RED FLAT NICKEL PROJECT

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DATE	INITIALS	CODE
7/8	WSM	400

Krupp - Renn Processing

of

Nickeliferous Ore

SOUTHWESTERN ENGINEERING COMPANY
Engineers * Constructors * Manufacturers
4800 Santa Fe Avenue, Los Angeles 58, California

TABLE OF CONTENTS

	Page
Table of Contents	i
Introduction	1
Summary & Conclusions	2
Location & Access	4
Mineralogy	5 - 7
Red Flat Deposit Plot Plan - Sheet 1	Plate I
Red Flat Deposit Plot Plan - Sheet 2	II
Topographical Map - Red Flat Area	III
Assay Values	8 - 17
Fuel	18 - 19
Metallurgy	20 - 22
Market	23
Economics - Carbonization Plant	24 - 26
Price Basis	27
Raw Material Costs	27
Operating Costs	27 - 28
Capital Costs	28
Total Costs	29
Economics - Krupp Renn Plant	30
Price Basis	30
Raw Material Costs	31 - 32
Operating Costs	33
Capital Costs	34
Total Costs	35

INTRODUCTION

During the summer of 1956, Southwestern Engineering Company sampled and tested a group of claims called the Red Flat Nickel project near Gold Beach, Curry County, Oregon.

Mr. Tom Lyons directed the work for Mrs. Rose Nunnemacher. The enclosed study includes an analysis of that sampling and subsequent assaying.

In addition, the application of the Krupp Renn process to this particular project has been considered in detail:

> The cost of the raw materials, the costs of operation, the capital costs involved in the erection of a Renn plant, and the profits to be expected.

SUMMARY AND CONCLUSIONS

Total Cost Per Ton Luppen

Plant Size	3 kilns of 15 x 360 feet
Investment Cost	$15,000,000
Raw Materials	29.04
Operating Costs	28.32
Capital Costs	10.41
Total Costs Per Ton Luppen	67.77

LOCATION AND ACCESS

The Red Flat Nickel Prospect is located in Section 19 & 30, T. 37 S., R 13 W, 8 miles East of Gold Beach, Curry County, Oregon.

Access is possible by traveling South on U. S. Highway 101, 3 miles from Gold Beach and then turning left at Hunters Creek. Proceed 15 miles on the Snow Camp Mountain road to the deposit.

Report on Petrography and Mineralogy of Serpentine and Laterite for Southwestern Engineering Company

March 14, 1957

I. Serpentine

Minerals:

Antigorite-80-90%. Colorless to pale greenish, moderate to low + relief, birefringence 1st order gray to white in thin section. Index of refraction 1.561. Occurs as intergrown plates and lamellae composing the bulk of the rock. Some along tiny veinlets is finely intergrown with iron oxide (mainly limonite) and has a slightly higher birefringence than the "islands" of colorless serpentine it surrounds. The material of the islands corresponds in appearance to the variety of serpentine mineral which has been called serpophite. The islands of serpophite are 0.2-0.3 mm in diameter, while the individual crystals of serpophite composing them, as well as the antigorite crystals surrounding them, are up to about 0.05 mm. in diameter.

Chrysotile- 3%. Colorless, moderate + relief, birefringence 1st order white to yellow. Occurs as veinlets of fibrous individuals oriented perpendicular to the veinlet walls. Iron oxide is commonly present in varying quantities up to about 50% in these veinlets,which are up to 0.5 mm wide.

Limonite- 2-5%. Red in transmitted and reflected light, very fine grained, apparently isotropic. Intergrown with the serpentine minerals as mentioned above, and also as patches up to 0.1 mm diameter with the islands of serpophite.

Hematite- 2-5%. Red in transmitted and reflected light, but much deeper color than the limonite, anisotropic, high relief. As grains 0.1 mm and less scattered thru the whole rock, and as concentrations along small fractures.

Chromite- 1%. Opaque, metallic but dull luster, dark brown on thin edges. 0.02-0.1 mm diam. Frequently as euhedral grains with octahedral shape. Very slightly magnetic.

Magnetite- 2-5%. Opaque, metallic luster, strongly magnetic, sometimes euhedral, but mostly as irregular grains from 0.01-0.1 mm diam.

Pyroxene?-trace. High relief, greenish, high birefringence. Two small remnants noted. Might also be olivine.

Pyrite- 1/2%. Brassy yellow color, cubic shape. 0.05 mm in size.

Opal?-trace. Greenish, almost isotropic, strong-relief. Occurs as a 0.5 mm veinlet with magnetite.

The rock is a typical serpentine, probably developed by alteration of an olivine-or pyroxene-rich rock during the process of cooling. The chromite and part of the magnetite probably represent original constituents of the peridotite. The limonite, hematite, and some of the magnetite were apparently developed during alteration of the serpentine by waters percolating thru the rock from the surface. Limonite appears to be most abundant in the initial stages of the latter alteration, with more and more hematite later developing along cracks.

The foregoing description applies to two thin sections out from the freshest chunks of rock in the sample, plus examination of crushed fragments of more weathered chips. The material in the "representative rock sample" differs from the above description by the presence of appreciably greater alteration to iron oxides in many of the fragments, and along with this a decrease in the amount of serpentine minerals.

II. Laterite.

Minerals:

Hematite- 60-90%. Dark red to opaque. Grain size 0.22 mm & less.

Limonite- 5-25%. Yellowish red. Grain size similar to hematite.

Magnetite- 5-10%. Opaque, metallic luster, strongly magnetic. 0.01-0.1 mm.

Chromite- 1-2%. Opaque, dull metallic luster, weakly magnetic. 0.02-0.1 mm.

Serpentine- 2-5%. Low birefringence, mod. + relief, finely intergrown with limonite.

An X-ray powder pattern of the laterite was made in an attempt to confirm the minerals believed to be present, and find other minerals which might have been missed owing to the generally fine-grained and opaque character of the material. The following lines were recorded:

d spacing	minerals
4.25 A	limonite?
3.68	hematite
3.35	?
2.70	hematite
2.51	"
2.20	"
1.69	"

The peaks were broad and of low intensity, suggesting that the material is very fine grained or else poorly crystalline.

