Shaft, in order to explore the territory Southwest of the No. 3 Mine or the Westerly extension of the ore bodies in this property and for the downward extension of the ore being mined in stopes above the 6th Level in contracts 8 and 28. The hole was drilling in soft ore jasper at a depth of 136' on the first of the year. This gave way to footwall dike, however, at 154'. With the exception of $6\frac{1}{2}$' of ore, from 315' to $321\frac{1}{2}$', probably the bottom of ore extending above, the hole was in footwall dike until it was finally bottomed at a depth of 429'. The ore averaged 65.24% Iron and .161% Phos.

A series of three holes, Nos. 443, 444 and 445, next were drilled from the bottom of an old stope on the 10th Level, a few hundred feet East of "A" Shaft. This work was planned to explore for a Westerly continuation, up the pitch, of ore encountered to the East on the 11th Level. First, Hole No. 443 was drilled vertically and

cut good ore from 11' to 41' averaging 62.17% Iron and .095% Phosphorus. The drill encountered footwall greenstone at 49' and the hole bottomed in it at 100'. Hole No. 444 was drilled due North from practically the same location with a dip of -30°. It encountered good ore from 20' to 53', averaging 59.16% Iron and .097% Phosphorus. The hole was bottomed in footwall siderite at 137'. Hole No. 445, also at the same general location, was drilled with a dip of -30° due South. It cut good ore from 5' to 20', dike from 20' to 21', and good ore again from 21' to 32'. The first run of ore averaged 62.43% Iron and .106% Phosphorus; and the second run averaged 59.71% Iron and .104% Phosphorus. The hole was bottomed in footwall greenstone at a depth of 98'.

Holes Nos. 446 to 454, inclusive, were drilled from the 14th Level, "B" Shaft. The first three of these holes, Nos. 446, 447 and 448, were drilled horizontally to the Southeast and South from the stopes on the South side of the level to definitely locate the footwall greenstone and explore for possible ore lenses in the iron formation lying between these stopes and the greenstone. No commercial ore bodies were developed by these holes. Hole No. 449 was drilled horizontally to the North from the North side of this same ore lens to cross-cut the iron formation lying between this ore and the main East-West drift on this level. We hoped to find that the ore to the East of this hole on the level above extended to the 14th Level elevation on the pitch. The results were negative since this hole was in unenriched hard ore jasper its entire length of 184'.

Holes Nos. 450 and 451 were drilled horizontally and to the North from the North side of the 14th Level. Hole No. 450, located on the 1300 West meridian, encountered 6' of good ore from 129' to 135' averaging 57.96% Iron and .302% Phosphorus with two additional seams of lean ore, all of which appeared to be located in a zone of fracture with footwall dike on either side. This fracture, in its lateral extent from foot to hanging, may develop ore in mineable quantity at a lower elevation. The balance of the hole was in footwall greenstone. Hole No. 451, located on the 1600 West meridian, encountered a nice run of ore from the collar of the hole to a depth of 42', with the exception of a 5' dike from 6' to 11'. The first 6' of ore averaged 62.72% Iron and .028% Phosphorus. From 11' to 42', the ore averaged 57.98% Iron and .091% Phosphorus. This ore is located immediately under the hanging wall slate and quartzite which was encountered by the drill hole at 46½', a seam of jasper lying between the ore and the hanging. A fault was crossed at a depth of 122' with footwall dike on the North side in which the hole was bottomed at 148'. This footwall was brought into direct contact with the hanging by a lateral displacement along this fault.

Holes Nos. 452 and 453 were drilled horizontally to the Southwest from the Northwest end of the 14th Level to explore the iron formation near and in contact with the hanging wall quartzite. Narrow seams of lean ore were cut in Hole 452 but it passed into footwall at a depth of 131' and was bottomed in it at 312'. Footwall was not expected in this hole and its occurrence demonstrates either a fold or a fracture which, up to this time, had not been developed. The knowledge of its existence is important in the future exploration of this area. Hole No. 453, drilled

more nearly West, kept closer to the hanging contact and did not encounter the folded or faulted footwall until it reached a depth of 321'. A lens of good ore was cut from 261' to 273' which averaged 61.69% Iron and .026% Phosphorus. This is very encouraging since it may lead to the development of important ore bodies along the hanging wall ore zone to the West of any previously known ore in this section of the mine. A drift will be driven along this hanging wall zone on the 15th Level to continue this exploration and from which additional drilling may be done more advantageously.

The remaining hole, No. 454, to be drilled from the 14th Level, "B" Shaft, was located at the Northwest end of the level and was drilled North 7° West with a dip of -23° in order to explore for the downward continuation, on a Westerly pitch, of an ore body cutting this level to the East and also encountered in drilling Hole No. 451. The results were very encouraging demonstrating that this ore does have an important Westerly continuation. The ore runs were as follows:

From	To	Amount	Iron	Phos.
0'	5'	5'	62.55	.125
9'	28'	19'	60.50	.079
33'	57'	24'	59.27	.060
79'	85'	6'	64.69	.154
89'	90'	1'	59.30	.051

Hole No. 455 was drilled horizontally and due South close to the 2000 East meridian from No. 4 drift on the North side of the 10th Level, "A" Shaft. This is on Company property about 300' South of the Bancroft Lease. The object of this hole was to cross-cut the area, hitherto unexplored, between this drift and the main drift from the shaft for a possible Westward extension of an ore lens about 100' to the East. The results were negative and the hole was in footwall dike and siderite its entire distance of 179'.

The only hole to be drilled on the Bancroft Lease during the year 1937 was No. 456. It was drilled horizontally and due North from near the West end of the main East-West Bancroft drift on the 10th Level, "A" Shaft, and along the 1400 E. meridian. The object of this hole was twofold. In the first place, we wanted to explore under the hanging wall slate for possible ore North of an East-West fault along which the block to the North had been dropped. Secondly, we wanted to locate the North limit of the Cliffs-Shaft ore horizon which is terminated by another East-West fault to the North of the first and North of which the lower rocks, underlying the iron formation, are thrust up so that what is normally the footwall greenstone of the Cliffs-Shaft area is exposed in a large outcrop on surface just North of Lake Bancroft. The hole was drilling in dike at a depth of 225' as the year ended but early in January cut a nice run of ore under the hanging wall in the block North of the first fault from 312' to 345'. This ore averaged 63.26% Iron and .080% Phosphorus. These results are very encouraging for the Bancroft Lease and further exploring in the area will be undertaken during the year 1938.

I. EXPLORATIONS AND NEW DEVELOPMENT BY OTHER COMPANIES

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

I-1. - MARQUETTE RANGE

The Inland Steel Company, at its Greenwood property, continued to mine a small tonnage of hard ore in stringers extending between the 1st and 3rd Levels. The 3rd Level was a new development during the year and was very discouraging. It appears to be in a barren zone, catching only the bottoms of the ore lenses which have been the principal producers on the 2nd Level (-1100'), and above. The total production for 1937 was approximately 49,000 tons. The shipments for 1937 were 37,280 tons, of which 25,313 tons was lump ore and 11,967 tons fines. Diamond drilling has been carried on underground intermittently during the year with mediocre results; however, shaft sinking for a new level 200' below the 3rd or at an elevation of -1500' will be started soon in hopes that new ore bodies may be found at this depth.

The North Range Mining Company, R. S. Archibald and associates, have leased the old Mary Charlotte Mine. It has been unwatered and is being reconditioned for mining in the pillars left by the former operators.

It was expected that the M. A. Hanna Company would start diamond drilling during the past year on options they have acquired along the hard ore horizon at the old Saginaw Mine and vicinity. For some reason this work has been postponed, at least temporarily.

All underground exploring activity at the Ropes Gold Mine was discontinued by the Calumet & Hecla Company during the year but pumping was continued to keep the workings drained. Some diamond drilling was done on the Goodney forty immediately to the West. One diamond drill hole was put down on this Company's property in Section 30, 48-27 and enough trenching in other parts of the Company's property by the Calumet & Hecla people to satisfy the conditions of the lease. In addition to this, the work of sampling the tailings from the old Ropes Mine, which occupy Company property to the East of the Ropes, was completed.

The early part of the year saw a considerable activity, both underground and in the completion of a small mill, at the old Michigan Gold Mine, located in the N½ of Section 35, 48-28. Financial troubles and a resulting reorganization of the company limited the activities during the latter part of the year and I do not know just what is going on at the present time. The Norgan Exploration Company, a subsidiary of the Hollinger Company of Ontario, which was so active in geological survey work, and also diamond drilling, during the summer and fall of 1936 on a large acreage of land optioned from the Ford Motor Company in the Yellow Dog River basin, did not resume its activities in 1937. I have not heard whether or not the option has been given up.

I-2. - GOGEBIC RANGE

I understand that the bottom level at the Newport Mine, which is served by the new shaft, sunk at great expense during 1936, has been a great disappointment. Much of the iron formation was found to be unoxidized, or only partially so, and the ore bodies anticipated on the lower dikes at this elevation have either not materialized or are disappointing. Developments at depth in the Sunday Lake Mine, located at the East end of the Range, on the other hand, have been very encouraging.

I-3. - MENOMINEE RANGE

The North Range Mining Company, Mr. Archibald and associates, continued to scram ore from the old Forbes Mine throughout the year and it is possible that the mine will not be exhausted before the middle of the present year. A total of 297,885 tons were shipped from this property during 1937 but approximately one half of this total came from a stockpile owned by the Jones & Laughlin Ore Company, former operators of this property.

