THE CLEVELAND-CLIFFS IRON COMPANY

Ore Mining Department

ANNUAL REPORT OF GENERAL MANAGER

For Year Ending December 31, 1957

#2028

THE CLEVELAND-CLIFFS IRON COMPANY
ORE MINING DEPARTMENT

Manager's Annual Report Year 1957

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CLIFFS SHAFT MINE
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I. GENERAL:

The production in 1957 was 760,695 tons and this is the highest annual production achieved at the Cliffs Shaft Mine. An operating schedule of 2-8 hour shifts per day with hoisting on 1-8 hour shift per day for 5 days per week was continued throughout the year. The mine was idle the first two weeks of July for a scheduled vacation.

The Cost of Production was $4.159 and the Total Cost at Mine was $5.449 compared with $4.520 and $5.758 respectively in 1956. The lower costs in 1957 are attributable to increased efficiency in the over-all operation as evidenced by the comparison of 8.83 tons per man per day in 1957 with 7.36 in 1956. Higher efficiency resulted in very favorable improvement in costs in many accounts. The most outstanding was miner output which rose from 14.65 tons per miner per day in 1956 to 21.85 tons per miner per day in 1957.

There was an average of 71 contracts working in the mine, the same as the previous year. Numerous mining areas were depleted, however better than budget production was maintained by re-entering old workings to recover relatively small areas and continuing a pillar recovery program.

Shipments totalled 670,883 tons leaving a balance of 103,004 tons on stockpile at the close of the year. This compares with 24,723 tons at the end of 1956. The products were screened to -1" fines and +1" lump until April 26, 1957 when a screen-deck change was made and the products screened to +1½" lump and -1½" fines. The ratio of lump to fines was 82% and 18% with the 1" screening and a 67% and 33% ratio was realized with the 1½" screening. Late in the year, screening was changed to 2" in accordance with the request to further improve both structure and analysis of the products. A small tonnage of second-class ore was processed and shipped as a third grade.

II. PRODUCTION

a. Production by Grade and Months

		CLIFFS SHAFT			BANCROFT			SECTION 10				
			Crushed			Crushed			Crushed			
Month	Optg. Days	Lump	No. 1	No. 2	Lump	No. 1	No. 2	Lump	No. 1	No. 2	Total	Rock
Jan.	22	35,765	7,931	-	4,644	1,029	-	16,820	3,730	-	69,919	2,908
Feb.	20	31,818	6,925	-	5,450	1,187	-	14,428	3,140	-	62,948	3,720
March	21	29,882	6,546	-	3,359	735	-	11,392	2,495	-	54,409	1,458
April	21	27,726	7,268	-	3,720	973	-	13,839	3,621	-	57,147	1,532
May	21	35,955	16,290	-	3,935	1,784	-	14,570	6,615	-	79,149	1,096
June	20	24,235	11,459	-	4,893	2,314	-	12,469	5,895	-	61,265	960
July	13	15,633	7,180	1,510	2,635	1,210	151	7,775	3,571	-	39,665	728
Aug.	22	19,310	8,608	3,768	9,328	4,157	396	14,026	6,250	546	66,389	880
Sept.	20	22,720	11,974	6,147	6,278	3,309	526	8,173	4,308	479	63,914	764
Oct.	23	26,639	13,312	-	8,074	3,945	-	11,120	5,431	-	68,521	1,476
Nov.	20	29,063	14,179	-	4,768	2,326	-	7,377	3,600	-	61,313	572
Dec.	20	27,005	13,136	-	5,310	2,584	-	7,721	3,755	-	59,511	736
Sub Total		325,751	124,808	11,425	62,394	25,553	1,073	139,710	52,411	1,025	744,150	16,830
Current Year's Stkp. Overrun		-	3,392	6,276	-	410	1,800	-	1,432	3,235	16,545	-
Total	243	325,751	128,200	17,701	62,394	25,963	2,873	139,710	53,843	4,260	760,695	16,830

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II. PRODUCTION (Cont'd)

b. Shipments

	Pocket Tons	Stockpile Tons	Total Tons 1957	Last Year Tons
Cliffs Shaft Lump	186,596	98,237	284,833	277,863
Cliffs Shaft Crushed #1	71,546	37,727	109,273	87,852
Cliffs Shaft Crushed #2	2,922	14,779	17,701	70,193
Bancroft Lump	36,930	17,475	54,405	44,373
Bancroft Crushed #1	17,284	5,299	22,583	14,476
Bancroft Crushed #2	271	2,602	2,873	6,635
Section 10 Lump	81,428	44,327	125,755	100,986
Section 10 Crushed #1	32,702	16,498	49,200	29,932
Section 10 Crushed #2	112	4,148	4,260	24,175
Total	429,791	241,092	670,883	656,485

c. Ore Statement

	On Hand 1- 1-57	Output For Year	Overruns	Total	Shipments	Balance on Hand
Cliffs Shaft Lump	3,752	325,751	-	329,503	284,833	44,670
C. S. Crushed #1	3,368	124,808	3,392	131,568	109,273	22,295
C. S. Crushed #2	7,744	11,425	6,276	25,445	17,701	-
Bancroft Lump	800	62,394	-	63,194	54,405	8,789
Bancroft Crushed #1	704	25,553	410	26,667	22,583	4,084
Bancroft Crushed #2	1,944	1,073	1,800	4,817	2,873	-
Section 10 Lump	1,588	139,710	-	141,298	125,755	15,543
Section 10 Crushed #1	1,435	52,411	1,432	55,278	49,200	6,078
Section 10 Crushed #2	3,388	1,025	3,235	7,648	4,260	-
Total	24,723	744,150	16,545	785,418	670,883	101,459
Total Last Year	38,119	628,832	14,257	681,208	656,485	24,723

d. Working Schedule

The table below shows a comparison of working schedules for the past five years:

Year	Schedule
1957	2-8 hour shifts per day with hoisting on 1-8 hour shift per day, five days per week.
1956	2-8 hour shifts per day with hoisting on 1-8 hour shift per day, five days per week.
1955	3-8 hour shifts per day with hoisting on 2-8 hour shifts per day, 4 days per week Jan. 1st through April 15th - 5 days per week April 16th through November 28th - then 2-8 hour shifts per day with hoisting on 1-8 hour shift per day for the balance of the year.
1954	3-8 hour shifts per day with hoisting on 2-8 hour shifts per day, 5 days per week Jan. 3rd through March 31st - 4 days per week April 1st through December 31st.
1953	3-8 hour shifts per day with hoisting on 2-8 hour shifts per day, 5 days per week.

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2. PRODUCTION (Cont'd)

e. Production Delays

The following production delays were experienced during the year:

1. The 6' x 20' vibrating feeder, from which debris and rock is sorted out of the ore, broke down on July 18th. Repairs were completed so that operations could be resumed on July 22nd. Loss of production on this account was approximately 4,500 tons.

2. The 6' x 20' vibrating feeder broke down again on September 10th. Repairs were completed so that operations could be resumed on September 11th. Loss of production on this account was approximately 3,000 tons.

3. ANALYSIS

a. Average Mine Analysis of 1957 Output:

	Iron Dried	Phos.	Silica
Combined Cliffs Shaft Lump	59.62	.106	8.60
Combined Cliffs Shaft Crushed #1	54.88	.112	13.56
Combined Cliffs Shaft Crushed #2	52.90	.107	17.76

b. Average Analysis of Shipments for 1957:

Grade	Iron	Phos.	Silica	Mang.	Alum.	Lime	Mag.	Sul.	Loss	Moisture
(°) Lump Ore	60.20	.110	8.07	.19	2.15	.76	.77	.005	1.02	1.10
(°) Crushed Ore #1	55.00	.113	13.41	.25	2.69	.99	1.08	.009	1.68	2.16
(°) Crushed Ore #2	52.90	.110	17.85	.31	2.08	.90	.88	.005	1.31	0.96

(°) Cliffs Shaft, Bancroft and Section 10 are combined.

c. Average Analysis of Ore in Stock Dec. 31, 1957:

		Iron	Phos.	Silica	Mang.	Alum.	Lime	Mag.	Sul.	Loss	Moist.
Combined C. S. Lump	Dried	58.60	.105	9.54	.19	2.15	.76	.77	.008	2.02	-
	Nat'l.	57.965	.104	9.44	.19	2.13	.75	.76	.008	2.00	1.10
" C. S. Crushed #1	Dried	54.42	.121	14.23	.25	2.69	1.19	1.08	.007	1.68	-
	Nat'l.	53.245	.118	13.92	.24	2.63	1.16	1.06	.007	1.64	2.16
" C. S. Crushed #2	Dried	-	-	-	-	-	-	-	-	-	-
	Nat'l.	-	-	-	-	-	-	-	-	-	-

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4. COST OF OPENING, EQUIPPING, DEVELOPING AND OPERATING

Comparative Mining Costs

	1957		1956	
Product	760,695		643,089	
	Amount	Cost/Ton	Amount	Cost/Ton
Underground Costs	$2,517,250.20	$ 3.309	$2,244,236.49	$ 3.490
Surface Costs	213,134.09	0.281	303,575.40	0.472
General Mine Expense	433,280.08	0.569	359,135.84	0.558
Cost of Production	3,163.664.37	4.159	2,906,947.73	4.520
Depreciation	678,920.75	0.892	532,613.18	0.828
Taxes	232,475.44	0.306	200,391.00	0.312
Loading and Shipping	57,275.66	0.075	65,238.01	0.098
Total Cost at Mine	$4,132,336.22	$ 5.432	$3,703,189.92	$ 5.758
Budget Cost of Production		$ 5.068		-
Number of Shifts and Hours	2-8 Hour		2-8 Hour	
Number of Days Operated	243		228	
Average Daily Product	3,137 Tons		2,821 Tons	

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4. COST OF OPENING, EQUIPPING, DEVELOPING & OPERATING: (Cont'd)

Detailed Cost Comparison

	Total 1957		Total 1956	
	Amount	Per Ton	Amount	Per Ton
Underground Costs				
Development	$ 51,408.98	.068	$ 60,607.38	.094
Mining	1,318,411.22	1.733	1,129,590.70	1.758
Tramming	342,997.03	.451	286,410.72	.445
Ventilation	10,332.49	.014	8,332.06	.013
Pumping	13,744.58	.018	44,653.73	.069
Compressors & Air Lines	57,050.16	.075	70,645.26	.110
Crushing & Screening - Undg.	63,500.32	.083	77,147.51	.120
Underground Superintendence	191,122.88	.251	159,668.98	.248
Maint: Pockets & Chutes	54,211,08	.071	52,590.58	.082
Mining Equipment	239,355.33	.315	205,796.18	.320
Shaft	3,874.04	.005	6,513.95	.010
Telephones & Safety Devices	29,110.25	.038	29,156.51	.045
Holiday Pay	41,192.29	.054	27,620.92	.043
Vacation Pay	100,939.55	.133	85,502.01	.133
Total Underground Costs	2,517,250.20	3.309	2,244,236.49	3.490
Surface Costs				
Hoisting	71,023.43	.093	70,503.65	.110
Crushing & Screening - Surface	11,820.94	.016	19,716.47	.030
Stocking	22,950.04	.030	15,629.19	.024
Timber Yard	2,805.62	.004	10,226.06	.016
Dry House	18,369.60	.024	26,209.69	.041
Policing	16,274.00	.021	13,721.14	.021
General Surface	17,096.17	.023	18,810.83	.029
Maint: Headframe Bldg. & Equip.	11,058.95	.015	11,537.81	.018
Other Mine Buildings	14,026.08	.018	86,616.22	.135
Telephones & Safety Devices	2,856.84	.004	5,178.35	.008
Holiday Pay	7,039.56	.009	5,919.19	.009
Vacation Pay	17,812.86	.024	19,506.80	.031
Total Surface Costs	213,134.09	.281	303,575.40	.472
General Mine Expenses				
Geological Department	13,040.63	.017	9,326.59	.015
Mining Engineering Department	14,795.54	.019	19,588.77	.030
Mechanical Engineering Dept.	5,110.14	.007	6,894.07	.010
Safety Department	6,221.31	.008	6,688.20	.010
Research Laboratory	2,202.56	.003	6,317.37	.010
Analysis & Grading - Laboratory	38,594.04	.050	35,059.63	.055
" & " - Shipping	4,363.87	.006	4,867.21	.008
Special Expense - Pensions	79.48	-	87.97	-
" " - Retirements	3,540.59	.005	3,876.92	.006
" " - Hygiene Clinic	5,258.58	.007	4,793.12	.007
" " - Employment Office	1,207.13	.001	1,025.02	.002
Ishpeming Office	76,656.45	.101	73,911.15	.115
Mine Office - Supt. & Clerks	48,645.03	.064	45,825.17	.070
Central Warehouse Overhead	18,018.63	.024	14,301.55	.022
Insurance - Property	4,554.09	.006	3,538.92	.006
" - Group, Health & Life	41,327.08	.054	32,885.85	.051
" - Group Annuity	12,882.54	.017	12,256.10	.019
" - Catastrophe	3,517.78	.005	4,537.58	.007
Personal Injury-Comp. & Doctors	23,747.61	.031	15,500.29	.024

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4. COST OF OPENING, EQUIPPING, DEVELOPING & OPERATING: (Cont'd)

Detailed Cost Comparison (Cont'd)

	Total 1957		Total 1956	
	Amount	Per Ton	Amount	Per Ton
General Mine Expenses (Cont'd)				
Design Department	$ 638.44	.001	$ 1,834.92	.003
Taxes - Unemployment Insurance	22,498.89	.030	9,592.76	.015
Taxes - Old Age Benefit	34,262.36	.045	31,850.00	.050
Electrical Engineering Dept.	14,018.52	.018	10,996.19	.017
Employees Insurance & Compensation	6,151.71	.008	6,903.72	.011
Operating Research Laboratory	1,432.63	.002	-	-
Supplemental Unemployment Benefits	30,514.45	.040	-	-
Power Credit	-	-	3,323.23	.005
Total General Mine Expenses	433,280.08	.569	359,135.84	.558
COST OF PRODUCTION	$3,163,664.37	4.159	$2,906,947.73	4.520

The lower cost, compared with 1956 is due to continued improvement in over-all efficiency since "C" Shaft plant went into operation. The improvements in the ore-handling phase of the operation, such as tramming, crushing and hoisting, are the chief reasons for lowering costs. A very favorable increase in miner output has also resulted from the factors mentioned above. The wage increase, effective July 1, two cost of living adjustments, and higher supply and material costs increased the expense in some accounts.

Underground Costs - Higher efficiency throughout the underground operation accounts for the reduction in this expense. The best cost improvements were realized in the Development, Pumping, Compressors & Air Lines, and the Crushing and Screening accounts. Tramming costs increased only slightly despite the major car repair expense under R & M CC-12 that is being charged to this account.

Surface Costs - A slight reduction in the labor force, combined with a cessation of construction work, accounts for the large reduction in costs compared with 1956. The largest cost improvements were in the Crushing and Screening, Dryhouse, and Maintenance of Mine Buildings, accounts.

General Mine Expenses - The proportion of general expenses incurred at the Cliffs Shaft was increased chiefly because of increased salaries and insurance costs. The addition of two new accounts, Operating Research Department and Supplemental Unemployment Benefits, also added to this expense.

Expenditure & Authorization Summary

E. & A. CC-705 - Diesel Loader

In March, a Oliver OC-4 diesel front-end loader was acquired on a trial basis. The unit is used to clean up spillage from the tracks and at loading points. Satisfactory performance resulted in the purchase of this unit in June. The project amount authorized was $28,400.00 and total expenditure was $25,924.98. This expense covers the cost of two Diesel Loaders, the first of which was purchased in 1956 for production work.

4. COST OF OPENING, EQUIPPING, DEVELOPING & OPERATING: (Cont'd)

Expenditure & Authorization Summary (Cont'd)

E. & A. CC-793 - Dust Control System

A Joy Microdyne unit for the dust collection system was installed in the crusher station underground. This system has reduced dust counts to an acceptable level and has been functioning very satisfactorily. The project amount authorized was $27,850.00 and the total expenditure was $21,816.99.

E. & A. CC-865 - Trolley Phones

This E. & A. covers the purchase of additional trolley phones for the underground locomotives. Trolley phones have been installed on all the motors on the lower levels where tramming has become more concentrated. This provides greater protection against collisions and good haulage efficiency. The project amount authorized was $4,300.00 and the total expenditure was $4,305.83.

E. & A. CC-916 - Fencing East Side of Property

The east side of the mine property along Spruce Street was enclosed with a 6' woven-wire fence. This fencing was needed to have better control of traffic into the mine property and to prevent trespassing by children. The project amount authorized was $2,525.00 and the total expenditure was $1,973.03.

E. & A. CC-928 - Trans-Weigh Belt Meter

This E. & A. covers the purchase and installation of a trans-weigh belt meter. The meter will improve control of skip weight determinations and aid in the calculation of lump to fine ratios. There was no expenditure against this account in 1957. The equipment is on order and delivery is expected early in 1958. The amount of the authorization is $3,800.00.

E. & A. CC-938 - Moro Shaft Ventilation Fan

A large capacity fan has been purchased, under this E. & A., to be installed at the collar of the Moro Shaft. Expanding mined-out areas has brought on the need to increase the ventilating air volume so the best efficiency can be maintained underground. The project amount authorized was $7,950.00. The fan was delivered late in the year so nearly all the expenditure on the project will take place early in 1958.

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5. ESTIMATE & ANALYSIS OF ORE RESERVES

The reserves are estimated on the basis of the following factors:

High Grade of First Class Ore	- 8 cu. ft. per ton
Second Class Ore	- 9 cu. ft. per ton
Conglomerate & Second Class Ore	- 10 cu. ft. per ton

The annual increase in the estimated reserves is due largely to the method employed in making up the tax estimates. Experience has shown that extension of proven ore reserves for any considerable distance away from a working area has been an unreasonable assumption at this property due to the complex mine geology. Therefore, much of the proven ore reserves and additions are based on an accumulated group of more or less standard breast extensions. This practice accounts for nearly the same magnitude of proven ore reserves each year fluctuating somewhat according to depletion and ore development. No significant ore reserve additions were realized this year.

The following table shows a comparison of developed ore with the previous year as reported to the State Tax Commission:

	Cliff Shaft	Bancroft	Section 10	Total Lease	Total Tons
Estimated Reserves-Dec. 31, 1956	609,325	70,643	227,046	297,689	907,014
Less 1957 Production	471,652	91,230	197,813	289,043	760,695
Balance as of 1956 Estimate	137,673	20,587	29,233	8,646	146,319
Estimated Reserves-Dec. 31, 1957	574,722	27,757	223,784	251,541	826,263
New Developed Ore	437,049	48,344	194,551	242,895	679,944

Expected Average Analysis of Ore Reserves

	Iron	Phos.	Silica	Mang.	Alum.	Lime	Mag.	Sul.	Loss	Moisture
Natural	57.50	.107	10.00	.35	2.10	.80	.80	.014	1.20	.85

The geological and engineering study of hard ore reserves, which was made in 1952, was reviewed in 1953, 1954, 1955, 1956 and 1957. Based on the 1957 revision, the proven and probable ore reserve is estimated at 1,634,519 tons as of December 31, 1957. The necessity of improving product grades and the suspension of any further No. 2 Grade production, together with the additional information obtained from mining in 1957, accounts for the reduction in reserves as compared with 1956.

6. LABOR AND WAGES

Labor relations have been satisfactory although the Committee has been active in submitting complaints and several formal grievances. There were 5 grievances submitted during the year, one of which went to arbitration. The arbitrator upheld the grievant and the small pay difference was adjusted. Two of the grievances were dropped by the Union in the fourth step and the Company conceded to the grievant in the third step of another grievance. There was one grievance pending at the end of the year.