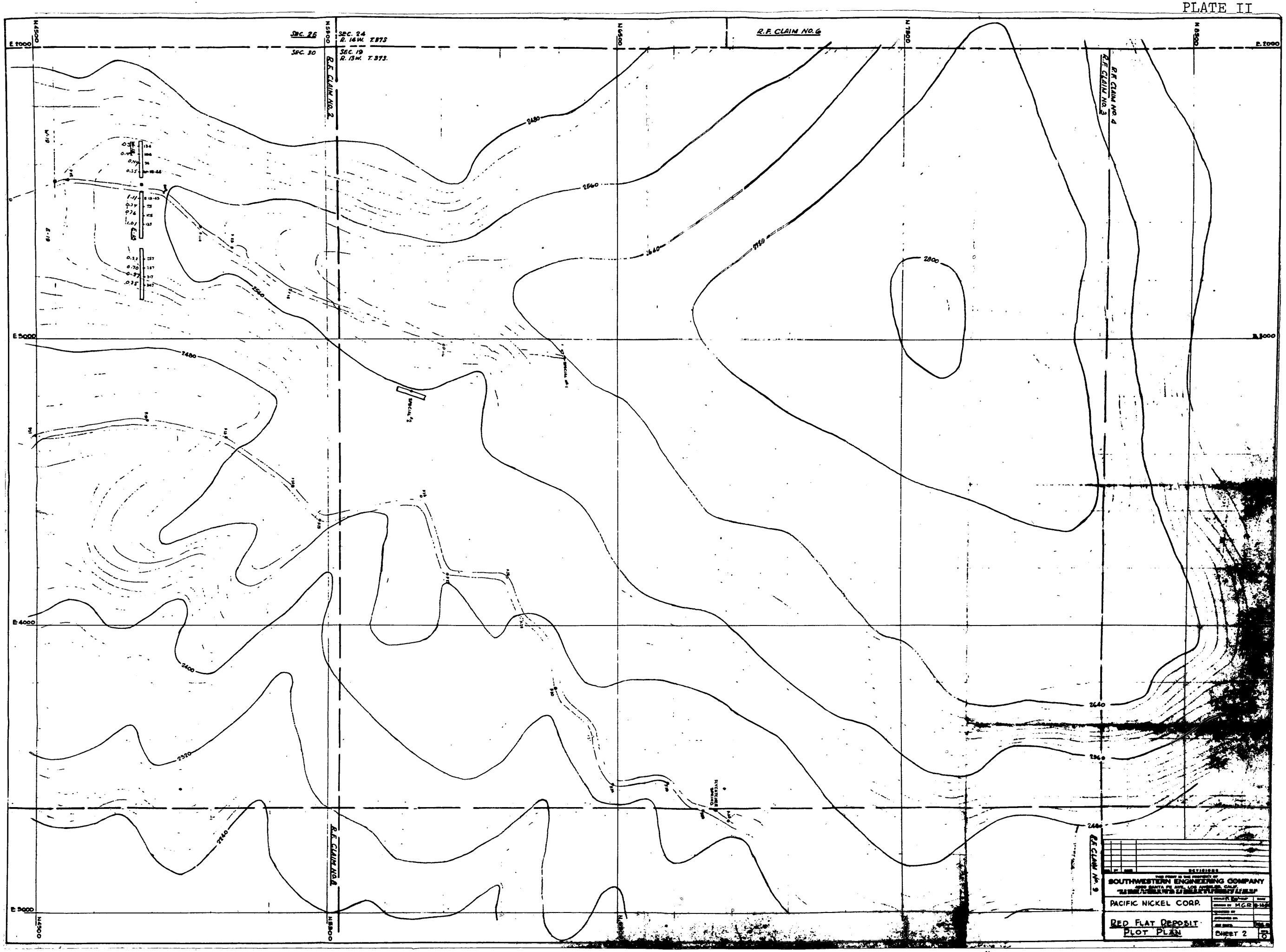
The material is composed dominantly of hematite, developed apparently by a continuation of the alteration and weathering process observed in the serpentine. The chromite and much of the magnetite, as well as the small amounts of serpentine minerals, appear to represent remnants of the original serpentine rock. A considerable amount of fine-grained magnetite seems to have developed in the weathering process, and of course hematite has become the dominant mineral.

(Signed) Arthur W. Rose

The following pages include a report on samples taken, their assay values and their specific locations on the ground. See Plates I, II and III.

Average depth of trenches, types of ores and assays:

	Top Soil	Laterite & Float	Unconsolidated & Peridotite	Total Depth	Assay averages K.D. & E. % Ni	Assay averages K.D & Ledoux % Ni
#18	1.50	1.50	5.80	8.80	0.64	0.80
#20	1.45	5.15	2.80	9.40	0.97)	
#21	1.40	5.30	2.90	9.60	0.98)	
#23	1.23	3.78	2.87	7.88	0.61)	0.87
#24	0.63	3.04	5.44	9.11	0.86)	
#25	1.20	3.20	3.00	7.40	0.82)	
#26	0.80	2.70	5.30	8.80	1.04)	
#27	0.72	3.02	5.07	8.81	.81)	
#28	0.58	3.49	3.74	7.81	1.08	1.12
#29	0.66	3.63	5.65	9.94	0.95	0.95
Aver.	1.01	3.48	4.26	8.75	0.88	0.94


SEC. 25
SEC. 30
SEC. 24
R. 14 W. T. 8 T.S.
SEC. 19
R. 13 W. T. 8 T.S.
R.F. CLAIM NO. 2
R.F. CLAIM NO. 6
R.F. CLAIM NO. 4
R.F. CLAIM NO. 3
R.F. CLAIM NO. 8
R.F. CLAIM No. 9
SPECIAL #2
SPECIAL #1
EXCAVATED SPRING
E 2000
E 3000
E 4000
E 5000
N 4500
N 5000
N 5500
N 6000
N 6500
N 7000
2480
2560
2640
2720
2800
2400
2320
2240
2960
SOUTHWESTERN ENGINEERING COMPANY
PACIFIC NICKEL CORP.
RED FLAT DEPOSIT
PLOT PLAN
SHEET 2

3.2" = 1000'

