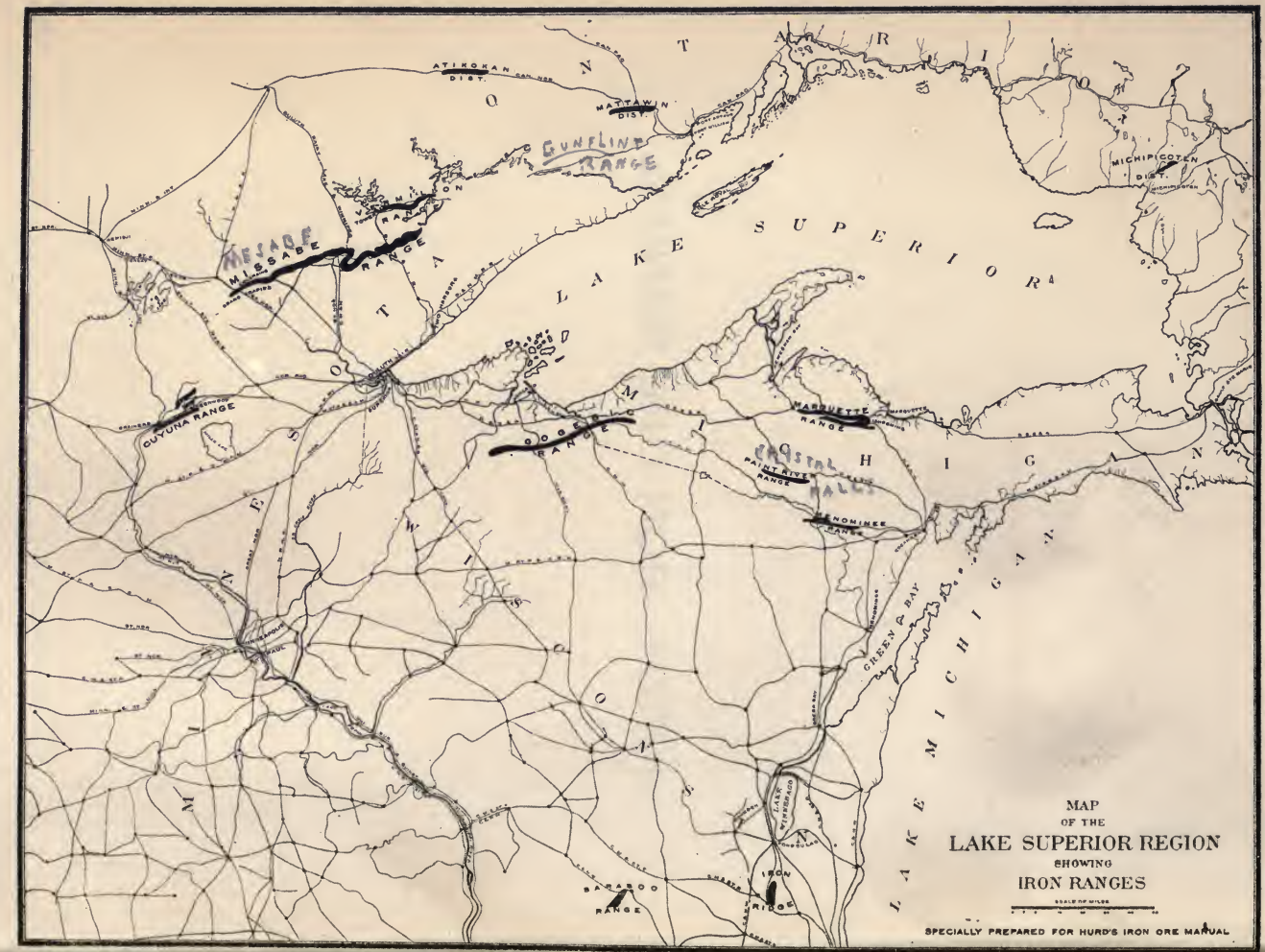
Iron Ore Manual

Lake Superior District

1911 Values

RUKARD HURD

HURD'S IRON ORE MANUAL


ONTARIO
ATIKOKAN DIST.
MATTAWIN DIST.
GUNFLINT RANGE
MICHIPICOTEN DIST.
MESABE
MISSABE RANGE
VERMILION RANGE
LAKE SUPERIOR
GUYUNA RANGE
GOGEBIC RANGE
MARQUETTE RANGE
CRYSTAL FALLS
PAINT RIVER RANGE
MENOMINEE RANGE
MINNESOTA
WISCONSIN
MICHIGAN
LAKE MICHIGAN
GREEN BAY
LAKE WINNEBAGO
BARABOO RANGE
IRON RIDGE
MAP
OF THE
LAKE SUPERIOR REGION
SHOWING
IRON RANGES
SCALE OF MILES
SPECIALLY PREPARED FOR HURD'S IRON ORE MANUAL

Hurd's Iron Ore Manual

A

General Reference, Guide, Hand Book

OF THE

Lake Superior District

WITH

Values Based on 1911 Prices and Guarantees at Lake Erie

Method of Determination

OF

Prices, Premiums and Penalties

Tables of Values

AND

Statistical Data

BY

RUKARD HURD, C. E.

Secretary Minnesota Tax Commission

Price, $7.50 Postpaid

F. M. CATLIN, SALES AGENT
510 CAPITAL BANK BLDG.
ST. PAUL, MINN.

1911

SYNDICATE PRINTING COMPANY
MINNEAPOLIS, MINN.

THIS WORK IS DEDICATED TO
MY DEAR WIFE
KATHERINE HATFIELD HURD

TABLE OF CONTENTS

Introduction

Mining engineering, exploration and drilling, outlining of ore bodies, horizontal and vertical sectioning and cross-sectioning of the ore bodies and of the intermediate layers of other material, showing results of innumerable chemical analyses, have reached a high degree of efficiency. Many operators, especially on the Mesaba Range, know in advance for years to come, the exact grades of ores they can mine and ship, what tonnages to group and how to raise to standard sub-grade ore.

Chemical analyses are so important that everywhere is found the ore sampler—at drills for every five feet of drilling, in test pits, in open pits, underground, at mine stock pile, in cars at mine, in cars at upper dock, in vessel at upper dock, in vessel at lower dock, at lower dock stock pile, in cars at lower dock, in cars at furnace, in stock pile at furnace—so vital is it for the mine and furnace operators to have the most accurate information of the ores to be reduced to metal.

What is iron ore worth? How is its value determined?

The ores of the Lake Superior District, Bessemer and non-Bessemer, of the *Old Range, Vermilion and the Mesaba, while varying in some respects, are generally similar as to contents, physical characteristics and structure. These conditions made it possible for producing and consuming interests** to agree and to establish on these ores a standardization of grades and prices and providing premiums for over-standard and penalties for sub-standard ores, based upon metallurgical principles. A great economic achievement was thereby realized. Mining and ore reduction could then proceed along lines of business order, stability and permanency. The system as a whole has given satisfaction to all concerned. Any defects appearing in the calculations, for the extremes of sub-standard values, and for over-standard values made by using arbitrary premiums instead of units or parts of units, can by agreement be corrected, To make the "basic system" consistent throughout a re-classification of grades and prices is evidently necessary, as will appear from a study of net values herein considered.

The law of supply and demand fixes the price for standard ores of basic values and the uniformity of the "basic system" places each furnace on an equality in having to pay the same price for such standard ores. This equality should extend to the sub-standard ores. While the reduction of ores is not a fixed science, and the cost varies according to furnace location, conditions and management, there should be established a closely approximated uniform reduction cost and a scientific penalization that will give an actual commercial value and a fair profit to present non-marketable ores.

In the absence of published explanation, the "basic system" has seemed very intricate, confusing and mysterious to mining men generally, and all along the line from mine to furnace, time and labor are consumed and wasted in miscalculating values and misapplying premiums and penalties. Even ore

*The Marquette, Menominee and Gogebic iron ranges as a group have the trade name, Old Range.

**The Lake Superior Ore Association organized January 14, 1905.

experts do not agree in their interpretations of the system, and many tables in use show discrepancies. It has therefore been difficult to reconcile and harmonize these differences.

Simple mathematical calculations can remove the confusion and make the subject comprehensible. Non-technical language has been used to explain the various steps followed in formulating (1) A method for the determination of prices, premiums and penalties; (2) a series of illustrative mathematical schedules; (3) reference tables of iron ore values at Lake Erie, for each percentage and fraction thereof covering all grades of standard iron ores of the Lake Superior district.

The owner and lessee of developed iron ores of known analyses may see at a glance what his ore is worth and how to determine its possible increase or decrease in value. The furnace man is able to know in like manner what he will have to pay for ore under a wide range of prices and of base unit values.

Time, weight, distance, measure, money, interest, discount, have all been determined and reference tables constructed for use in calculations. It is hoped that the tables here presented will prove valuable when iron ore values are considered.

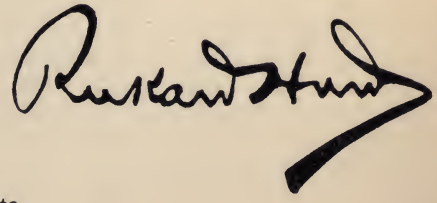
During the study of the iron ore situation considerable data had to be prepared and many sources were consulted. The information was widely scattered. Everything of known possible technical or historical worth has been assembled, consolidated and incorporated in, or written for, this Iron Ore Manual of the Lake Superior District. The general statistics are introduced to show the connection and relation between the raw and finished products. The desire is to furnish those interested, especially heads of departments in general offices, mines and furnaces, a ready general reference, guide, hand-book on iron ore.

The iron ore districts of New York, New Jersey, Alabama, Tennessee and Colorado, on account of their limited extent and production, ownership by consuming interests and without a basic system of valuation of ores, are not now considered.

Herein are given: Values and their determining method, Minnesota taxation and its methods, shipments, prices, transportation, net values with cost of production and delivery, rule for determining present values of iron ore royalties, prices and production of pig iron, geology and mineralogy, latest special reports, publications, concluding with the iron ore reserves of the United States.

The information credited to the Iron Trade Review, Marine Review, Iron Age, American Iron and Steel Association, United States Geological Survey Reports and Congressional Reports and that found in the Engineering and Mining Journal, has been of great service and statistical value.

Suggestions and criticisms for use in future editions are invited.



State Capitol, St. Paul, Minnesota.

April 21, 1911.

Method and Determination
OF
1911
Prices, Premiums and Penalties
at Lake Erie
OF
Natural Iron Ores
OF THE
Lake Superior District
Governed by 1911 Basic Guarantees
WITH
Illustrative Schedules
AND
Tables of Iron Ore Values

By RUKARD HURD, C. E.

GOVERNING FACTORS

To determine the furnace value of natural iron ore, as mined, many factors must be considered, such as: Percentages of content, physical characteristics and structure, lump value, density, porosity and availability. The percentage of natural iron content is the governing factor in all ore contracts.

THE IRON UNIT

The primary determinant for calculating values of natural iron ore is the "Iron Unit" of one (1) per cent of a long ton, such ton containing one hundred (100) units of one (1) per cent each.

THE IRON UNIT VALUE

The percentage of natural iron, that is, the number of determining "Iron Units" contained therein, is found by expelling the moisture, always present in natural iron ore, by drying the sample at 212 degrees F., and analyzing the dried sample. Deducting the percentage of moisture found in the natural iron sample from one hundred, and multiplying the remainder, expressed decimally, by the percentage of iron found in the dried sample the result is the percentage of natural iron, the iron unit value. See table, page 18.

BASE UNIT VALUE

In order to obtain the market value of iron ore of any grade, it is necessary to establish a standard or "base unit value" for each grade. This is theoretically determined by dividing the price per ton by the percentage of natural iron, but, practically, having as standards an agreed trade base price per ton, with a guaranteed percentage of natural iron units (and agreed precentages of moisture, and of phosphorus, if Bessemer) in the ton, a base unit of value is established. This base unit when multiplied by the percentage of natural iron determines the price for standard ore. When the product is increased by certain agreed premiums the result is the price for over-standard ore, and when, beginning with the price of 50 per cent ore of any class, certain agreed penalties are deducted the result is the price for sub-standard ore.

THE 1911 BASIC GUARANTEES, PRICES AND BASE UNIT VALUES FOR STANDARD IRON ORES—LAKE SUPERIOR DISTRICT

The following standards established the 1911 base percentages and prices for Lake Superior ores, and determined their base unit values from which are calculated prices, premiums and penalties of all classes:

	*BASE PERCENTAGES				†PRICES		
Standard Grade	Natural Iron %	Phos. %	Moist %	Iron Dried %	Lake Erie	Valley	Base Unit Value
Old Range-Vermilion Bessemer ..	55.00	.045	10	61.12	$4.50	$5.10	$0.0927273
Mesaba Bessemer.....	55.00	.045	10	61.12	4.25	4.85	0.0881818
Old Range-Vermilion Non-Bessemer.....	51.50	.....	12	58.52	3.70	4.30	0.0834951
Mesaba Non-Bessemer.....	51.50	.....	12	58.52	3.50	4.10	0.0796116

DETERMINATION OF NATURAL AND DRIED IRON PERCENTAGES

Having a given percentage of standard Bessemer natural iron, divide by .9, or of non-Bessemer natural iron, divide by .88 to obtain percentage of iron dried. Having a given percentage of standard Bessemer iron dried, multiply by .9, or of non-Bessemer iron dried, multiply by .88 to obtain percentage of natural iron. This applies to ores having moisture percentages as above. See moisture table on page 18.

The base unit value for each grade is obtained by adding an arbitrary 60 cents per ton, rail freight, to the Lake Erie base price, making the Valley base price, and dividing this Valley base price by the base percentage of natural iron.

The Valley base price therefore establishes the base unit value and determines the premium and penalty.

*Base percentages established in 1907. For 1905-6 the natural iron base percentages were: Old Range, Vermilion and Mesaba, Bessemer 56.70%; non-Bessemer 52.80%, except Mesaba non-Bessemer, 53%.

†Ore prices announced April 21, 1911

LAKE ERIE PRICES

As all ore is sold delivered at Lower Lake ports, the accompanying tables of iron ore values give Lake Erie base prices which are used in market quotations and govern ore contracts.

VALLEY PRICES

Valley base prices are therefore an arbitrary sixty (60) cents, rail freight, more per ton than the calculated Lake Erie base price of the tables.

DETERMINATION OF 1911 BASE UNIT VALUES

1. For Old Range-Vermilion Bessemer, the Valley base price, $5.10, divided by the base 55 per cent natural iron, determines the base unit value, $0.0927273.

2. For Mesaba Bessemer, the Valley base price, $4.85, divided by the base 55 per cent natural iron, determines the base unit value, $0.0881818.

3. For Old Range-Vermillion non-Bessemer, the Valley base price, $4.30, divided by the base 51.50 per cent natural iron, determines the base unit value, $0.0834951.

4. For Mesaba non-Bessemer, the Valley base price, $4.10, divided by the base 51.50 per cent natural iron, determines the base unit value, $0.0796116.

DETERMINATION OF 1911 PRICES, PREMIUMS AND PENALTIES

(A) LAKE ERIE PRICES FOR STANDARD GRADES

1. Lake Erie prices for Old Range-Vermilion Bessemer ore of the following percentages (or fraction thereof) of natural iron: 50, 51, 52, 53, 54 and 55 are determined by multiplying each percentage by the base unit value of $0,0927273 and deducting sixty (60) cents per ton. See Schedule 1, on page 8.

2. Lake Erie prices for Mesaba Bessemer ore of the following percentages (or fraction thereof) of natural iron: 50, 51, 52, 53, 54 and 55, are determined by multiplying each percentage by the base unit value of $0.0881818 and deducting sixty (60) cents per ton. See Schedule No. 2, on page 10.

3. Lake Erie prices for Old Range-Vermillion non-Bessemer ore of the following percentages (or fraction thereof) of natural iron: 50, 51, 52 and 53, are determined by multiplying each percentage by the base unit value of $0.0834951 and deducting sixty (60) cents per ton. See Schedule No. 3, on page 12.

4. Lake Erie prices for Mesaba non-Bessemer ore of the following percentages (or fraction thereof) of natural iron: 50, 51, 52 and 53, are determined by multiplying each percentage by the base unit value of $0.0796116 and deducting sixty (60) cents per ton. See Schedule No. 4, on page 14.

It will be specially noted that the base unit value determines the price of the above classes and percentages of standard ores. Their value below the base price is simply an automatic reduction. It is in no sense a penalty.

The same results for Lake Erie prices may also be obtained by a process of addition. Beginning with the 50 per cent base price, add thereto the base unit value of the proper class; the sum is the 51 per cent price. Add to that amount the same base unit value; the total is the 52 per cent price; and so on for each per cent, the cumulative premium applying at the proper place. See Constructive Schedules 1, 2, 3 and 4 on pages 8, 10, 12 and 14.

(B) LAKE ERIE PRICES FOR OVER-STANDARD GRADES—PREMIUMS

Lake Erie prices of all grades of standard Bessemer ore, Old Range-Vermilion and Mesaba of the following percentages (or fraction thereof) of natural iron: above 55, 56, 57, 58, 59 and 60, and of all grades of standard non-Bessemer ore, Old Range-Vermilion and Mesaba of the following percentages of natural iron: above 53, 54, 55, 56, 57 and 58, are determined by multiplying the percentage of natural iron by the base unit value of the proper class as shown above, and deducting sixty (60) cents per ton, and then, within the limits specified and beginning with the 55.01 per cent Bessemer and the 53.01 per cent non-Bessemer, adding thereto a premium of one (1) cent, cumulative, per unit.

The premium never exceeds 15 cents per ton per iron unit, and beyond the percentages named the calculations for succeeding prices revert to the use of the original base unit values, each percentage, however, receiving the premium of 15 cents per ton. See Schedules 1, 2, 3 and 4, on pages 8, 10, 12 and 14.

(C) LAKE ERIE PRICES FOR SUB-STANDARD GRADES—PENALTIES

For Bessemer ore, deduct from the 50 per cent Lake Erie base price 1½ base units of the proper class; the result is the 49 per cent price; deduct from that amount 2 base units, the result is the 48 per cent price; deduct 2 base units from each succeeding result, and each result will give Lake Erie price for 47, 46, 45, 44, 43, 42, 41 and 40 per cent.

The 1911 penalty for each unit below 49 per cent is: for Old Range-Vermilion $0.1854546; for Mesaba $0.1763636.

For non-Bessemer ore, deduct from the 50 per cent Lake Erie base price 1½ base units of the proper class; the result is the 49 per cent price; deduct from that amount and from each succeeding result 2 base units, and each result will give Lake Erie price for 48, 47, 46, 45, 44, 43, 42, 41 and 40 per cent.

The 1911 penalty for each unit below 49 per cent is: for Old Range-Vermilion $0.1669902; for Mesaba $0.1592232; although for below 49 per cent trade ore tables carry the $0.1592232 as an arbitrary 18 cents.

TABULAR PRICES FOR ESTIMATING

The prices for 45, 46 and 47 percentages of natural iron in the tables of values, and the prices for 40 to 45 percentages found in the Illustrative Schedules are given as of service for estimating probable future value of sub-grade reserve ores.

PHOSPHORUS PREMIUM AND PENALTY

Should there be a phosphorus premium or penalty the amount to be added or deducted will be found in the standard table of phosphorus values, on page 16.

ADDITIONAL PREMIUM OR PENALTY BY PRIVATE CONTRACT

Any further premium for such as lump value is added to and any further penalty for such as silica, manganese and sulphur, is deducted from the standard prices for standard ores, by private contract at an arbitrary amount per ton.

MATHEMATICAL AND TRADE CALCULATING DECIMALS

To secure mathematical accuracy seven (7) decimals are used in calculating units of value and prices, and are given in the illustrative schedules.

For trade purposes five (5) decimals in the price are sufficient, and are so used in the tables of iron ore values.

Any tonnage multiplied by the tabular price of the proper percentage of any given grade, will result in the value of that tonnage at Lake Erie.

BASE UNIT VALUE FOR CHANGE IN PRICE

Should the present natural iron base standards continue, but the price of ore be raised or lowered from 1911 prices, the base unit values to correspond with such new prices within the limits named, will be found in the schedule of permanent base unit values. A new table of ore values would be constructed by the method herein described in "Determination of 1911 Prices, Premiums and Penalties," using any other consideration named in the new ore contracts. See Schedule on page 17.

BASE UNIT VALUE FOR CHANGES IN PRICE AND OF NATURAL IRON BASE

Where both base price and natural iron base standards change, add to the new Lake Erie base price, 60 cents, making the Valley base price; and divide this Valley base price by the new base percentage of natural iron, thereby establishing the new base unit value, and proceed as described in "Determination of 1911 Prices, Premiums and Penalties."

In the event of a change in base price, but no change in the 1911 base natural iron percentages, new values may be quickly determined, as follows:

To any given 1911 Lake Erie price, of any percentage, or fraction, of any grade, add 60 cents (for Valley price, which determines the base unit value) and multiply the total by the decimal multiple corresponding with the new base price; deduct from that amount (the Valley price) 60 cents, and the result is the new Lake Erie price. For decimal multiple, see schedule on page 17.

A DEFINITION OF BESSEMER ORE

Bessemer ore dried at 212°F. has a typical analysis of 61.55 per cent iron, 0.47 per cent phosphorus, 4.6 per cent silica and 1.5 per cent manganese. With a generally accepted moisture of 10 per cent this is equivalent to 55.39 per cent natural iron. The per cent of iron may be diminished provided there is a diminution of phosphorus equal to .0075 for each per cent of iron loss.

ABNORMAL CONDITIONS

The work cannot enter into abnormal conditions. Until mine and furnace operators agree upon and establish tables, of premiums for lump ore, and of penalty for excess of silica, manganese, sulphur, etc., settlements for such contents must of necessity remain a matter for private adjustment. They cannot now be tabulated.

Even though furnaces may be able to buy sub-grades ores at their own terms and for less than the tabular price, the price determined from base values are given to govern theoretically until sub-grade values are established that will be accepted and adhered to by buyer and seller.

Illustrative Schedules and Abridged Tables of Values

1911

COMPILED BY
RUKARD HURD

ILLUSTRATIVE SCHEDULE No. 1

OLD RANGE-VERMILION BESSEMER

Constructive Mathematical Table of Lake Erie Prices by Subtraction of 1½ and 2 Base Units, as indicated, by Addition of the Base Unit and the Premium, and by Multiplication of the Base Units with added Premium

BY SUBTRACTION		
Natural Iron Per Cent	Net Lake Erie Price	Total Penalty
50	$4.0363650	
1*	.1390909	
49	$3.8972741	$0.1390909
2*	.1854546	
48	$3.7118195	.3245455
	.1854546	
47	$3.5263649	.5100001
	.1854546	
46	$3.3409103	.6954547
	.1854546	
45	$3.1554557	.8809093
	.1854546	
44	$2.9700011	1.0663639
	.1854546	
43	$2.7845465	1.2518185
	.1854546	
42	$2.5990919	1.4372731
	.1854546	
41	$2.4136373	1.6227277
	.1854546	
40	$2.2281827	1.8081823

	BY ADDITION	
		Premium
50	$4.0363650	
	.0927273	
51	$4.1290923	
	.0927273	
52	$4.2218196	
	.0927273	
53	$4.3145469	
	.0927273	
54	$4.4072742	
	.0927273	
55	$4.5000015	
	.1027273	
56	$4.6027288	$0.01
	.1127273	
57	$4.7154561	.03
	.1227273	
58	$4.8381834	.06
	.1327273	
59	$4.9709107	.10
	.1427273	
60	$5.1136380	.15
	.0927273	
61	$5.2063653	.15

BY MULTIPLICATION				
Natural Iron Per Cent		Base Unit		*Lake Erie Price
50	x	$0.0927273		$4.0363650
51	x	.0927273		4.1290923
52	x	.0927273		4.2218196
53	x	.0927273		4.3145469
54	x	.0927273		4.4072742
55	x	.0927273		4.5000015
			Premium	
56	x	.0927273	+ 1c	4.6027288
57	x	.0927273	+ 3c	4.7154561
58	x	.0927273	+ 6c	4.8381834
59	x	.0927273	+10c	4.9709107
60	x	.0927273	+15c	5.1136380
61	x	.0927273	+15c	5.2063653

1* 1½ Base Units. 2* 2 Base Units.
*Every price includes a deduction of 60 cents per ton.

SCHEDULE No. 1 OF PRICES

OLD RANGE-VERMILION BESSEMER

Base Natural Iron 55%, Base Valley Price $5.10, Base Unit Value $0.0927273

Base Lake Erie Price $4.50

*ABRIDGED TABLE

CLASS	Natural Iron Per Cent	Net Lake Erie Price	
			Penalty
Sub-Standard	40	$2.2281827	$1.8081823
	41	2.4136373	1.6227277
	42	2.5990919	1.4372731
	43	2.7845465	1.2518185
	44	2.9700011	1.0663639
	45	3.1554557	.8809093
	46	3.3409103	.6954547
	47	3.5263649	.5100001
	48	3.7118195	.3245455
	49	3.8972741	.1390909
			Base Unit Value
Standard	50	$4.0363650	$0.0927273
	51	4.1290923	.0927273
	52	4.2218196	.0927273
	53	4.3145469	.0927273
	54	4.4072742	.0927273
	55	4.5000015	.0927273
			Premium
Over Standard	56	$4.6027288	$0.1027273
	57	4.7154561	.2154546
	58	4.8381834	.3381819
	59	4.9709107	.4709092
	60	5.1136380	.6136365
	61	5.2063653	.7063638

Special Note:

*Complete tables are placed at the end of the Manual for convenient reference.
The Penalty ending with 49.99% is deducted pro rata from prices.
The Premium beginning with 55.01% is added pro rata to prices.

ILLUSTRATIVE SCHEDULE No. 2

MESABA BESSEMER

Constructive Mathematical Table of Lake Erie prices by Subtraction of 1½ and 2 Base Units, as indicated, by Addition of the Base Unit and the Premium, and by Multiplication of the Base Unit with added Premium

BY SUBTRACTION

	Natural Iron Per Cent	Lake Erie Price	Total Penalty
	50	$3.8090900	
1*		.1322727	
	49	$3.6768173	$0.1322727
		.1763636	
2*	48	$3.5004537	.3086363
		.1763636	
	47	$3.3240901	.4849999
		.1763636	
	46	$3.1477265	.6613635
		.1763636	
	45	$2.9713629	.8377271
		.1763636	
	44	$2.7949993	1.0140907
		.1763636	
	43	$2.6186357	1.1904543
		.1763636	
	42	$2.4422721	1.3668179
		.1763636	
	41	$2.2659085	1.5431815
		.1763636	
	40	$2.0895449	1.7195451

BY ADDITION

Natural Iron Per Cent		Premium
50	$3.8090900	Premium
	.0881818	
51	$3.8972718	
	.0881818	
52	$3.9854536	
	.0881818	
53	$4.0736354	
	.0881818	
54	$4.1618172	
	.0881818	
	$4.2499990	
	(to adjust) 10	
55	$4.2500000	
	(to adjust) 10	
	$4.2499990	
	.0981818	
56	4.3481808	$0.01
	.1081818	
57	$4.4563626	.03
	.1181818	
58	$4.5745444	.06
	.1281818	
59	$4.7027262	.10
	.1381818	
60	$4.8409080	.15
	.0881818	
61	$4.9290898	.15

BY MULITPLICATION

Natural Iron Per Cent		Base Unit	*Lake Erie Price
50	x	$0.0881818	$3.8090900
51	x	.0881818	3.8972718
52	x	.0881818	3.9854536
53	x	.0881818	4.0736354
54	x	.0881818	4.1618172
55	x	.0881818	4.2499990
		(To adjust)	.0000010
			$4.2500000
		Premium	
56	x	.0881818+ 1c	4.3481808
57	x	.0881818+ 3c	4.4563626
58	x	.0881818+ 6c	4.5745444
59	x	.0881818+10c	4.7027262
60	x	.0881818+15c	4.8409080
61	x	.0881818+15c	4.9290898

1* 1½ Base Units. 2* 2Base Units.
*Every price includes a deduction of 60 cents per ton.

SCHEDULE No. 2 OF PRICES

MESABA BESSEMER

Base Natural Iron 55%, Base Valley Price $4.85, Base Unit Value $0.0881818
Base Lake Erie Price $4.25

***ABRIDGED TABLE**

CLASS	Natural Iron Per Cent	Net Lake Erie Price	
			Penalty
Sub-Standard	40	$2.0895449	$1.7195451
	41	2.2659085	1.5431815
	42	2.4422721	1.3668179
	43	2.6186357	1.1904543
	44	2.7949993	1.0140907
	45	2.9713629	.8377271
	46	3.1477265	.6613635
	47	3.3240901	.4849999
	48	3.5004537	.3086363
	49	3.6768173	.1322727
			Base Unit Value
Standard	50	$3.8090900	$0.0881818
	51	3.8972718	.0881818
	52	3.9854536	.0881818
	53	4.0736354	.0881818
	54	4.1618172	.0881818
	55	4.2500000	.0881818
			Premium
Over-Standard	56	$4.3181808	$0.0981818
	57	4.4563626	.2063636
	58	4.5745444	.3245454
	59	4.7027262	.4527272
	60	4.8409080	.5909090
	61	4.9290898	.6790908

Special Note:

*Complete tables are placed at the end of the Manual for convenient reference.
The Penalty ending with 49.99% is deducted pro rata from prices.
The Premium beginning with 55.01% is added pro rata to prices.

ILLUSTRATIVE SCHEDULE No. 3

OLD RANGE-VERMILION NON-BESSEMER

Constructive Mathematical Table of Lake Erie prices by Subtraction of 1½ and 2 Base Units, as indicated, by Addition of the Base Unit and the Premium, and by Multiplication of the Base Unit with added Premium

BY SUBTRACTION		
Natural Iron Per Cent	Lake Erie Price	Total Penalty
50	$3.5747550	
1*	.1252426	
49	$3.4495124	$0.1252426
2*	.1669902	
48	$3.2825222	.2922328
	.1669902	
47	$3.1155320	.4592230
	.1669902	
46	$2.9485418	.6262132
	.1669902	
45	$2.7815516	.7932034
	.1669902	
44	$2.6145614	.9601936
	.1669902	
43	$2.4475712	1.1271838
	.1669902	
42	$2.2805810	1.2941740
	.1669902	
41	$2.1135908	1.4611642
	.1669902	
40	$1.9466006	1.6281544

BY ADDITION		
50	$3.5747550	Premium
	.0834951	
51	$3.6582501	
	.0834951	
52	$3.7417452	
	.0834951	
53	$3.8252403	
	.0934951	
54	$3.9187354	$0.01
	.1034951	
55	$4.0222305	.03
	.1134951	
56	$4.1357256	.06
	.1234951	
57	$4.2592207	.10
	.1334951	
58	$4.3927158	.15
	.0834951	
59	$4.4762109	.15
	.0834951	
60	$4.5597060	.15

BY MULTIPLICATION				
Natural Iron Per Cent		Base Unit		*Lake Erie Price
50	x	$0.0834951		$3.5747550
51	x	.0834951		3.6582501
52	x	.0834951		3.7417452
53	x	.0834951		3.8252403
			Premium	
54	x	.0834951 +	1c	3.9187354
55	x	.0834951 +	3c	4.0222305
56	x	.0834951 +	6c	4.1357256
57	x	.0834951 +	10c	4.2592207
58	x	.0834951 +	15c	4.3927158
59	x	.0834951 +	15c	4.4762109
60	x	.0834951 +	15c	4.5597060

1* 1½ Base Units. 2* 2 Base Units.
*Every price includes a deduction of 60 cents per ton.

SCHEDULE No. 3 OF PRICES

OLD RANGE-VERMILION NON-BESSEMER

Base Natural Iron 51.50%, Base Valley Price $4.30, Base Unit Value $0.0834951
Base Lake Erie Price $3.70

*ABRIDGED TABLE

CLASS	Natural Iron Per Cent	Net Lake Erie Price	
			Penalty
Sub-Standard	40	$1.9466006	$1.6281544
	41	2.1135908	1.4611642
	42	2.2805810	1.2941740
	43	2.4475712	1.1271838
	44	2.6145614	.9601936
	45	2.7815516	.7932034
	46	2.9485418	.6262132
	47	3.1155320	.4592230
	48	3.2825222	.2922328
	49	3.4495124	.1252426
			Base Unit Value
Standard	50	$3.5747550	$0.0834951
	51	3.6582501	.0834951
	52	3.7417452	.0834951
	53	3.8252403	.0834951
			Premium
Over-Standard	54	$3.9187354	$0.0934951
	55	4.0222305	.1969902
	56	4.1357256	.3104853
	57	4.2592207	.4339804
	58	4.3927158	.5674755
	59	4.4762109	.6509706
	60	4.5597060	.7344657

Special Note:

*Complete tables are placed at the end of the Manual for convenient reference.
The Penalty ending with 49.99% is deducted pro rata from prices.
The Premium beginning with 53.01% is added pro rata to prices.

ILLUSTRATIVE SCHEDULE No. 4

MESABA NON-BESSEMER

Constructive Mathematical Table of Lake Erie prices by Subtraction of 1½ and 2 Base Units, as indicated, by Addition of the Base Unit and the Premium, and by Multiplication of the Base Unit with added Premium

BY SUBTRACTION

Natural Iron Per Cent	Lake Erie Price	Total Penalty
50	$3.3805800	
1*	.1194174	
49	$3.2611626	$0.1194174
2*	.1592232	
48	$3.1019394	.2786406
	.1592232	
47	$2.9427162	.4378638
	.1592232	
46	$2.7834930	.5970870
	.1592232	
45	$2.6242698	.7563102
	.1592232	
44	$2.4650466	.9155334
	.1592232	
43	$2.3058234	1.0747566
	.1592232	
42	$2.1466002	1.2339798
	.1592232	
41	$1.9873770	1.3932030
	.1592232	
40	$1.8281538	1.5524262

	BY ADDITION	
50	$3.3805800	Premium
	.0796116	
51	$3.4601916	
	.0796116	
52	$3.5398032	
	.0796116	
53	$3.6194148	
	.0896116	
54	$3.7090264	$0.01
	.0996116	
55	$3.8086380	.03
	.1096116	
56	$3.9182496	.06
	.1196116	
57	$4.0378612	.10
	.1296116	
58	$4.1674728	.15
	.0796116	
59	$4.2470844	.15
	.0796116	
	$4.3266960	.15

BY MULTIPLICATION

Natural Iron Per Cent		Base Unit		Premium	*Lake Erie Price
50	x	$0.0796116			$3.3805800
51	x	.0796116			3.4601916
52	x	.0796116			3.5398032
53	x	.0796116			3.6194148
54	x	.0796116	+	1c	3.7090264
55	x	.0796116	+	3c	3.8086380
56	x	.0796116	+	6c	3.9182496
57	x	.0796116	+	10c	4.0378612
58	x	.0796116	+	15c	4.1674728
59	x	.0796116	+	15c	4.2470844
60	x	.0796116	+	15c	4.3266960

1* 1½ Base Units. 2* 2 units used instead of the arbitrary 18 cents.
*Every price includes a deduction of 60 cents per ton.

SCHEDULE No. 4 OF PRICES

MESABA NON-BESSEMER

Base Natural Iron 51.50%, Base Valley Price $4.10, Base Unit Value $0.0796116
Base Lake Erie Price $3.50

***ABRIDGED TABLE**

CLASS	Natural Iron Per Cent	Net Lake Erie Price	
			Penalty
Sub-Standard	40	$1.8281538	$1.5524262
	41	1.9873770	1.3932030
	42	2.1466002	1.2339798
	43	2.3058234	1.0747566
	44	2.4650466	.9155334
	45	2.6242698	.7563102
	46	2.7834930	.5970870
	47	2.9427162	.4378638
	48	3.1019394	.2786406
	49	3.2611626	.1194174
			Base Unit Value
Standard	50	$3.3805800	$0.0796116
	51	3.4601916	.0796116
	52	3.5398032	.0796116
	53	3.6194148	.0796116
			Premium
Over-Standard	54	$3.7090264	$0.0896116
	55	3.8086380	.1892232
	56	3.9182496	.2988348
	57	4.0378612	.4184464
	58	4.1674728	.5480580
	59	4.2470844	.6276696
	60	4.3266960	.7072812

Special Note:

*Complete tables are placed at the end of the Manual for convenient reference.
The Penalty ending with 49.99% is deducted pro rata from prices.
The Premium beginning with 53.01% is added pro rata to prices.

STANDARD TABLE OF PHOSPHORUS VALUES

PENALTY			PREMIUM		
Phosphorus			Phosphorus		
Per cent	Penalty Cents	Progression Per Unit Cents	Per cent	Premium Cents	Progression Per Unit Cents
.045	.0000	.0000	.045	.0000	.0000
.046	.0080	.0080	.044	.0080	.0080
.047	.0165	.0085	043	.0165	.0085
.048	.0255	.0090	.042	.0255	.0090
.049	.0350	.0095	.041	.0350	.0095
.050	.0450	.0100	.040	.0450	.0100
.051	.0555	.0105	.039	.0555	.0105
.052	.0665	.0110	.038	.0665	.0110
.053	.0780	.0115	.037	.0780	.0115
.054	.0900	.0120	.036	.0900	.0120
.055	.1025	.0125	.035	.1025	.0125
.056	.1155	.0130	.034	.1155	.0130
.057	.1290	.0135	.033	.1290	.0135
.058	.1430	.0140	.032	.1430	.0140
.059	.1575	.0145	.031	.1575	.0145
.060	.1725	.0150	.030	.1725	.0150
.061	.1880	.0155	.029	.1880	.0155
.062	.2040	.0160	.028	.2040	.0160
.063	.2205	.0165	.027	.2205	.0165
.064	.2375	.0170	.026	.2375	.0170
.065	.2550	.0175	.025	.2550	.0175
.066	.2730	.0180	.024	.2730	.0180
.067	.2915	.0185	.023	.2915	.0185
.068	.3105	.0190	.022	.3105	.0190
.069	.3300	.0195	.021	.3300	.0195
.070	.3500	.0200	.020	.3500	.0200
....	.....	.....	.019	.3705	.0205
....	.....	.....	.018	.3915	.0210
....	.....	.....	.017	.4130	.0215
....	.....	.....	.016	.4350	.0220
....	.....	.....	.015	.4575	.0225
....	.....	.....	.014	.4805	.0230
....	.....	.....	.013	.5040	.0235
....	.....	.....	.012	.5280	.0240
....	.....	.....	.011	.5525	.0245
....	.....	.....	.010	.5775	.0250
....	.....	.....	.009	.6030	.0255
....	.....	.....	.008	.6290	.0260
....	.....	.....	.007	.6555	.0265
....	.....	.....	.006	.6825	.0270
....	.....	.....	.005	.7100	.0275

SCHEDULE OF PERMANENT BASE UNIT VALUES

FOR DETERMINING FROM ANY BASE PRICE
VALLEY PRICES, PREMIUMS AND PENALTIES
BASE NATURAL IRON, BESSEMER 55% NON BESSMER 51.50%

And the Corresponding Decimal Multiple to apply to Rule on Page 6
Deduct from all calculations 60 cents to obtain Lake Erie prices

Specially Compiled by Rukard Hurd for this Manual

Old Range-Vermilion Bessemer
1911 Base Standard
55%—$5.10—$0.0927273
Lake Erie Price $4.50

Valley Base Price	Valley Base Unit Value	1911 Decimal Multiple
$4.85	$0.0881818	.95098
4.90	.0890909	.96078
4.95	.0900000	.97059
5.00	.0909091	.98039
5.05	.0918182	.99020
5.10	.0927273	1.00000
5.15	.0936364	1.00980
5.20	.0945454	1.01961
5.25	.0954545	1.02491
5.30	.0963636	1.03921
5.35	.0972727	1.04902
5.40	.0981818	1.05882
5.45	.0990909	1.06863
5.50	.1000000	1.07843
5.55	.1009091	1.08823
5.60	.1018182	1.09804
5.65	.1027273	1.10784
5.70	.1036364	1.11765
5.75	.1045454	1.12745
5.80	.1054545	1.13725
5.85	.1063636	1.14706

Mesaba Bessemer
1911 Base Standard
55%—$4.85—$0.0881818
Lake Erie Price $4.25

Valley Base Price	Valley Base Unit Value	1911 Decimal Multiple
$4.60	$0.0836364	.94845
4.65	.0845454	.95876
4.70	.0854545	.96907
4.75	.0863636	.97938
4.80	.0872727	.98969
4.85	.0881818	1.00000
4.90	.0890909	1.01031
4.95	.0900000	1.02062
5.00	.0909091	1.03093
5.05	.0918182	1.04124
5.10	.0927273	1.05155
5.15	.0936364	1.06186
5.20	.0945454	1.07216
5.25	.0954545	1.08247
5.30	.0963636	1.09278
5.35	.0972727	1.10309
5.40	.0981818	1.11340
5.45	.0990909	1.12371
5.50	.1000000	1.13402
5.55	.1009091	1.14433
5.60	.1018182	1.15464

Old Range-Vermilion Non-Bessemer
1911 Base Standard
51.50%—$4.30—$0.0834951
Lake Erie Price $3.70

$4.05	$0.0786408	.94186
4.10	.0796116	.95349
4.15	.0805825	.96512
4.20	.0815534	.97674
4.25	.0825243	.98837
4.30	.0834951	1.00000
4.35	.0844660	1.01163
4.40	.0854369	1.02326
4.45	.0864078	1.03488
4.50	.0873786	1.04651
4.55	.0883495	1.05814
4.60	.0893204	1.06977
4.65	.0902913	1.08139
4.70	.0912621	1.09302
4.75	.0922330	1.10465
4.80	.0932039	1.11628
4.85	.0941748	1.12791
4.90	.0951456	1.13953
4.95	.0961165	1.15116
5.00	.0970874	1.16279
5.05	.0980582	1.17442

Mesaba Non-Bessemer
1911 Base Standard
51.50%—$4.10—$0.0796116
Lake Erie Price $3.50

$3.85	$0.0747573	.93902
3.90	.0757281	.95122
3.95	.0766990	.96341
4.00	.0776699	.97561
4.05	.0786408	.98780
4.10	.0796116	1.00000
4.15	.0805825	1.01219
4.20	.0815534	1.02439
4.25	.0825243	1.03659
4.30	.0834951	1.04878
4.35	.0844660	1.06097
4.40	.0854369	1.07317
4.45	.0864079	1.08536
4.50	.0873786	1.09756
4.55	.0883495	1.10976
4.60	.0893204	1.12195
4.65	.0902913	1.13415
4.70	.0912621	1.14634
4.75	.0922330	1.15854
4.80	.0932039	1.17073
4.85	.0941748	1.18293

MOISTURE TABLE

MOISTURE RANGING FROM 1% TO 10%, INCLUSIVE

Showing by the Per Cent of Moisture Found in Iron Dried at 212° F.