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6. LABOR AND WAGES (Cont'd)

Name	Nature of Grievance	Step of Grievance Procedure
Edward J. Karno	Disputes Filling of Temporary Vacancy	Arbitration (Allowed)
Gerald Gauthier & George Swanson	Dispute Temporary Removal from Mining Category	(4) Dropped
Carl Kurin, Et. Al.	Dispute Calculation of Incentive Earnings for 2½ month period	(4) Dropped
Roy Peterson	Vacation Pay Shortage	(3) Allowed
Nels Santti	Vacation Pay Shortage	(3) Pending

Employment

No. of Men Beginning of Year		363
Separations	18	
Added During Year	4	
Decrease in Men	14	14
Total End of Year		349
Avg. No. of Men as per Labor Statement (Statistical)		355
Avg. Absenteeism (Statistical)		22

The following table shows a classification of separations in 1957:

	No. of Men
Quit	1
Retired	5
Transfers	10
Discharged	1
Deceased	1
Absence for 2 years or more on account of sickness	0
Total	18

During 1957, there were 210 employees entitled to 3-week vacations, 136 for two-week vacations and none for one week.

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6. LABOR AND WAGES (Cont'd)

Statement of Wages

a. Average Wages Per Day

	1957	1956
Total Surface & Underground	24.49	22.75

b. Average Wages Per Month

	1957	1956
Total Surface & Underground	517.47	472.06

The mine operated an average of 21¼ days per month in 1957 while averaging 20¾ days per month in 1956.

c. Tons Per Man Per Day

	1957	1956
Total Surface & Underground	8.83	7.36

d. Labor Cost Per Ton

	1957	1956
Total Surface & Underground	2.78	3.05

7. SURFACE

New Construction & Installation

A motor generator set that was acquired from the Lloyd Mine was installed in the Engine House. An increase in the generating capacity for the D.C. underground haulage system was needed and the 150 K.W. set was acquired for that purpose.

The old No. 3 Shaft on the east side of the property, that has served as a ventilation connection to the mine, was sealed at ledge with a concrete and steel bulkhead and then backfilled to collar elevation.

A 6' woven wire fence was erected along the east side of the property.

8. UNDERGROUND

A. General

The development program has continued on a small scale during the year due to lack of new areas to develop for mining. Continued stress on analysis, depletion of a number of stoping areas and lack of possible ore exploration areas all contributed to a program of continual stoping area changes and revisions. Pillar recovery continued throughout the year but at a lower rate than in 1956. The proportion of contracts on this type of work decreased from 36% at the beginning of the year to approximately 33% by the end of the year. The contracts included in this category are not confined entirely to pillar recovery work, but perform predominantly this type of work during the major part of a year.

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8. UNDERGROUND (Cont'd.)

A. General (Cont'd.)

The number of contracts in the "B" Shaft, Section 10 Lease-Moro Mine and Bancroft Lease-"A" Shaft Northeast areas remained the same throughout the year while the "A" Shaft East area lost one contract to the "A" Shaft area. While contract re-location due to depletion is not noticeable in the above statement, it is true that many re-locations were made, but generally within the same map area. Pillar recovery has been carried on in all map areas during the year and will continue as conditions permit.

The mine is split into mapping areas in which "A" and "B" Shaft map units represent the inlying areas in which a large proportion of the contracts are mining in old stopes. Bancroft and "A" Shaft Northeast, "A" Shaft East and the Section 10 Lease and Moro Mine represent the outlying or fringe areas which must be depleted prior to the inlying areas for orderly mining.

In May, R. & M. CC-12 was authorized to cover the rebuilding of many badly worn underground cars. The program includes the reconstruction of 36 cars and at the end of the year, 27 have been completed.

As a result of a ventilation study, some major changes were made to improve the mine ventilation. The old No. 3 Shaft, which has served as the air intake for the mine, was abandoned in favor of using the old No. 1 incline which connects to pit workings near surface on the east side of the property. An expensive repair job in No. 3 Shaft was thereby eliminated. A constricted section near the bottom of the Moro Shaft was enlarged in preparation for handling a larger volume of air through this shaft. By means of a large capacity fan installation at the collar of the Moro Shaft, the mine air volume will be increased by 45%. These changes will aid in maintaining good operating efficiency in the major producing areas.

The roof area and portions of the structure and equipment in the underground crushing station were treated with a sound-absorbing material, Insul-Mastic, to reduce the noise level. This work resulted in a reduction in the noise level and an improvement in working conditions.

A diesel front-end loader was purchased after a trial proved it was applicable to our conditions. This loader is employed on cleaning up spillage on the various tramming levels and at the loading chute, rapid clean-up is being accomplished with this unit and labor costs on this work reduced considerably.

Because of the very abrasive nature of the hard ore, considerable maintenance on the flow-sheet has been necessary. On the screens and feeders, heavier screen and deck plate including manganese steel are being tested to determine which material gives the best life. Worn-out and discarded crusher jaws are now used to line a chute section in the flow-sheet where repairs were frequently required. Maintenance in this section has been practically eliminated with the use of discarded crusher jaws.

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8. UNDERGROUND (Cont'd)

B. Mining Area

1. "A" Shaft East - (East of 2800 E and extending from the south boundary of the Bancroft Lease to 1200 S)

No development was done in the "A" Shaft East area this year. All known ore areas are presently being mined.

The number of contracts in this area was reduced by one because of depletion.

The remaining reserves here lie between the 2nd and 8th level. Emphasis on mining the fringe areas will continue to be stressed as we attempt to deplete the out-lying ore structures before retreating towards shaft.

2. "B" Shaft - (West of 400 E)

Development in "B" Shaft consisted of driving sub-level drifts and short raises to develop ore body extensions and provide travelling roads. One raise was driven from 5th level to 2nd level to facilitate the mining of the 1st level floor pillar and the 1145' sub-level floor pillar immediately above this area.

The number of contracts working in "B" Shaft was increased in 1957. This increase occurred when the Traxcavator became available to load broken ore from old rock-filled stope bottoms. This application of the tractor-loader unit has now made some previously inaccessible areas mineable. Eight of the contracts are mining on or above 1st level and six have only pillars as reserves.

The bulk of the first-class ore reserves continue to lie above 1st level. The "Lake Bancroft" structure, drilled in 1953, continues to be mined below 2nd level elevation and appears to get narrower as mining progresses downward.

3. "A" Shaft - (400 E - 2800 E, between the Bancroft & Section 10 Leases)

Some main-level drift was advanced on 8th level to provide tail-room for a top timber slide. A raise was driven from 8th to 7th level to facilitate the mining of a 6th level stope back. Several contracts advanced sub-level drifts and short raises in their respective stopes to develop ore body extensions and provide travelling roads.

Ten contracts have no reserves other than upright and floor pillars. Reserves in "A" Shaft are dispersed and in part, tied up by tramming operations. During the year, mining continued on the 6th level floor pillar and a section of the 8th level floor pillar. Another section of the 8th level floor pillar is now available for mining. Other such areas will be opened to mining after relocation of travelling and tramming roads.

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8. UNDERGROUND (Cont'd)

B. Mining Area (Cont'd)

4. Bancroft and "A" Shaft Northeast

Development in the Bancroft Lease and "A" Shaft Northeast area consisted of driving sub-level drifts and short raises to develop ore body extensions and provide travelling roads. One raise was driven from 8th to 6th level elevation in the Bancroft Lease to facilitate mining a 6th level floor area.

The number of contracts working in this area remained the same as in 1956 although there was some shifting of contracts in the various stopes. Reserves of ore in the Bancroft Lease and the "A" Shaft Northeast area are now concentrated between the 9th and 11th levels although a small tonnage remains at the 6th level elevation. Four of the contracts in this area have only pillars as ore reserves.

5. Section 10 Lease and the Moro Mine

Development in the Section 10 Lease was fairly extensive during the year. One raise was driven from 10th to 9th level to develop an ore body extension of No. 4 stope. Another raise was driven from 10th to 8th level to develop an ore body extension of #47 stope. Considerable sub-level drifting was done both above and below 9th level elevation to outline the ore body and develop a fairly large area for mining.

Mining, during the year, ranged in elevation from the 5th to 10th levels with most crews concentrated between the 5th and 8th levels. The number of contracts mining this area has remained the same as in 1956. This area contains the bulk of the reserves and is the major producing area in the mine.

Three contracts did some pillar recovery work in 1957. Two of these contracts are in the Section 10 Lease and the remaining contract is in the Moro Mine area.

C. Delimiting Ore

The underground diamond drilling program was completed in 1955. There was no drilling done underground or on surface for hard ore reserves in 1957.

A drilling program has been continued until mid-year from surfaced to explore for deep-lying soft ore reserves that would be mineable from the "C" Shaft. This exploration is summarized in the following paragraphs:

Section 10, 47-27 - Deep Exploration - Diamond drilling for deep soft ore in Section 10, 47-27 commenced in 1955, and was terminated in March, 1957. Drilling was confined to one hole.

Hole No. 29 is located on the old Lake Mine surface on the north shore of Lake Angeline in the NW¼ of the SE¼ of Section 10. In 1957, drilling encountered intrusive, lean ore, oxidized iron-formation, unoxidized iron-formation and argillaceous oxidized iron-formation. The hole was stopped at a depth of 5345' because of badly caving ground, the apparent proximity of the footwall contact, and generally adverse drilling conditions. This hole proved a much greater depth to the footwall Siamo slate than had been anticipated so further drilling plans were dropped.

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8. UNDERGROUND (Cont'd)

C. Delimiting Ore (Cont'd)

Section 4, 47-27 - Deep Exploration - Drilling was continued in D.D.H. #53 in Section 4 in an effort to determine if a continuous ore structure existed between Holes #37 and #44. This hole is located approximately midway between #37 and #44 and was stopped at a depth of 3340' after penetrating a short distance in footwall slate. No ore was encountered in this drilling. A branch from the parent hole was drilled to the north to gain more structure information on this section. The branch hole was stopped at a depth of 2790' and only 6' of ore was encountered in the hole.

D. New Equipment

A large amount of equipment was purchased for maintenance of existing plant and equipment and necessary spare parts for the flow-sheet. A number of drill machines were purchased to replace worn out machines and the expanding rock bolt program.required the purchase of a number of impact wrenches.

Item	Amount
1 - Set of Trac-Pads & Rails for Traxcavator	$ 675.00
1 - Dust Collector for Welding Shop	283.58
110 - Plastic Friction Lining Inserts for Koepe Hoists	3,566.16
4 - Thor Impact Wrenches	1,530.00
2 - Sets of spare Koepe hoisting ropes	12,698.16
4 - C.P. Impact Wrenches	1,920.00
36 - Underground Car Truck Frames	19,681.20
2 - Joy JAL-47 Airleg Drill Machines	1,570.00
2 - 14" Air Cylinders for Undg. Pockets	1,028.74
1 - Riveting Hammer	201.65
2000' - 6 Conductor #14 Cable for Undg. Scraping	818.00
1 - Set of Track Shoes for D-8 Tractor	852.94
11 - COPCO BBD-41K Drill Machines	6,030.00
1 - Set of Cage Hoist Tail Ropes	5,916.00
1 - Set of Trac-Pads for Oliver OC-4 Diesel Loader	272.41
8 - Primary Crusher Jaw Plates	6,282.21
3 - Tires for Euclid Trucks	2,233.29
1 - Tube for Euclid Truck	22.42
6 - Troughing Idlers for Conveyor	175.20
4 - Sections of Screen Decking for 4" Scalping Screen	316.00
Accoustical Treatment - Undg. Flow-Sheet	1,140.46
Spare Electrical Parts for Koepe Hoists	591.56
Remote Controls for Scraper Hoist Conversion	2,027.96
Roof Bolts and Shells	3,674.72
Motor Overhaul on Fork Lift	884.18
Flow-Sheet Equip. - Bearing, Gears, V-Belts, etc.	8,901.71
TOTAL	$83,293.55

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8. UNDERGROUND (Cont'd)

E. Explosives

The price of powder increased from $18.18 per cwt. to $19.24 per cwt. and there were substantial increases in miscellaneous blasting supply costs also. Despite the price increases, the cost per ton for explosives remained the same as last year due to a drawdown of accumulated broken ore in the mine from the previous year. Also, a reduction in the amount of secondary blasting helped to reduce powder consumption slightly. The explosives costs are summarized in the following tables:

TABLE I

Cost of Explosives-Operating

	Quantity	Avg. Price	1957	1956
Powder, Lbs. - All Kinds	575,300	19.24	$110,668.11	$ 87,941.12
Misc. Supplies (Caps, Fuse, Testers, etc.)			53,887.94	51,149.22
Total			$164,556.05	$139,090.34

TABLE II

Unit Cost and Consumption of Explosives

	1957	1956
Pounds of Powder Per Ton of Ore	.756	.798
Tons Ore Per Pound of Powder	1.322	1.253
Cost Per Ton For Powder	.145	.137
Cost Per Ton For Blasting Supplies	.071	.080
Cost Per Ton For All Explosives	.216	.216

TABLE III

	1957	1956
Cost Per Ton Developing	.001	.001
Cost Per Ton Mining	.215	.215
Total	.216	.216

F. Tungsten Carbide Bits

Numerous tungsten carbide bit tests were made during the year and the results show the I.R. Carset bit is still superior in the hard ore to other makes. Late in the year a test on a new Kennametal carbide bit was indicating very good performance and testing on a production basis was planned to get more conclusive data

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8. UNDERGROUND (Cont'd)

F. Tungsten Carbide Bits (Cont'd)

Description	Quantity	Price	Amount 1957	Amount 1956
Ing. Rand, Series 113 - 1-3/8"	2,479	11.48	$28,469.00	$35,904.00
" " 113 - 1-5/8"	50	14.60	730.00	682.50
" " 115 - 1-5/8"	270	12.90	3,483.00	3,612.00
" " 115 - 1-3/4"	100	15.00	1,498.75	736.25
Rockbits " 113 - 1-3/8"	468	10.90	5,101.20	1,287.50
" " 113 - 1-5/8"	129	13.50	1,741.50	-
" " 115 - 1-5/8"	118	13.50	1,593.00	-
" " 115 - 2-1/8"	24	19.15	459.60	459.60
" " 115 - 2-1/4"	6	23.57	141.42	-
Kennametal " 113 - 1-3/8"	0	-	-	337.90
Copco " 113 - 1-3/8"	10	10.00	100.00	-
Joy Rap-ons - 1-3/8"	12	11.00	132.00	-
TOTAL	3,126	11.67	$36,483.47	$43,019.75
Production - Tons			760,695	643,089
Cost Per Ton of Ore Produced			.048	.067
Feet Drilled - Rock & Ore			700,031	628,337
Average Feet Drilled Per Bit			224	164
Cost Per Foot of Hole			.052	.068

The average price per bit increased by approximately 10% compared with 1956. A factor which aided in lowering over-all bit costs was the drastically reduced production of the very hard second-class ore that was processed as No. 2 Grade.

G. Pumping

The automatic pumping system operated very satisfactorily throughout the year and very little maintenance was required. A 500 g.p.m. centrifugal pump, that was obtained from the Spies Mine, was installed in the pumphouse to serve as an emergency spare.

The two obsolete Prescott plunger pumps were removed from the mine and sold for scrap.

9. TAXES

Comparative data for 1957 and 1956 is shown below:

	1957		1956	
	Valuation	Taxes	Valuation	Taxes
Realty	3,530,000	160,085.50	3,600,000	146,880.00
Personal	316,100	14,335.13	451,100	18,404.88
Lot 2, Sec. 3, 47-27, Bancroft	440,000	19,954.00	545,000	22,236.00
Lot 174, Nelson's Addition	100	4.54	100	4.08
S. 35.91' of Lot 179	50	2.27	50	2.04
S½ of NW¼ of Section 10, 47-27	840,000	38,094.00	900,000	36,720.00
Total Cliffs Shaft Mine	5,126,250	232,475.44	5,496,250	224,247.00
Taxes Per Ton Produced		.306		.349
Taxes Per Ton Shipped		.347		.348

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10. ACCIDENTS & PERSONAL INJURY

There were 21 compensable injuries in 1957 and the total lost time for all accidents was 840 days. In the previous year, the total lost time was 491 days. The Cliffs Shaft ranked third on safety in 1957 among the underground mines.

Comparison of Frequency and Severity in 1957 and 1956 is as follows:

Year	Frequency	Severity
1956	33.65	.718
1957	37.33	1.254

Frequency Rate - Number of accidents for every 1,000,000 man hours

Severity Rate - Number of days lost per 1,000,000 man hours

A summary of the compensable accidents is listed below:

#1358 - Lowell Liquia - Contract Miner - February 6, 1957 - struck on right foot by chunk while drilling. Fracture 5th toe, right foot - contusions - time lost, 11 days.

#1359 - Arthur Luoma - Scraper Operator - February 14, 1957 - struck on right leg below the knee by 10" block which broke loose while scraping. Fracture of both bones in lower right leg. Time lost, 250 days. (*)

#1360 - James Marra - Contract Miner - February 18, 1957 - struck by a small piece of loose while barring. He stumbled and fell on dirt pile injuring left arm. Cut below left eye, swelling and discoloration of left elbow region. Time lost, 35 days.

#1361 - Kenneth Decaire - Motor Brakeman - March 28, 1957 - squeezed finger between ore car and rail tie while attempting to sprag car onto track. Crushed index finger, right hand. Time lost, 57 days.

#1362 - Joseph Nora - Motor Brakeman - March 27, 1957 - struck his head on back of drift while motor was moving. He fell off the motor and was dragged a short distance before motor could be stopped. Contusions of neck, back and right hip - Time lost, 9 days.

#1363 - Einar Pentti - Contract Miner - April 4, 1957 - struck on right foot by chunk while caving down pile. Fracture of second metatarsal, right foot. Time lost, 129 days.

#1364 - Edward Poirier, Jr. - Flagman - May 22, 1957 - slipped and fell 10' while climbing ladder, landing on his back. Sore back. Time lost, 81 days.

#1365 - Joseph Coron - Motor Brakeman - June 24, 1957 - squeezed between car and rib of drift while attempting to re-rail a car. Contusions and abrasions of right chest and right upper arm. Time lost, 23 days.

#1366 - Leonard Werner - Motor Brakeman - July 16, 1957 - struck on right foot by chunk while loading ore from chute. Sore arch on right foot. Time lost, 41 days.

#1367 - Nels Wirtala - Scraper Operator - July 26, 1957 - slipped on ladder and banged left knee on ladder rung. Twisted left knee. Time lost, 43 days.

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10. ACCIDENTS & PERSONAL INJURY (Cont'd)

#1368 - John Maki - Maintenance Mechanic - September 5, 1957 - struck in left arm by chip of steel from a sledge hammer he was using. A sliver of steel lodged in bicep of left arm. Time lost, 7 days.

#1369 - Ellsworth Pascoe - Contract Miner - September 25, 1957 - stumbled and fell while barring from top of broken ore pile. He landed on his right wrist causing fracture of right distal radius. Time lost, 51 days.

#1370 - Joseph Billings - Contract Miner - October 3, 1957 - struck on left knee by small piece of ore while removing a ladder from a raise. Traumatic bursitis, left knee. Time lost, 17 days.

#1371 - Bernard Crawford - Contract Miner - October 25, 1957 - struck behing left ear and along left lower jaw by a bar being used to operate a locomotive jack. Small cut on lobe of ear, bruises and slight concussion. Time lost, 8 days.

#1372 - Ronald Jensen - Contract Miner - October 28, 1957 - sprayed in face and eyes with creosote while tapping 50 gallon drum of creosote. Chemical burns of conjunctiva and cornea's of both eyes. Time lost, 8 days.

#1373 - William Collins - Motor Brakeman - October 23, 1957 - slipped and struck left lower chest on chute apron while climbing down from chute. Contusions and ligamental strain of lower left chest. Time lost, 12 days.

#1374 - Arthur Kivisto - Contract Miner - October 22, 1957 - attempted to get out of way of falling drill machine. Slipped, fell and wrenched his back. Lumbo-sacral spine normal - sprain. Time lost, 15 days.