There was no activity at the Millie Mine siliceous ore open pit at Iron Mountain. This property was reopened in 1936 by Mr. Archibald and a small tonnage of siliceous ore supplied to the Ford Motor Company. The Globe Iron Company, who opened a low phosphorus siliceous ore pit on the old Cornell property in 1936 and shipped 5,435 tons that season, extended their pit in 1937 and shipped a total of 54,403 tons. The Jackson Iron and Steel Company shipped 65,643 tons of low phosphorus siliceous ore from its West Chapin property and, this past fall, did additional stripping. Both mining and stripping were done under contract by Mr. Bradley. Mr. John T. Spencer, of Iron Mountain, acquired a lease on the old Davidson Mine at Florence, Wisconsin, operated years ago by the Florence Iron Co. There are two stockpiles of high grade siliceous ore at this property and Mr. Spencer shipped out a part of one of these piles during 1937. He is preparing to unwater the old pit and do some exploring underground the coming season.

I-4. - MESABA RANGE

It was expected that the North Range Mining Company would start stripping operations on its wash ore leases on the West side of Pokegema Lake, Southwest of Grand Rapids, during the past season. I believe that a small amount of experimental work was done on the structure drill hole samples but there was no activity at the property during the year 1937. It is now planned to start this stripping during the season of 1938. There are some 4,000,000 cubic yards of stripping involved, and a washing and jigging plant will have to be erected before ore can be produced.

The experimental concentrating unit located at the Harrison Mine of the Butler Brothers near Nashwauk, continued in operation throughout the operating season. This plant treats jig tailings and concentrates magnetically after roasting the feed. A new drying unit was added to reduce the moisture in the feed before roasting. Experimental work on the new Wade-Gleason pneumatic-water pulsating jig was completed and a

commercial size machine was built and installed by Pickands-Mather in their Danube washing plant. The installation was not completed until near the end of the shipping season so that not much tonnage was actually handled by it. There are one or two minor mechanical deficiencies to be corrected after which it is anticipated that excellent results will be accomplished. We are watching this development closely as we will be faced with the jigging of some of our own lean ores within the next year or two. The tests which we are making at the Mines Experiment Station, University of Minnesota at Minneapolis, on jig material from the bottom of the Trumbull Pit are being made with the laboratory model of this jig which is of commercial length but only one-third of commercial width. The results, however, should be the same as on a full commercial size machine.

J. EXAMINATION OF MINERAL LAND OFFERS

A total of 29 land offers were received by this office during the year 1937. Eighteen of these offers were mineral land offers. Of the remaining 11 offers, nine of them were of surface property in the city of Negaunee; one the surface of a property just West of Ishpeming and one a surface property in Gwinn. The offers and their numbers are as follows:

Offer No.	Description	Remarks
1967	Brown iron ore Southwest of Indianapolis, Indiana.	Declined.
1968	Old Haggerton residence on Ann Street, East of Sterling Addition in Negaunee.	Purchased for $4,000.00.
1969	House and Lot 1, Block 1, Mary Gaffney's Addition, Negaunee.	Declined.
1970	Iron ore lands in Newfoundland.	Declined
1971	Lot 3, Block 18, Pioneer Iron Company Plat, Negaunee.	"
1972	Lots 7 & 8, Block 11, Plat of Gwinn.	Declined
1973	Lots 2 & 5, Block 33, and Lot 5, Block 10, Pioneer Iron Co. Plat and Lot 23, Block 3, Pioneer Iron Company Second Addition, Negaunee.	Pending.
1974	Lands outside of Iron River, Michigan.	Declined
1975	Lot 5 except 2' and East half of Lot 4, Block 7, Pioneer Iron Co. Plat, Negaunee.	"
1976	Chromite Deposit of Independence Consolidated Mines Company, Sweet Grass County, Montana.	Declined
1977	Lot 11, Block 32, Pioneer Iron Company Plat, Negaunee.	Purchased for $3300.00.
1978	Lands in Section 20, 40-30 near Iron Mountain, Mich.	Option Pending.
1979	Lands in Sections 13 and 24, 43-35 near Iron River, Michigan.	Pending.
1980	Lean iron ore in Quebec, Canada.	Declined.
1981	House and Lot 1, MacKenzie Addition, Negaunee.	Recommended.
1982	Property at corner of Kanter and Clark Streets, Pioneer Iron Co. Plat, Negaunee.	Declined.

Offer No.	Description	Remarks
1983	Lot 9, Block 24, Pioneer Iron Company Plat, Negaunee.	Declined
1984	Pettit, Schley & Hobart Mines on Mesaba Range, Minnesota.	Pending
1985	Iron ore 100 miles North of Cheyenne, Wyoming.	Declined.
1986	Iron ore 25 miles Southwest of Logan, Utah.	Pending.
1987	Surface of property in Section 8, 47-27, West of Ishpeming.	Declined.
1988	Molybdenite property in Ontario, Canada.	"
1989	Mineral rights on various descriptions in Ontonagon and Gogebic Counties.	"
1990	NE¼ of Section 36, 43-35, Iron River District.	"
1991	Mineral rights in Section 12, 59-18, St. Louis County, Minnesota.	"
1992	120 acres of high alumina lands in St. Louis County, Minnesota.	"
1993	1,120 acres of Washington Iron Company lands, including old Barron Mine at Humboldt, Michigan.	"
1994	NE¼ of Section 30, 47-25, Marquette County, Michigan.	"
1995	Minowan Iron Mining Company, property on Cascade Range, Palmer, Michigan.	Pending.

K. EXPENSE STATEMENTS

Tables VII and VIII, which follow, show a detailed statement of charges to Geological expense for the year 1937 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 1937.

Salaries	$ 12,867.25
Travel & Entertainment	1,120.35
Operating Automobiles	546.40
Supplies & Office Expense	1,101.89
Personal Injury	249.08
Accrual of Unemployment Tax	249.08
Old Age Benefit Tax	124.53
Unclassified	29.42
TOTAL	$ 16,288.00

TABLE VIII

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

	1937	1936	1935
Salaries	$ 12,867.25	$ 8,383.15	$ 4,774.00
Travel & Entertainment	1,120.35	1,453.10	1,101.79
Operating Automobiles	546.40	463.95	491.07
Supplies & Office Expense	1,101.89	726.14	512.36
Personal Injury	249.08	168.27	95.48
Accrual of Unempl. Tax	249.08	80.86	-
Old Age Benefit Tax	124.53	-	-
Unclassified	29.42	37.29	12.85
Total	$ 16,288.00	$11,312.76	$ 6,987.55

L. RESEARCH DEPARTMENT

Mr. George H. Beasley spent a part of his time from April 1st to the end of the year in the experimental laboratory in the office of the Great Northern Iron Ore Properties at Hibbing, Minnesota, making glass classifier tests on the samples of jig material from our structure drilling program at the Trumbull Pit. From these results, curves were plotted to assist in classifying the possible jig ore in this drilling. Mr. Beasley, working under the supervision of the Geological Department, has charge of the hand washed tests on all of our structure drill hole samples on the Mesaba Range and the recording of the results of this drilling. He also supervised the preparation and shipment of three carload samples from the jig ore material in the bottom of the Trumbull Pit. These samples were shipped to the Mines Experiment Station at Minneapolis for jig tests during the current winter.

Respectfully submitted,

E. L. Derby, Jr.

Geologist

ELD:DWC
2-26-38

ANNUAL REPORT OF THE MINING ENGINEERING DEPARTMENT FOR THE YEAR ENDING DECEMBER 31, 1937.

The usual books of photographic maps, showing the areas mined on the various sub-levels, etc. in the different mines during 1937, accompany this report. These books are loose leaf, with paper covers, and contain views, maps or sections of the mines that were operated during the year. The maps show in color the portions mined or development work, and the sections show in color the unmined parts. Books have been prepared for the different companies interested in the various properties, the following list shows the companies for which books have been prepared, and the mines included therein:

Company	Mines
The Cleveland-Cliffs Iron Company	Athens, Canisteo, Cliffs-Shaft, Gardner-Mackinaw, Hill-Trumbull, Lloyd, Maas, Negaunee, Spies-Virgil and Tilden.
Bethlehem Mines Corporation	Negaunee
Hanna Ore Mining Company	Canisteo and Hill-Trumbull
Inland Steel Company	Canisteo and Hill-Trumbull
Jones & Laughlin Steel Corporation	Canisteo and Hill-Trumbull
Otis Steel Corporation	Canisteo and Hill-Trumbull
Pickands, Mather & Company	Athens
Pittsburgh Steel Corporation	Canisteo and Hill-Trumbull
Republic Steel Corporation	Canisteo, Hill-Trumbull and Lloyd
Wheeling Steel Corporation	Canisteo and Hill-Trumbull

Two copies of the Cleveland-Cliffs Iron Company book were made, one for the Cleveland office and one for the Engineering office at Ishpeming. One copy was made of each of the other books.

Similar books were made for the following:

Person	Mines
Arthur Iron Mining Company, Fee owner	Hill-Trumbull
E. C. Congdon, Fee owner	Canisteo
M. H. Barber, District Superintendent	Canisteo and Hill-Trumbull
H. C. Bolthouse, Superintendent	Canisteo and Hill-Trumbull
W. W. Graff, Superintendent	Athens and Negaunee
H. O. Moulton, Superintendent	Maas
C. W. Allen, Superintendent	Lloyd and Spies-Virgil

B. MAP REPORTS

Two sets of blue prints of the mine maps, scale 1" equals 50', were made at the end of each month, one for the General Superintendent and the other for the mine superintendent. These maps showed in red the areas mined during that month. It was not feasible to make similar monthly report maps of the Cliffs-Shaft Mine, as it is impossible to survey

the mine completely oftener than every three months, besides, the advances per month, except for development drifts, would hardly warrant more frequent surveys. Several sets of maps of this mine were prepared for the General Superintendent during the year, and the development work posted frequently.

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

ATHENS MINE

Two sets of monthly report blue prints of the Athens Mine were sent to the Cleveland office for the Pickands, Mather & Company, colored to show the areas mined during the month.

GARDNER-MACKINAW MINE

A set of blue prints of the Mackinaw Mine were sent at the end of each quarter, to Mr. G. P. McCallum, Ann Arbor, Michigan, showing the areas mined and the work done during the previous three months.