The Per Cent of Natural Iron

Specially Compiled by Rukard Hurd for this Manual

Per Cent Iron Dried	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
	Natural Iron	Natural Iron	Natural Iron	Natural Iron	Natural Iron	Natural Iron	Natural Iron	Natural Iron	Natural Iron	Natural Iron
35.00	34.65	34.30	33.95	33.60	33.25	32.90	32.55	32.20	31.85	31.50
36.00	35.64	35.28	34.92	34.56	34.20	33.84	33.48	33.12	32.76	32.40
37.00	36.63	36.26	35.89	35.52	35.15	34.78	34.41	34.04	33.67	33.30
38.00	37.62	37.24	36.86	36.48	36.10	35.72	35.34	34.96	34.58	34.20
39.00	38.61	38.22	37.83	37.44	37.05	36.66	36.27	35.88	35.49	35.10
40.00	39.60	39.20	38.80	38.40	38.00	37.60	37.20	36.80	36.40	36.90
41.00	40.59	40.18	39.77	39.36	38.95	38.54	38.13	37.72	37.31	37.80
42.00	41.58	41.16	40.74	40.32	39.90	39.48	39.06	38.64	38.22	38.70
43.00	42.57	42.14	41.71	41.28	40.85	40.42	39.99	39.56	39.13	39.60
44.00	43.56	43.12	42.68	42.24	41.80	41.36	40.92	40.48	40.04	40.50
45.00	44.55	44.10	43.65	43.20	42.75	42.30	41.85	41.40	40.95	40.50
46.00	45.54	45.08	44.62	44.16	43.70	43.24	42.78	42.32	41.86	41.40
47.00	46.53	46.06	45.59	45.12	44.65	44.18	43.71	43.24	42.77	42.30
48.00	47.52	47.04	46.56	46.08	45.16	45.12	44.64	44.16	43.68	43.20
49.00	48.51	48.02	47.53	47.04	46.55	46.06	45.57	45.08	44.59	44.10
50.00	49.50	49.00	48.50	48.00	47.50	47.00	46.50	46.00	45.50	45.00
51.00	50.49	49.98	49.47	48.96	48.45	47.94	47.43	46.92	46.41	45.90
52.00	51.48	50.96	50.44	49.92	49.40	48.88	48.36	47.84	47.32	46.80
53.00	52.47	51.94	51.41	50.88	50.35	49.82	49.29	48.76	48.23	47.70
54.00	53.46	52.92	52.38	51.84	51.30	50.76	50.22	49.68	49.14	48.60
55.00	54.45	53.90	53.35	52.80	52.25	51.70	51.15	50.60	50.05	49.50
56.00	55.44	54.88	54.32	53.76	53.20	52.64	52.08	51.52	50.96	50.40
57.00	56.43	55.86	55.29	54.72	54.15	53.58	53.01	52.44	51.87	51.30
58.00	57.42	56.84	56.26	55.68	55.10	54.52	53.94	53.36	52.78	52.20
59.00	58.41	57.82	57.23	56.64	56.05	55.46	54.87	54.28	53.69	53.10
60.00	59.40	58.80	58.20	57.60	57.00	56.40	55.80	55.20	54.60	54.00
61.00	60.39	59.78	59.17	58.56	57.95	57.34	56.73	56.12	55.51	54.90
62.00	61.38	60.76	60.14	59.52	58.90	58.28	57.66	57.04	56.42	55.80
63.00	62.37	61.74	61.11	60.48	59.85	59.22	58.59	57.96	57.33	56.70
64.00	63.36	62.72	62.08	61.44	60.80	60.16	59.52	58.88	58.24	57.60
65.00	64.35	63.70	63.05	62.40	61.75	61.10	60.45	59.80	59.15	58.50
66.00	65.34	64.68	64.02	63.36	62.70	62.04	61.38	60.72	60.06	59.40
67.00	66.33	65.66	64.99	64.32	63.65	62.98	62.31	61.64	60.97	60.30
68.00	67.32	66.64	65.96	65.28	64.60	63.92	63.24	62.56	61.88	61.20
Factor...	.99	.98	.97	.96	.95	.94	.93	.92	.91	.90

Multiply the per cent of Iron dried at 212° F. by the factor corresponding to the per cent of moisture found therein. The result is the per cent of Natural Iron.

The above is an abridged table and applies only to the even percentages of moisture and of Iron dried as stated. To obtain any per cent or fraction thereof:

Deduct from 100 the per cent of moisture found in Natural Iron dried at 212° F. and multiply the remainder, expressed decimally, by the per cent of Iron dried. The result is the per cent of Natural Iron.

MOISTURE TABLE

MOISTURE RANGING FROM 11% TO 20%, INCLUSIVE

Showing by the Per Cent of Moisture Found in Iron Dried at 212° F.

The Per Cent of Natural Iron

Specially Compiled by Rukard Hurd for this Manual

Per Cent Iron Dried	11% Natural Iron	12% Natural Iron	13% Natural Iron	14% Natural Iron	15% Natural Iron	16% Natural Iron	17% Natural Iron	18% Natural Iron	19% Natural Iron	20% Natural Iron
35.00	31.15	30.80	30.45	30.10	29.75	29.40	29.05	28.70	28.35	28.00
36.00	32.04	31.68	31.32	30.96	30.60	30.24	29.88	29.52	29.16	28.80
37.00	32.93	32.56	32.19	31.82	31.45	31.08	30.71	30.34	29.97	29.60
38.00	33.82	33.44	33.06	32.68	32.30	31.92	31.54	31.16	30.78	30.40
39.00	34.71	34.32	33.93	33.54	33.15	32.76	32.37	31.98	31.59	31.20
40.00	35.60	35.20	34.80	34.40	34.00	33.60	33.20	32.80	32.40	32.00
41.00	36.49	36.08	35.67	35.26	34.85	34.44	34.03	33.62	33.21	32.80
42.00	37.38	36.96	36.54	36.12	35.70	35.28	34.86	34.44	34.02	33.60
43.00	38.27	37.84	37.41	36.98	36.55	36.12	35.69	35.26	34.83	34.40
44.00	39.16	38.72	38.28	37.84	37.40	36.96	36.52	36.08	35.64	35.20
45.00	40.05	39.60	39.15	38.70	38.25	37.30	37.35	36.90	36.45	36.00
46.00	40.94	40.48	40.02	39.56	39.10	38.64	38.18	37.72	37.26	36.80
47.00	41.83	41.36	40.89	40.42	39.95	39.48	39.01	38.54	38.07	37.60
48.00	42.72	42.24	41.76	41.28	40.80	40.32	39.84	39.36	38.88	38.40
49.00	43.61	43.12	42.63	42.14	41.65	41.16	40.67	40.18	39.69	39.20
50.00	44.50	44.00	43.50	43.00	42.50	42.00	41.50	41.00	40.50	40.00
51.00	45.39	44.88	44.37	43.86	43.35	42.84	42.33	41.82	41.31	40.80
52.00	46.28	45.76	45.24	44.72	44.20	43.68	43.16	42.64	42.12	41.60
53.00	47.17	46.64	46.11	45.58	45.05	44.52	43.99	43.46	42.93	42.40
54.00	48.06	47.52	46.98	46.44	45.90	45.36	44.82	44.28	43.74	43.20
55.00	48.95	48.40	47.85	47.30	46.75	46.20	45.65	45.10	44.55	44.00
56.00	49.84	49.28	48.72	48.16	47.60	47.04	46.48	45.92	45.36	44.80
57.00	50.73	50.16	49.59	49.02	48.45	47.88	47.31	46.74	46.17	45.60
58.00	51.62	51.04	50.46	49.88	49.30	48.72	48.14	47.56	46.98	46.40
59.00	52.51	51.92	51.33	50.74	50.15	49.56	48.97	48.38	47.79	47.20
60.00	53.40	52.80	52.20	51.60	51.00	50.40	49.80	49.20	48.60	48.00
61.00	54.29	53.68	53.07	52.46	51.85	51.24	50.63	50.02	49.41	48.80
62.00	55.18	54.56	53.94	53.32	52.70	52.08	51.46	50.80	50.22	49.60
63.00	56.07	55.44	54.81	54.18	53.55	52.92	52.29	51.66	51.03	50.40
64.00	56.96	56.32	55.68	55.04	54.40	53.76	53.12	52.48	51.84	51.20
65.00	57.85	57.20	56.55	55.90	55.25	54.60	53.95	53.30	52.65	52.00
66.00	58.74	58.08	57.42	56.76	56.10	55.44	54.78	54.12	53.46	52.80
67.00	59.63	58.96	58.29	57.62	56.95	56.28	55.61	54.94	54.27	53.60
68.00	60.52	59.84	59.16	58.48	57.80	57.12	56.44	55.76	55.08	54.40
Factor...	.89	.88	.87	.86	.85	.84	.83	.82	.81	.80

Multiply the per cent of Iron dried at 212° F. by the factor corresponding to the per cent of moisture found therein. The result is the per cent of Natural Iron.

The above is an abridged table and applies only to the even percentages of moisture and of Iron dried as stated. To obtain any per cent or fraction thereof:

Deduct from 100 the per cent of moisture found in Natural Iron dried at 212° F. and multiply the remainder, expressed decimally, by the per cent of Iron dried. The result is the per cent of Natural Iron.

The Minnesota Tax Commission

and

Its Valuation of Iron Ore

By Rukard Hurd

The history of the Lake Superior Iron District would not be complete without referring to the Minnesota Tax Commission, and the manner in which it has accomplished the arduous work of valuing for taxation purposes the greatest known iron ore deposit in the world, of the Vermilion and Mesaba Ranges, contained within the State of Minnesota and in the counties of St. Louis and Itasca.

The Minnesota Tax Commission was created by an act of the legislature approved April 23, 1907. On April 27, 1907, the three commissioners were appointed by the governor to serve for two, four and six year terms respectively, and on that date qualified, organized, elected a secretary and were then ready for business. It is a permanent commission, in continuous session, has been granted very broad powers, is maintained by an annual appropriation of $30,000, and obtains such additional extra appropriation upon request as it finds necessary to facilitate its work.

The commission is in sole charge of taxation matters and of tax officials. The commission is practically a court on taxation, and establishes its own procedure; it orders and grants hearings; considers and decides upon all applications for reduction or abatement of taxes; prescribes and publishes taxation blanks and forms; orders re-assessments both on its own volition or upon certified official requests, appointing its own special assessors; has authority to call for persons and papers. Finally, the commission is the State Board of Equalization.

Among the many matters taken under immediate consideration were: 1st, The determination of the relation of the true to the assessed value of realty prevailing throughout the state by the sales method, which resulted in obtaining for the years 1902-1907 inclusive, a record of 53,010 real estate sales amounting to $98,647,719, the assessed valuation of which for year of transfer was $42,892,017; and

2d: The placing of an ad valorem value on the realty contained within the so-called ore belts of the Vermilion Range in St. Louis County, and the Mesaba Range in St. Louis and Itasca Counties.*

The Mesaba Range, after hasty and often unreliable and incomplete exploration, had only been opened and shipping since 1892. For a number of years the value of its grade of iron ore had not been fully commercially determined. The total tonnage was not known and explorations were mainly incomplete and unreliable.

*From 1881 to 1897 there was a tax of one cent per ton on shipments.

No previous attempt had been made to locate and assess tonnage. Crude methods and arbitrary values were used, based upon previous output, or expected shipments and such fragmentary information as was available. The 1906 realty assessment on the mines amounted to a total of $64,486,409.

The Tax Commission decided to avoid arbitrary methods and to obtain, if possible, the necessary information on which to base an intelligent, just and equitable assessment of the mineral properties.

On June 18, 1907, by circular letter, the commission requested all owners and operators of iron ore properties to furnish by July 15, 1907, full information concerning their holdings—tonnages with average analyses, character and structure of the ore, date and term of mining leases and amount of royalty, mining and other cost, average price of their ore for a term of years at Lower Lake ports, etc., etc.

The commission, with its secretary and the state inspector of mines, then proceeded upon a thorough investigation and inspection of the underground and open pit mines, of prospects and of mineral lands on the ranges. It became apparent that many mines were operating under the most favorable conditions and shipping high grade ore at low cost, while many other mines had a higher cost and lower grade of ore, and many others were mining under adverse conditions, with excessive rock, water, quicksand and a low grade of ore. Many mines had ore beginning at the surface; others would have 50 to 100 feet of overburden containing many millions of cubic yards that must be removed at great cost prior to open pit mining; while others, on account of overburden could be operated only as underground mines.

The commission grasped the situation and evolved the unprecedented plan of placing an ad valorem value on and taxing iron ore in the ground and by the ton.

Taking the Hull-Rust and the Mahoning mines as models, or standards for the highest type of mining of high grade ore under the most favorable conditions and at the minimum cost, by a process of comparison, elimination and adjustment, there were created 6 groups or classes of active shipping mines, with differentials to cover the varying adverse conditions of each class. The reserves, part of active mines, or independent tonnages, were placed in 3 groups or classes, according to their availability as future active mines.

The prospects were assessed as near as their value could be approximated according to their surrounding conditions and speculative value, on account of proximity to or possibly being part of known ore bodies, until development should make a reclassification necessary.

The mineral lands within the known ore belt were similarly treated, their values being gradually increased as they approached to what seemed good prospects.

Within 90 days after receipt of the tax commission's circular letter, mining companies and mineral owners generally complied with the request,

furnishing data as to mining cost, analyses, prices, etc., and complete inventories of 258 mines and reserves, containing a total of 1,192,509,757 tons of merchantable iron ore.

The next step was the classification of this great tonnage into the 6 groups of active mines and the 3 groups of reserves.

Then was considered the average price of iron ore for a term of years at Lower Lake ports, and the costs of production and delivery, the difference being the full value in Minnesota of ore ready for shipment. Then followed considerations of the term of the lease, the average life of the mine and the present or discounted value of all the ore in the mine or reserve on a 4 per cent annuity basis. Then came an investigation through every known source: sales of realty, U. S. census, state auditor and state board of equalization reports, etc., of the average per cent prevailing throughout the state of true to assessed value on all realty, and the application of that ratio to this mineral realty.

Proceeding in the above outlined manner, the Tax Commission defined its classification and based the taxable value per ton of ore in the ground as follows:

CLASSIFICATION FOR 1907

ACTIVE MINES

Class 1:	Inexpensive mining and high grade ore	33 cents
Class 2:	Comparatively inexpensive mining and lower grade ore	30 cents
Class 3:	Higher mining cost and mixed grade ore	27 cents
Class 4:	Underground, low mining cost and high grade ore	23 cents
Class 5:	Underground, higher mining cost and medium grade ore	19 cents
Class 6:	Underground, high mining cost, excess rock and water	14 cents

RESERVES

Class 1:	Partially developed and stripped, about ready for shipping	15 cents
Class 2:	Not stripped and not fully developed	10 cents
Class 3:	Not stripped and only partially developed	8 cents

Prospects, unexplored but located near to developed tonnages to be assessed at from $2,000 to $20,000 per 40-acre tracts.

Mineral lands unexplored, but in ore belt, to be assessed at from $3.00 to $50.00 per acre.

After due notice and a public hearing, the Tax Commission placed a total assessed valuation of $186,720,026.00 on a total of 1,192,509,757 tons. In addition, the assessed valuation on 1858 prospects and parcels of mineral lands, was raised to $4,986,656. The personality of the mining companies was assessed and the total was $4,334,490.

The 1908 grand total assessment made by the Tax Commission, after due notice and a public hearing, was $174,273,632 on a total of 1,193,728,959 tons, a decrease from 1907 value of $12,446,394. This decrease was caused by deductions for shipments, stock piles (assessed as personal property) corrections of tonnage estimates hastily prepared for the commission in 1907, and by revisions of classifications.

In 1909, there was a further re-classification and the establishment of rates for active mines, their reserves and sub-reserves, to use in determining the assessed valuation per ton of iron ore in the ground, as follows:

CLASSIFICATION FOR 1909

Class	Active Mines	Reserves	Sub-Reserves
	Cents	Cents	Cents
1	33	21	15
2	30	18	15
3	27	15	10
4	23	11	..
5	19	10	..
6	14	..	..
..	..	8	..

And the total assessment made by the Tax Commission, after due notice and a public hearing was $199,008,838 on 1,310,190,194 tons.

In 1910 the Tax Commission made the customary yearly adjustments; of deductions for shipments and stock piles, of additions for new tonnages and re-classifications of certain reserves into rates for active mines and the Commission then ordered a general raise of five (5) per cent on all realty in the townships, villages and cities (except the Village of Gilbert which had no ore) contained within the known ore belts of the Vermilion and Mesaba ranges. This action of the Tax Commission resulted in a total assessed value of $220,423,038 for 1910 upon a total of 1,347,596,291 tons.

This general raise established new rates for determining the assessed valuation per ton of iron ore in the ground, for the active mines, reserves and sub-reserves. The 33-cent class changed to .3465 cents, the 30-cent class to .3150 cents, etc. The new rates are as follows:

CLASSIFICATION FOR 1910

Class	Active Mines	Reserves	Sub-Reserves
	Cents	Cents	Cents
1	.3465	.2205	.1575
2	.3150	.1890	.1575
3	.2835	.1575	.1050
4	.2415	.1155	.....
5	.1995	.1050	.....
6	.1470	.....	.....
..	.....	.0840	.....

Re-classification and adjustments are necessarily made every year. From the remaining tonnage of the previous year must be deducted over-estimates (subject to verification by the mining engineer to the Tax Commission), shipments and stock piles. New developed tonnage and increases in estimates must be added and rates must be increased as properties pass from reserves to active mines.

Since 1908, there has been a yearly increase in tonnage notwithstanding decreases by revised estimates and shipments, and there has been a largely increased yearly assessed value.

The summary of the work of the Tax Commission in assessing the mineral properties of the state in 1907-8-9 and 10, the state board assessment of 1906, and the shipments of those years are as follows:

	Remaining Tonnage May 1st	Assessed Value	Minnesota Shipments
1906		$ 64,486,409	25,611.384
*1907	1,192,509,757	186,720,026	29,180,975
*1908	1,193,728,959	174,273,632	18,098,894
*1909	1,310,190,194	199,008,838	29,284,496
*1910	1,347,596,291	220,423,038	30,317,583

*Assessed value of the remaining tonnage only; the assessment of Personalty, Prospects and Mineral Lands is not included.

The following is a comparative statement of realty assessments on tonnages, prospects and mineral lands in towns, villages and cities in the ore belts of St. Louis and Itasca counties:

State Board of Equalization	1906	$64,486.409
Minnesota Tax Commission	1907	191,706,682
Minnesota Tax Commission	1908	180,210,693
Minnesota Tax Commission	1909	204,526,139
Minnesota Tax Commission	1910	224,669,845

This great work has been accomplished by the Tax Commission without the slightest friction, without drastic measures of any kind and apparently with the feeling among the operators that they were being fairly treated, and that they had every opportunity of presenting proof and of being heard at all times on points or questions at issue.

The estimates of the official mining engineer to the Tax Commission, the School of Mines of the University of Minnesota, and of its representative, Edward P. McCarty, E. M., Professor of Mining, in verifying tonnage estimates, are accepted cheerfully and practically without question. They inspire confidence and insure satisfaction to the operators and Tax Commission.

In fact, some operators know through this source for the first time the actual facts regarding their property.

The Cuyuna Range is still in its infancy. Exploration work on a large scale has just begun. There may be hundreds of millions of tons of iron ore waiting development—only the expenditure of millions of dollars can determine this. See special Cuyuna Range report in this manual.

The Vermilion Range also may have a new life awaiting it from the tonnages yet undiscovered.

The Minnesota Tax Commission has brought to light vast tonnages and values. It has assessed every tonnage property on its own merits regardless of ownership and by a method that is fair to all concerned

Net Values of Iron Ores

Average Costs of Production, Administration and Transportation

By Rukard Hurd

As the Valley furnace price establishes the base unit value and determines the premium and penalty on iron ores, it will be of interest to know how these factors affect the net value of iron ore, and if the ratio of fair, remunerative profit is equitably apportioned between mine and furnace.

To produce one ton of pig iron at Pittsburg, and worth there in 1910 an average of $17.19 for Bessemer, required about 4,000 lbs. of 55% ore (or 4,200 lbs. of 51.50% ore), 2,200 lbs. of coke and 1,200 lbs. of limestone. approximate cost of these items is distributed as follows:

Ore	4,000 lbs. at	$5.00	per ton	$8.93	Freight	$1.73	Total	$10.66
Ore	4,200 lbs at	4.00	per ton	7.50	Freight	1.73	Total	9.23
Coke	2,200 lbs. at	2.10	per ton	2.31	Freight	.83	Total	3.14
Lime	1,200 lbs. at	.53	per ton	.28	Freight	.35	Total	.63
Total cost using $5.00 ore								$14.43
Total cost using 4.00 ore								13.00

The net values per ton are $2.76 and $4.19, according to the grade of the ore used, and they are subject to a deduction for furnace operation and administration.

The approximate cost of the items named at the Valley furnace is distributed as follows:

Ore	4,000 lbs. at	$5.00	per ton	$8.93	Freight	$1.14	Total	$10.07
Ore	4,200 lbs. at	4.00	per ton	7.50	Freight	1.14	Total	8.64
Coke	2,200 lbs. at	2.10	per ton	2.31	Freight	1.19	Total	3.80
Lime	1,200 lbs at	.44	per ton	.24	Freight	.19	Total	.43
Total cost using $5.00 ore								$14.30
Total cost using 4.00 ore								12.87

and the net values would be in proportion as named from Pittsburg.

In considering the average net values of iron ores a general average of all producing mines has been taken.

Net values here presented may be subjected to further revision for carrying charges classified as follows:

1. Diversified tonnages needed for mixing and grading
2. Non-profitable, low-grade ore which must be mined and shipped as encountered
3. Reserve ores for distant future use
4. Protracted non-working periods
5. Profit and loss items: (a) Excessive water
   (b) Strikes
   (c) Fires
   (d) Accidents
   (e) Other contingencies
   (f) Negative explorations

Both gross and net average values have been figured for the year 1910, and for the 19-year period, 1892-1910, inclusive. That is from the opening of the Mesaba Range in 1892 when all iron ranges were in operation. As values were more or less unstable during the first half of the above mentioned period, and as Mesaba values had hardly been determined at that time, another comparative period of 10 years (1901-1910) is given.

The general average shipments from Minnesota for 1910 approximates 58.50% iron dried and 11.96% moisture, or 51.55% natural iron, and indicates the general lowering of grades.

Values based on 55 per cent Bessemer and 51.50 per cent non-Bessemer are taken instead of on general average cargo analyses. The latter could be used if the individual shipments of mine groups and trade ore blends were separately reported.

Gross Value

The 1910 value per ton of ore at lower lake ports is taken as follows:

Bessemer, Old Range—Vermilion	$5.00
Bessemer, Mesaba	4.75
Non-Bessemer, Old Range—Vermilion	4.20
Non-Bessemer, Mesaba	4.00

Cost Group

The following grouping has been adopted as a basis for general average estimate of production and delivery at lower lake ports:

1. Production:
   - (a) Mining Cost
   - (b) Development
   - (c) Exploration
   - (d) Depreciation
   - (e) Supplies and Repairs
2. Royalty
3. Administration:
   - (a) General Office
   - (b) Profit and Loss
   - (c) Commissions
   - (d) Insurance
   - (e) Taxes
   - (f) Miscellaneous
4. Transportation:
   - (a) Rail
   - (b) Vessel

Item 1. Each mine has its own special problem; extremes are often encountered. While open pit mining is comparatively inexpensive, its cost for preparatory stripping may largely counterbalance underground mining costs. Taking into consideration these and other conditions, $1.40 for the Old Range, $1.25 for the Vermilion and 70 cents for the Mesaba, are adopted as conservative average estimates for total production costs.

Item 2. Royalty is paid by the operator and depends upon the terms of the lease; there is a wide range in rates. The average estimate of Old Range royalties is 38 cents, although many old leases fall as low as 10 and 15 cents. The Vermilion royalties are based on old leases and are estimated at 33 cents. Old leases on the Mesaba Range call for 15 to 25 cents, but the newer leases with very largely increased royalties, and a tendency to excess, raise the present average estimate to 50 cents.

Item 3. An average estimate of 20 cents on all ranges is made for administration costs.

Item 4. Transportation rates are public and fixed. For the Old Range and the Vermilion they are here averaged.

These items when assembled present the following table:

GENERAL AVERAGE ESTIMATE COST TABLE

Item	Average Costs	Old Range	Vermilion	Mesaba
1	Production	$1.40	$1.25	$0.70
2	Royalty	.38	.33	.50
3	Administration	.20	.20	.20
4	Transportation:			
	Rail	.37*	.97*	.80
	Vessel	.60*	.70	.70
	Total cost	$2.95	$3.45	$2.90

*Averaged.

The following tables show 1910 gross and net values per ton at Lake Erie for Bessemer and non-Bessemer Ores, containing 55 per cent and 51.50 per cent natural iron:

(a) VALUES OF ORE CONTAINING 55 PER CENT NATURAL IRON

1910 Lake Erie Gross Values	Range	Grade	Estimated Average Cost	Estimated 1910 Lake Erie Net Values
$5.000	Old Range	Bessemer	$2.95	$2.050
5.000	Vermilion	Bessemer	3.45	1.550
4.756	Mesaba	Bessemer	2.90	1.856
4.556	Old Range	Non-Bessemer	2.95	1.606
4.556	Vermilion	Non-Bessemer	3.45	1.106
4.342	Mesaba	Non-Bessemer	2.90	1.442

(b) VALUES OF ORE CONTAINING 51.50 PER CENT NATURAL IRON

1910 Lake Erie Gross Values	Range	Grade	Estimated Average Cost	Estimated 1910 Lake Erie Net Values
$4.643	Old Range	Bessemer	$2.95	$1.693
4.643	Vermilion	Bessemer	3.45	1.193
4.409	Mesaba	Bessemer	2.90	1.509
4.200	Old Range	Non-Bessemer	2.95	1.250
4.200	Vermilion	Non-Bessemer	3.45	.750
4.000	Mesaba	Non-Bessemer	2.90	1.100

The 1910 values are given to illustrate how the 1911 lowering of prices 50 cents per ton on all grades affects profits or net values.

Referring to the Table of Prices or Ore from 1855 to 1910, on page 52, assuming that such prices are equivalent to prices on present base grades, deducting the foregoing total average costs from the gross value per ton from each range we have Table No. 1:

COMPARATIVE TABLE NO. 1.

General Average Gross Values			Range	Grade	General Average Net Values		
1910	10 Year Period	19 Year Period			1910	10 Year Period	19 Year Period
$5.00	$4.32	$3.95	Old Range..	Bessemer....	$2.05	$ 1.37	$1.00
5.00	4.32	3.95	Vermilion....	Bessemer.....	1.55	.87	.50
4.75	3.90	3.39	Mesaba.....	Bessemer.....	1.85	1.00	.49
4.20	3.53	3.16	Old Range..	Non-Bessemer	1.25	.58	.21
4.20	3.53	3.16	Vermilion....	Non-Bessemer	.75	.08	—.29
4.00	3.27	2.75	Mesaba	Non-Bessemer	1.10	.37	—.15

It may be claimed that the total costs for each range shown in the General Average Cost Table are excessive by 50 cents per ton for the 19 year period and by 25 cents for the 10 year period, and that production and royalty costs have largely increased only during recent years. If so, such conditions are covered in Table No. 2:

COMPARATIVE TABLE NO. 2.

General Average Gross Values			Range	Grade	General Average Net Values		
1910	10 Year Period	19 Year Period			1910	10 Year Period	19 Year Period
$5.00	$4.32	$3.95	Old Range..	Bessemer.....	$2.05	$1.62	$1.50
5.00	4.32	3.95	Vermilion...	Bessemer.....	1.55	1.12	1.00
4.75	3.90	3.39	Mesaba.....	Bessemer.....	1.85	1.25	.99
4.20	3.53	3.16	Old Range..	Non-Bessemer	1.25	.83	.71
4.20	3.53	3.16	Vermilion....	Non-Bessemer	.75	.33	.21
4.00	3.27	2.75	Mesaba.....	Non-Bessemer	1.10	.62	.35

It can be readily seen from these fixed cost charges and fluctuations that lowering prices, bad management, great disaster, financial distress or general adverse conditions may destroy profit and create loss.

The need of a re-classification of certain grades and prices is apparent. Normal conditions should prevail between ore and iron, mine and furnace, and prices should move in harmony and practically along parallel lines.

Present Value of Iron Ore Royalties

Of Mineral Leases Containing Merchantable Tonnage

By Rukard Hurd

Newly Created Wealth Through Mineral Value

The recent development of vast tonnages of iron ore in what has been considered a wilderness of rock and swamp, without timber and useless for agriculture and known as "mineral lands" or "wild lands," having previously only a nominal, speculative or prospective value, has brought to life practically a new form of value: that of the present worth to the fee owner of the royalty on the ore therein covered by a mineral lease.

More and more must this element of value be reckoned with; by the state in the enforcement of the inheritance taxes, by probate courts in the administration of estates, and by other courts in adjudication and in proceedings of receiverships, trusts, bankruptcy, etc., where mineral rights are involved. Newly developed wealth usually entails litigation as to ownership and value.

Extent of Capital and Diversity of Ownership

To respond to furnace demands for tonnages of every possible grade, physical characteristics and structure, and to obtain even a reasonable profit, mining operations must be conducted on a very extensive scale, Operation, equipment, supplies, wages, carrying charges, etc., require an enormous working capital. Therefore very few active mines or reserves containing developed tonnages of iron ore are owned in fee by the operating company. This would require an investment of capital as vast in proportion as is the developed tonnage, and in amount almost beyond comprehension. The Vermilion and Mesaba Ranges alone have a total of nearly 1,400,000,000 tons of merchantable iron ore assessed at $225,000,000, the full value of which approximates $562,000,000. These mines and reserves have a very large, widely scattered ownership, resident and non-resident. The known tonnage on the Mesaba Range is contained within some 35,000 acres. There is an equal or perhaps larger acreage within the so-called Mesaba "ore belt" either unexplored, or explored and found barren of iron ore, or located as to almost certainly contain no ore.

Mineral Leases

From the diversified fee ownerships the mine operators have from time to time secured, ordinarily upon a small payment, what is known as a "mining option" or the right to explore, and to obtain a lease with the privilege of mining the ore. These leases are made for a period usually of fifty (50) years, and the amount of royalty to be paid the fee owner for each ton of ore mined and shipped is stated therein. The lease also provides for an annual minimum payment in quarterly installments, being advance payments on account, and a charge against the maximum royalty on the ore as mined. Such minimum payment is made quarterly to the fee owner whether ore is mined or not. It is practically a guaranteed annual income, rental or annuity.

As a rule these leases are executed when the explorations and drillings seem to demonstrate that a sufficient tonnage will be developed to justify

an agreed minimum payment based upon an estimate of expected minimum shipments. Complete explorations follow in due time and the full extent, quantity and quality of the ore body is determined. The fee owner receives regular reports of the explorations and mining. Occasionally leases may contain modifications, such as a sliding scale of royalty or an increased royalty for increase in metallic content.

All leases may be surrendered by the lessee upon giving stipulated notice, usually ninety (90) days, in which event he loses all advance made on account of annual minimum payments. Under all mineral leases the operating company pays all taxes and assessments.

Valuation of Developed Leases

The minimum annual payment is a purely estimated, arbitrary amount and regular royalties range from ten cents (10c) to one dollar and ten cents ($1.10), and even more, per ton. There is no uniformity in rates. Each lease must be valued according to its terms and own merits.

On mines or reserves that have been thoroughly explored and where the tonnage is developed and the amount and grade of merchantable ore is known, a simple but accurate method of determining the present or discounted value of the total royalty of a mineral lease is herewith presented.

The Determining Valuation Factors

1. Unexpired period of the lease
2. Amount of merchantable tonnage subject to royalty
3. Total value of the same calculated by the royalty rate per ton
4. Amount of the annual minimum payment or annuity, on estimated tonnage
5. Amount of an annual minimum payment or annuity on actual tonnage
6. "Life of mine," the term required to mine out the total tonnage
7. Present value of one dollar, per annum, payable quarterly

RULE FOR DETERMINATION OF PRESENT VALUE OF ROYALTIES

Total Royalty

Multiply the tonnage (reduced by the equivalent due by reason of any overpayment of annual minimum advanced) by the amount of royalty per ton. The result is the total royalty which the fee owner will ultimately receive, and it will be paid in, approximately, quarterly installments.

Life of the Mine

Divide the total royalty, as ascertained, by the amount of the annual minimum payment. The result is the "life of the mine;" that is, the annuity paying period, or the number of years required to exhaust the ore. Provided, however, that if this period as calculated extends beyond the lease, then the unexpired term of the lease should be arbitrarily considered as the "life of the mine." It is safe to assume that the operator will exhaust the ore during the life of the lease.

Present Value of the Royalty

A—Where total royalty does not exceed total of guaranteed annual minimum payments

Multiply the annual minimum payment, payable quarterly, by the present value of one dollar per annum, payable quarterly, at the assumed rate of interest and for the number of years determined as the life of the mine. The result is the present royalty value of the lease.

B—Where total royalty exceeds total of guaranteed annual minimum payments

Divide the total royalty by the unexpired term of the lease. The amount is the adjusted approximate annual minimum which will be paid. Multiply this annual minimum payment by the present value of one dollar per annum, payable quarterly, at the assumed rate of interest and for the number of years of the unexpired term of the lease. The result is the present royalty value of the lease.

This method is a practical approximation for finding the true present value of the excess of developed tonnage over the assumed minimum. It will be specially noted that no general rule can be laid down when determining factors have yearly variations.

Attention is again called to the assumption that the ore will be exhausted before the expiration of the lease.

Illustration for A

Term of lease 50 years
Unexpired term of lease 30 years
Royalty per ton 25 cents
Complete explorations develop as remaining 2,000,000 tons
Total royalty at 25c per ton, = $500,000
Life of the mine, $500,000 ÷ $20,000 = 25 years
Guaranteed annual minimum payments $20,000 x 25 = $500,000.

Present Value	At 7%	$20,000 per year, payable quarterly, for 25 Years	$239.104
	At 8%		219.796
	At 9%		202.962
	At 10%		188.210

Illustration for B

Term of lease 50 years
Unexpired term of lease 30 years
Royalty per ton 25 cents
Complete explorations develop as remaining 4,000,000 tons
Total royalty at 25c per ton, = $1,000,000
Life of the mine, the unexpired term of the lease = 30 years
Guaranteed annual minimum payments $20,000 x 30 = $600,000
Excess of total royalty over annual minimum value $1,000,000—$600,000 = $400,000
Adjusted approximate annual minimum payment, $1,000,000 ÷ 30 = $33,333

Present Value	At 7%	$33.333 per year, payable quarterly for 30 years.	$424.332
	At 8%		386.329
	At 9%		353.803
	At 10%		325.773

DETERMINING INTEREST RATE AND FACTORS

While under the conditions named the security of the investment is unquestioned, for calculating present value the determining interest rate depends upon a number of factors, such as:

1. Average worth of money at the given time and interest rate expected for a long time investment.

2. Fluctuating yearly income as the property passes back and forth from shipping and non-shipping stages, from large royalty income on shipments one year to minimum annual payments when not operating.

3. Quality of the ore and availability for furnace demands.

4. Amount of the tonnage and the time required under normal mining conditions to exhaust the ore.

5. Character and standing of the lessee, and his ability to meet the terms of the lease.

6. Possibility of a surrender of the lease, depending upon whether the ore is good or lean, monetary situation and the financial condition of the lessee.

Under all these conditions such an investment demands and is entitled to a high rate of interest, even greater than a highest grade preferred stock or bond security would yield. Capitalists would not entertain the purchase of such a proposition at ordinary rates of 5, 6 or even 7%. While 10% seems to be the customary prevailing interest rate, it would appear that 8% to 10% should be now used in calculating the present value of iron ore royalties, that is, the investment required to purchase the royalty rights of a mineral lease containing known, developed tonnage of merchantable iron ore.

Royalty only Basis of Value

It will be observed that the assessed or full value or market price of the tonnage is not and should not be considered. That concerns only the operating company and the tax officials. That value has gone beyond the control of the fee owner with the lease; his value is in the royalty alone.

Valuation of Undeveloped Leases

On leases of properties not developed, or only partially developed, or containing present non-merchantable ore, or where in underground mines an estimate of total tonnage is impossible, any appraisement of royalty value becomes a matter of judgment of experts familiar with mining and geological conditions.

Accuracy of Information

As has been previously stated in this manual, the exploration is now so thorough that the outlining of the ore bodies and the securing of accurate information to obtain correct estimates of the amount of tonnage and its grade especially on the Mesaba Range, is now practically a known quantity. To a certain extent this holds true of many underground mines on other ranges. Where formerly their ore bodies could be followed, blocked out and their tonnages known for only a year or two ahead, modern drilling methods now disclose the geological formation and determine the character and extent of the ore body.

Tables of Present Values

For convenient reference in connection with this subject standard tables of present values, quarterly and annual, are embodied with and follow this article.

PRESENT VALUE OF ONE DOLLAR PER ANNUM

PAYABLE QUARTERLY

At the End of Each Quarter

Due in any Number of Years from 1 to 50, Inclusive

Specially Compiled by Rukard Hurd for this Manual

Years	5 per cent	6 per cent	7 per cent	8 per cent	9 per cent	10 per cent
1	0.9701	0.9643	.9587	.9532	.9478	.9425
2	1.8939	1.8740	1.8547	1.8359	1.8174	1.7992
3	2.7738	2.7322	2.6922	2.6531	2.6151	2.5782
4	3.6119	3.5419	3.4748	3.4098	3.3470	3.2863
5	4.4099	4.3057	4.2063	4.1105	4.0186	3.9301
6	5.1700	5.0262	4.8898	4.7593	4.6345	4.5153
7	5.8939	5.7061	5.5287	5.3600	5.1998	5.0473
8	6.5834	6.3474	6.1258	5.9162	5.7182	5.5309
9	7.2398	6.9524	6.6838	6.4312	6.1938	5.9706
10	7.8652	7.5231	7.2053	6.9081	6.6304	6.3704
11	8.4607	8.0616	7.6927	7.3497	7.0307	6.7338
12	9.0280	8.5695	8.1482	7.7585	7.3980	7.0641
13	9.5682	9.0488	8.5740	8.1370	7.7350	7.3644
14	10.0825	9.5009	8.9718	8.4875	8.0442	7.6374
15	10.5725	9.9273	9.3436	8.8121	8.3278	7.8856
16	11.0391	10.3298	9.6910	9.1126	8.5881	8.1112
17	11.4836	10.7094	10.0158	9.3908	8.8267	8.3164
18	11.9068	11.0675	10.3194	9.6485	9.0457	8.5028
19	12.3098	11.4053	10.6031	9.8870	9.2467	8.6723
20	12.6937	11.7240	10.8681	10.1078	9.4310	8.8264
21	13.0594	12.0247	11.1159	10.3124	9.6001	8.9665
22	13.4075	12.3084	11.3474	10.5082	9.7553	9.0938
23	13.7382	125.760	11.5639	10.6772	9.8977	9.2096
24	14.0550	12.8284	11.7661	10.8395	10.0283	9.3148
25	14.3557	13.0666	11.9552	10.9898	10.1481	9.4105
26	14.6423	13.2913	12.1318	11.1290	10.2580	9.4975
27	14.9150	13.5031	12.2969	11.2579	10.3589	9.5766
28	15.1749	13.7032	12.4512	11.3772	10.4513	9.6486
29	15.4224	13.8918	12.5954	11.4877	10.5363	9.7139
30	15.6581	14.0697	12.7301	11.5900	10.6142	9.7733
31	15.8825	14.2377	12.8561	11.6848	10.6855	9.8273
32	16.0963	14.3960	12.9739	11.7725	10.7510	9.8765
33	16.2998	14.5454	13.0838	11.8537	10.8112	9.9210
34	16.4937	14.6864	13.1866	11.9288	10.8663	9.9617
35	16.6784	14.8194	13.2828	11.9985	10.9170	9.9986
36	16.8543	14.9449	13.3725	12.0630	10.9635	10.0321
37	17.0218	15.0633	13.4564	12.1227	11.0060	10.0626
38	17.1813	15.1749	13.5349	12.1780	11.0451	10.0903
39	17.3332	15.2803	13.6082	12.2292	11.0809	10.1155
40	17.4779	15.3796	13.6767	12.2765	11.1139	10.1384
41	17.6157	15.4733	13.7407	12.3204	11.1441	10.1592
42	17.7469	15.5618	13.8005	12.3610	11.1717	10.1781
43	17.8719	15.6453	13.8565	12.3986	11.1972	10.1954
44	17.9909	15.7240	13.9088	12.4335	11.2204	10.2110
45	18.1043	15.7982	13.9576	12.4657	11.2418	10.2252
46						
47	18.2123	15.8683	14.0032	12.4956	11.2614	10.2382
48	18.3141	15.9343	14.0459	12.5233	11.2794	10.2499
49	18.4131	15.9967	14.0858	12.5488	11.2959	10.2606
50	18.5062	16.0556	14.1231	12.5726	11.3110	10.2703
	18.5951	16.1111	14.1578	12.5945	11.3250	10.2791

PRESENT VALUE OF ONE DOLLAR PER ANNUM.

PAYABLE ANNUALLY

At the End of Each Year

Due in any Number of Years from 1 to 50, inclusive

Years	5 per cent	6 per cent	7 per cent	8 per cent	9 per cent	10 per cent
1	0.9524	0.9434	.9346	.9259	.9174	.9091
2	1.8594	1.8334	1.8080	1.7833	1.7591	1.7355
3	2.7232	2.6730	2.6243	2.5771	2.5313	2.4869
4	3.5460	3.4651	3.3872	3.3121	3.2397	3.1699
5	4.3295	4.2124	4.1002	3.9927	3.8897	3.7908
6	5.0757	4.9173	4.7665	4.6229	4.4859	4.3553
7	5.7864	5.5824	5.3893	5.2064	5.0330	4.8684
8	6.4632	6.2098	5.9713	5.7466	5.5348	5.3349
9	7.1078	6.8017	6.5152	6.2469	5.9952	5.7590
10	7.7217	7.3601	7.0236	6.7101	6.4177	6.1446
11	8.3064	7.8869	7.4987	7.1390	6.8052	6.4951
12	8.8633	8.3838	7.9427	7.5361	7.1607	6.8137
13	9.3936	8.8527	8.3577	7.9038	7.4869	7.1034
14	9.8986	9.2950	8.7455	8.2442	7.7862	7.3667
15	10.3797	9.7122	9.1079	8.5595	8.0607	7.6061
16	10.8378	10.1059	9.4466	8.8514	8.3126	7.8237
17	11.2741	10.4773	9.7632	9.1216	8.5436	8.0216
18	11.6896	10.8276	10.0591	9.3719	8.7556	8.2014
19	12.0853	11.1581	10.3356	9.6036	8.9501	8.3649
20	12.4622	11.4699	10.5940	9.8181	9.1285	8.5136
21	12.8212	11.7641	10.8355	10.0168	9.2922	8.6487
22	13.1630	12.0416	11.0612	10.2007	9.4424	8.7715
23	13.4886	12.3034	11.2722	10.3711	9.5802	8.8832
24	13.7986	12.5504	11.4693	10.5288	9.7066	8.9847
25	14.0939	12.7834	11.6536	10.6748	9.8226	9.0770
26	14.3752	13.0032	11.8258	10.8100	9.9200	9.1609
27	14.6430	13.2105	11.9867	10.9352	10.0266	9.2372
28	14.8981	13.4062	12.1371	11.0511	10.1161	9.3066
29	15.1411	13.5907	12.2777	11.1584	10.1983	9.3696
30	15.3725	13.7648	12.4090	11.2578	10.2737	9.4269
31	15.5928	13.9291	12.5318	11.3498	10.3498	9.4790
32	15.8027	14.0840	12.6466	11.4350	10.4062	9.5264
33	16.0025	14.2302	12.7538	11.5139	10.4644	9.5694
34	16.1929	14.3681	12.8540	11.5869	10.5178	9.6086
35	16.3742	14.4982	12.9477	11.6546	10.5668	9.6442
36	16.5469	14.6210	13.0352	11.7172	10.6118	9.6765
37	16.7113	14.7368	13.1170	11.7752	10.6530	9.7059
38	16.8679	14.8460	13.1935	11.8289	10.6908	9.7327
39	17.0170	14.9491	13.2649	11.8786	10.7255	9.7570
40	17.1591	15.0463	13.3317	11.9246	10.7574	9.7791
41	17.2944	15.1380	13.3941	11.9672	10.7866	9.7991
42	17.4232	15.2245	13.4524	12.0067	10.8134	9.8174
43	17.5459	15.3062	13.5070	12.0432	10.8380	9.8340
44	17.6628	15.3832	13.5579	12.0771	10.8605	9.8491
45	17.7741	15.4558	13.6055	12.1084	10.8812	9.8628
46	17.8801	15.5244	13.6500	12.1374	10.9002	9.8753
47	17.9801	15.5890	13.6916	12.1643	10.9176	9.8866
48	18.0772	15.6500	13.7305	12.1891	10.9336	9.8969
49	18.1687	15.7076	13.7668	12.2122	10.9482	9.9063
50	18.2559	15.7619	13.8007	12.2335	10.9617	9.9148

Prospecting, Mining and Ore Estimating Methods in Minnesota

With Special Reports on the

Western Mesaba and Cuyuna Ranges

A Reprint from the Second Biennial Report, 1910, of the Minnesota Tax Commission

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PROSPECTING FOR IRON ORE

In metal mine prospecting the percussion drill is largely used for iron, zinc, lead, gypsum and coal work.