#1375 - August Barbiere - Motor Brakeman - November 21, 1957 - squeezed fingers on left hand while attempting to lift car box into position. Lacerations on left middle and ring finger including profundis flexor tendon in middle finger. Time lost, 40 days. (°)

#1376 - Walfred Mantela - Contract Miner - November 25, 1957 - struck on left foot by chunk while drilling. Compound fracture, distal end of second metatarsal, left foot. Time lost, 40 days. (°)

#1377 - Oscar Stolen - Motorman - December 6, 1957 - struck on outside edge of left hand by small chunk while loading ore at a chute. Laceration, palm of left hand. Time lost, 8 days.

#1378 - Toivo Laitinen - Motor Brakeman - December 6, 1957 - slipped on walkway plank and twisted his left leg. Fracture, shaft, upper 1/3 left fibula. Time lost, 50 days. (°)

(°) Time Lost in 1957 Actual - Balance until man returns to work, Estimated.

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11. POWER

	1957	1956
Total Cost	$51,438.47	$81,464.60
K. W. H.	8,302,354	8,960,441
Average Cost Per K.W.H.	.0061956	.0090916
K.W.H. Per Ton	10.9	13.9
Cost Per Ton	.068	.127

The decrease in K.W.H. consumption is due largely to the full realization of operating efficiencies with the Koepe hoists. Power distribution for the underground tramming operation has also been improved with the installation of an additional 150 K.W. M.G. set to maintain proper voltage throughout the various tramming levels. The M.G. set was salvaged equipment from the Lloyd Mine.

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1. GENERAL:

The Humboldt Mine operated 10 2/3 months during 1957, being idle from March 1 through April 8. During this idle period, major improvements were made to the mill and crushing plants. On November 3, the mine operation was reduced to fifteen shifts per week compared to the twenty-shift operation that has been in effect since early in the life of the mine.

During the operating months, the mill produced 283,206 tons of concentrate from 737,081 tons of crude ore, indicating a weight recovery of 38.4%. The year's concentrate production as well as costs was affected by the milling of a large tonnage of lean, fine-grained ore during January and February. Production during these two months was limited to a total of 45,045 tons of concentrate milled from 135,144 tons of crude which is a weight recovery of 33.3%. Also handled during the year was 22,654 tons of mining waste, 155,780 cubic yards of rock and 184,335 cubic yards of overburden. The grade of the concentrate produced was 61.96% iron, 0.088% phosphorous, 9.48% silica, 0.016% sulphur and 6.86% moisture.

The pit development program varied in size during the year from a stripping operation totaling eighteen shifts per week during January and February down to three shifts per week through the summer and fall. In general, this program involved the initial work towards the opening of the north end of the pit early in the year and the stripping of large quantities of footwall rock and mining waste during the remainder of the year. Also, an additional earth project located along the hanging wall contact in the southern end of the pit was completed during the late fall.

The year 1957 should be considered as the year of many projects at the Humboldt operation, as numerous jobs of all types were undertaken in an effort to improve the operation. These jobs involved investigations associated with expansion plans as well as necessary changes and improvements that have been under consideration since the opening of the mill.

Although affecting the yearly costs, this work accomplished in 1957 will greatly increase the efficiency of the Humboldt operation for the remaining life of the mine.

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2. PRODUCTION, SHIPMENTS AND INVENTORIES:

a. Production by Months

Month	Tons of Crude Crushed	Tons of Crude Milled	Tons of Concentrate
January	68,366	66,808	21,303
February	66,527	68,336	23,742
March	-	-	-
April	52,683	52,351	19,067
May	74,284	73,460	29,669
June	70,918	71,044	29,991
July	73,358	72,965	32,273
August	79,387	75,796	31,851
September	75,496	74,585	29,915
October	78,497	76,639	26,994
November	56,233	55,906	20,803
December	48,969	49,191	17,598
TOTAL	744,718	737,081	283,206

b. Production Averages

	1956	1957
Average Crude Ore Per Day	2,476	2,466
Average Concentrate Per Day	985	937
Tons Per Man Per Day - Crude Ore	33.06	35.01
Tons Per Man Per Day - Concentrate	13.16	13.31
Average Weight Recovery	39.94	38.42

c. Shipments, Inventories and Analysis

Shipments	Tons	Iron	Phos.	Sil.	Sul.	Moist.
On hand - December 31, 1956	51,010	61.65	.077	10.01	.013	6.84
Production - 1957	283,206	61.96	.088	9.48	.016	6.86
Stockpile to Presque Isle	102,788	61.30	.093	10.24	.027	6.48
Pocket to Presque Isle	76,398	62.28	.092	9.10	.017	6.75
Pocket to Lurgi	135	61.70	.089	9.44	.023	7.21
Pocket to Sharon Steel	62	63.90	.080	7.85	.018	7.25
On hand - December 31, 1957	154,833	61.83	.085	9.70	.017	6.81

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3. LABOR AND WAGES:

a. General

The hourly-rate crew at Humboldt averaged 107 men during January and February, 95 men from April through October and 73 men during November and December. This latter cut-back was due to reducing the operation to a five-day week. The large crew during the winter represented extra men to work in the crushing plant and in the pit. The extra crushing plant labor was needed because of delays attributed to the Ross Feeder which was removed during March. The pit labor involved an earth stripping program undertaken during January and February.

Two grievances were filed within the year. The first involved a dispute over the scheduling of working hours and the second concerned promotions. Both of these grievances were dropped by the union and no arbitrations were necessary.

4. OPEN PIT:

a. Stripping

The surface stripping program involving a total of 184,335 cubic yards was continued throughout the year except for the month of March. During the months of January and February, 70,930 cubic yards were moved from the extreme north end of the pit in an effort to expose a portion of the ledge in that area. Throughout the spring and summer, a very limited earth program was also centered in the north area of the pit along the footwall. During the fall, the old haul road in the southern section was removed.

Rock stripping was moved during every month in 1957 and totaled 155,780 cubic yards for the year. The bulk of the material represented large intrusives and lean, partially oxidized material associated with these dikes. During March, approximately 20,000 cubic yards of hanging wall conglomerate were stripped from the central area.

b. Stripping Expenditures

	Amount Authorized	Amount Expended	Amount Unexpended
E&A HM - 28	$ 241,843.00	$ 241,843.00	-
E&A HM - 43	$ 215,900.00	$ 51,993.13	$ 163,906.87

c. Open Pit Mining

A total of 744,718 tons of crude ore was hauled to the crusher from the pit. The majority of this tonnage was mined from the 1545' bench in the center and southern areas of the pit. A very small portion of the crude ore was mined from the 1580' bench on the footwall side of the center area. This latter mining represented the crude utilized during January and February. Following the idle period in March and April, the mining was started in the southern area and progressed to the north along the old Barron Mine workings. At the end of the year, the mining face was well into the center area of the pit. A second face at the north end of the center area was also opened during the summer months.

The crude ore mined from the center area was lean, argillaceous iron formation. The southern area produced ore of a good grade, but the numerous intrusives and quartzitic zones made mining difficult. The average analysis for all of the crude ore mined during the year was 30.69% Fe.

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5. PLANT:

a. General

The crude ore utilized during the year was higher in grade though not as amenable to concentration as that processed in 1956. The net feed rate for the year was 108 LTPH.

The various rates were:

	Crusher Feed LTPH		Concentrator Feed LTPH		Concentrate LTPH	
	Gross Time	Net Time	Gross Time	Net Time	Gross Time	Net Time
1957	290.23	357.95	105.06	107.80	40.37	41.42
1956	237.81	306.64	106.02	111.13	42.34	44.38

The recoveries from the crude were:

	Crude		Concentrate	
	Tonnage	% Fe	% Wt. Recovery*	% Fe Unit Recovery*
1957	737,081	30.69	37.54	75.81
1956	518,044	29.70	37.42	77.94

*Based on dry tons of feed and concentrate.

The operating time for the crushing plant and mill was:

	Crushing Plant	Mill
1957	81.08%	97.46%
1956	77.55%	95.40%

Mechanical failure of mill equipment caused 51% of the total mill delays. Operational type mill delays were responsible for 27% and pit-crushing plant delays causing "out of feed" stoppages in the mill accounted for the remaining 22% of the total delay time.

b. Metallurgical Balance

Product	% Wt.	% Wt. Crude	% Fe	% SiO2	% Fe Unit Recovery
Concentrate	39.21	37.54	61.97*	9.48*	75.81
Flotation Tailing	60.79	58.21	11.09		21.03
Flotation Feed	100.00	95.75	31.04		96.84
Secondary Cyclone Overflow		4.25	22.84		3.16
Calculated Head		100.00	30.69		100.00

*Based on weighted averages carried at the Humboldt Mill.

		Iron	Phos.	Sil.	Sul.	Moist.
Concentrate Assay(Shipping Dep't.)	Dry	61.96	.088	9.48	.016	6.86
	Natural	57.71		8.83		
Guarantee for 1957	Dry	61.80	.085	9.50	.015	7.00

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5. PLANT: (Con't.)

c. Maintenance, Repairs and Changes

1. Crushing Plant

In addition to routine repairs in the crushing plant, the following major repairs and plant changes were completed in 1957:

1) Replaced the Ross Chain Feeder with a 48" Pioneer Pan Feeder.
2) Removed the #1 buffer belt and extended the #1 conveyor underneath the pan feeder.
3) Removed the #2 buffer belt and extended the #2 conveyor underneath the secondary crusher.
4) Installed new heavy-duty shells on the tertiary crusher.
5) Installed a new 350 HP motor on the primary crusher.
6) Removed the skirtboards on the surge bin feeder and replaced the flat rollers with troughing idlers.
7) Replaced the concaves, mantle, head nut, dust seal, spider bearing oil seal and six spider rim liners on the primary crusher. The tonnage on the mantle was 991,056 tons and the tonnage on the concaves was 1,649,684 tons.
8) Replaced the pinion countershaft bearing on the tertiary crusher.
9) Leveled the conveyor bed and installed a new belt on the #1 conveyor.
10) Replaced four accumulators and installed a 6" check valve on the tertiary crusher hydraulic reset system.
11) Removed the tertiary crusher mainshaft assembly and shipped the entire piece to the factory in Milwaukee to have the head center built up and new head nut threads machined on the mainshaft.

2. Concentrator

Major repairs and changes in 1957 were:

1) Replaced the wooden Steffensen Tanks in the center flotation section with steel Fagergren Tanks.
2) Replaced both Worthington filtrate pumps with 1 - 3" Barrett-Haentgens pump and 1 - 2" Dorr-Oliver olivite pump.
3) Installed Lincoln automatic lubrication systems on both rod mills.
4) Completed extensive repair work on the hydroscillator bowl oscillating mechanism. This included several crankshaft and bearing changes, a new turntable top and base and new yoke assemblies.
5) Installed new ring and pinion gears, pinion shaft bearings, crankshaft bearings, cam roller and cam roller arm on the hydroscillator rake mechanism.
6) Replaced the cylinder liners and lifter bars in both rod mills.
7) Turned the ring and pinion gear on the #1 rod mill and revamped the gear guards on both rod mills.
8) Constructed a coffer dam around the Lake Lory fresh water pumps and installed a 2000 GPM submersible pump for pumping water into the coffer dam. This was completed to avert a possible water shortage due to the low water level in the lake.
9) Poured a concrete floor along the east end of the mill.

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6. CAPITAL EXPENDITURES:

	1957 Expenditures $	Total Expenditures $
HM- 9 Plant Changes	618.03	40,939.69
HM-11 Dust Collection	5,447.45	26,775.96
HM-20 Mill Electrical Control Center	3,451.71	6,949.52
HM-21 Plant Improvement	4,787.75	9,611.97
HM-25 Primary Rock Box	5,513.81	7,679.42
HM-28 Stripping	241,843.00	241,843.00
HM-29 Primary Crusher Changes	54,227.70	54,227.70
HM-30 TD-18 Tractor	16,000.00	18,000.00
HM-31 Jet Drill Compensator	3,000.00	3,000.00
HM-32 Mill Improvements	15,150.66	15,150.66
HM-33 Pit Pump	6,231.08	6,231.08
HM-34 Service Truck	3,890.78	3,890.78
HM-35 M.O.C. Testing	50,057.45	58,476.99
HM-36 Plant Expansion	96,186.38	96,392.50
HM-38 Tertiary Crusher Shells	25,813.66	25,813.66
HM-39 Pickup Truck	1,767.73	1,767.73
HM-40 Payloader	13,977.00	13,977.00
HM-43 Stripping	53,255.05	53,255.05
TOTAL	$ 601,219.24	$ 683,982.71

7. TAXES:

Humboldt Mine including stockpile, supplies and equipment as placed by State Mine Appraiser:

	1957 Valuation $	1957 Taxes $	1956 Valuation $	1956 Taxes $
Real Estate	813,000	20,934.75	862,000	17,240.00
Personal Property	760,000	19,570.00	730,000	14,600.00
Dr. Burke Camp	400	10.30	400	8.00
		40,515.05		31,848.00
Collection Fee		405.15		318.48
TOTAL HUMBOLDT MINING COMPANY	$1,573,400	$ 40,920.20	$1,592,400	$ 32,166.48
Tax Rate		$ 25.75		$ 20.00

OCTOBER - 1957

A view of the pit operation in the extreme southern end of the pit in the 1580 foot bench. The broken ore is material located along the mining footwall and is part of the area that was formerly designated as knob one.

NOVEMBER - 1957

A view of the pit operation looking northwest. The shovel is loading in the central pit area and the southern pit area is in the foreground.

NOVEMBER - 1957

A view of the stripping operation in the southern area of the Humboldt pit. This is a swamp area covering the hanging wall formation. The uneven ledge exposed to the left of the drag-line is the ore formation that extends over to the old Foxdale Mine.

NOVEMBER - 1957

A view of the plant looking east. From left to right - primary crusher building, secondary crusher building, mill-garage and office, pocket and concentrate stockpile.

MATHER MINE "A" SHAFT
ANNUAL REPORT
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1. GENERAL:

Production for the year at the Mather Mine, "A" Shaft was 1,350,201 tons. This is the highest annual tonnage ever produced at the "A" Shaft and exceeded last year's total by 98,009 tons. Operations were on a three shift five day basis until November 3rd when a three shift four day schedule went into effect. Shipments from the pocket commenced on April 1st and ceased on November 14th. Stockpile shipments commenced on April 18th and ceased on October 31st. Total shipments for the year amounted to 1,361,260 tons, exceeding last year's shipments by 242,566 tons and slightly exceeding the years production.

The analysis of the Mather Mine, "A" Shaft product for the year was 58.11 iron, 9.08 silica, and .040 sulphur. The analysis of the shipments for the year was 52.30 iron natural.

The cost of production of $3.934 showed an increase of $.264 per ton as compared to 1956; however, the cost was $.124 below the budget. The total cost at mine increased by $.374 over 1956. The increased costs are attributed to increases in the cost of labor and supplies. The unit production increased from 10.04 tons per man per day in 1956 to 10.71 tons per man per day in 1957.

Steel sets continued as the principal means of ground support with yielding arch sets being used in block caving areas and square steel sets being used for transfer drifts and for main level development.

The 1957 diamond drilling program for the Mather Mine, "A" Shaft totaled 8,105 feet. Of the year's drilling, approximately 10% was outlining ore between 7th and 8th Levels, 28% was determining ore sections above the 9th Level, and 62% was defining enrichment below 9th Level.

Labor relations for the year were satisfactory. Three formal grievances were presented. One of the grievances, regarding the loss of holiday pay, was allowed by management. The other two grievances, the first with respect to incentive pay and the other with respect to the pay period on which the grievant's holiday pay had been based, were denied by management and the decisions accepted by the union.

Most of the production during the year came from the 8th Level with a total of 762,639 tons or 57.11% of the mine output being produced. The production from other levels was as follows: 5th Level - 11,805 tons or .88%; 7th Level - 425,885 tons or 31.89%; and 9th Level - 135,088 tons or 10.12%. Mining operations on the 5th Level were completed.

The use of sub-level belt conveyors for handling ore increased during the year. At the end of the year approximately 60% of the total mine production was being handled by belts. Studies show that the efficiency of the tramming system was improved 25% during the past year.

Development of ore reserves below the 9th Level was started during the year. An inclined belt conveyor drift is being driven from the 9th Level to the 12th Level. The belt will handle all ore from the 10th, 11th, and 12th Levels. A total of 1,060' of the conveyor drift was excavated during the year. In addition, the excavation for the room to house the single drum man and materials hoist, and a switch turn-out from the inclined drift

MATHER MINE "A" SHAFT
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1. GENERAL: (Continued)

to the 10th Level were also completed. The man and material hoist was installed during the year and is being used to haul a supply car and a magnetic brake car for personnel, up and down the incline. The belt conveyor is being installed in 200' to 250' increments as the drift is advanced. A total of 685' of the conveyor has been installed to date. The tail pulley of the belt, a scraper hoist, and a reciprocating feeder are integral components of a scraper slide which is kept within 50' to 250' of the heading. Broken rock is scraped from the heading onto the scraper slide and then fed to the belt which discharges the rock into cars on the 9th Level.

The belt is presently being powered by a temporary drive unit which is located at the 9th Level elevation. Early in 1958 the permanent drive will be installed in the hoist room located 42' above the 9th Level. Development rock will then be discharged to the 9½ Level through a raise. Present skip loading facilities on the 9½ Level will continue to be utilized for hoisting ore and rock to the surface.

A 50' x 140' addition to the mine shops was constructed during the year. The new addition is completely fireproof consisting of a steel framework, masonry walls with a brick facing and a concrete roof. Architecturally the exterior of the new shop was designed to blend well with the original buildings.

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2. PRODUCTION:

a. Production by Grade and Months:

Grade:	Product	Stockpile Overrun	Total	1956 Total
Mather	1,335,417	14,784	1,350,201	1,252,192
Mather Special	-	-	-	-
Total	1,335,417	14,784	1,350,201	1,252,192
Rock			42,328	57,860

Months:	Ore	Rock
January	106,599	5,247
February	112,531	5,522
March	108,052	3,201
April	104,182	3,531
May	126,916	3,025
June	120,684	2,563
July	76,637	1,353
August	148,160	3,696
September	126,577	2,992
October	144,549	2,948
November	89,188	3,949
December	86,126	4,301
Total	1,350,201*	42,328

* Total includes 14,784 tons, current year stockpile overrun pro-rated monthly.

b. Shipments:

	Pocket	Stockpile	Total	1956 Total	Increase
Mather	757,731	603,529	1,361,260	1,118,694	
Mather Special	-	-	-	-	
	757,731	603,529	1,361,260	1,118,694	242,566

A balance of 219,266 tons of ore was left in stock as of the end of the year. An overrun of 14,784 tons was developed from the south and center stockpiles which were completely loaded out during the shipping season.

MATHER MINE "A" SHAFT
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2. PRODUCTION: (Continued)

c. Ore Statement:

	Mather	Mather Special	Total	1956 Total
On Hand January 1, 1957	230,325	-	230,325	96,827
Output for Year	1,335,417	-	1,335,417	1,243,555
Transfers	-	-	-	-
Overruns	14,784	-	14,784	8,637
Total	1,580,526	-	1,580,526	1,349,019
Shipments	1,361,260	-	1,361,260	1,118,694
Balance on Hand	219,266	-	219,266	230,325
Decrease in Output				
Increase in Output			98,009	206,783
Decrease in Ore on Hand			11,059	
Increase in Ore on Hand				133,498

Working Schedule:

1957 - 3-8 hr. shifts, 5 days per week, Jan. 1st to Nov. 3rd.
3-8 hr. shifts, 4 days per week, Nov. 3rd to Dec. 31st.

1956 - 3-8 hr. shifts, 5-1/3 days per week, Jan. 1st to Nov. 11th.
3-8 hr. shifts, 5 days per week, Nov. 11th to Dec. 31st.

1955 - 2-8 hr. shifts, 4 days per week, Jan. 1st to Apr. 18th.
2-8 hr. shifts, 5 days per week, Apr. 18th to Aug. 1st.
3-8 hr. shifts, 5-1/3 days per week, Aug. 1st to Dec. 31st.

