

MEMORANDUM

002084

TO: M.O. Hampton
FROM: F.P. Forrest
DATE: August 18, 1971
SUBJECT: COMPARISON OF PREDICTED AND ACTUAL
ORE GRADE AND TONNAGE

CONCLUSION:

An analysis of the available diamond drill hole and ore blast hole data within respective ore blocks suggests the following conclusions:

On the average, better ore grades will be mined for ore blocks predicted with less than the average pit grade (approximately 10% combined Pb-Zn) and lower ore grades will be mined for ore blocks predicted with greater than the average pit grade.

The correlation of actual ore mined to the predicted grade can be estimated by the equation $y = 0.36x + 6.36$ where y represents the actual grade mined and x represents the predicted grade. The range of error for various degrees of confidence are shown in the text of this report. Ore blocks on the higher benches (4065 and above) tend to be below the average curve and the converse is true for the blocks in the lower benches. This allows one to generalize that better agreement between mined and predicted grade will be obtained within the heart of the orebody than at its periphery. Overweighting of lower values is suggested by the fact that 44% of the total number of samples were obtained from the 4065 bench or above, while this portion of the pit only represents 26% of the total production to July 31, 1971.

The data available for tonnages mined above the 4065 level shows that, with limited ore remaining, only 59% of the predicted ore reserve (1967) was mined.

RECOMMENDATIONS:

Further methods of analysis should be pursued to obtain better reliability. Radial continuity of values could be checked. It has been suggested that a method of contouring equal values and aerial averaging be compared to the ore blast hole data. Other standard methods could be compared.

The reliability of the correlation equation should be appreciated.

The pit progress and ore blast hole data collection and recording system should be revised and maintained.

The comparison of diamond drill hole and ore blast hole data should be up-dated periodically.

Tonnage comparisons should be made regularly.

DISCUSSION:

The study required the compilation of ore blast hole data, ore reserve data, and mined tonnages.

The collection of blast hole data was the most time consuming as it required searching through numerous sources of information. This resulted in the establishment of a defined ore blast hole collection and recording system as documented in my memorandum to you dated July 27, 1971. The data was compiled such that all ore blast hole data within each ore block on each bench was listed on ore block comparison sheets. Block totals and averages were determined. Ore holes which fell outside ore blocks were compiled on separate sheets to be later included with all other information for the bench totals and averages.

The ore reserve data was obtained from original bench plans with revisions for benches 3990 and below, dated July 15, 1970. Selected diamond drill holes were revised to conform to the present bench analysis procedure.

A compilation of pit ore removal was made from the muck sheets and the 1969 planning file.

A data comparison table of ore reserve and ore blast hole assay data was made for ore zones on reserve blocks with over 75% mined out and for 40% to 75% mined out. These values were plotted for comparative purposes. Graph I shows the ratio of ore blast hole combined Pb-Zn assay to the diamond drill hole combined Pb-Zn assay plotted against the diamond drill hole reserve calculation data for ore zones in reserve blocks with greater than 75% mined out. Graph II shows the ratio of the

ore blast hole combined Pb-Zn assay to the revised diamond drill hole combined Pb-Zn assay plotted against the revised diamond drill hole combined Pb-Zn assay. Very little change was apparent between the two graphs. Graph III shows the same data as Graph II but includes all the data for ore zones in reserve blocks for over 40% mined out. The greater than 40% and less than 75% ore zone data corresponds closely to that of the greater than 75% ore zone data and was thus considered representative for further use. Graph IV shows the ore blast hole data plotted against the revised diamond drill hole data for all ore zones having greater than 40% of the ore zone mined out. An average straight line relationship was established on graph IV and the respective error envelopes developed for four sample grouping percentages to establish prediction confidence levels. The results were tabulated. (The phrase, ore zone in reserve blocks, is used because some earlier work shows an ore block extending beyond a later determination of the half bench outline or extending beyond a known ore/waste contact. This allows additional samples to be included in this analysis.)

Data was tabulated for bench tonnage and grade comparisons. With limited ore remaining above the 4065 level, only 59% of the predicted ore reserve has been mined due to the irregularity of the higher zone. For this portion of the pit the predicted combined Pb-Zn assay was 10.5% compared to the mined value of 9.2%.