AVERAGE OF INDIVIDUAL AND COMPOSITE ASSAYS BY SEPARATE TRENCHES

Averages of Assays

		(K.D. & E.)	Ledoux & K.D.
E & W-18	(12 samples)	0.64% Ni	0.80 (Composite #1-10 samples)
E & W-20	(20 samples)	0.97%)	
E & W-21	(28 samples)	0.98%)	
*E & W-22	(3 samples)	0.85%)	(Composite #4-43 samples)
E & W-23	(41 samples)	0.61%)	0.87 (Composite #5-23 samples)
E-24	(40 samples)	0.86%)	(Composite #6-21 samples)
E & W-25	(16 samples)	0.82%)	
E-26	(17 samples)	1.04%	
E-27	(13 samples)	0.81%	
E-28	(19 samples)	1.08%	1.12 (Composite 'A' & B - 17 samples)
E-29	(24 samples)	0.95%	0.95 (Composite A,B & C - 24 samples)
Average		0.87%	0.94
Average by number of samples		0.86%	0.91
Length of trench x assay		0.99%) slide rule calculations	
Length x depth x assay		0.87%)	

K.D. & E. - 233 samples - 160 assays
Ledoux & K.D. - 138 samples - 9 assays

*Omitted from general average due to shallow trenching

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CALCULATIONS FOR COMPUTING TONNAGE USING SPECIFIC GRAVITY DETERMINATIONS

Specific gravity tests

Laterite

59.00 grams displaced 18.1 ml water = 3.26 sp. gr.

Serpentine

51.25 grams displaced 19.9 ml water = 2.58 sp. gr.

Tonnage calculations:

	Depth in ft.	%	Sp. gr.
Top soil & laterite	4.488	51.3	3.26
Serpentinized peridotite	4.257	48.7	2.58
	8.745	100.0	2.93

	% Wt.	Cubic ft/ton
Estimated free water	25.0%	32.0
Dry ore (Sp.gr. 2.93)	75.0%	10.9
	100.0%	16.2

AVERAGE OF THE ASSAYS FROM EACH TRENCH

						Trench Average
E-18-45-347	8 assays	-	Average	0.80% Ni	(6-E-2-KD)	
W-18-44-134	4 assays	-	Average	0.38%	(E)	0.64%
E-20-66-530	11 assays	-	Average	0.79%	(E)	
W-20-85-315	9 assays	-	Average	1.19%	(K-D)	0.97%
E-21-65-555	14 assays	-	Average	0.79%	(12-E-2-KD)	
W-21-83-513	14 assays	-	Average	1.16%	(K.D.)	0.98%
E-22-52-82	2 assays	-	Average	0.92%	(K.D.)	
W-22-100	1 assay	-	Average	0.72%	(E)	0.85%
E-23-86-656	18 assays	-	Average	0.69%	(E)	
E-23-1054-1324	1 assay	(10 sample composite)		0.65%	(K.D.)	
W-23-64-454	13 assays	-	Average	0.46%	(E)	0.61%
E-24-63-2143	24 assays	-	Average	0.86%	(15-E-9-KD)	
E-24-653-883	1 assay	(3 sample composite)		0.95%	(KD)	
E-24-1123-1333	1 assay	(8 sample composite)		0.88%	(KD)	
E-24-1873-2143	1 assay	(5 sample composite)		0.78%	(KD)	0.86%
E-25-97-467	11 assays	-	Average	0.76%	(6-KD-5-E)	KD 0.90%
W-25-51-171	5 assays	-	Average	0.94%	(KD)	E & KD 0.82%
E-26-380-560	7 assays	-	Average	0.44%	(E)	
E-26-955-1165	1 assay	(8 sample composite)		1.24%	(KD)	(Average
E-26-1195-1435	1 assay	(9 sample composite)		1.33%	(KD)	(E & KD 1.04%)
E-27-82-642	13 assays	-	Average	0.81%	(9-KD-4-E)	0.81%
E-28-80-441	1 assay	(10 sample composite)		1.28%	(KD)	
E-28-611-901	1 assay	(7 sample composite)		0.88%	(KD)	
E-28-931-961	2 assays	-	Average	0.77%	(1-KD-1-E)	1.08%
E-29-110-320	1 assay	(8 sample composite)		0.83%	(KD)	
E-29-440-710	1 assay	(9 sample composite)		0.94%	(KD)	0.95%
E-29-890-1060	1 assay	(7 sample composite)		1.09%	(KD)	

AVERAGE OF INDIVIDUAL ASSAYS BY KENNARD & DRAKE

E-18-317	-	0.97%
E-18-347	-	0.88%
W-20- 85	-	1.22%
W-20-135	-	1.02%
W-20-165	-	1.07%
W-20-195	-	1.38%
W-20-225	-	1.25%
W-20-255	-	1.39%
W-20-285	-	1.55%
W-21- 83	-	1.14%
W-21-113	-	1.21%
W-21-143	-	1.01%
W-21-173	-	1.04%
W-21-203	-	1.12%
W-21-233	-	1.23%
W-21-263A	-	1.00%
W-21-293	-	1.05%
W-21-313	-	1.50%
W-21-393	-	1.53%
W-21-513	-	1.23%
E-21-525	-	1.04%
E-21-555	-	0.87%
E-22-52	-	1.01%
E-22-82	-	0.84%
E-23-357	-	0.82%
E-23-387	-	0.84%
E-23-447	-	1.12%
E-23-477	-	1.06%
E-24-213	-	1.20%
E-24-243	-	1.47%
E-24-373	-	1.28%
E-24-403	-	0.46%
E-24-433	-	1.22%
E-24-503	-	0.64%
E-24-593	-	1.24%
E-24-943	-	0.61%
E-24-1933	-	1.01%
E-24-2053	-	1.01%
W-25- 51	-	1.38%
W-25- 81	-	0.91%
W-25-111	-	0.83%
W-25-141	-	0.81%
W-25-171	-	0.79%
E-25- 97	-	0.93%
E-25-127	-	0.99%
E-25-157	-	0.83%
E-25-177	-	0.77%
E-25-287	-	0.84%
E-25-317	-	0.98%
E-27- 82	-	1.10%
E-27-152	-	1.12%
E-27-242	-	0.75%
E-27-332	-	0.73%
E-27-382	-	0.91%
E-27-412	-	0.87%
E-27-552	-	0.65%
E-27-612	-	0.77%
E-27-642	-	0.97%
E-28-961	-	0.91%
		59.94%