1954 - 3-8 hr. shifts, 5 days per week, Jan. 1st to Mar. 1st.
(Excluding a small production crew, Saturday, day shift.)
3-8 hr. shifts, 5 days per week, March 1st to Apr. 5th.
3-8 hr. shifts, 4 days per week, Apr. 5th to May 15th.
2-8 hr. shifts, 4 days per week, May 15th to Dec. 31st.

1953 - 3-8 hr. shifts, 5 days per week, Jan. 1st to Dec. 31st.
(Excluding a small production crew, Saturday, day shift.)

MATHER MINE "A" SHAFT
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2. PRODUCTION: (Continued)

d. Division of Product by Levels and Months:

Months	Fifth (2050') Level	Seventh (2400') Level	Eighth (2590') Level	Ninth (2810') Level	Total	Rock
January	6,875	41,962	55,688	713	105,238	5,247
February	1,300	43,275	65,700	1,000	111,275	5,522
March	287	49,138	54,425	2,862	106,712	3,201
April	1,591	47,287	51,257	2,748	102,883	3,531
May	1,752	48,613	69,296	5,915	125,576	3,025
June	-	29,413	73,350	16,665	119,428	2,563
July	-	23,477	42,969	9,395	75,841	1,353
August	-	38,404	93,778	14,575	146,757	3,696
September	-	35,421	77,001	12,919	125,341	2,992
October	-	29,912	90,851	22,341	143,104	2,948
November	-	19,033	46,163	22,966	88,162	3,949
December	-	19,950	42,161	22,989	85,100	4,301
	11,805	425,885	762,639	135,088	1,335,417	42,328
Current Year Stockpile Overrun					14,784	
					1,350,201	

e. Production Delays:

Delays during the year were few and minor with no delays of more than a single shift duration.

MATHER MINE "A" SHAFT
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3. ANALYSIS:

a. Average Mine Analysis on Output:

Grade	Iron	Phos.	Silica	Sulphur
Mather	58.11	-	9.08	.040

b. Average Analysis of Shipments:

Grade	Iron	Phos.	Silica	Mang.	Alum.	Sulphur	Lime	Mag.	Loss	Moist.
Mather	58.10	.095	9.14	.34	3.29	.032	.60	1.08	2.04	9.98

c. Average Analysis of Ore in Stock: (Natural)

Grade	Tons	Iron	Phos.	Silica	Mang.	Alum.	Sulphur	Lime	Mag.	Loss	Moist.
Mather	219,266	52.00	.085	7.72	.30	2.93	.033	.53	.96	1.82	10.85

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4. COST OF OPENING, EQUIPPING, DEVELOPING AND OPERATING:

Capital account expenditures amounted to $1,103,905.16, which brought the total at the end of the year to $12,391,149.51. The total figure does not include an additional $318,223.11 charged in a prior year to Negaunee Mine Company "Idle Expense". By including the "Idle Expense" the grand total expended to date amounts to $12,709,372.62. The following table shows the main items of capital expenditures which are included in the total capital account charges above.

	Percentage of Total Capital Account Charges in 1957
Main Level Development	35.4
12th to 9th Level Inclined Belt Conveyor System	36.0
Underground Conveyor Belt and Crusher Systems	10.5
Underground Exploration	7.8
Underground Equipment	5.7
Surface Projects	4.1
Subsidence	0.5

Total Charge-Offs	$1,046,809.24
Total Capital Account Charges as Above	1,103,905.16
Actual Net Increase in Capital Account	$ 57,095.92

MATHER MINE "A" SHAFT
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4. COST OF OPENING, EQUIPPING, DEVELOPING AND OPERATING: (Continued)

Comparative Mining Costs:

The unit production increased from 10.04 tons per man per day in 1956 to 10.71 tons per man per day in 1957.

	1957	1956
Product	1,350,201	1,252,192
Underground cost	2.912	2.746
Surface cost	.356	.331
General mine expense	.460	.410
Vacation pay expense	.124	.141
Social Security Taxes	.082	.061
Cost of Production	3.934	3.689
Loading and shipping expense	.060	.053
Ad valorem taxes	.295	.244
Depreciation - plant and equipment	.215	.186
Depreciation - movable equipment	.006	.004
Depreciation - office equipment	.001	.001
Amortization of development	.104	.104
Depletion - preproduction development	.013	.013
Administrative expense	.050	.050
Total Cost, Exclusive of Royalty, etc.	4.678	4.344
Royalty	.500	.500
Pensions	.107	.095
Miscellaneous expense less income	.034	.031
Total Cost	5.319	4.970
Other Charges:		
Amortization of defense facilities	.014	.043
Current year's development	.424	.373
Idle expense account of strike	____	.097
GRAND TOTAL COST	5.757	5.483
Number of Shifts and Hours	49 1-8 hr. 48 2-8 hr. 187 3-8 hr.	33 1-8 hr. 36 2-8 hr. 204 3-8 hr.
Total 8 Hour Operating Shifts	706	717
Number of Operating Days	235-1/3	239
Average Daily Product	5,737	5,239

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4. COST OF OPENING, EQUIPPING, DEVELOPING AND OPERATING: (Continued)

		Proportion of Labor and Supplies	
Labor	$3,409,619.01	2.525/ton	54%
Supplies	2,907,132.40	2.153/ton	46%
Total Cost at Mine	$6,316,751.41	*4.678/ton	100%

* Does not include Amortization of Defense Facilities and Allowance Under Section 616.

MATHER MINE "A" SHAFT
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4. COST OF OPENING, EQUIPPING, DEVELOPING AND OPERATING: (Continued)

Detailed Cost Comparison:

	1957		1956	
	Amount	Per Ton	Amount	Per Ton
Underground Costs:				
Development	1,013,141.39	.750	834,977.79	.667
Mining	1,449,236.19	1.073	1,384,713.19	1.106
Tramming	622,844.99	.461	586,347.37	.468
Power Adjustment	2,772.65	.002	4,539.86	.003
Ventilation	16,210.28	.012	13,449.59	.011
Pumping	101,722.45	.076	59,135.90	.048
Compressors and Air Lines	68,576.45	.051	56,493.18	.045
Crushing and Screening - UG	39,694.54	.029	30,633.35	.024
Underground Superintendence	231,574.78	.171	194,365.75	.155
Maintenance:				
Pocket and Chutes	10,170.54	.008	10,240.39	.008
Mining Equipment	184,228.99	.136	128,754.20	.103
Levels and Cross-cuts	67,293.42	.050	43,709.33	.035
Shaft	12,673.58	.009	4,433.66	.003
Telephones and Safety Devices	52,629.89	.038	48,740.04	.039
Vacation Pay	134,681.63	.100	141,855.19	.113
Holiday Allowance	65,504.56	.048	46,476.51	.037
Fire Loss			365.16	.000
Wage Adjustment	1,205.03	.000		
Total Underground Cost	4,066,206.00	3.010	3,580,150.74	2.859
Surface Costs:				
Hoisting	199,084.33	.147	167,029.41	.133
Crushing and Screening - Surface	17,713.24	.014	14,335.89	.012
Stocking	87,484.67	.065	65,227.81	.052
Timber Yard	58,350.83	.043	61,527.46	.049
Dry House	45,100.06	.033	42,097.04	.033
Policing	25,083.49	.019	19,755.54	.016
General Surface	17,744.34	.013	17,070.79	.014
Maintenance:				
Headframe Bldg. and Equipment	9,037.93	.007	12,057.94	.010
Other Mine Buildings	10,704.91	.009	7,096.99	.005
Telephones and Safety Devices	871.57	.000	1,389.61	.001
Vacation Pay	33,670.41	.025	35,463.78	.028
Holiday Allowance	9,434.21	.007	6,676.64	.006
Total Surface Cost	514,279.99	.382	449,728.90	.359

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4. COST OF OPENING, EQUIPPING, DEVELOPING AND OPERATING: (Continued)

Detailed Cost Comparison: (Continued)

	1957		1956	
	Amount	Per Ton	Amount	Per Ton
General Mine Expenses:				
Geological Department	15,606.99	.012	9,966.11	.008
Mining Engineering Department	56,725.90	.042	39,740.45	.032
Mech. Engineering Department	5,878.61	.004	6,725.08	.005
Safety Department	10,238.12	.008	10,541.34	.009
Research Laboratory	6,954.24	.005	5,704.54	.005
Analysis and Grading - Laboratory	38,532.37	.029	41,433.41	.033
" " " - Shipping	9,103.90	.007	7,363.00	.005
Project Engineering	1,264.75	.001		
Special Expense-Pensions	132.21	.000	142.67	.000
" " -Retirements	5,889.03	.004	6,384.86	.005
" " -Hygiene Clinic	10,404.47	.008	9,119.20	.008
" " -Employment Office	2,007.83	.001	1,693.43	.001
Ishpeming Office	131,352.28	.098	122,642.99	.098
Mine Office - Supt. and Clerks	80,765.26	.060	71,136.08	.057
Central Warehouse Overhead	35,097.69	.026	28,884.75	.023
Insurance - Property	3,922.40	.003	4,195.85	.003
" - Group, Health & Life	67,412.40	.050	54,019.11	.044
" - Group Annuity	16,572.09	.012	15,610.60	.012
" - Catastrophe	5,981.79	.004	6,414.71	.005
Personal Injury - Comp. & Doctors	38,437.31	.028	34,624.30	.028
" " - Comp. Department			6.91	.000
Operating Research Department	14,351.79	.011		
Taxes - Unemployment Insurance	54,254.81	.040	25,467.30	.020
" - Old Age Benefit	56,592.23	.042	50,492.09	.040
Electrical Engineering Department	4,541.55	.003	2,790.69	.002
Employees Insurance & Compensation	10,232.09	.007	11,372.56	.009
Design Department	72.91	.000	67.66	.000
Supplemental Unemployment Benefits	49,517.68	.037		.019
Total General Mine Expenses	731,842.70	.542	566,539.69	.471
COST OF PRODUCTION	5,312,328.69	3.934	4,596,419.33	3.689

MATHER MINE "A" SHAFT
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5. ESTIMATE AND ANALYSIS OF ORE RESERVES:

The net ore reserves as of December 31, 1957 were 10,350,519 tons. This is an increase of 2,112,477 net tons from the 1956 estimate. Included in the 1957 estimate are 691,153 net tons in Section 1, 47-27, to be mined by Mather Mine, "A" Shaft.

Reserves on the 8th Level and above were decreased, whereas, reserves between the 8th and 9th Levels and below 9th Level were increased. The decrease in reserves above 8th Level, in addition to the decrease by mining operations, was due mainly to contamination by intrusives.

The 1957 estimate indicates a net increase in ore reserves of 3,462,678 net tons as compared to a loss of 587,641 net tons in 1956.

Estimated Net Reserves as of December 31, 1956	8,238,042
Production, January 1, 1957 to December 31, 1957	1,350,201
Net Reserves December 31, 1957 by Subtraction	6,887,841
Estimated Net Reserves as of December 31, 1957	10,350,519
Net Increase in Reserves	3,462,678

Expected Average Natural Analysis of Ore Reserves as of December 31, 1957

Grade	Tons	Iron	Phos.	Sil.	Mang.	Alum.	Lime	Mag.	Sul.	Loss	Moist.
Mather - Surface Diamond Drilling....	508,937	53.15	.122	5.08	0.25	2.62	.58	.60	.014	1.97	12.50
Mather - Underground Development.....	7,120,907	51.62	.100	8.75	0.20	2.45	1.00	.50	.050	2.25	11.00
	7,629,844										

The tonnage and analysis figures shown in the preceding table are the same as the figures that were turned into the Michigan State Tax Commission.

MATHER MINE "A" SHAFT
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6. LABOR AND WAGES:

a. Employment:

The total mine payroll at the end of the year was 578 with a decrease of 19 men from the previous year.

Number of Men 1/1/57.....	597
Added to Roll During the Year.....	21
Total.....	618
Separations.....	40
Total on Payroll 12/31/57.....	578
Average Number of Men as per December Labor Statement.....	523

During the year, as indicated in the table above, there were forty separations and twenty-one additions. Of the separations, twelve quit, six retired, two died, twelve were laid off due to a curtailment in operations, two were given disability pensions, one was transferred to the Humboldt Mine, one entered the service, one was dropped from the payroll due to prolonged illness, one was given a temporary transfer to the General Storehouse, one was transferred to the Pellet Plant, and one was discharged. Of the additions, four were returned servicemen, one was hired, one was transferred from the Pellet Plant, one was transferred from the General Storehouse, three were transferred from the Maas Mine, five were transferred from the Bunker Hill Mine, and six were transferred from the Cambria-Jackson Mine.

b. Statement of Wages:

	1957	1956
Average Wages Per Day		
Surface	$21.45	$21.09
Underground	25.78	23.97
Total	$24.90	$23.40
Average Wages Per Month		
	(19-2/3 Days)	(21-3/4 Days)
Surface	$421.70	$458.70
Underground	506.83	521.35
Total	$489.53	$508.95
Tons Per Man Per Day		
Surface	52.34	50.57
Underground	13.47	12.53
Total	10.71	10.04
Labor Cost Per Ton		
Surface	$ .410	$ .417
Underground	1.914	1.913
Total	$2.324	$2.330

MATHER MINE "A" SHAFT
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6. LABOR AND WAGES: (Continued)

c. Labor Relations:

Labor relations in general were satisfactory.

Three formal grievances were presented during the year. John P. Carlson and George Koski submitted a grievance regarding a loss of holiday pay which was incurred while they were suspended from work due to a violation of a safety regulation. This grievance was allowed. William Anderson and Eugene Arsenault submitted a grievance regarding the pay period on which their holiday pay had been based. Their grievance was denied by management and the decision accepted by the union. The third grievance was submitted collectively by John Kosonen, Rudolph Holappa, Kenneth Ball, and Toivo Koski. These men were all contract miners. They claimed that they were not allowed enough time for performing 'company account' work in their contract. This grievance was denied by management and the case was dropped by the union in the fourth step of the grievance procedure.

The men benefited by seven paid holidays, New Year's, Good Friday, Memorial Day, Independence Day, Labor Day, Thanksgiving, and Christmas, in accordance with the provisions of the labor contract.

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7. SURFACE:

Buildings:

A 50' x 140' addition to the mine shops was constructed during the year. This building, located between the present shops and storage building will serve many needs. Additional floor space will be used for welding facilities to relieve the present cramped quarters. A newly acquired steel punch machine will be mounted on the east side with adjoining room for the fabrication of underground steel sets. Conveyor belting will be repaired and reconditioned over a mezzanine section on the west side and the main aisleways will be used for nighttime garage facilities for trucks and other mobile equipment.

The new addition is completely fireproof consisting of a steel framework, masonry walls with a brick facing and a concrete roof. Architecturally the exterior of the new shop was designed to blend well with the original buildings.

Headframe and Trestles:

The throat grooves of the two skip head sheaves have been worn down approximately 1½" since their installation in 1942. This condition was deemed unsatisfactory for the heavy skip service and to correct it the counterweight head sheave was interchanged with the north skip head sheave and the south skip head sheave replaced with the spare unit. Also four bearings were rebabbitted and the throat grooves ground on the cage and counterweight head sheaves to provide the proper operating clearance.

During the scheduled mine shutdown in July the Kennedy Van Saun feeder was overhauled with new supporting beams and rails, fifteen new shafts, forty-two rebushed wheels and fourteen rebabbitted pans being installed.

A painting contractor painted the headframe below the trestle deck and the major portion of the trestle structurals that had not been painted previously.

Stocking:

All new and old style top tram cars operated throughout the year with only minor delays. Maintenance on this equipment was of only a routine nature.

Engine House:

All skip and cage hoist equipment operated throughout the year without any delays. Maintenance of hoist equipment consisted primarily of cleaning of the MG sets and hoist motors.

Skips:

The north and south skips were removed on November 22nd and December 20th respectively for routine repairs, after operating for a full year without any delays.

Hoist Ropes:

Four 1-7/8" diameter hoisting ropes were removed in 1957 as follows:

The north skip rope was removed on July 23rd because of a reduction in diameter to approximately 1-5/8" in a section 800 - 1800 feet from the skip end, and twelve broken wires occurring in a two day period. This rope hoisted 752,500 tons of ore and rock with no cage service.

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7. SURFACE: (Continued)

Hoist Ropes: (Continued)

On October 5, 1957 the south skip hoisting rope was removed from service because of three raised strands in a section 500 - 900 feet from the skip end and a reduction in diameter to 1-11/16". This rope hoisted 904,848 tons of ore and rock with no cage service.

On November 15, 1957 the counterweight rope was removed from service because of one hundred sixty-five broken wires (uniformly scattered over the entire length). This rope was in operation for five years, seven months, and thirteen days of which approximately one year was on the Mather "B" cage hoist.

On November 16, 1957 the cage rope was removed from service due to three raised strands in a section 100 - 1600 feet from the cage end. This rope gave very poor service operating for only one year, two months, and fourteen days on the cage hoist.

New Equipment:

A new FWD platform truck for transporting supplies and equipment was purchased to replace an older unit, and a steel punch machine was obtained for fabricating underground steel sets.

Subsidence Studies:

Microseismic activity over the old 5th and 6th Level workings was recorded throughout the year from geophones located in surface subsidence holes D.D.H. #65, D.D.H. #68, and D.D.H. #69. D.D.H. #65 and D.D.H. #68 are located over the 5th Level workings and D.D.H. #69 is located over the 6th Level workings. In comparing the number of microseismic counts recorded from the three holes during the year, it was concluded that the major portion of the activity was over the 6th Level workings. During the first part of the year, the number of microseisms recorded from D.D.H.'s #65 and #68 was low, whereas, the number recorded from D.D.H. #69 was by comparison relatively high. For the remainder of the year, the microseismic count gradually increased from D.D.H. #65 and D.D.H. #69 while the count from D.D.H. #68 remained about the same as in the previous months.

Because of the very low level (magnitude) and the low count of the microseisms recorded from the area under observation as compared with other areas studied, it is considered that the Mather "A" subsidence area has remained relatively stable during the year. However, with the increase in activity indicated during the past few months, the area will be observed closely and any or all methods applicable for determining the position of the cave and the rate of cave progression towards surface will be given careful consideration.

During the latter part of April, the water level in D.D.H. #69 was tested with electrodes and it was revealed that the cement plug, located at a depth of 1,150' from the collar, had washed out. The plug had been put in during November 1956 and, although the seal was not entirely satisfactory, the hole did support a small head of water allowing the geophone to function. In order for a geophone to function it is necessary that it be under a sufficient head of water. Since the hole would no longer support a head of water, it was necessary to re-cement so that microseismic recording could be continued. Cement was pumped into the hole beginning from the bottom, 1,150 feet from collar, and the hole would not support a head of water until the final cement plug was set at 1,072' from the collar. This hole, D.D.H. #69, intersected the Mather Fault in the vicinity of 1,076' from the collar and this fact explains the necessity for the cement plug to be set at 1,072' from the collar.

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7. SURFACE: (Continued)

Subsidence Studies: (Continued)

Before cementing D.D.H. #69 a dye test was conducted with the use of Uranine Water Soluble (Sodium Fluoresein) dye. The dye was put in the hole and a continuous flow of water, regulated and controlled at 10½ g.p.m. was pumped into the hole until completion of the project. Water samples were collected underground on the 6th and 7th Levels near the Mather Fault zone. The rate of percolation of the surface water through the Mather Fault zone to underground openings was computed when the dye was first detected in the water samples taken underground and approximated 10' per hour. From this experiment it was concluded that the Mather Fault is of considerable importance in regard to the Mather "A" subsidence program as a possible water course.

During the month of October a velocity survey was made in subsidence hole #65 to obtain velocity data through the rock in the vicinity of the subsidence area. The data collected will be used to reinterpret the reflection work of 1956 conducted by Mr. L. O. Bacon of Michigan College of Mining & Technology and will be used with the microseismic studies. Personnel involved in the velocity project were L. O. Bacon of Michigan College of Mining & Technology, G. Durfee of the U.S. Bureau of Mines, and G. Ulrickson and L. Erickson of Cleveland-Cliffs Iron Company.