F.P. Ferrest
Assistant Planning Engineer

Attachments
Calculations
Graph I
" II
" III
" IV
Data

FPF/abc

CALCULATIONS:

AVERAGE GRADE CURVE

$$y = mx + b$$

$$m = \frac{11.0 - 9.0}{13.0 - 7.4} = \frac{2.0}{5.6}$$

$$x = 10.0$$

$$y = 9.93 \quad 9.93 = \frac{2.0}{5.6} (10.0) + b$$

$$b = 9.93 - 3.57 = 6.36$$

$$\underline{\underline{y = 0.36x + 6.36}}$$

check; $x = 13.0$

$$y = 11.0$$

$$11.0 = \frac{2.0}{5.6} (13.0) + 6.36 = 4.64 + 6.36$$

$$11.0 = 11.0$$

ERROR RANGE	(1) 38% of Samples	± 0.54	or	± 0.5
	(2) 51% of Samples	± 0.81	or	± 0.8
	(3) 87% of Samples	± 2.05	or	± 2.1
	(4) 95% of Samples	± 3.96	or	± 4.0

DATA SIGNIFICANT TO ONE DECIMAL PLACE

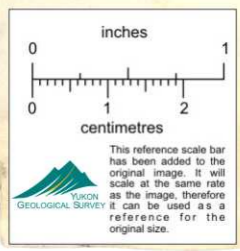
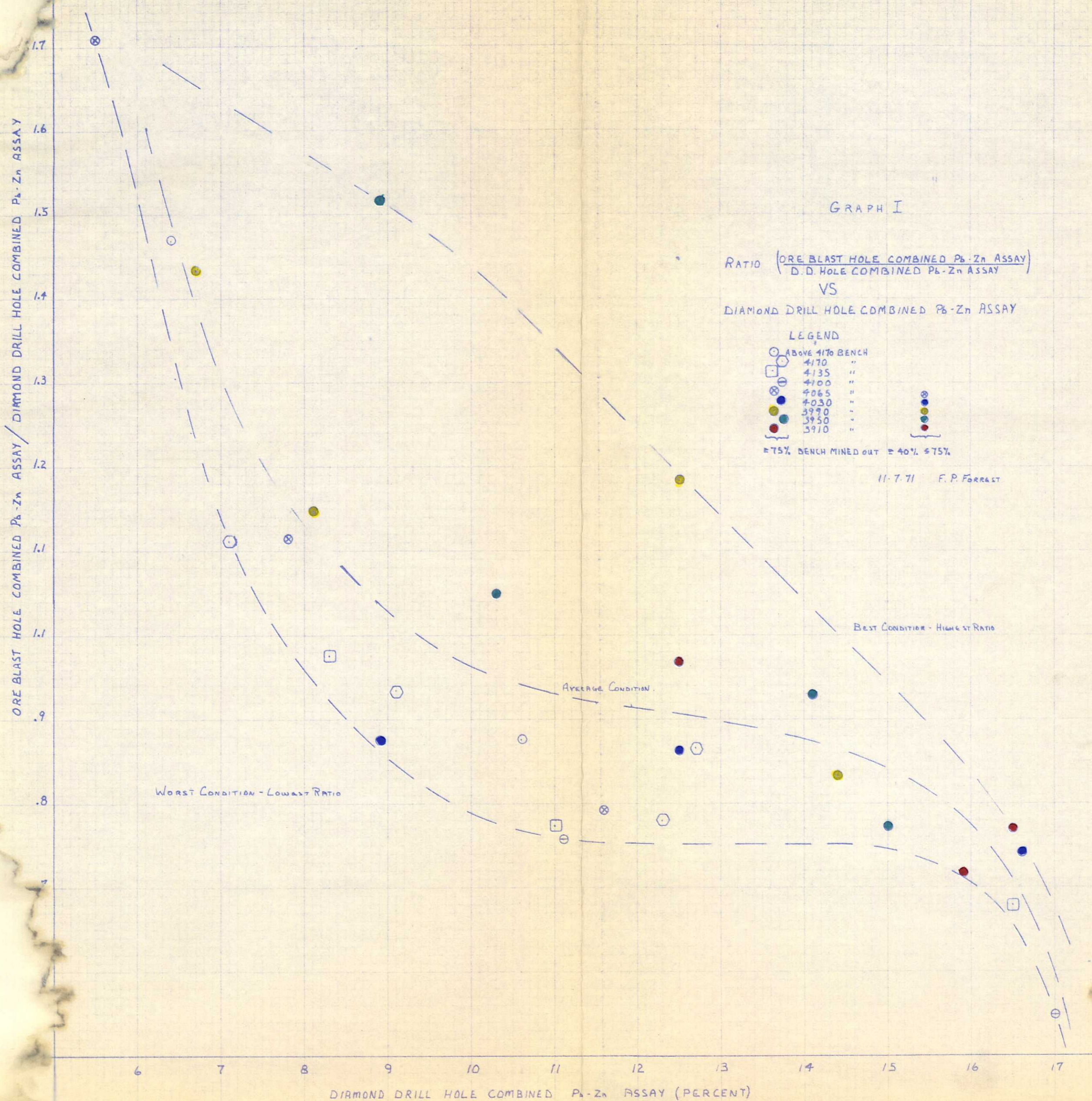
ORE BLAST HOLE COMBINED Pb-Zn ASSAY / DIAMOND DRILL HOLE COMBINED Pb-Zn ASSAY