The churn drill or form of percussion drill as used on the Mesaba Iron Range consists of a chisel drill on an extensible hollow rod. This rod is attached by a flexible coupling to a pump which forces a stream of water into the hole and out of perforations near the attachment to the bit. This water returns inside the casing, which is an ordinary pipe, 3 inches in diameter when in surface material and 2 inches in rock and ore. The drill is manipulated by a rope passing several times over a drum driven by a 6 to 8 horsepower oscillating engine, and the "jerk" is given by a man tightening or slacking the rope coil. The drill is rotated by hand, the driller standing on a platform built in the tripod. When boulders are encountered they are blasted out with dyanmite. A churn drill outfit, boiler and all, costs from $1,000 to $2,000.

When taconite or hard slate is struck the churn drill has to be abandoned and the diamond drill is used until it passes through the taconite into the ore. It is customary to blast out the hole and force the casing down and then resume drilling with the churn drill. This blasting is done by suspending in the hole two or more sticks of dynamite and firing them with a battery. The casing, which had been partly pulled out, is then forced down with a drive weight, and the churn drill inside chops out the hole until the casing can follow to the bottom of the hole. A churn drill will make from 5 to 25 feet a day in a formation in which it can be used at all. Three men are required to run it. Wood and water hauling may run up expenses—sometimes requiring a team for each.

The surface indications of iron are meager and not very reliable. Some of the explorations have taken into account the topographical features of the district, and the theoretical geological conditions, but generally a tract located on or in the vicinity of the ranges is selected and drilled without regard to indications on the surface. The unit of explorations is forty acres, and this is called locally a "forty." The federal mining laws do not apply in Minnesota so the property is included in the vertical boundaries of the tract. The usual test for a forty-acre tract is to put five holes—one in the center and four 300 feet toward the center from each corner. However, drilling five holes is not considered a final test.

In proving up an ore body or testing completely, the practice is to divide the property into squares of 300 feet each, commencing 100 feet inside of

the forty line, and drilling on the intersections. The Oliver Iron Mining Company ignores the survey lines, which are very irregular; they tie the tract to some surveyed property and lay it off in squares of 100 feet each. Drill holes are then sunk on each second and third intersection according to the purposes of the test and the intersections are taken alternately so as to leave the smallest possible radius of undrilled land. Sometimes, in drilling for development, it is necessary to put holes in at closer intervals; especially where the work is along the edge of an irregular deposit. The ore bodies do not always taper out.

Most of the drilling is done by contract. The usual contract price is $3.00 per foot for churn drill and $6.00 per foot for diamond drill work. In some cases the diamond drill work costs more. Considerable test pitting is done at the surface at a cost of $1.60 to $2.00 per foot, a ten cent increase for each 10 feet after the first 20 feet being customary. Daily reports of the work are made to the contractor and frequent reports to the parties interested. Samples are taken every 5 feet, and wherever the formation changes, these samples are usually analyzed for iron, phosphorus, manganese and silica. The drill results are platted showing the location and the record of the holes. These reports are signed and dated and are considered reliable data as to the property. The contractors are well known and responsible, and misleading or false reports are rare.

The drill holes vary much in depth in different districts; near Hibbing one hole is over 350 feet in ore. It is a rule when ore is found to go through it. If quartzite is found this is taken as final, but most of the ore bodies are bottomed in taconite and sometimes the drill will go through a bed of ore into a taconite layer and then again into ore. It is generally believed that much ore exists below the present bottom. The old rule was to stop when taconite was found, but some of the best ore bodies are found to be below the taconite. Usually these are the extensions of ore bodies which outcrop to the north. In some parts of the range the finding of taconite under the surface is considered a good indication of an ore body beneath.

In some of the mines jumper drills worked by man power are used to check the grade of the ore or do surface work. The Mahoning mine sunk numerous test pits in the ore body to determine the character and grade in advance of mining. Much test pitting and drilling is now done before any property is considered sufficiently well known to permit planning its mining.

The cost of the diamond drill outfits in use is from $2,500 to $4,000; the shallow nature of the work permitting a comparatively cheap equipment.

Prospecting on the Vermilion range is generally done with a diamond drill, followed up by the sinking of shafts and the driving of drifts after the ledge has been struck. On the Cuyuna range churn and diamond drills are used. The holes are much deeper as a rule than on the Mesaba and in case of the diamond drill work frequently driven on an angle. The contract price on the Cuyuna is $2.00 per foot for churn drilling and $4.00 per foot for diamond drilling.

MINING METHODS

On the Vermilion range the mining is confined to underground work and this will be the method employed upon the Cuyuna range. On the Mesaba range conditions are such that a large part of the mining may be

done by open pit work. The ore ledges on the Vermilion stand at angles approaching 80 degrees and in some cases are vertical. The ore is hard—so hard that the ordinary air drill makes very slow progress through it and the expensive diamond drill must be largely used, both for mining and exploring the formation. A large amount of explosives is required to break the ore into small enough pieces to permit loading. The Cuyuna range ore, while not as hard as Vermilion ore, nevertheless will be more expensive to mine than that of the Mesaba range.

Open Pit Mining

The Mesaba ore is soft. It lies near the surface in an almost horizontal plane, with a covering of 20 feet or more of glacial drift composed of sand and clay in which there are many huge boulders. The ore bodies vary in size but are fairly uniform in most respects. They may be a mile or more in length, though this is unusual. The width of the body sometimes reaches a half mile, with a thickness running from 50 to 300 feet. The open pit method is much used, both for stripping over burden and mining ore. There are, however, many deposits where open pit mining cannot be employed. Its application is determined by the thickness and extent of the ore body relative to the overburden; the character of the ore; the distance of haul to the dump, etc. The increasing efficiency of the steam shovel, the greater cost of timbering and the lack of skilled miners necessary for underground mining, all have contributed toward extending open pit mining.

In open pit mining the ore body is reached by removing the overburden with a steam shovel, not unlike that used in railroad excavation work. Many million cubic yards have been stripped to lay bare the ore bodies and recently a stripping depth of 150 feet, involving seven million cubic yards of stripping, was undertaken. The steam shovel has removed more material on the Mesaba range than the total excavation required for the Panama canal.

A shovel crew consists of an engineer, a crane man, and four pit men to prepare the road bed and lay the track upon which the steam shovel stands. A "spotter" keeps the stripping train which stands on a parallel track moving as the successive cars are filled. The shovel lifts four or five tons at a time from the bank and dumps its load into cars. In many cases it is necessary to shake up the earth by the use of powder. Charges are placed in drill holes a short distance back from the edge of the bank, and on exploding the charge, which is done by means of the ordinary fuse and cap, the bank is loosened up to permit easy working for the shovel. The large boulders require breaking up by the use of dynamite. The dump cars loaded by the steam shovel are hauled to the dump by a "dinky" engine or by engines weighing as much as 60 tons.

In this way the ore is cleaned off and made ready for mining, the final cleaning up of the top of the ore being done by men with shovels and wheelbarrows. The ore is so soft that the shovel frequently digs it without blasting, though in general black powder is used to shake up the mass. It is the universal practice to load the ore direct from the pit into railroad cars which are drawn out three to ten at a time by a standard gauge locomotive. In this way the deposit is worked down bench by bench, until a little of the rim only is left. The grades become too heavy for the locomotive or the deposit too thin and underground mining finishes the work. The ore is generally carried in steel cars which have a nominal capacity

of 50 tons each, actual capacity 46 tons. A standard shovel weighs 90 tons, and one crew can load up to 8,000 tons of ore per ten-hour day, with 4,000 or 5,000 as an average day's work. Both stripping and ore handling are done on a two-shift basis of ten hours each. Work is suspended on Sunday except that of repairing the shovels.

Milling System

The milling system is a combination of open pit and underground mining. The ore is stripped as in open pit mining. A shaft is sunk near the edge of the ore body and drifts are run into the ore, say 60 feet below its top. Raises are made from the drift to the surface and through these the ore is "milled" down into chutes, loaded into cars and hauled by mules or electric power to the shaft where it is hoisted to the surface and dumped into railroad cars. When the ore is very soft it may be "milled" into the raises by use of the pick alone—in other cases blasting must be resorted to. In some cases the steam shovel is used to throw the ore into the "mill." As the "mill" becomes larger it finally becomes too dangerous for the miner on account of the steepness of the sides and underground mining methods must be used. A relatively small amount of ore has been won on the Mesaba by "milling."

UNDERGROUND MINING

Only a few deposits permit the removal of all the ore without resorting to underground mining and many mines may be worked only by underground methods. Formerly the square set system, much used in metal mining elsewhere, was the accepted method on the Mesaba. While satisfactory in the main and still employed to a limited extent in a few places this method has given way to the "slicing and caving" system which is effective and economical. Nearly all the ore is recovered. The method consists in beginning at the top of the ore and working out a slice, dropping the surface as the work goes on. The caving of the surface is necessary on account of the character of the roof, which is generally sand or a gravel. A shaft is sunk as in the milling system and a drift is run into the ore. Sub-levels are then driven at distances from 8 to 14 feet high and raises are run to the top of the ore. The ore is sliced out just wide enough to carry the roof while working. The ore is shoveled into the raises, at the bottom of which a chute is set from which the ore is drawn direct into mine cars. As each slice is taken out the overburden is caved—either of its own weight or is blasted down. This overburden packs so as to hold up laterally with a little temporary timbering and lagging.

Slice after slice is taken until the whole top of the ore body has been drawn into the raises, when the same process is gone through on the next sub-level. The floors of the slices are covered with plank or boards so as to keep the sand from mixing with the ore and to make a roof for the next slice below. This floor under the sand follows the ore down with each slice. This general system has a number of modifications, permitting it to be used on the other ranges. It calls for the use of a small amount of timber and is comparatively free from accident to miners.

Regarding the three methods of mining in vogue it may be said in general that underground mining is increasing while open pit work has reached its maximum service.

ORE ESTIMATES

Mesaba Range

To make an "ore estimate" certain recognized principles must be adapted to the particular case in hand, for each property presents an individual problem. In general, it may be said that a total tonnage estimate is the one first made. This will suffice in case of reserve ore bodies, and needs but little adjustment, provided the ore body has been thoroughly drilled. Where the drill data is incomplete, it will be necessary from time to time to revise the ore estimate.

As to the method it may be briefly stated as follows: The outline of the ore body is established from the drill holes. The ore lying without the outer rim of holes is elliptical in outline and triangular in cross section. Inside this outer limit of the ore body is drawn a line connecting the centers of the bases of all these triangles. This line should be midway between the crest and toe of the slope of the ore bank.

The area inclosed, multiplied by the average depth of ore in all holes within the area, is the total volume of ore.

The number of cubic feet per ton for various grades of ore has been established by experience dealing with every part of the ranges and it varies from 13 cubic feet for 62 per cent iron to 17 cubic feet for 49 per cent iron. All analyses are based on the dried samples.

The ore is carefully graded into: (a) bessemer, (b) non-bessemer, and in some cases, into (c) ore material.

The limiting analyses are about as follows:

	Iron per cent	Phosphorus per cent	Silica per cent	Manganese per cent
Bessemer	61.55	.047	4.6	1.0
Non-Bessemer	57.20	.099	7.2	1.5

All ore above 49 per cent is considered merchantable.

The ore material class is made up of the ore lying between 40 per cent and 49 per cent. It may or may not have commercial value, depending upon whether it can be washed or concentrated.

Furthermore, from the drill records and the locations of drill holes, cross sections of the ore body may be made. The sections may be made by passing vertical planes through adjoining holes; then all the planes (in practically the same plane) joined together, constitute a section. By many engineers a plane is passed which cuts as many of the holes in one direction as possible, and those holes not on the section are projected upon it. This second method is simple and can be used in making estimates without a correction for the length of section due to the broken planes.

If inaccuracy occurs in that the hole is off the section and it does not show the true depth of ore at the place indicated, interpolation may be used to correct this depth from adjoining holes by a section at right angles to the one in question.

The ore sometimes ends abruptly against rock and then again will run out in long lenses. In general it may be stated that the edge of the ore body is placed at a distance outside the outer rim holes equal to the depth of ore in the hole. An examination of the sections will show the different grades of ore more or less continuous in layers. From these sections carefully drawn to scale their areas may be measured and by the method of "average end areas" the total volume of the body obtained and the number of tons computed. This cross section method usually checks closely the first method described.

As the shipments are made from each property the number of tons shipped is annually deducted so that the ore remaining in the mine is checked up each year.

Where doubtful drill records, irregular, or large rock intrusions render the above described methods unsatisfactory, it becomes necessary to make a "pillar estimate" in order to ascertain the tonnage in the mine. This consists in measuring up the ore pillars from the underground maps, giving due consideration to "probable ore," thus determining the ore tonnage.

Vermilion Range

Estimates are made for this range by measuring up the pillars of ore from the underground maps.

WESTERN MESABA RANGE ESTIMATES

Special Report

The distinguishing feature of the Western Mesaba ore formation is the incompleteness and irregularity of the alteration as compared with Eastern Mesaba. The ore bodies show all gradations from ferruginous chert to completely oxidized iron ore almost free from silica and alumina.

The ore may be generally characterized as silicious, carrying from 30% to slightly over 60% iron; the phosphorus compared with Eastern Mesaba ores is notably low, rarely above 0.05% and frequently as low as 0.01%; the percentage of silica varies from 25% to 75%—35% being perhaps a normal silica percentage. This silica or "sand" is not water-worn,—it consists of small sharp fragments derived from the disintegration of the ferruginous chert, the so-called "iron-bearing taconite."

Experiments in concentration indicate that, while much of the silica is so combined with iron as to be wholly unsusceptible of concentration, the probabilities are decidedly in favor of concentration—or more correctly speaking, washing—being developed to a commercial success.

The softness of the ore formation practically limits drill prospecting to churn drilling. Since much of the ore is largely composed of the sharp "sand" just referred to it is difficult if not impossible to judge from an examination of the drillings (which consist wholly of sharp fragments) whether the stratum passed through is taconite or paint-rock, or whether it is material that can be commercially washed.

Recent development by test pits and raises has disclosed large quantities of "paint-rock." One of the distinguishing features of paint-rock on Eastern Mesaba is the presence of comparatively large percentages of alumina and phosphorus which are readily determined by analysis. On the Western Mesaba the paint-rock contains so little alumina and phosphorus that dependence cannot be placed upon the chemical analysis of drill samples to distinguish between paint-rock and ore. Until quite recently ore esti-

mates in the Western Mesaba district were based wholly upon chemical analysis. Three grades were established: First, a non-Bessemer shipping ore containing 57% iron and 0.04% phosphorus of which quite a little tonnage was developed. Second, a first-class silicious ore averaging 49% iron and 0.04% phosphorus. Third, a second-class silicious ore averaging 40% iron and 0.04% phosphorus. It was assumed that the bulk of the silicious ore could be successfully raised to merchantable grade by washing. The sinking of test pits quickly showed a wide variation in chemical analysis of churn-drill samples and test pit samples from the same stratum. This variation was caused by a washing away of silica and alumina and concentration of iron due to the churning action in the drill hole. The alumina in some cases was reduced from 17% to 0.2%, while the iron was correspondingly increased,—in some instances sufficiently to make drill samples run 7% higher than test-pit samples.

This selective or concentration action within the drill hole might readily make a poor class of paint-rock appear to be a good grade of non-Bessemer ore; it might readily show a large tonnage of washable ore in ground which really averaged as low as 30% iron.

A number of comparisons between drill hole and test-pit data show that a concentration of iron in the drill hole is inevitable. The degree of concentration varies greatly but would seem to average about 4%. Therefore in grading this 4% reduction has been adopted.

The impracticability of using the chemical analysis as a basis for the classification of the ore as "washable" and "non-washable" led to the adoption of a classification of test-pit and drill samples, according to physical characteristics into "ore"—"sand and ore"—"paint-rock" and "taconite." A number of estimates were made on this plan by a leading mining company but its engineers have now abandoned the method as unsatisfactory.

It would be impossible for two men, however expert and conscientious, to check within reasonable limits on an ore estimate based purely on the physical characteristics of drill samples. Therefore estimates are based on the chemical analysis.

As a matter of fact, present day estimates in the Western Mesaba district are largely speculative and will so remain until the washing plant now in construction at Coleraine has thoroughly tested out the various ore bodies, determining the ratio of washable to non-washable ore and the ratio of concentration.

CUYUNA RANGE ESTIMATES

Special Report

The deposits are irregular in shape. The drilling shows them in the form of lenses which are commonly narrow and may be single or double; when double they are parallel and are separated by lean material. There are no outcrops and no topographic features to indicate the presence of an ore deposit. The iron-bearing formation continues for miles though the bodies of ore are small and in general end abruptly; the greatest length is approximately 2,000 feet.

Two hundred (200) feet is probably close to the average width for the north part of the range, while the width is considerably less on the south end.

The greatest depth shown to date is 850 feet. Greater depths are obtained on the north than on the south range. Four hundred and fifty (450) feet is in all probability a fair average depth. These lenses of ore are pitched at a high angle in many cases nearly vertical.

Samples taken from the Kennedy mine, situated in the N½ of the SE¼ of Section 30-47-28, averaged 57.06 per cent iron, .119 per cent phosphorus, .61 per cent manganese, 11.10 per cent silica with a moisture of approximately 10 per cent. This is typical of the ore as it is found on the north end of the range. The percentage of iron is lower on the south end. Cuyuna ores are hydrous and silicious limonites, usually red or brown in color, intermixed with paint-rock. Some hematites are found. From present indications the percentage of iron is higher near the top of the ore body and decreases with depth.

Over the range in general the phosphorus is higher than that just shown in the Kennedy mine. Bessemer ore seems to exist only in very small quantities.

Manganese will run about as shown in the Kennedy.

Silica is high and usually increases as the iron decreases until the ore becomes too lean to be merchantable.

Moisture is as yet largely undetermined, but it may in some cases reach 14 per cent.

The texture of the ore runs from soft, slaty to a dense, hard, silicious ore.

The ore will probably be rated only as of medium grade. Its physical characteristics make it a desirable furnace material, while low iron and high silica detract from its value.

Mining must be done entirely by underground methods—no stripping being possible. At present the Kennedy mine owned by Rogers, Brown & Company is the only one hoisting ore. Two levels are opened up on this property and a stock pile has accumulated awaiting the completion of the railroad and ore docks. The season of 1911 should see a fair production from this mine.

The Meacham shaft of Rogers, Brown & Company in the NE¼ of the NE¼ of Section 11-46-29 is made of concrete and has been sunk 78 feet to the ledge and will be continued to 400 feet in depth. Railroad tracks have been provided for this shaft and the property should be a producer in 1911.

At Ironton a location is now building and a shaft just begun in the SE¼ of the NE¼, Section 10-46-29. Tracks and yards are already in place. This property also belongs to Rogers, Brown & Company.

There are no other active mines at present on the Cuyuna range.

IRON MINES OF THE MARQUETTE RANGE

With 1910, Prior and Total Shipments From Each Mine
Reprinted from the Iron Trade Review

Name of Mine	Shipments		
	1910	Prior	Total
American (Sterling)	163,290	240,339	403,629
Austin	188,588	433,037	621,625
Beaufort (Ohio)	23,427	566,705	590,132
Bessie	.....	59,097	59,097
Breitung Hematite	114,202	301,583	415,785
Cambria	150,422	2,037,727	2,188,149
Champion	18,746	4,394,385	4,413,131
*Cleveland-Cliffs Group	955,374	21,449,896	22,405,270
East New York	.....	327,604	327,604
Empire	53,687	203,095	256,782
Foxdale	.....	31,447	31,447
Hartford	183,471	1,766,951	1,950,422
Imperial	83,404	376,691	460,095
Jackson	40,320	3,885,213	3,925,533
Lake Angeline	244,923	8,285,460	8,530,383
Lake Superior	271,445	14,961,563	15,233,008
Lillie	10,121	1,748,490	1,758,611
Lucy (McComber)	11,257	519,031	530,288
Maas	208,103	220,611	428,714
Magnetic (stock pile)	.....	292	292
Mary Charlotte	197,522	1,057,184	1,254,706
Mitchell	23,428	29,319	52,747
Moore	.....	68,131	68,131
Negaunee	348,818	3,662,127	4,010,945
New York (York)	.....	1,123,071	1,123,071
Palmer	.....	14,172	14,172
Portland	49,584	79,652	129,236
Princeton (Swanzey)	89,441	1,271,761	1,361,202
Queen (Blue)	230,119	5,992,421	6,222,540
Republic	150,732	6,193,471	6,344,203
Richmond	95,772	688,455	784,227
Rolling Mill	115,193	578,916	694,109
Star West (Wheat)	.....	204,649	204,649
Stegmiller	48,842	39,869	88,711
Stephenson	225,726	122,968	348,694
Volunteer	.....	1,419,197	1,419,197
Washington	96,769	65,341	162,110
Webster	.....	34,905	34,905
Winthrop (Marquette)	.....	1,912,022	1,912,022
Miscellaneous	.....	5,537,143	5,537,143
Total	4,392,726	91,903,991	96,296,717

*Cliffs, Lake, Moro and Salisbury Mines.

IRON MINES OF THE MENOMINEE RANGE

With 1910, Prior and Total Shipments From Each Mine
Reprinted from the Iron Trade Review

Name of Mine	Shipments		
	1910	Prior	Total
Alpha	.....	1,370	1,370
Antoine	.....	1,353,792	1,353,792
Aragon	241,046	5,836,281	6,077,327
Armenia	65,473	311,608	377,081
Baker	39,417	45,003	84,420
Baltic	171,930	1,168,663	1,340,593
Berkshire	97,999	37,735	135,734
Breen	.....	75,425	75,425
Bristol (Claire)	270,742	2,185,367	2,456,109
Calumet	.....	121,354	121,354
Caspian	171,334	527,971	699,305
Chapin (Ludington)	465,543	17,183,934	17,649,477
Chatham	51,988	129,439	181,427
Clifford	91,081	103,626	194,707
Columbia	.....	942,703	942,703
Commonwealth	89,116	2,511,784	2,600,900
Crystal Falls	.....	1,735,251	1,735,251
Cuff	.....	58,419	58,419
Cundy (Quinnesec)	.....	1,344,645	721,321
Dober (Riverton)	84,269	2,110,877	2,195,146
Dunn	136,144	1,521,871	1,658,015
Eleanor (Appleton)	.....	18,719	18,719
Fairbanks (P't R.)	.....	379,789	379,789
Florence	239,161	2,718,019	2,957,180
Fogarty	51,071	117,865	168,936
Forest	.....	11,988	11,988
Genesee (Ethel)	66,185	471,439	537,624
Gibson	45,202	57,151	102,353
Great Western	80,709	1,872,228	1,952,937
Groveland	26,462	74,092	100,554
Hemlock	115,407	1,589,818	1,705,225
Hiawatha	128,884	485,612	614,496
Hilltop	.....	20,229	20,229
Hollister	49,434	46,982	96,416
Hope	.....	28,530	28,530
James	78,388	152,971	231,359
Keel Ridge	.....	93,101	93,101
Kimball	.....	16,224	16,224
Lamont (Monitor)	3,183	555,341	558,524
Lincoln	.....	241,627	241,627

IRON MINES OF THE MENOMINEE RANGE—Concluded AND BARABOO DISTRICT

With 1910, Prior and Total Shipments From Each Mine
Reprinted from the Iron Trade Review

Name of Mine	Shipments		
	1910	Prior	Total
Loretto	116,048	1,195,020	1,311,068
Mansfield	114,357	1,102,998	1,217,355
McDonald	6,022	1,144	7,166
Michigan	17,922	153,797	171,719
Millie (Hewitt)	.....	368,267	368,267
Monongahela	.....	9,310	9,310
Munroe	20,022	278,556	298,578
Nanaimo	.....	373,765	373,765
Northwestern	.....	35,810	35,810
Penn Iron Mining Company	344,760	8,500,375	8,845,135
Pewabic	380,376	6,936,789	7,317,165
Quinnesec	744	3,147	627,215
Saginaw (Perkins)	.....	502,985	502,985
Sheridan	.....	116,299	116,299
Tobin	235,812	1,394,737	1,630,549
Tully	2,726	.....	2,726
Verona	.....	130,975	130,975
Vivian	14,827	405,412	420,239
Youngs	98,399	375,385	473,784
Zimmerman	25,555	12,135	37,690
Miscellaneous	.....	1,057,306	1,057,306
Total	4,237,738	71,213,055	75,450,793

BARABOO DISTRICT

(In Wisconsin)

Illinois	.....	309,741	309,741
Iron Ridge	14,487	158,994	173,481
Mayville	77,195	411,892	489,087
Total	91,682	880,627	972,309

IRON MINES OF THE GOGEBIC RANGE

With 1910, Prior and Total Shipments From Each Mine
Reprinted from the Iron Trade Review

Name of Mine	Shipments		
	1910	Prior	Total
Anvil	7,235	766,962	774,197
Ashland	231,506	5,386,884	5,618,390
Atlantic	79,847	1,547,123	1,626,970
Brotherton	102,626	1,752,498	1,855,124
Cary (and Superior)	205,674	2,540,147	2,745,821
Castile	20,197	35,247	55,444
Chicago	.....	68,727	68,727
Colby	194,754	2,450,347	2,645,101
Davis (Wisconsin)	.....	103,961	103,961
Eureka	41,611	462,134	503,745
Geneva	.....	7,108	7,108
Harmony (Germania)	20,080	422,239	442,319
Hennepin	.....	259,733	259,733
Iron Belt	66,627	1,185,502	1,252,129
Ironton	109,925	848,985	958,910
Jack Pot	.....	99,090	99,090
Meteor (Comet)	.....	216,367	216,367
Mikado	52,715	997,085	1,049,800
Montreal	187,325	2,804,485	2,991,810
Newport	1,182,324	5,845,039	7,027,363
*Norrie Group	1,333,006	24,052,924	25,385,930
Ottawa (Odanah)	83,389	481,359	564,748
Palms	.....	1,284,489	1,284,489
Pence	8,954	40,566	49,520
Pike	3,324	98,732	102,056
Puritan (Ruby)	50,019	109,572	159,591
Shores	.....	55,808	55,808
Sunday Lake	115,486	1,306,975	1,422,461
Tilden	99,937	5,088,635	5,188,572
Upson	.....	11,375	11,375
Winona	10,500	.....	10,500
Yale (West Colby)	108,253	373,173	481,426
Miscellaneous	.....	117,232	117,232
Total	4,315,314	60,820,503	65,135,817

*Norrie, N. Norrie, E. Norrie, Aurora, Pabst and Vaughn Mines.

IRON MINES OF THE MESABA RANGE

With 1910, Prior and Total Shipments from Each Mine
Reprinted from the Iron Trade Review

Name of Mine	Shipments		
	1910	Prior	Total
Adams	1,258,295	12,585,828	13,844,123
Adriatic	135,685	288,927	424,612
Agnew	152,834	923,881	1,076,715
Ajax (Kanawha)	.....	207,650	207,650
Albany	267,583	1,731,036	1,998,619
Alberta	25,404	82,175	107,579
Alexander	1,652	231,699	233,351
Auburn	.....	2,143,028	2,143,028
Bangor	17,673	.....	17,673
Bessemer	117,173	756,853	874,026
Biwabik	544,353	9,121,569	9,665,922
Bray	57,789	65,514	123,303
Brunt	110,630	269,184	379,814
Burt	1,032,815	7,859,698	8,892,513
Canisteo	1,105,160	93,719	1,198,879
Canton	.....	713,048	713,048
Cass	.....	241,343	241,343
Chisholm	634,236	1,946,993	2,581,229
Cincinnati	.....	152,075	152,075
Clark	529,222	2,942,375	3,471,597
Columbia	.....	16,987	16,987
Commodore	341,548	2,201,854	2,543,402
Corsica	277,537	636,176	913,713
Crosby	159,569	678,192	837,761
Croxton	71,632	1,075,759	1,147,391
Cyprus	102,233	1,278,034	1,380,267
Day	.....	319,453	319,453
Diamond	.....	171	171
Duluth	57,239	1,737,233	1,794,472
Elba	186,993	1,668,853	1,855,846
Elizabeth	7,214	.....	7,214
Euclid	53,009	82,627	135,636
Fayal	1,485,099	18,132,550	19,617,649
Forest	8,264	240,276	248,540
Fowler	204,640	155,417	360,057
Franklin	31,614	1,712,008	1,743,622
Frantz	.....	145,069	145,069
Genoa	283,299	2,985,287	3,268,586
Gilbert	110,788	1,220,788	1,331,576
Glen	286,051	1,917,410	2,203,461
Grant	297,761	164,514	462,275
Hanna	308,009	238,873	546,882
Harold	27,711	.....	27,711

IRON MINES OF THE MESABA RANGE—Continued

With 1910, Prior and Total Shipments from Each Mine
Reprinted from the Iron Trade Review

Name of Mine	Shipments		
	1910	Prior	Total
Hartley	113,512	390,108	503,620
Hawkins	224,406	1,545,523	1,769,929
Hector (Hale)	82,393	418,336	500,729
Higgins No. 2	151,854	1,111,146	1,263,000
Hill	801,088	.....	801,088
Hobart	.....	8,314	8,314
Holland	.....	270,864	270,864
Holman	413,873	400,907	814,780
Hudson	168,553	.....	168,553
Hull-Rust	3,189,975	12,390,506	15,580,481
Humphrey	† 8,227	25,348	33,575
Iroquois	231,842	877,767	1,109,609
Jennings	.....	213,317	213,317
Jordan	20,314	925,330	945,644
Kellogg	142,906	196,789	339,695
Kinney	401,920	795,349	1,197,269
Knox	50,942	7,464	58,406
La Belle	20,349	472,668	493,017
*Lake Superior Group	.....	4,962,469	4,962,469
Larkin (Tesora)	21,700	94,722	116,422
La Rue	128,658	1,277,745	1,406,403
Laura	189,046	768,970	958,016
Leetonia	615,396	2,262,496	2,877,892
Leonard	987,910	858,095	1,846,005
Lincoln	318,912	2,144,253	2,463,165
Longyear	.....	121,391	121,391
McKinley	.....	109,086	109,086
Mace	15,267	.....	15,267
Maderia	83,922	.....	83,922
Mahoning	1,515,723	12,531,132	14,046,855
Malta	72,035	1,044,325	1,116,360
Mariska	23,265	108,053	131,318
Mayas	.....	220,765	220,765
Meadow	4,392	.....	4,392
Miller	216,263	1,133,484	1,349,747
Minnewas	963	16,523	17,486
Minorca	66,511	900,463	966,974
Mississippi	36,581	.....	36,581
Mohawk	123,180	557,315	680,495
Monica	69,503	7,614	77,117
Monroe	.....	628,899	628,899
Morris	1,364,673	7,316,409	8,681,082
Morrow	.....	279,296	279,296
Mountain Iron (Aetna)	.....	17,198,871	17,198,817

*Burt, Hull and Hull-Rust Mines.
†A Trespass.

IRON MINES OF THE MESABA RANGE—Concluded
With 1910, Prior and Total Shipments From Each Mine
Reprinted from the Iron Trade Review

Name of Mine	Shipments		
	1910	Prior	Total
Myers	131,440	914,736	1,046,176
Nassau	39	31,112	31,151
Onandaga	61,935	90,797	152,732
Pearce	60,411	242,830	303,241
Pearson	78 133	68,683	146,816
Penobscot	.....	706,071	706,071
Perkins	80,622	59,029	139,651
Pettit	62,456	496,830	559,286
Pillsbury	.....	1,640.265	1,640,265
Roberts	26,915	190,154	217,069
Sauntry-Alpena	242,373	700,140	942,513
Scranton	.....	1,168	1,168
Sellers	954,042	2,870,890	3,824,932
Seville	2,677	23,585	26,262
Schley	13,369	.....	13,369
Sharon	.....	329,535	329,535
Shenango	965,148	2,303,257	3,268,405
Silverton	13,740	.....	13,740
Sliver	358,432	305,364	663,796
Sparta	.....	1,244,197	1,244,197
Spring	31,909	35,773	67,682
Spruce (Cloquet)	613,947	5,166,199	5,780,146
St. Clair	.....	94,688	94,688
St. Paul	.....	137,430	137,430
Stephens	.....	454,819	454,819
Stevenson	953,079	9,984,191	10,937,270
Susquehanna	176,869	583,592	760,461
Sweeney	769	7,579	8,348
Syracuse	2,363	5,509	7,872
Tener	.....	853,765	853,765
Troy	104,057	489,824	593,881
Union	.....	399,877	399,877
Uno	341,939	.....	341,939
Utica	232,582	1,303,649	1,536,231
Victoria	27,592	289,525	317,117
*Virginia Group	992,389	8,218,097	9,210,486
Virginia Mine	299,046	.....	299,046
Wacoutah	35,498	226,424	261,922
Webb	46,384	369,783	416,167
Williams (N. Cincinnati)	.....	97,842	97,842
Wills	26,712	20,148	46,860
Winnifred (Day)	67,686	365,102	432,788
Yates	.....	679,038	679,038
Yawkey	30,439	145,689	176,128
Total	229,201,760	195,703,424	224,905,184

*Lone Jack, Missabe Mountain, Norman and Ohio Mines.

IRON MINES OF THE VERMILION RANGE.

With 1910, Prior and Total Shipments From Each Mine
Reprinted from the Iron Trade Review

Name of Mine	Shipments		
	1910	Prior	Total
Chandler	.....	9,537,378	9,537,378
Pioneer	526,435	6,991,297	7,517,732
Savoy	59,875	1,359,611	1,419,486
Section 30	51,650	.....	51,650
Sibley	206,386	1,352,575	1,558,961
Soudan (Minnesota)	75,511	8,281,852	8,357,363
Zenith	283,320	1,602,672	1,885,992
Total	1,203.177	29,125,385	30,328,562

GRAND SUMMARY OF SHIPMENTS

Range	1910	Prior	Total
Marquette	4,392,726	91,903,991	96,296,717
Menominee	4,237,738	71,213,055	75,450,793
Gogebic	4,315,314	60,820,503	65.135,817
Baraboo	91,682	880,627	972,309
Mesaba	29,201,760	195,703,424	224,905,184
Vermilion	1,203,177	29,125,385	30,328,562
Grand Total	43,442,397	449,646,985	493,089,382

YEARLY TONNAGE SHIPMENTS OF IRON ORE FROM EACH RANGE OF THE LAKE SUPERIOR DISTRICT

Since the Opening of the Lock and Canal at Sault Ste. Marie in 1855

Reprinted from the Iron Trade Review

Year	Marquette	Menominee	Gogebic	Vermilion	Mesaba	Grand Total
1855	1,449	.....	.....	.....	.....	1,449
1856	36,343	.....	.....	.....	.....	36,343
1857	25,646	.....	.....	.....	.....	25,646
1858	15,876	.....	.....	.....	.....	15,876
1859	68,832	.....	.....	.....	.....	68,832
1860	114,401	.....	.....	.....	.....	114,401
1861	49,909	.....	.....	.....	.....	49,909
1862	124,169	.....	.....	.....	.....	124,169
1863	203,055	.....	.....	.....	.....	203,055
1864	243,127	.....	.....	.....	.....	243,127
1865	236,208	.....	.....	.....	.....	236,208
1866	278,796	.....	.....	.....	.....	278,796
1867	473,567	.....	.....	.....	.....	473,567
1868	491,449	.....	.....	.....	.....	491,449
1869	617,444	.....	.....	.....	.....	617,444
1870	830,940	.....	.....	.....	.....	830,940
1871	779,607	.....	.....	.....	.....	779,607
1872	900,901	.....	.....	.....	.....	900,901
1873	1,162,458	.....	.....	.....	.....	1,162,458
1874	919,557	.....	.....	.....	.....	919,557
1875	891,257	.....	.....	.....	.....	891,257
1876	992,764	.....	.....	.....	.....	992,764
1877	1,010,494	4,593	.....	.....	.....	1,015,087
1878	1,033 082	78,028	.....	.....	.....	1,111,110
1879	1,130,019	245,672	.....	.....	.....	1,375.691
1880	1,384,010	524,735	.....	.....	.....	1,908,745
1881	1,579,834	727,171	.....	.....	.....	2,307,005
1882	1,829,394	1,136,018	.....	.....	.....	2,965,412
1883	1,305,425	1,047,415	.....	.....	.....	2,352,840
1884	1,548,034	895,634	1,022	62,124	.....	2,506,814
1885	1,480,422	690,435	119,860	225,484	.....	2,516,201
1886	1,627,383	880,006	747,589	304,396	.....	3,559,374
1887	1,851,414	1,193,343	1,303,267	394,252	.....	4,742,276
1888	1,918,750	1,191,101	1,424,699	511,953	.....	5,046,503
1889	2,634,816	1,796,755	2,016,391	844,682	.....	7,292,644
1890	2,993,664	2,282,237	2,847,786	880,114	.....	9,003,801
1891	2,512,242	1,824,619	1,839,574	894,618	.....	7,071,053
1892	2,665,169	2,261,499	2,971,991	1,167,650	4,245	9,070,554
1893	1,835,893	1,466,197	1,329,385	820,621	613,620	6,065,716
1894	2,060,260	1,137,949	1 809,468	948,513	1,793,052	7,749 242
1895	2,097,838	1,923,798	2,547,976	1,077,838	2,781,587	10,429 037
1896	2,604,221	1,560,467	1,799,971	1,088,090	2,882,079	9,934,828
1897	2,715,035	1,937,013	2,258,236	1,278,481	4,275,809	12,464,574
1898	3,125,039	2,522,265	2,498,461	1,265,142	4,613,766	14,024,673
1899	3,757,010	3,301,052	2,795,856	1,771,502	6,626,384	18,251,804
1900	3,457,522	3,261,221	2,875,295	1,655,820	7,809,535	19,059,393
1901	3,245,346	3,619,053	2,938,155	1,786,063	9,004,890	20,593,507
1902	3,868,025	4,612,509	3,654,929	2,084,263	13,342,840	27,562,566
1903	3,040,245	3,749,567	2,912,708	1,676,699	12,892,542	24,271,761
1904	2,843,703	3,074,848	2,398,287	1,282,513	12,156,008	21,755,359
1905	4,215,572	4,495,451	3,705,207	1,677,186	20,158,699	34,252,115
1906	4,057,187	5,109,088	3,643,514	1,792,355	23,819,029	38,421,173
1907	4,388,073	4,964,728	3,637,102	1,685,267	27,495,708	42,170,878
1908	2,414,632	2,679,156	2,699,856	841,544	17,257,350	25,892,538
1909	4,256,172	4,875,385	4,088,057	1,108,215	28,176,281	42,504.110
1910	4,392,726	4,237,738	4,315,314	1,203,177	29,201,760	43,350,715
Total	96,336,406	75,306,746	65,179,956	30,328,562	224,905,184	492,056,854
To Adjust	— 39,689	+ 144,047	— 44,139	.....	.....	+ 60,219
Baraboo	.....	.....	.....	.....	.....	972,309
Total	96,296,717	75,450,793	65,135,817	30,328,562	224,905,184	493,089,382

Author's note;

There should be added to the above grand total 1,032,528 tons of which 972,309 tons are shipments from the Baraboo district in Wisconsin, and 60,219, tons are to correct miscellaneous shipment records prior to 1891 from the Marquette, Menominee and Gogebic ranges. The correct grand total of shipments is 493, 089,382 tons, as shown in preceding lists of individual mine shipments.