59 assays

Average 1.02%

AVERAGE OF INDIVIDUAL ASSAYS BY EISENHAUER

W-18- 44	-	0.35%
W-18- 74	-	0.44%
W-18-104	-	0.42%
W-18-134	-	0.32%
E-18- 45	-	1.11%
E-18- 75	-	0.74%
E-18-105	-	0.76%
E-18-135	-	1.01%
E-18-257	-	0.22%
E-18-287	-	0.70%
W-20-315	-	0.94%
E-20- 66	-	0.86%
E-20-260	-	0.78%
E-20-290	-	0.70%
E-20-320	-	0.99%
E-20-350	-	0.93%
E-20-380	-	0.80%
E-20-410	-	0.73%
E-20-440	-	0.88%
E-20-470	-	0.75%
E-20-500	-	0.56%
E-20-530	-	0.70%
W-21-423	-	1.25%
W-21-453	-	1.04%
W-21-483	-	0.95%
E-21- 65	-	0.79%
E-21- 95	-	0.93%
E-21-125	-	0.94%
E-21-155	-	1.17%
E-21-175	-	0.95%
E-21-315	-	0.50%
E-21-345	-	0.53%
E-21-375	-	0.66%
E-21-405	-	0.90%
E-21-435	-	0.65%
E-21-465	-	0.62%
E-21-495	-	0.49%
W-22-100	-	0.72%

W-23- 64	-	0.88%
W-23- 94	-	0.43%
W-23-124	-	0.56%
W-23-154	-	0.55%
W-23-214	-	0.64%
W-23-244	-	0.22%
W-23-274	-	0.27%
W-23-304	-	0.46%
W-23-334	-	0.32%
W-23-364	-	0.46%
W-23-394	-	0.30%
W-23-424	-	0.54%
W-23-454	-	0.31%
E-23- 86	-	0.55%
E-23-116	-	0.35%
E-23-146	-	0.92%
E-23-166	-	0.26%
E-23-266	-	0.47%
E-23-296	-	0.53%
E-23-326	-	0.47%
E-23-506	-	0.63%
E-23-536	-	0.94%
E-23-566	-	0.73%
E-23-596	-	0.71%
E-23-626	-	0.64%
E-23-656	-	0.76%
E-24- 63	-	0.74%
E-24- 93	-	0.94%
E-24-123	-	0.77%
E-24-273	-	0.87%
E-24-463	-	0.84%
E-24-443A	-	0.98%
E-24-473A	-	0.72%
E-24-533	-	0.69%
E-24-563	-	0.59%
E-24-623	-	1.07%
E-24-853	-	0.65%
E-24-913	-	0.57%
E-24-1903	-	0.58%
E-24-1963	-	0.77%
E-24-2083	-	0.93%

E-25-347	-	0.44%
E-25-377	-	0.86%
E-25-407	-	0.46%
E-25-417	-	0.70%
E-25-437	-	0.64%
E-25-467	-	0.62%
E-26-380	-	0.35%
E-26-410	-	0.40%
E-26-440	-	0.40%
E-26-470	-	0.41%
E-26-500	-	0.47%
E-26-530	-	0.56%
E-26-560	-	0.48%
E-27-212	-	0.72%
E-27-272	-	0.73%
E-27-442	-	0.62%
E-27-582	-	0.64%
E-28-931	-	0.55%
		64.44

97 samples

Average 0.66%

AVERAGE DEPTH OF THE THREE TYPES OF ORES FROM INDIVIDUAL TRENCHES

Note: All parts of trenches less than five feet deep omitted in the following calculations.

	Top Soil	Laterite & Float	Unconsolidated & Peridotite	Total Depth
W-18- 24-144	1.7	0.3	8.0	10.0
E-18- 25-175	1.5	2.7	3.2	7.4
E-18-227-397	1.2	1.4	6.2	8.8
	4.4	4.4	17.4	26.2
Average	1.5	1.5	5.8	8.8
W-20- 45-355	1.6	3.5	3.7	8.8
E-20-240-570	1.3	6.8	1.9	10.0
	2.9	10.3	5.6	18.8
Average	1.45	5.15	2.80	9.40
E-21- 45-195	1.3	4.8	4.1	10.2
E-21-255-565	1.5	7.9	0.3	9.7
W-21- 73-513	1.3	3.2	4.2	8.7
	4.1	15.9	8.6	28.6
Average	1.4	5.3	2.9	9.6
W-23- 54-454	1.5	3.5	3.5	8.5
E-23- 86-176	1.5	4.5	1.5	7.5
E-23-256-336	1.5	3.9	0.4	5.8
E-23-347-487	1.5	2.4	2.3	6.2
E-23-496-676	1.1	5.0	3.1	9.2
E-23-1034-1334	0.3	3.4	6.4	10.1
	7.4	22.7	17.2	47.3
Average	1.23	3.78	2.87	7.88
E-24- 43-133	0.7	6.3	1.5	8.5
E-24-203-293	0.4	0.7	8.2	9.3
E-24-353-483	1.1	1.3	8.4	10.8
E-24-443A-653	0.9	2.7	5.4	9.0
E-24-803-953	0.6	4.9	2.7	8.2
E-24-1153-1353	0.2	2.0	7.9	10.1
E-24-1853-2163	0.5	3.4	4.0	7.9
	4.4	21.3	38.1	63.8
Average	0.63	3.04	5.44	9.11

	Top Soil	Laterite & Float	Unconsolidated & Peridotite	Total Depth
E-26-370-590	1.3	3.2	3.0	7.5
E-26-905-1455	0.3	2.2	7.6	10.1
	1.6	5.4	10.6	17.6
Average	0.8	2.7	5.3	8.8
E-27- 62-262	0.500	2.237	5.000	7.737
E-27-322-442	0.808	3.077	4.808	8.693
E-27-552-642	0.850	3.750	5.400	10.000
	2.158	9.064	15.208	26.430
Average	0.719	3.021	5.069	8.810
E-28- 70-210	0.357	3.071	4.964	8.392
E-28-301-451	0.467	1.038	7.731	9.236
E-28-601-731	0.604	6.437	None	7.041
E-28-861-981	0.900	3.400	2.250	6.550
	2.328	13.946	14.945	31.219
Average	0.582	3.487	3.736	7.805
E-29-100-320	0.159	3.545	6.432	10.136
E-29-430-560	0.375	7.458	1.500	9.333
E-29-610-710	1.200	1.300	6.400	8.900
E29-880-1060	0.895	2.211	8.263	11.369
	2.629	14.514	22.595	39.738
Average	0.657	3.628	5.649	9.934
E-16-06-256	0.66	0.44	8.60*	9.70
W- 9-110-270	0.86	0	9.40*	10.26
W- 9-250-490	0.60	1.50	8.20*	10.30
W- 9-630-830	0.85	0.14	9.81*	10.80
	2.31	1.64	27.41	31.36
Average	0.77	0.55	9.14	10.46
W-25- 51-181	0.9	1.5	3.9*	6.3
E-25- 77-197	1.4	2.4	3.8*	7.6
E-25-287-487	1.4	5.8	1.2*	8.4
	3.7	9.7	8.9	22.3
Average	1.2	3.2	3.0	7.4

* Unconsolidated serpentinized peridotite and peridotite.