GRAPH I

RATIO $\left(\frac{\text{ORE BLAST HOLE COMBINED Pb-Zn ASSAY}}{\text{D.D. HOLE COMBINED Pb-Zn ASSAY}} \right)$
 VS
 DIAMOND DRILL HOLE COMBINED Pb-Zn ASSAY

- LEGEND
- ABOVE 4170 BENCH
 - 4170 "
 - ⊗ 4135 "
 - ⊕ 4100 "
 - 4065 "
 - 4030 "
 - 3990 "
 - 3950 "
 - 3910 "
- ± 75% BENCH MINED OUT ± 40% ± 75%

11-7-71 F.P. FORREST



GRAPH II

RATIO $\left(\frac{\text{ORE BLAST HOLE COMBINED Pb-Zn ASSAY}}{\text{REVISED D.D.H. COMBINED Pb-Zn ASSAY}} \right)$

VS

REVISED DIAMOND DRILL HOLE COMBINED Pb-Zn ASSAY

LEGEND

- ABOVE 4170 BENCH
- 4170 "
- ⊕ 4135 "
- ⊖ 4100 "
- ⊗ 4065 "
- 4030 "
- 3990 "
- 3950 "
- 3910 "

≥ 75% BENCH MINED OUT

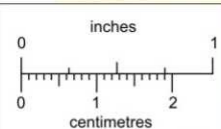
AUG. 17, 1971 B. FOSTER

WORST CONDITION - LOWEST RATIO

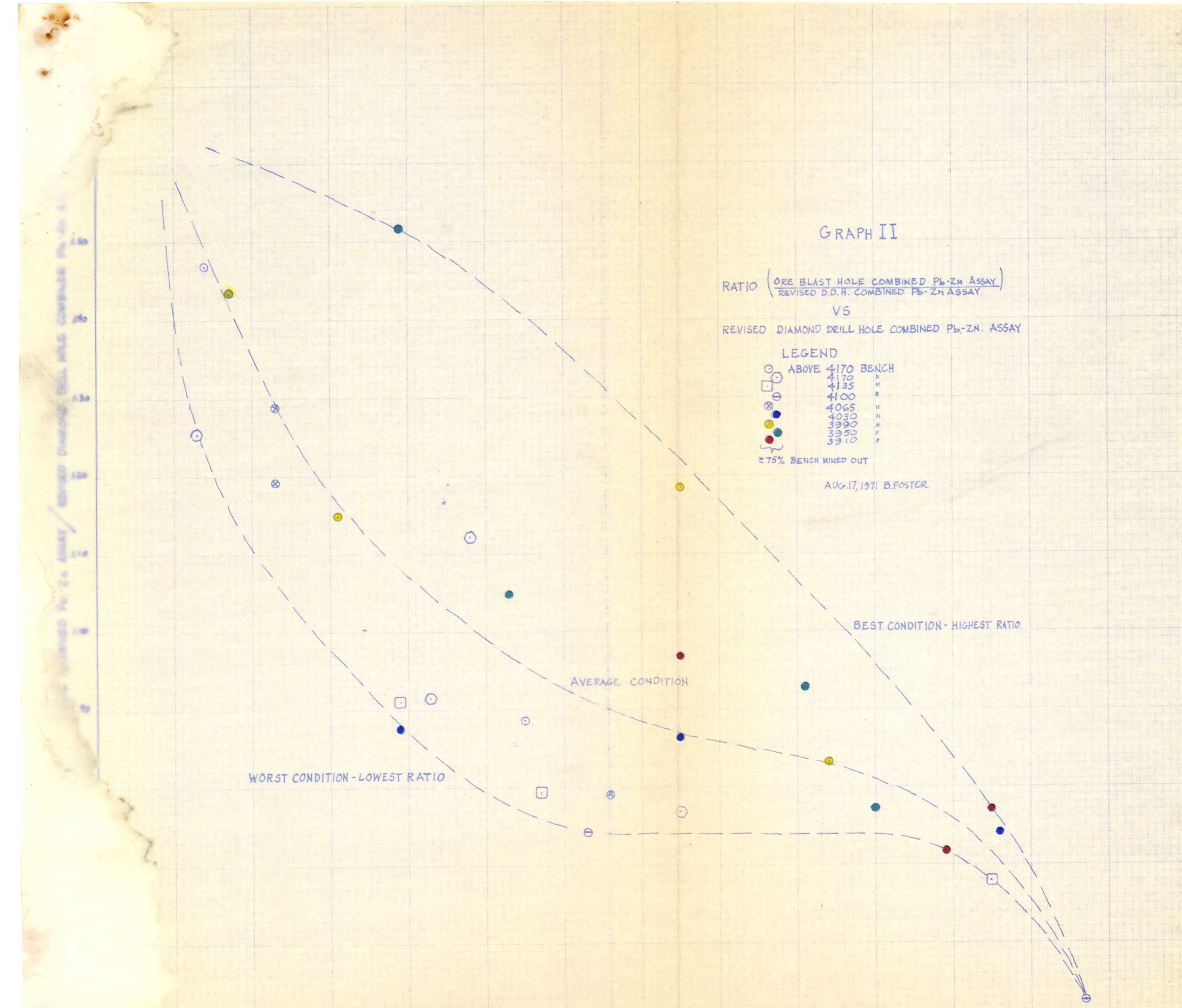
AVERAGE CONDITION

BEST CONDITION - HIGHEST RATIO

REVISED DIAMOND DRILL HOLES COMBINED Pb-Zn ASSAY (PERCENT)



This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.



GRAPH III

RATIO (ORE BLAST HOLE COMBINED Pb-Zn. ASSAY)
 (REVISED D.D.H COMBINED Pb-Zn. ASSAY)