The results of the survey produced another possible means by which the subsidence problem may be handled. The velocity recorded in the diorite sill overlying the cave area was extremely high. "The extremely high velocity of the diorite at Mather "A" is attributed to the stressed condition of the rock. The diorite sill can be represented approximately by a uniformly loaded beam. The upper surface of the sill is in compression while the lower surface is in tension and somewhere near the center it is essentially unstressed. This condition provides a possible method of determining the rate of subsidence. Providing that the above conditions are correct and exist, the zone of no stress should gradually move up the hole (i.e. the sill) as subsidence takes place. Repeated interval velocity surveys should detect this condition if normal velocity of diorite is approximately 14,000 ft./sec."*

During November, the Bureau of Mines electronic counter equipment was set up at subsidence hole #65 to verify or disprove the high velocity of the diorite recorded by the velocity survey. Considering the difference in instrumentation of the two sets of gear used, the resulting velocity was very acceptable and in close agreement with that previously recorded.

The subsidence studies undertaken during 1957 gave valuable information needed in order to continue the subsidence program. By conducting a velocity survey, average velocities of various rock types were obtained and can be used for future seismic reflection surveys. Also, the information was needed if, or when, the magnitude and frequency of the microseisms, generated by rock fracture due to caving, reach a point where triangulation can be used to establish the source of the rock disturbances. Another important outcome of the velocity survey was that it produced another possible means by which the subsidence problem may be handled; that of following the rate of subsidence by the stressed condition of the rock.

From the microseismic activity during the year it is concluded that the rate of subsidence does not seem to be too rapid and the ground fracturing above the old 5th and 6th Level workings remains approximately the same as for the previous year; at an elevation between 1,100' and 950' from surface.

* Report On Velocity Survey at Mather A and B Areas - Ishpeming, Michigan By L. O. Bacon.

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8. UNDERGROUND:

5th Level:

Mining above the 5th Level was completed in May. The production for the year was 11,805 tons. All of the ore which was mined was Standard grade and came from over the #7 Cross-cut.

7th Level:

Production from the 7th Level was 425,885 tons or 31.89% of the total mine output; a reduction of 172,902 tons from that produced in 1956. It is anticipated that all mining on the 7th Level will be completed during 1958. The production came from seven areas. Four of the areas were in Section 2 and three areas were in Section 1. The areas in Section 2 were the North Block East, #1 Cross-cut, #7 South Cross-cut, and the #780 Block. Mining areas in Section 1 were over the #7, #8, and #9 Cross-cuts.

During the year mining was completed over the #7 Cross-cut in Section 1 and over the #1 Cross-cut in Section 2. The reserves in both of the areas were exhausted. The #7 Cross-cut produced 13,559 tons and the #1 Cross-cut produced 17,182 tons.

Areas which are still active in Section 2 are the North Block East, #7 South Cross-cut, and the #780 Block. The North Block East is located immediately above the loading trench of the main 7th Level belt conveyor. 27,648 tons were produced from this area during the year with two drifts being caved. No new development is planned. It is anticipated that caving operations will be completed in the North Block East early in 1958. Mining over the #7 South Cross-cut produced 81,225 tons for the year. One undercutting drift is required to complete the development in this area. Operations should be completed by the middle of 1958. Operations in the #780 Block consisted of caving back the transfer drifts. 91,922 tons were produced from the area during the year.

In Section 1 two active areas remain; the #8B Cross-cut and the #9B Cross-cut. 31,847 tons were produced from the #8B Cross-cut. At the end of the year mining was restricted to a 60' wide pillar immediately above the cross-cut. All other reserves in the area have been exhausted and mining will be completed early in 1958. The largest reserve tonnage remaining on the 7th Level is over the #9B Cross-cut. Operations in this area produced 161,385 tons during the year. Caving is progressing down the footwall from the 6th Level workings. At the end of the year two undercutting drifts and the main transfer drift to the north were being caved. The bulk of the remaining reserves can be reached from top-timber transfers. Mining from this area should continue well into 1958.

U.H. #210, located on the 13,400 West section and collared at an elevation of -932, was drilled from the 7100 Cross-cut at S. 2,497 and 13,430 W., at an inclination of $-29\frac{1}{2}^{o}$, and S. 0°11'W to a depth of 1,841' without disclosing any ore. A wedge was set at 840' in an effort to increase the inclination and the hole was redrilled to 1,070'. At this depth the hole was discontinued because the dip could not be maintained even with the aid of knuckle joints and tapered reamers.

8th Level:

Production from the 8th Level increased to 762,639 tons and represented 57.11% of the total mine output. The tonnage came from one area in Section 1 and eight areas in Section 2. The production from the various areas was as follows: #3 Cross-cut - 125,550

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8. UNDERGROUND: (Continued)

8th Level: (Continued)

tons, #7 Cross-cut - 117,366 tons, #8 Cross-cut - 66,093 tons, #9 Cross-cut (Section 1) - 93,548 tons, #811 Transfer - 116,100 tons, #812 Transfer - 178,243 tons, #821 Transfer - 2,799 tons, #822 Transfer - 27,438 tons, and #823 Transfer - 14,486 tons. All areas designated by a transfer number are the areas that are serviced by belt conveyors.

Currently, more than 60% of the 8th Level ore is being handled by belt conveyors from the stopes to shaft. There are two sub-level belts in service. One belt, the #81 conveyor, serves two mining areas or blocks while the second belt, the #82 conveyor, serves four areas. During the year the #81 belt carried 283,605 tons bringing the total tonnage carried by the belt to date to 381,962 tons. The #82 belt, which was installed during the year, carried 113,948 tons. Rail tramming of ore on the 8th Level, where it is necessary, was improved when the ore pass system was adapted to permit dumping of ore through the #5 Cross-cut ore pass raise instead of tramming the ore to shaft. The average rail tramming distance was reduced to 28% of the previous distance. The discharge from the two sub-level belt conveyors is directed into the same ore pass raise; thus, all of the 8th Level ore is passed to the 9th Level storage trench.

Eight diamond drill holes were drilled from the 8th Level during the year. U.H. #375 was drilled from the -1100 sub-level at S. 2,209 and 11,469 W., at an inclination of ∠60°, and S. 0°43'E and U.H. #377 was drilled from the -1100 sub-level at S. 2,206 and 11,468 W., at an inclination of ∠60° and N.1°49'E to further investigate and outline the iron formation hangingwall that was revealed by mining operations. U.H. #380 was drilled from the -950 sub-level at S. 1,550 and 10,583 W., at an inclination of ∠60° and S. 2°17'E to find the northern limit of the ore body overlying the 8800 Cross-cut. U.H. #395, drilled at S. 2,321 and 12,240 W., at an inclination of ∠60° and S. 1°37'E and U.H. #400, drilled at S. 2,314 and 12,239 W., at an inclination of ∠55° and N.4°18'E and U.H. #402, drilled at S. 2,324 and 12,239 W., at an inclination of ∠7° and S. 0°12'W, were drilled from the -1025 sub-level so that additional development could be planned above the 8300 Cross-cut. U.H. #418, drilled at S. 2,349 and 12,335 W., at an inclination of ∠70° and S.0°37'E, and U.H. #423, drilled at S. 2,345 and 12,335 W., at an inclination of ∠70° and N. 0°50'W, were drilled from the -1100 sub-level to further outline the ore body west of the Mather Fault above the 8300 Cross-cut. This drilling proved the ore body to pinch out to the west of the 12,350 W. section at approximately 2,350 South.

9th Level:

Production from the 9th Level amounted to 135,088 tons or 10.12% of the mine total. Two areas were brought into the production stage during the year.

All of the mining between the 8th and 9th Levels was planned with a system of sub-level belt conveyors as the ore transportation method. Three sub-level belts were planned originally. Two of these sub-level belts were installed during the year and serve two block caving areas. Development work for the third belt of the original three is progressing satisfactorily.

The #91 conveyor was placed in operation in May. Ore is loaded at the tail pulley end by the #92 belt, and by a feeder a short distance to the north. The conveyor sections are designed for mounting a conveyor scale to weigh all ore handled by the 9th Level sub conveyors. Installation of the #92 wire rope conveyor and two feeders was completed during the year. This 490' conveyor runs from east to west and discharges at right angles

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8. UNDERGROUND: (Continued)

9th Level: (Continued)

onto the #91 conveyor. All structural steel work including the #93 conveyor drive base was installed at the intersection point of the #92 and #93 conveyors. The balance of the #93 conveyor equipment and feeders should be placed early in 1958.

Operation of the 3100' long, 30" wide 9th Level main conveyor and crushing system commenced in January. In this system ore is scraped by a 125 H.P. remote operated hoist and slusher through the 9th Level storage trench onto a 5' x 12' scalping screen. The undersize passes through the scalper to a reciprocating plate feeder that loads a 48" wide buffer belt. Oversize material from the scalper discharges into a 36" x 42" jaw crusher set at 4" and then onto the buffer belt. This 50' buffer belt loads the 30" main conveyor which transports the ore 3100 feet to shaft where it is ore-passed to the 9½ Level skip loading station.

During the year, sixteen holes were drilled from the 9th Level. Six of these holes were drilled to outline the ore body above the 9900-A and 9900-B Cross-cuts. The remainder of the holes were drilled to disclose the extent of the ore body below 9th Level. A summary of the drilling is as follows:

U.H.'s #359 and #360 were drilled from the 9900-A Cross-cut to test for ore above the level and west of the N-S dike on the 10,350 W. section. This drilling proved the ore body to pinch out to the south. U.H. #417 was drilled to the south from this same location to investigate possible enrichment south of a small fault.

U.H.'s #379 and #394 were drilled from the 9900-B Cross-cut to outline the ore body above the level and east of the N-S dike on the 10,100 W. section. 103' of 1st class ore was disclosed in hole #379 which was drilled to the north. The drilling of hole #394, drilled to the south, indicated little enrichment due, probably, to an E-W trending fault located near the collar of the hole. U.H. #406 was drilled from the end of the 9900-B Cross-cut on the 10,000 W. section for correlation purposes with drilling that had been completed on the 9,950 W. section.

Five holes, U.H.'s #397, #403, #409, #432, and #439, were drilled from the 9620 West drift on the 11,350 W. section and five holes, U.H.'s #376, #378, #396, #414, and #419 were drilled from the 9620 East drift on the 10,850 W. section. All were drilled to outline reserves below the 9th Level with the exception of U.H.'s #419 and #432. U.H. #419 was drilled from the 9620 East drift at S. 3,249 and 10,874 W. and at an inclination of $\angle 90^{\circ}$ in an attempt to locate the large sill overlying the level. U.H. #432 was drilled from the 9620 West drift at S. 3,246 and 11,328 W., at an inclination of $\angle 2^{\circ}$ and N.0°33'W for the purpose of correlating the information gained from surface hole #45 on the 11,400 W. section and U.H.'s #274 and #308 on the 11,350 W. section. Some enrichment was indicated along the E-W Fault extending above the 9th Level elevation but not a sufficient amount for mining from this elevation. U.H.'s #397, #403, #409, and #439 were drilled at various inclinations from the 9620 West drift to outline the ore body below the level along the 11,350 W. section. The interpretation of the information gained from this drilling made it possible to correlate the ore thus disclosed on this section with that in surface D.D.H. #44 on the 11,400 W. section. U.H.'s #376, #378, #396, and #414 were drilled at various inclinations from the 9620 East drift to outline the ore body below the level along the 10,850 W. section. U.H.'s #376, #378, and #414 disclosed some ore built up along the E-W Fault and bounded on the south by a fairly large northwest-southeast trending intrusive. Extremely vuggy ground was encountered

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8. UNDERGROUND: (Continued)

9th Level: (Continued)

in U.H. #396, drilled to the south at an inclination of -65°, and after considerable difficulty with caving ground and cementing operations the hole had to be abandoned before reaching the footwall. A small drift was then driven further along this section south, and at the close of the year, drilling operations were again underway with U.H. #446 being drilled at S. 3451 at an inclination of -90°.

The 1957 diamond drilling program for the Mather Mine, "A" Shaft totaled 8,105 feet. Of the year's drilling, approximately 10% was outlining ore between 7th and 8th Levels, 28% was determining ore sections above 9th Level, and 62% was defining enrichment below 9th Level.

The preliminary drilling for reserves below 9th Level was done from two top-timber drifts, 9620 East and 9620 West, driven to the southeast and southwest respectively, from the end of the 9600 Cross-cut. Ore reserves below 9th Level were increased during 1957 by 2,677,674 net tons as a result of diamond drilling.

Development Below the 9th Level:

Development of the ore reserves below the 9th Level was started during the year. An inclined belt conveyor drift is being driven from the 9th Level to the 12th Level. The belt will handle all ore from the 10th, 11th, and 12th Levels. The belt conveyor drift is 10' high by 12' wide with the belt conveyor being installed in one-half of the drift and a 30" gauge trackway in the other half of the drift. The track is of the standard mine gauge and will accommodate all of the equipment which will be required in development work. Rock bolts have been used as the means of support except at the 10th Level switch turn-out where steel sets were installed.

A total of 1,060' of the conveyor drift was excavated during the year. In addition, the excavation for the room to house the permanent belt drive equipment was completed. An excavation was made to accommodate the single drum man and materials hoist, and a switch turn-out from the inclined drift to the 10th Level was also completed. The man and material hoist was installed during the year and is being used to haul a supply car and a magnetic brake car for personnel, up and down the incline. Due to the inclination of the drift, which is 12°26' or 22.35%, a departure from the normal method of excavation had to be made. Changes were made in the drilling operation and a different method of removing the development rock was devised.

In the drilling phase of the drifting cycle, jack-leg mounted sinker machines were tried first. The sinkers operated fairly well; however, it was felt that drifters would do a much better job. Subsequently, a cat mounted jumbo was purchased. This jumbo accommodates three 3½" drifters. The actual drilling time was decreased considerably. Maneuverability of the jumbo is to be improved with the installation of larger air motors.

The belt conveyor is being installed in approximately 200'-250' increments as the drift is advanced. The tail pulley of the belt, a scraper hoist, and a reciprocating feeder are integral components of a scraper slide which is kept within 50'-250' of the heading. Broken rock is scraped from the heading onto the scraper slide and then fed to the belt. The belt discharges the rock into cars at the 9th Level elevation. A temporary driving unit operates the belt at present, but will be replaced by the permanent drive unit early in 1958. The belt conveyor when completed will be 3,688.15' long and will have a

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8. UNDERGROUND: (Continued)

Development Below the 9th Level: (Continued)

lift of 795.81'. Width of the belt will be 36". Power will be furnished by two 350 H.P. motors. The head end of the belt will be located 42' above the 9th Level and ore and rock will be discharged into a raise which will pass the ore to the 9½ Level. Present skip loading facilities on the 9½ Level will be utilized.

Mining Methods and Developments:

Block caving with the radial drilling system of undercutting continued as the mining method.

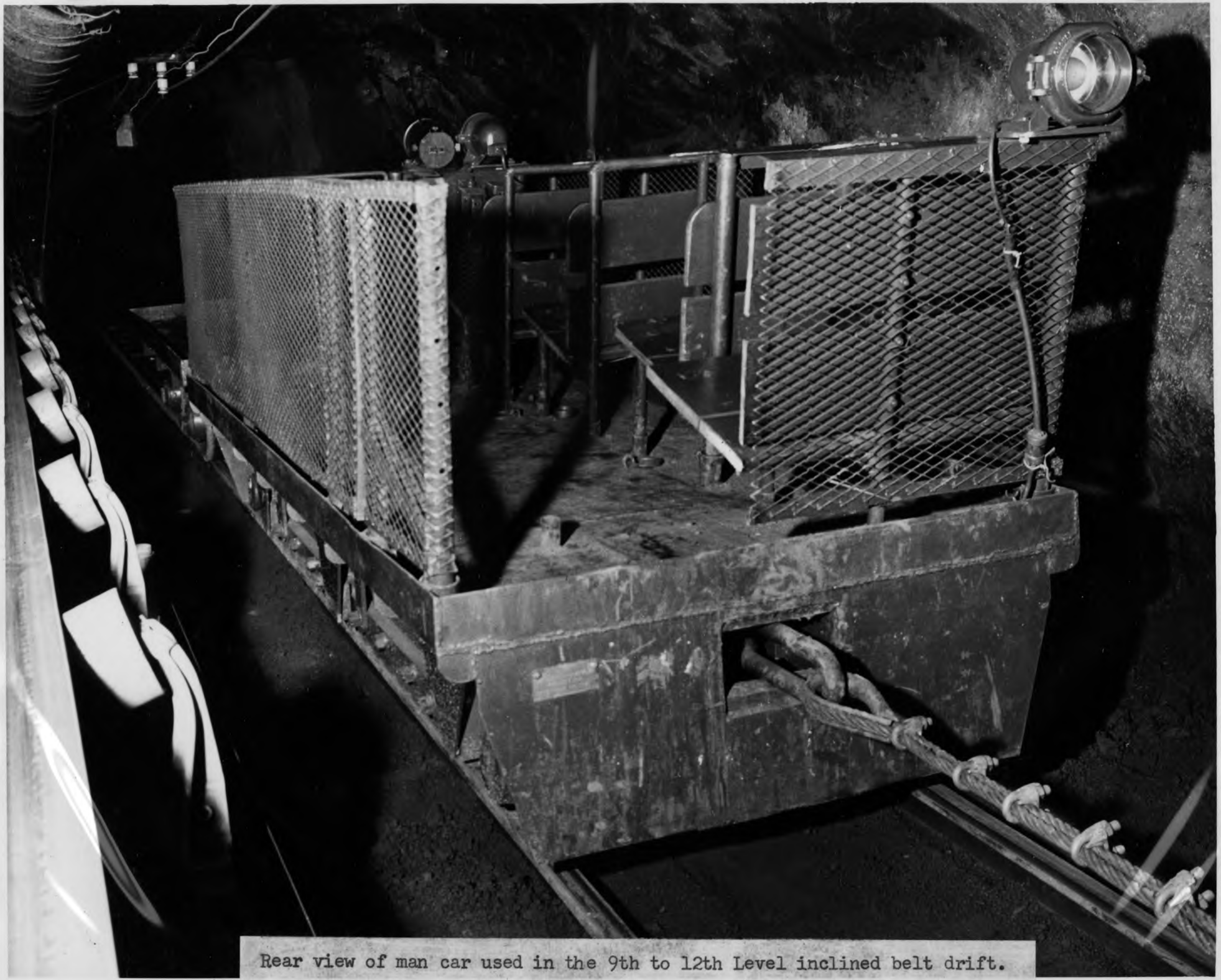
Steel sets continued as the principal means of support. Three different types of yielding steel sets were used in the undercutting drifts. Rigid arch sets were used for the development of sub-level belt conveyor drifts, for cutting over raises and for tugger rooms. A three piece, straight steel set consisting of a 7' cap and 7½' legs was used in transfer drifts. A three piece, straight steel set consisting of a 9' cap and 9' legs was used for main level development.

The use of steel raise tube sections of ¼" plate, 30" long by 42" in diameter was continued in lining main transfer raises.