AVERAGE DEPTH IN FEET

	Top Soil	Laterite & Float	Unconsolidated serpentinized peridotite and peridotite	Total Depth	% Ni
9-W-110-270	0.86	0	9.40	10.26	0.47
9-W-250-490	0.60	1.50	8.20	10.30	
9-W-630-830	0.85	0.14	9.81	10.80	0.37
	2.31	1.64	27.41	31.36	
Average	0.77 9"	0.55 0-6"	9.14 9'1½"	10.46	0.42
Average by number of samples					0.44

W-9 - Composite 'A' 0.47%Ni - 13 samples - (120-470)
W-9 - Composite 'B' 0.37%Ni - 7 samples - (630-810)

E-16-06-256	0.66	0.44	8.60	9.70	0.42

E-16 - Composite 'A' 0.42%Ni - 9 samples - (16-256)

FUEL

Reduction fuel for the Renn process must be material with volatile combustible matter of 10% or less. Since anthracite and coke breeze is unavailable at a reasonable price, on the West Coast, it is necessary to subject available fuels to low temperature carbonization.

The nearest available fuels are located 2 townships north of Gold Beach between Marshfield, Oregon and Coquille, Oregon. This coal would be of sub-bituminous or lignite rank. Friability of the coals appears to range around 27%. The slag index is around 25%. Agglomeration tests on samples indicate that the coals are non-coking in character and produce a non-coherent granular char rather than coke when subjected to low temperature carbonization.

A low temperature carbonization test was made on a large sample of coal from the Southport Mine near Marshfield, Oregon and was submitted by the State Department of Geology & Mineral Industries from Oregon to the American Lurgi Corporation in 1944. Each ton of coal produced a char of 62.4%, tar oil of 7%, and gas of 12%, with water 18.6%. It is expected that this type of yield could be obtained from other coals in the Coos Bay District and that sufficient tonnages are probably available in this district to be utilized in the operation of a Renn plant near Gold Beach, Curry County, Oregon.

An extremely thorough study has been made of the Geology & coal resources of the Coos Bay Quadrangle in Oregon by John Eliott Allen, & Ewart M. Baldwin. This study is known as Bulletin No. 27 and has been issued by the State of Oregon, Department of Geology & Mineral Industries, 702 Woodlark Building, Portland 5, Oregon. It is available for purchase price of $1.00.

FUEL
(Continued)

We have used the information in that bulletin to arrive at figures for fuel costs.

1957
CODE

Metallurgy

For

Krupp - Renn Process

Nickeliferous Laterite & Serpentine

Red Flat Nickel Prospect

I The nickeliferous laterites and underlying serpentines of the Red Flat area would produce material of approximately the following analysis. This information is based on SWECO work and the U. S. Bureau of Mines "Report of Investigation 5072 - Preliminary Investigation of the Red Flats Nickel Prospect".

A.

Laterite			Serpentine	Dry Basis
Fe	=	29.0%	10.0%	Water (Free) 15%
Ni	=	.91%	.91%	
Co	=	.10%	.10%	
Al_2O_3	=	6.0%	2.0%	
Cr_2O_3	=	2.5%	1.0%	
CaO	=	1.1%	1.2%	
MgO	=	5.5%	25.0%	
SiO_2	=	26.0%	40.0%	
S	=	.04%	.04%	
P	=	.18%	.18%	
O_2	=	12.0%	4.0%	
Loss on Ignition	=	11.4%	10.0%	

Metallurgy
(Continued)

II. Due to high magnesia content of serpentine it is necessary to blend laterite with serpentine to produce an acceptable feed. We shall assume a ratio of one to one for this study.

Constituent	Fe	Ni	Co	Al_2O_3	Cr_2O_3	CaO	MgO	SiO_2	S	P	O_2	L.O.I.
Serpentine	10.0	.91	.10	2.0	1.0	1.2	25.0	40.0	.04	.18	4.0	10.0
Laterite	29.0	.91	.10	6.0	2.5	1.1	5.5	26.0	.04	.18	12.0	11.4
Combined	39.0	1.82	.20	8.0	3.5	3.3	30.5	66.0	.08	.36	16.0	21.4
Mill Feed Average	19.5	.91	.10	4.0	1.8	1.1	15.2	33.0	.04	.18	8.0	10.7

Plant Feed		Flux	Slag	Slag %
Fe	19.5%			
Ni	.91%			
Co	.10%			
Al_2O_3	4.0%	5%	9.0	15.0%
Cr_2O_3	1.8%		1.4	2.34
CaO	1.1%		1.1	1.84
MgO	15.2%		15.2	25.46
SiO_2	33.0%		33.0	55.36
S	.04%		59.7	100.00%
P	.18%			
O_2	8.0%			
L.O.I.	10.7%			

Metallurgy
(Continued)

III Product

The recovery of nickel in this process is generally in excess of 90% of the contained nickel and 92% of the contained iron.

Assume ore Fe = 19.5%: Recovery 92%: Product Fe 91%:

$$\frac{91 \text{ Fe in product}}{92 \text{ recovery}} \times \frac{100}{19.5 \text{ Fe in ore}} = 5.07 \text{ tons ore/ton luppen}$$

Thus the final product will contain:

$$\frac{90\%}{100} \times .91 \text{ Ni} \times 5.07 = 4.15\% \text{ Ni}$$

or 84# of nickel per ton of luppen

The luppen will assay approximately as follows, if the foregoing raw materials are used:

Fe	91.0%
Ni	4.15%
C	.8%
Cr_2O_3	.1
SiO_2	2.0
MgO	1.1
Al_2O_3	.4
S	.35
P	.1

MARKET

The U. S. Nickel Market has been established by the International Nickel Company at $ .74 per pound of nickel.