MAAS MINE

Blue prints of those portions of the Maas Mine workings in the Roman Catholic Cemetery were sent monthly to Mr. R. S. Archibald, Negaunee, Michigan, showing in red the areas mined.

NEGAUNEE MINE

Fourteen sets of the Annual Report Maps of the Ninth, Eleventh, Twelfth, and Thirteenth Levels of the Negaunee Mine were sent, at the end of the year, to the Cleveland office for the fee owners.

A set of blue prints, scale 1" equals 50', of the cross-sections of the Negaunee Mine, were sent at the end of the year to Mr. W. L. Cummings, Bethlehem Mines Corporation, Bethlehem, Pa.

MICHIGAN STATE TAX COMMISSION

New ore reserve estimates of the Athens, Cliffs-Shaft, Gardner-Mackinaw, Lloyd, Maas, Negaunee and Spies-Virgil Mines were made as of December 31, 1937 and annual report maps prepared showing the areas mined, new development drifts, geology, etc. of these mines, for the Michigan State Tax Commission.

C. REMARKS ON MISCELLANEOUS DOCUMENTS AND ABSTRACTS

All documents affecting the Company's lands and holdings, pass through the Engineering Department for record and approval, irrespective of the Department from which they originate. These documents have been handled by Mr. Brewer and placed by him on the Mining Department records. After the descriptions are approved, they are initialed by him. Copies of those documents which affect the mineral lands are kept on file in the Department.

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

CLASSIFICATION	Number Received	Last File Number
Mining Leases	2	70
Miscellaneous Documents	13	1330
Easements	3	397
Rights of Way	0	219
Water Rights	0	58
Surface Leases	750	5053
Applications for Sale	5	167
Sales	126	1162
Tax Histories	0	702
Legal Opinions	0	195

The following comments cover the various documents, etc. that were placed on the Department records during 1937:

MINING LEASES

The two mining leases added during the year include the so-called Jackson-Cambria Mine lease and the Lloyd Mine lease. The former lease was to the Republic Steel Corporation and covers the North 660' of the N½ of the NW¼ of Section 1, 47-27 and the North 660' of the NE¼ of the NE¼ of Section 2, 47-27. This lease was dated April 15, 1936. The Lloyd Mine lease was also to the Republic Steel Corporation and covered the SW¼ of the NW¼ and the N½ of the S½ of Section 6, 47-27 and was also dated April 15, 1936.

MISCELLANEOUS DOCUMENTS

This classification covers all documents of every nature involving transfer of rights affecting mineral lands. Nine of these documents covered purchases of land in the City of Negaunee, one was a transfer of tax title rights by the Cliffs Power & Light Company and three were for various rights of way.

EASEMENTS

These documents cover transmission line rights of way acquired by the Cliffs Power & Light Company. One was a permit for a rural line, one was for a railroad crossing and the third was for a meter station.

RIGHTS OF WAY

This file covers all railroad rights of way across mineral lands. None were received during the year.

WATER RIGHTS

These are permits granting rights for mine water discharges, etc. across lands adjacent to the various mines.

SURFACE LEASES

The surface leases cover all sorts of permits for the use of Company lands for residence, gardens, farms, camping, etc., and all originate in the Land Department.

APPLICATIONS FOR SALE

These also originate in the Land Department and are the preliminary report covering the area to be sold and are for the most part, issued for farm lands off the mineral formation.

SALES

This classification covers sales of all kinds. There were 26 documents for the sale of Company houses in various locations; 12 rights of way for highways, telephone lines, etc.; and the balance covered the sale of lands in various counties by the Company.

TAX HISTORIES

There were no Tax Histories received during the year. These are usually secured when lands are being purchased to make sure that all taxes have been paid.

LEGAL OPINIONS

This file is for ready reference of legal opinions as to the title of lands. None were received during the year.

ABSTRACTS

Very little work was done during the year on the abstracts of the mineral lands for the Cliffs Power & Light Company. Only such documents were added as passed through the office. All of our records are sadly in arrears and will require a tremendous amount of work to bring them up to date.

TAXES

The 1937 tax lists of the lands under the Mining Department and the Cliffs Power & Light Company were prepared as usual during October. The tax receipts were checked with the tax lists before the taxes were paid.

There was no sale of lands for delinquent taxes held during the year as the Legislature, which was in session in the spring, did not pass any bill in time for sales to be held in 1937.

D. THE FORCE

There were three additions to the Engineering Department during the year. William A. Richards entered the Department on March 2nd as Engineer. On September 3rd, Roland J. Devine entered the Department as a helper and Mr. Fayette Brown, Jr. came into the Department on October 13th also as a helper. Mr. R. J. Chenneour has been ill all year and has done no work for the Company.

The following table shows the personnel of the Department during the year, their position and period employed in 1937:

Name	Position	Entered	Left	1937 Employment
C. Brewer	Chief Mng. Engr.			12 months
J. Trosvig	Engineer			12 "
F. J. Haller	"			12 "
O. Marjama	"			12 "
W. R. Atkins	"			12 "
W. A. Richards	"	Mar. 2nd		10 "
A. Minnear	Draftsman			12 "
A. Koski	Helper			12 "
R. J. Devine	"	Sept. 3rd		4 "
F. Brown, Jr.	"	Oct. 13th		2½ "
D. W. Carlson	Stenographer			12 "

The next table shows the length of service of the men now employed in the Engineering Department:

Name	Date Entered	Years of Service	
C. Brewer	August, 1906	19 years, 3 months.	
J. Trosvig	June, 1911	20 " 10 "	(1)
F. J. Haller	June, 1930	3 " 7 "	(2)
O. Marjama	September, 1936	1 " 3½ "	
W. R. Atkins	November, 1936	1 " 1½ "	
W. A. Richards	March, 1937	10 "	
A. Minnear	June, 1917	16 " 2 "	(3)
A. Koski	January, 1936	2 "	
R. J. Devine	September, 1937	4 "	
F. Brown, Jr.	October, 1937	2½ "	
D. W. Carlson	August, 1936	1 " 4½ "	

(1) Not employed by Company from October 15, 1914 to December 1, 1915, also from June 1, 1932 to November 9, 1936.
(2) Not employed by Company from February 1, 1932 to January 6, 1936.
(3) Not employed by Company from February 1, 1932 to March 1, 1935.

The above "Years 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 working days, days worked, the days overtime, sick and absent for the year:

Name	Working Days.	Days Worked	Days Overtime	Days Sick	Days Absent.
C. Brewer	276½	257½	4	4½	18½
J. Trosvig	276½	265	4½	3½	12½
F. J. Haller	276½	273	6½	1½	8½
O. Marjama	276½	276	6	1	5½
W. R. Atkins	276½	272½	4½	1½	7
W. A. Richards	232½	234	5	-	3½
A. Minnear	276½	263	½	6	8
A. Koski	276½	279	9	1	5½
R. J. Devine	90	90	-	-	-
F. Brown, Jr.	60	60	-	-	-
D. W. Carlson	276½	268½	-	-	8

The next table shows the distribution of the days spent underground, in the field and in the office during 1937. This table includes overtime:

Name	Underground	Field	Office	Total
C. Brewer	7½	42	208	257½
J. Trosvig	55	27	183	265
F. J. Haller	60½	59½	153	273
O. Marjama	111½	10½	154	276
W. R. Atkins	96½	24	152	272½
W. A. Richards	80½	52½	101	234
A. Minnear	47½	23½	192	263
A. Koski	109½	60½	109	279
R. J. Devine	19½	30½	40	90
F. Brown, Jr.	16	10	34	60
D. W. Carlson	15	10½	243	268½
TOTAL	619	350½	1569	2538½
%	24.4	13.8	61.8	100.0

The following is a brief summary of the work done by each person in the Department during the year:

CARL BREWER, Chief Mining Engineer, had charge of the Department and exercised general supervision over all the work. He entered on the records, all documents that were received by the Mining Department and made such reports on them as were necessary. He compiled the annual report books, estimates of ore reserves, maps for the Michigan State Tax Commission, stockpile estimates, etc. During the early part of the year he prepared a map for the Cleveland office of the City of Negaunee, showing various surface ownerships and containing other

information which they desired. He is also preparing a new report for the Cleveland office covering the data relating to the purchase of surface rights on lands in which the Arctic Iron Company has mineral interests. A similar report was made as of May 22, 1931. He is also preparing maps showing the ownership of surface and mineral rights in the City of Negaunee. These are also for the Cleveland office. He has been unable to do much on these reports on account of the large amount of other work. He spent considerable time supervising the engineer in charge of the house moving in Negaunee during the year. In this connection he has compiled a history relating to the purchase, moving, etc., of all the houses now owned by the Athens, Maas and Negaunee Mines. This work was done for answers to the many questions which have been asked the Engineering Department regarding these properties. He assisted in some surface and underground surveys, shaft gauging, etc.

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

Property	Underground	Field	Office	Total	%
General Engineering		7	195	202	78.4
Negaunee Mine	1½	4	3½	9	3.5
Lloyd Mine	1½	5	1½	8	3.1
Athens Mine	3	1½	1	5½	2.1
C. P. & L. Co.		4	1½	5½	2.1
E. & A. #727		11	5½	16½	6.5
Maas Mine		1½		1½	.6
Stephenson Mine		½		½	.2
Spies-Virgil Mine	1	3½		4½	1.7
Francis Mine		1		1	.4
Mackinaw Mine	½	2		2½	1.0
Jackson Lease		1		1	.4
TOTAL	7½	42	208	257½	
%	2.9	16.4	80.7		100.0

JOHN TROSVIG, Engineer, has taken care of the engineering work at the Cliffs-Shaft Mine during the entire year. During April, he spent ten days in Cleveland making estimates of the ore in stock at the plant of the Otis Steel Company. During May, he took over the engineering work on the Jackson-Cambria Mine lease. This work has involved underground inspections of the mining areas on our company's land and regular monthly map reports similar to the other mines. He has also written the monthly reports of the work done at this property. He made a survey for the C. P. & L. Co. transmission line in Section 6, 46-26.