PRICES OF IRON ORE AT LOWER PORTS FOR EACH RANGE SINCE OPENING

PRICES OF PIG IRON AND PRODUCTION

Reprinted from the Iron Trade Review

Year	Old Range-Vermilion		Mesaba	
	Bessemer	Non-Bessemer	Bessemer	Non-Bessemer
1855..	$10.00	$10.00	.....	.....
1856..	8.00	8.00	.....	.....
1857..	8.00	8.00	.....	.....
1858..	6.50	6.50	.....	.....
1859..	6.00	6.00	.....	.....
1860..	5.25	5.50	.....	.....
1861..	5.25	5.00	.....	.....
1862..	5.25	5.37	.....	.....
1863..	7.50	7.50	.....	.....
1864..	8.50	8.50	.....	.....
1865..	7.50	7.50	.....	.....
1866..	9.50	9.50	.....	.....
1867..	10.50	8.00	.....	.....
1868..	8.25	8.25	.....	.....
1869..	8.25	9.50	.....	.....
1870..	8.50	8.50	.....	.....
1871..	8.00	8.00	.....	.....
1872..	9.00	7.50	.....	.....
1873..	12 00	9.00	.....	.....
1874..	9.00	7.00	.....	.....
1875..	7.00	4.50	.....	.....
1876..	6.75	5.50	.....	.....
1877..	6.50	4.25	.....	.....
1878..	5.50	4.25	.....	.....
1879..	6.25	4.75	.....	.....
1880..	9.25	8.00	.....	.....
1881..	9.00	7.00	.....	.....
1882..	9.00	6.25	.....	.....
1883..	6.00	4.75	.....	.....
*1884..	*5.25	4.50	.....	.....
1885..	4.75	4.00	.....	.....
1886..	5.25	4.50	.....	.....
1887..	6.00	5.00	.....	.....
1888..	4.75	4.00	.....	.....
1889..	4.50	4.50	.....	.....
1890..	5.50	5.25	.....	.....
1891..	4.50	4.25	.....	.....
1892..	4.50	3.65	.....	.....
1893..	3.85	3.20	$3.00	.....
1894..	2.75	2.50	2.35	.....
1895..	2.90	2.25	2.15	$1.90
1896..	4.00	2.70	3.50	2.25
1897..	2,60	2,15	2.25	1.90
1898..	2.75	1.85	2.25	1.75
1899..	3.00	2.15	2.40	2.00
1900..	5.50	4.25	4.50	4.00
1901..	4.25	3.00	3.25	2.75
1902..	4.25	3.25	3.25	2.75
1903..	4.50	3.60	4.00	3.20
1904..	3.25	2.75	3.00	2.50
1905..	3.75	3.20	3.50	3.00
1906..	4.25	3.70	4.00	3.50
1907..	5.00	4.20	4 75	4.00
1908..	4.50	3.70	4.25	3.50
1909..	4.50	3.70	4.25	3.50
1910..	5.00	4.20	4.75	4.00
1911..	4.50	3.70	4.25	3.50

Year	Price	Long Tons
1855..	$27 75	700.159
1856..	27.12	788,515
1857..	26.37	712,640
1858..	22.25	629,548
1859..	23.37	750,560
1860..	22.75	821,223
1861..	20 25	653,164
1862..	23.87	703,270
1863..	35.25	846,075
1864..	59.25	1,014,282
1865..	46.12	831,770
1866..	46.87	1,205,663
1867..	44.12	1,305.023
1868..	39.25	1,431,250
1869..	40.62	1,711,287
1870..	33.25	1,665,179
1871..	35.12	1,706,793
1872..	48.87	2,548,71g
1873..	42.75	2,560,963
1874..	30.25	2,401,262
1875..	25.50	2,023,733
1876..	22.25	1,868,961
1877..	18.87	2,066,594
1878..	17.62	2,301,215
1879..	21.50	2,741,853
1880..	28.50	3,835,191
1881..	25.12	4,144,254
†1882..	21.85	4,623,323
1883..	19.04	4,595,510
1884..	17.18	4,097,868
1885..	15.27	4,044,526
1886..	18.96	5,683.329
1887..	21.37	6,417,148
1888..	17.38	6,489,738
1889..	18.00	7,603,642
1890..	22.15	9,202,703
1891..	15.15	8,279.870
1892..	15.00	9,157,000
1893..	12.65	7,124,502
1894..	9.65	6,657,388
1895..	9.40	9,446,308
1896..	12.40	8,623,127
1897	8.35	9,652,680
1898..	9.55	11,773,934
1899..	10.30	13,620,703
1900..	24.15	13,789,242
1901..	16.15	15,878,354
1902..	15.90	17,821,307
1903..	21.50	18,009,252
1904..	13.35	16,497,033
1905..	15.50	22,992,380
1906..	17.25	25,307,191
1907..	21.50	25,781,361
1908..	16.00	15,936,018
1909..	14.75	25,795,471
1910..	19.00	27,298i545

*The Vermilion and Gogebic Ranges opened in 1884.

†Prior to 1882 prices are for No. 1 Anthracite Foundry Pig iron at Philadelphia. Succeeding prices are for Bessemer Pig Iron in the Valley at the time ore prices were fixed.

RAIL FREIGHTS ON IRON ORE TO UPPER LAKE PORTS

Reprinted from The Marine Review

Year	Marquette Range		Menominee Range	Gogebic Range	Mesaba Range	Vermilion Range	
	Marquette	Escanaba	Escanaba	Ashland	Duluth Superior Two Harbors	Two Harbors From Ely	Two Harbors From Tower
1855	$3 00						
1856	1.27						
1857	1.27						
1858	.87						
1859	.87						
1860	1.09						
1861	1.09						
1862	1.09						
1863	1.09						
1864	1.09						
1865	1.10						
1866	1.10	$1.55					
1867	1.10	1 80					
1868	1.10	1.80					
1869	1.10	1.85					
1870	1.10	1.85					
1871	.95	1.70					
1872	.84	1.70					
1873	.84	2.00					
1874	.84	2.00					
1875	.65	1.25					
1876	.55	1.15					
1877	.55	1.15					
1878	.55	1.15					
1879	.55	1.15					
1880	.55	1.25					
1881	.55	1.25					
1882	.55	1.25					
1883	.55	1.10					
1884	.40	.80					
1885	.45	.80					
1886	.55	.80					
1887	.55	.80	$0.85	$0.80			
1888	.45	.70	.75	.70			
1889	.45	.70	.75	.70			
1890	.45	.70					
1891	.45	.70	.70	.65			
1892	.40	.65	.70	.65	$0.80	$1.00	$0.90
1893	.40	.65	.70	.65	.80	1.00	.90
1894	.32	.52	.70	.65	.80	1.00	.90
1895	.32	.52	.52	.52	.80	1.00	.90
1896	.32	.52	.52	.52	.80	1.00	.90
1897	.32	.52	.52	.52	.80	1.00	.90
1898	.32	.40	.45	.45	.80	1.00	.90
1899	.25	.40	.40	.40	.80	1.00	.90
1900	.25	.40	.40	.40	.80	1.00	.90
1901	.25	.40	.40	.40	.80	1.00	.90
1902	.25	.40	.40	.40	.80	1.00	.90
1903	.25	.40	.40	.40	.80	1.00	.90
1904	.25	.40	.40	.40	.80	1.00	.90
1905	.32	.40	.40	.40	.80	1.00	.90
1906	.32	.40	.40	.40	.80	1.00	.90
1907	.32	.40	.40	.40	.80	1.00	.90
1908	.32	.40	.40	.40	.80	1.00	.90
1909	.32	.40	.40	.40	.80	1.00	.90
1910	.32	.40	.40	.40	.80	1.00	.90
1911	.32	.40	.40	.40	.80	1.00	.90

VESSEL FREIGHTS ON IRON ORE TO LOWER LAKE PORTS

Reprinted from The Marine Review

Year	Marquette	Escanaba	Duluth Superior Ashland Two Harbors
1855	$3.00	.....	.....
1856	3.00	.....	.....
1857	2.67	.....	.....
1858	2.09	.....	.....
1859	2.00	.....	.....
1860	2.00	.....	.....
1861	2.21	.....	.....
1862	2.89	.....	.....
1863	3.19	.....	.....
1864	3.37	.....	.....
1865	3.23	.....	.....
1866	4.17	$3.77	.....
1867	2.98	3.28	.....
1868	3.11	2.44	.....
1869	3.21	2.43	.....
1870	3.06	2.40	.....
1871	2.83	2 07	.....
1872	3.59	2.50	.....
1873	3.44	2 74	.....
1874	3.84	*	.....
1875	2.87	*	.....
1876	2.54	*	.....
1877	1.40	*	.....
1878	1.26	.85	.....
1879	1.61	1.07	.....
1880	2.50	1 77	.....
1881	2.25	1.55	.....
1882	1.50	1.22	.....
1883	1.30	1.11	.....
1884	1.21	.98	.....
1885	1 01	.84	$1.20
1886	1 35	1.16	1.49
1887	1 75	1.49	2.11
1888	1.22	.97	1.34
1889	1.14	1.00	1.29
1890	1.16	.99	1.26
1891	.96	.74	1.05
1892	1.06	.87	1.20
1893	.85	.70	.88
1894	.70	.53	.79
1895	.83	.64	.96
1896	.80	.61	.91
1897	.60	.45	.63
1898	.60	.48	.61
1899	.84	.72	.95
1900	.94	.85	1.05
1901	.74	.62	.84
1902	.68	.59	.76
1903	.73	.63	.83
1904	.61	.54	.70
1905	.70	.60	.76
1906	.70	.60	.76
1907	.70	.60	.76
1908	.60	.50	.65
1909	.60	.50	.65
1910	.65	.55	.70
1911	.55	.45	.60

*No shipment.
Freight rates are averaged.

Shipments and Receipts of Iron Ore

Shipments by Ranges, Ports and Rail and Receipts at Lake Erie Ports

Reprinted from the Iron Trade Review

SHIPMENTS BY RANGES, GROSS TONS

Range	1910	1909	1908	1907	1906	1905
Marquette	4,392,726	4,256,172	2,414,632	4,388,073	4,057,187	4,215,572
Menominee	4,237,738	4,875,385	2,679,156	4,964,728	5,109,088	4,495,451
Gogebic	4,315,314	4,088,057	2,699,856	3,637,102	3,643,514	3,705,207
Vermilion	1,203,177	1,108,215	841,544	1,685,267	1,792,355	1,677,186
Mesaba	29,201,760	28,176,281	17,257,350	27,495,708	23,819,029	20,158,699
Baraboo	91,682	82,759	122,449	95,790	144,589	132,001
Total	43,442,397	42,586,869	26,014,987	42,266,668	38,565,762	34,384,116

SHIPMENTS BY PORTS AND ALL-RAIL, GROSS TONS

Port	1910	1909	1908	1907	1906	1905
Escanaba	4,959,726	5,747,801	3,351,502	5,761,988	5,851,050	5,307,938
Marquette	3,248,516	2,909,451	1,487,487	3,013,826	2,791,033	2,977,828
Ashland	4,094,374	3,834,207	2,513,670	3,436,867	3,388,106	3,485,344
Two Harbors	8,271,177	9,181,132	5,702,237	8,188,906	8,180,125	7,779,850
Superior	8,414,799	6,540505	3,564,030	7,440,386	6,083,057	5,118,385
Duluth	13,640,166	13,470,503	8,808,168	13,448,736	11,220,218	8,807,559
Total by lake	42,628,758	41,683,599	25,427,094	41,288,755	37,513,589	33,475,904
Total by rail	813,639	903,270	587,893	975,959	1,052,173	907,212
Total	43,442,397	42,586,869	26,014,987	42,266,668	38,565,762	34,384,116

IRON ORE RECEIPTS AT LAKE ERIE PORTS, GROSS TONS

Port	1910	1909	1908	1907	1906	1905
Toledo	1,225,202	1,374,224	680,553	1,314,140	1,423,741	1,006,855
Sandusky	.....	11,088	.....	83,043	35,847	51,202
Huron	197,951	243,082	213,377	971,430	778,453	825,278
Lorain	2,884,738	2,796,856	2,286,388	2,621,025	2,191,965	1,605,823
Cleveland	6,344,943	6,051,342	4,240,815	6,495,998	6,604,661	5,854,745
Fairport	1,516,434	1,734,277	1,518,961	2,437,649	1,861,498	2,008,621
Ashtabula	9,620,638	8,056,941	3,012,064	7,521,859	6,833,352	6,373,779
Conneaut	6,309,548	7,007,834	4,798,631	5,875,937	5,432,370	5,327,552
Erie	942,592	1,235,057	828,602	2,294,239	1,986,539	2,112,476
Buffalo	4,704,439	5,002,235	2,835,099	5,580,438	4,928,331	3,774,928
Detroit	296,412	159,889	.....	.....	.....	.....
Total	34,042,897	33,672,825	20,414,491	35,195,758	32,076,757	28,941,259

Lake Erie Stock Piles

Iron Ore on Lake Erie Docks Dec. 1 and May 1 1905-1910

Reprinted from the Iron Trade Review

IRON ORE ON LAKE ERIE DOCKS, DEC. 1, GROSS TONS

Port	1910	1909	1908	1907	1906	1905
Toledo	433,215	332,456	590,925	518,645	281,000	368,024
Sandusky	17,728	39,557	36,079	44,546	17,467	52,977
Huron	375,118	477,333	458,158	415,730	245,499	208,023
Lorain	259,448	407,129	426,274	366,271	336,321	271,695
Cleveland	1,638,795	1,547,142	1,458,392	1,281,335	1,224,606	1,330,619
Fairport	839,970	867,640	835,821	523,981	590,783	759,961
Ashtabula	3,287,816	2,594,359	2,293,531	2,056,820	1,631,312	1,589,951
Conneaut	1,329,997	1,411,002	1,296,675	1,000,774	1,057,424	976,976
Erie	792,011	788,046	730,530	652,219	552,631	564,961
Buffalo	452,783	501,125	315,148	435,407	315,412	315,780
Total	9,426,681	8,965,789	8,441,533	7,385,728	6,252,455	6,438,967

IRON ORE ON LAKE ERIE DOCKS, MAY 1, GROSS TONS

Port	1910	1909	1908	1907	1906	1905
Toledo	366,631	380,675	217,788	147,397	52,550	71,642
Sandusky	22,468	31,528	42,256	5,439	29,320	44,444
Huron	336,693	379,364	392,731	98,106	80,738	68,100
Lorain	205,445	362,096	327,052	176,300	140,452	165,586
Cleveland	985,725	1,018,055	1,029,198	447,573	350,382	513,559
Fairport	541,299	562,679	225,328	154,246	266,162	390,869
Ashtabula	1,609,931	1,392,430	1,799,454	568,485	462,564	623,451
Conneaut	461,365	497,203	462,392	139,853	148,528	96,295
Erie	550,187	557,029	595,660	189,276	169,488	236,414
Buffalo	364,336	189,209	388,441	50,313	90,906	61,271
Total	5,444,080	5,370,268	5,480,300	1,976,988	1,791,090	2,271,631

Production of Iron Ore in the United States

In 1907 and 1908

Reprinted from "The Production of Iron Ores, Pig Iron, and Steel in 1908," United States Geological Survey, 1909.—By E. C. Harder

States Gross Tons	1907	1908	States Gross Tons	1907	1908
Minnesota	28,969,658	18,652,220	Pennsylvania	837,287	443,161
Michigan	11,830,342	8,839,199	Tennessee	813,690	635,343
Alabama	4,039,453	3,734,438	New Jersey	549,760	394,767
New York	1,375,020	697,473	Georgia	444,114	321,060
Mont., Nev., N. Mex., Utah, Wy., Tex., Ark., Col., Cal. and Wash.	949,925	584,591	Mo. and Iowa	111,768	98,414
			North Carolina	50,439	48,522
			Conn. and Mass	37,166	28,112
Virginia	786,856	692,223	Ohio	23,589	26,585
W. Va., Ky., and Md.	62,808	53,235			
Wisconsin	838,744	733,993	Total	51,720,619	35,983,336

Imports of Iron Ore

By Countries, In 1907, 1908 and 1909

Countries Gross Tons	1907		1908		1909	
	Tons	Values	Tons	Values	Tons	Values
Cuba	657,133	$2,522,710	579,668	$1,756,091	927,774	$2,681,028
Spain	296,318	760,801	126,074	331,070	291,547	664,460
Greece	23,800	42,927	4,580	5,311	19,080	21,782
Newfoundland	89,685	97,735	48,285	48,285	224,395	330,056
United Kingdom	5,765	16,491	2,028	32,027	869	12,846
Germany	273	2,096	602	4,052	3	100
Canada	26,878	51,328	5,013	16,321	27,155	84,613
Belgium	125	1,102	1	28	3	179
Russia in Europe	54,995	161,697	5,750	15,220	32,010	62,418
French Africa	65,940	252,897	.....	.....	37,208	67,515
Other countries	8,256	27,699	4,627	15,843	134,913	654,081
Total	1,229,168	$3,937,483	776,898	$2,224,248	1,694,957	$4,579,078

Imports of Iron Ore For Twenty Years

Totals for 1881-1910

Years	Gross Tons	Years	Gross Tons	Years	Gross Tons
1881	782,887	1891	912,856	1901	966,950
1882	589,655	1892	806,585	1902	1,165,470
1883	490,875	1893	526,951	1903	980,440
1884	487,820	1894	168,541	1904	487,613
1885	390,786	1895	524,153	1905	845,651
1886	1,039,433	1896	682,806	1906	1,060,390
1887	1,194,301	1897	489,970	1907	1,229,168
1888	587,470	1898	187,093	1908	776,898
1889	853,573	1899	674,082	1909	1,694,957
1890	1,246,830	1900	897,831	1910	2,591,031

Note—For many years Cuba has annually shipped more than one-half of the imported iron ore. The above tables are credited to the Bureau of Statistics of the U. S. Department of Commerce and Labor.

Apparent Annual Iron Ore Consumption

In the United States

1889-1910, Gross Tons

Compiled from the American Iron and Steel Association Statistics and 1910 Report and "The Production of Iron Ores, Pig Iron and Steel in 1908," United States Geological Survey, 1909.—By E. C. Harder

Year	Domestic Iron Ore Produced	Stocks of Ore at Mines	Imports	Exports	Stocks of Ore at Lower Lake Ports Dec. 1	Zinc Resid.	Apparent Consumption	Pig Iron Produced
1889..	14,518,041	2,256,973	853,573	.....	2,607,106	43,648	14,366,562	7,603,642
1890..	16,036,043	2,000,000	1,246,830	.....	3,893,487	48,560	16,302,025	9,202,703
1891..	14,591,178	2,450,279	912,864	.....	3,508,489	38,228	15,476,989	8,279,870
1892..	16,296,666	2,911,740	806,585	.....	4,149,451	31,859	16,032,687	9,157,000
1893..	11,587,629	3,526,161	526,951	.....	4,070,710	37,512	11,616,412	7,124,502
1894..	11,879,679	3,236,198	167,307	.....	4,834,247	26,981	11,600,393	6,657,388
1895..	15,957,614	2,976,494	524,153	.....	4,415,712	43,249	17,203,255	9,446,308
1896..	16,005,449	3,405,302	682,806	.....	4,954,984	44,953	15,765,128	8,623,127
1897..	17,518,046	3,098,287	489,970	.....	5,923,755	33,924	17,380,184	9,652,680
1898..	19,433,716	2,846,457	187,208	.....	5,136,407	48,502	20,708,604	11,773,934
1899..	24,683,173	2,320,278	674,082	40,665	5,530,283	65,010	25,513,903	13,620,703
1900..	27,553,161	3,709,950	897,831	51,460	5,904,670	87,110	26,722,583	13,789,242
1901..	28,887,479	4,239,823	966,950	64,703	5,859,663	52,311	29,357,171	15,878,354
1902..	35,554,135	3,834,717	1,165,470	88,445	7,074,254	65,246	35,886,921	17,821,307
1903..	35,019,308	6,297,888	980,440	80,611	6,371,085	73,264	34,232,399	18,009,252
1904..	27,644,330	4,666,931	487,613	213,865	5,763,399	68,189	30,224,910	16,497,033
1905..	42,526,133	3,812,281	845,651	208,017	6,438,967	90,289	43,433,138	22,992,380
1906..	47,749,728	3,281,789	1,060,390	265,240	6,252,455	93,461	49,355,343	25,307,191
1907..	51,720,619	3,033,110	1,229,168	278,208	7,385,728	93,413	51,880,398	25,781,361
1908..	35,983,336	6,065,397	776,898	309,099	8,441,533	110,225	32,473,268	15,936,018
1909..	51,294.271	6,135.271	1,694,957	455,934	8,965,789	141,264	52,080,428	25,795,471
1910..	.....	.....	2,591.031	644,875	9,426,681	.....	.....	27,298,545

"The above table includes data on certain factors from which an approximate estimate of the annual consumption of iron ore in the United States is deduced. The result is of course merely an approximation, for no data are available on certain factors which should enter into the final result. The elements accounted for in the table and estimate are (1) domestic iron-ore production; (2) stock of ore at mines; (3) imports of ore; (4) exports of ore; (5) stocks of ore at lake ports; (6) zinc residuum production."

Production of Steel

In the United States

1860-1910, Gross Tons

Compiled from the American Iron and Steel Association Statistics and 1910 Report and "The Production of Iron Ores, Pig Iron and Steel in 1908," United States Geological Survey, 1909.—By E. C. Harder

Year	Bessemer	Open-Hearth	Crucible	Other Steel	Total
1860	.....	.....	* 11,838	.....	11,838
1863	.....	.....	8,075	.....	8,075
1864	.....	.....	9,258	.....	9,258
1865	.....	.....	13,627	.....	13,627
1866	.....	.....	16,940	.....	16,940
1867	2,679	.....	16,964	.....	19,643
1868	7,589	.....	19,197	.....	26,786
1869	10,714	893	19,643	.....	31,250
1870	37,500	1,339	29,911	.....	68,750
1871	40,179	1,785	31,250	.....	73,214
1872	107,239	2,679	26,125	6,911	142,954
1873	152,368	3,125	31,059	12,244	198,796
1874	171,369	6,250	32,436	5,672	215,727
1875	335,283	8,080	35,180	11,256	389,799
1876	469,639	19,187	35,163	9,202	533,191
1877	500,524	22,349	36,098	10,647	569,618
1878	653,773	32,255	38,309	7,640	731,977
1879	829,439	50,259	50,696	4,879	935,273
1880	1,074,262	100,851	64,664	7,558	1,247,335
1881	1,374,247	131,202	80,145	2,720	1,588,314
1882	1,514,687	143,341	75,973	2,691	1,736,692
1883	1,477,345	119,356	71,835	4,999	1,673,535
1884	1,375,531	117,515	53,270	4,563	1,550,879
1885	1,519,430	133,376	57,599	1,515	1,711,920
1886	2,269,190	218,973	71,973	2,367	2,562,503
1887	2,936,033	322,069	75,375	5,594	3,339,071
1888	2,511,161	314,318	70,279	3,682	2,899,440
1889	2,930,204	374,543	75,865	5,120	3,385,732
1890	3,688,871	513,232	71,175	3,793	4,277,071
1891	3,247,417	579,753	72,586	4,484	3,904,240
1892	4,168,435	669,889	84,709	4,548	4,927,581
1893	3,215,686	737,890	63,613	2,806	4,019,995
1894	3,571,313	784,936	51,702	4,081	4,412,032
1895	4,909,128	1,137,182	67,666	858	6,114,834
1896	3,919,906	1,298,700	60,689	2,394	5,281,689
1897	5,475,315	1,608,671	69,959	3,012	7,156,957
1898	6,609,017	2,230,292	89,747	3,801	8,932,857
1899	7,586,354	2,947,316	101,213	4,974	10,639,857
1900	6,684,770	3,398,135	100,562	4,862	10,188,329
1901	8,713,302	4,656,309	98,513	5,471	13,473,595
1902	9,138,363	5,687,729	112,772	8,386	14,947,250
1903	8,592,829	5,829,911	102,434	9,804	14,534,978
1904	7,859,140	5,908,166	83,391	9,190	13,859,887
1905	10,941,375	8,971,376	102,233	8,963	20,023,947
1906	12,275,830	10,980,413	127,513	14,380	23,398,136
1907	11,667,549	11,549,736	131,234	14,075	23,362,594
1908	6,116,755	7,836,729	63,631	6,132	14,0232,47
1909	9,330,783	14,493,936	107,355	22,947	23,955,021
1910	9,412,722	16,504,509	122,303	55,365	26,094,919

*Part of the 1860-1871 Crucible Steel Production should be credited to "Other Steel."

"The first steel produced in this country was probably made in Connecticut in 1728 by Samuel Higley and Joseph Dewey. Crucible steel was first successfully produced in the United States in 1832 at the works of William and John H. Garrard, at Cincinati, Ohio. Bessemer steel was first made in this country in September 1864, by William F. Durfee at an experimental plant at Wyandotte, Mich., and open-hearth steel in 1864 by the New Jersey Steel and Iron Company at Trenton, N. J."

Production of Finished Rolled Steel and Iron

In the United States 1887-1909

Reprinted from American Iron and Steel Association Report 1910

Years	Iron and Steel Rails Gross Tons	Plates and Sheets, Except Nail Plate	Wire Rods Gross Tons	Structural Shapes, Not Including Plates	Nail Plate Gross Tons	Bars, Hoops, and all Other Forms	Total Gross Tons
1887	2,139,640	603,355	.....	.....	308,432	2,184,279	5,235,706
1888	1,403,700	609,827	279,769	.....	289,891	2,034,162	4,617,349
1889	1,522,204	716,496	363,851	.....	259,409	2,374,968	5,236,928
1890	1,885,307	809,981	457,099	.....	251,828	2,618,660	6,022,875
1891	1,307,176	678,927	536,607	.....	223,312	2,644,941	5,390,963
1892	1,551,844	751,460	627,829	453,957	201,242	2,579,482	6,165,814
1893	1,136,458	674,345	537,272	387,307	136,113	2,104,190	4,975,685
1894	1,021,772	682,900	673,402	360,305	108,262	1,795,570	4,642,211
1895	1,306,135	991,459	791,130	517,920	95,085	2,487,845	6,189,574
1896	1,122,010	965,776	623,986	495,571	72,137	2,236,361	5,515,841
1897	1,647,892	1,207,286	970,736	583,790	94,054	2,497,970	7,001,728
1898	1,981,241	1,448,301	1,071,683	702,197	70,188	3,239,760	8,513,370
1899	2,272,700	1,903,505	1,036,398	850,376	85,015	4,146,425	10,294,419
1900	2,385,682	1,794,528	846,291	815,161	70,245	3,575,536	9,487,443
1901	2,874,639	2,254,425	1,365,934	1,013,150	68,850	4,772,329	12,349,327
1902	2,947,933	2,665,409	1,574,293	1,300,326	72,936	5,383,219	13,944,116
1903	2,992,477	2,599,665	1,503,455	1,095,813	64,102	4,952,185	13,207,697
1904	2,284,711	2,421,398	1,699,028	949,146	61,601	4,597,497	12,013,381
1905	3,375,929	3,532,230	1,808,688	1,660,519	64,542	6,398,107	16,840,015
1906	3,977,887	4,182,156	1,871,614	2,118,772	54,211	7,383,828	19,588,468
1907	3,633,654	4,248,832	2,017,583	1,940,352	52,027	7,972,374	19,864,822
1908	1,921,015	2,649,693	1,816,949	1,083,181	45,747	4,311,608	11,828,193
1909	3,023,845	4,234,346	2,335,685	2,275,562	63,746	7,711,506	19,644,690

Rolled forging blooms and forging billets are included from 1905. Prior to 1892 structural shapes were included with bars, hoops, etc.

Production of Coke

In the United States 1907-1908

Reprinted from American Iron and Steel Association Report 1910

States—Net Tons	1907	1908
Pennsylvania	26,513,214	15,511,634
West Virginia	4,112,896	2,637,123
Alabama	3,021,794	2,362,666
Indiana, Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New York, Oklahoma, and Wisconsin	2,655,610	2,286,092
Virginia	1,545,280	1,162,051
Colorado and Utah	1,421,579	982,291
Illinois	372,697	362,182
New Mexico	265,125	274,565
Tennessee	467,499	214,528
Ohio	270,634	159,578
Georgia	74,934	39,422
Washington	52,028	38,889
Kansas	6,274	2,497
Total	40,779,564	26,033,518

Shipments and Prices of Connellsville Coke

1881-1910

Reprinted from American Iron and Steel Association Report 1910

Calendar Years	Total Ovens	Shipments Net Tons	Average Price	Calendar Years	Total Ovens	Shipments Net Tons	Average Price
1881	8,208	2,639,002	$1.63	1896	18,351	5,411,602	1.90
1882	9,283	3,043,394	1.47	1897	18,628	6,915,052	1.65
1883	10,176	3,552,402	1.14	1898	18,643	8,460,112	1.55
1884	10,543	3,192,105	1.13	1899	19,689	10,129,764	2.00
1885	10,471	3,096,012	1.22	1900	20,954	10,166,234	2.70
1886	10,952	4,180,521	1.36	1901	21,575	12,609,949	1.95
1887	11,923	4,146,989	1.79	1902	26,329	14,138,740	2.37
1888	13,975	4,955,553	1.19	1903	28,092	13,345,230	3.00
1889	14,458	5,930,428	1.34	1904	29,119	12,427,468	1.75
1890	16,020	6,464,156	1.94	1905	30,842	17,896,526	2.26
1891	17,204	4,760,665	1.87	1906	34,059	19,999,326	2.75
1892	17,256	6,329,452	1.83	1907	35,697	19,029,058	2.90
1893	17,513	4,805,623	1.49	1908	37,842	10,700,022	1.80
1894	17,834	5,454,451	1.00	1909	39,158	17,785,832	2.00
1895	17,947	8,244,438	1.23	1910	39,137	18,689,722	2.10

Freight Rates per Net Ton for 1911 on Furnace Coke

Connellsville Field to

Pittsburgh	$0.75	Philadelphia and Schuylkill Valley	$2.00
Youngstown	1.35	Chicago	2.35
Cleveland	1.65		
Buffalo	1.85		

Rail Freights on Iron Ore
1890-1910

Rate per Gross Ton from Lake Erie Docks

Specially compiled by Rukard Hurd for this Manual.

Year	Cleveland, Fairport, Lorain and Ashtabula		Buffalo and Erie To Philadelphia and Schuylkill Valley
	To Youngstown	To Pittsburgh	
1890	$0.625	$1.05	$1.36
1891	.625	1.05	1.36
1892	.625	1.05	1.36
1893	.675	1.15	1.46
1894	.675	1.15	1.46
1895	.675	1.15	1.46
1896	.625	1.05	1.46
1897	.625	1.05	1.28
1898	.59	.98	1.33
1899	.59	.98	1.33
1900	.69	1.18	1.43
1901	.69	1.18	1.43
1902	.69	1.18	1.43
1903	.69	1.18	1.43
1904	.69	1.18	1.43
1905	.69	1.18	1.43
1906	.69	1.18	1.43
1907	.69	1.18	1.53
1908	.69	1.18	1.53
1909	.64	1.04	1.53
1910	.64	1.04	1.53

Note—For direct load, vessel to car, the above rates are 8 cents per ton less.

Production and Price of Limestone for Furnace Flux

1906-1909, Gross Tons

WITH 1911 RAIL FREIGHTS

From United States Geological Survey Report and other Sources

Compiled by Rukard Hurd for this Manual

STATES	1906			1907		
	Quantity Gross Tons	Value	Value per ton Cents	Quantity Gross Tons	Value	Value per ton Cents
Pennsylvania	6,396,765	$3,168,186	.49	7,178,508	$3,829,967	.53
Illinois	909,375	384,282	.42	970,158	423,315	.44
Indiana	500,702	210,124	.42	577,052	279,838	.48
Ohio	3,098,346	1,013,497	.33	2,497,616	1,134,793	.45
Missouri	43,574	28,381	.65	55,371	43,612	.79
New York	513,452	294,659	.57	584,964	343,866	.59
Alabama	803,643	473,062	.59	939,437	604,654	.64
West Virginia	1,019,931	513,413	.50	1,063,772	528,587	.50
Colorado	552,651	301,913	.55	672,801	397,244	.59
Virginia	467,341	219,707	.47	541,610	275,517	.51
Total	14,305,780	$6,607,224	.46	15,081,289	$7,861,393	.52
All others	1,771,422	$1,005,468	.57	2,038,008	$1,283,096	.63
Grand total & av.	16,077,202	$7,612,692	.47	17,119,297	$9,144,489	.53
		1908			1909	
Pennsylvania	4,350,381	$2,324,173	.53	4,593,822	$3,165,872	.48
Illinois	1,209,326	540,718	.45	1,820,590	714,631	.39
Indiana	272,505	139,703	.51	369,938	190,809	.51
Ohio	1,444,412	635,354	.44	2,161,681	1,130,082	.52
Missouri	18,524	14,678	.79	43,909	31,075	.70
New York	357,194	205,758	.58	580,802	343,891	.59
Alabama	582,958	386,874	.66	974,650	512,585	.52
West Virginia	666,087	337,742	.51	900,993	492,497	.54
Colorado	441,490	276,146	.62	462,291	267,806	.58
Virginia	289,369	169,847	.59	388,746	213,444	.55
Total	9,632,246	$5,030,993	.52	14,297,422	$7,062,692	.49
All others	1,459,196	874,248	.60	1,475,441	859,115	.58
Grand total & av.	11,091,442	$5,905,241	.53	15,772,863	$7,921,807	.50

1911 Freight Rates on Limestone per Gross Ton from Adjacent Quarries

To Pittsburg, 65 cents
Youngstown, 35 "
Cleveland, 50 "
Buffalo, 35+ "

To Chicago, 20+ cents
Philadelphia, 80 "
Schuylkill Valley, 65 "

Average Annual Prices at Pittsburgh

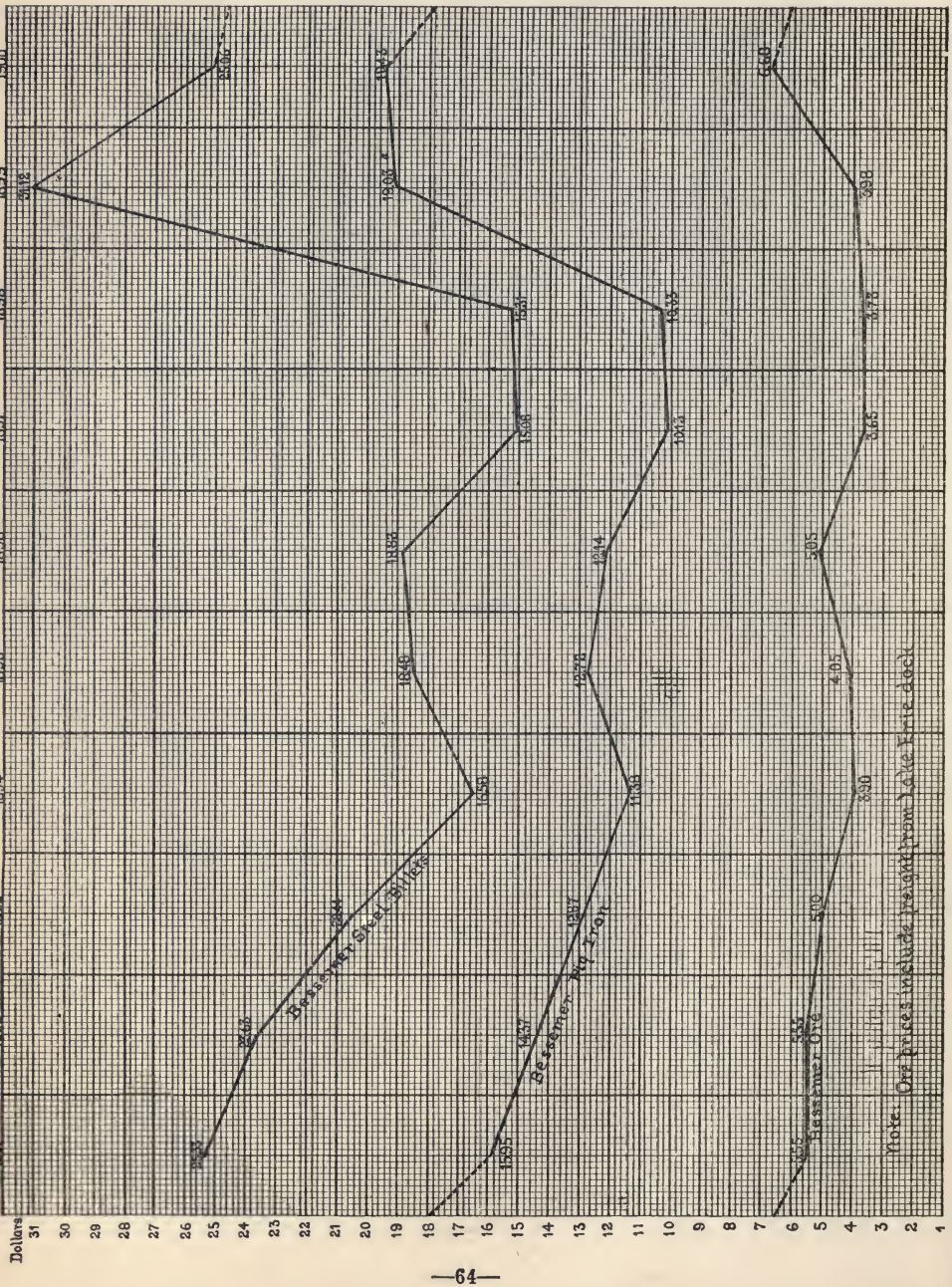
1891-1900

Bessemer Iron Ore

Bessemer Pig Iron and Bessemer Steel Billets

From Statistics of the American Iron and Steel Association and The Iron Trade Review

Compiled by Rukard Hurd



Average Annual Prices at Pittsburgh

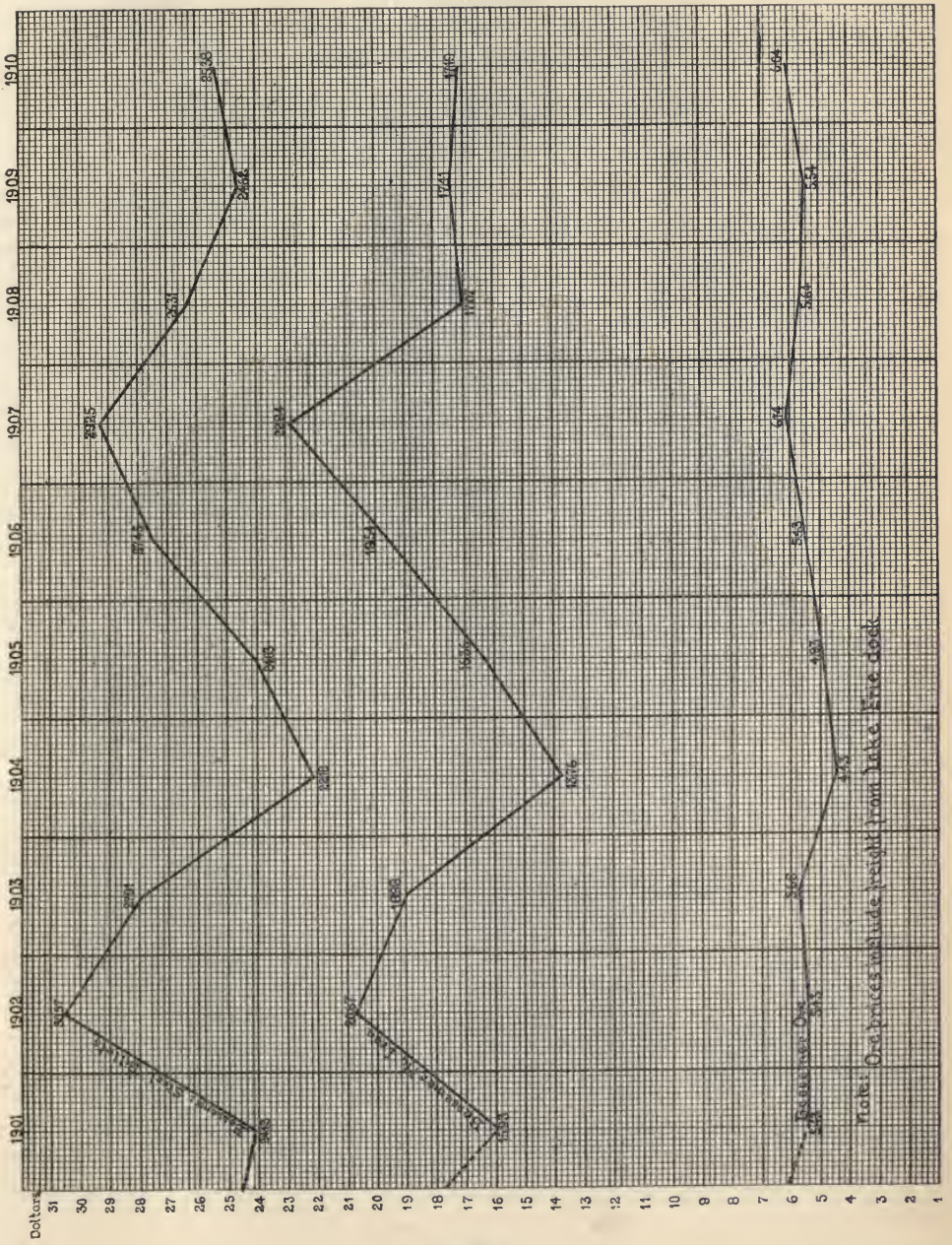
1901-1910

Bessemer Iron Ore

Bessemer Pig Iron and Bessemer Steel Billets

From Statistics of the American Iron and Steel Association and The Iron Trade Review

Compiled by Rukard Hurd



Average Yearly Prices at Pittsburgh 1890-1910

Bessemer Iron Ore, Bessemer Pig Iron, Bessemer Steel Billets

Average Yearly Price Bessemer Ore

at Cleveland, Youngstown, Pittsburgh, Philadelphia and Schuylkill Valley Points

From American Iron and Steel Association records for prices on Pig Iron and Steel Billets, and the Iron Trade Review for Ore Prices

Specially compiled by Rukard Hurd for this Manual

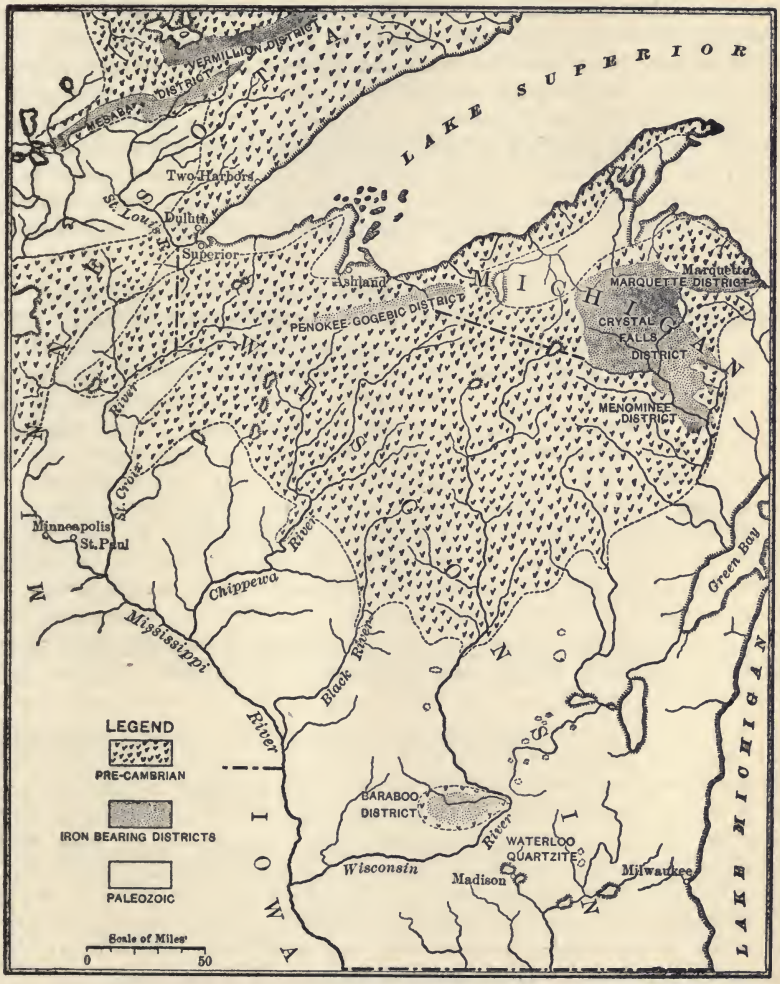
Year	Average Price Bessemer Ore				Average Pittsburgh Prices	
		With Freight Added				
	Cleveland and all Lower Lake Ports	Philadelphia and Schuylkill Valley	Youngstown	Pittsburgh	Bessemer Pig Iron	Bessemer Steel Billets
1890...	$5.50	$6.86	$6.125	$6.55	$18.87	$.....
1891....	4.50	5.86	5.125	5.55	15.95	25.33
1892....	4.50	5.86	5.125	5.55	14.37	23.63
1893....	3.85	5.31	4.525	5.00	12.87	20.44
1894....	2.75	4.21	3.425	3.90	11.38	16.58
1895....	2.90	4.36	3.575	4.05	12.72	18.48
1896....	4.00	5.28	4.625	5.05	12.14	18.83
1897....	2.60	3.93	3.225	3.65	10.13	15.08
1898....	2.75	3.93	3.34	3.73	10.33	15.31
1899....	3.00	4.43	3.59	3.98	19.03	31.12
1900....	5.50	6.93	6.19	6.68	19.43	25.06
1901....	4.25	5.68	4.94	5.43	15.93	24.13
1902....	4.25	5.68	4.94	5.43	20.67	30.57
1903....	4.50	5.93	5.19	5.68	18.98	27.91
1904....	3.25	4.68	3.94	4.43	13.76	22.18
1905....	3.75	5.18	4.44	4.93	16.36	24.03
1906....	4.25	5.68	4.94	5.43	19.54	27.45
1907....	5.00	6.53	5.74	6.14	22.84	29.25
1908....	4.50	6.03	5.24	5.64	17.07	26.31
1909....	4.50	6.03	5.14	5.54	17.41	24.62
1910....	5.00	6.53	5.64	6.04	17.19	25.38

Geological Map

Lake Superior

Pre-Cambrian Iron Bearing Districts

Furnished by The Iron Age*



*From issue of March 9, 1911

Geology and Mineralogy

FOREWORD

This Article Should be used in Connection with the Following Reprint on "The Geology and Mineralogy of the Lake Superior District"

In Monograph 52 of the U. S. Geological Survey just issued from the press, C. R. Van Hise and C. K. Leith summarize the geology of the Lake Superior region and its ore deposits. This is the first comprehensive attempt to consider the geology of the region as a whole in any of the U. S. Geological Survey reports. The monograph is accompanied by revised geological maps of all the iron ranges and a general geological map of the entire region. In connection with the present report, we are interested principally in the treatment of the iron formations and the iron ores. It is shown that the iron formations of the region belong to three geological periods, and that the last of these periods, the upper Huronian (which includes the Mesaba and Cuyuna districts of Minnesota) contains over 75% of the known ore of Lake Superior. The total area of the iron formations of the Lake Superior region is 227 square miles, but the iron ores occupy only a small fraction of this area.