VS

REVISED DIAMOND DRILL HOLE COMBINED Pb-Zn. ASSAY

LEGEND

- ABOVE 4170 BENCH
- 4170
 - 4135
 - 4100
 - 4065
 - 4030
 - 3996
 - 3950
 - 3910

≥75% BENCH MINED OUT ≥40% ≤75%

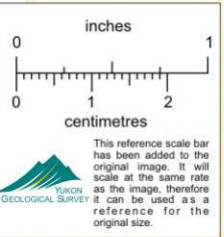
AUG 17, 1971 B.FOSTER

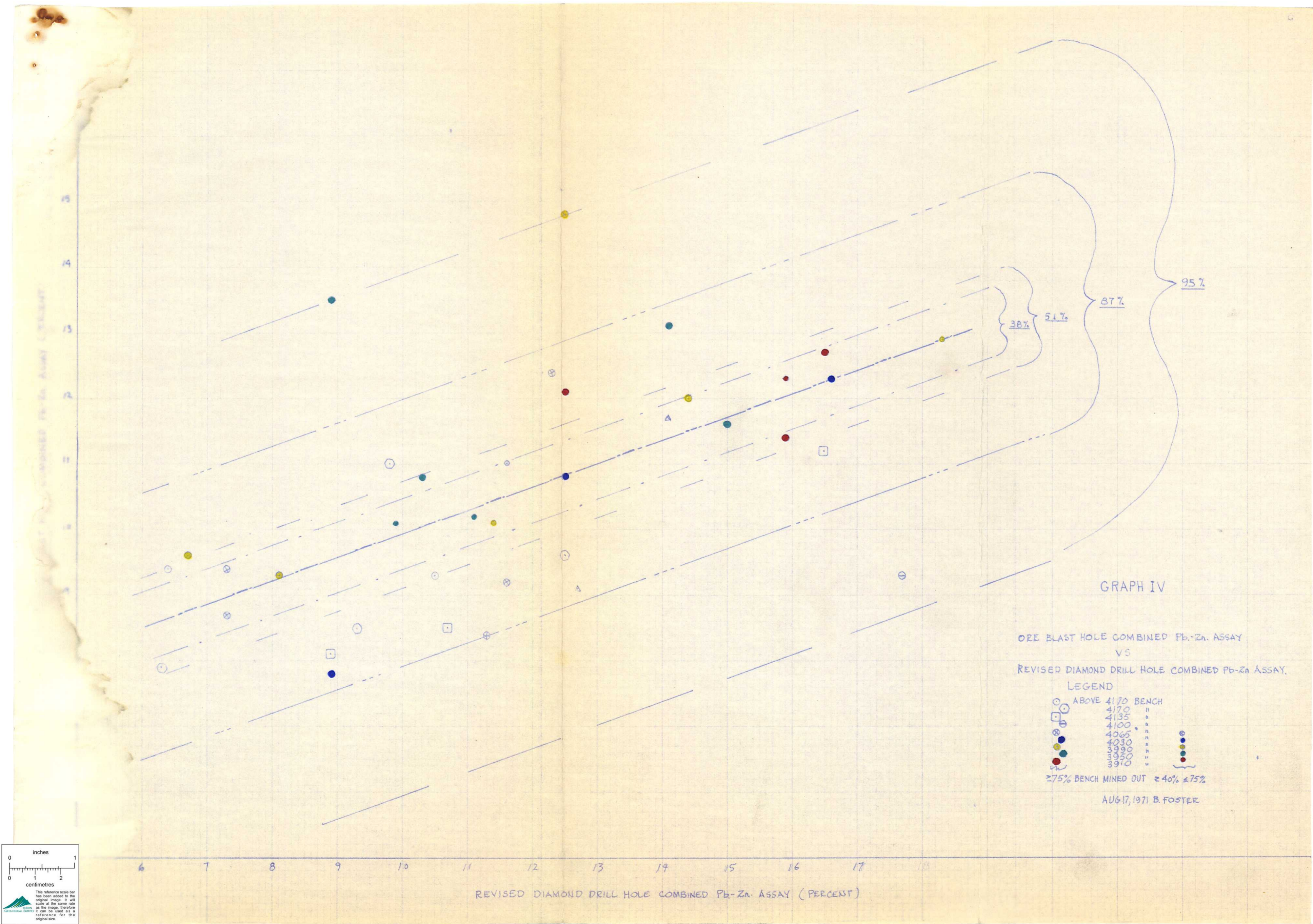
WORST CONDITION - LOWEST RATIO

AVERAGE CONDITION

BEST CONDITION - HIGHEST RATIO

REVISED DIAMOND DRILL HOLES COMBINED Pb-Zn. ASSAY (PERCENT)





THIS SCALE BAR IS NOT TO BE USED TO MEASURE DISTANCES IN THIS PLOT

GRAPH IV

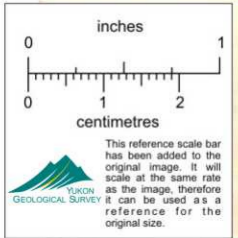
ORE BLAST HOLE COMBINED Pb-Zn ASSAY
 VS
 REVISED DIAMOND DRILL HOLE COMBINED Pb-Zn ASSAY.

LEGEND

○	ABOVE 4170 BENCH	●
□	4170	●
⊗	4135	●
○	4100	●
○	4065	●
○	4030	●
○	3990	●
○	3950	●
○	3910	●

≥75% BENCH MINED OUT ≥40% ≤75%

AUG. 17, 1971 B. FOSTER



REVISED DIAMOND DRILL HOLE COMBINED Pb-Zn ASSAY (PERCENT)

ORE REMOVAL - 1971 (TONS)