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

Property	Underground	Field	Office	Total	%
Cliffs-Shaft Mine	45½	8	162½	216	81.5
Jackson-Cambria Lease	8	1	15½	24½	9.2
C. P. & L. Co.		4	2	6	2.3
Athens Mine	½			½	.2
Lloyd Mine	1		1½	2½	.9
Maas Mine			1	1	.4
General Engineering		1		1	.4
Otis Steel Company		13		13	4.9
Spies-Virgil Mine			½	½	.2
TOTAL	55	27	183	265	
%	20.7	10.2	69.1		100.0

F. JOSEPH HALLER, Engineer, has taken care of the engineering work at the Maas Mine throughout the year. From January to May he also made the inspections and prepared the reports on the Jackson-Cambria Mine lease. Throughout the year he has had charge of the engineering work and supervision of operations at the Tilden Mine. The operations at the latter property have required so much of his time that towards the end of the year he has been assisted by Mr. Richards with the engineering work at the Maas Mine.

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

Property	Underground	Field	Office	Total	%
Maas Mine	52½	6½	79	138	50.5
Tilden Mine		51	53½	104½	38.3
Jackson-Cambria Lease	5½	½	13½	19½	7.1
Spies-Virgil Mine	2	1	6	9	3.3
Cliffs-Shaft Mine	½			½	.2
Athens Mine		½	1	1½	.6
TOTAL	60½	59½	153	273	
%	22.2	21.7	56.1		100.0

ONNI MARJAMA, Engineer, has spent his entire time during the year on the engineering work at the Negaunee and Athens Mines. This work has kept him exceedingly busy and he has had no time to do any other engineering work.

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

Property	Underground	Field	Office	Total	%
Athens Mine	56½	3	81	140½	50.8
Negaunee Mine	54	6½	73	133½	48.4
E. & A. #727		1		1	.4
Lloyd Mine	1			1	.4
TOTAL	111½	10½	154	276	
%	40.4	3.8	55.8		100.0

WILLIAM R. ATKINS, Engineer, has taken care of the engineering work at the Gardner-Mackinaw Mine throughout the year. He was also doing this work at the Lloyd Mine until the end of May when Mr. Richards took over the engineering work at that property. When underground operations were resumed at the Spies-Virgil Mine during the spring, Mr. Atkins took over the engineering work at this property and continued it throughout the balance of the year.

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

Property	Underground	Field	Office	Total	%
Gardner-Mackinaw Mine	48½	1½	82½	132½	48.5
Spies-Virgil Mine	16	3	22½	41½	15.2
Lloyd Mine	28½	½	43½	72½	26.5
Stephenson Mine		1½		1½	.6
Francis Mine		1	½	1½	.6
Princeton Mine		2	1	3	1.1
Athens Mine	1½			1½	.6
Negaunee Mine	1			1	.4
Maas Mine	1			1	.4
E. & A. #761		14½	2	16½	6.1
TOTAL	96½	24	152	272½	100.0
%	35.4	8.8	55.8		100.0

WILLIAM A. RICHARDS, Engineer, entered the Department on March 2nd. During the first few months he accompanied the various engineers on their underground inspections to familiarize himself with the work and in May took over the engineering work at the Lloyd Mine. He assisted in much of the miscellaneous work of the Department and toward the end of the year has assisted Mr. Haller with the inspections and engineering work at the Maas Mine.

The following table shows the distribution of his time for the ten months he has been in the Department:

Property	Underground	Field	Office	Total	%
Lloyd Mine	52½	11	59	122½	52.5
Mackinaw Mine	9		1½	10½	4.5
Negaunee Mine		1	2½	3½	1.5
Maas Mine	8	6	14	28	12.0
Tilden Mine		6	2	8	3.4
Jackson-Cambria Lease	1½			1½	.6
Athens Mine	8½	1½	4	14	6.0
Spies-Virgil Mine	1	1½	3	5½	2.3
E. & A. #727		13½	8	21½	9.2
E. & A. #761		2½	4½	7	3.0
C. P. & L. Co.		6½		6½	2.7
General Engineering		1½	2½	4	1.7
Cliffs-Shaft Mine		1		1	.4
Geological Department		½		½	.2
TOTAL	80½	52½	101	234	
%	34.4	22.4	43.2		100.0

ARCHIBALD MINNEAR, Draftsman, has been in the Department the entire year, most of his time being occupied in making maps and other miscellaneous work. He has given lines underground at various mines and assisted in various surveys and in office calculations.

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

Property	Underground	Field	Office	Total	%
General Engineering			66	66	25.1
Cliffs-Shaft Mine	22	3½	9	34½	13.1
Athens Mine	8½	1½	7	17	6.5
Maas Mine	4	1½	40	45½	17.3
Lloyd Mine	1	½	8	9½	3.5
Negaunee Mine	6	2	37½	45½	17.3
E. & A. #731		½		½	.2
Jackson-Cambria Lease			2	2	.8
Mackinaw Mine	2		13½	15½	5.9
Tilden Mine		4	6	10	3.8
Stephenson Mine		1	½	1½	.6
Spies-Virgil Mine	4		2½	6½	2.4
E. & A. #727		5		5	1.9
Princeton Mine		1		1	.4
C. P. & L. Co.		1		1	.4
E. & A. #761		2		2	.8
TOTAL	47½	23½	192	263	
%	18.1	8.9	73.0		100.0

ALFRED KOSKI, helper, has assisted in most of the underground and surface surveys, has looked after the automobiles of the Department and has done most of the blue printing. He has also made tracings and assisted in other office activities.

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

Property	Underground	Field	Office	Total	%
General Engineering		4	102½	106½	38.2
Cliffs-Shaft Mine	44	2½	3	49½	17.7
Athens Mine	15	1	2	18	6.4
Negaunee Mine	6½	4		10½	3.8
Maas Mine	7	4	½	11½	4.1
Lloyd Mine	7	6	½	13½	4.8
Mackinaw Mine	17	2		19	6.8
Spies-Virgil Mine	3½	1½	½	5½	1.9
Tilden Mine		7		7	2.5
Jackson-Cambria Lease	9½	1		10½	3.8
E. & A. #731		½		½	.2
Otis Steel Company		13		13	4.7
E. & A. #727		4½		4½	1.6
C. P. & L. Co.		3		3	1.1
Princeton Mine		1		1	.4
E. & A. #761		4½		4½	1.6
Francis Mine		1		1	.4
TOTAL	109½	60½	109	279	
%	39.2	21.7	39.1		100.0

ROLAND J. DEVINE, entered the Department on September 3rd as a helper. He has assisted in various underground and surface surveys, made tracings, blueprints, etc. in the office.

The following table shows the distribution of his time for the four months he has been in the Department:

Property	Underground	Field	Office	Total	%
General Engineering		1	27½	28½	31.8
Negaunee Mine	4½	7	2½	14	15.6
Lloyd Mine	4	4½	1	9½	10.6
Athens Mine	2½	1	½	4	4.4
Maas Mine	1	2	½	3½	3.9
Mackinaw Mine	3		3½	6½	7.2
Cliffs-Shaft Mine	1	7	1½	9½	10.6
Jackson-Cambria Lease	1½		½	2	2.2
Tilden Mine		5½	2	7½	8.3
C. P. & L. Co.		2		2	2.2
E. & A. #761		½		½	.5
Spies-Virgil Mine	2		½	2½	2.7
TOTAL	19½	30½	40	90	
%	21.7	33.9	44.4		100.0

FAYETTE BROWN, JR., entered the Department on October 13th as helper. He has assisted in various underground and surface surveys and in the office has helped in calculations, plotting and other miscellaneous work.

The following table shows the distribution of his time for the 2½ months he has been in the Department:

Property	Underground	Field	Office	Total	%
Lloyd Mine	1½	1½	1½	4½	7.5
Geological Department		½		½	.8
Mackinaw Mine	1	2	7½	10½	17.5
Francis Mine		1	2½	3½	5.8
Negaunee Mine	1½		5½	7	11.7
Athens Mine		½		½	.8
Spies-Virgil Mine	1	1	2	4	6.7
Cliffs-Shaft Mine	10		2	12	20.0
Tilden Mine		2	1	3	5.0
Maas Mine	1	1½	7	9½	15.8
General Engineering			5	5	8.4
TOTAL	16	10	34	60	
%	26.7	16.7	56.6		100.0

DONALD W. CARLSON, Stenographer, has been in the Department for the entire year. He has done work for both the Engineering and Geological Departments and has has 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			243	243	90.5
Cliffs-Shaft Mine	11	2		13	4.9
E. & A. #731		½		½	.2
Tilden Mine		3		3	1.2
Jackson-Cambria Lease		1		1	.3
General Engineering		1½		1½	.7
Negaunee Mine	1			1	.3
Lloyd Mine	1	½		1½	.7
Athens Mine	1			1	.3
Gardner-Mackinaw Mine	1			1	.3
Maas Mine		1		1	.3
Spies-Virgil Mine		1		1	.3
TOTAL	15	10½	243	268½	100.0
%	5.6	3.9	90.5		100.0

E. DISTRIBUTION OF TIME

There has been very little engineering work done in the Department outside of that connected with the various operating mines. These properties have all been working to capacity and there has been a great deal of development work done which has not only required considerable preliminary study but also careful following up, giving lines, etc. All the work in connection with the mines has been charged to that property and all other work such as miscellaneous reports, blue prints, etc., has been classified under General Engineering.