The ores are concentrated in the upper parts of the iron formation. The concentration is mainly accomplished by percolating waters taking out the silica, usually leaving the ores very porous; but sometimes this action is followed by slumping of the ore or by crushing during the folding with the result that pore space is eliminated. The concentration takes place where the percolating waters are able to flow freely. These places are determined by a great variety of conditions, such as folds, impervious basements, bedding, etc. Other things being equal, it is obvious that the iron formations with the largest area of exposure at the rock surface is the one which would have the most chance of being entered by concentrating waters from the surface. A comparison of the ore reserves of different areas shows that they are roughly proportional to the area of exposure. For instance, the Mesaba iron formation, with a flat dip and a correspondingly wide area of exposure, shows a high reserve, while the equally thick Gogebic formation, standing steeply and therefore with smaller exposure, has a much smaller reserve.

The ores are fully described with reference to chemical, mineralogical and physical characteristics, with the aid of many tables of quantitative determinations and graphic diagrams, prepared with the co-operation of Mr. W. J. Mead. Some of the quantitative data for the first time presented, cover the average chemical and mineralogical composition for each district and for the region as a whole, the porosity, the density, the cubic contents per ton, phosphorus distribution, etc. The phosphorus tables show clearly that the phosphorus is associated with the iron rather than silica, and by taking out silica in the concentration of the ores, whether in nature or artifically by washing, as in the western Mesaba, phosphorus is increased.

Of especial note is a new conception of the ultimate source of the iron formations. They are sediments thought to be derived from basic volcanic rocks which were abundantly extruded over this area both before and during the deposition of the sediments. Some of these volcanic rocks were submarine extrusives, which may have contributed hot iron-bearing solutions directly to the sea in which the iron-bearing sediments were being deposited.

The Geology and Mineralogy

of the

Lake Superior Iron Districts

Occurrence of Iron Ores in the Lake Superior Districts of the United States

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Reprint from "The Production of Iron Ores, Pig Iron, and Steel in 1908," published by the United States Geological Survey, 1909.—*By E. C. Harder*

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Iron minerals are classified as sulphides, oxides, carbonates, silicates, etc., of which only the oxides and carbonates are used in the steel industry. The ores of iron are generally classed under four heads:

1. **Hematite:** Including all the anhydrous sesquioxides (Fe_2O_3—theoretical percentage of iron, 70). This is known locally as red hematite, specular ore, gray ore, fossil ore, oolitic ore etc.

2. **Brown ore:** Including hydrated sesquioxides, such as limonite, gothite, and turgite ($Fe_2O_3\ nH_2O$ –theoretical percentage of iron, 59.8–66). This is known locally as brown iron ore, brown hematite, bog ore, limonite, etc.

3. **Magnetite:** Including magnetic oxides (Fe_3O_4—theoretical percentage of iron, 72.4). Magnetite is known generally as magnetic iron ore.

4. **Iron carbonate:** Including carbonates of various types ($FeCO_3$—theoretical percentage of iron, 48.2). Iron carbonate is known locally as spathic iron ore, kidney ore, black band ore, siderite, etc.

Hematite has always been predominant as an ore of iron and at present constitutes almost nine-tenths of the iron ores produced. Brown ore and magnetite are far below it in importance, each furnishing at present about one-twentieth of the total iron-ore production. The production of iron carbonate is insignificant in comparison with that of the other ores, constituting only about one-twentieth of 1 per cent of the total.

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For purposes of description, the iron-ore deposits of the United States may be conveniently grouped into three districts—the eastern district, the central district, and the western district. The eastern district includes the northeastern and southeastern commercial districts, the central district includes the Mississippi Valley and Lake Superior districts, and the western district includes the Rocky Mountain and Pacific Slope districts.

The following descriptions are partly the result of personal observation and partly summarized from various reports. A bibliography of the principal articles on iron ores of the United States is given at the end of this report. Some of the descriptions of the western deposits were taken from unpublished notes kindly furnished the survey by Mr. R. C. Hills and Mr. O. A. Hershey.

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Central District

The iron ores of the central district may be classified as follows.

Hematite:

Soft, hard, and specular hematite associated with the pre-Cambrian iron formations of the Marquette, Menominee, Penokee-Gogebic, Mesabi, Vermilion, Cuyuna, and Baraboo ranges, Lake Superior district.

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Clinton hematite in east-central Wisconsin and in Missouri.

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Brown Ore.

Bog ore in central and northwestern Wisconsin.

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Magnetite:

Magnetite formed by regional and contact metamorphism of the pre-Cambrian hematite deposits in the Marquette, Mesabi, and Gunflint ranges, Lake Superior district.

Titaniferous magnetite in gabbro in northern Minnesota.

Iron carbonate:

Iron carbonate and silicate composing the unaltered iron formation in the Lake Superior district.

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HEMATITE

Lake Superior Hematite.—The Lake Superior hematite deposits constitute by far the most important type of iron ore in the United States and yield about four-fifths of the total annual product. They are grouped into seven minor districts or ranges, viz: The (a) Vermilion, (b) Mesabi, and (c) Cuyuna ranges of northern Minnesota; the (d) Penokee-Gogebic, (e) Marquette (including the Republic and Swanzy areas), and (f) Menominee (including the Crystal Falls, Iron River, Metropolitan and Florence areas) ranges of northern Michigan and Wisconsin, and the (g) Baraboo range of southern Wisconsin. Other districts with similar ore occur in Ontario and north and northeast of Lake Superior.

The rocks of the Lake Superior district range in age from Archean to Cambrian with the following succession:

Succession of Rocks in Lake Superior Iron-ore District

Cambrian:

Potsdam sandstone.

Algonkian:

Keweenawan series (sediments, trap, gabbro, etc.).

Huronian series:

Upper Huronian quartzite, iron formation, and slate.
Middle Huronian quartzite, iron formation, and slate.
Lower Huronian quartzite, conglomerate, dolomite, slate, iron formation and instrusives.

Archean:

Laurentian series (granite, gneiss, and porphyry).

Keewatin series (greenstone, basic schists, and iron formation).

Of these rocks only the upper and middle Huronian and the Keewatin contain productive iron-ore deposits. (*) Iron ores occur in the upper Huronian, in the Mesaba, Cuyuna, Penokee-Gogebic, and Menominee districts; in the middle Huronian, in the Baraboo district; in both the upper and the middle Huronian, in the Marquette district; and in the Keewatin, in the Vermilion district.

*Leith, C. K., a summary of Lake Superior geology with special reference to recent studies of the iron-bearing series. Bimo. Bull. Am. Inst. Min. Eng. No. 3, 1905, p. 453.

The iron ores are confined to the iron formations, in which they occur as local concentration deposits, resulting largely from the leaching out of silica from the iron formation, though partly from additional precipitation of iron oxide. The iron formations are bedded deposits consisting chiefly of a mixture of chert or quartz and ferric oxide segregated in bands or mingled irregularly. Banded iron formation which has become highly crystalline through metamorphism and in which the bands are bright red is known as jasper. The ordinary reddish-gray iron formation consisting of banded or irregularly intermingled chert and iron oxide is known as ferruginous chert; on the Mesabi range the local name "taconite" is appiled to it. There are many other subordinate phases of the iron formations resulting from metamorphism or from an admixture with other sediments. Locally, masses of cherty iron carbonate and hydrous ferrous silicate (greenalite) occur, which are supposed to be remnants of the original form in which the iron formations were deposited. Greenalite is characteristic of the Mesabi district, and cherty iron carbonate occurs in all the other districts. The ferruginous chert was formed by the weathering of the iron carbonate and greenalite. Where the cherty iron carbonate has been altered by contact or regional metamorphism, local areas of amphibole-magnetite rocks occur. Where the ferruginous chert was metamorphosed, jasper is found. Frequently layers and lenses of slate are found interbedded with the iron formation, and these show all gradations to ferruginous chert. Paint rock, a decomposed slate deeply stained and impregnated with ferric oxide, is characteristic of many of the iron-ore deposits. It forms from slate lenses at the same time that the alteration of the surrounding iron formation to iron ore and ferruginous chert is taking place. The last and most important phase of the iron formation is the iron ore itself, which occurs locally along the outcrop of the iron formation where meteoric waters have had a chance to operate and where favorable conditions for concentration prevail.

The rocks have suffered folding, faulting, and metamorphism to varying degrees in the different ranges and these have influenced the form and character of the ore deposits, so that there is considerable variation in different districts and different parts of the same district.

Vermilion Range

(a) The Vermilion range is in northern Minnesota in the northern part of St. Louis and Lake counties. The principal ore deposits are in the vicinity of Tower and Ely, and occur in iron formation of Keewatin age. The rocks are intricately folded and intensely metamorphosed, so that the iron formation is largely altered to jasper. The country rock is for the most part greenstone in which the jasper is infolded in local synclinical basins or trough, so that areally it occurs in small patches surrounded by greenstone. The ores are associated with the jasper in these troughs and generally have a foot wall of greenstone. They consist of dense, hard, blue or red hematite, often brecciated but rarely specular.

Mesabi Range

(b) The Mesabi range is in central St. Louis and southeastern Itasca counties, Minn. The principal ore deposits are in the vicinity of Mesaba, Colby, Biwabik, McKinley, Sparta, Eveleth, Virginia, Mountain Iron, Buhl, Chisholm, Hibbing, Stevenson, and Nashwauk. The rocks of this region have suffered less folding and metamorphism than those of the other ranges. They dip slightly to the southeast, so that the iron formation outcrops in a

general northeast-southwest belt. There are minor transverse folds. Above the iron formation and to the south is a thick slate; underneath it is a thin quartzite underlain by granite or graywacke and slate of lower-middle Huronian age, the former composing the Giants range north of the district. The iron formation is largely ferruginous chert, but at the eastern end of the range a heavy gabbro formation has metamorphosed it to amphibole-magnetite rock.

The iron ores cover large areas along the outcrop of the iron formation and are irregular in their occurrence, though in general they are best developed and most abundant at the minor transverse folds. The deposits are very irregular in shape, frequently having big arms extending from the main deposits, and these in places connect with other deposits. They are of great horizontal extent as compared with their vertical extent, being usually not more than 200 feet in depth, while they may extend continuously in a horizontal direction for a mile or more. Mining is carried on largely in large, shallow, open pits, the ore being loaded with steam shovels directly on railway cars and shipped without concentration. There are a few underground mines, and here the mining is carried on either by milling or by the regular underground methods.

The ore is a soft porous brown, red, or blue hematite of high grade. It shows the layering of the original iron formation, and in places the ore layers can be traced directly into the iron formation bounding the deposit. The ore layers generally show a slumping near the contact, showing that material has been leached from the iron formation during the process of ore concentration. In many instances ore bodies are bounded by joint planes. The following description of the factors controlling the ore deposition on the Mesabi range is given by Leith:*

The agent of the alteration is water, coming more or less directly from the surface, carrying oxygen and carbon dioxide. The concentration of the ores has been found to occur where such waters have been converged. Various factors have determined this convergence—fracturing and brecciation of the iron formation, existence of impervious layers in such attitudes as either to converge waters coming from above or to impound the waters and deflect their course between two layers. * * * The iron formation and its associated rocks lie in beds on the south slope of the Giants range, and dip off gently to the south at angles averaging from 8 degrees to 10 degrees. In addition to the general southward tilting of the beds, they are gently flexed into folds with axes transverse to the trend of the range. Waters falling on the south slope of the Giants range, and flowing to the south, enter the eroded edges of the iron formation and continue their way down along its layers, some of which are pervious and some of which are slaty and comparatively impervious to water. The flow thus tends to become concentrated along the axes of the synclines which pitch gently to the southward. Such synclines are not necessarily surface troughs. They are evidenced by the attitude of the layers of the iron formation, and may not be apparent in the unequally eroded rock surface or at the surface of the irregular covering of glacial drift. * * * Further study shows that other factors modify the circulation of water and the localization of the ore, and that these secondary factors may be locally dominant.

The most important of these modifying factors is the fracturing of the iron formation which has furnished numerous trunk channels for the circula-

*Leith, C. K., a summary of Lake Superior geology with special reference to recent studies of the iron-bearing series: Bimo. Bull. Am. Inst. Min. Eng., No. 3, 1905, pp. 485, 488, 489.

tion of underground waters. The water has been confined to narrow, irregular, and most devious trunk channels formed by the fracturing of the iron formation, and while it has probably followed the fracture openings along synclines to a greater extent than along anticlines, it has not filled the entire syncline formed by the folding of the iron formation. The result is that the ores have developed along limited and irregular areas within the synclines. They may occupy a considerable part of the syncline, in which case the synclinal structure of the iron formation may be observed in the layers of wall rock adjacent to the ores. In other cases they occupy so small a proportion of the syncline that the layers of the iron formation in the adjacent wall rock give no indication of synclinal dips. Not infrequently several more or less independent deposits may have developed in the same general syncline, as, for instance, in the aera adjacent to the town of Virginia. To put it briefly, the ores show such a position, irregularity, extent, and relations to wall rocks as to make applicable the expression sometimes heard in the district that the ores have developed through the "rotting" of the iron formation along fractures, usually, but not always, in broad synclinal areas.

Other factors modifying the general underground flow of water in the Mesabi iron formation are the numerous impervious slaty layers within the iron formation, and the Virginia slate capping the iron formation of the south; all of which have considerable effect in directing water circulation. So far as the water is free to flow southward through the iron formation, the impervious layers serve only to limit the flow below. But the continuous south dip of the impervious strata carries the waters down to a point where the ground is saturated and the waters are ponded between impervious layers above and below. That ponding actually occurs is shown by the fact that drill holes penetrating the slates and entering the iron formation frequently meet water under pressure, indicating artesian conditions. When ponded, the water seeks the lowest point of escape, which is likely to be found near the north margin of the slate layers. The movement of the water toward the lowest point of escape causes a considerable lateral movement in the circulation, and this lateral movement has probably, at least in part, controlled the shape of certain deposits on the range which have their longer dimensions parallel to the strike of the layers of the iron formation.

The ponding of the water and consequent overflow has still another effect. Where ponded the flow is governed by the point of lowest escape rather than by the shape of the impervious basement. When water is drawn off at the edge of a basin, the flow is greatest near the point of escape and diminishes in all directions away from that point. This statement is true where the bottom of the basin is flat or fluted; hence, in the Mesabi iron formation, where the water is ponded, the flow is concentrated near the point of lowest escape regardless of whether this be over a syncline or anticline so far as both are below water level. The lowest point of escape is likely to be over synclines, but the surface erosion, both by glacial and meteoric agencies, has been such that this is not always the case. For this reason it is not certain that iron-ore deposits near the edge of the Virginia slate or near the edge of the interstratafied slate layers may not have developed along arches as well as in synclines of the iron formation.

The above facts are intimately related to the problem of finding ore under the solid black Virginia slate. The question is frequently asked, Is there any reason why ore shall not be found under the black slate? The absence of ore under the slate has not been demonstrated by actual drilling; only a comparatively few holes have penetrated any considerable thickness

of the Virginia slate and entered the iron formation below. Yet such holes as have been put down have revealed ore only near the slate margin and frequently of low grade. In several cases the iron formation beneath the slate has been shown to be of a green, unaltered variety, indicating that the alteration necessary for the development of ore deposits has not gone far. If the development of the ore is dependent upon a vigorous circulation and this vigorous circulation is lacking under the Virginia slate because of the ponding, we have here an adequate cause for the non-existence of ore deposits under the black slate. Yet further work may show that other factors have entered, and, considering the extent and value of the new iron-bearing territory which would be thrown open were ore found under the Virginia slate, more actual drilling seems advisable to settle the question.

Cuyuna Range

(c) The Cuyuna district extends in a northeast-southwest direction along the Northern Pacific Railway in the vicinity of Aitkin, Deerwood, and Brainerd, in Crow Wing, Aitkin and Morrison counties, central Minnesota. Geologically the district is situated along a series of minor northeast-southwest anticlines in the broad synclinal basin, on the northern limb of which is the Mesabi district and on the southern limb the Penokee-Gogebic district. The first ore was discovered here in 1904 by drilling along a line of magnetic attraction near Deerwood. No ore has been shipped from this district. Leith gives the following description of the geology and structure of the district:*

From the information so far available, consisting largely of drill samples, the succession of rocks for the Cuyuna district, from the base upward, is as follows:

Quartzite and its altered equivalents, quartzose, micaceous and hornblende schists.

Iron formation, consisting principally of iron carbonate where unaltered, but largely altered to amphibole-magnetite rock, ferruginous slates, and iron ore. The ores thus far found are soft, reddish, slightly hydrated hematite, reddish slaty hematite, and hard blue, banded, siliceous magnetite and hematite.

Chloritic and carbonaceous slate, interbedded in its lower part with iron formation.

Intrusive granite and diorite, principally the latter.

Cretaceous sediments.

Glacial drift, 80 to 350 feet.

It is possible that some of the igneous rock is really older than the sedimentary series, and lies unconformably beneath it, but no evidence of this has yet been found and the structural relations do not favor this view.

So far as the sedimentary rocks go, the emphasis should be placed on the altered phases, for they have all been much metamorphosed. Failure to recognize the schists as parts of the sedimentary series has caused confusion in the local interpretation of drill records. The changes in the quartzite and slate to schists are the typical anamorphic changes of the zone of rock flowage. When subsequently exposed at the surface, there has been a leaching out of all of the basic constituents, leaving light-colored, soft, kaolinic and quartzose schists. This action is most conspicuous in their upper 15 or 20 feet. The iron formation, originally mainly iron carbonate, has also undergone anamorphism, resulting in the development of amphibole magnetite

*Leith, C. K., The geology of the Cuyuna iron range, Minnesota: Econ. Geology, vol. 2, p. 145.

rocks essentially similar to amphibole magnetite rocks wherever they are found in other parts of the Lake Superior region. This action, however, was not sufficiently effective to destroy a large part of the iron carbonate constituting the original mass of the formation. When exposed to weathering, the amphibole-magnetite rocks have remained substantially as they were, being very resistant, although becoming somewhat softer. The iron carbonate has been altered to iron ore. The gradation phases between the iron carbonate and slate have become ferruginous slates.

The anamorphism of the Cuyuna series is probably to be explained in large part by the existence of intrusives in the area itself and to the west and south of it.

The sedimentary series has been folded into a series of repeated folds, as shown by drilling and magnetic work, and erosion has cut off the top of the anticlines, exposing the iron formation in a number of belts, in general parallel, but presumably coming together at the ends of the folds. The dips are thus for the most part high, in the neighborhood of 80 degrees, although near the crests of the folds they are less. The folding has been accompanied by the development of cleavage in the softer layers, especially in the softer slates. Where the cleavage can be definitely distinguished from the bedding, there is usually a slight angle between them, and the cleavage has the steeper dip. The iron formation itself is less affected by the cleavage than the slate.

The ores constitute the altered and concentrated upper parts of the steeply dipping iron formation strata exposed by the erosion of the anticlines. The hanging wall is commonly chloritic slate and iron carbonate in varying proportions and degrees of alteration; the foot wall is either a quartz schist or amphibole-magnetite schist. Intrusives complicate these relations in many deposits, suggesting that the presence of these rocks has favored the development of the ore deposits. This is yet to be proved.

The ore bodies thus far found seem to be in the form of lenses 1 to 250 feet in thickness, with their longer dimensions parallel to the highly tilted bedding of the series. It is probable that also several parallel or overlapping lenses may be present, judging from analogy with the lower part of the Animikie series elsewhere in the Lake Superior region, as in the Paint River, Crystal Falls, and western Menominee country. Along the strike these lenses pinch out or widen, the change often being accompanied by a change in grade of the ore. It is difficult to tell from the present state of exploration just how far the parallel lenses are independent lenses in the same general formation and how far they may be the result of duplication by folding. The broader features of distribution are undoubtedly to be explained by folding. There is a narrow zone of iron formation extending from east of Aitkin southwest past Deerwood and Brainerd and for some distance west of the Mississippi river, as shown by magnetic attractions and by drilling. This is made up of a large number of short parallel and overlapping belts. Whether these minor belts are repeated by folding or whether they are parallel, independent lenses is not known. Six miles to the north, however, in the vicinity of Rabbit Lake, there is again a belt of iron formation which is undoubtedly brought up here by folding, for if it were an independent belt in a monoclinal succession it would imply too great a thickness of intervening strata. Still farther to the northwest between Rabbit Lake and Mississippi river are at least two more belts of iron formation repeated by folding. Whether the folds reappear again elsewhere, prospectors are now trying to determine.

The rock surface beneath the drift shows local variations of 100 feet or

more, and between widely separated points, because of the general slope of the surface, may show a difference of elevation of as much as 250 feet. Frequently the soft hanging-wall slates are found to be at lower elevations, because of erosion, than the harder iron formation or the foot-wall quartzite adjacent, as, for instance, near Pickands, Mather & Co.'s shaft in sec. 8, 45-29. Notwithstanding these local irregularities of the surface, it is, in a broad way, relatively flat. At many places in the district and in adjacent parts of Minnesota cretaceous deposits are found just above the rock surface and beneath the drift, suggesting that this flat surface may be part of a pre-Cretaceous base level or peneplain. The Cuyuna district contrasts in topography of the rock surface with the producing ranges of the Lake Superior region, where there is usually a marked ridge or range giving a head to the percolating surface waters of from 200 to 500 feet and making it possible for the waters to circulate vigorously and accomplish ore concentration to considerable depths where structural conditions allow. This suggests the inference that in the Cuyuna district vigorously circulating ore-concentrating waters may not have been effective to so great a depth as in other Lake Superior iron ranges. On the other hand, if the ores were developed before the base level and before reaching the present base level, there may have been greater topographic relief, which would have aided the alteration of the rocks and concentration of the ore to a greater depth than would the present relief. The existence of the heavy mantle of weathered material over the area may represent a remnant of the weathered material which in the other districts has been removed by glacial erosion. It is obvious that the Cuyuna district has been one in which glacial deposition has predominated over glacial erosion. When it is remembered that in the other Lake Superior districts glacial erosion has probably removed large amounts of iron ore, the lack of glacial erosion in the Cuyuna district may not be an unfavorable indication.

Gogebic Range

(d) The Penokee-Gogebic range is in northern Michigan and Wisconsin, crossing the boundary in a northeast-southwest direction at Ironwood. The principal mines are at Hurley, Wis., and at Ironwood, Wakefield, and Bessemer, Mich.

The ores occur in iron formation of upper Huronian age which is overlain by slate and underlain by quartzite and black slate. Above the upper slate is a heavy gabbro of Keweenawan age, which in a few localities has come into contact with the iron formation and has metamorphosed it to jasper and amphibole-magnetite rock. For the most part, however, the iron formation is ferruginous chert. The sedimentary rocks dip steeply to the northwest. They are cut by dikes of basic igneous rocks of probable Keweenawan age, which cross them at varying angles to the bedding. The ores are concentrated in large irregular bodies in the angles between the foot-wall quartzite or black slate and the igneous dikes. These two formations make an impervious trough toward which underground channels for meteoric waters converge and in which the waters are ponded and precipitate their load. The deposits are of a different form and character from those of the Mesabi range. Most of them reach depths of a thousand feet and upward, but their horizontal extent is very much smaller than that of the deposits of the Mesabi range. The ore is for the most part soft hydrated hematite, but hard slaty ore is abundant, and more rarely needle ore is found. In a few deposits local pockets of manganese oxide occur. Mining is carried on by underground methods entirely.

Marquette Range

(e) The Marquette range, including the Republic and Swanzy areas, occupies a large east and west elongated area west and southwest of Mar-

quette, Mich. The principal mines are in the vicinity of Michigamme, Negaunee, Ishpeming, Swanzy, and Republic. Iron formations occur in both the upper and middle Huronian, the latter containing the principal ores. The iron formation of the upper Huronian is underlain by quartzite and overlain by slate. Ores occur locally as concentration deposits in the lower part of the iron formation and in other places as detrital deposits at the base of the quartzite underlying it. The latter type of ore is derived from deposits in the underlying iron formation occurring at the top of the middle Huronian. The middle Huronian iron formation (Negaunee) is underlain by slate, which in turn is underlain by quartzite. The sedimentary rocks are abundantly intruded by dikes, bosses, and stocks of basic igneous rock of probable Keweenawan age.

The sediments are folded into a great east-west synclinal basin composed of a number of minor synclines and anticlines. Ores occur on both limbs of the basin, but are most abundant on the north limb. The deposits near Ishpeming and Negaunee occur in a part of the basin where the upper Huronian rocks have been eroded away and the middle Huronian iron formation is exposed over the entire width of the basin. The deposits near Republic are in a minor syncline branching southeastward from the western part of the main basin. The Swanzy area is southeast of the main basin.

The ores of the middle Huronian and the detrital ores at the base of the upper Huronian occur at nearly the same geologic horizon, and the latter are derived from the former. The ores may be divided into three classes* (1) Ores at the base of the iron-bearing Negaunee (middle Huronian) formation; (2) ores within the Negaunee formation; and (3) detrital ores at the base of the Goodrich (upper Huronian) quartzite.

(1) The ores of this class occur only at the base of the Negaunee formation, and, therefore, at the outskirts of the iron formation areas. They occur at places where the underlying slate has been folded so as to form pitching synclinal basins. In these impervious troughs the ore deposits have developed. In many places basic dikes have cut the rocks, and the ore has developed between the dikes and the slate, thus presenting a similarity to the deposits of the Penokee-Gogebic district.

(2) The ores of the second class are developed at the contact of the iron formation with basic intrusions. They occur either in local irregularities (basins) on the surface of the intrusive masses or in pitching troughs formed between igneous masses and dikes branching out from them. The surfaces of the igneous masses are very much altered, leached out, and impregnated with iron oxide, being changed largely to soapstone and paint rock. Many of the dikes are entirely altered.

(3) The detrital ores were formed by the breaking up of the deposits of types (1) and (2) during the erosional period intervening between the deposition of the middle and upper Huronian. These deposits are also localized by pitching troughs in the basic intrusions, between dikes and intrusive masses or slate layers, as are the lower ores. They may rest on a basement of soapstone (altered igneous rock), iron formation, or slate.

The ore of classes (1) and (2) are chiefly soft hydrated hematite; those of class (3) are hard, specular ores with some magnetite. The metamorphism of class (3) is apparently due to greater movement along the contact of the middle and upper Huronian during the folding than within these rocks themselves. With the hard ore are developed jasper and amphibole-magnetite rock.

*Van Hise, C. R., The iron-ore deposits of the Lake Superior region: Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 3, 1901, p. 305.

Menominee Range

(f) The Menominee range, including the Crystal Falls, Iron River, Metropolitan, and Florence areas, is in Dickinson and Iron counties, Mich., and extends across the boundary into Florence county, Wis. The principal mines occur at Iron Mountain, Norway, Metropolitan, Crystal Falls, Amasa, and Iron River, Mich., and at Florence, Wis.

Iron formations are found in both the upper and middle Huronian, but only the former carry iron ores of commercial importance. The middle Huronian iron formation is found only in the northern part of the district, while the upper Huronian iron formation occurs in the southern part of the district. Thus the productive areas are confined to the southern part.

The upper Huronian iron formation is known as the Vulcan formation in the Menominee district proper. The rocks are intricately folded so that the structure of the range is very complicated. The ores of the different areas occur in separate local basins or structural units.

The Vulcan formation in the Menominee district proper is divided into three members, viz: The Curry iron-bearing member, the Brier slate member, and the Traders iron-bearing member. It is overlain by upper Huronian (Hanbury) slate and underlain by lower Huronian (Randville) dolomite. Iron ores may occur at any horizon within the ore-bearing members, but are more prevalent at the top or bottom. The deposits are of large size and occur on relatively impervious formations which are usually folded into pitching troughs at the places where the ores are found. Pitching troughs may be formed (1) by the dolomite underlying the Traders member, (2) by a slate layer constituting the lower part of the Traders member and (3) by the Brier slate underlying the Curry member.

The sedimentary formations are folded into two major anticlines trending a little north of west so that the iron formation is distributed in several belts, along which ore deposits occur locally. Minor folds are superimposed on the major folds. The sediments are bounded on the north by Archean granite and on the south by Archean (Quinnesec) schist.

The iron ores are principally gray, finely banded hematite with subordinate amounts of flinty block hematite locally banded.

The iron-bearing formation in the outlying areas consists mainly of ferruginous slates and cherts with some cherty iron carbonate. The former are generally carbonaceous immediately above and below the ore-bearing beds. The formation is underlain by slate, which is in turn underlain by lower Huronian formations. Above the iron formation is the Michigamme slate. In some of the outlying areas the iron formation and the underlying slate have not been separated from the Michigamme slate.

In general the ores occur in pitching synclinal basins bottomed and capped by slate layers. They are largely soft red hematite, considerably hydrated in places.

Baraboo Range

(g) The Baraboo range is located in southern Wisconsin in the central part of Sauk county. The principal deposits occur near the town of North Freedom.

The Huronian rocks are in the form of an east and west elongated syncline surrounded by Cambrian sandstone and containing a considerable thickness of Cambrian sandstone within it. Thus only the rim of the syncline consisting of heavy bedded quartzite is exposed. This quartzite forms the base of the series and rests on Archean rock. Above it is the Seeley slate and above this the iron formation which carries the ores of the district. The iron formation is overlain by the Freedom dolomite. The rocks of the iron formation immediately associated with the ores are ferruginous dolomite, ferruginous chert, and ferruginous slate.

The principal workable deposits have been found in the southwestern portion of the syncline. The deposits are stratified and are conformable with the beds above and below. They have the same dip and strike as the associated rocks and are found dipping at angles varying from nearly vertical to nearly horizontal.

The ore of the Baraboo range is of lower grade than the average ore of the other Lake Superior ranges, generally containing less than 55 per cent of iron. It is soft hydrated hematite, in many places containing so much water as to be limonitic in character.

The iron ores of the Lake Superior district in general consist of high grade hematite, ranging from hard, dense, blue, specular nonhydrated ore to soft, blue, red, or brown hydrated varieties. The upper portions of the deposits in general are more hydrated than the lower portions and in places contain sufficient water to form a brown ore. The ores are uniformly high in iron and low in phosphorus, so that the great bulk is of Bessemer grade. The soft ores, especially those of the Mesabi range, are frequently troublesome during smelting operations, but when they are mixed with hard ore this trouble is remedied.

The following tables show the average composition of the iron ores which are now mined and shipped in the Lake Superior district :

Average Analysis of Iron Ore Mined in the Lake Superior District During 1905

Fe	59.6	P	.067
SiO_2	7.5	S	.019

Range in Composition of Iron Ore Mined in the Lake Superior District During 1906 and 1907

	1906	1907
Fe	38.00–65.00	39.00–67.00
SiO_2	2.00–40.00	1.00–43.00
P	.008–.85	.01–1.00
S	.006–.13	.005–.14
Mn	.04–7.4	.03–8.7

* * * * * * * * * * * * * *

Clinton hematite.—Deposits of Clinton hematite occur in eastern Wisconsin and in Missouri. Those of Wisconsin are of considerable importance

and have been mined for many years. Those of Missouri, according to H. A. Buehler, have only been discovered recently by drilling and occur at such depths as not to be at present workable.

Iron Ridge Range

In Wisconsin, the principal Clinton ores occur near Iron Ridge and Mayville, in eastern Dodge county, outcropping for several miles in a north and south direction. The entire Clinton formation is represented by iron ore which occurs in the form of a lens-shaped bed at the base of the Niagaran limestone and overlying the Cincinnatian shale. Small deposits of no commercial importance occur at the same horizon near Hartford, Washington county; near De Pere, Brown county; and west of Sturgeon Bay, Door county.

The bed in Dodge county varies in thickness from 15 to 25 feet and is nearly horizontal, the overlying Niagaran limestone forming a westward facing escarpment above it. The ore bed is made up of numerous horizontal layers 3 to 14 inches in thickness.

The ore consists chiefly of small lenticular concretions. The prevailing color is dark reddish-brown, though locally it becomes purple. It is generally soft and friable, containing just enough cement to keep the concretions together. The top layer varying from 3 to 8 inches in thickness differs from the rest in being hard and compact and of a deep purple color with bright scarlet streaks. It contains very few oölites and breaks with conchoidal fracture. Clay is intermingled with ore in the lower layers.

The ore is of about the same grade as the soft Clinton ores of the eastern district. It is smelted chiefly in local furnaces, though occasionally shipments are made to Milwaukee.

* * * * * * * * * * * * *

BROWN ORE.

Bog ore.—Bog iron ores are found in small deposits throughout the Mississippi Valley, but only at a few localities have they been mined, the most important of which are in Wisconsin. They are usually in the form of superficial blanket deposits mixed with more or less clay and earthy matter. Bog deposits are for the most part too small and isolated to pay for the expense of mining and transportation. Occasionally, however, deposits of such size are found as to permit the erection of a local furnace. Such deposits occur at Spring Valley and vicinity, Pierce county, Wis.

Limonite gossan.—Limonite gossan ore occurs in the upper part of the lead and zinc deposits in the upper Mississippi Valley. It results from the alteration of the iron sulphides, pyrite, and marcasite, which are associated with lead and zinc sulphides in the deeper parts of the veins. The gossan deposits of the Mississippi Valley are too small to be of commercial importance.

MAGNETITE

Lake Superior magnetite.—Magnetite deposits worthy of notice are found in the Marquette, Mesabi, and Gunflint ranges of the Lake Superior district. They are related to the Lake Superior hematite deposits, being

formed from the cherty iron carbonate or from the hematite deposits by igneous intrusives or by regional metamorphism. In the Marquette range magnetite is formed by both of these processes; in the other ranges it is formed by contact metamorphism by the great gabbro mass of northern Minnesota. This gabbro extends across the eastern part of the Mesabi range and has altered the iron formation along the contact to amphibole-magnetite rock and local magnetite deposits. Although considerable exploration has been done in this area, deposits of great importance have not been found.

In the Gunflint district in northern Minnesota near the Canadian boundary, the upper Huronian iron formations reappear from underneath the gabbro and extend northeastward into the Animikie district, Ontario. Near the gabbro contact the iron formation is altered to a coarsely crystalline green quartzite, with beds and lenses of magnetite associated with various ferrous silicates. The iron formation rests in Keewatin greenstone and dips away from it at steep angles. The magnetite lenses are most abundant near the contact with the greenstone.

Local occurrences of magnetite are also found at both ends of the Penokee-Gogebic range where the gabbro has come into contact with the iron formations.

Titaniferous magnetite.—Titaniferous magnetite in large bodies is reported to occur locally in the great gabbro mass of northern Minnesota. The most important of these deposits are located a short distance south of the Gunflint district. Little has been done with them in the way of exploration and they are practically unknown.

IRON CARBONATE

Iron carbonate.—Iron carbonate and silicate originally composed the Lake Superior iron formation and are still found in scattered masses where they have been protected from weathering processes. They are described in connection with the Lake Superior hematite.

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Addenda

IRON ORE RESERVES OF THE UNITED STATES.

Report of John Birkinbine

Resume of the Report of John Birkinbine on the Iron Ore Reserves of the United States—marked Appendix A to Supplemental Report of Joseph G. Butler, Jr., Filed with the Senate Finance Committee, June 15, 1909.

The foregoing will indicate that the reserves of iron ore in the Lake Superior region, of material such as is now shipped, exceed 1,600,000,000 tons, and that this amount may be greatly augmented by the utilization of some ore not now classed as desirable.

That in the Adirondack District of New York the ore reserves amount to 125,000,000 tons, which may be supplemented by 25,000,000 tons of other New York ores and the possibility of large future additions from the deposits of Clinton ores in the center of the state.

That New Jersey has over 35,000,000 tons of available ore, and in addition 100,000,000 tons of concentrating ore can be obtained.

That Pennsylvania has reserves amounting to 45,000,000 tons, which may be increased by liberal exploitations of Clinton and carbonate ores.

That the Southern States may be counted on for a supply exceeding 1,200,000,000 tons, and possibly a much larger amount.

The reserves in the Rocky Mountain region and west of this, tentatively estimated as 100,000,000 tons, cover but a small part of the producing territory.

The grand total is 3,230,000,000 tons.

That the new England and other Atlantic states and the Central states, including Indiana, Illinois, Iowa, Mississippi, Missouri, Arkansas and Texas, will further add to the reserves.

ABSTRACT OF REPORT FOR THE CONSERVATION COMMISSION

By Mr. C. Willard Hayes, Chief Geologist, United States Geological Survey, Marked Appendix C to Supplemental Report of Joseph G. Butler, Jr. Filed with the Senate Finance Committee, June 15, 1909.

		Available Gross Tons	Not Available Gross Tons
Northeastern States		298 000,000	1,095,000,000
Vermont	Maryland		
Massachusetts	New Jersey		
Connecticut	Pennsylvania		
New York	Ohio		
Southeastern States		538,440,000	1,276,500,000
Virginia	South Carolina		
West Virginia	Georgia		
Eastern Kentucky	Alabama		
North Carolina	East Tennessee		
Lake Superior States		3,510,000,000	72,030,000,000
Michigan	Wisconsin		
Minnesota			
Mississippi Valley States		315,000,000	570,000,000
Northwest Alabama	Iowa, Missouri		
West Tennessee	Arkansas		
West Kentucky	East Texas		
Rocky Mountain States		57,760.000	120,665.000
Montana	Utah		
Idaho	Nevada		
Wyoming, Colorado	New Mexico		
Arizona	West Texas		
Pacific Slope States		68,950.000	23,905,000
Washington	Oregon		
California			
Total		4,788,150,000	75,116,070,000

The total supplies are divided into two classes, "available" and "not available."

"Available." This class includes those Ores which can be worked at a profit under the conditions at present existing in the Iron and Steel industry in the United States.

"Not Available." This class includes all Ores which cannot be worked at a profit under existing conditions in the Iron and Steel industry.

UNITED STATES STEEL CORPORATION ESTIMATED IRON ORE RESERVES

Marked Appendix F to Supplemental Report of Joseph G. Butler, Jr.. Filed with the Senate Finance Committee June 15, 1909

	GROSS TONS		
	Ores of Present Standard Commercially	Silicious and Other Low Grade Ores	Total
Northern Ores— Total	1,258,289,000	365,845,000	1,624,134,000
Southern Ores— Total Red and Brown	459,300,000	239,000,000	698,300,000
Total	1,717,589,000	604,843,000	2,322,434,000

THE CONCLUSIONS OF JOSEPH G. BUTLER, JR.

And His Estimates on the Iron Ore Reserves of the United States—Made in a Supplemental Report Filed With the Senate Finance. Committee, June 15, 1909.

Lake Superior	1,618,000,000 tons
New York	750,000,000 tons
New Jersey	135,000,000 tons
Pennsylvania	45,000,000 tons
South	1,814,940,000 tons
Rocky Mountain District	100,000,000 tons
Total	4,462,940,000 tons

"Taking the figures of the United States Steel Corporation of the 'available ores, to-wit: 1,717,589,000 tons, it would appear that the corporation owns 38½ per cent of the available, desirable ores."