<u>Bench</u>	<u>January</u>	<u>February</u>	<u>March</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Cumulative to Date</u>
4275								65
4240								37,145
4205		22,395						100,420
4170		325	35,522 27,760					154,002 146,240
4135			11,536	25,285	13,054 17,238	10,530		235,003 235,187
4100				7,150	31,535			300,745
4065					5,395	1,755		346,060
4030						39,482	2,600	413,557
3990	7,215					49,920	73,970	846,555
3950	210,730	109,750				36,140	178,585	896,800
3910	25,285	132,515 131,215	237,624	277,750 271,640	16,590	3,120	61,880	754,764 747,354
3870					242,632	45,240	390	288,262
	<u>243,230</u>	<u>264,985</u> 263,605	<u>284,682</u> 276,920	<u>310,185</u> 304,075	<u>309,206</u> 309,390	<u>186,187</u>	<u>317,425</u>	<u>4,373,378</u> 4,358,390

Data Source - 1970-71 Daily Muck Sheets
1969 - File 1 - Planning

ORE REMOVAL - 1970 (TONS)

<u>Bench</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>	<u>Sept.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>Cumulative to Date</u>
4275				65						65
4240	260				14,495	65				37,145
4205							585			78,025
4170		5,915								118,155
4135	910		520							174,598
4100	455		4,485	2,600						262,060
4065	93,210	14,235			11,960	130				338,910
4030	95,550	119,145	58,825	130	38,865	30,355	780			371,475
3990		17,290	128,245	124,020	106,535	144,885	129,435	29,355	35,685	715,450
3950							62,575	118,075	180,945	361,595
3910										0
3870										0
	190,385	156,585	192,075	126,815	166,855	175,435	193,375	147,430	216,630	2,457,478

ORE REMOVAL 1969 - 1970 (TONS)

<u>Bench</u>	<u>September</u>	<u>October</u>	<u>November</u>	<u>December</u>	<u>Cumulative</u> <u>to Date</u>	<u>January</u>	<u>February</u>	<u>March</u>	<u>Cumulative</u> <u>to Date</u>
4275									0
4240	22,325				22,325				22,325
4205	60,860	16,580			77,440				77,440
4170		80,065	25,090		105,155	6,110	390	585	112,240
4135		31,663	95,355	30,550	157,568	2,600	13,000		173,168
4100			1,820	141,310	143,130	14,820	3,120	93,450	254,520
4065						121,940	75,790	21,645	219,375
4030								32,825	32,825
3990									0
3950									0
3910									0
3870									0
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
	83,185	128,308	122,265	171,860	505,618	145,470	92,300	148,505	891,893

BENCH GRADE AND TONNAGE COMPARISON

(PORTION OF BENCH MINED TO JULY 31/71)

BENCH	ORE RESERVE DATA (<u>REVISED</u>)				MINED DATA				RATIO (2)/(1)	
	Pb	Zn	COMB	TONNAGE (1)	Pb	Zn	COMB	TONNAGE (2)		
4275			6.7	27,953				65	0.002	
4240	2.5	3.9	6.4	21,176	2.9	6.1	9.0	37,145	1.75	
4205	2.8	6.0	8.8	102,604	3.3	5.9	9.2	100,420	0.98	
4170	3.2	6.7	9.9	374,447	3.2	5.4	8.6	154,002 141,240	0.41 0.37	
4135	3.7	7.9	11.6	366,081	3.2	5.8	9.0	235,003 235,127	0.64 0.64	
4100	5.5	8.0	13.5	363,507	3.0	5.7	8.7	300,745	0.83	
4065	3.8	5.4	9.2	706,971	4.2	6.0	10.2	346,060	0.49	
4030	NOT EASILY RELATED - PART ORE BLOCKS MINED.									
3990	"	"	"	"	"	"	"	"	"	
3950	"	"	"	"	"	"	"	"	"	
3910	"	"	"	"	"	"	"	"	"	
3870	"	"	"	"	"	"	"	"	"	
				20,570,769 1,962,737				10,776,813 1,165,747		0.59
				<u>10.5</u>						<u>9.2</u>

Note: Used Revised D.D. Hole DATA.