The following table shows the distribution of time of the entire Department spent underground, in the field or in the office for the various operating mines:

Property	Underground	Field	Office	Total	%
General Engineering		16	398½	414½	16.3
Cliffs-Shaft Mine	134	24	178	336	13.2
Athens Mine	97	10½	96½	204	8.0
Gardner-Mackinaw Mine	82	7½	108½	198	7.8
Lloyd Mine	99	29½	116½	245	9.7
Maas Mine	74½	24	142	240½	9.5
Negaunee Mine	76	24½	124½	225	8.9
Tilden Mine		78½	64½	143	5.6
Spies-Virgil Mine	30½	12½	37½	80½	3.2
Stephenson Mine		3	½	3½	.1
Francis Mine		4	3	7	.3
Princeton Mine		4	1	5	.2
C. P. & L. Co.		20½	3½	24	.9
Geological Department		1		1	.1
E. & A. #727		35	13½	48½	1.9
E. & A. #731		1½		1½	.1
E. & A. #761		24	6½	30½	1.2
Stenography			243	243	9.6
Otis Steel Company		26		26	1.0
Jackson-Cambria Lease	26	4½	31½	62	2.4
TOTAL	619	350½	1569	2538½	
%	24.4	13.8	61.8		100.0

F. COSTS

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

	1935	1936	1937
Salaries	$12,426.53	$13,675.58	$17,469.54
Auto Expense	253.20	253.60	575.69
Furniture and Fixtures		28.07	22.18
Heat, Light and Power	52.17	189.24	175.59
Insurance	108.34	142.25	171.53
Postage	29.60	18.00	18.33
Repairs	11.27	280.07	1,449.93
Stationery and Printing	8.80	75.72	115.59
Supplies	807.40	1,017.43	1,812.10
Taxes	41.35	44.49	44.67
Traveling and Entertaining		79.44	88.40
Personal Injury Expense	250.98	279.62	368.93
Telephone and Telegraph	73.59	102.33	103.80
Papers and Publications	6.20	7.00	2.25
Janitor and Cleaning			204.79
Accrual of Un-employment Ins. Tax		139.81	368.93
General - Unclassified	74.16	96.83	38.06
Old Age Benefit Tax			176.36
TOTAL	$14,143.59	$16,429.48	$23,206.67

H. AUTOMOBILES

The Ford Station Wagon has been operated throughout the year. Although this car is seven years old it is still giving good service but it is not suitable for long trips. The Ford Sedan which had been purchased in July, 1930 was turned in on a Chevrolet Coupe which was received June 1st, 1937. The Ford Sedan was in very bad running condition and the reopening of the Spies-Virgil Mine in Iron River made it imperative that a better car be secured for these trips.

The following table shows the mileage travelled by these cars in 1937, the total mileage and the date purchased:

Car	Miles		Date	
	1937	Total	Purchased	Turned in
Ford Sedan	2,050	41,210	July 9, 1930	July 1, 1937
Ford Station Wagon	3,856	29,066	Nov.10, 1930	
Chevrolet Coupe	6,249	6,249	July 1, 1937	

I. MINES

The following summary covers the work done in the Department in connection with the various mines, that has not been mentioned heretofore:

GENERAL

Weekly inspections of soft ore mines were made throughout the year by the engineer in charge of the property. These inspections were made in company with the Mining Captain or a shift boss and have proved very valuable in planning underground development work and recording the progress of underground mining operations. The regular monthly map reports of the operating mines were prepared and in many cases the Mine Superintendent was assisted by the engineer in writing the underground portion of the monthly and annual reports. During the year, studies were made for new development work and plans prepared.

ATHENS MINE

The principal work at this property for the year has been the development of the 7th Level. This was driven both from the shaft and from the ore body. Several surveys were run from the 8th Level for this work and the headings holed accurately early in September. Another important job done was the plumbing of the two skip roads in the circular part of the shaft to find out how much the skip runners were out of plumb. The vibration of the rope was causing much concern and on May 23rd two wires were hung in the South skip road from surface to the top of the square shaft. Accurate measurements were then taken from these wires to the steel dividers. When these measurements were plotted, the large variation in alignment showed the reason for the rope vibration. On the 6th of June, similar measurements were taken in the North skip road. The data secured by this work was used by the Mechanical Department in designing the new runners that were installed later in the year. A similar plumbing of the skip roads had been done in 1936. At that time some of the worst kinks were straightened out but the trouble had not been eliminated and the more extensive program was necessary. Plans were prepared for the development of the 9th Level and the actual work was started toward the end of the year.

On September 8th, the 11th annual inspection of experimental treated timber was made by Mr. F. S. Crawford of the U. S. Bureau of Mines and Mr. R. M. Wirka of the U. S. Forest Laboratory, Madison, Wisconsin. These timbers were placed in the mine in 1926. The summary of this report is as follows:

Preservative	Number of Timbers Placed.	Condition			Removed	
		Good	Partly Decayed	Badly Decayed	Decay	Crushed
Borax	15	-	3	4	5	3
Sodium Fluoride	27	-	-	2	19	6
Zinc Chloride	15	8	-	-	3	4
Untreated	12	-	-	-	12	-

The average life of the untreated timber was 3.8 years.

CLIFFS-SHAFT MINE

Numerous underground drill holes were located and surveyed during the year. More attention was paid this year to putting raises up on line and this required more survey work than in previous years. During the early part of the year a study was made of the possibilities of locating more ore in the old Incline and No. 3 shafts which lie East of the Cliffs-Shaft workings.

GARDNER-MACKINAW MINE

The extension of the ore body to the Northwest in the lower part of the mine has required a large amount of attention and survey work. A recalculation of the surface survey of Section 35, 45-25 on which the Gardner-Mackinaw Mine is located will be necessary in order to sub-divide the section and determine property lines of the new areas recently placed under lease in the SE¼ of this section. The survey that located the section corners is not the same one that was carried underground, hence the recalculation.

LLOYD MINE

The development of the new 6th Level was started early in the year and the plans for the pocket were prepared and the construction supervised. Concrete bulkheads with treated timber stop logs were constructed on the 7th (old 6th) Level and the 4th Level in the connecting drifts between the Morris and Lloyd shafts. These dams were designed and constructed under the supervision of this Department. On surface, a new survey was run around the caves of the Lloyd East ore body.

MAAS MINE

On March 14th, a new cave occurred, the center of which was about the Southeast corner of the Race Course property. There was considerable concern over the amount of water that this cave brought to the underground workings and some time was spent in trying to ascertain whether or not some of this water was caused by a leak in the city mains. It was finally decided that it was merely surface drainage. Plans were prepared and lines given as necessary for No. 3 Cross-Cut on the 4th Level and the South end of No. 7 Cross-Cut on the 5th Level. The development of the territory made available by this work was carefully studied and the proposed plans drawn up before the work was started. On surface, grades and lines were given for the foundation of the crushing plant to be built on the South side of the shaft house. Toward the end of the year surveys and plans were made for the proposed new rock pile trestle to the Northeast of the shaft.

NEGAUNEE MINE

Surveys were run and iron pins established on the East side of the Negaunee property in the vicinity of No. 1 and No. 2 shafts and the limit of cave was resurveyed in this vicinity. Lines and elevations were given in September for a new ditch in the swamp East of the Mine for the mine water discharge. The old ditch had become filled with silt and was backing up the water.

Underground, drifting was done on the 9th, 12th and 13th Levels and many raises were put up. All of this work required considerable attention for lines. On the 9th Level, each raise was carefully located and checked for lines as the development in this territory was for mining in the vicinity of the old square set rooms near No. 1 Shaft. The information in regard to the old workings in this territory is very limited and a great deal of studying was done as to what the possibilities for ore might be. A new set of East-West cross-sections are being made by the Geological Department in the hopes that these will aid in planning development work above the 9th Level in the East part of the mine.

SPIES-VIRGIL MINE

The principal work at this property was the planning and running of necessary surveys for the new ventilation drift on the 4th Level and the ventilation raise from the 6th to the 4th Levels. Plans were also made for the development of the ore below the 6th Level stopes.

TILDEN MINE

The drilling at both pits was supervised by the engineer and the charges for the various blasts were calculated. The loading of the holes for the blasts was done under the engineer's direction. This work required constant attention during the summer. After the shipping season, plans were prepared for the stripping and grading in connection with the opening up of the lower level of the West Pit. The engineer in charge made investigations as to the proper equipment to use for the operations on this lower bench next summer. He also designed and directed the construction of a bag house for the collection of dust removed from the crushing plant. This work was done in connection with the Mechanical Department.

J. MISCELLANEOUS

SHAFT RUNNERS

The shaft runners in the various mines were gauged during April and May and the results reported to the various superintendents.

VENTILATION

In February and August, the volume and direction of air currents in the various mines were checked and the ventilation maps in the Engineering office and various mine offices were posted up to date.

STOCKPILES

The engineer's estimates of ore in stock at the various mines in Michigan were made during September and October and were reported as of November 1st, 1937. The following table shows the adjusted engineer's estimate, book figures and overruns as of November 1st:

Date reported	1936 November 1st	1937 November 1st.	Difference
Adjusted Engineers estimate	1,071,167	684,929	-386,238
Book Figures	799,358	460,900	-338,458
Overrun	271,809	224,029	- 47,790

Mr. Trosvig made an estimate of the ore in stock at the Otis Steel Company's plant in Cleveland during April and reported direct to the Cleveland office.

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

During April, Mr. Richards spent some time completing the foundation plans for houses that were to be moved. It was expected that Mr. Richards would look after the engineering work at the Addition but there was too much work in the office to spare him. Mr. David Klinglund was employed for the remainder of the year to take care of all the engineering work necessary in the new location. During the summer, before the street pavements were put in, eight iron pins were located to preserve the lot lines, the original surveys and iron pins having been lost during the preliminary work in 1931 and recent years. Toward the end of the summer the entire addition was mapped.

STOREHOUSE AND STORAGE YARD

During the summer surveys were run and plans made for the track changes and new buildings at the Storage Yard. Lines and grades for foundations were given when construction was started for the various buildings.

CLIFFS POWER & LIGHT COMPANY

During July, levels were run and a study made East of the Athens Mine in connection with proposed diversion of Partridge Creek into the Carp River. This project was abandoned as it is not legal to divert streams into different water sheds.