SUMMARY OF THE ESTIMATES OF AVAILABLE IRON ORE RESERVES OF THE UNITED STATES

Joseph G. Butler, Jr	4,462,940,000 tons
C. Willard Hayes	4,788,150,000 tons
John Birkinbine	3,230,000,000 tons
U. S. Steel Corporation	1,717,589,000 tons

OLD RANGE-VERMILION BESSEMER

NATURAL IRON ORE

LAKE ERIE PRICES

1911

17 TABLES

45 PER CENT TO 61 PER CENT
INCLUSIVE

COMPILED BY
RUKARD HURD

OLD RANGE-VERMILION BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
45.00	$3.15545	45.50	$3.24818
.01	3.15731	.51	3.25003
.02	3.15916	.52	3.25189
.03	3.16101	.53	3.25374
.04	3.16287	.54	3.25560
.05	3.16472	.55	3.25745
.06	3.16658	.56	3.25931
.07	3.16843	.57	3.26116
.08	3.17029	.58	3.26301
.09	3.17214	.59	3.26487
45.10	3.17400	45.60	3.26672
.11	3.17585	.61	3.26858
.12	3.17771	.62	3.27043
.13	3.17956	.63	3.27229
.14	3.18141	.64	3.27414
.15	3.18327	.65	3.27600
.16	3.18512	.66	3.27785
.17	3.18698	.67	3.27971
.18	3.18883	.68	3.28156
.19	3.19069	.69	3.28341
45.20	3.19254	45.70	3.28527
.21	3.19440	.71	3.28712
.22	3.19625	72	3.28898
.23	3.19811	.73	3.29083
.24	3.19996	.74	3.29269
.25	3.20181	.75	3.29454
.26	3.20367	.76	3.29640
.27	3.20552	.77	3.29825
.28	3.20738	.78	3.30011
.29	3.20923	.79	3.30196
45.30	3.21109	45.80	3.30381
.31	3.21294	.81	3.30567
.32	3.21480	.82	3.30752
.33	3.21665	.83	3.30938
.34	3.21851	.84	3.31123
.35	3.22036	.85	3.31309
.36	3.22221	.86	3.31494
.37	3.22407	87	3.31680
.38	3.22592	.88	3.31865
.39	3.22778	.89	3.32051
45.40	3.22963	45.90	3.32236
.41	3.23149	.91	3.32421
.42	3.23334	.92	3.32607
.43	3.23520	.93	3.32792
.44	3.23705	.94	3.32978
.45	3.23891	.95	3.33163
.46	3.24076	.96	3.33349
.47	3.24261	.97	3.33534
.48	3.24447	.98	3.33720
.49	3.24632	.99	3.33905

OLD RANGE-VERMILION BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
46.00	$3.34091	46.50	$3.43363
.01	3.34276	.51	3.43549
.02	3.34461	.52	3.43734
.03	3.34647	.53	3.43920
.04	3.34832	.54	3.44105
.05	3.35018	.55	3.44291
.06	3.35203	.56	3.44476
.07	3.35389	.57	3.44661
.08	3.35574	.58	3.44847
.09	3.35760	.59	3.45032
46.10	3.35945	46.60	3.45218
.11	3.36131	.61	3.45403
.12	3.36316	.62	3.45589
.13	3.36501	.63	3.45774
.14	3.36687	.64	3.45960
.15	3.36872	.65	3.46145
.16	3.37058	.66	3.46331
.17	3.37243	.67	3.46516
.18	3.37429	.68	3.46701
.19	3.37614	.69	3.46887
46.20	3.37800	46.70	3.47072
.21	3.37985	.71	3.47258
.22	3.38171	.72	3.47443
.23	3.38356	.73	3.47629
.24	3.38541	.74	3.47814
.25	3.38727	.75	3.48000
.26	3.38912	.76	3.48185
.27	3.39098	.77	3.48371
.28	3.39283	.78	3.48556
.29	3.39469	.79	3.48741
46.30	3.39654	46.80	3.48927
.31	3.39840	.81	3.49112
.32	3.40025	.82	3.49298
.33	3.40211	.83	3.49483
.34	3.40396	.84	3.49669
.35	3.40581	.85	3.49854
.36	3.40767	.86	3.50040
.37	3.40952	.87	3.50225
.38	3.41138	.88	3.50411
.39	3.41323	.89	3.50596
46.40	3.41509	46.90	3.50781
.41	3.41694	.91	3.50967
.42	3.41880	.92	3.51152
.43	3.42065	.93	3.51338
.44	3.42251	.94	3.51523
.45	3.42436	.95	3.51709
.46	3.42621	.96	3.51894
.47	3.42807	.97	3.52080
.48	3.42992	.98	3.52265
.49	3.43178	.99	3.52451

OLD RANGE-VERMILION BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
47.00	$3.52636	47.50	$3.61909
.01	3.52821	.51	3.62094
.02	3.53007	.52	3.62280
.03	3.53192	.53	3.62465
.04	3.53378	.54	3.62651
.05	3.53563	.55	3.62836
.06	3.53749	.56	3.63021
.07	3.53934	.57	3.63207
.08	3.54120	.58	3.63392
.09	3.54305	.59	3.63578
47.10	3.54491	47.60	3.63763
.11	3.54676	.61	3.63949
.12	3.54861	.62	3.64134
.13	3.55047	.63	3.64320
.14	3.55232	.64	3.64505
.15	3.55418	.65	3.64691
.16	3.55603	.66	3.64876
.17	3.55789	.67	3.65061
.18	3.55974	.68	3.65247
.19	3.56160	.69	3.65432
47.20	3.56345	47.70	3.65618
.21	3.56531	.71	3.65803
.22	3.56716	.72	3.65989
.23	3.56901	.73	3.66174
.24	3.57087	.74	3.66360
.25	3.57272	.75	3.66545
.26	3.57458	.76	3.66731
.27	3.57643	.77	3.66916
.28	3.57829	.78	3.67101
.29	3.58014	.79	3.67287
47.30	3.58200	47.80	3.67472
.31	3.58385	.81	3.67658
.32	3.58571	.82	3.67843
.33	3.58756	.83	3.68029
.34	3.58941	.84	3.68214
.35	3.59127	.85	3.68400
.36	3.59312	.86	3.68585
.37	3.59498	.87	3.68771
.38	3.59683	.88	3.68956
.39	3.59869	.89	3.69141
47.40	3.60054	47.90	3.69327
.41	3.60240	.91	3.69512
.42	3.60425	.92	3.69698
.43	3.60611	.93	3.69883
.44	3.60796	.94	3.70069
.45	3.60981	.95	3.70254
.46	3.61167	.96	3.70440
.47	3.61352	.97	3.70625
.48	3.61538	.98	3.70811
.49	3.61723	.99	3.70996

OLD RANGE-VERMILION BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
48.00	$3.71181	48.50	$3.80454
.01	3.71367	.51	3.80640
.02	3.71552	.52	3.80825
.03	3.71738	.53	3.81011
.04	3.71923	.54	3.81196
.05	3.72109	.55	3.81381
.06	3.72294	.56	3.81567
.07	3.72480	.57	3.81752
.08	3.72665	.58	3.81938
.09	3.72851	.59	3.82123
48.10	3.73036	48.60	3.82309
.11	3.73221	.61	3.82494
.12	3.73407	.62	3.82680
.13	3.73592	.63	3.82865
.14	3.73778	.64	3.83051
.15	3.73963	65	3.83236
.16	3 74149	.66	3.83421
.17	3.74334	.67	3.83607
.18	3.74520	.68	3.83792
.19	3.74705	.69	3.83978
48.20	3.74891	48.70	3.84163
.21	3.75076	.71	3.84349
.22	3.75261	.72	3.84534
.23	3.75447	.73	3.84720
.24	3.75632	.74	3.84905
.25	3.75818	.75	3.85091
.26	3.76003	.76	3.85276
.27	3.76189	.77	3.85461
.28	3.76374	.78	3.85647
.29	3.76560	.79	3.85832
48.30	3.76745	48.80	3.86018
.31	3.76931	.81	3.86203
.32	3.77116	.82	3.86389
.33	3.77301	.83	3.86574
.34	3.77487	.84	3.86760
.35	3.77672	.85	3.86945
.36	3.77858	.86	3.87131
.37	3.78043	.87	3.87316
.38	3.78229	.88	3.87501
.39	3.78414	.89	3.87687
48.40	3.78600	48.90	3.87872
.41	3.78785	.91	3.88058
.42	3.78971	.92	3.88243
.43	3.79156	.93	3.88429
.44	3.79341	.94	3.88614
.45	3.79527	.95	3.88800
.46	3.79712	.96	3.88985
.47	3.79898	.97	3.89171
.48	3.80083	.98	3.89356
.49	3.80269	.99	3.89541

OLD RANGE-VERMILION BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
49.00	$3.89727	49.50	$3.96681
.01	3.89866	.51	3.96821
.02	3.90005	.52	3.96960
.03	3.90144	.53	3.97099
.04	3.90283	.54	3.97238
.05	3.90422	.55	3.97377
.06	3.90561	.56	3.97516
.07	3.90701	.57	3.97655
.08	3.90840	.58	3.97794
.09	3.90979	.59	3.97933
49.10	3.91118	49.60	3.98072
.11	3.91257	.61	3.98211
.12	3.91396	.62	3.98351
.13	3.91535	.63	3.98490
.14	3.91674	.64	3.98629
.15	3.91813	.65	3.98768
.16	3.91952	.66	3.98907
.17	3.92091	.67	3.99046
.18	3.92231	.68	3.99185
.19	3.92370	.69	3.99324
49.20	3.92509	49.70	3.99463
.21	3.92648	.71	3.99602
.22	3.92787	.72	3.99741
.23	3.92926	.73	3.99881
.24	3.93065	.74	4.00020
.25	3.93204	.75	4.00159
.26	3.93343	.76	4.00298
.27	3.93482	.77	4.00437
.28	3.93621	.78	4.00576
.29	3.93761	.79	4.00715
49.30	3.93900	49.80	4.00854
.31	3.94039	.81	4.00993
.32	3.94178	.82	4.01132
.33	3.94317	.83	4.01271
.34	3.94456	.84	4.01411
.35	3.94595	.85	4.01550
.36	3.94734	.86	4.01689
.37	3.94873	.87	4.01828
.38	3.95012	.88	4.01967
.39	3.95151	.89	4.02106
49.40	3.95291	49.90	4.02245
.41	3.95430	.91	4.02384
.42	3.95569	.92	4.02523
.43	3.95708	.93	4.02662
.44	3.95847	.94	4.02801
.45	3.95986	.95	4.02941
.46	3.96125	.96	4.03080
.47	3.96264	.97	4.03219
.48	3.96403	.98	4.03358
.49	3.96542	.99	4.03497

OLD RANGE-VERMILION BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
50.00	$4.03636	50.50	$4.08272
.01	4.03729	.51	4.08365
.02	4.03821	.52	4.08458
.03	4.03914	.53	4.08551
.04	4.04007	.54	4.08643
.05	4.04100	.55	4.08736
.06	4.04192	.56	4.08829
.07	4.04285	.57	4.08921
.08	4.04378	.58	4.09014
.09	4.04471	.59	4.09107
50.10	4.04563	50.60	4.09200
.11	4.04656	.61	4.09292
.12	4.04749	.62	4.09385
.13	4.04841	.63	4.09478
.14	4.04934	.64	4.09571
.15	4.05027	.65	4.09663
.16	4.05120	.66	4.09756
.17	4.05212	.67	4.09849
.18	4.05305	.68	4.09941
.19	4.05398	.69	4.10034
50.20	4.05491	50.70	4.10127
.21	4.05583	.71	4.10220
.22	4.05676	.72	4.10312
.23	4.05769	.73	4.10405
.24	4.05861	.74	4.10498
.25	4.05954	.75	4.10591
.26	4.06047	.76	4.10683
.27	4.06140	.77	4.10776
.28	4.06232	.78	4.10869
.29	4.06325	.79	4.10961
50.30	4.06418	50.80	4.11054
.31	4.06511	.81	4.11147
.32	4.06603	.82	4.11240
.33	4.06696	.83	4.11332
.34	4.06789	.84	4.11425
.35	4.06881	.85	4.11518
.36	4.06974	.86	4.11611
.37	4.07067	.87	4.11703
.38	4.07160	.88	4.11796
.39	4.07252	.89	4.11889
50.40	4.07345	50.90	4.11981
.41	4.07438	.91	4.12074
.42	4.07531	.92	4.12167
.43	4.07623	.93	4.12260
.44	4.07716	.94	4.12352
.45	4.07809	.95	4.12445
.46	4.07901	.96	4.12538
.47	4.07994	.97	4.12631
.48	4.08087	.98	4.12723
.49	4.08180	.99	4.12816

OLD RANGE-VERMILION BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
51.00	$4.12909	51.50	$4.17545
.01	4.13001	.51	4.17638
.02	4.13094	.52	4.17731
.03	4.13187	.53	4.17823
.04	4.13280	.54	4.17916
.05	4.13372	.55	4.18009
.06	4.13465	.56	4.18101
.07	4.13558	.57	4.18194
.08	4.13651	.58	4.18287
.09	4.13743	.59	4.18380
51.10	4.13836	51.60	4.18472
.11	4.13929	.61	4.18565
.12	4.14021	.62	4.18658
.13	4.14114	.63	4.18751
.14	4.14207	.64	4.18843
.15	4.14300	.65	4.18936
.16	4.14392	.66	4.19029
.17	4.14485	.67	4.19121
.18	4.14578	.68	4.19214
.19	4.14671	.69	4.19307
51.20	4.14763	51.70	4.19400
.21	4.14856	.71	4.19492
.22	4.14949	.72	4.19585
.23	4.15041	.73	4.19678
.24	4.15134	.74	4.19771
.25	4.15227	.75	4.19863
.26	4.15320	.76	4.19956
.27	4.15412	.77	4.20049
.28	4.15505	.78	4.20141
.29	4.15598	.79	4.20234
51.30	4.15691	51.80	4.20327
.31	4.15783	.81	4.20420
.32	4.15876	.82	4.20512
.33	4.15969	.83	4.20605
.34	4.16061	.84	4.20698
.35	4.16154	.85	4.20791
.36	4.16247	.86	4.20883
.37	4.16340	.87	4.20976
.38	4.16432	.88	4.21069
.39	4.16525	.89	4.21161
51.40	4.16618	51.90	4.21254
.41	4.16711	.91	4.21347
.42	4.16803	.92	4.21440
.43	4.16896	.93	4.21532
.44	4.16989	.94	4.21625
.45	4.17081	.95	4.21718
.46	4.17174	.96	4.21811
.47	4.17267	.97	4.21903
.48	4.17360	.98	4.21996
.49	4.17452	.99	4.22089

OLD RANGE-VERMILION BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
52.00	$4.22181	52.50	$4.26818
.01	4.22274	.51	4.26911
.02	4.22367	.52	4.27003
.03	4.22460	.53	4.27096
.04	4.22552	.54	4.27189
.05	4.22645	.55	4.27281
.06	4.22738	.56	4.27374
.07	4.22831	.57	4.27467
.08	4.22923	.58	4.27560
.09	4.23016	.59	4.27652
52.10	4.23109	52.60	4.27745
.11	4.23201	.61	4.27838
.12	4.23294	.62	4.27931
.13	4.23387	.63	4.28023
.14	4.23480	.64	4.28116
.15	4.23572	.65	4.28209
.16	4.23665	.66	4.28301
.17	4.23758	.67	4.28394
.18	4.23851	.68	4.28487
.19	4.23943	.69	4.28580
52.20	4.24036	52.70	4.28672
.21	4.24129	.71	4.28765
.22	4.24221	.72	4.28858
.23	4.24314	.73	4.28951
.24	4.24407	.74	4.29043
.25	4.24500	.75	4.29136
.26	4.24592	.76	4.29229
.27	4.24685	.77	4.29321
.28	4.24778	.78	4.29414
.29	4.24871	.79	4.29507
52.30	4.24963	52.80	4.29600
.31	4.25056	.81	4.29692
.32	4.25149	.82	4.29785
.33	4.25241	.83	4.29878
.34	4.25334	.84	4.29971
.35	4.25427	.85	4.30063
.36	4.25520	.86	4.30156
.37	4.25612	.87	4.30249
.38	4.25705	.88	4.30341
.39	4.25798	.89	4.30434
52.40	4.25891	52.90	4.30527
.41	4.25983	.91	4.30620
.42	4.26076	.92	4.30712
.43	4.26169	.93	4.30805
.44	4.26261	.94	4.30898
.45	4.26354	.95	4.30991
.46	4.26447	.96	4.31083
.47	4.26540	.97	4.31176
.48	4.26632	.98	4.31269
.49	4.26725	.99	4.31361

OLD RANGE-VERMILION BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
53.00	$4.31454	53.50	$4.36091
.01	4.31547	.51	4.36183
.02	4.31640	.52	4.36276
.03	4.31732	.53	4.36369
.04	4.31825	.54	4.36461
.05	4.31918	.55	4.36554
.06	4.32011	.56	4.36647
.07	4.32103	.57	4.36740
.08	4.32196	.58	4.36832
.09	4.32289	.59	4.36925
53.10	4.32381	53.60	4.37018
.11	4.32474	.61	4.37111
.12	4.32567	.62	4.37203
.13	4.32660	.63	4.37296
.14	4.32752	.64	4.37389
.15	4.32845	.65	4.37481
.16	4.32938	.66	4.37574
.17	4.33031	.67	4.37667
.18	4.33123	.68	4.37760
.19	4.33216	.69	4.37852
53.20	4.33309	53.70	4.37945
.21	4.33401	.71	4.38038
.22	4.33494	.72	4.38131
.23	4.33587	.73	4.38223
.24	4.33680	.74	4.38316
.25	4.33772	.75	4.38409
.26	4.33865	.76	4.38501
.27	4.33958	.77	4.38594
.28	4.34051	.78	4.38687
.29	4.34143	.79	4.38780
53.30	4.34236	53.80	4.38872
.31	4.34329	.81	4.38965
.32	4.34421	.82	4.39058
.33	4.34514	.83	4.39151
.34	4.34607	.84	4.39243
.35	4.34700	.85	4.39336
.36	4.34792	.86	4.39429
.37	4.34885	.87	4.39521
.38	4.34978	.88	4.39614
.39	4.35071	.89	4.39707
53.40	4.35163	53.90	4.39800
.41	4.35256	.91	4.39892
.42	4.35349	.92	4.39985
.43	4.35441	.93	4.40078
.44	4.35534	.94	4.40171
.45	4.35627	.95	4.40263
.46	4.35720	.96	4.40356
.47	4.35812	.97	4.40449
.48	4.35905	.98	4.40541
.49	4.35998	.99	4.40634

OLD RANGE-VERMILION BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
54.00	$4.40727	54.50	$4.45363
.01	4.40820	.51	4.45456
.02	4.40912	.52	4.45549
.03	4.41005	.53	4.45641
.04	4.41098	.54	4.45734
.05	4.41191	.55	4.45827
.06	4.41283	.56	4.45920
.07	4.41376	.57	4.46012
.08	4.41469	.58	4.46105
.09	4.41561	.59	4.46198
54.10	4.41654	54.60	4.46291
.11	4.41747	.61	4.46383
.12	4.41840	.62	4.46476
.13	4.41932	.63	4.46569
.14	4.42025	.64	4.46661
.15	4.42118	.65	4.46754
.16	4.42211	.66	4.46847
.17	4.42303	.67	4.46940
.18	4.42396	.68	4.47032
.19	4.42489	.69	4.47125
54.20	4.42581	54.70	4.47218
.21	4.42674	.71	4.47311
.22	4.42767	.72	4.47403
.23	4.42860	.73	4.47496
.24	4.42952	.74	4.47589
.25	4.43045	.75	4.47681
.26	4.43138	.76	4.47774
.27	4.43231	.77	4.47867
.28	4.43323	.78	4.47960
.29	4.43416	.79	4.48052
54.30	4.43509	54.80	4.48145
.31	4.43601	.81	4.48238
.32	4.43694	.82	4.48331
.33	4.43787	.83	4.48423
.34	4.43880	.84	4.48516
.35	4.43972	.85	4.48609
.36	4.44065	.86	4.48701
.37	4.44158	.87	4.48794
.38	4.44251	.88	4.48887
.39	4.44343	.89	4.48980
54.40	4.44436	54.90	4.49072
.41	4.44529	.91	4.49165
.42	4.44621	.92	4.49258
.43	4.44714	.93	4.49351
.44	4.44807	.94	4.49443
.45	4.44900	.95	4.49536
.46	4.44992	.96	4.49629
.47	4.45085	.97	4.49721
.48	4.45178	.98	4.49814
.49	4.45271	.99	4.49907

OLD RANGE-VERMILION BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
55.00	$4.50000	55.50	$4.55136
.01	4.50102	.51	4.55239
.02	4.50205	.52	4.55341
.03	4.50308	.53	4.55444
.04	4.50411	.54	4.55547
.05	4.50513	.55	4.55650
.06	4.50616	.56	4.55752
.07	4.50719	.57	4.55855
.08	4.50821	.58	4.55958
.09	4.50924	.59	4.56061
55.10	4.51027	55.60	4.56163
.11	4.51130	.61	4.56266
.12	4.51232	.62	4.56369
.13	4.51335	.63	4.56471
.14	4.51438	.64	4.56574
.15	4.51541	.65	4.56677
.16	4.51643	.66	4.56780
.17	4.51746	.67	4.56882
.18	4.51849	.68	4.56985
.19	4.51951	.69	4.57088
55.20	4.52054	55.70	4.57191
.21	4.52157	.71	4.57293
.22	4.52260	.72	4.57396
.23	4.52362	.73	4.57499
.24	4.52465	.74	4.57601
.25	4.52568	.75	4.57704
.26	4.52671	.76	4.57807
.27	4.52773	.77	4.57910
.28	4.52876	.78	4.58012
.29	4.52979	.79	4.58115
55.30	4.53081	55.80	4.58218
.31	4.53184	.81	4.58321
.32	4.53287	.82	4.58423
.33	4.53390	.83	4.58526
.34	4.53492	.84	4.58629
.35	4.53595	.85	4.58731
.36	4.53698	.86	4.58834
.37	4.53801	.87	4.58937
.38	4.53903	.88	4.59040
.39	4.54006	.89	4.59142
55.40	4.54109	55.90	4.59245
.41	4.54211	.91	4.59348
.42	4.54314	.92	4.59451
.43	4.54417	.93	4.59553
.44	4.54520	.94	4.59656
.45	4.54622	.95	4.59759
.46	4.54725	.96	4.59861
.47	4.54828	.97	4.59964
.48	4.54931	.98	4.60067
.49	4.55033	.99	4.60170

OLD RANGE-VERMILION BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
56.00	$4.60272	56.50	$4.65909
.01	4.60385	.51	4.66021
.02	4.60498	.52	4.66134
.03	4.60611	.53	4.66247
.04	4.60723	.54	4.66360
.05	4.60836	.55	4.66472
.06	4.60949	.56	4.66585
.07	4.61061	.57	4.66698
.08	4.61174	.58	4.66811
.09	4.61287	.59	4.66923
56.10	4.61400	56.60	4.67036
.11	4.61512	.61	4.67149
.12	4.61625	.62	4.67261
.13	4.61738	.63	4.67374
.14	4.61851	.64	4.67487
.15	4.61963	.65	4.67600
.16	4.62076	.66	4.67712
.17	4.62189	.67	4.67825
.18	4.62301	.48	4.67938
.19	4.62414	.69	4.68051
56.20	4.62527	56.70	4.68163
.21	4.62640	.71	4.68276
.22	4.62752	.72	4.68389
.23	4.62865	.73	4.68501
.24	4.62978	.74	4.68614
.25	4.63091	.75	4.68727
.26	4.63203	.76	4.68840
.27	4.63316	.77	4.68952
.28	4.63429	.78	4.69065
.29	4.63541	.79	4.69178
56.30	4.63654	56.80	4.69291
.31	4.63767	.81	4.69403
.32	4.63880	.82	4.69516
.33	4.63992	.83	4.69629
.34	4.64105	.84	4.69741
.35	4.64218	.85	4.69854
.36	4.64331	.86	4.69967
.37	4.64443	.87	4.70080
.38	4.64556	.88	4.70192
.39	4.64669	.89	4.70305
56.40	4.64781	56.90	4.70418
.41	4.64894	.91	4.70531
.42	4.65007	.92	4.70643
.43	4.65120	.93	4.70756
.44	4.65232	.94	4.70869
.45	4.65345	.95	4.70981
.46	4.65458	.96	4.71094
.47	4.65571	.97	4.71207
.48	4.65683	.98	4.71320
.49	4.65796	.99	4.71432

OLD RANGE-VERMILION BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
57.00	$4.71545	57.50	$4.77681
.01	4.71668	.51	4.77804
.02	4.71791	.52	4.77927
.03	4.71913	.53	4.78050
.04	4.72036	.54	4.78172
.05	4.72159	.55	4.78295
.06	4.72281	.56	4.78418
.07	4.72404	.57	4.78541
.08	4.72527	.58	4.78663
.09	4.72650	.59	4.78786
57.10	4.72772	57.60	4.78909
.11	4.72895	.61	4.79031
.12	4.73018	.62	4.79154
.13	4.73141	.63	4.79277
.14	4.73263	.64	4.79400
.15	4.73386	.65	4.79522
.16	4.73509	.66	4.79645
.17	4.73631	.67	4.79768
.18	4.73754	.68	4.79891
.19	4.73877	.69	4.80013
57.20	4.74000	57.70	4.80136
.21	4.74122	.71	4.80259
.22	4.74245	.72	4.80381
.23	4.74368	.73	4.80504
.24	4.74491	.74	4.80627
.25	4.74613	.75	4.80750
.26	4.74736	.76	4.80872
.27	4.74859	.77	4.80995
.28	4.74981	.78	4.81118
.29	4.75104	.79	4.81241
57.30	4.75227	57.80	4.81363
.31	4.75350	.81	4.81486
.32	4.75472	.82	4.81609
.33	4.75595	.83	4.81731
.34	4.75718	.84	4.81854
.35	4.75841	.85	4.81977
.36	4.75963	.86	4.82100
.37	4.76086	.87	4.82222
.38	4.76209	.88	4.82345
.39	4.76331	.89	4.82468
57.40	4.76454	57.90	4.82591
.41	4.76577	.91	4.82713
.42	4.76700	.92	4.82836
.43	4.76822	.93	4.82959
.44	4.76945	.94	4.83081
.45	4.77068	.95	4.83204
.46	4.77191	.96	4.83327
.47	4.77313	.97	4.83450
.48	4.77436	.98	4.83572
.49	4.77559	.99	4.83695

OLD RANGE-VERMILION BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
58.00	$4.83818	58.50	$4.90454
.01	4.83951	.51	4.90587
.02	4.84083	.52	4.90720
.03	4.84216	.53	4.90852
.04	4.84349	.54	4.90985
.05	4.84481	.55	4.91118
.06	4.84614	.56	4.91251
.07	4.84747	.57	4.91383
.08	4.84880	.58	4.91516
.09	4.85012	.59	4.91649
58.10	4.85145	58.60	4.91781
.11	4.85278	.61	4.91914
.12	4.85411	.62	4.92047
.13	4.85543	.63	4.92180
.14	4.85676	.64	4.92312
.15	4.85809	.65	4.92445
.16	4.85941	.66	4.92578
.17	4.86074	.67	4.92711
.18	4.86207	.68	4.92843
.19	4.86340	.69	4.92976
58.20	4.86472	58.70	4.93109
.21	4.86605	.71	4.93241
.22	4.86738	.72	4.93374
.23	4.86871	.73	4.93507
.24	4.87003	.74	4.93640
.25	4.87136	.75	4.93772
.26	4.87269	.76	4.93905
.27	4.87401	.77	4.94038
.28	4.87534	.78	4.94171
.29	4.87667	.79	4.94303
58.30	4.87800	58.80	4.94436
.31	4.87932	.81	4.94569
.32	4.88065	.82	4.94701
.33	4.88198	.83	4.94834
.34	4.88331	.84	4.94967
.35	4.88463	.85	4.95100
.36	4.88596	.86	4.95232
.37	4.88729	.87	4.95365
.38	4.88861	.88	4.95498
.39	4.88994	.89	4.95631
58.40	4.89127	58.90	4.95763
.41	4.89260	.91	4.95896
.42	4.89392	.92	4.96029
.43	4.89525	.93	4.96161
.44	4.89658	.94	4.96294
.45	4.89791	.95	4.96427
.46	4.89923	.96	4.96560
.47	4.90056	.97	4.96692
.48	4.90189	.98	4.96825
.49	4.90321	.99	4.96958

OLD RANGE-VERMILION BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
59.00	$4.97091	59.50	$5.04227
.01	4.97233	.51	5.04370
.02	4.97376	.52	5.04512
.03	4.97519	.53	5.04655
.04	4.97661	.54	5.04798
.05	4.97804	.55	5.04941
.06	4.97947	.56	5.05083
.07	4.98090	.57	5.05226
.08	4.98232	.58	5.05369
.09	4.98375	.59	5.05511
59.10	4.98518	59.60	5.05654
.11	4.98661	.61	5.05797
.12	4.98803	.62	5.05940
.13	4.98946	.63	5.06082
.14	4.99089	.64	5.06225
.15	4.99231	.65	5.06368
.16	4.99374	.66	5.06511
.17	4.99517	.67	5.06653
.18	4.99660	.68	5.06796
.19	4.99802	.69	5.06939
59.20	4.99945	59.70	5.07081
.21	5.00088	.71	5.07224
.22	5.00231	.72	5.07367
.23	5.00373	.73	5.07510
.24	5.00516	.74	5.07652
.25	5.00659	.75	5.07795
.26	5.00801	.76	5.07938
.27	5.00944	.77	5.08081
.28	5.01087	.78	5.08223
.29	5.01230	.79	5.08366
59.30	5.01372	59.80	5.08509
.31	5.01515	.81	5.08651
.32	5.01658	.82	5.08794
.33	5.01801	.83	5.08937
.34	5.01943	.84	5.09080
.35	5.02086	.85	5.09222
.36	5.02229	.86	5.09365
.37	5.02371	.87	5.09508
.38	5.02514	.88	5.09651
.39	5.02657	.89	5.09793
59.40	5.02800	59.90	5.09936
.41	5.02942	.91	5.10079
.42	5.03085	.92	5.10221
.43	5.03228	.93	5.10364
.44	5.03371	.94	5.10507
.45	5.03513	.95	5.10650
.46	5.03656	.96	5.10792
.47	5.03799	.97	5.10935
.48	5.03941	.98	5.11078
.49	5.04084	.99	5.11221

OLD RANGE-VERMILION BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
60.00	$5.11363	60.50	$5.16000
.01	5.11456	.51	5.16092
.02	5.11549	.52	5.16185
.03	5.11641	.53	5.16278
.04	5.11734	.54	5.16371
.05	5.11827	.55	5.16463
.06	5.11920	.56	5.16556
.07	5.12012	.57	5.16649
.08	5.12105	.58	5.16741
.09	5.12198	.59	5.16834
60.10	5.12291	60.60	5.16927
.11	5.12383	.61	5.17020
.12	5.12476	.62	5.17112
.13	5.12569	.63	5.17205
.14	5.12661	.64	5.17298
.15	5.12754	.65	5.17391
.16	5.12847	.66	5.17483
.17	5.12940	.67	5.17576
.18	5.13032	.68	5.17669
.19	5.13125	.69	5.17761
60.20	5.13218	60.70	5.17854
.21	5.13311	.71	5.17947
.22	5.13403	.72	5.18040
.23	5.13496	.73	5.18132
.24	5.13589	.74	5.18225
.25	5.13681	.75	5.18318
.26	5.13774	.76	5.18411
.27	5.13867	.77	5.18503
.28	5.13960	.78	5.18596
.29	5.14052	.79	5.18689
60.30	5.14145	60.80	5.18781
.31	5.14238	.81	5.18874
.32	5.14331	.82	5.18967
.33	5.14423	.83	5.19060
.34	5.14516	.84	5.19152
.35	5.14609	.85	5.19245
.36	5.14701	.86	5.19338
.37	5.14794	.87	5.19431
.38	5.14887	.88	5.19523
.39	5.14980	.89	5.19616
60.40	5.15072	60.90	5.19709
.41	5.15165	.91	5.19801
.42	5.15258	.92	5.19894
.43	5.15351	.93	5.19987
.44	5.15443	.94	5.20080
.45	5.15536	.95	5.20172
.46	5.15629	.96	5.20265
.47	5.15721	.97	5.20358
.48	5.15814	.98	5.20451
.49	5.15907	.99	5.20543

OLD RANGE-VERMILION BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
61.00	$5.20636	61.50	$5.25272
.01	5.20729	.51	5.25365
.02	5.20821	.52	5.25458
.03	5.20914	.53	5.25551
.04	5.21007	.54	5.25643
.05	5.21100	.55	5.25736
.06	5.21192	.56	5.25829
.07	5.21285	.57	5.25921
.08	5.21378	.58	5.26014
.09	5.21471	.59	5.26107
61.10	5.21563	61.60	5.26200
.11	5.21656	.61	5.26292
.12	5.21749	.62	5.26385
.13	5.21841	.63	5.26478
.14	5.21934	.64	5.26571
.15	5.22027	.65	5.26663
.16	5.22120	.66	5.26756
.17	5.22212	.67	5.26849
.18	5.22305	.68	5.26941
.19	5.22398	.69	5.27034
61.20	5.22491	61.70	5.27127
.21	5.22583	.71	5.27220
.22	5.22676	.72	5.27312
.23	5.22769	.73	5.27405
.24	5.22861	.74	5.27498
.25	5.22954	.75	5.27591
.26	5.23047	.76	5.27683
.27	5.23140	.77	5.27776
.28	5.23232	.78	5.27869
.29	5.23325	.79	5.27961
61.30	5.23418	61.80	5.28054
.31	5.23511	.81	5.28147
.32	5.23603	.82	5.28240
.33	5.23696	.83	5.28332
.34	5.23789	.84	5.28425
.35	5.23881	.85	5.28518
.36	5.23974	.86	5.28611
.37	5.24067	.87	5.28703
.38	5.24160	.88	5.28796
.39	5.24252	.89	5.28889
61.40	5.24345	61.90	5.28981
.41	5.24438	.91	5.29074
.42	5.24531	.92	5.29167
.43	5.24623	.93	5.29260
.44	5.24716	.94	5.29352
.45	5.24809	.95	5.29445
.46	5.24901	.96	5.29538
.47	5.24994	.97	5.29631
.48	5.25087	.98	5.29723
.49	5.25180	.99	5.29816

MESABA BESSEMER

NATURAL IRON ORE

LAKE ERIE PRICES

1911

17 TABLES

45 PER CENT TO 61 PER CENT
INCLUSIVE

COMPILED BY
RUKARD HURD

MESABA BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
45.00	$2.97136	45.50	$3.05954
.01	2.97312	.51	3.06130
.02	2.97489	.52	3.06307
.03	2.97665	.53	3.06483
.04	2.97841	.54	3.06659
.05	2.98018	.55	3.06836
.06	2.98194	.56	3.07012
.07	2.98370	.57	3.07189
.08	2.98547	.58	3.07365
.09	2.98723	.59	3.07541
45.10	2.98899	45.60	3.07718
.11	2.99076	.61	3.07894
.12	2.99252	.62	3.08070
.13	2.99429	.63	3.08247
.14	2.99605	.64	3.08423
.15	2.99781	.65	3.08599
.16	2.99958	.66	3.08776
.17	3.00134	.67	3.08952
.18	3.00310	.68	3.09129
.19	3.00487	.69	3.09305
45.20	3.00663	45.70	3.09481
.21	3.00839	.71	3.09658
.22	3.01016	.72	3.09834
.23	3.01192	.73	3.10010
.24	3.01369	.74	3.10187
.25	3.01545	.75	3.10363
.26	3.01721	.76	3.10539
.27	3.01898	.77	3.10716
.28	3.02074	.78	3.10892
.29	3.02250	.79	3.11069
45.30	3.02427	45.80	3.11245
.31	3.02603	.81	3.11421
.32	3.02779	.82	3.11598
.33	3.02956	.83	3.11774
.34	3.03132	.84	3.11950
.35	3.03309	.85	3.12127
.36	3.03485	.86	3.12303
.37	3.03661	.87	3.12479
.38	3.03838	.88	3.12656
.39	3.04014	.89	3.12832
45.40	3.04190	45.90	3.13009
.41	3.04367	.91	3.13185
.42	3.04543	.92	3.13361
.43	3.04719	.93	3.13538
.44	3.04896	.94	3.13714
.45	3.05072	.95	3.13890
.46	3.05249	.96	3.14067
.47	3.05425	.97	3.14243
.48	3.05601	.98	3.14419
.49	3.05778	.99	3.14596

MESABA BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
46.00	$3.14772	46.50	$3.23590
.01	3.14949	.51	3.23767
.02	3.15125	.52	3.23943
.03	3.15301	.53	3.24119
.04	3.15478	.54	3.24296
.05	3.15654	.55	3.24472
.06	3.15830	.56	3.24649
.07	3.16007	.57	3.24825
.08	3.16183	.58	3.25001
.09	3.16359	.59	3.25178
46.10	3.16536	46.60	3.25354
.11	3.16712	.61	3.25530
.12	3.16889	.62	3.25707
.13	3.17065	.63	3.25883
.14	3.17241	.64	3.26059
.15	3.17418	.65	3.26236
.16	3.17594	.66	3.26412
.17	3.17770	.67	3.26589
.18	3.17947	.68	3.26765
.19	3.18123	.69	3.26941
46.20	3.18299	46.70	3.27118
.21	3.18476	.71	3.27294
.22	3.18652	.72	3.27470
.23	3.18829	.73	3.27647
.24	3.19005	.74	3.27823
.25	3.19181	.75	3.27999
.26	3.19358	.76	3.28176
.27	3.19534	.77	3.28352
.28	3.19710	.78	3.28529
.29	3.19887	.79	3.28705
46.30	3.20063	46.80	3.28881
.31	3.20239	.81	3.29058
.32	3.20416	.82	3.29234
.33	3.20592	.83	3.29410
.34	3.20769	.84	3.29587
.35	3.20945	.85	3.29763
.36	3.21121	.86	3.29939
.37	3.21298	.87	3.30116
.38	3.21474	.88	3.30292
.39	3.21650	.89	3.30469
46.40	3.21827	46.90	3.30645
.41	3.22003	.91	3.30821
.42	3.22179	.92	3.30998
.43	3.22356	.93	3.31174
.44	3.22532	.94	3.31350
.45	3.22709	.95	3.31527
.46	3.22885	.96	3.31703
.47	3.23061	.97	3.31879
.48	3.23238	.98	3.32056
.49	3.23414	.99	3.32232

MESABA BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
47.00	$3.32409	47.50	$3.41227
.01	3.32585	.51	3.41403
.02	3.32761	.52	3.41579
.03	3.32938	.53	3.41756
.04	3.33114	.54	3.41932
.05	3.33290	.55	3.42109
.06	3.33467	.56	3.42285
.07	3.33643	.57	3.42461
.08	3.33819	.58	3.42638
.09	3.33996	.59	3.42814
47.10	3.34172	47.60	3.42990
.11	3.34349	.61	3.43167
.12	3.34525	.62	3.43343
.13	3.34701	.63	3.43519
.14	3.34878	.64	3.43696
.15	3.35054	.65	3.43872
.16	3.35230	.66	3.44049
.17	3.35407	.67	3.44225
.18	3.35583	.68	3.44401
.19	3.35759	.69	3.44578
47.20	3.35936	47.70	3.44754
.21	3.36112	.71	3.44930
.22	3.36289	.72	3.45107
.23	3.36465	.73	3.45283
.24	3.36641	.74	3.45459
.25	3.36818	.75	3.45636
.26	3.36994	.76	3.45812
.27	3.37170	.77	3.45989
.28	3.37347	.78	3.46165
.29	3.37523	.79	3.46341
47.30	3.37699	47.80	3.46518
.31	3.37876	.81	3.46694
.32	3.38052	.82	3.46870
.33	3.38229	.83	3.47047
.34	3.38405	.84	3.47223
.35	3.38581	.85	3.47399
.36	3.38758	.86	3.47576
.37	3.38934	.87	3.47752
.38	3.39110	.88	3.47929
.39	3.39287	.89	3.48105
47.40	3.39463	47.90	3.48281
.41	3.39639	.91	3.48458
.42	3.39816	.92	3.48634
.43	3.39992	.93	3.48810
.44	3.40169	.94	3.48987
.45	3.40345	.95	3.49163
.46	3.40521	.96	3.49339
.47	3.40698	.97	3.49516
.48	3.40874	.98	3.49692
.49	3.41050	.99	3.49869

MESABA BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
48.00	$3.50045	48.50	$3.58863
.01	3.50221	.51	3.59039
.02	3.50398	.52	3.59216
.03	3.50574	.53	3.59392
.04	3.50750	.54	3.59569
.05	3.50927	.55	3.59745
.06	3.51103	.56	3.59921
.07	3.51279	.57	3.60098
.08	3.51456	.58	3.60274
.09	3.51632	.59	3.60450
48.10	3.51809	48.60	3.60627
.11	3.51985	.61	3.60803
.12	3.52161	.62	3.60979
.13	3.52338	.63	3.61156
.14	3.52514	.64	3.61332
.15	3.52690	.65	3.61509
.16	3.52867	.66	3.61685
.17	3.53043	.67	3.61861
.18	3.53219	.68	3.62038
.19	3.53396	.69	3.62214
48.20	3.53572	48.70	3.62390
.21	3.53749	.71	3.62567
.22	3.53925	.72	3.62743
.23	3.54101	.73	3.62919
.24	3.54278	.74	3.63096
.25	3.54454	.75	3.63272
.26	3.54630	.76	3.63449
.27	3.54807	.77	3.63625
.28	3.54983	.78	3.63801
.29	3.55159	.79	3.63978
48.30	3.55336	48.80	3.64154
.31	3.55512	.81	3.64330
.32	3.55689	.82	3.64507
.33	3.55865	.83	3.64683
.34	3.56041	.84	3.64859
.35	3.56218	.85	3.65036
.36	3.56394	.86	3.65212
.37	3.56570	.87	3.65389
.38	3.56747	.88	3.65565
.39	3.56923	.89	3.65741
48.40	3.57099	48.90	3.65918
.41	3.57276	.91	3.66094
.42	3.57452	.92	3.66270
.43	3.57629	.93	3.66447
.44	3.57805	.94	3.66623
.45	3.57981	.95	3.66799
.46	3.58158	.96	3.66976
.47	3.58334	.97	3.67152
.48	3.58510	.98	3.67329
.49	3.58687	.99	3.67505

MESABA BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
49.00	$3.67681	49.50	$3.74295
.01	3.67814	.51	3.74427
.02	3.67946	.52	3.74559
.03	3.68078	.53	3.74692
.04	3.68210	.54	3.74824
.05	3.68343	.55	3.74956
.06	3.68475	.56	3.75089
.07	3.68607	.57	3.75221
.08	3.68739	.58	3.75353
.09	3.68872	.59	3.75485
49.10	3.69004	49.60	3.75618
.11	3.69136	.61	3.75750
.12	3.69269	.62	3.75882
.13	3.69401	.63	3.76014
.14	3.69533	.64	3.76147
.15	3.69665	.65	3.76279
.16	3.69798	.66	3.76411
.17	3.69930	.67	3.76544
.18	3.70062	.68	3.76676
.19	3.70194	.69	3.76808
49.20	3.70327	49.70	3.76940
.21	3.70459	.71	3.77073
.22	3.70591	.72	3.77205
.23	3.70724	.73	3.77337
.24	3.70856	.74	3.77469
.25	3.70988	.75	3.77602
.26	3.71120	.76	3.77734
.27	3.71253	.77	3.77866
.28	3.71385	.78	3.77999
.29	3.71517	.79	3.78131
49.30	3.71649	49.80	3.78263
.31	3.71782	.81	3.78395
.32	3.71914	.82	3.78528
.33	3.72046	.83	3.78660
.34	3.72179	.84	3.78792
.35	3.72311	.85	3.78924
.36	3.72443	.86	3.79057
.37	3.72575	.87	3.79189
.38	3.72708	.88	3.79321
.39	3.72840	.89	3.79454
49.40	3.72972	49.90	3.79586
.41	3.73104	.91	3.79718
.42	3.73237	.92	3.79850
.43	3.73369	.93	3.79983
.44	3.73501	.94	3.80115
.45	3.73634	.95	3.80247
.46	3.73766	.96	3.80379
.47	3.73898	.97	3.80512
.48	3.74030	.98	3.80644
.49	3.74163	.99	3.80776

MESABA BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
50.00	$3.80909	50.50	$3.85318
.01	3.80997	.51	3.85406
.02	3.81085	.52	3.85494
.03	3.81173	.53	3.85582
.04	3.81261	.54	3.85670
.05	3.81349	.55	3.85758
.06	3.81438	.56	3.85847
.07	3.81526	.57	3.85935
.08	3.81614	.58	3.86023
.09	3.81702	.59	3.86111
50.10	3.81790	50.60	3.86199
.11	3.81878	.61	3.86288
.12	3.81967	.62	3.86376
.13	3.82055	.63	3.86464
.14	3.82143	.64	3.86552
.15	3.82231	.65	3.86640
.16	3.82319	.66	3.86728
.17	3.82408	.67	3.86817
.18	3.82496	.68	3.86905
.19	3.82584	.69	3.86993
50.20	3.82672	50.70	3.87081
.21	3.82760	.71	3.87169
.22	3.82848	.72	3.87258
.23	3.82937	.73	3.87346
.24	3.83025	.74	3.87434
.25	3.83113	.75	3.87522
.26	3.83201	.76	3.87610
.27	3.83289	.77	3.87698
.28	3.83378	.78	3.87787
.29	3.83466	.79	3.87875
50.30	3.83554	50.80	3.87963
.31	3.83642	.81	3.88051
.32	3.83730	.82	3.88139
.33	3.83818	.83	3.88228
.34	3.83907	.84	3.88316
.35	3.83995	.85	3.88404
.36	3.84083	.86	3.88492
.37	3.84171	.87	3.88580
.38	3.84259	.88	3.88668
.39	3.84348	.89	3.88757
50.40	3.84436	50.90	3.88845
.41	3.84524	.91	3.88933
.42	3.84612	.92	3.89021
.43	3.84700	.93	3.89109
.44	3.84788	.94	3.89198
.45	3.84877	.95	3.89286
.46	3.84965	.96	3.89374
.47	3.85053	.97	3.89462
.48	3.85141	.98	3.89550
.49	3.85229	.99	3.89638