The U. S. Government is paying up to $1.42 per pound for nickel being purchased for the stock pile.

A similar nickel luppen being made in Greece with 4 1/2% nickel has been sold in France for $2.00 per pound of contained nickel in multi-thousand ton lots.

The iron content of the luppen should bring a price of $.03 per pound.

Using these three markets, the luppen will be valued at:

International Nickel Company	
(84# x $.74) + (.03 x 1820#) =	116.76/ton luppen
U. S. Government	
(84# x $1.42) + (.03 x 1820#) =	173.88/ton luppen
World Market	
(84# x 2.00) + (.03 x 1820#) =	222.60/ton luppen

Economics

Krupp - Renn Plant

Total Cost Per Ton Luppen

Plant Size	3 kilns of 15 x 360 feet
Investment Cost	$15,000,000
Raw Materials	29.04
Operating Costs	28.32
Capital Costs	10.41
Total Costs Per Ton Luppen	67.77

Economics
(Continued)

The profit situation of a plant of this nature would vary according to the market (iron at $.03/#).

Price of Nickel			Profit Per Ton Luppen	108,000 tons/year Profit per year
Ni	$ .74/#	116.76 - 67.77	$ 48.99	$ 5,290,900
Ni	$1.42/#	173.88 - 67.77	$ 106.11	$ 11,459,900
Ni	$2.00/#	222.60 - 67.77	$ 154.83	$ 16,721,600

Economics

C O M P U T A T I O N S

For

Low Temperature Carbonization Process

Coal With 40% Volatiles

Basic Variable Data	Assumptions
a. Cost per ton of coal at site	$5.40/ton
b. Cost of electric power - cents per kwh	$ .01/kwh
c. Cost of water - cents per 1000 gallons	$ .25/1000 gals.
d. Cost of steam - price per ton	$1.82/ton
e. Cost of labor - labor - hourly rate	$2.30
foremen - hourly rate	$3.00
f. Market price of tar oil - produced - cents/gallon	$ .06/gal.

Basic Fixed Data

880 tons coal per day feed

550 tons coke per day produced

Operating 340 days per year

Connected load - 325 kw per hour

Water Consumption - 13,750 gallons per hour

Steam Consumption - 1.1 tons per hour

Heat Value of surplus gas - 3168 x 10^6 Btu per day

Repairs & Maintenance - 6% investment/year

Fringe Benefits on hourly wages - 20%

Supervision Salaries - 20% of labor

Amortization - 5% per year on investment

Interest - 5% per year on unpaid balance

COMPUTATIONS

For

Low Temperature Carbonization Process

2 - 440 ton per day units

Basis: 880 tons coal

550 tons coke

340 days per year

		per day	per ton coke
I	RAW MATERIAL		
	880 tons coal		
	5.40/t x 880 tons/day	4,752.00	8.64
	Raw Material Cost	4,752.00	8.64
II	OPERATING COSTS		
	A. Power 325 kw connected load	78.00	.14
	325 kw x 24 hrs. x .01		
	B. Water 13,750 gals/hr. x 24 hrs. x .25/1000 gals.	82.50	.15
	C. Steam 1.1 tons/hr.		
	1.1 t/hr. x 24 hrs. x 1.82/ton	48.00	.09
	D. Repairs & Maintenance 6% Investment/year		
	$\frac{6\%}{100}$ x $1,964,500 ÷ 340 days	346.67	.63
	E. Wages - Labor 2.30/hr. - Supervision 3.00/hr.		
	20% fringe benefits		
	2.30/hr. x 8 hrs. x 16 men x 1.2 fr. ben. x $\frac{365}{340}$ days	379.22	.69

II OPERATING COSTS (Continued)	per day	per ton coke
E. (Cont'd)		
Foremen		
3.00/hr. x 8 hrs. x 3 men x 1.2 fr. ben. x $\frac{365}{340}$	92.75	.17
F. Salaries		
20% of wages		
$\frac{20\%}{100}$ x (92.75 + 379.22)	94.39	.17
Operating Cost Total	1,121.53	2.04

III CAPITAL COSTS	
A. Investment	
1. Plant Delivered German Port 5,010,500 DM ÷ 4.20 DM/$	1,195,000
2. Additional Construction $2,598,750 ÷ 4.20 DM/$	619,500
3. Coke & Coal Preparation Plants $150,000	150,000
Investment Total	1,964,500
B. Amortization 5%/year	
5% x 1,964,500 ÷ 340 days	288.89
	.53

		per day	per ton coke
III	CAPITAL COSTS (Continued)		
	C. Interest 5% on unpaid balance		
	1/2 time x 5.0% x $1,964,500		
	÷ 340 days	144.45	.26
	Capital Cost Total	433.34	.79
TOTAL COSTS			
I	RAW MATERIALS	4,752.00	8.64
II	OPERATING COSTS	1,121,53	2.04
III	CAPITAL COSTS	433.34	.79
	TOTAL COSTS	6,306.87	11.47
IV	INCOME, BY-PRODUCT		
	A. Tar oil .06/gal; 60 tons/day		
	.06/gal. 60 tons x 2000 lbs./ton ÷ 8 lbs./gal.	900.00	1.64
	B. Surplus Gas - Heat Value		
	3168 x 10^6 Btu/day		
	Heat Value - Coal		
	22.3 x 10^6 Btu/ton coal		
	$\frac{5.40/\text{ton} \times 3168 \times 10^6 \text{ Btu}}{22.3 \times 10^6 \text{ Btu/ton}}$	766.80	1.39
Total Income (By-Product)		1,666.80	3.03
V	NET COKE COSTS		
	TOTAL PLANT COSTS	6,306.87	11.47
	LESS INCOME	1,666.80	3.03
	NET COKE COSTS	4,640.07	8.44