OFFICE HOURS

The office hours during the year were as follows:

	A. M.	P. M.	Saturday
From January 1st to December 31st	8:30-12:00	1:15-5:00	8:30-12:15

HOLIDAYS

The following holidays were granted during the year:

January 1st	New Years Day
February 22nd	Washington's Birthday
March 26th	Good Friday
April 5th	Local Election Day
June 24th	Midsummer Day
July 5th	Independence Day
September 6th	Labor Day
November 11th	Armistice Day
November 25th	Thanksgiving Day
December 24th	Christmas Eve ($\frac{1}{2}$ day)
December 25th	Christmas Day
December 31st	$\frac{1}{2}$ day

Carl Brewer

Chief Mining Engineer

CB:DWC

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CLIFFS SHAFT MINE:

The hoisting equipment at this mine operated very satisfactorily during the year. On January 3rd. it was necessary to replace some broken bolts in the spider hubs on the "B" shaft drum, which was the only repair necessary on this equipment.

The new combination cage and skips are operating very good. The "A" shaft skip was put in operation in November 1934, and the "B" shaft skip in May 1936. The only repairs made on these skips has been replacement of wearing shoes, wearing plates, and dump spools. We built a spare box for these skips and it has not been necessary as yet to put it in service.

New axles and bearings were installed in the upper tram cars, which prevented considerable leakage and delay.

In April we started preparing a foundation for the Morris Mine Ingersoll-Rand air compressor. This installation was completed and put in operation in July. This addition gives us a total capacity of 8,400 cu. ft. per minute.

A steel reinforcing ring was installed on the #8 McCully crusher to repair a crack in the bowl.

A rebuilt set of pans and rollers were installed on the picking belt to replace a set that was worn out.

In general the operating of all mechanical equipment at this mine has been very satisfactory during the year.

Additional equipment in the laboratory necessitated an increase in capacity, with some additional wiring. New lighting equipment was also installed.

The shops and crusher building were re-wired, and sectionalizing protective equipment installed. This adds materially to the safety and reliability of the electrical equipment.

TILDEN MINE:

A 32,400 cu. ft. fan that was formerly used at the Princeton Central Plant was installed in the Crusher plant to collect the dust which is suspended in the air from the crushing operations. This fan has improved the dust condition considerably and the men can now work in most of the plant without respirators.

The oil furnaces for heating churn drill bits was changed a little so that there should be a considerable saving in the amount of oil consumed.

The shovels and crushers operated during the season without any serious delays, but there is considerable repairing necessary to put them in condition for next season's operations.

All the mechanical equipment operated satisfactorily during the year.

A substation was installed at the mine by the Cliffs Power & Light Co. and this has improved the service materially.

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ATHENS MINE:

A brake lever on the cage hoist broke on January 27th. A new arm was purchased and installed on January 31st.

The motor on the pump in the Breitung shaft burned out during an electrical storm in July. A new pump was ordered and installed in August, and the old motor was repaired and we now have a complete spare unit.

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

A new double deck aluminum cage built at the Hard Ore shops was put in operation September 1937. This cage enables them to handle sixty (60) men an each trip or two trucks of timber on each trip, and saves considerable time each day in transporting men and timber in and out of the mine.

MAAS MINE:

In January the skip hoist drum developed several cracks in the shell, repairs were made, but the drum continu ed to show signs of failure. Some of the rope grooves were worn almost through the shell. A new drum shell was ordered and installed in April, and the hoist is now in good condition.

A new double deck aluminum cage which was built at the Hard Ore shops was put in operation on May 30th. It is possible to handle sixty (60) men or two trucks of timber at each trip, saving considerable time in transporting the men and timber in and out of the mine.

A large cast steel pipe fitting on the discharge line in the third level pump house failed. This fitting was repaired at the Hard Ore shops.

The wood enclosure on the shaft house has been removed and replaced with steel sheeting.

The pinion on the #8 McCully crusher at the Crushing Plant stripped the teeth. It was replaced with a new pinion which we had in stock.

The foundation for the #5 McCully crusher in the shaft house has been completed, and we are now working on a steel enclosure. As soon as it is completed we will install the crusher.

The mechancial equipment operated satisfactorily during the year.

NEGAUNEE MINE: A crew of electricians have been busy a large part of the season wiring houses and street lighting in the new Location, which is now in excellent condition.

A new 250 K.W. motor-generator set with synchronous motor was purchased from the Allis-Chalmers Mfg. Company, and connected for service. This was necessitated by increase in the load with more intensive mining operations and additional scrapers.

NEGAUNEE MINE:

A tie-rod between the water cylinders on one of the Prescott pumps broke on February 8th. A new rod was made at the Hard Ore shops and the necessary repairs completed.

All mechanical equipment operated satisfactorily during the year.

MECHANICAL DEPARTMENT
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LLOYD MINE:

The skip hoist drum was in very poor condition, several cracks developing in the shell, making it necessary to replace the shell. On May 30th. we installed a drum that was formerly used at the Barnes-Hecker Mine. This drum has operated very satisfactorily.

We installed a new boiler and stoker in the shaft houst heating plant. This plant is operating very satisfactorily.

All mechanical equipment operated satisfactorily during the year.

Considerable work was done in re-wiring all of the surface electrical equipment and changing the connecting lines. This is now in good condition.

MACKINAW MINE:

On March 16th. the rope in the incline shaft broke, and did considerable damage in the shaft. Repairs were completed, and started to hoist ore again on March 22nd.

The heating plant went out of commission in November. It was in very poor condition and was scrapped. The Gwinn District shops heating plant boiler was moved to the Mackinaw and used to replace the boiler that was scrapped.

We had some trouble with the Nordberg air compressor, a cap screw coming out of the follower on the high pressure piston. The piston was broken and the piston rod bent. We had a spare piston rod and made a follower to complete the repairs.

All mechanical equipment operated satisfactorily during the year.

SPIES-VIRGIL MINE:

The mechanical equipment at this mine is operating satisfactorily.

The electrical equipment wiring is not in very good condition, but with the new electrician working it is gradually being improved to meet our usual standards.

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CLIFFS POWER & LIGHT COMPANY:

The operation of the Cliffs Power & Light Company during the past year reached an all-time high record in total out-put, use, and revenue. The total production during the year amounted to nearly 85,000,000 K.W.H., of which 72,500,000 was made from our own plants, and about 12,500,000 K.W.H. was purchased from the Munising Paper Company, the Cliffs Dow Chemical Company, the Wisconsin Michigan Power Company, and Marquette City. The compiled out-put for the years 1936 and 1937 show a production increase over the previous high year of 10,000,000 K.W.H., which shows a production increase at the rate of approximately 15% per year instead of a normal 10% increase, which has been expected. More than 50% of the total production was sold to customers not affiliated with the Company, and less than 50% to the Cleveland-Cliffs Iron Company and its affiliates, which condition has not prevailed in the past. At the first of the year we purchased liberally from the Munising Paper Co. but about the middle of January it was apparent that we would have sufficient water in storage to last until the spring break-up, and on January 20th. we stopped our purchases from them. The early spring break-up did not fill the storage basins as had been expected. However, the connection with the Wisconsin Michigan Power Co. was completed, and the connection made on April 16th. During the next two months we drew fairly liberally from this source while developing a proper and workable operating technique. In July we again began purchasing power from the Paper Company, and in August notified them to give us all the power they could on all work days. Of course, during this period we drew liberally from the Wisconsin Michigan Power Co. Whatever current the Cliffs Dow were able to furnish us was also used. Very good precipitation during October and November gave us a very considerable increase in our storage basins, and we had ample for our needs until the next spring break-up. Early in the year we made a verbal agreement with Marquette City, and set the rate for the exchange of current at 1¢ per K.W.H., instead of at 3/4 ¢, as had previously been done.

Our maintenance during the year was very much routine on the lines and plants. Considerable pipe line maintenance was underway on the Carp wood pipe line, and the portion contemplated for repair was finished, and has been operating satisfactorily during this time.

Several leaks developed on the McClure pipe line, which were promptly repaired in the usual manner. At two different periods when it was necessary we shut down the McClure Plant, and through cascading of various sectionalizing switches, we were out of service at all points for a short time.

The principal construction items completed during the year were the completion of the substation at Gwinn for the Wisconsin Michigan Power Co. connection; changing the service at the Tilden Mine, with a new substation, from 2,300 volt to 30,000 volts; the installation of a substation and establishment of service for the Hartford Mine in Negaunee; a substation and lines to the Wisconsin Michigan Power Co. in Mueller Township from the Quarry substation of the Inland line, to serve a rural line east of Manistique, and and existing line west of Manistique in the vicinity of Cooks; Due to additional load of the Michigan Gas & Electric Co. and increased load in our General Shops, the substation at the Brownstone became over-loaded. This was remedied by removing the 2,000 K.V.A. transformer bank from Gwinn and exchaning it for the 1,200 K.V.A. bank which had been located at the Brownstone. An increase in the load of the Wisconsin Michigan Power Co. at Michigamme necessitated additional capacity at Clarksburg, and two 150 K.V.A. transformers were installed. Two 65' steel towers were erected for the over-pass of highway U.S. 41 over the L. S. & I. Ry. about three miles east of Carlshend. This construction, amounting to something over $2,000.00, is to be paid by the State Highway Department.

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CLIFFS POWER & LIGHT COMPANY (Cont.)

The Mary Charlotte Mine development is being handled through the lines of the Michigan Gas & Electric Company in order to avoid duplication of substation and lines. An arrangement was made, satisfactory to them, whereby we make allowance for their losses.

The present outlook of snowfall and storage basin conditions indicates that we will probably have a complete filling of our storage basins, and some water will probably be wasted in the next spring breakup. A qualified forecast of the load would seem to indicate some increase in the next season, unless the present depression should develop adversely, affecting all industry in the area we serve.