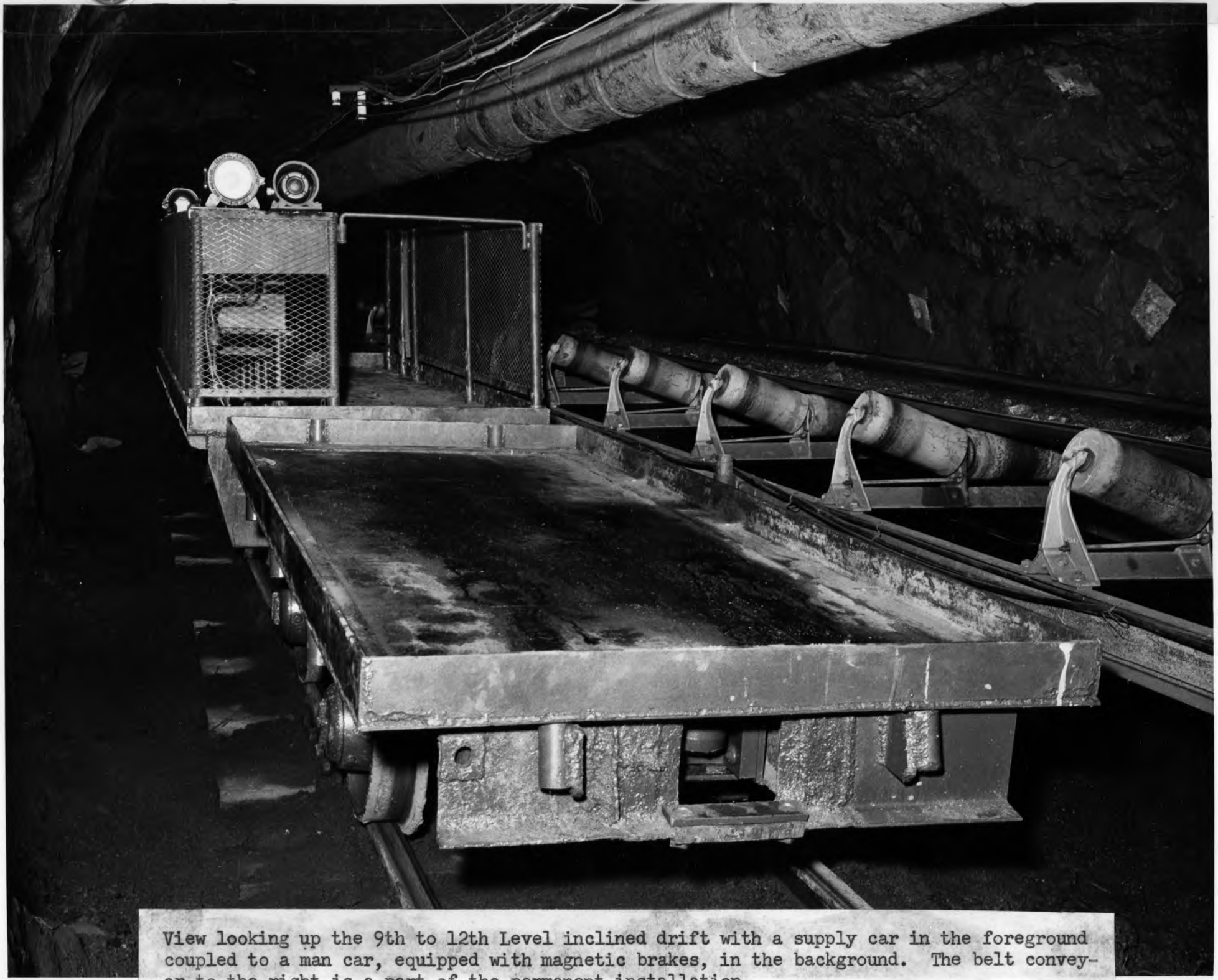
Extensive use of 6" x 6" x 4'4" treated hardwood cribbing was begun during the year in development work above the 9th Level. Mining on the 9th Level is at a height approximately 90' above the main level. Maintenance of long supply and manway raises is minimized by the use of treated cribbing.

The use of sub-level belt conveyors for handling ore has increased. At the end of the year approximately 60% of the total mine production was being handled by belts. Studies show that the efficiency* of the tramming system improved 25% during the past year.

* Tons per man per day based on the number of men required to move the ore from the stopes to shaft.



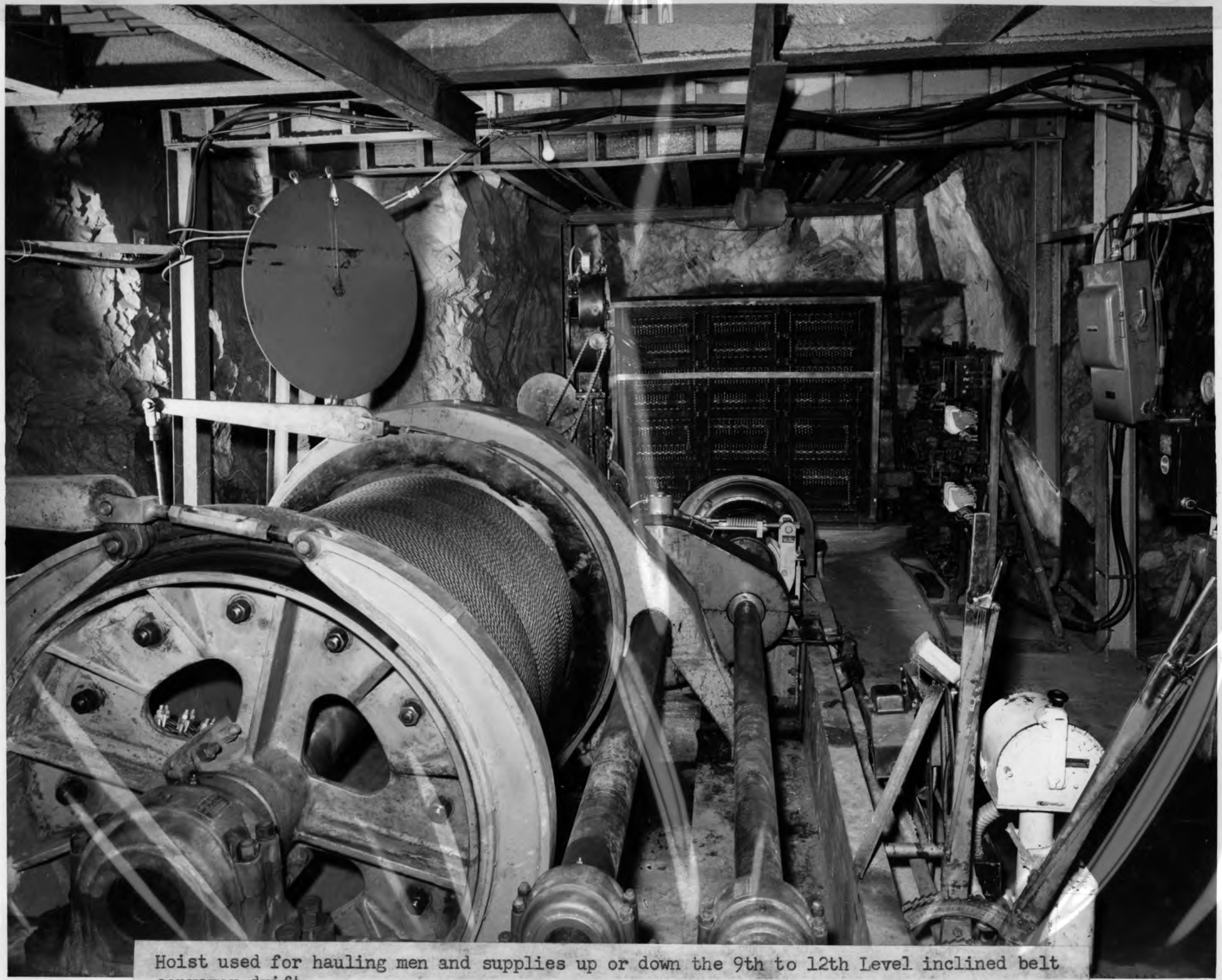
Rear view of man car used in the 9th to 12th Level inclined belt drift.



View looking up the 9th to 12th Level inclined drift with a supply car in the foreground coupled to a man car, equipped with magnetic brakes, in the background. The belt conveyor to the right is a part of the permanent installation.

Rear view of the cat mounted jumbo showing counterweight required to balance the drill machines on the front end.

Front view of cat mounted jumbo, equipped with 3½" drifters, that is used in the inclined belt conveyor drift.



Hoist used for hauling men and supplies up or down the 9th to 12th Level inclined belt conveyor drift.

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8. UNDERGROUND: (Continued)

Statement of Timbering Supplies Used in Operating Accounts

ITEM	AMOUNT	COST PER TON
Cribbing	$ 16,832.80	$.01247
Stulls	620.20	.00046
Lagging	13,688.36	.01014
Poles	9,285.56	.00688
Steel	440,306.29	.32610
Minecrete Supplies	45.49	.00003
Total 1957	$480,778.70	$.35608
Total 1956	$426,142.04	$.34032

Explosives:

The following tables show the cost of explosives used in mining 1,350,201 tons of ore (Table I), the unit costs and consumption of explosives (Table II), and the cost per ton of explosives used in Development for Mining as compared to the cost per ton for mining (Table III).

TABLE I

Cost of Explosives - Operating

	1957	1956
Powder - All Kinds	$102,436.32	$100,849.90
Miscellaneous Blasting Supplies (Fuse, Caps, Bags, etc.)	51,800.41	54,050.11
Total	$154,236.73	$154,900.01

TABLE II

Unit Costs and Consumptions of Explosives

	1957	1956
Pounds of Powder per Ton of Ore	0.387	0.443
Tons of Ore per Pound of Powder	2.590	2.256
Cost per Ton for Powder	$0.076	$0.081
Cost per Ton for Fuse, Caps, etc.	$0.038	$0.043
Cost per Ton for all Explosives	$0.114	$0.124

TABLE III

	1957	1956
Cost per Ton in Development for Mining	$.042	$.042
Cost per Ton in Mining	.072	.082
Total	$.114	$.124

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8. UNDERGROUND: (Continued)

Pumping:

Pumping of underground water from the 3rd and 6th Levels was continued. The average total pumping rate decreased from 425 gallons per minute average in 1956 to 361 gallons per minute average in 1957.

The average pumping rate from the 3rd Level decreased from 59 gallons per minute in 1956 to 49 gallons per minute in 1957, a decrease of 17%.

The average pumping rate on the 6th Level decreased from 366 gallons per minute in 1956 to 312 gallons per minute in 1957, a decrease of 15%. This change is directly related to a decrease in water flow from the Mather Mine, "B" Shaft which commenced pumping a portion of their water from the 6th Level to surface in July. The "B" Shaft water decreased from an average of 182.5 gallons per minute in 1956 to 142 gallons per minute in 1957.

	Mather Mine, "A" Shaft Water G.P.M. Av.	Mather Mine, "B" Shaft Water G.P.M. Av.	Total Water Pumped G.P.M. Av.
1956			
3rd Level	59	-	59
6th Level	183.5	182.5	366
Total			425
1957			
3rd Level	49	-	49
6th Level	170	142	312
Total			361

All mine discharge water is carried through a 16" pipe line and then by ditch to the Carp River, approximately two miles towards the west. In the event of emergency pumping conditions, a second pipe line will provide additional capacity and allow water to discharge at the west end of the timber tunnel.

Additional pumping facilities were provided on the 6th and 9th Levels for emergency conditions.

Three automatic series pumps with a total capacity of 1000 gallons per minute were placed in operation in June to pump to surface. On the 9th Level a 500 gallons per minute horizontal centrifugal pump was installed and a pump base for a 400 gallons per minute centrifugal pump was provided so the pump could be installed within a few hours. Pumping capacities are given below in tabular form.

Pump Station	Capacity & Discharge Level
9th Level	1500 g.p.m. to 6th Level
	400 g.p.m. to 7th Level
7th Level	500 g.p.m. to 6th Level
6th Level	2500 g.p.m. to surface
	500 g.p.m. to 1st Level
3rd Level	950 g.p.m. to surface
1st Level	1250 g.p.m. to surface

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9. TAXES:

Taxes for the year at the Mather Mine, "A" Shaft totaled $399,109.48. The tax rate was $45.35 per $1,000.00 of assessed valuation. As shown in the table below, the 1957 valuation was increased $410,000 over 1956.

	1957		1956	
	VALUATION	TAXES	VALUATION	TAXES
Mather Mine "A" Shaft including Stockpiles, Supplies & Equipment as placed by State Mine Appraiser:				
Real Estate	$6,595,000	$299,083.25	$7,440,000	$303,552.00
Personal Property	2,205,000	99,996.75	950,000	38,760.00
Pipeline - Cloverdale Tract	650	29.48	650	26.52
Total Mather Mine "A" Shaft (Sec. 2, City of Ishpeming)	$8,800,650	$399,109.48	$8,390,650	$342,338.52

	1957		
	TAXES	PER TON PRODUCED	PER TON SHIPPED
Total Operating	$399,109.48	$0.296	$0.293

	1956		
	TAXES	PER TON PRODUCED	PER TON SHIPPED
Total Operating	$342,338.52	$0.273	$0.306

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10. ACCIDENTS AND PERSONAL INJURY:

There were 23 compensable injuries during the year with a lost time of 889 days for these injuries. There were 20 non-compensable injuries, which added 58 days of lost time for a grand total of 947 days. The severity was 870 and the frequency was 39.51 compared with company averages for underground mines of 3,836 on severity and 46.03 on frequency. The total hours worked was 1,088,387 as compared with 1,127,568 in 1956 for a decrease of 3.5%.

DATE	NAME	NATURE OF INJURY	NUMBER OF DAYS LOST
1/23/57	Waino Lehtinen	Partial avulsion, middle and third fingers.	13
1/25/57	Arthur Linna	Fractured right knee.	260
3/ 7/57	Charles Horst	Sprained right shoulder.	7
4/ 3/57	Angelo Moretti	Contusion of dorsum of left foot. No fracture.	7
4/ 8/57	William A. Maki	Cut hand. Fourteen stitches required to close wound.	19
4/12/57	John Treloar	Fracture left clavicle and scapula - ribs left.	90
4/19/57	George Pearce	Severe contusion right costal cartilages.	33
4/30/57	John W. Koski	Contusion & abrasions (severe) right knee.	7
5/23/57	Hugo Sikkila	Spiral fracture distal shaft, left fibula.	68
5/29/57	Matt Maki	Contusion left lower leg anterior.	38
6/ 4/57	Raymond Sarasin	Contusion and laceration right hand.	16
6/18/57	Nick Hautamaki	Compound fracture - right middle finger.	40
7/ 3/57	Uno Kangas	Bruised left instep.	7
8/22/57	Robert Peterson	Sprained right ankle. No fracture.	36
8/26/57	Sulo Helenius	Fracture, right great toe.	17
8/26/57	Louis Marcotte	Compound fracture proximal 5th phalanx, right - 1/3 loss of joint.	25
8/27/57	Walter Peronto	Contusion - right knee.	13
9/11/57	John Pietila	Strained back.	7
9/24/57	Hugh Smail	Laceration and avulsion nail, left index finger.	10
9/30/57	Elzy Hutchens	Fracture right fibula.	49
11/14/57	Anselm Heikkinen	Contusion muscles both thighs.	7
11/14/57	Alger Mattila	Strained back.	60
12/20/57	Willis C. Medlyn	Sprained right wrist.	60
		Total Days Lost	889

MATHER MINE "A" SHAFT
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11. POWER:

A total of 19,663,002 kilowatt hours of electric power was consumed in 1957. This is approximately 1,500,000 kilowatt hours higher than the previous year, and is a direct result of increased production.

The power rate was determined by dividing the total operating cost of the Cleveland-Cliffs Electric Power Department by the total kilowatt hours sold and charging each consumer proportionately. To this is added a wheeling charge by the Upper Peninsula Power Company for distributing this power to the mine.

An additional charge was made for the rental of the Cleveland-Cliffs Iron Company generating equipment. This rental charge is a proportionate amount of $7,375 per month, to be divided between the Mather Mine, "A" and "B" Shafts according to the amount of power consumed on each property.

	CONSUMPTION K.W. HOURS	AVERAGE MAX. DEMAND	AVERAGE DEM. FACTOR	COST OF CURRENT	AVERAGE PRICE PER K.W. HOUR
1957	19,663,002	4200 K.W.	54%	$219,090.30	$.0111
1956	18,229,341	3120	68%	164,413.16	.0090
1955	16,245,161	3620	52%	150,266.76	.0092
1954	14,249,248	3550	46%	132,087.61	.0093
1953	17,431,000	3720	54%	283,853.29	.0164

MORRIS MINE
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1. GENERAL:

The production for the year was 309,150 tons compared with 300,518 tons in 1956. The proportion of tonnage mined from Fee Lands increased in 1957 and will continue to increase as stope development work progresses on the 10th Level.

A working schedule of 2-8 hour shifts per day for 5 days per week has been continued throughout the year. A decrease in efficiency over the previous year is reflected in the comparison of 6.50 tons per man per day in 1957 with 6.74 tons per man per day in 1956. However, when the 10th Level stoping operations are in full production, this figure should improve. Total shipments, 295,685 tons, were less than the production, 309,150 tons. The stockpile carry-over at the end of the year was 43,159 tons.

A substantial increase in the estimated ore reserves, 845,420 tons, was realized mainly due to the 10th Level development work.

Deep-well surface pumping has been continued and an average of 914 g.p.m. was pumped compared with 1,035 g.p.m. in the previous year. The volume of underground water averaged 1,644 g.p.m. compared with 1,600 g.p.m. in 1956. Pumping costs were $.06 per ton for surface drainage and $.56 per ton for underground pumping, a total of $.62 per ton.

2. PRODUCTION, SHIPMENTS AND INVENTORIES:

a. Production

Year	Grade	Tons
1957	Morris	309,150
1956	Morris	300,518

The 1957 production came from Fee and Leased Lands in the following proportions:

	Fee	Leased	Total
Production - Tons	64,540	244,610	309,150
Percentage	20.8%	79.2%	100.0%
Percentage - 1956	18.0%	82.0%	100.0%

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2. PRODUCTION, SHIPMENTS AND INVENTORIES: (continued)

A summary of the total production, Fee and Lease, since the Inland Steel Company took over the Morris Mine Lease is listed below:

	Tons	Percent
Lease Ore Production 1933-1957	5,699,664	75.55
Fee Ore Production 1933-1957	1,844,636	24.45
Total	7,544,300	100.00

b. Shipments

Grade	Pocket	Stockpile	Total
Morris	171,373.07	124,312.20	295,685.27

Grade	Fee	Lease	Total
Morris	59,170.29	236,514.98	295,685.27

The following table shows the shipments for the past five years:

Year	Total
1957	295,685
1956	302,710
1955	335,939
1954	326,001
1953	324,150

Total shipments since Inland acquired lease in 1933 - 7,491,576 tons.

c. Ore in Stock December 31, 1957

Grade	Tons
Morris	43,159

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2. PRODUCTION, SHIPMENTS AND INVENTORIES: (continued)

d. Production by Months

Month	Days Worked	Average No. of Men	Tons Per Man Per Day	Production
January	23	195	6.71	28,570
February	20	195	6.43	25,450
March	21	198	6.29	26,410
April	21	197	5.74	24,079
May	22	197	6.37	27,161
June	20	193	6.13	22,875
July	22	194	6.82	26,872
August	19	194	6.81	24,668
September	20	192	7.08	26,620
October	23	200	7.10	29,645
November	20	188	6.73	24,364
December	20	188	5.80	22,436
Total	251	194.25	6.50	309,150

e. Working Schedule

The mine operated 2-8 hour shifts per day 5 days per week.

f. Delays

There were no significant delays to operations during the year.

3. ANALYSIS:

a. Shipments

Grade	Tons	Iron	Phos.	Silica	Mang.	Alum.	Sulphur	Moisture
Morris	295,685							
Dried		56.086	.081	13.04	.44	2.67	.043	-
Natural		49.844	.072	11.59	.39	2.37	.038	11.13

b. Ore in Stock December 31, 1957 (Natural)

Grade	Tons	Iron	Phos.	Silica	Mang.	Alum.	Sulphur	Moisture
Morris	43,159	50.66	.068	10.76	.37	-	-	11.00

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3. ANALYSIS: (continued)

c. Ore Reserves - Expected Natural Analysis

Grade	Tons	Iron	Phos.	Silica	Mang.	Alum.	Sulphur	Moisture
Morris	3,250,156	48.75	.075	12.00	.44	2.40	.015	12.00
Hi-Sul	296,342	49.06	.090	12.00	.40	2.40	.385	12.00

4. ESTIMATE OF ORE RESERVES:

The estimated reserves, after allowance for ore mined in 1957, shows 845,420 tons of new ore developed. The Cleveland-Cliffs Iron Company's Lands had an increase of 721,791 tons, principally in Deposit #84 above 10th Level due to new development work on the 10th Level. The Chase Leases show a net gain of 123,629 tons with substantial increases in Deposit #33 and #75C below 9th Level, Deposit #86 between 8th and 9th, Deposit #87 between 8th and 9th, Deposit #87 between 9th and 10th, and Deposit #79 above 8th Level. The above increases were due to revised estimates by the Mining Engineer and additional development work on the 9th Level.