Economics

COMPUTATIONS

For

Krupp - Renn Plant

Nickeliferous Ore

Basic Variable Data	Assumptions
a. Luppen production	
$\frac{\%\ \text{Fe in product}}{\%\ \text{recovery}} \times \frac{100}{\%\ \text{Fe in ore}} = \frac{\text{No. tons ore}}{\text{Ton luppen}}$	
$\frac{91\%}{92\%} \times \frac{100\%}{19.5\%} =$	5.07
b. Cost of ore per ton at mine	1.00
c. Freight on ore per ton - mine to plant	.50
d. Cost of flux per ton at source	4.00
e. Freight on flux per ton - source to site	1.00
f. Cost of coal per ton at mine	5.00
g. Freight on coal per ton - mine to site	.40
h. Cost of coke per ton at source	8.44
i. Freight on coke per ton - source to site	4.25
j. Cost of water at site - cents per 1000 gallons	.25
k. Cost of electric power at site - cents per kwh	.01
l. Cost of labor - hourly rate	2.30
m. Amount of fuel for reduction expressed in % per ton ore	28%
n. Amount of fuel for heating expressed in % per ton ore	8%
o. Amount of flux required expressed in % per ton ore	5%

Basic Fixed Data

Amortization - 5%/year on investment
Interest - 5%/year on 1/2 investment
Maintenance - 6%/year on investment
Labor - Hourly rate + 20% fringe benefits
Salaries & Supervision - 20% of wages

Raw Material costs per ton of luppen

Iron ore needs

Cost per ton of ore	1.50/ton ore
Cost per ton luppen	
5.07 tons ore/ton luppen x 1.50 =	7.60/ton luppen

Flux needs

Flux 5%	
Cost	$5.00/ton
Cost per ton of ore	
5% x $5.00/ton	$ .25/ton
Cost per ton of luppen	
5.07 x cost per ton of ore $ .25/ton	$1.27/ton

Fuel needs

Reduction fuel 28%/ton ore	
5.07 x 28%	142%/ton luppen
Heating fuel 8%/ton ore	
5.07 x 8%	40.6%/ton luppen
Cost - Coal 5.00 + .40	$5.40/ton
Coke 8.44 + 4.25	$12.69/ton
Cost of coke per ton ore	
$\frac{28}{100}$ x 12.69	$ 3.55
Cost of coke per ton luppen	
5.07 x $\frac{28}{100}$ x 12.69	$17.99

Cost of coal per ton ore

$\frac{8}{100} \times 5.40 =$ .43

Cost of coal per ton luppen

$5.07 \times \frac{8}{100} \times 5.40$ 2.18

Total raw material costs per ton luppen

1.	Ore	7.60
2.	Flux	1.27
3.	Fuel - reduction coke	17.99
	heating coal	2.18
	TOTAL	29.04

Operating Cost Per Ton Of Luppen

Plant Size	3 kilns of 15 x 360 feet
Investment Cost	$15,000,000
Production of luppen per year	108,000 tons
Ore throughput per day & per kiln	616 tons
Power - 50 kwh/ton dry ore	
5.07 tons ore/ton luppen x 50 kwh x .01	2.54
Heating of kiln - 10°/hr. to 720° after relining	
2.5 tons coal/hr. x $\frac{720°}{10°/\text{hr.}}$ x 5.40 x	
2 times/year ÷ 108,000 tons luppen	.02
Maintenance & Repair	
$\frac{6\%}{100}$ x $\frac{15,000,000 \text{ investment}}{108,000 \text{ tons luppen}}$	8.33
Kiln Lining (German prices)	
$\frac{223,000}{108,000}$ tons luppen	2.06
Transport in plant	
This figure includes personnel & equipment transfer within the area, it is empirical & derived from German practice.	.10
Slag Disposal	
This covers movement to & disposal on slag pile	.10
Water - 350 gals/ton luppen for quenching & cooling	
Rate - .25/1000 gals x 350 gals.	.09

Wages

194 men x 304 days x 8 hours x 2.76 ÷ 108,000 tons luppen — 12.57

Average wage rate is 2.30 plus 20% fringe benefits = (2.30 + 20% = 2.76

Overhead

This is equal to 20% of the basic wage rate.

$\frac{20\%}{100}$ x 12.57 — 2.51

Total Operating Costs per ton luppen — 28.32

Capital Costs Per Ton Luppen

Investment - $15,000,000

Interest - 5% on 1/2 investment

1/2 x $\frac{5\%}{100}$ x 15,000,000 ÷ 108,000 tons luppen — 3.47

Amortization

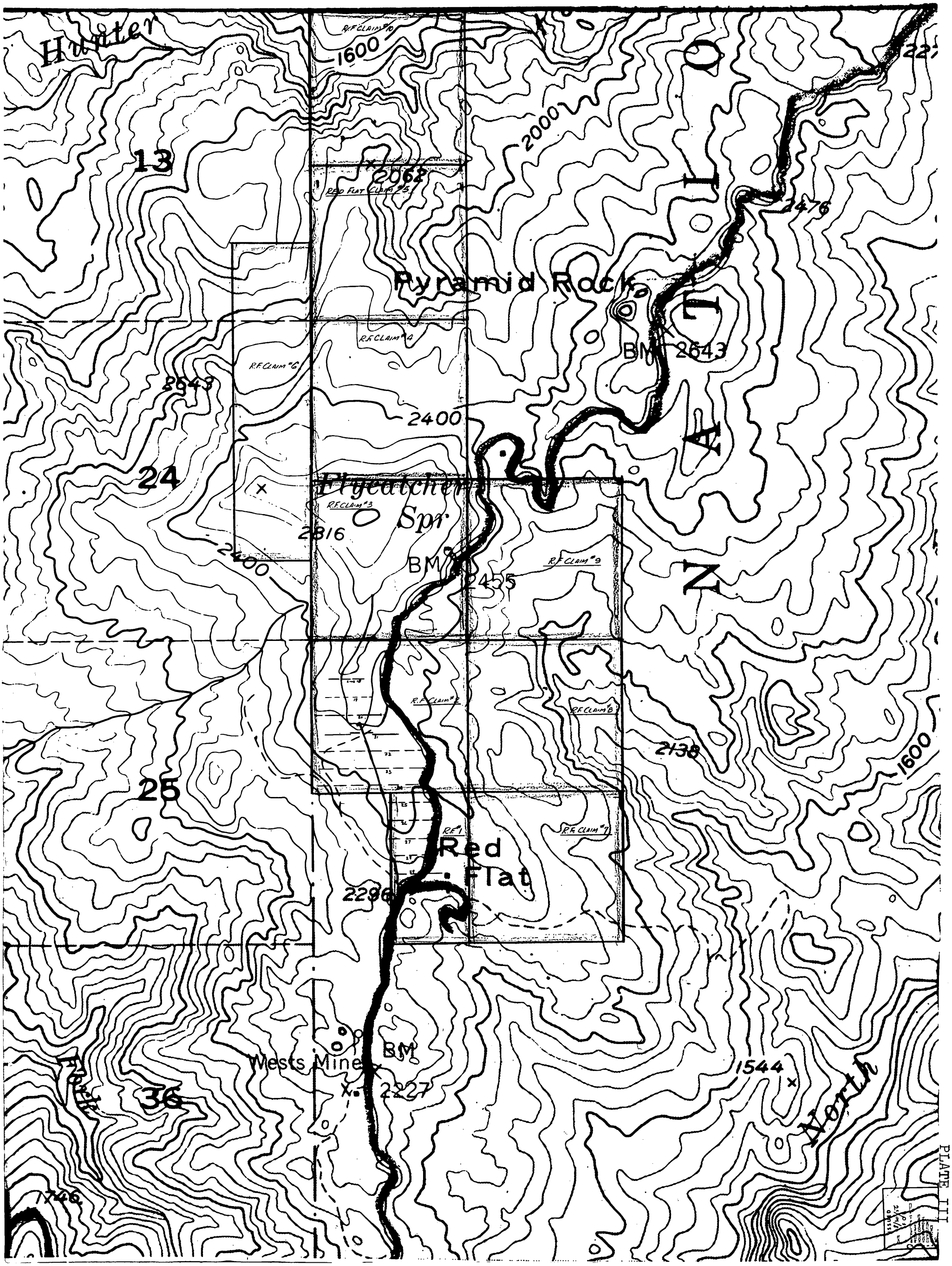
$\frac{5\%}{100}$ x 15,000,000 ÷ 108,000 tons luppen — 6.94