The Federal Power Commission have issued a revised uniform system of accounts effective as of January 1, 1937. The power system of this Company lies entirely within the State of Michigan and the Michigan Public Utilities Commission, under an order dated September 15, 1937 have ordered that all utilities within the State of Michigan follow this uniform system of accounts, beginning as of January 1, 1938. This uniform system of accounts provides for an accounting system in much greater detail than has been followed by us in the past, and it will require a reorganization of our accounting system in order to comply with the provisions as setup in this account and it will require some time to get this new system operating efficiently. A complete physical inventory and appraisal of our property plant and equipment has been taken in the past year, and our accounting system has been reorganized setting up accurate records of plant construction and equipment and providing for the proper adjustment of our supplies and spare parts account.

Necessary work orders and accounting forms required in connection with the new Federal and State Commissions' order have been put into effect and are now functioning.

The usual load curves and tabulations relating to the plant operations are attached.

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CLIFFS POWER & LIGHT CO.

Statistical Data - 1937

Month	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Precipitation -	2.23	2.86	0.31	1.85	2.75	0.93	5.80	1.52	3.26	4.52	3.28	0.79

Total Precipitation at Ishpeming during 1937 - 30.10" (2.51')
Average " " Marquette - 32.8" (46 year record)

CARP RIVER PLANT:

Drainage area above Intake Dam,	66.66 sq. miles
Cubic Feet Precipitation in 1937,	4,664,519,100
Kilowatt Hours generated in 1937,	16,988,900
Cubic feet water utilized (90 cu. ft. = 1 KWH),	1,529,001,000
" " " in Carp Storage Basin Jan. 1, 1937,	179,639,700
" " " " " " Dec.31, 1937,	328,756,580
" " " stored in 1937,	149,116,880
" " " wasted over Intake Dam,	131,688,000
Total run-off for year 1937, (cubic feet)	1,809,805,880
Run-off per square mile of drainage area,	27,149,800

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

	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932
Total Precipitation,	21.90	22.95	20.71	35.69	29.86	36.06	32.28	23.14	36.70	31.20
Sec.ft.per sq.mile run-off	.59	.50	.25	.85	.98	1.11	.67	1.10	.83	1.13

	1933	1934	1935	1936	1937
Total Precipitation,	32.72	32.87	27.10	30.23	30.10
Sec.ft.per sq.mile run-off	1.14	1.00	.79	.89	.86

McCLURE PLANT:

Drainage area above Intake Dam,	140.52 sq. miles
Cu. Ft. Precipitation in 1937, (Hoist Plant - 38.18")	12,457,563,400
Kilowatt Hours generated at McClure Plant in 1937,	32,686,600
Cubic feet water utilized, (125 cu. ft. = 1 KWH)	4,085,825,000
" " " wasted over Intake Dam in 1937,	0
" " " in Hoist Storage Basin Jan. 1, 1937,	534,404,800
" " " " " " Dec.31, 1937,	1,496,246,500
" " " stored in Hoist Storage Basin in 1937,	961,841,700
" " " in Silver Lake Jan. 1, 1937,	402,798,500
" " " " " " Dec.31,1937,	639,045,000
" " " stored in Silver Lake in 1937,	236,246,500
Total run-off for year 1937, (cubic feet)	5,283,913,200
Run-off per square mile of drainage area,	37,602,000

	1920	1921	1922	1923	1924	1925	1926	1927	1928
Total Precipitation,	*27.40	35.10	42.03	26.60	30.49	24.06	43.85	35.51	43.80
Sec.ft. per sq.mi. run-off,	1.22	1.02	1.54	.85	.92	.52	1.52	1.80	2.22

	1929	1930	1931	1932	1933	1934	1935	1936	1937
Precipitation - Hoist Plant,	38.75	30.81	37.02	32.54	35.07	35.02	29.96	32.16	38.18
Sec. ft. per sq.mi. run-off,	1.36	1.45	1.10	1.23	1.30	1.16	.90	1.05	1.19

*1920 Precipitation figure is total precipitation at Ishpeming.

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

	INSTALLED TO JAN. 1 1937	INSTALLED IN 1937	TAKEN OUT IN 1937	CONNECTED JAN1,1938 TOTALS
CLIFFS SHAFT MINE:				
Shop	25			
No. 8 Crusher	125			
Screens	15			
Top Tram	125			
Hoist for "A" Shaft	750			
Underground Plunger Pump #1	180			
" Centrifugal Pump	250			
Allis-Chalmers Compressor	175			
Hoist for "B" Shaft	750			
Underground Plunger Pump #2	200			
Laboratory Crusher	5			
Cooling Water Pump for Compressors	10			
Ingersoll-Rand Compressor #1	400			
" " " #2	400			
Lower Tram #2	50			
Heating Plant Condensing Water Pump	5			
Underground Haulage Set #2	215			
Jaw Crusher - New Crushing Plant	75			
Underground Scrapers - 73 - 25 H.P. motors	1,650	175		
Lower Tram #3	30			
Batter Charging Set, 2nd Level "A" Shaft	7-1/2			
Grinder in Drill Sharpening Shop	7-1/2			
Boiler Feed Pump at Central Office	3/4			
Undg. Haulage Set #1 (from Gen. Storehouse)	150			
Carpenter Shop	25			
Return Water Pump at Central Office	1			
Stoker " " "	3/4			
Rock Tram	50			
Laboratory Stoker	3/4			
Rock Picking Belt	5			
Machine Shop Stoker	1			
Bit Grinders - 4 - 2 H.P.	8			
Laboratory Compressor	5			
No. 4 Compressor (From Morris Mine)		500		
				6,372-1/4
BROWNSTONE SUBSTATION:				
Test Set	1/2			
Oil Filter Press	1/4			
Battery Charging Motor-Generator Set	3			
Commutator Grinder	1			
Synchronous Condenser	80			
M.G. Set on Voltage Regulator Control	1/4			
Large Oil Filter Press	2			
Drill	1			88
fwd.	5,785-1/4	675	0	6,460-1/4

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Alternating current motor record: (Cont'd.)

	INSTALLED TO JAN. 1 1937	INSTALLED IN 1937	TAKEN OUT IN 1937	CONNECTED JAN. 1, 1938 TOTALS
brt. fwd.	5,785-1/4	675	0	6,460-1/4
HARD ORE SHOPS:				
Machine Shop	25			
Carpenter Shop	25			
Blacksmith Shop Punch	3			
Armature Bending Machine	2			
" " "	1/2			
" " "	1/8			
Lathe Grinder	1			
Portable Drill - Small (Stanley)	1/4			
" " - Large	1/4			
Commutator Slotter	1/8			
Lathe	7-1/2			
Blacksmith Shop Blower	1/4			
Hacksaw	1/2			
Small Grinder	1/4			
Portable Drill (Stanley)	1			
Carpenter Shop Saw	25			
Water Pump (S.R. Elliott)	2			
Motor-Generator Set	15			
Air Compressor	60			
Hard Ore Office Stoker	1/4			
Bandsaw	5			
Crane	2			
Shop Stoker	1			
Welder	35			
Punch Press	10			
Portable Welder		20		
Drill Press		5		
Drill Threader		1/2		
Small Lathe		1		
#7 Grinder		1/2		
Small Grinder		1/4		
Titan Grinder		1/2		
K. C. Drill		1/4		
Ventilating Fan		1/4		250-1/4
ISHPEMING HOSPITAL:				
Passenger Elevator	7-1/2			
Dumb Waiter	3			
Large Washer	2			
Small Washer	1			
Extractor	2			
Vacuum Cleaner	3			
Water Supply Pump	1			
X-Ray Machine	1/4			
Hot Water Circulating Pump	1/2			
" " Return - High Pressure	5			
" " " - Low "	1-1/2			
Vacuum Pump	3			
Refrigerator	1-1/2			31-1/4
fwd.	6,038-1/2	703-1/4	0	6,741-3/4

MECHANICAL DEPARTMENT
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Alternating current motor record: (Cont'd.)

	INSTALLED TO JAN. 1 1937	INSTALLED IN 1937	TAKEN OUT IN 1937	CONNECTED JAN.1,1938 TOTALS
brt. fwd.	6,038-1/2	703-1/4	0	6,741-3/4
TILDEN MINE:				
Compressor	150			
Centrifugal Pump	275			
Scraper on Coal Dock	15			
#29 Shovel - Motor-Generator Set	110			
" " - Air Compressor	4-1/2			
" " - Oil Pump	1/4			
" " - Trip Motor	2			
" " - Exciter Motor	10			
Cyclone Drill	10			
" Drills - 4 - 15 H.P.	60			
Car Dumper	30			
Large Crusher	250			
Car Puller	10			
Sample Crusher	3			
Belt Conveyor	50			
Secondary Crushers - 2 - 100 H.P.	200			
Small Hoist over Crusher	3			
#31 Shovel - Motor-Generator Set	110			
" " - Exciter Motor	7-1/2			
" " - Trip Motor	1-1/4			
" " - Air Compressor	5-3/4			
Drill Sharpener	15			
Pump for Drills	10			
Synchronous Condenser from P.C.P. Plant	625			
Shop Motor	5			
" " #2	3			
Armstrong Drill	15			
Blower Fan	1/2			
Fan in Crusher Bldg.	1/2			
Centrifugal Pump in Compressor Pit	2			
Booster Pump	125			
Pump for Summit Pit	50			
Emery Wheel	1/4			
Marion Shovel - M.G. Set	85			
Drill Sharpener 9"	15			
Armstrong Drill 9"	20			
Blower	1-1/2			
D. Drill Pump	20		20	
Armstrong Drill		20		
Scraper		50		2,350
ATHENS MINE:				
Cage Hoist	400			
Nordberg Compressor	325			
Compressor Cooling Water Pump	3			
Auxiliary Compressor for Hoist Brakes	5			
Underground Ventilating Fan #1(to Spies)	15		15	
Skip Hoist Set	850			
" " " Oil Pump	1			
Shop	10			
Underground Haulage Converter	150			
Skip Pit Pump	2			
fwd.	8,338-1/2	773-1/4	20	9,091-3/4

MECHANICAL DEPARTMENT
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Alternating current motor record: (Cont'd.)