	Estimate 9-1-56	Production 9-1-56 to 9-1-57	Estimated Deducting Product	Actual Estimate 10-1-57	Incr. or Decr. from 1956 Estimate
Chase Lease #24	39,342	-	39,342	39,342	-
Chase Lease #24 (High Sulphur)	283,505	19,889	263,616	262,093	1,523
Chase Lease #9	1,803,175	195,098	1,608,077	1,714,452	106,375
Chase Lease #9 (High Sulphur)	45,623	37,569	8,054	26,831	18,777
Total Chase Leases	2,171,645	252,556	1,919,089	2,042,718	123,629
C.C.I. Lands	813,694	57,543	756,151	1,496,362	740,211
C.C.I. Lands (High Sulphur)	27,969	2,131	25,838	7,418	18,420
Total C.C.I. Lands	841,663	59,674	781,989	1,503,780	721,791
GRAND TOTAL	3,013,308	312,230	2,701,078	3,546,498	845,420

5. LABOR AND WAGES:

The labor force went from a high of 200 men in October to a low of 188 men in December. The average of 194 men in 1957 compared with the yearly average of 196 in 1956. The industry-wide wage increase became effective July 1, 1957.

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6. SURFACE:

A major change in the surface facilities was the addition of a "wet" ore trestle. The additional trestle permits the stocking of wet and dry ores on separate stockpiles. The wet pile is allowed to dry before shipping.

Surface Pumping

The table below shows the amount of water pumped from surface wells in December 1956 and 1957:

Well No.	G.P.M. December 1957	G.P.M. December 1956
1	137	87
2	-	10
3	161	170
3A	200	257
5	-	-
8	92	125
9	68	92
10	195	272
Cave #2	20	-
	873	1013

The average drop in the water level in the surface material above ledge, since pumping started in 1937, to December 27, 1957, is shown in the table below:

Test Hole	Drop 8-25-37 to 12-27-57	Depth Remaining To Ledge
501	81.2	13.3
506	66.3	20.9
510	38.9	84.5
511	42.7	111.6
514	31.7	96.2
515	22.1	106.5
517	32.7	79.4
522	27.5	81.4
524	19.5	63.3
527	54.2	20.8
528	15.1	84.4
531	6.7	70.0
534	0.7	94.7
Total	382.9	927.0
Average	29.45	71.31

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6. SURFACE: (continued)

Surface Pumping (continued)

Operating expenses for surface drainage in 1957 amounted to $16,756.00 which was $.06 per ton, the same as 1956.

7. UNDERGROUND:

a. Pumping

The following table shows a comparison of the mine water pumped over a five year period:

Year	4th	6th	7th	8th	9th	10th	Total
1957	46	112	111	495	865	15	1644
1956	51	109	109	476	840	15	1600
1955	57	52	108	509	791	15	1535
1954	72	44	97	554	797	15	1574
1953	76	37	77	546	882	-	1621

The following table shows a comparison of underground pumping cost per ton for the last seven years:

Year	Cost Per Ton
1957	$.56
1956	.61
1955	.51
1954	.46
1953	.55
1952	.65
1951	.49

b. Development

A major development underground was the completion of the ore pass raise from the 9th to 8th Levels in Chase Lease #24, which eliminated the tramming operations on the 8th Level.

On 9th Level, a new main haulage drift was driven South of the mining areas in Deposit #33 to eliminate congestion of tramming ore and supplies.

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7. UNDERGROUND: (continued)

b. Development (continued)

Development continued on the 10th Level both in the Fee Lands stopes and the main level drift to the West. At shaft, the pump room and sump were completed. A new travelling roll-over car dumper was installed and trench facilities completed.

Respectfully submitted,

Ralph E. Magnuson, Jr.

Ralph E. Magnuson, Jr.
Chief Mining Engineer

DPI:jcj

July 24, 1958

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1. INTRODUCTION:

The winter stripping schedule continued during January and February. In March, the heavy-mobile equipment was transferred to the Ishpeming shops for repairs prior to being moved to the Tilden Mine. Pumping of the West Pit continued throughout the winter. The decision not to let the pit flood proved to be of considerable importance because of the emergency move from the Tilden to the Ohio Mine during the first week of May. This change of operations was caused by the breakdown of the Tilden primary crusher.

Extremely heavy rains during the Labor Day week-end caused flooding of the West Pit.

Production of concentrate commenced on May 21. The stripping of surface material and hanging rock was carried on in conjunction with the production of crude ore. Production ceased on August 31 and the heavy equipment was immediately moved back to the Tilden Mine. Upon completion of the Tilden Mine production on September 31, the equipment was moved back to the Ohio Mine to continue the surface stripping program. The Ohio Mine winter stripping season was terminated on December 21. At this time, most of the heavy equipment was moved to the Humboldt Mine for repair and storage.

2. PRODUCTION, SHIPMENTS AND INVENTORIES:

a. Operating Schedule

	No. of Days	Shifts Per Day	Hours Per Shift	Total Shifts
Pit Operating	80	1, 2 & 3	8	130
Mill Operating	85	1, 2 & 3	8	219

b. Pit

	Tons
Ohio-Norwood Crude Ore - Pit to Surge Pile	295,850
Total Crude Ore - Pit to Surge Pile	295,850
Crude Ore Per Day	3,698
Crude Ore Per Shift	2,276
Crude Ore Per Man Day	67.45

c. Mill

Crude Ore - Surge Pile to Mill	295,850
Ohio-Norwood Concentrates - Produced	116,701
Total Ohio Concentrates - Produced	116,701
Concentrate Per Day	1,373
Concentrate Per Shift	533
Concentrate Per Man Day	26.61
Percent of Recovery	39.45

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2. PRODUCTION, SHIPMENTS AND INVENTORIES: (Con't.)

d. Shipments (Gross Tons)

	From Pocket	From Stockpile	Total Year	Remaining Ore in Stock
Ohio-Norwood Concentrates	83,579	33,122	116,701	-
Total Ohio Concentrates	83,579	33,122	116,701	-

e. Stockpile

	Gross Tons
In Stock January 1, 1957	-
Placed in Stockpile, 1957	33,122
Total	33,122
Removed from Stockpile During Year	33,122
Stockpile Balance December 31, 1957	-

f. Production by Months

	Crude Ore Ohio-Norwood	Concentrates Ohio-Norwood
May	32,000	11,251
June	82,400	36,086
July	90,675	33,843
August	90,775	30,894
September	-	3,738*
October	-	889*
Total Tons	295,850	116,701

* Stockpile Overrun

3. ANALYSIS:

a. Analysis of Pit Crude Ore

	Tons	Iron
Ohio-Norwood	295,850	42.27%
Total	295,850	42.27%

b. Tonnage and Analysis of Concentrates Produced and Shipped

From	To	Tons	Iron	Phos.	Sil.	Sul.	Moist.
Pocket	Presque Isle	83,579	52.35	0.195	6.96	0.149	6.27
Stockpile	Presque Isle	33,122	51.91	0.205	8.06	0.138	5.91
Concentrates Out Put		116,701	52.33	0.198	7.13	0.151	6.42

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4. COST OF OPERATIONS:

a. Comparison of 1957 and 1956 Costs

	1957	1956
Total Ohio Mine:		
Production - Concentrates (tons)	116,701	122,401
- Crude Ore (tons)	295,850	225,999
Cost of Production: (Cost per ton of concentrate)		
Pit Expense	$ 0.874	$ 0.646
Crushing and Screening	0.240	0.214
Milling Expense	0.410	0.348
Stocking Expense	0.016	0.006
General Mine Expense	0.335	0.369
Winter and Idle Expense	0.791	0.591
Holiday Pay	0.016	0.591
Cost of Production	$ 2.682	$ 2.174
Taxes	0.147	0.064
Depletion - Original Cost	0.098	0.089
Depreciation	0.667	0.567
Amortization of Stripping	-	-
Shipping Expense	0.111	0.068
Total Cost at Mine Per Ton of Concentrate	$ 3.705	$ 2.962
Total Cost at Mine Per Ton of Crude	$ 1.461	$ 1.604

b. Analysis of Costs

The cost of production at the Ohio Mine during 1957 was $2.682 as compared to $2.174 realized in 1956. This increase is largely due to the large drop in recovery experienced at the Ohio Mine during 1957. The 1956 season was very successful due to a run of crude ore that permitted a 52.08% recovery while the recovery for 1957 was 39.45%. The normal estimated recovery for the Ohio operation is 40%.

To a lesser extent, a heavy maintenance program on pit and mill equipment also added to Ohio expenditures for the year. These repair costs are reflected in both the pit and mill costs as well as the W&I expense.

5. LABOR AND WAGES:

a. Comments

Labor relations between the Cleveland-Cliffs Iron Company and the Ohio Mine Union Local #4681 were excellent throughout the year. By December 31, 1957, forty-six Ohio employees were receiving supplemental unemployment benefits.

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5. LABOR AND WAGES: (Con't.)

b. Report of Vacations Paid

	No. Men	Total Hours	Total Amount	Avg. Rate Per Hour
One week - 40 hours-Vacation Paid	1	40	$ 101.44	$ 2.536
One week - 48 hours-Vacation Paid	7	336	$ 943.92	$ 2.809
Two weeks- 80 hours-Vacation Paid	2	160	$ 513.17	$ 3.207
Two weeks- 84 hours-Vacation Paid	1	84	$ 321.89	$ 3.832
Two weeks- 88 hours-Vacation Paid	2	176	$ 418.00	$ 2.375
Two weeks- 92 hours-Vacation Paid	4	368	$1072.74	$ 2.915
Two weeks- 92½ hours-Vacation Paid	1	92½	$ 280.92	$ 3.037
Two weeks- 96 hours-Vacation Paid	31	2,976	$8637.46	$ 2.902
Three weeks-129 hours-Vacation Paid	1	129	$ 272.71	$ 2.114
TOTAL	50	4,361½	$12562.25	$ 2.880

c. Statement of Production and Wages (Operating - Ore)

	Year - 1957
Production - Concentrates	116,701
Number of Days Operated	85
Number of Shifts Operated	219
Average Daily Product (Tons)	1,373
Average Product Per Shift (Tons)	533
Average Number of Men Employed	59½
Product Per Man Per Day	26.61
Average Wages Per Man Per Day	$ 23.60
Total Amount Paid for Labor During Operating Season	$135,151.50
Labor Cost Per Ton	$ 1.035

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5. LABOR AND WAGES: (Con't.)

d. Annual Statement of Labor

	Statistical Men	Hours	Amount	Average Rate
Mine Payroll:				
Hourly Employees				
Straight Time	50¼	70,924	$171,113.45	$2.413
Overtime		(9,847½)	11,964.08	1.215
Shift Differential - Afternoon		(19,186)	1,308.77	0.068
Shift Differential - Night		(13,044)	1,227.19	0.094
Holiday Allowance		(1,584)	3,853.49	2.433
Worked - Premium Time Only		(479)	1,135.11	2.370
Sunday Premium	—	(3,975½)	1,636.75	0.412
Sub Total	50¼	70,924	$192,238.84	$2.710
Vacation Pay Accrual	—		$ 11,743.61	--
Total Hourly Employees	50¼	70,924	$203,982.45	$2.876
Average Job Class				9
Salaried Employees				
Mine Payroll	2¾	3,722	$ 13,162.32	$3.536
Total Mine Payroll	53	74,646	$217,144.77	$2.909
General Payroll:				
Salaried - Straight Time	2¾	3,709½	$ 10,756.58	$2.899
Salaried - Overtime		(201)	248.67	1.237
Labor from Other Mines	9	12,871	40,928.05	3.179
GRAND TOTAL LABOR	64¾	91,226½	$269,078.07	$2.949
Distributed as Follows:				
Idle Expense	-	-	-	-
Operating Mine	27¾	38,935	$120,782.35	$3.102
Winter and Idle	3½	4,881	14,369.15	2.943
Stripping	31½	44,307	125,980.80	2.843
Uncompleted Construction	-	-	-	-
Other Mines	2	3,005½	7,732.09	2.572
Other Accounts	-	98	213.68	2.180
GRAND TOTAL AS ABOVE	64¾	91,226½	$269,078.07	$2.949

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5. LABOR AND WAGES: (Con't.)

d. Annual Statement of Labor (Con't.)

Average Number of Men

	Hourly	Salaried	General Payroll	Total	Hourly Job Rate
Average - Year	43	2	2	47	9.0

	Days Mine Operated	Tons Ore	Cubic Yards Stripping	Units Per Man Day	Labor Cost Per Unit
Pit Crude Ore	80	295,850	-	67.45	0.140
Mill Concentrating	85	116,701	-	26.61	0.366
Stripping	213		594,471	106.89	0.212

6. OPEN PIT:

a. Stripping Operations

E&A Numbers	Rock Cubic Yards	Surface Cubic Yards	Total Cubic Yards	Amount Expended	
844 907(935(	260,504	333,967	594,471	$161,306.69 $132,294.71 $293,601.40	Rock Surface Total
Cost Per Yard	$ 0.619	$ 0.396	$ 0.494		

b. Cost Comments

The total cost per cubic yard of rock at $0.619 was slightly higher than the yearly estimate of $0.60. Increased powder charges for blasting were the primary cause for this small increase over the budgeted figure. Surface stripping costs were practically identical to the estimate being $0.396 as compared to the budgeted figure of $0.40. The earth stripping costs were running under the budget throughout the early part of the year but were increased during the fall due to the use of a dragline.

c. Detail of Stripping
Ohio-Norwood (West Pit)

Stripping continued throughout the year with the exception of the periods from March 1 to May 10 and from September 1 to October 5.

During the ore production season, stripping of hanging rock and surface material was carried out in conjunction with crude ore production. Stripping was also continued on weekends in order to maintain an adequate supply of ore.

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6. OPEN PIT: (Con't.)

d. Open Pit Mining (West Pit)

Mining of crude ore commenced on May 20 with production being centered in an area 1,400 feet in length (7800W to 9200W). The lowest pit depth reached was the 1520' bench. An area roughly 400 feet in length, located in the western half of the pit, proved to be an extremely lean iron formation and was consequently removed as waste ore. The water problem continued as an estimated 1,200 gallons per minute was continuously pumped in order to keep the pit dewatered.

7. BENEFICIATION:

a. Plant Operations

The plant produced 116,701 tons of concentrate. The shipping analysis of the overall product was 52.33% Fe, 0.198% phosphorous, 7.13% SiO2, 0.151% sulphur and 6.17% moisture. The overall weight recovery was 39.44%. The heavy media concentrate assayed 52.70% Fe, 6.94% SiO2 and represented 35.42% of the crude feed. The fines concentrate assayed 49.96% Fe, 9.86% SiO2 and represented 4.02% of the crude feed.

The feed rate to the plant from the surge pile was 163.63 LTPH gross and 184.39 LTPH net. The feed rate to the heavy media section was 128.74 LTPH gross and 145.08 LTPH net. Concentrates were produced at the rate of 64.55 LTPH gross and 72.73 LTPH net.

Mill delays for 1957 consumed 11.26% of the total plant operating time. The major sources of delays were due to conveyor breakdowns, the classifiers, the heavy media circuit and power failures.

The media loss for the season was 0.484 pounds of ferrosilicon per ton of heavy media feed and 1.08 pounds of ferrosilicon per ton of heavy media concentrate.

During 1957, the crude ore was mined in the West Pit. All of the crude ore mined for treatment in the plant was taken from the Norwood Lease area. For the most part, the crude ore had favorable concentrating characteristics; however, the overall weight recovery was considerably lower than experienced in 1956.

The operating time for the 1957 season was 88.74%. This is somewhat lower than the operating time for 1956 which was 91.16%. One of the largest single delays can be traced to conveyor breakdowns which accounted for 60 of the 204 delay hours or roughly 30% of the total delay time.

Separation Circuit:

1. Primary Preparation

For the most part, no major difficulties were experienced in the primary preparation circuit during the 1957 season. Periodically, large chunks becoming jammed in the pocket or throat of the pocket would cause a delay. However, this was not serious. No major repair jobs were done during the season on the primary section.

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7. BENEFICIATION: (Con't.)
a. Plant Operations (Con't.)

2. Secondary Preparation

The mantle and bowl liner for the Symons crusher was replaced on July 27. The season had started with a new mantle and bowl liner installed. The bowl liner and mantle had been in use for approximately 1,050 hours before replacement was required, and it is estimated that approximately 90,000 tons of crude ore had been fed to the crusher.

Heavy Media Circuit:

The average specific gravities in the heavy media section were as follows: circulating 2.99, float 2.95 and sink 3.04. Recovery in the heavy media circuit was 45.02%, producing a concentrate analyzing 52.70% Fe and 6.94% SiO2. The rate of feed to the drum was 145.08 LTPH net.

Ferrosilicon losses for the season were 1.08 pounds of ferrosilicon per ton of heavy media concentrate and 0.484 pounds per ton of heavy media feed. These very favorable media losses can be chiefly traced to the type of ore being treated and the troughs used for agitating the sink and float products to insure a thorough washing action.

Spiral Circuit:

The special port collectors which divert the primary concentrate from the second and fourth ports of the primary spirals direct to the concentrate classifier were used throughout the 1957 season. Except for rare occasions when the fines section would be temporarily overloaded, only half of the available spirals were used.

Jig Circuit:

The 24 x 36 Denver duplex jig was operated periodically during the 1957 season. At times, it was difficult to effect a favorable separation in the jig circuit due to the small differential in gravity existing between the rich iron particles and the leaner iron particles. During the 1957 season, roughly 25% of the time the classifier sands were diverted directly to the concentrate classifier, bypassing the jig circuit.

Metallurgy:

Routine samples, such as media loss samples, royalty samples and samples for structure analyses were collected during the year for plant control studies. Several checks were also obtained of the car tops to obtain a correlation between the production analyses obtained by using the sample cutter located at the end of the concentrate belt versus the results obtained by sampling car tops.