DATA COMPARISON (≈ 75% ORE ZONE MINERAL)

ORE RESERVE CALCULATION

ORE BLAST AREA DATA

	<u>ORE RESERVE CALCULATION</u>			<u>ORE BLAST AREA DATA</u>			<u>PLOT SYMBOL</u>	<u>PERCENT BLAST/RESERVE</u>
	<u>Pb</u>	<u>Zn</u>	<u>COMB</u>	<u>Pb</u>	<u>Zn</u>	<u>COMB</u>		
BENCH 4290								
D.D.H.								
66-45	2.5	3.9	6.4	3.3	6.1	9.4	○	146.9
BENCH 4205								
66-1	2.1	4.9	7.0	2.1	5.0	7.1		
66-19	3.3	7.3	10.6	3.4	5.9	9.3	○	87.7
BENCH 4170								
66-48	3.0	4.1	7.1	3.0	4.9	7.9		111.2
66-17	4.2	8.1	12.3	3.7	5.9	9.6		78.0
66-1	4.8	7.9	12.7	3.9	7.1	11.0		86.6
66-24	2.2	6.9	9.1	3.0	5.5	8.5	○	93.4
BENCH 4135								
66-51	2.8	8.2	11.0	2.3	6.2	8.5		77.3
66-1	5.7	10.8	16.5	4.7	6.5	11.2		67.9
66-25	5.0?	6.1?	11.1	5.0	6.1	11.1		
66-24	3.6	4.7	8.3	1.9	6.2	8.1	□	97.6
BENCH 4100								
66-1	6.4	10.6	17.0	3.5	5.8	9.3		54.7
66-25	4.8	6.3	11.1	3.1	5.3	8.4	-	75.7
BENCH 4065								
66-1	1.6?	3.9?	5.5	3.8	5.6	9.4		170.9
66-25	4.9	6.7	11.6	3.9	5.3	9.2		79.3
66-44	4.5	3.3	7.8	3.5	5.2	8.7	x	111.5
BENCH 4030								
66-1	6.6	10.0	16.6	4.8	7.5	12.3		74.1
66-44	5.8	6.7	12.5	4.7	6.1	10.8		86.4
66-32	2.9	6.0	8.9	2.2	5.6	7.8	●	87.6

DATA COMPARISON (≈ 75% ORE ZONE MINED OUT)

Pg 2.

	<u>ORE RESERVE CALCULATION</u>			<u>ORE BLAST HOLE DATA</u>			<u>BLAST / RESERVE</u>
	<u>Pb</u>	<u>Zn</u>	<u>COMB</u>	<u>Pb</u>	<u>Zn</u>	<u>COMB</u>	
BENCH 3990							
D.O.H.							
66-20	6.5	7.9	14.4	4.5	7.5	12.0	83.3
66-44	5.7	6.8	12.5	6.3	8.5	14.8	118.4
66-24	2.7	5.4	8.1	3.6	5.7	9.3	114.8
70-5	2.3	4.4	6.7	3.5	6.1	9.6	143.3
BENCH 3953							
66-20	6.3	8.7	15.0	4.6	7.0	11.6	77.3
66-16	5.9	8.2	14.1	5.7	7.4	13.1	92.9
66-44	3.8	5.1	8.9	5.9	7.6	13.5	151.7
65-11	4.7	5.6	10.3	4.6	6.2	10.8	104.9
BENCH 3910							
66-12	6.8	9.7	16.5	5.1	7.6	12.7	77.0
66-16	7.0	8.9	15.9	4.4	7.0	11.4	71.7
70-6	5.2	7.3	12.5	4.9	7.2	12.1	96.8

DATA COMPARISON ($\geq 75\%$ ORE ZONE MINED OUT)