	INSTALLED TO JAN. 1 1937	INSTALLED IN 1937	TAKEN OUT IN 1937	CONNECTED JAN.1,1938 TOTALS
brt. fwd.	8,338-1/2	773-1/4	20	9,091-3/4
ATHENS MINE: (Cont'd.) " "	1 761		15	
Underground Plunger Pumps - 2 - 400 H.P.	800			
Ore Tram 2 - 50 H.P.	100			
Carpenter Shop	20			
Ore Crusher	25			
Underground Ventilating Fan #2	50			
Ingersoll-Rand Compressor	450			
Rock Tram	50			
Underground Haulage Converter #2	150			
Saw Gumming Machine	1/4			
Nordberg Compressor Oil Pump	1/2			
Breitung Shaft Pump	25			
MAAS MINE:				3,416-3/4
Turbine Auxiliaries (Circulating Pump	40			
Turbine Auxiliaries (Injection	25			
Turbine Auxiliaries Exciter	35			
Underground Haulage Set	215			
Shop	10			
3rd. Level Centrifugal Pump	350			
" " Plunger Pump #1	500			
Ore Tram - 2 50 H.P. motors	100			
Coal Crushing Plant	15			
3rd Level Plunger Pump #2	250			
Ingersoll-Rand Compressors - 2 - 400 H.P.	800			
Skip Hoist	700			
Cage "	400			
Skip Hoist Reheostat Pump	3			
Carpenter Shop Saw	15			
Auxiliary Compressor for Hoist Brakes	7-1/2			
Cooling Water Pump	5			
Saw Gumming Outfit in Carpenter Shop	2			
Underground Haulage Set #2 (From Neg. Mine)	215			
5th. Level Aldrich Pump (" Being ")	100			
3rd. " Centrifugal Pump	400			
" " " " - Primer	50			
5th. " Prescott Plunger Pump (From Lake)	75			
" " Centrifugal Pump (From Princeton)	125			
New Undergground Haulage Set		365		
Surface Well Pump		40		
#104 Crusher		35		
				4,877-1/2
NEGAUNEE MINE:				
Underground Haulage Set #1	300			
"Ilgner" Hoist Set	450			
Ore Tram 2 - 50 H.P.	100			
Carpenter Shop in Lab. Bldg. (From Athens)	5			
Auxiliary Compressor for Hoist Brakes	3			
10th Level Plunger Pumps - 2 - 300 H.P.	600			
" " Centrifugal Pump	350			
" " Section Pumps - 2 - 15 H.P.	30			
Compressor Cooling Water Pump	3			
fwd.	16,207-3/4	1,213-1/4	35	17,386

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Alternating current motor record: (Cont'd.)

	INSTALLED TO JAN. 1 1937	INSTALLED IN 1937	TAKEN OUT IN 1937	CONNECTED JAN.1,1938 TOTALS
NEGAUNEE MINE: (Cont'd.) brt. fwd.	16,207-3/4	1,213-1/4	35	17,386
" "	1,841			
Nordberg Air Compressor	325			
Shop	15			
Ore Crusher	25			
Ingersoll-Rand Compressor	400			
13th Level Plunger Pump	15			
11th " " Pumps - 2 - 75 H.P.	150			
Exciters for 10th Level Pump Motors (2)	40			
Signal System Motor-Generator Set	1/2			
Timber Hoist - #2 Shaft	25			
Ventilating Fan " "	150			
Gravel Hoist	15			
Saw in Carpenter Shop	15			
Skip Pit Pump	5			
Underground Haulage Set #2	220			
Pump - Temporary	35			
New Flywheel Set for Hoists	800			
Oil Pump on #2 Flywheel Set	1			
" " " " " "	1			
" " " Nordberg Compressor	1			
Hot Well Pump	2			
				4,081-1/2
MAAS CRUSHING PLANT:				
Jaw Crusher	100			
Belt Conveyor	50			
Pan Conveyor Motor -Generator Set	50			
				200
LLOYD MINE:				
Skip Hoist (From Republic)	500			
Cage "	400			
Top Tram	50			
Ore Crusher	25			
Water Supply Pump Installed Underground	50			
Concrete Mixer	5			
Top Tram	50			
Compressor	100			
"	225			
Underground Haulage Converter	120			
Timber Yard Saw	7-1/2			
Underground Haulage Converter (From Wade)	150			
Compressor Cooling Water Pump	3			
				1,685-1/2
MORRIS MINE:				
Ingersoll-Rand Compressor #2	500		500	
				0
SECTION 6 SHAFT:				
Hoist	200			
Water Pump in Change House	2		2	
				200
fwd.	22,876-3/4	1,213-1/4	537	23,553

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Alternating current motor record: (Cont'd.)

	INSTALLED TO JAN. 1 1937	INSTALLED IN 1937	TAKEN OUT IN 1937	CONNECTED JAN.1,1938 TOTALS
brt. fwd.	22,876-3/4	1,213-1/4	537	23,553
GWINN CRUSHING PLANT:				
Crusher	85			
Pan Conveyor	50			
Belt "	50			
Compressor	15			
Compressor Cooling Water Pump	3			
				203
FRANCIS MINE STOCKPILE:				
Triplex Pump (To Mackinaw)	7-1/2		7-1/2	
				0
GARDNER MINE:				
Hoist	400			
Top Tram	50			
Laboratory Crusher	3			
				453
MACKINAW MINE:				
Hoist	400			
Shop	7-1/2			
Ore Tram	50			
Underground Haulage Set	150			
Air Compressor	325			
Compressor Cooling Water Pump	7-1/2			
4th Level Quintuplex Pump	350			
5th " Pump - Automatic #1	30			
Winze Hoist	200			
4th Level Centrifugal Pump	400			
6th " " " - Automatic #2	20			
Grinder in Shop	3			
Loader Used by Raiio & Rytkonen	25			
10th Level Pump		7-1/2		
				1,975-1/2
PRINCETON MINE #2:				
Hoist	200			
				200
PRINCETON MINE #3:				
Hoist	75			
				75
PRINCETON CENTRAL POWER PLANT:				
(Circulating Pump	50			
Turbine Auxiliaries (Injection "	40			
(Exciter	33			
Boiler Room Fan	50			
Coal Handling Machinery	10			
" " "	5			
				188
PRINCETON CENTRAL SHOPS:				
Shop Motor	25			
				25
PRINCETON CENTRAL PUMP STATION:				
Centrifugal Pump	100		100	
				0
fwd.	26,096-1/4	1,220-3/4	644-1/2	26,672-1/2

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Alternating current motor record: (Cont'd.)

	INSTALLED TO JAN. 1 1937	INSTALLED IN 1937	TAKEN OUT IN 1937	CONNECTED JAN.1,1938 TOTALS
brt. fwd.	26,096-1/4	1,220-3/4	644-1/2	26,672-1/2
NEW PUMP STATION AT KIDDER SHAFT:				
Layne & Bowler Pump	75			
Automatic Pump	30			
Booster Pump at Austin	10			
				115
CARP PLANT:				
Auxiliaries 2-15 H.P. pump motors	30			
Water Supply Pump	1			
Air Compressor	5			
				36
HOIST PLANT:				
Exciter Motor-Generator Set	20			
Oil Pump	3			
Air Compressor	5			
Small Supply Hoist Motor (Incline hoist)	3			
				31
McCLURE PLANT:				
Water Supply Pump	2			
Exciter Motor-Generator Set	17-1/2			
Air Compressor	5			
				24-1/2
ESCANABA PLANT:				
Air Compressor	5			
Oil Pump	5			
Valve Operating Motor	1			
				11
TOTAL MINING DEPARTMENT and CLIFFS POWER & LIGHT CO.	26,313-3/4	1,220-3/4	644-1/2	26,890

MECHANICAL DEPARTMENT
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Alternating current motor record: (Cont'd.)

	INSTALLED TO JAN. 1 1937	INSTALLED IN 1937	TAKEN OUT IN 1937	CONNECTED JAN.1,1938 TOTALS
TOTAL MINING DEPARTMENT AND CLIFFS POWER & LIGHT CO.	26,313-3/4	1,220-3/4	644-1/2	26,890
CLIFFS DOW CHEMICAL CO:				
Chemical Plant & Sawmill	1,195			1,195
L. S. & I. R.R. CO.:				
Shops, Sawmill, Ore Dock & Pumps	800			800
LAND DEPARTMENT:				
Grand Island 3 motors	15-1/2			15-1/2
LUMBERING DEPARTMENT:				
Location Water Supply Pump	5			
Tie Mill Saw	75			
" " Conveyors	37			
" " Shop	10			127
MICHIGAN GAS. & ELECTRIC CO.:				
Ishpeming	2,170			
Munising	250			
Munising City Pumping	125			2,545
REPUBLIC TOWNSHIP:				
Water Supply Pump	25			25
OLIVER IRON MINING CO.:				
Pumps at Angeline & Sec. 16 Mines	525			
Holmes Mine	2,552-1/2			3,077-1/2
CITY OF ISHPEMING:				
Booster Pump at Brownstone	15			
Air Compressor for Tank	10			25
CITY OF NEGAUNEE:	435			435
C.P.&L.Co. RETAIL:	100 Est.			100
PALMER MINING COMPANY:				
Volunteer Mine, Palmer	800			800
PIQUA MUNISING WOOD PRODUCTS CO.? MUNISING	695			695
NORTH RANGE MINING CO.:				
Blueberry Mine	1,165			1,165
INLAND STEEL CO.:				
Greenwood Mine	450			
Morris Mine	3,360			3,810
INLAND LIME & STONE CO.:				
Quarry & Dock	4,000			4,000
MICHIGAN GOLD MINE:	150			150
ROPES GOLD MINE:	350			350
REPUBLIC STEEL CORPORATION:				
Hartford Mine	625			625
TOTAL OUTSIDE LOAD	19,940	0	0	19,940
GRAND TOTAL CONNECTED LOAD	46,253-3/4	1,220-3/4	644-1/2	46,830