MESABA BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
51.00	$3.89727	51.50	$3.94136
.01	3.89815	.51	3.94224
.02	3.89903	.52	3.94312
.03	3.89991	.53	3.94400
.04	3.90079	.54	3.94488
.05	3.90168	.55	3.94577
.06	3.90256	.56	3.94665
.07	3.90344	.57	3.94753
.08	3.90432	.58	3.94841
.09	3.90520	.59	3.94929
51.10	3.90608	51.60	3.95018
.11	3.90697	.61	3.95106
.12	3.90785	.62	3.95194
.13	3.90873	.63	3.95282
.14	3.90961	.64	3.95370
.15	3.91049	.65	3.95458
.16	3.91138	.66	3.95547
.17	3.91226	.67	3.95635
.18	3.91314	.68	3.95723
.19	3.91402	.69	3.95811
51.20	3.91490	51.70	3.95899
.21	3.91578	.71	3.95988
.22	3.91667	.72	3.96076
.23	3.91755	.73	3.96164
.24	3.91843	.74	3.96252
.25	3.91931	.75	3.96340
.26	3.92019	.76	3.96428
.27	3.92108	.77	3.96517
.28	3.92196	.78	3.96605
.29	3.92284	.79	3.96693
51.30	3.92372	51.80	3.96781
.31	3.92460	.81	3.96869
.32	3.92548	.82	3.96958
.33	3.92637	.83	3.97046
.34	3.92725	.84	3.97134
.35	3.92813	.85	3.97222
.36	3.92901	.86	3.97310
.37	3.92989	.87	3.97398
.38	3.93078	.88	3.97487
.39	3.93166	.89	3.97575
51.40	3.93254	51.90	3.97663
.41	3.93342	.91	3.97751
.42	3.93430	.92	3.97839
.43	3.93518	.93	3.97928
.44	3.93607	.94	3.98016
.45	3.93695	.95	3.98104
.46	3.93783	.96	3.98192
.47	3.93871	.97	3.98280
.48	3.93959	.98	3.98368
.49	3.94048	.99	3.98457

MESABA BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
52.00	$3.98545	52.50	$4.02954
.01	3.98633	.51	4.03042
.02	3.98721	.52	4.03130
.03	3.98809	.53	4.03218
.04	3.98898	.54	4.03307
.05	3.98986	.55	4.03395
.06	3.99074	.56	4.03483
.07	3.99162	.57	4.03571
.08	3.99250	.58	4.03659
.09	3.99338	.59	4.03748
52.10	3.99427	52.60	4.03836
.11	3.99515	.61	4.03924
.12	3.99603	.62	4.04012
.13	3.99691	.63	4.04100
.14	3.99779	.64	4.04188
.15	3.99868	.65	4.04277
.16	3.99956	.66	4.04365
.17	4.00044	.67	4.04453
.18	4.00132	.68	4.04541
.19	4.00220	.69	4.04629
52.20	4.00308	52.70	4.04718
.21	4.00397	.71	4.04806
.22	4.00485	.72	4.04894
.23	4.00573	.73	4.04982
.24	4.00661	.74	4.05070
.25	4.00749	.75	4.05158
.26	4.00838	.76	4.05247
.27	4.00926	.77	4.05335
.28	4.01014	.78	4.05423
.29	4.01102	.79	4.05511
52.30	4.01190	52.80	4.05599
.31	4.01278	.81	4.05688
.32	4.01367	.82	4.05776
.33	4.01455	.83	4.05864
.34	4.01543	.84	4.05952
.35	4.01631	.85	4.06040
.36	4.01719	.86	4.06128
.37	4.01808	.87	4.06217
.38	4.01896	.88	4.06305
.39	4.01984	.89	4.06393
52.40	4.02072	52.90	4.06481
.41	4.02160	.91	4.06569
.42	4.02248	.92	4.06658
.43	4.02337	.93	4.06746
.44	4.02425	.94	4.06834
.45	4.02513	.95	4.06922
.46	4.02601	.96	4.07010
.47	4.02689	.97	4.07098
.48	4.02778	.98	4.07187
.49	4.02866	.99	4.07275

MESABA BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
53.00	$4.07363	53.50	$4.11772
.01	4.07451	.51	4.11860
.02	4.07539	.52	4.11948
.03	4.07628	.53	4.12037
.04	4.07716	.54	4.12125
.05	4.07804	.55	4.12213
.06	4.07892	.56	4.12301
.07	4.07980	.57	4.12389
.08	4.08068	.58	4.12478
.09	4.08157	.59	4.12566
53.10	4.08245	53.60	4.12654
.11	4.08333	.61	4.12742
.12	4.08421	.62	4.12830
.13	4.08509	.63	4.12918
.14	4.08598	.64	4.13007
.15	4.08686	.65	4.13095
.16	4.08774	.66	4.13183
.17	4.08862	.67	4.13271
.18	4.08950	.68	4.13359
.19	4.09038	.69	4.13448
53.20	4.09127	53.70	4.13536
.21	4.09215	.71	4.13624
.22	4.09303	.72	4.13712
.23	4.09391	.73	4.13800
.24	4.09479	.74	4.13888
.25	4.09568	.75	4.13977
.26	4.09656	.76	4.14065
.27	4.09744	.77	4.14153
.28	4.09832	.78	4.14241
.29	4.09920	.79	4.14329
53.30	4.10008	53.80	4.14418
.31	4.10097	.81	4.14506
.32	4.10185	.82	4.14594
.33	4.10273	.83	4.14682
.34	4.10361	.84	4.14770
.35	4.10449	.85	4.14858
.36	4.10538	.86	4.14947
.37	4.10626	.87	4.15035
.38	4.10714	.88	4.15123
.39	4.10802	.89	4.15211
53.40	4.10890	53.90	4.15299
.41	4.10978	.91	4.15388
.42	4.11067	.92	4.15476
.43	4.11155	.93	4.15564
.44	4.11243	.94	4.15652
.45	4.11331	.95	4.15740
.46	4.11419	.96	4.15828
.47	4.11508	.97	4.15917
.48	4.11596	.98	4.16005
.49	4.11684	.99	4.16093

MESABA BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
54.00	$4.16181	54.50	$4.20590
.01	4.16269	.51	4.20678
.02	4.16358	.52	4.20767
.03	4.16446	.53	4.20855
.04	4.16534	.54	4.20943
.05	4.16622	.55	4.21031
.06	4.16710	.56	4.21119
.07	4.16798	.57	4.21208
.08	4.16887	.58	4.21296
.09	4.16975	.59	4.21384
54.10	4.17063	54.60	4.21472
.11	4.17151	.61	4.21560
.12	4.17239	.62	4.21648
.13	4.17328	.63	4.21737
.14	4.17416	.64	4.21825
.15	4.17504	.65	4.21913
.16	4.17592	.66	4.22001
.17	4.17680	.67	4.22089
.18	4.17768	.68	4.22178
.19	4.17857	.69	4.22266
54.20	4.17945	54.70	4.22354
.21	4.18033	.71	4.22442
.22	4.18121	.72	4.22530
.23	4.18209	.73	4.22618
.24	4.18298	.74	4.22707
.25	4.18386	.75	4.22795
.26	4.18474	.76	4.22883
.27	4.18562	.77	4.22971
.28	4.18650	.78	4.23059
.29	4.18738	.79	4.23148
54.30	4.18827	54.80	4.23236
.31	4.18915	.81	4.23324
.32	4.19003	.82	4.23412
.33	4.19091	.83	4.23500
.34	4.19179	.84	4.23588
.35	4.19268	.85	4.23677
.36	4.19356	.86	4.23765
.37	4.19444	.87	4.23853
.38	4.19532	.88	4.23941
.39	4.19620	.89	4.24029
54.40	4.19708	54.90	4.24118
.41	4.19797	.91	4.24206
.42	4.19885	.92	4.24294
.43	4.19973	.93	4.24382
.44	4.20061	.94	4.24470
.45	4.20149	.95	4.24558
.46	4.20238	.96	4.24647
.47	4.20326	.97	4.24735
.48	4.20414	.98	4.24823
.49	4.20502	.99	4.24911

MESABA BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
55.00	$4.24999	55.50	$4.29908
.01	4.25098	.51	4.30007
.02	4.25196	.52	4.30105
.03	4.25294	.53	4.30203
.04	4.25392	.54	4.30301
.05	4.25490	.55	4.30399
.06	4.25588	.56	4.30498
.07	4.25687	.57	4.30596
.08	4.25785	.58	4.30694
.09	4.25883	.59	4.30792
55.10	4.25981	55.60	4.30890
.11	4.26079	.61	4.30988
.12	4.26178	.62	4.31087
.13	4.26276	.63	4.31185
.14	4.26374	.64	4.31283
.15	4.26472	.65	4.31381
.16	4.26570	.66	4.31479
.17	4.26668	.67	4.31578
.18	4.26767	.68	4.31676
.19	4.26865	.69	4.31774
55.20	4.26963	55.70	4.31872
.21	4.27061	.71	4.31970
.22	4.27159	.72	4.32068
.23	4.27258	.73	4.32167
.24	4.27356	.74	4.32265
.25	4.27454	.75	4.32363
.26	4.27552	.76	4.32461
.27	4.27650	.77	4.32559
.28	4.27748	.78	4.32658
.29	4.27847	.79	4.32756
55.30	4.27945	55.80	4.32854
.31	4.28043	.81	4.32952
.32	4.28141	.82	4.33050
.33	4.28239	.83	4.33148
.34	4.28338	.84	4.33247
.35	4.28436	.85	4.33345
.36	4.28534	.86	4.33443
.37	4.28632	.87	4.33541
.38	4.28730	.88	4.33639
.39	4.28828	.89	4.33738
55.40	4.28927	55.90	4.33836
.41	4.29025	.91	4.33934
.42	4.29123	.92	4.34032
.43	4.29221	.93	4.34130
.44	4.29319	.94	4.34228
.45	4.29418	.95	4.34327
.46	4.29516	.96	4.34425
.47	4.29614	.97	4.34523
.48	4.29712	.98	4.34621
.49	4.29810	.99	4.34719

MESABA BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
56.00	$4.34818	56.50	$4.40227
.01	4.34926	.51	4.40335
.02	4.35034	.52	4.40443
.03	4.35142	.53	4.40551
.04	4.35250	.54	4.40659
.05	4.35358	.55	4.40768
.06	4.35467	.56	4.40876
.07	4.35575	.57	4.40984
.08	4.35683	.58	4.41092
.09	4.35791	.59	4.41200
56.10	4.35899	56.60	4.41308
.11	4.36008	.61	4.41417
.12	4.36116	.62	4.41525
.13	4.36224	.63	4.41633
.14	4.36332	.64	4.41741
.15	4.36440	.65	4.41849
.16	4.36548	.66	4.41958
.17	4.36657	.67	4.42066
.18	4.36765	.68	4.42174
.19	4.36873	.69	4.42282
56.20	4.36981	56.70	4.42390
.21	4.37089	.71	4.42498
.22	4.37198	.72	4.42607
.23	4.37306	.73	4.42715
.24	4.37414	.74	4.42823
.25	4.37522	.75	4.42931
.26	4.37630	.76	4.43039
.27	4.37738	.77	4.43148
.28	4.37847	.78	4.43256
.29	4.37955	.79	4.43364
56.30	4.38063	56.80	4.43472
.31	4.38171	.81	4.43580
.32	4.38279	.82	4.43688
.33	4.38388	.83	4.43797
.34	4.38496	.84	4.43905
.35	4.38604	.85	4.44013
.36	4.38712	.86	4.44121
.37	4.38820	.87	4.44229
.38	4.38928	.88	4.44338
.39	4.39037	.89	4.44446
56.40	4.39145	56.90	4.44554
.41	4.39253	.91	4.44662
.42	4.39361	.92	4.44770
.43	4.39469	.93	4.44878
.44	4.39578	.94	4.44987
.45	4.39686	.95	4.45095
.46	4.39794	.96	4.45203
.47	4.39902	.97	4.45311
.48	4.40010	.98	4.45419
.49	4.40118	.99	4.45528

MESABA BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
57.00	$4.45636	57.50	$4.51545
.01	4.45754	.51	4.51663
.02	4.45872	.52	4.51781
.03	4.45990	.53	4.51899
.04	4.46108	.54	4.52018
.05	4.46227	.55	4.52136
.06	4.46345	.56	4.52254
.07	4.46463	.57	4.52372
.08	4.46581	.58	4.52490
.09	4.46699	.59	4.52608
57.10	4.46818	57.60	4.52727
.11	4.46936	.61	4.52845
.12	4.47054	.62	4.52963
.13	4.47172	.63	4.53081
.14	4.47290	.64	4.53199
.15	4.47408	.65	4.53318
.16	4.47527	.66	4.53436
.17	4.47645	.67	4.53554
.18	4.47763	.68	4.53672
.19	4.47881	.69	4.53790
57.20	4.47999	57.70	4.53908
.21	4.48118	.71	4.54027
.22	4.48236	.72	4.54145
.23	4.48354	.73	4.54263
.24	4.48472	.74	4.54381
.25	4.48590	.75	4.54499
.26	4.48708	.76	4.54618
.27	4.48827	.77	4.54736
.28	4.48945	.78	4.54854
.29	4.49063	.79	4.54972
57.30	4.49181	57.80	4.55090
.31	4.49299	.81	4.55208
.32	4.49418	.82	4.55327
.33	4.49536	.83	4.55445
.34	4.49654	.84	4.55563
.35	4.49772	.85	4.55681
.36	4.49890	.86	4.55799
.37	4.50008	.87	4.55918
.38	4.50127	.88	4.56036
.39	4.50245	.89	4.56154
57.40	4.50363	57.90	4.56272
.41	4.50481	.91	4.56390
.42	4.50599	.92	4.56508
.43	4.50718	.93	4.56627
.44	4.50836	.94	4.56745
.45	4.50954	.95	4.56863
.46	4.51072	.96	4.56981
.47	4.51190	.97	4.57099
.48	4.51308	.98	4.57218
.49	4.51427	.99	4.57336

MESABA BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
58.00	$4.57454	58.50	$4.63863
.01	4.57582	.51	4.63991
.02	4.57710	.52	4.64119
.03	4.57838	.53	4.64248
.04	4.57967	.54	4.64376
.05	4.58095	.55	4.64504
.06	4.58223	.56	4.64632
.07	4.58351	.57	4.64760
.08	4.58479	.58	4.64888
.09	4.58608	.59	4.65017
58.10	4.58736	58.60	4.65145
.11	4.58864	.61	4.65273
.12	4.58992	.62	4.65401
.13	4.59120	.63	4.65529
.14	4.59248	.64	4.65658
.15	4.59377	.65	4.65786
.16	4.59505	.66	4.65914
.17	4.59633	.67	4.66042
.18	4.59761	.68	4.66170
.19	4.59889	.69	4.66298
58.20	4.60018	58.70	4.66427
.21	4.60146	.71	4.66555
.22	4.60274	.72	4.66683
.23	4.60402	.73	4.66811
.24	4.60530	.74	4.66939
.25	4.60658	.75	4.67068
.26	4.60787	.76	4.67196
.27	4.60915	.77	4.67324
.28	4.61043	.78	4.67452
.29	4.61171	.79	4.67580
58.30	4.61299	58.80	4.67708
.31	4.61428	.81	4.67837
.32	4.61556	.82	4.67965
.33	4.61684	.83	4.68093
.34	4.61812	.84	4.68221
.35	4.61940	.85	4.68349
.36	4.62068	.86	4.68478
.37	4.62197	.87	4.68606
.38	4.62325	.88	4.68734
.39	4.62453	.89	4.68862
58.40	4.62581	58.90	4.68990
.41	4.62709	.91	4.69118
.42	4.62838	.92	4.69247
.43	4.62966	.93	4.69375
.44	4.63094	.94	4.69503
.45	4.63222	.95	4.69631
.46	4.63350	.96	4.69759
.47	4.63478	.97	4.69888
.48	4.63607	.98	4.70016
.49	4.63735	.99	4.70144

MESABA BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
59.00	$4.70272	59.50	$4.77181
.01	4.70410	.51	4.77319
.02	4.70548	.52	4.77458
.03	4.70687	.53	4.77596
.04	4.70825	.54	4.77734
.05	4.70963	.55	4.77872
.06	4.71101	.56	4.78010
.07	4.71239	.57	4.78148
.08	4.71378	.58	4.78287
.09	4.71516	.59	4.78425
59.10	4.71654	59.60	4.78563
.11	4.71792	.61	4.78701
.12	4.71930	.62	4.78839
.13	4.72068	.63	4.78978
.14	4.72207	.64	4.79116
.15	4.72345	.65	4.79254
.16	4.72483	.66	4.79392
.17	4.72621	.67	4.79530
.18	4.72759	.68	4.79668
.19	4.72898	.69	4.79807
59.20	4.73036	59.70	4.79945
.21	4.73174	.71	4.80083
.22	4.73312	.72	4.80221
.23	4.73450	.73	4.80359
.24	4.73588	.74	4.80498
.25	4.73727	.75	4.80636
.26	4.73865	.76	4.80774
.27	4.74003	.77	4.80912
.28	4.74141	.78	4.81050
.29	4.74279	.79	4.81188
59.30	4.74418	59.80	4.81327
.31	4.74556	.81	4.81465
.32	4.74694	.82	4.81603
.33	4.74832	.83	4.81741
.34	4.74970	.84	4.81879
.35	4.75108	.85	4.82018
.36	4.75247	.86	4.82156
.37	4.75385	.87	4.82294
.38	4.75523	.88	4.82432
.39	4.75661	.89	4.82570
59.40	4.75799	59.90	4.82708
.41	4.75938	.91	4.82847
.42	4.76076	.92	4.82985
.43	4.76214	.93	4.83123
.44	4.76352	.94	4.83261
.45	4.76490	.95	4.83399
.46	4.76628	.96	4.83538
.47	4.76767	.97	4.83676
.48	4.76905	.98	4.83814
.49	4.77043	.99	4.83952

MESABA BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
60.00	$4.84090	60.50	$4.88499
.01	4.84178	.51	4.88588
.02	4.84267	.52	4.88676
.03	4.84355	.53	4.88764
.04	4.84443	.54	4.88852
.05	4.84531	.55	4.88940
.06	4.84619	.56	4.89028
.07	4.84708	.57	4.89117
.08	4.84796	.58	4.89205
.09	4.84884	.59	4.89293
60.10	4.84972	60.60	4.89381
.11	4.85060	.61	4.89469
.12	4.85148	.62	4.89558
.13	4.85237	.63	4.89646
.14	4.85325	.64	4.89734
.15	4.85413	.65	4.89822
.16	4.85501	.66	4.89910
.17	4.85589	.67	4.89998
.18	4.85678	.68	4.90087
.19	4.85766	.69	4.90175
60.20	4.85854	60.70	4.90263
.21	4.85942	.71	4.90351
.22	4.86030	.72	4.90439
.23	4.86118	.73	4.90528
.24	4.86207	.74	4.90616
.25	4.86295	.75	4.90704
.26	4.86383	.76	4.90792
.27	4.86471	.77	4.90880
.28	4.86559	.78	4.90968
.29	4.86648	.79	4.91057
60.30	4.86736	60.80	4.91145
.31	4.86824	.81	4.91233
.32	4.86912	.82	4.91321
.33	4.87000	.83	4.91409
.34	4.87088	.84	4.91498
.35	4.87177	.85	4.91586
.36	4.87265	.86	4.91674
.37	4.87353	.87	4.91762
.38	4.87441	.88	4.91850
.39	4.87529	.89	4.91938
60.40	4.87618	60.90	4.92027
.41	4.87706	.91	4.92115
.42	4.87794	.92	4.92203
.43	4.87882	.93	4.92291
.44	4.87970	.94	4.92379
.45	4.88058	.95	4.92468
.46	4.88147	.96	4.92556
.47	4.88235	.97	4.92644
.48	4.88323	.98	4.92732
.49	4.88411	.99	4.92820

MESABA BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
61.00	$4.92908	61.50	$4.97318
.01	4.92997	.51	4.97406
.02	4.93085	.52	4.97494
.03	4.93173	.53	4.97582
.04	4.93261	.54	4.97670
.05	4.93349	.55	4.97758
.06	4.93438	.56	4.97847
.07	4.93526	.57	4.97935
.08	4.93614	.58	4.98023
.09	4.93702	.59	4.98111
61.10	4.93790	61.60	4.98199
.11	4.93878	.61	4.98288
.12	4.93967	.62	4.98376
.13	4.94055	.63	4.98464
.14	4.94143	.64	4.98552
.15	4.94231	.65	4.98640
.16	4.94319	.66	4.98728
.17	4.94408	.67	4.98817
.18	4.94496	.68	4.98905
.19	4.94584	.69	4.98993
61.20	4.94672	61.70	4.99081
.21	4.94760	.71	4.99169
.22	4.94848	.72	4.99258
.23	4.94937	.73	4.99346
.24	4.95025	.74	4.99434
.25	4.95113	.75	4.99522
.26	4.95201	.76	4.99610
.27	4.95289	.77	4.99698
.28	4.95378	.78	4.99787
.29	4.95466	.79	4.99875
61.30	4.95554	61.80	4.99963
.31	4.95642	.81	5.00051
.32	4.95730	.82	5.00139
.33	4.95818	.83	5.00228
.34	4.95907	.84	5.00316
.35	4.95995	.85	5.00404
.36	4.96083	.86	5.00492
.37	4.96171	.87	5.00580
.38	4.96259	.88	5.00668
.39	4.96348	.89	5.00757
61.40	4.96436	61.90	5.00845
.41	4.96524	.91	5.00933
.42	4.96612	.92	5.01021
.43	4.96700	.93	5.01109
.44	4.96788	.94	5.01198
.45	4.96877	.95	5.01286
.46	4.96965	.96	5.01374
.47	4.97053	.97	5.01462
.48	4.97141	.98	5.01550
.49	4.97229	.99	5.01638

OLD RANGE-VERMILION NON-BESSEMER

NATURAL IRON ORE

LAKE ERIE PRICES

1911

16 TABLES

45 PER CENT TO 60 PER CENT
INCLUSIVE

COMPILED BY
RUKARD HURD

OLD RANGE-VERMILION NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
45.00	$2.78155	45.50	$2.86504
.01	2.78322	.51	2.86671
.02	2.78489	.52	2.86838
.03	2.78656	.53	2.87005
.04	2.78823	.54	2.87172
.05	2.78990	.55	2.87339
.06	2.79157	.56	2.87506
.07	2.79324	.57	2.87673
.08	2.79491	.58	2.87840
.09	2.79658	.59	2.88007
45.10	2.79825	45.60	2.88174
.11	2.79992	.61	2.88341
.12	2.80159	.62	2.88508
.13	2.80326	.63	2.88675
.14	2.80493	.64	2.88842
.15	2.80660	.65	2.89009
.16	2.80827	.66	2.89176
.17	2.80993	.67	2.89343
.18	2.81160	.68	2.89510
.19	2.81327	.69	2.89677
45.20	2.81494	45.70	2.89844
.21	2.81661	.71	2.90011
.22	2.81828	.72	2.90178
.23	2.81995	.73	2.90345
.24	2.82162	.74	2.90512
.25	2.82329	.75	2.90679
.26	2.82496	.76	2.90846
.27	2.82663	.77	2.91013
.28	2.82830	.78	2.91180
.29	2.82997	.79	2.91347
45.30	2.83164	45.80	2.91514
.31	2.83331	.81	2.91681
.32	2.83498	.82	2.91848
.33	2.83665	.83	2.92015
.34	2.83832	.84	2.92182
.35	2.83999	.85	2.92349
.36	2.84166	.86	2.92516
.37	2.84333	.87	2.92683
.38	2.84500	.88	2.92850
.39	2.84667	.89	2.93017
45.40	2.84834	45.90	2.93184
.41	2.85001	.91	2.93351
.42	2.85168	.92	2.93518
.43	2.85335	.93	2.93685
.44	2.85502	.94	2.93852
.45	2.85669	.95	2.94019
.46	2.85836	.96	2.94186
.47	2.86003	.97	2.94353
.48	2.86170	.98	2.94520
.49	2.86337	.99	2.94687

OLD RANGE-VERMILION NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
46.00	$2.94854	46.50	$3.03203
.01	2.95021	.51	3.03370
.02	2.95188	.52	3.03537
.03	2.95355	.53	3.03704
.04	2.95522	.54	3.03871
.05	2.95689	.55	3.04038
.06	2.95856	.56	3.04205
.07	2.96023	.57	3.04372
.08	2.96190	.58	3.04539
.09	2.96357	.59	3.04706
46.10	2.96524	46.60	3.04873
.11	2.96691	.61	3.05040
.12	2.96858	.62	3.05207
.13	2.97025	.63	3.05374
.14	2.97192	.64	3.05541
.15	2.97359	.65	3.05708
.16	2.97526	.66	3.05875
.17	2.97693	.67	3.06042
.18	2.97860	.68	3.06209
.19	2.98026	.69	3.06376
46.20	2.98193	46.70	3.06543
.21	2.98360	.71	3.06710
.22	2.98527	.72	3.06877
.23	2.98694	.73	3.07044
.24	2.98861	.74	3.07211
.25	2.99028	.75	3.07378
.26	2.99195	.76	3.07545
.27	2.99362	.77	3.07712
.28	2.99529	.78	3.07879
.29	2.99696	.79	3.08046
46.30	2.99863	46.80	3.08213
.31	3.00030	.81	3.08380
.32	3.00197	.82	3.08547
.33	3.00364	.83	3.08714
.34	3.00531	.84	3.08881
.35	3.00698	.85	3.09048
.36	3.00865	.86	3.09215
.37	3.01032	.87	3.09382
.38	3.01199	.88	3.09549
.39	3.01366	.89	3.09716
46.40	3.01533	46.90	3.09883
.41	3.01700	.91	3.10050
.42	3.01867	.92	3.10217
.43	3.02034	.93	3.10384
.44	3.02201	.94	3.10551
.45	3.02368	.95	3.10718
.46	3.02535	.96	3.10885
.47	3.02702	.97	3.11052
.48	3.02869	.98	3.11219
.49	3.03036	.99	3.11386

OLD RANGE-VERMILION NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
47.00	$3.11553	47.50	$3.19902
.01	3.11720	.51	3.20069
.02	3.11887	.52	3.20236
.03	3.12054	.53	3.20403
.04	3.12221	.54	3.20570
.05	3.12388	.55	3.20737
.06	3.12555	.56	3.20904
.07	3.12722	.57	3.21071
.08	3.12889	.58	3.21238
.09	3.13056	.59	3.21405
47.10	3.13223	47.60	3.21572
.11	3.13390	.61	3.21739
.12	3.13557	.62	3.21906
.13	3.13724	.63	3.22073
.14	3.13891	.64	3.22240
.15	3.14058	.65	3.22407
.16	3.14225	.66	3.22574
.17	3.14392	.67	3.22741
.18	3.14559	.68	3.22908
.19	3.14726	.69	3.23075
47.20	3.14893	47.70	3.23242
.21	3.15059	.71	3.23409
.22	3.15226	.72	3.23576
.23	3.15393	.73	3.23743
.24	3.15560	.74	3.23910
.25	3.15727	.75	3.24077
.26	3.15894	.76	3.24244
.27	3.16061	.77	3.24411
.28	3.16228	.78	3.24578
.29	3.16395	.79	3.24745
47.30	3.16562	47.80	3.24912
.31	3.16729	.81	3.25079
.32	3.16896	.82	3.25246
.33	3.17063	.83	3.25413
.34	3.17230	.84	3.25580
.35	3.17397	.85	3.25747
.36	3.17564	.86	3.25914
.37	3.17731	.87	3.26081
.38	3.17898	.88	3.26248
.39	3.18065	.89	3.26415
47.40	3.18232	47.90	3.26582
.41	3.18399	.91	3.26749
.42	3.18566	.92	3.26916
.43	3.18733	.93	3.27083
.44	3.18900	.94	3.27250
.45	3.19067	.95	3.27417
.46	3.19234	.96	3.27584
.47	3.19401	.97	3.27751
.48	3.19568	.98	3.27918
.49	3.19735	.99	3.28085

OLD RANGE-VERMILION NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
48.00	$3.28252	48.50	$3.36601
.01	3.28419	.51	3.36768
.02	3.28586	.52	3.36935
.03	3.28753	.53	3.37102
.04	3.28920	.54	3.37269
.05	3.29087	.55	3.37436
.06	3.29254	.56	3.37603
.07	3.29421	.57	3.37770
.08	3.29588	.58	3.37937
.09	3.29755	.59	3.38104
48.10	3.29922	48.60	3.38271
.11	3.30089	.61	3.38438
.12	3.30256	.62	3.38605
.13	3.30423	.63	3.38772
.14	3.30590	.64	3.38939
.15	3.30757	.65	3.39106
.16	3.30924	.66	3.39273
.17	3.31091	.67	3.39440
.18	3.31258	.68	3.39607
.19	3.31425	.69	3.39774
48.20	3.31592	48.70	3.39941
.21	3.31759	.71	3.40108
.22	3.31926	.72	3.40275
.23	3.32092	.73	3.40442
.24	3.32259	.74	3.40609
.25	3.32426	.75	3.40776
.26	3.32593	.76	3.40943
.27	3.32760	.77	3.41110
.28	3.32927	.78	3.41277
.29	3.33094	.79	3.41444
48.30	3.33261	48.80	3.41611
.31	3.33428	.81	3.41778
.32	3.33595	.82	3.41945
.33	3.33762	.83	3.42112
.34	3.33929	.84	3.42279
.35	3.34096	.85	3.42446
.36	3.34263	.86	3.42613
.37	3.34430	.87	3.42780
.38	3.34597	.88	3.42947
.39	3.34764	.89	3.43114
48.40	3.34931	48.90	3.43281
.41	3.35098	.91	3.43448
.42	3.35265	.92	3.43615
.43	3.35432	.93	3.43782
.44	3.35599	.94	3.43949
.45	3.35766	.95	3.44116
.46	3.35933	.96	3.44283
.47	3.36100	.97	3.44450
.48	3.36267	.98	3.44617
.49	3.36434	.99	3.44784

OLD RANGE-VERMILION NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
49.00	$3.44951	49.50	$3.51213
.01	3.45076	.51	3.51338
.02	3.45201	.52	3.51463
.03	3.45326	.53	3.51589
.04	3.45452	.54	3.51714
.05	3.45577	.55	3.51839
.06	3.45702	.56	3.51964
.07	3.45827	.57	3.52090
.08	3.45953	.58	3.52215
.09	3.46078	.59	3.52340
49.10	3.46203	49.60	3.52465
.11	3.46328	.61	3.52591
.12	3.46454	.62	3.52716
.13	3.46579	.63	3.52841
.14	3.46704	.64	3.52966
.15	3.46829	.65	3.53092
.16	3.46955	.66	3.53217
.17	3.47080	.67	3.53342
.18	3.47205	.68	3.53467
.19	3.47330	.69	3.53592
49.20	3.47456	49.70	3.53718
.21	3.47581	.71	3.53843
.22	3.47706	.72	3.53968
.23	3.47831	.73	3.54093
.24	3.47957	.74	3.54219
.25	3.48082	.75	3.54344
.26	3.48207	.76	3.54469
.27	3.48332	.77	3.54594
.28	3.48458	.78	3.54720
.29	3.48583	.79	3.54845
49.30	3.48708	49.80	3.54970
.31	3.48833	.81	3.55095
.32	3.48959	.82	3.55221
.33	3.49084	.83	3.55346
.34	3.49209	.84	3.55471
.35	3.49334	.85	3.55596
.36	3.49459	.86	3.55722
.37	3.49585	.87	3.55847
.38	3.49710	.88	3.55972
.39	3.49835	.89	3.56097
49.40	3.49960	49.90	3.56223
.41	3.50086	.91	3.56348
.42	3.50211	.92	3.56473
.43	3.50336	.93	3.56598
.44	3.50461	.94	3.56724
.45	3.50587	.95	3.56849
.46	3.50712	.96	3.56974
.47	3.50837	.97	3.57099
.48	3.50962	.98	3.57225
.49	3.51088	.99	3.57350

OLD RANGE-VERMILION NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
50.00	$3.57475	50.50	$3.61650
.01	3.57558	.51	3.61733
.02	3.57642	.52	3.61817
.03	3.57725	.53	3.61900
.04	3.57809	.54	3.61984
.05	3.57892	.55	3.62067
.06	3.57976	.56	3.62151
.07	3.58059	.57	3.62234
.08	3.58143	.58	3.62318
.09	3.58226	.59	3.62401
50.10	3.58310	50.60	3.62485
.11	3.58393	.61	3.62568
.12	3.58477	.62	3.62652
.13	3.58560	.63	3.62735
.14	3.58644	.64	3.62819
.15	3.58727	.65	3.62902
.16	3.58811	.66	3.62986
.17	3.58894	.67	3.63069
.18	3.58978	.68	3.63153
.19	3.59061	.69	3.63236
50.20	3.59145	50.70	3.63320
.21	3.59228	.71	3.63403
.22	3.59312	.72	3.63487
.23	3.59395	.73	3.63570
.24	3.59479	.74	3.63654
.25	3.59562	.75	3.63737
.26	3.59646	.76	3.63821
.27	3.59729	.77	3.63904
.28	3.59813	.78	3.63988
.29	3.59896	.79	3.64071
50.30	3.59980	50.80	3.64155
.31	3.60063	.81	3.64238
.32	3.60147	.82	3.64322
.33	3.60230	.83	3.64405
.34	3.60314	.84	3.64489
.35	3.60397	.85	3.64572
.36	3.60481	.86	3.64656
.37	3.60564	.87	3.64739
.38	3.60648	.88	3.64823
.39	3.60731	.89	3.64906
50.40	3.60815	50.90	3.64990
.41	3.60898	.91	3.65073
.42	3.60982	.92	3.65157
.43	3.61065	.93	3.65240
.44	3.61149	.94	3.65324
.45	3.61232	.95	3.65407
.46	3.61316	.96	3.65491
.47	3.61399	.97	3.65574
.48	3.61483	.98	3.65658
.49	3.61566	.99	3.65741

OLD RANGE-VERMILION NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
51.00	$3.65825	51.50	$3.69999
.01	3.65908	.51	3.70083
.02	3.65992	.52	3.70166
.03	3.66075	.53	3.70250
.04	3.66158	.54	3.70333
.05	3.66242	.55	3.70417
.06	3.66325	.56	3.70500
.07	3.66409	.57	3.70584
.08	3.66492	.58	3.70667
.09	3.66576	.59	3.70751
51.10	3.66659	51.60	3.70834
.11	3.66743	.61	3.70918
.12	3.66826	.62	3.71001
.13	3.66910	.63	3.71085
.14	3.66993	.64	3.71168
.15	3.67077	.65	3.71252
.16	3.67160	.66	3.71335
.17	3.67244	.67	3.71419
.18	3.67327	.68	3.71502
.19	3.67411	.69	3.71586
51.20	3.67494	51.70	3.71669
.21	3.67578	.71	3.71753
.22	3.67661	.72	3.71836
.23	3.67745	.73	3.71920
.24	3.67828	.74	3.72003
.25	3.67912	.75	3.72087
.26	3.67995	.76	3.72170
.27	3.68079	.77	3.72254
.28	3.68162	.78	3.72337
.29	3.68246	.79	3.72421
51.30	3.68329	51.80	3.72504
.31	3.68413	.81	3.72588
.32	3.68496	.82	3.72671
.33	3.68580	.83	3.72755
.34	3.68663	.84	3.72838
.35	3.68747	.85	3.72922
.36	3.68830	.86	3.73005
.37	3.68914	.87	3.73089
.38	3.68997	.88	3.73172
.39	3.69081	.89	3.73256
51.40	3.69164	51.90	3.73339
.41	3.69248	.91	3.73423
.42	3.69331	.92	3.73506
.43	3.69415	.93	3.73590
.44	3.69498	.94	3.73673
.45	3.69582	.95	3.73757
.46	3.69665	.96	3.73840
.47	3.69749	.97	3.73924
.48	3.69832	.98	3.74007
.49	3.69916	.99	3.74091

OLD RANGE-VERMILION NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
52.00	$3.74174	52.50	$3.78349
.01	3.74258	.51	3.78432
.02	3.74341	.52	3.78516
.03	3.74425	.53	3.78599
.04	3.74508	.54	3.78683
.05	3.74591	.55	3.78766
.06	3.74675	.56	3.78850
.07	3.74758	.57	3.78933
.08	3.74842	.58	3.79017
.09	3.74925	.59	3.79100
52.10	3.75009	52.60	3.79184
.11	3.75092	.61	3.79267
.12	3.75176	.62	3.79351
.13	3.75259	.63	3.79434
.14	3.75343	.64	3.79518
.15	3.75426	.65	3.79601
.16	3.75510	.66	3.79685
.17	3.75593	.67	3.79768
.18	3.75677	.68	3.79852
.19	3.75760	.69	3.79935
52.20	3.75844	52.70	3.80019
.21	3.75927	.71	3.80102
.22	3.76011	.72	3.80186
.23	3.76094	.73	3.80269
.24	3.76178	.74	3.80353
.25	3.76261	.75	3.80436
.26	3.76345	.76	3.80520
.27	3.76428	.77	3.80603
.28	3.76512	.78	3.80687
.29	3.76595	.79	3.80770
52.30	3.76679	52.80	3.80854
.31	3.76762	.81	3.80937
.32	3.76846	.82	3.81021
.33	3.76929	.83	3.81104
.34	3.77013	.84	3.81188
.35	3.77096	.85	3.81271
.36	3.77180	.86	3.81355
.37	3.77263	.87	3.81438
.38	3.77347	.88	3.81522
.39	3.77430	.89	3.81605
52.40	3.77514	52.90	3.81689
.41	3.77597	.91	3.81772
.42	3.77681	.92	3.81856
.43	3.77764	.93	3.81939
.44	3.77848	.94	3.82023
.45	3.77931	.95	3.82106
.46	3.78015	.96	3.82190
.47	3.78098	.97	3.82273
.48	3.78182	.98	3.82357
.49	3.78265	.99	3.82440

OLD RANGE-VERMILION NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
53.00	$3.82524	53.50	$3.87198
.01	3.82617	.51	3.87292
.02	3.82711	.52	3.87385
.03	3.82804	.53	3.87479
.04	3.82898	.54	3.87572
.05	3.82991	.55	3.87666
.06	3.83085	.56	3.87759
.07	3.83178	.57	3.87853
.08	3.83271	.58	3.87946
.09	3.83365	.59	3.88040
53.10	3.83458	53.60	3.88133
.11	3.83552	.61	3.88227
.12	3.83645	.62	3.88320
.13	3.83739	.63	3.88414
.14	3.83832	.64	3.88507
.15	3.83926	.65	3.88601
.16	3.84019	.66	3.88694
.17	3.84113	.67	3.88788
.18	3.84206	.68	3.88881
.19	3.84300	.69	3.88975
53.20	3.84393	53.70	3.89068
.21	3.84487	.71	3.89162
.22	3.84580	.72	3.89255
.23	3.84674	.73	3.89349
.24	3.84767	.74	3.89442
.25	3.84861	.75	3.89536
.26	3.84954	.76	3.89629
.27	3.85048	.77	3.89723
.28	3.85141	.78	3.89816
.29	3.85235	.79	3.89910
53.30	3.85328	53.80	3.90003
.31	3.85422	.81	3.90097
.32	3.85515	.82	3.90190
.33	3.85609	.83	3.90284
.34	3.85702	.84	3.90377
.35	3.85796	.85	3.90471
.36	3.85889	.86	3.90564
.37	3.85983	.87	3.90658
.38	3.86076	.88	3.90751
.39	3.86170	.89	3.90845
53.40	3.86263	53.90	3.90938
.41	3.86357	.91	3.91032
.42	3.86450	.92	3.91125
.43	3.86544	.93	3.91219
.44	3.86637	.94	3.91312
.45	3.86731	.95	3.91406
.46	3.86824	.96	3.91499
.47	3.86918	.97	3.91593
.48	3.87011	.98	3.91686
.49	3.87105	.99	3.91780

OLD RANGE-VERMILION NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
54.00	$3.91873	54.50	$3.97048
.01	3.91977	.51	3.97151
.02	3.92080	.52	3.97255
.03	3.92184	.53	3.97358
.04	3.92287	.54	3.97462
.05	3.92391	.55	3.97565
.06	3.92494	.56	3.97669
.07	3.92598	.57	3.97772
.08	3.92701	.58	3.97876
.09	3.92804	.59	3.97979
54.10	3.92908	54.60	3.98083
.11	3.93011	.61	3.98186
.12	3.93115	.62	3.98290
.13	3.93218	.63	3.98393
.14	3.93322	.64	3.98497
.15	3.93425	.65	3.98600
.16	3.93529	.66	3.98704
.17	3.93632	.67	3.98807
.18	3.93736	.68	3.98911
.19	3.93839	.69	3.99014
54.20	3.93943	54.70	3.99118
.21	3.94046	.71	3.99221
.22	3.94150	.72	3.99325
.23	3.94253	.73	3.99428
.24	3.94357	.74	3.99532
.25	3.94460	.75	3.99635
.26	3.94564	.76	3.99739
.27	3.94667	.77	3.99842
.28	3.94771	.78	3.99946
.29	3.94874	.79	4.00049
54.30	3.94978	54.80	4.00153
.31	3.95081	.81	4.00256
.32	3.95185	.82	4.00360
.33	3.95288	.83	4.00463
.34	3.95392	.84	4.00567
.35	3.95495	.85	4.00670
.36	3.95599	.86	4.00774
.37	3.95702	.87	4.00877
.38	3.95806	.88	4.00981
.39	3.95909	.89	4.01084
54.40	3.96013	54.90	4.01188
.41	3.96116	.91	4.01291
.42	3.96220	.92	4.01395
.43	3.96323	.93	4.01498
.44	3.96427	.94	4.01602
.45	3.96530	.95	4.01705
.46	3.96634	.96	4.01809
.47	3.96737	.97	4.01912
.48	3.96841	.98	4.02016
.49	3.96944	.99	4.02119