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7. BENEFICIATION: (Con't.)

b. Plant Delays

Source of Delay	Total Delay Hours	% of Total Delay Hours	% of 1808 Working Hours
1. Startup	8.25	4.05	0.46
2. Conveyors	60.06	29.51	3.32
3. Tunnel Feeder	9.78	4.80	0.54
4. Ripl-Flo Screen	9.96	4.89	0.55
5. Symons Crusher	9.25	4.54	0.51
6. LoHead Screen	12.00	5.89	0.66
7. Drum Separator	-	-	-
8. Drain and wash screens	6.85	3.36	0.37
9. Pumps	8.15	4.00	0.45
10. Wash and conc. classifiers	12.25	6.02	0.68
11. Spiral Circuit	-	-	-
12. Conc. Pocket	0.50	0.25	0.03
13. Chutes and Transfer Points	4.67	2.29	0.25
14. 3 x 10 Screen	6.00	2.95	0.33
15. Media Circuit	14.17	6.96	0.78
16. Hydroseparator	1.50	0.74	0.09
17. Power Failure	12.25	6.02	0.68
18. Cold Weather	2.00	0.98	0.12
19. Tailings Line	17.50	8.60	0.96
20. Magnetic Separators	3.00	1.47	0.18
21. Shutdown	5.45	2.68	0.30
Total	203.59	100.00	11.26

Operating Time - 1957 Season - 88.74%

c. Surge Pile Balance

	Tons	% Fe	% SiO2
Crude Ore on Surge Pile - May 21, 1957	None		
Crude Ore on Surge Pile from Pit during 1957 Season	295,850		
Crude Ore from Surge Pile to Plant - 1957 Season	295,850		
Crude Ore on Surge Pile - September 1, 1957	None		

Concentrate Stockpile Balance

Concentrate Stocked during 1957 Season	33,122		
Concentrate Shipped from Stockpile - 1957 Season	33,122		
Stockpile Balance - September 1, 1957	None		

Heavy Media Reject Pile Balance

H.M. Reject Pile - May 21, 1957	486,481	32.33	
H.M. Rejects to Pile during 1957 Season	127,976	32.80	
H.M. Reject Pile - September 1, 1957	614,457	32.43	
Less 6,192 tons used in road building			
4,550 tons to Ore Improvement Plant			
10,742	10,742		
Balance	603,715	32.43	

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7. BENEFICIATION: (Con't.)

d. Royalty Samples

Size	% Wt.	Cuml. % Wt.	% Fe	% SiO2	% Phos.	% Sul.
≠ 1-1/2"	2.97	2.97	39.21	24.25	0.016	0.023
≠ 1"	16.02	18.99	49.88	12.18	0.166	0.185
≠ 3/4"	25.23	44.22	52.26	7.60	0.180	0.091
≠ 1/2"	18.37	62.59	52.77	6.62	0.207	0.061
≠ 3/8"	13.37	75.96	53.34	6.72	0.193	0.106
≠ 3 Mesh	6.75	82.71	53.32	5.90	0.219	0.285
≠ 6 Mesh	4.94	87.65	53.53	6.29	0.218	0.168
≠ 8 Mesh	2.15	89.80	50.42	9.15	0.210	0.269
≠ 10 Mesh	2.91	92.71	46.91	11.52	0.205	0.308
≠ 14 Mesh	1.12	93.83	46.38	11.58	0.204	0.192
≠ 20 Mesh	0.86	94.69	47.24	10.52	0.213	0.236
≠ 28 Mesh	0.91	95.60	48.31	9.54	0.214	0.260
≠ 35 Mesh	0.76	96.36	50.59	8.36	0.202	0.272
≠ 48 Mesh	0.86	97.22	51.84	7.97	0.191	0.265
≠ 65 Mesh	0.83	98.05	51.37	8.73	0.194	0.273
≠100 Mesh	0.70	98.75	52.53	8.92	0.191	0.264
-100 Mesh	1.25	100.00	52.44	9.50	0.216	0.236
Total	100.00	-	51.50	8.64	0.187	0.139

e. Heavy Media Loss

	Lb. FeSi Dumped	Tons H.M. Feed	Tons H.M. Conc.	FeSi Loss #/ton H.M. Feed	FeSi Loss #/ton H.M. Conc.	% Recovery
May	10,412	21,521	10,149	0.484	1.03	47.16
June	39,759	66,028	33,778	0.602	1.18	51.16
July	24,582	73,099	31,734	0.336	0.775	42.92
August	37,943	72,121	29,132	0.526	1.30	40.39
Grand Total-1957	112,696	232,769	104,793	0.484	1.08	45.02

Media Loss by Inventory

	Barrels	Pounds
On hand - May 20, 1957	76	41,626
Received during 1957	231	123,446
Total	307	165,072
Used during 1957	209	112,696
Balance - September 1, 1957	98	52,376

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7. BENEFICIATION: (Con't.)

f. Average of Plant Products

	Tons	% Wt.	% Wt. Crude	% Fe	% P.	% SiO2	% S.
Plant Head	295,850						
H.M. Concentrate	104,793	45.02	35.42	52.70		6.94	
H.M. Reject	127,976	54.98	43.26	32.80			
H.M. Feed	232,769	100.00	78.68	41.76			
Fines Concentrate	11,904	28.55	4.02	49.96		9.86	
Fines Tailing	29,791	71.45	10.07	42.85			
Fines Feed	41,695	100.00	14.09	44.88			
Hydroseparator Overflow	21,386		7.23	42.63			
Calculated Plant Head	295,850		100.00	42.27			

Concentrates

	Tons	% Wt.	% Wt. Crude	% Fe	% P.	% SiO2	% S.
H.M. Concentrate	104,797	89.80	35.42	52.70		6.94	
Classifier Concentrate	11,904	10.20	4.02	49.96		9.86	
Calculated Total Conc. (by Plant Analysis)	116,701	100.00	39.44	52.42		7.24	
Total Concentrate Shipped from Pocket	83,579			52.35	0.195 Moist.	6.96 6.27%	0.149
Total Concentrate Shipped from Stockpile	33,122			51.91	0.205 Moist.	8.06 5.91%	0.138
Total Concentrate (by Car Analyses)	116,701			52.33	0.198 Moist.	7.13 6.17%	0.151

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7. BENEFICIATION: (Con't.)

g. Hourly Operating Rates

	Tons	Gross Hrs. Operation	Net Hrs. Operation	LTPH Gross	LTPH Net
Stockpile to Plant					
1957 Season	295,850	1808.00	1604.41	163.63	184.39
1956 Season	225,999	1636.00	1491.30	138.14	151.54
1955 Season	208,404	1632.00	1395.95	127.70	149.29
1954 Season	276,559	2117.00	1679.00	130.64	164.72
Heavy Media Feed					
1957 Season	232,769	1808.00	1604.41	128.74	145.08
1956 Season	172,087	1636.00	1491.30	105.19	115.39
1955 Season	172,134	1632.00	1395.95	105.47	123.31
1954 Season	194,669	2117.00	1679.00	91.95	115.94
Fines Feed					
1957 Season	41,695	1808.00	1604.41	23.06	25.99
1956 Season	46,621	1636.00	1491.30	28.50	31.26
1955 Season	27,977	1632.00	1395.95	17.14	20.04
1954 Season	68,644	2117.00	1679.00	32.43	40.88
Concentrates					
1957 Season	116,701	1808.00	1604.41	64.55	72.73
1956 Season	122,401	1636.00	1491.30	74.82	82.08
1955 Season	117,528	1632.00	1395.95	72.01	84.19
1954 Season	101,776	2117.00	1679.00	48.08	60.62

Plant Operating Time

1957 Season	88.74%	
1956 Season	91.16%	
1955 Season	85.54%	
1954 Season	79.31%	- (90.37% would be the 1954 operating time discounting 259.33 hours lost in April and May due to cold weather and the breakdown of conveyor #1.)

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8. GENERAL SURFACE:

a. Buildings and Repairs

A shelter sized 6' x 22' was added to the garage for the storage of tires and tubes used for heavy equipment.

b. Roads, Transmission Lines, Etc.

No changes or additions were made to the main roads or transmission lines. A temporary access road to the pit along the footwall contact was prepared during the fall stripping season.

9. ORE RESERVES (CONCENTRATES):

a. Tonnage Estimate

	Proven Plus Probable	Prospective	Total
Webster Ore Reserves (Tons)	-	-	-
Portland Ore Reserves (Tons)	-	-	-
Ohio-Norwood Ore Reserves (Tons)	245,000	-	245,000
Beaufort Ore Reserves (Tons)	-	-	-
Total Ohio Mine Ore Reserves (Tons)	245,000	-	245,000

b. Estimated Analysis for Remaining Reserve

	Iron	Phos.	Sil.	Sul.	Moist.
Ohio-Norwood Concentrate (Dried)	52.33	0.19	17.18	0.15	-
Ohio-Norwood Concentrate (Natural)	48.97	0.18	6.72	0.14	6.42

10. EXPLORATION AND FUTURE EXPLORATION:

(None)

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7.82 F.U.B. Mine

11. TAXES:

a. Comparative Statement of Taxes for the Year 1957 and 1956:

	1957		1956	
	Valuation	Taxes	Valuation	Taxes
Spurr Township, Barage County		50.03		
Ohio Mine, etc. Real	$295,600	$14,788.84	$207,800	$ 9,870.50
Ohio Mine Personal Property	60,000	3,001.80	76,000	3,610.00
Collection Fee		177.91		134.81
Total Spurr Township	$335,600	$17,968.55	$283,800	$13,615.31
Tax Rate		$ 55.47		$ 47.50

b. Detail of Valuation and Taxes

	1956	1957	Increase	Decrease
Value	$283,800	$335,600	$51,800	-
Taxes	$13,615.31	$17,968.55	$ 4,353.24	

12. ACCIDENT AND PERSONAL INJURY:

One compensable accident occurred at the Ohio Mine resulting in the severence of an index finger of a tractor operator.

13. PROPOSED NEW CONSTRUCTION:

(None)

14. EQUIPMENT RECEIVED AND PROPOSED NEW EQUIPMENT:

a. Equipment Received

Four International 24-ton Payhaulers were received to replace the original 22-ton Euclid trucks.

One 60-HP centrifugal pump was acquired to help control the excessive flow of water into the pit.

One Ford F-600 service truck was received to replace the 1951 Ford service truck that no longer was suitable for highway use.

b. Proposed New Equipment

(None)

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1. GENERAL:

The Republic Mine operated for nine months on ore production and for three months on the regrinding of stockpiled concentrates during 1957. Ore production was maintained from January 7th to March 4th and from May 27th to the end of the year. During the intervening periods, stockpiled concentrates were returned to the plant for additonal grinding prior to shipment to the pelletizing plant or restocking. This practice was discontinued after more grinding capacity was added to the pelletizing plant flowsheet.

A five day per week work schedule was followed until April 1st at which time the regrinding program was extended to a seven day per week basis. With the return to production on May 27th, the five day per week schedule was resumed. On October 7th, the schedule was cut back to a four day per week basis which was continued for the remainder of the year. The pit and crushing plant operated on a one to one and a half shift per day basis while the concentrator operated generally on a three shift per day schedule. Stripping was done on one, two or three shifts per day as permitted by availability of men and equipment.

Major construction projects during the year consisted of (1) the development of the First Addition to the plat of Republic and (2) the moving of 27 dwellings and a church from the vicinity of the mining area. In addition, seven houses were purchased which are to be torn down by the previous owners. The houses involved were located in the Park City - West Republic area and on School Street.

The performance of both pit and plant facilities through the year was generally excellent. Delays due to operating problems and equipment failures remained at a minimum. Feed rates both to the crushing plant and concentrator improved over last year. The ore processed during the year was mined to a large extent from areas near the footwall in contrast to predominantly hangingwall ores mined in 1956. This crude ore was somewhat lower in iron content and generally more difficult to treat than the hangingwall ores. However, the concentrate produced from this more difficult type ore was more readily pelletized than concentrates produced from hangingwall material. As a result, a greater tonnage of the more refractory ore was treated, which resulted in a lower weight recovery for the year as a whole.

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2. PRODUCTION, SHIPMENTS AND INVENTORIES:

a. Operating Schedule:

	No. of Days	Shifts Per Day	Hours Per Shift	Total Shifts
Mining	178	1 & 2	8	199
Hauling & Crushing	178	1 & 2	8	199
Mill Operating	182	1, 2 & 3	8	535

b. Production by Months:

Month	Tons of Crude Crushed	Tons of Crude Milled	Tons of Concentrates
January	57550	55581	25203
February	64928	64921	27735
March	3920	5896	2828
April	0	0	0
May	12359	10135	5123
June	75761	78295	40548
July	84988	82828	42658
August	81450	82218	44161
September	78500	77038	36430
October	76532	78129	35372
November	59145	61217	32447
December	75107	69928	31355
TOTAL YEAR - 1957	670240	666186	323860
TOTAL YEAR - 1956	395185	395185	217166

c. Production Averages:

	Year 1956	Year 1957
Average Crude Ore Per Day	2971 Tons	3765 Tons
Average Concentrates Per Day	1574 Tons	1779 Tons
Tons Per Man Per Day - Crude Ore	33.15 Tons	40.98 Tons
Tons Per Man Per Day - Concentrate	18.22 Tons	19.80 Tons
Average Weight Recovery	54.95 %	48.61 %

d. Tonnage and Analysis of Concentrate Produced and Shipped:

	Tons	Iron	Phos.	Sil.	Sul.	Moist.
On Hand Dec. 31, 1956	132027	63.24	.039	8.10	.006	5.26
Produced Year 1957	323860	63.11	.034	8.52	.007	5.86
Pocket to Pellet Plt.	105489	63.00	.038	8.51	.005	6.08
Stkpile to " "	210430	63.32	.036	8.24	.007	6.21
On Hand Dec. 31, 1957	139968	63.23	.035	8.39	.007	5.67

e. Estimated Production and Analysis:

	Tons	Iron	Phos.	Sil.	Sul.	Moist.
Dried	286380	63.10	.028	8.82	.013	-
Natural	306289	59.00	.026	8.25	.012	6.50

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2. PRODUCTION, SHIPMENTS AND INVENTORIES: (CONT'D.)

f. Stockpile Regrind:

	Year 1956	Year 1957
Stockpile Regrind Produced	29811 Tons	* 160776 Tons
Gain or Loss	2100 Tons	6273 Tons
Feed to Mill	31911 Tons	154503 Tons
Ending Inventory in Bins	3237 Tons	0 Tons
Stockpile to Crusher	35148 Tons	151266 Tons

* Higher moisture content than incoming feed.

g. Operating Schedule Stockpile Regrind:

	No. of Days	Shifts Per Day	Hours Per Shift	Total Shifts
Hauling and Crushing	67	1	8	67
Mill Operating	75	1, 2 & 3	8	193

h. Production Averages Stockpile Regrind:

	Year 1956	Year 1957
Average Stockpile to Crusher Per Day	1674 Tons	2258 Tons
Average Concentrates Produced Per Day	1574 Tons	2144 Tons
Tons Per Man Per Day from Stockpile	28.74 Tons	46.94 Tons
Tons Per Man Per Day - Produced	24.37 Tons	49.90 Tons

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3. ESTIMATE OF ORE RESERVES:

a. Estimated Reserves:

The reserves shown in last year's report were revised upward based on a change in factor from 15 to 11 cu. ft. per ton for ore in place. The new figure which is still conservative is based on specific gravity determinations and bank measure. Some adjustment was also made where work during the year indicated that actual contacts were different to those previously assumed from earlier studies.

Proven and Probable Ore as of January 1, 1958

Main pit to elevation 1100 and Park City to elevation 1200 using a conversion factor of 11 cu. ft./ton.

Elevation	Total Crude	Total Concentrates *
1500	25,985,088	12,992,544
1400	28,366,913	14,183,456
1300	29,403,430	14,701,715
1200	29,956,799	14,978,400
1100	17,259,612	8,629,806
Total	130,971,842	65,485,921

* Concentrates calculated at 50% recovery.

Elevation	Stripping Cu. Yds. Surface	Cu. Yds. Rock	Cu. Yds. Equiv. Stripping *
1500	846,085	769,581	2,616,121
1400	741,039	2,966,742	7,564,546
1300	602,344	4,976,437	12,048,149
1200	718,963	8,654,711	20,624,798
1100	1,013,751	8,623,810	20,848,514
Total	3,922,182	25,991,281	63,702,128

* Rock calculated at a factor of 2.3 for equivalent stripping.

b. Estimated Analysis:

	Iron	Phos.	Sil.	Sul.	Moist.
Dried	63.10	.028	8.82	.013	-
Natural	59.00	.026	8.25	.012	6.50

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4. LABOR AND WAGES:

a. General:

While on ore production the total number of hourly rate and salaried employees on the mine payroll ranged from 88 to 91 men.

Labor relations were generally satisfactory during the year and no grievances were filed.

A wage increase went into effect on July 1, 1957 which amounted to a general increase of .07 per hour, plus a .002 increment increase between job classes. The cost of living adjustment was .03 per hour to July 1, 1957 at which time it was increased to .07 which continued to the end of the year. Also effective July 1, 1957 the Sunday premium increased to 20% of the standard hourly rate and the holiday premium for hours worked became double time and one-tenth.

b. Report of Men Hired, Transferred and Separated:

Month	Total Beginning of Month	New	Trans. Fr. Other Mines	Total Men	Trans. To Other Mines	Lay-Off	Quits	Total End of Month
January	69	7	15	91				91
February	91			91				91
March	91			91		17		74
April	74	9		83				83
May	83	5		88				88
June	88	2		90				90
July	90			90				90
August	90			90			1	89
September	89	1		90				90
October	90			90		9		81
November	81		11	91	1	1		90
December	90			90	1			89
TOTAL	69	24	26	119	2	27	1	89

The above table included only hourly and salaried men on the Republic Mine Payroll.

c. Report of Vacations Paid:

	Year	No. Men	Total Hours	Total Amount	Avg. Rate Per Hour
Actual	1956	35	2080	$ 5728.48	$ 2.754
Est.	1957	93	4880	14700.00	3.012
Actual	1957	87	4870	12652.86	2.598
Est.	1958	85	5420	$ 14880.00	$ 2.745

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4. LABOR AND WAGES: (CONT'D.)

d. Annual Statement of Labor:

	Stat. Men	Hours	Amount	Average Rate
Hourly Employees				
Straight Time	79¼	165078½	$ 400452.19	2.426
Overtime		9392½	11420.76	1.216
Sunday Premium Time		2901½	891.08	0.307
Shift Diff. - Aft.		49269	3017.86	0.061
Shift Diff. - Nite		1637½	1494.62	0.091
Holiday Allowance		4576	11222.38	2.452
Jury Pay		16	27.84	1.740
Vacation Pay		4870	12652.86	2.598
Total Hourly Employees	79¼	165078½	441179.59	2.672
Salaried Employees				
Mine Payroll	5¼	10823	38055.82	3.516
Total Mine Payroll	84½	175901½	479235.41	2.724
General Payroll				
Salaried Straight Time	4	8464½	23242.56	2.746
Overtime		58	71.24	1.228
Labor from Other Mines	3¼	6585	20335.18	3.088
TOTAL LABOR	91¾	190951	522884.39	2.738
Distributed as Follows:				
Operating Republic Mine	63	130836	356420.97	2.702
Stockpile Regrind	12¼	25779	66774.95	2.590
Idle Expense	-	0	0	0
Stripping	10⅜	2231½	63749.58	2.857
Uncompleted Construction	2⅝	5684	16881.54	2.970
Other Mines	2½	5113½	15724.47	3.075
Other Accounts	½	1224	3332.88	2.722
Total as Above	91¾	190951	522884.39	2.738

e. Labor Cost:

	Year 1956	Year 1957
Production of Concentrates - Long Tons	217,166 Tons	323860 Tons
Number of Days Operated	138	182
Number of Shifts Operated	384	535
Average Daily Production - Concentrates	1,574 Tons	1779 Tons
Average Production Per Shift	566 Tons	605 Tons
Tons Concentrate Per Man Per Day	18.22	19.80 Tons
Average Wages Per Man Per Day	20.17	21.90
Average Job Class	10.20	10.1
Total Amount Paid for Labor (Production)	$232,836.29	$356,420.97
Labor Cost Per Ton of Concentrate	$1.072	$1.101

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5. GENERAL SURFACE:

a. Buildings and Repairs:

Much of the mining activity during the year was near the primary crusher building and consequently some damage resulted to this building from fly rock. Holes in the sheeting were repaired and two structural members were replaced, restoring this building to first class condition.

b. Roads and Grading:

The road paralleling the railroad track at the concentrate loading pocket has widened 25 feet for a length of approximately 900 feet.

The stockpile grounds were widened by approximately 125 feet and lengthened by 800 feet.

An area was filled and graded east of the Driox unit, between the two railroad tracks for a scrap yard.

c. Water Supply:

A 6" water line was installed from the vicinity of the mill building to the stockpile grounds to supply water for the sprinkler system used for stockpile dust loss control.

The sump below the reuse pump house was lined with concrete and a more effective screening system was installed ahead of the sump.

A water dock consisting of a 6" insulated elevated water line was installed south of the primary crusher building for filling the water truck. This truck is used to supply the jet piercing machine with water and for road sprinkling service.

d. Tailings Disposal:

An installation consisting of three 24" cyclones, a pump, power facilities and 5000' of 6" spiralweld pipe was erected at the discharge end of the present mill tailing line. This will be used during summer months to pump the bulk of the solids contained in the tailings to the deep end of the tailing pond for storage and dike reinforcement.

No. 1 Dike was raised three to four feet using 2052 cu. yards of stripping earth. A total of 3152 cu. yards of stripping rock was hauled to dike No. 2 and 11085 cu. yards was hauled to dike No. 4 to reinforce these dikes.

A weir was installed between the tailing dam outlet and Milwaukee Lake to determine water flow rates.