Total Capital Costs Per Ton Luppen — 10.41

Krupp - Renn Plant

Total Cost Per Ton Luppen

Plant Size	3 kilns of 15 x 360 feet
Investment Cost	$15,000,000
Raw Materials	29.04
Operating Costs	28.32
Capital Costs	10.41
Total Costs Per Ton Luppen	67.77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13
2062
RED FLAT CLAIM #5
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Pyramid Rock
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2943
2400
24
Hygeatchem
R.F. CLAIM #3
Spr.
2816
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BM
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2138
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North
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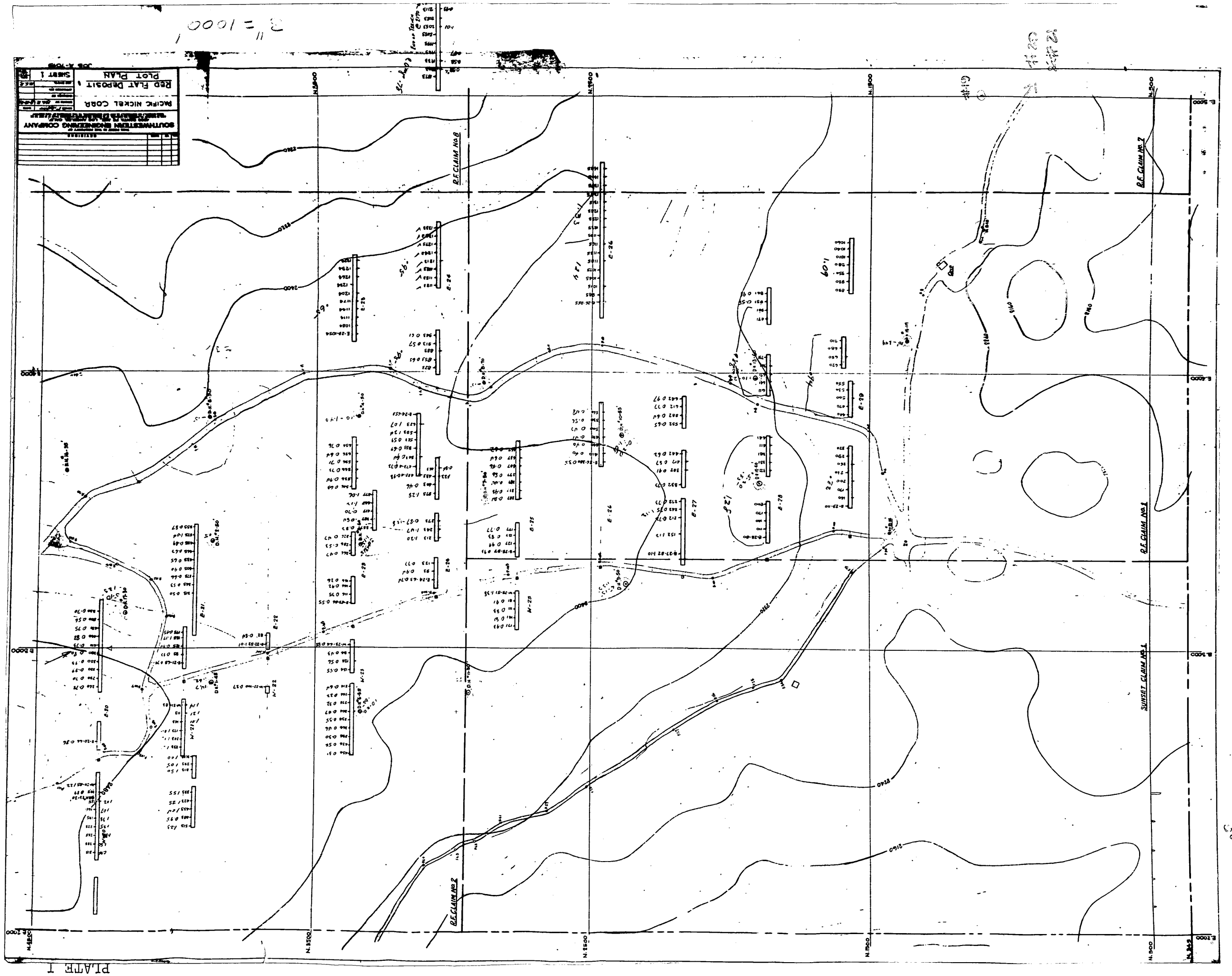
746

PLATE III


SOUTHWESTERN ENGINEERING COMPANY
PACIFIC NICKEL CORP.
RED FLAT DEPOSIT
PLOT PLAN
SHEET 1
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R.F. CLAIM NO. 7
R.F. CLAIM NO. 1
R.F. CLAIM NO. 2
SUNSET CLAIM NO. 1
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PLATE I