OLD RANGE-VERMILION NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
55.00	$4.02223	55.50	$4.07897
.01	4.02336	.51	4.08011
.02	4.02450	.52	4.08124
.03	4.02563	.53	4.08238
.04	4.02677	.54	4.08351
.05	4.02790	.55	4.08465
.06	4.02904	.56	4.08578
.07	4.03017	.57	4.08692
.08	4.03131	.58	4.08805
.09	4.03244	.59	4.08919
55.10	4.03358	55.60	4.09032
.11	4.03471	.61	4.09146
.12	4.03584	.62	4.09259
.13	4.03698	.63	4.09373
.14	4.03811	.64	4.09486
.15	4.03925	.65	4.09600
.16	4.04038	.66	4.09713
.17	4.04152	.67	4.09827
.18	4.04265	.68	4.09940
.19	4.04379	.69	4.10054
55.20	4.04492	55.70	4.10167
.21	4.04606	.71	4.10281
.22	4.04719	.72	4.10394
.23	4.04833	.73	4.10508
.24	4.04946	.74	4.10621
.25	4.05060	.75	4.10735
.26	4.05173	.76	4.10848
.27	4.05287	.77	4.10962
.28	4.05400	.78	4.11075
.29	4.05514	.79	4.11189
55.30	4.05627	55.80	4.11302
.31	4.05741	.81	4.11416
.32	4.05854	.82	4.11529
.33	4.05968	.83	4.11643
.34	4.06081	.84	4.11756
.35	4.06195	.85	4.11870
.36	4.06308	.86	4.11983
.37	4.06422	.87	4.12097
.38	4.06535	.88	4.12210
.39	4.06649	.89	4.12324
55.40	4.06762	55.90	4.12437
.41	4.06876	.91	4.12551
.42	4.06989	.92	4.12664
.43	4.07103	.93	4.12778
.44	4.07216	.94	4.12891
.45	4.07330	.95	4.13005
.46	4.07443	.96	4.13118
.47	4.07557	.97	4.13232
.48	4.07670	.98	4.13345
.49	4.07784	.99	4.13459

OLD RANGE-VERMILION NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
56.00	$4.13572	56.50	$4.19747
.01	4.13696	.51	4.19870
.02	4.13819	.52	4.19994
.03	4.13943	.53	4.20117
.04	4.14066	.54	4.20241
.05	4.14190	.55	4.20364
.06	4.14313	.56	4.20488
.07	4.14437	.57	4.20611
.08	4.14560	.58	4.20735
.09	4.14684	.59	4.20858
56.10	4.14807	56.60	4.20982
.11	4.14931	.61	4.21105
.12	4.15054	.62	4.21229
.13	4.15177	.63	4.21352
.14	4.15301	.64	4.21476
.15	4.15424	.65	4.21599
.16	4.15548	.66	4.21723
.17	4.15671	.67	4.21846
.18	4.15795	.68	4.21970
.19	4.15918	.69	4.22093
56.20	4.16042	56.70	4.22217
.21	4.16165	.71	4.22340
.22	4.16289	.72	4.22464
.23	4.16412	.73	4.22587
.24	4.16536	.74	4.22711
.25	4.16659	.75	4.22834
.26	4.16783	.76	4.22958
.27	4.16906	.77	4.23081
.28	4.17030	.78	4.23205
.29	4.17153	.79	4.23328
56.30	4.17277	56.80	4.23452
.31	4.17400	.81	4.23575
.32	4.17524	.82	4.23699
.33	4.17647	.83	4.23822
.34	4.17771	.84	4.23946
.35	4.17894	.85	4.24069
.36	4.18018	.86	4.24193
.37	4.18141	.87	4.24316
.38	4.18265	.88	4.24440
.39	4.18388	.89	4.24563
56.40	4.18512	56.90	4.24687
.41	4.18635	.91	4.24810
.42	4.18759	.92	4.24934
.43	4.18882	.93	4.25057
.44	4.19006	.94	4.25181
.45	4.19129	.95	4.25304
.46	4.19253	.96	4.25428
.47	4.19376	.97	4.25551
.48	4.19500	.98	4.25675
.49	4.19623	.99	4.25798

OLD RANGE-VERMILION NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
57.00	$4.25922	57.50	$4.32596
.01	4.26055	.51	4.32730
.02	4.26189	.52	4.32863
.03	4.26322	.53	4.32997
.04	4.26456	.54	4.33130
.05	4.26589	.55	4.33264
.06	4.26723	.56	4.33397
.07	4.26856	.57	4.33531
.08	4.26990	.58	4.33664
.09	4.27123	.59	4.33798
57.10	4.27257	57.60	4.33931
.11	4.27390	.61	4.34065
.12	4.27524	.62	4.34198
.13	4.27657	.63	4.34332
.14	4.27791	.64	4.34465
.15	4.27924	.65	4.34599
.16	4.28057	.66	4.34732
.17	4.28191	.67	4.34866
.18	4.28324	.68	4.34999
.19	4.28458	.69	4.35133
57.20	4.28591	57.70	4.35266
.21	4.28725	.71	4.35400
.22	4.28858	.72	4.35533
.23	4.28992	.73	4.35667
.24	4.29125	.74	4.35800
.25	4.29259	.75	4.35934
.26	4.29392	.76	4.36067
.27	4.29526	.77	4.36201
.28	4.29659	.78	4.36334
.29	4.29793	.79	4.36468
57.30	4.29926	57.80	4.36601
.31	4.30060	.81	4.36735
.32	4.30193	.82	4.36868
.33	4.30327	.83	4.37002
.34	4.30460	.84	4.37135
.35	4.30594	.85	4.37269
.36	4.30727	.86	4.37402
.37	4.30861	.87	4.37536
.38	4.30994	.88	4.37669
.39	4.31128	.89	4.37803
57.40	4.31261	57.90	4.37936
.41	4.31395	.91	4.38070
.42	4.31528	.92	4.38203
.43	4.31662	.93	4.38337
.44	4.31795	.94	4.38470
.45	4.31929	.95	4.38604
.46	4.32062	.96	4.38737
.47	4.32196	.97	4.38871
.48	4.32329	.98	4.39004
.49	4.32463	.99	4.39138

OLD RANGE-VERMILION NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
58.00	$4.39271	58.50	$4.43446
.01	4.39355	.51	4.43529
.02	4.39438	.52	4.43613
.03	4.39522	.53	4.43696
.04	4.39605	.54	4.43780
.05	4.39689	.55	4.43863
.06	4.39772	.56	4.43947
.07	4.39856	.57	4.44030
.08	4.39939	.57	4.44114
.09	4.40023	.59	4.44197
58.10	4.40106	58.60	4.44281
.11	4.40190	.61	4.44364
.12	4.40273	.62	4.44448
.13	4.40357	.63	4.44531
.14	4.40440	.64	4.44615
.15	4.40524	.65	4.44698
.16	4.40607	.66	4.44782
.17	4.40690	.67	4.44865
.18	4.40774	.68	4.44949
.19	4.40857	.69	4.45032
58.20	4.40941	58.70	4.45116
.21	4.41024	.71	4.45199
.22	4.41108	.72	4.45283
.23	4.41191	.73	4.45366
.24	4.41275	.74	4.45450
.25	4.41358	.75	4.45533
.26	4.41442	.76	4.45617
.27	4.41525	.77	4.45700
.28	4.41609	.78	4.45784
.29	4.41692	.79	4.45867
58.30	4.41776	58.80	4.45951
.31	4.41859	.81	4.46034
.32	4.41943	.82	4.46118
.33	4.42026	.83	4.46201
.34	4.42110	.84	4.46285
.35	4.42193	.85	4.46368
.36	4.42277	.86	4.46452
.37	4.42360	.87	4.46535
.38	4.42444	.88	4.46619
.39	4.42527	.89	4.46702
58.40	4.42611	58.90	4.46786
.41	4.42694	.91	4.46869
.42	4.42778	.92	4.46953
.43	4.42861	.93	4.47036
.44	4.42945	.94	4.47120
.45	4.43028	.95	4.47203
.46	4.43112	.96	4.47287
.47	4.43195	.97	4.47370
.48	4.43279	.98	4.47454
.49	4.43362	.99	4.47537

OLD RANGE-VERMILION NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
59.00	$4.47621	59.50	$4.51795
.01	4.47704	.51	4.51879
.02	4.47788	.52	4.51962
.03	4.47871	.53	4.52046
.04	4.47955	.54	4.52129
.05	4.48038	.55	4.52213
.06	4.48122	.56	4.52296
.07	4.48205	.57	4.52380
.08	4.48289	.58	4.52463
.09	4.48372	.59	4.52547
59.10	4.48456	59.60	4.52630
.11	4.48539	.61	4.52714
.12	4.48623	.62	4.52797
.13	4.48706	.63	4.52881
.14	4.48790	.64	4.52964
.15	4.48873	.65	4.53048
.16	4.48957	.66	4.53131
.17	4.49040	.67	4.53215
.18	4.49124	.68	4.53298
.19	4.49207	.69	4.53382
59.20	4.49290	59.70	4.53465
.21	4.49374	.71	4.53549
.22	4.49457	.72	4.53632
.23	4.49541	.73	4.53716
.24	4.49624	.74	4.53799
.25	4.49708	.75	4.53883
.26	4.49791	.76	4.53966
.27	4.49875	.77	4.54050
.28	4.49958	.78	4.54133
.29	4.50042	.79	4.54217
59.30	4.50125	59.80	4.54300
.31	4.50209	.81	4.54384
.32	4.50292	.82	4.54467
.33	4.50376	.83	4.54551
.34	4.50459	.84	4.54634
.35	4.50543	.85	4.54718
.36	4.50626	.86	4.54801
.37	4.50710	.87	4.54885
.38	4.50793	.88	4.54968
.39	4.50877	.89	4.55052
59.40	4.50960	59.90	4.55135
.41	4.51044	.91	4.55219
.42	4.51127	.92	4.55302
.43	4.51211	.93	4.55386
.44	4.51294	.94	4.55469
.45	4.51378	.95	4.55553
.46	4.51461	.96	4.55636
.47	4.51545	.97	4.55720
.48	4.51628	.98	4.55803
.49	4.51712	.99	4.55887

OLD RANGE-VERMILION NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
60.00	$4.55970	60.50	$4.60145
.01	4.56054	.51	4.60228
.02	4.56137	.52	4.60312
.03	4.56221	.53	4.60395
.04	4.56304	.54	4.60479
.05	4.56388	.55	4.60562
.06	4.56471	.56	4.60646
.07	4.56555	.57	4.60729
.08	4.56638	.58	4.60813
.09	4.56722	.59	4.60896
60.10	4.56805	60.60	4.60980
.11	4.56889	.61	4.61063
.12	4.56972	.62	4.61147
.13	4.57056	.63	4.61230
.14	4.57139	.64	4.61314
.15	4.57223	.65	4.61397
.16	4.57306	.66	4.61481
.17	4.57390	.67	4.61564
.18	4.57473	.68	4.61648
.19	4.57557	.69	4.61731
60.20	4.57640	60.70	4.61815
.21	4.57723	.71	4.61898
.22	4.57807	.72	4.61982
.23	4.57890	.73	4.62065
.24	4.57974	.74	4.62149
.25	4.58057	.75	4.62232
.26	4.58141	.76	4.62316
.27	4.58224	.77	4.62399
.28	4.58308	.78	4.62483
.29	4.58391	.79	4.62566
60.30	4.58475	60.80	4.62650
.31	4.58558	.81	4.62733
.32	4.58642	.82	4.62817
.33	4.58725	.83	4.62900
.34	4.58809	.84	4.62984
.35	4.58892	.85	4.63067
.36	4.58976	.86	4.63151
.37	4.59059	.87	4.63234
.38	4.59143	.88	4.63318
.39	4.59226	.89	4.63401
60.40	4.59310	60.90	4.63485
.41	4.59393	.91	4.63568
.42	4.59477	.92	4.63652
.43	4.59560	.93	4.63735
.44	4.59644	.94	4.63819
.45	4.59727	.95	4.63902
.46	4.59811	.96	4.63986
.47	4.59894	.97	4.64069
.48	4.59978	.98	4.64153
.49	4.60061	.99	4.64236

MESABA NON-BESSEMER

NATURAL IRON ORE

LAKE ERIE PRICES

1911

16 TABLES

45 PER CENT TO 60 PER CENT
INCLUSIVE

COMPILED BY
RUKARD HURD

MESABA NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
45.00	$2.62426	45.50	$2.70388
.01	2.62586	.51	2.70547
.02	2.62745	.52	2.70706
.03	2.62904	.53	2.70865
.04	2.63063	.54	2.71025
.05	2.63223	.55	2.71184
.06	2.63382	.56	2.71343
.07	2.63541	.57	2.71502
.08	2.36700	.58	2.71661
.09	2.36859	.59	2.71821
45.10	2.64019	45.60	2.71980
.11	2.64178	.61	2.72139
.12	2.64337	.62	2.72298
.13	2.64496	.63	2.72458
.14	2.64656	.64	2.72617
.15	2.64815	.65	2.72776
.16	2.64974	.66	2.72935
.17	2.65133	.67	2.73094
.18	2.65292	.68	2.73254
.19	2.65452	.69	2.73413
45.20	2.65611	45.70	2.73572
.21	2.65770	.71	2.73731
.22	2.65929	.72	2.73891
.23	2.66089	.73	2.74050
.24	2.66248	.74	2.74209
.25	2.66407	.75	2.74368
.26	2.66566	.76	2.74527
.27	2.66726	.77	2.74687
.28	2.66885	.78	2.74846
.29	2.67044	.79	2.75005
45.30	2.67203	45.80	2.75164
.31	2.67362	.81	2.75324
.32	2.67522	.82	2.75483
.33	2.67681	.83	2.75642
.34	2.67840	.84	2.75801
.35	2.67999	.85	2.75960
.36	2.68159	.86	2.76120
.37	2.68318	.87	2.76279
.38	2.68477	.88	2.76438
.39	2.68636	.89	2.76597
45.40	2.68795	45.90	2.76757
.41	2.68955	.91	2.76916
.42	2.69114	.92	2.77075
.43	2.69273	.93	2.77234
.44	2.69432	.94	2.77393
.45	2.69592	.95	2.77553
.46	2.69751	.96	2.77712
.47	2.69910	.97	2.77871
.48	2.70069	.98	2.78030
.49	2.70228	.99	2.78190

MESABA NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
46.00	$2.78349	46.50	$2.86310
.01	2.78508	.51	2.86469
.02	2.78667	.52	2.86628
.03	2.78826	.53	2.86788
.04	2.78986	.54	2.86947
.05	2.79145	.55	2.87106
.06	2.79304	.56	2.87265
.07	2.79463	.57	2.87425
.08	2.79623	.58	2.87584
.09	2.79782	.59	2.87743
46.10	2.79941	46.60	2.87902
.11	2.80100	.61	2.88061
.12	2.80259	.62	2.88221
.13	2.80419	.63	2.88380
.14	2.80578	.64	2.88539
.15	2.80737	.65	2.88698
.16	2.80896	.66	2.88858
.17	2.81056	.67	2.89017
.18	2.81215	.68	2.89176
.19	2.81374	.69	2.89335
46.20	2.81533	46.70	2.89494
.21	2.81692	.71	2.89654
.22	2.81852	.72	2.89813
.23	2.82011	.73	2.89972
.24	2.82170	.74	2.90131
.25	2.82329	.75	2.90291
.26	2.82489	.76	2.90450
.27	2.82648	.77	2.90609
.28	2.82807	.78	2.90768
.29	2.82966	.79	2.90927
46.30	2.83125	46.80	2.91087
.31	2.83285	.81	2.91246
.32	2.83444	.82	2.91405
.33	2.83603	.83	2.91564
.34	2.83762	.84	2.91724
.35	2.83922	.85	2.91883
.36	2.84081	.86	2.92042
.37	2.84240	.87	2.92201
.38	2.84399	.88	2.92360
.39	2.84559	.89	2.92520
46.40	2.84718	46.90	2.92679
.41	2.84877	.91	2.92838
.42	2.85036	.92	2.92997
.43	2.85195	.93	2.93157
.44	2.85355	.94	2.93316
.45	2.85514	.95	2.93475
.46	2.85673	.96	2.93634
.47	2.85832	.97	2.93793
.48	2.85992	.98	2.93953
.49	2.86151	.99	2.94112

MESABA NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
47.00	$2.94271	47.50	$3.02232
.01	2.94430	.51	3.02392
.02	2.94590	.52	3.02551
.03	2.94749	.53	3.02710
.04	2.94908	.54	3.02869
.05	2.95067	.55	3.03028
.06	2.95226	.56	3.03188
.07	2.95386	.57	3.03347
.08	2.95545	.58	3.03506
.09	2.95704	.59	3.03665
47.10	2.95863	47.60	3.03825
.11	2.96023	.61	3.03984
.12	2.96182	.62	3.04143
.13	2.96341	.63	3.04302
.14	2.96500	.64	3.04461
.15	2.96659	.65	3.04621
.16	2.96819	.66	3.04780
.17	2.96978	.67	3.04939
.18	2.97137	.68	3.05098
.19	2.97296	.69	3.05258
47.20	2.97456	47.70	3.05417
.21	2.97615	.71	3.05576
.22	2.97774	.72	3.05735
.23	2.97933	.73	3.05894
.24	2.98092	.74	3.06054
.25	2.98252	.75	3.06213
.26	2.98411	.76	3.06372
.27	2.98570	.77	3.06531
.28	2.98729	.78	3.06691
.29	2.98889	.79	3.06850
47.30	2.99048	47.80	3.07009
.31	2.99207	.81	3.07168
.32	2.99366	.82	3.07327
.33	2.99525	.83	3.07487
.34	2.99685	.84	3.07646
.35	2.99844	.85	3.07805
.36	3.00003	.86	3.07964
.37	3.00162	.87	3.08124
.38	3.00322	.88	3.08283
.39	3.00481	.89	3.08442
47.40	3.00640	47.90	3.08601
.41	3.00799	.91	3.08760
.42	3.00958	.92	3.08920
.43	3.01118	.93	3.09079
.44	3.01277	.94	3.09238
.45	3.01436	.95	3.09397
.46	3.01595	.96	3.09557
.47	3.01755	.97	3.09716
.48	3.01914	.98	3.09875
.49	3.02073	.99	3.10034

MESABA NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
48.00	$3.10193	48.50	$3.18155
.01	3.10353	.51	3.18314
.02	3.10512	.52	3.18473
.03	3.10671	.53	3.18632
.04	3.10830	.54	3.18791
.05	3.10990	.55	3.18951
.06	3.11149	.56	3.19110
.07	3.11308	.57	3.19269
.08	3.11467	.58	3.19428
.09	3.11626	.59	3.19588
48.10	3.11786	48.60	3.19747
.11	3.11945	.61	3.19906
.12	3.12104	.62	3.20065
.13	3.12263	.63	3.20225
.14	3.12423	.64	3.20384
.15	3.12582	.65	3.20543
.16	3.12741	.66	3.20702
.17	3.12900	.67	3.20861
.18	3.13059	.68	3.21021
.19	3.13219	.69	3.21180
48.20	3.13378	48.70	3.21339
.21	3.13537	.71	3.21498
.22	3.13696	.72	3.21658
.23	3.13856	.73	3.21817
.24	3.14015	.74	3.21976
.25	3.14174	.75	3.22135
.26	3.14333	.76	3.22294
.27	3.14492	.77	3.22454
.28	3.14652	.78	3.22613
.29	3.14811	.79	3.22772
48.30	3.14970	48.80	3.22931
.31	3.15129	.81	3.23091
.32	3.15289	.82	3.23250
.33	3.15448	.83	3.23409
.34	3.15607	.84	3.23568
.35	3.15766	.85	3.23727
.36	3.15925	.86	3.23887
.37	3.16085	.87	3.24046
.38	3.16244	.88	3.24205
.39	3.16403	.89	3.24364
48.40	3.16562	48.90	3.24524
.41	3.16722	.91	3.24683
.42	3.16881	.92	3.24842
.43	3.17040	.93	3.25001
.44	3.17199	.94	3.25160
.45	3.17358	.95	3.25320
.46	3.17518	.96	3.25479
.47	3.17677	.97	3.25638
.48	3.17836	.98	3.25797
.49	3.17995	.99	3.25957

MESABA NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
49.00	$3.26116	49.50	$3.32087
.01	3.26235	.51	3.32206
.02	3.26355	.52	3.32325
.03	3.26474	.53	3.32445
.04	3.26593	.54	3.32564
.05	3.26713	.55	3.32684
.06	3.26832	.56	3.32803
.07	3.26952	.57	3.32923
.08	3.27071	.58	3.33042
.09	3.27191	.59	3.33161
49.10	3.27310	49.60	3.33281
.11	3.27429	.61	3.33400
.12	3.27549	.62	3.33520
.13	3.27668	.63	3.33639
.14	3.27788	.64	3.33758
.15	3.27907	.65	3.33878
.16	3.28026	.66	3.33997
.17	3.28146	.67	3.34117
.18	3.28265	.68	3.34236
.19	3.28385	.69	3.34356
49.20	3.28504	49.70	3.34475
.21	3.28624	.71	3.34594
.22	3.28743	.72	3.34714
.23	3.28862	.73	3.34833
.24	3.28982	.74	3.34953
.25	3.29101	.75	3.35072
.26	3.29221	.76	3.35191
.27	3.29340	.77	3.35311
.28	3.29459	.78	3.35430
.29	3.29579	.79	3.35550
49.30	3.29698	49.80	3.35669
.31	3.29818	.81	3.35789
.32	3.29937	.82	3.35908
.33	3.30057	.83	3.36027
.34	3.30176	.84	3.36147
.35	3.30295	.85	3.36266
.36	3.30415	.86	3.36386
.37	3.30534	.87	3.36505
.38	3.30654	.88	3.36624
.39	3.30773	.89	3.36744
49.40	3.30892	49.90	3.36863
.41	3.31012	.91	3.36983
.42	3.31131	.92	3.37102
.43	3.31251	.93	3.37222
.44	3.31370	.94	3.37341
.45	3.31490	.95	3.37460
.46	3.31609	.96	3.37580
.47	3.31728	.97	3.37699
.48	3.31848	.98	3.37819
.49	3.31967	.99	3.37938

MESABA NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
50.00	$3.38058	50.50	$3.42038
.01	3.38137	.51	3.42118
.02	3.38217	.52	3.42197
.03	3.38296	.53	3.42277
.04	3.38376	.54	3.42357
.05	3.38456	.55	3.42436
.06	3.38535	.56	3.42516
.07	3.38615	.57	3.42595
.08	3.38694	.58	3.42675
.09	3.38774	.59	3.42755
50.10	3.38854	50.60	3.42834
.11	3.38933	.61	3.42914
.12	3.39013	.62	3.42993
.13	3.39092	.63	3.43073
.14	3.39172	.64	3.43153
.15	3.39252	.65	3.43232
.16	3.39331	.66	3.43312
.17	3.39411	.67	3.43391
.18	3.39491	.68	3.43471
.19	3.39570	.69	3.43551
50.20	3.39650	50.70	3.43630
.21	3.39729	.71	3.43710
.22	3.39809	.72	3.43790
.23	3.39889	.73	3.43869
.24	3.39968	.74	3.43949
.25	3.40048	.75	3.44028
.26	3.40127	.76	3.44108
.27	3.40207	.77	3.44188
.28	3.40287	.78	3.44267
.29	3.40366	.79	3.44347
50.30	3.40446	50.80	3.44426
.31	3.40525	.81	3.44506
.32	3.40605	.82	3.44586
.33	3.40685	.83	3.44665
.34	3.40764	.84	3.44745
.35	3.40844	.85	3.44824
.36	3.40924	.86	3.44904
.37	3.41003	.87	3.44984
.38	3.41083	.88	3.45063
.39	3.41162	.89	3.45143
50.40	3.41242	50.90	3.45223
.41	3.41322	.91	3.45302
.42	3.41401	.92	3.45382
.43	3.41481	.93	3.45461
.44	3.41560	.94	3.45541
.45	3.41640	.95	3.45621
.46	3.41720	.96	3.45700
.47	3.41799	.97	3.45780
.48	3.41879	.98	3.45859
.49	3.41958	.99	3.45939

MESABA NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
51.00	$3.46019	51.50	$3.49999
.01	3.46098	.51	3.50079
.02	3.46178	.52	3.50158
.03	3.46257	.53	3.50238
.04	3.46337	.54	3.50318
.05	3.46417	.55	3.50397
.06	3.46496	.56	3.50477
.07	3.46576	.57	3.50557
.08	3.46656	.58	3.50636
.09	3.46735	.59	3.50716
51.10	3.46815	51.60	3.50795
.11	3.46894	.61	3.50875
.12	3.46974	.62	3.50955
.13	3.47054	.63	3.51034
.14	3.47133	.64	3.51114
.15	3.47213	.65	3.51193
.16	3.47292	.66	3.51273
.17	3.47372	.67	3.51353
.18	3.47452	.68	3.51432
.19	3.47531	.69	3.51512
51.20	3.47611	51.70	3.51591
.21	3.47691	.71	3.51671
.22	3.47770	.72	3.51751
.23	3.47850	.73	3.51830
.24	3.47929	.74	3.51910
.25	3.48009	.75	3.51990
.26	3.48089	.76	3.52069
.27	3.48168	.77	3.52149
.28	3.48248	.78	3.52228
.29	3.48327	.79	3.52308
51.30	3.48407	51.80	3.52388
.31	3.48487	.81	3.52467
.32	3.48566	.82	3.52547
.33	3.48646	.83	3.52626
.34	3.48725	.84	3.52706
.35	3.48805	.85	3.52786
.36	3.48885	.86	3.52865
.37	3.48964	.87	3.52945
.38	3.49044	.88	3.53024
.39	3.49124	.89	3.53104
51.40	3.49203	51.90	3.53184
.41	3.49283	.91	3.53263
.42	3.49362	.92	3.53343
.43	3.49442	.93	3.53423
.44	3.49522	.94	3.53502
.45	3.49601	.95	3.53582
.46	3.49681	.96	3.53661
.47	3.49760	.97	3.53741
.48	3.49840	.98	3.53821
.49	3.49920	.99	3.53900

MESABA NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
52.00	$3.53980	52.50	$3.57960
.01	3.54059	.51	3.58040
.02	3.54139	.52	3.58120
.03	3.54219	.53	3.58199
.04	3.54298	.54	3.58279
.05	3.54378	.55	3.58358
.06	3.54457	.56	3.58438
.07	3.54537	.57	3.58518
.08	3.54617	.58	3.58597
.09	3.54696	.59	3.58677
52.10	3.54776	52.60	3.58757
.11	3.54856	.61	3.58836
.12	3.54935	.62	3.58916
.13	3.55015	.63	3.58995
.14	3.55094	.64	3.59075
.15	3.55174	.65	3.59155
.16	3.55254	.66	3.59234
.17	3.55333	.67	3.59314
.18	3.55413	.68	3.59393
.19	3.55492	.69	3.59473
52.20	3.55572	52.70	3.59553
.21	3.55652	.71	3.59632
.22	3.55731	.72	3.59712
.23	3.55811	.73	3.59791
.24	3.55890	.74	3.59871
.25	3.55970	.75	3.59951
.26	3.56050	.76	3.60030
.27	3.56129	.77	3.60110
.28	3.56209	.78	3.60190
.29	3.56289	.79	3.60269
52.30	3.56368	52.80	3.60349
.31	3.56448	.81	3.60428
.32	3.56527	.82	3.60508
.33	3.56607	.83	3.60588
.34	3.56687	.84	3.60667
.35	3.56766	.85	3.60747
.36	3.56846	.86	3.60826
.37	3.56925	.87	3.60906
.38	3.57005	.88	3.60986
.39	3.57085	.89	3.61065
52.40	3.57164	52.90	3.61145
.41	3.57244	.91	3.61224
.42	3.57324	.92	3.61304
.43	3.57403	.93	3.61384
.44	3.57483	.94	3.61463
.45	3.57562	.95	3.61543
.46	3.57642	.96	3.61623
.47	3.57722	.97	3.61702
.48	3.57801	.98	3.61782
.49	3.57881	.99	3.61861

MESABA NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
53.00	$3.61941	53.50	$3.66422
.01	3.62031	.51	3.66511
.02	3.62120	.52	3.66601
.03	3.62210	.53	3.66690
.04	3.62299	.54	3.66780
.05	3.62389	.55	3.66870
.06	3.62479	.56	3.66959
.07	3.62568	.57	3.67049
.08	3.62658	.58	3.67138
.09	3.62747	.59	3.67228
53.10	3.62837	53.60	3.67318
.11	3.62927	.61	3.67407
.12	3.63016	.62	3.67497
.13	3.63106	.63	3.67587
.14	3.63196	.64	3.67676
.15	3.63285	.65	3.67766
.16	3.63375	.66	3.67855
.17	3.63464	.67	3.67945
.18	3.63554	.68	3.68035
.19	3.63644	.69	3.68124
53.20	3.63733	53.70	3.68214
.21	3.63823	.71	3.68303
.22	3.63912	.72	3.68393
.23	3.64002	.73	3.68483
.24	3.64092	.74	3.68572
.25	3.64181	.75	3.68662
.26	3.64271	.76	3.68751
.27	3.64360	.77	3.68841
.28	3.64450	.78	3.68931
.29	3.64540	.79	3.69020
53.30	3.64629	53.80	3.69110
.31	3.64719	.81	3.69200
.32	3.64809	.82	3.69289
.33	3.64898	.83	3.69379
.34	3.64988	.84	3.69468
.35	3.65077	.85	3.69558
.36	3.65167	.86	3.69648
.37	3.65257	.87	3.69737
.38	3.65346	.88	3.69827
.39	3.65436	.89	3.69916
53.40	3.65525	53.90	3.70006
.41	3.65615	.91	3.70096
.42	3.65705	.92	3.70185
.43	3.65794	.93	3.70275
.44	3.65884	.94	3.70364
.45	3.65974	.95	3.70454
.46	3.66063	.96	3.70544
.47	3.66153	.97	3.70633
.48	3.66242	.98	3.70723
.49	3.66332	.99	3.70813

MESABA NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
54.00	$3.70902	54.50	$3.75883
.01	3.71002	.51	3.75982
.02	3.71101	.52	3.76082
.03	3.71201	.53	3.76182
.04	3.71301	.54	3.76281
.05	3.71400	.55	3.76381
.06	3.71500	.56	3.76480
.07	3.71599	.57	3.76580
.08	3.71699	.58	3.76680
.09	3.71799	.59	3.76779
54.10	3.71898	54.60	3.76879
.11	3.71998	.61	3.76978
.12	3.72097	.62	3.77078
.13	3.72197	.63	3.77178
.14	3.72297	.64	3.77277
.15	3.72396	.65	3.77377
.16	3.72496	.66	3.77477
.17	3.72596	.67	3.77576
.18	3.72695	.68	3.77676
.19	3.72795	.69	3.77775
54.20	3.72894	54.70	3.77875
.21	3.72994	.71	3.77975
.22	3.73094	.74	3.78074
.23	3.73193	.73	3.78174
.24	3.73293	.74	3.78273
.25	3.73392	.75	3.78373
.26	3.73492	.76	3.78473
.27	3.73592	.77	3.78572
.28	3.73691	.78	3.78672
.29	3.73791	.79	3.78771
54.30	3.73890	54.80	3.78871
.31	3.73990	.81	3.78971
.32	3.74090	.82	3.79070
.33	3.74189	.83	3.79170
.34	3.74289	.84	3.79270
.35	3.74389	.85	3.79369
.36	3.74488	.86	3.97469
.37	3.74588	.87	3.79568
.38	3.74687	.88	3.79668
.39	3.74787	.89	3.79768
54.40	3.74887	54.90	3.79867
.41	3.74986	.91	3.79967
.42	3.75086	.92	3.80066
.43	3.75185	.93	3.80166
.44	3.75285	.94	3.80266
.45	3.75385	.95	3.80365
.46	3.75484	.96	3.80465
.47	3.75584	.97	3.80564
.48	3.75683	.98	3.80664
.49	3.75783	.99	3.80764

MESABA NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
55.00	$3.80863	55.50	$3.86344
.01	3.80973	.51	3.86453
.02	3.81083	.52	3.86563
.03	3.81192	.53	3.86673
.04	3.81302	.54	3.86782
.05	3.81411	.55	3.86892
.06	3.81521	.56	3.87002
.07	3.81631	.57	3.87111
.08	3.81740	.58	3.87221
.09	3.81850	.59	3.87330
55.10	3.81959	55.60	3.87440
.11	3.82069	.61	3.87550
.12	3.82179	.62	3.87659
.13	3.82288	.63	3.87769
.14	3.82398	.64	3.87878
.15	3.82507	.65	3.87988
.16	3.82617	.66	3.88098
.17	3.82727	.67	3.88207
.18	3.82836	.68	3.88317
.19	3.82946	.69	3.88427
55.20	3.83056	55.70	3.88536
.21	3.83165	.71	3.88646
.22	3.83275	.72	3.88755
.23	3.83384	.73	3.88865
.24	3.83494	.74	3.88975
.25	3.83604	.75	3.89084
.26	3.83713	.76	3.89194
.27	3.83823	.77	3.89303
.28	3.83932	.78	3.89413
.29	3.84042	.79	3.89523
55.30	3.84152	55.80	3.89632
.31	3.84261	.81	3.89742
.32	3.84371	.82	3.89851
.33	3.84480	.83	3.89961
.34	3.84590	.84	3.90071
.35	3.84700	.85	3.90180
.36	3.84809	.86	3.90290
.37	3.84919	.87	3.90400
.38	3.85029	.88	3.90509
.39	3.85138	.89	3.90619
55.40	3.85248	55.90	3.90728
.41	3.85357	.91	3.90838
.42	3.85467	.92	3.90948
.43	3.85577	.93	3.91057
.44	3.85686	.94	3.91167
.45	3.85796	.95	3.91276
.46	3.85905	.96	3.91386
.47	3.86015	.97	3.91496
.48	3.86125	.98	3.91605
.49	3.86234	.99	3.91715

MESABA NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
56.00	$3.91824	56.50	$3.97805
.01	3.91944	.51	3.97925
.02	3.92064	.52	3.98044
.03	3.92183	.53	3.98164
.04	3.92303	.54	3.98283
.05	3.92423	.55	3.98403
.06	3.92542	.56	3.98523
.07	3.92662	.57	3.98642
.08	3.92781	.58	3.98762
.09	3.92901	.59	3.98882
56.10	3.93021	56.60	3.99001
.11	3.93140	.61	3.99121
.12	3.93260	.62	3.99240
.13	3.93379	.63	3.99360
.14	3.93499	.64	3.99480
.15	3.93619	.65	3.99599
.16	3.93738	.66	3.99719
.17	3.93858	.67	3.99838
.18	3.93977	.68	3.99958
.19	3.94097	.69	4.00078
56.20	3.94217	56.70	4.00197
.21	3.94336	.71	4.00317
.22	3.94456	.72	4.00436
.23	3.94576	.73	4.00556
.24	3.94695	.74	4.00676
.25	3.94815	.75	4.00795
.26	3.94934	.76	4.00915
.27	3.95054	.77	4.01035
.28	3.95174	.78	4.01154
.29	3.95293	.79	4.01274
56.30	3.95413	56.80	4.01393
.31	3.95532	.81	4.01513
.32	3.95652	.82	4.01633
.33	3.95772	.83	4.01752
.34	3.95891	.84	4.01872
.35	3.96011	.85	4.01991
.36	3.96130	.86	4.02111
.37	3.96250	.87	4.02231
.38	3.96370	.88	4.02350
.39	3.96489	.89	4.02470
56.40	3.96609	56.90	4.02590
.41	3.96729	.91	4.02709
.42	3.96848	.92	4.02829
.43	3.96968	.93	4.02948
.44	3.97087	.94	4.03068
.45	3.97207	.95	4.03188
.46	3.97327	.96	4.03307
.47	3.97446	.97	4.03427
.48	3.97566	.98	4.03546
.49	3.97685	.99	4.03666

MESABA NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
57.00	$4.03786	57.50	$4.10266
.01	4.03915	.51	4.10396
.02	4.04045	.52	4.10525
.03	4.04174	.53	4.10655
.04	4.04304	.54	4.10785
.05	4.04434	.55	4.10914
.06	4.04563	.56	4.11044
.07	4.04693	.57	4.11173
.08	4.04823	.58	4.11303
.09	4.04952	.59	4.11433
57.10	4.05082	57.60	4.11562
.11	4.05211	.61	4.11692
.12	4.05341	.62	4.11822
.13	4.05471	.63	4.11951
.14	4.05600	.64	4.12081
.15	4.05730	.65	4.12210
.16	4.05859	.66	4.12340
.17	4.05989	.67	4.12470
.18	4.06119	.68	4.12599
.19	4.06248	.69	4.12729
57.20	4.06378	57.70	4.12858
.21	4.06507	.71	4.12988
.22	4.06637	.72	4.13118
.23	4.06767	.73	4.13247
.24	4.06896	.74	4.13377
.25	4.07026	.75	4.13506
.26	4.07156	.76	4.13636
.27	4.07285	.77	4.13766
.28	4.07415	.78	4.13895
.29	4.07544	.79	4.14025
57.30	4.07674	57.80	4.14155
.31	4.07804	.81	4.14284
.32	4.07933	.82	4.14414
.33	4.08063	.83	4.14543
.34	4.08192	.84	4.14673
.35	4.08322	.85	4.14803
.36	4.08452	.86	4.14932
.37	4.08581	.87	4.15062
.38	4.08711	.88	4.15191
.39	4.08840	.89	4.15321
57.40	4.08970	57.90	4.15451
.41	4.09100	.91	4.15580
.42	4.09229	.92	4.15710
.43	4.09359	.93	4.15839
.44	4.09489	.94	4.15969
.45	4.09618	.95	4.16099
.46	4.09748	.96	4.16228
.47	4.09877	.97	4.16358
.48	4.10007	.98	4.16488
.49	4.10137	.99	4.16617

MESABA NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
58.00	$4.16747	58.50	$4.20727
.01	4.16826	.51	4.20807
.02	4.16906	.52	4.20887
.03	4.16986	.53	4.20966
.04	4.17065	.54	4.21046
.05	4.17145	.55	4.21125
.06	4.17224	.56	4.21205
.07	4.17304	.57	4.21285
.08	4.17384	.58	4.21364
.09	4.17463	.59	4.21444
58.10	4.17543	58.60	4.21523
.11	4.17623	.61	4.21603
.12	4.17702	.62	4.21683
.13	4.17782	.63	4.21762
.14	4.17861	.64	4.21842
.15	4.17941	.65	4.21922
.16	4.18021	.66	4.22001
.17	4.18100	.67	4.22081
.18	4.18180	.68	4.22160
.19	4.18259	.69	4.22240
58.20	4.18339	58.70	4.22320
.21	4.18419	.71	4.22399
.22	4.18498	.72	4.22479
.23	4.18578	.73	4.22558
.24	4.18657	.74	4.22638
.25	4.18737	.75	4.22718
.26	4.18817	.76	4.22797
.27	4.18896	.77	4.22877
.28	4.18976	.78	4.22956
.29	4.19056	.79	4.23036
58.30	4.19135	58.80	4.23116
.31	4.19215	.81	4.23195
.32	4.19294	.82	4.23275
.33	4.19374	.83	4.23355
.34	4.19454	.84	4.23434
.35	4.19533	.85	4.23514
.36	4.19613	.86	4.23593
.37	4.19692	.87	4.23673
.38	4.19772	.88	4.23753
.39	4.19852	.89	4.23832
58.40	4.19931	58.90	4.23912
.41	4.20011	.91	4.23991
.42	4.20090	.92	4.24071
.43	4.20170	.93	4.24151
.44	4.20250	.94	4.24230
.45	4.20329	.95	4.24310
.46	4.20409	.96	4.24389
.47	4.20489	.97	4.24469
.48	4.20568	.98	4.24549
.49	4.20648	.99	4.24628

MESABA NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
59.00	$4.24708	59.50	$4.28689
.01	4.24788	.51	4.28768
.02	4.24867	.52	4.28848
.03	4.24947	.53	4.28927
.04	4.25026	.54	4.29007
.05	4.25106	.55	4.29087
.06	4.25186	.56	4.29166
.07	4.25265	.57	4.29246
.08	4.25345	.58	4.29325
.09	4.25424	.59	4.29405
59.10	4.25504	59.60	4.29485
.11	4.25584	.61	4.29564
.12	4.25663	.62	4.29644
.13	4.25743	.63	4.29723
.14	4.25823	.64	4.29803
.15	4.25902	.65	4.29883
.16	4.25982	.66	4.29962
.17	4.26061	.67	4.30042
.18	4.26141	.68	4.30122
.19	4.26221	.69	4.30201
59.20	4.26300	59.70	4.30281
.21	4.26380	.71	4.30360
.22	4.26459	.72	4.30440
.23	4.26539	.73	4.30520
.24	4.26619	.74	4.30599
.25	4.26698	.75	4.30679
.26	4.26778	.76	4.30758
.27	4.26857	.77	4.30838
.28	4.26937	.78	4.30918
.29	4.27017	.79	4.30997
59.30	4.27096	59.80	4.31077
.31	4.27176	.81	4.31156
.32	4.27256	.82	4.31236
.33	4.27335	.83	4.31316
.34	4.27415	.84	4.31395
.35	4.27494	.85	4.31475
.36	4.27574	.86	4.31555
.37	4.27654	.87	4.31634
.38	4.27733	.88	4.31714
.39	4.27813	.89	4.31793
59.40	4.27892	59.90	4.31873
.41	4.27972	.91	4.31953
.42	4.28052	.92	4.32032
.43	4.28131	.93	4.32112
.44	4.28211	.94	4.32191
.45	4.28290	.95	4.32271
.46	4.28370	.96	4.32351
.47	4.28450	.97	4.32430
.48	4.28529	.98	4.32510
.49	4.28609	.99	4.32589

MESABA NON-BESSEMER

Per Cent Natural Iron	Lake Erie Price	Per Cent Natural Iron	Lake Erie Price
60.00	$4.32669	60.50	$4.36650
.01	4.32749	.51	4.36729
.02	4.32828	.52	4.36809
.03	4.32908	.53	4.36889
.04	4.32988	.54	4.36968
.05	4.33067	.55	4.37048
.06	4.33147	.56	4.37127
.07	4.33226	.57	4.37207
.08	4.33306	.58	4.37287
.09	4.33386	.59	4.37366
60.10	4.33465	60.60	4.37446
.11	4.33545	.61	4.37525
.12	4.33624	.62	4.37605
.13	4.33704	.63	4.37685
.14	4.33784	.64	4.37764
.15	4.33863	.65	4.37844
.16	4.33943	.66	4.37923
.17	4.34022	.67	4.38003
.18	4.34102	.68	4.38083
.19	4.34182	.69	4.38162
60.20	4.34261	60.70	4.38242
.21	4.34341	.71	4.38322
.22	4.34421	.72	4.38401
.23	4.34500	.73	4.38481
.24	4.34580	.74	4.38560
.25	4.34659	.75	4.38640
.26	4.34739	.76	4.38720
.27	4.34819	.77	4.38799
.28	4.34898	.78	4.38879
.29	4.34978	.79	4.38958
60.30	4.35057	60.80	4.39038
.31	4.35137	.81	4.39118
.32	4.35217	.82	4.39197
.33	4.35296	.83	4.39277
.34	4.35376	.84	4.39356
.35	4.35456	.85	4.39436
.36	4.35535	.86	4.39516
.37	4.35615	.87	4.39595
.38	4.35694	.88	4.39675
.39	4.35774	.89	4.39755
60.40	4.35854	60.90	4.39834
.41	4.35933	.91	4.39914
.42	4.36013	.92	4.39993
.43	4.36092	.93	4.40073
.44	4.36172	.94	4.40153
.45	4.36252	.95	4.40232
.46	4.36331	.96	4.40312
.47	4.36411	.97	4.40391
.48	4.36490	.98	4.40471
.49	4.36570	.99	4.40551