Page 1002

REVISED ORE RESERVE CALCULATION

ORE BLAST HOLE DATA

	<u>Pb</u>	<u>Zn</u>	<u>COMB</u>	<u>Pb</u>	<u>Zn</u>	<u>COMB</u>	<u>Plot SYMBOL</u>	<u>PERCENTAGE BLAST / RESERVE</u>
BENCH 4240 D.D.H. 66-45	2.5	3.9	6.4	3.3	6.1	9.4	○	146.9
BENCH 4205 66-1	2.1	4.9	7.0	0	0	0		
66-19	(3.4)	(7.1)	(10.5)	3.4	5.9	9.3	○	(88.6)
BENCH 4170 66-48	(2.4)	(3.9)	(6.3)	3.0	4.9	7.9		(125.4)
66-17	(4.3)	(8.2)	(12.5)	3.7	5.9	9.6		(76.3)
66-1	(3.6)	(6.2)	(9.8)	3.9	7.1	11.0	○	(112.2)
66-24	(2.1)	(7.2)	(9.3)	3.0	5.5	8.5		(91.4)
BENCH 4136 66-51	2.8	(7.9)	(10.7)	2.3	6.2	8.5		(77.4)
66-1	5.7	10.8	16.5	4.7	6.5	11.2		67.9
66-25	5.0?	6.1?	11.1	0	0	0		
66-24	(1.4)	(7.5)	(8.9)	1.9	6.2	8.1	□	(91.0)
BENCH 4100 66-1	(6.8)	(10.9)	(17.7)	3.5	5.8	9.3		(52.5)
66-25	(5.0)	(6.3)	(11.3)	3.1	5.3	8.4	○	(74.3)
BENCH 4065 65-1	(2.4)	(4.9)	(7.3)	3.8	5.6	9.4		(128.8)
66-25	4.9	6.7	11.6	3.9	5.3	9.2		79.3
66-44	(4.2)	(3.1)	(7.3)	3.5	5.2	8.7	×	(119.2)
BENCH 4030 65-1	6.6	10.0	16.6	4.8	7.5	12.3		74.1
66-44	5.8	6.7	12.5	4.7	6.1	10.8		86.4
66-32	2.9	6.0	8.9	2.2	5.6	7.8	●	87.6

DATA COMPARISON ($\approx 75\%$ ORE ZONE MINED OUT)

P. 2.

REVISED ORE RESERVE CALCULATION

ORE BLAST HOLE DATA

PERCENTAGE
BLAST / RESERVE
PLOT
SYMBOL

BENCH 3990

	<u>Pb</u>	<u>Zn</u>	<u>COMB</u>
DDH.			
66-20	6.5	7.9	14.4
66-44	5.7	6.8	12.5
66-24	2.7	5.4	8.1
70-5	2.3	4.4	6.7

<u>Pb</u>	<u>Zn</u>	<u>COMB</u>
4.5	7.5	12.0
6.3	8.5	14.8
3.6	5.7	9.3
3.5	6.1	9.6

83.3
118.4
114.8
143.3

BENCH 3950

66-20	6.3	8.7	15.0
66-16	5.9	8.2	14.1
66-44	3.8	5.1	8.9
65-11	4.7	5.6	10.3

4.6	7.0	11.6
5.7	7.4	13.1
5.9	7.6	13.5
4.6	6.2	10.8

77.3
92.9
151.7
104.9

BENCH 3910

66-12	6.8	7.7	16.5
66-16	7.0	8.9	15.9
70-6	5.2	7.3	12.5

5.1	7.6	12.7
4.4	7.0	11.4
4.9	7.2	12.1

77.0
71.7
96.8

(REVISED D.D. HOLE ASSAY DATA)

DATA COMPARISON ($\geq 40\%$, $< 75\%$ ORE ZONE MINE OUT)

REVISED ORE RESERVE CALCULATION

ORE BLAST HOLE DATA

PERCENTAGE
BLAST / RESERVE
PLOT SYMBOL

Pb Zn COMB

Pb Zn COMB

	<u>Pb</u>	<u>Zn</u>	<u>COMB</u>		<u>Pb</u>	<u>Zn</u>	<u>COMB</u>		PERCENTAGE BLAST / RESERVE
BENCH 4065 DDH. 66-1	(4.3)	(8.0)	(12.3)		5.1	7.3	12.4	x	(100.8)
BENCH 3990									
65-1	8.7	9.6	18.3		5.2	7.7	12.9		70.5
70-16	3.8	7.6	11.4		3.8	6.3	10.1	●	88.6
BENCH 3950									
66-15	4.0	7.1	11.1		3.7	6.5	10.2		91.9
66-32	4.1	5.8	9.9		4.5	5.6	10.1	●	102.0
BENCH 3910									
66-44	7.3	8.6	15.9		4.8	7.5	12.3		77.4
65-11	6.4	5.2	11.6		4.4	6.6	11.0	●	94.8
BENCH 3870									
65-11	6.7	7.4	14.1		4.3	7.4	11.7		83.0
70-6	4.8	7.9	12.7		5.2	5.9	9.1	△	71.7

(REVISED D D HOLE ASSAY DATA)