10/1/70 FILE

cc G. Elkins
N. Comin...
E. Wedekind
J. Mossop

2

DST

Parsons-Jurden Corporation

A SUBSIDIARY OF THE RALPH M. PARSONS COMPANY

26 BROADWAY, NEW YORK, N. Y. 10004

October 23, 1970

115-1-1

Anvil Mining Corp. Ltd.
P. O. Box 1000
Faro, Yukon Territory
Canada

ATTENTION of Mr. H. Jomini

SUBJECT P-J Job No. 3746-6
Anvil Project
Study of Fuels and Equipment for the Anvil Project

Dear Mr. Jomini:

In accordance with your telex of October 19, 1970, we are appending one copy of a study entitled "Study of Fuels and Equipment for Plant Heating, Drying of Concentrates and Lime Calcining" for the Anvil Project.

We would also like to advise that we have discussed the boiler breeching and insulation with Mr. A. R. Mehne, and wish to offer the following:

1. The fabrication and installation of the boiler breeching was done by the R. M. Parsons Co. The insulation of same was done by the subcontractor.

2. We are presently studying means of isolating duct supports, structures to eliminate transfer of heat from duct steel to laboratory floor.

We will be in touch with you on the solution of this problem in the near future.

Very truly yours,

PARSONS-JURDEN CORPORATION

D. Van De Voort
Project Director

DV/ct

Enclosure
(as above)

CC: A. Mehne
C. Skinker/W. White
J. Villari

ANVIL MINING CORPORATION LTD.

THE ANVIL PROJECT

FARO NUMBER 1 ORE BODY

STUDY

OF

FUELS AND EQUIPMENT

FOR

PLANT HEATING, DRYING OF CONCENTRATES

AND

LIME CALCINING

THE RALPH M. PARSONS CONSTRUCTION CO. OF CANADA, LTD.
ENGINEERS AND CONSTRUCTORS

TORONTO, ONTARIO

CANADA

INDEX

INTRODUCTION

This study determines the most economical available fuel, type of plant heating system and number of boilers, and the most financially attractive combination of equipment and fuel for plant heating, concentrate drying, and lime calcining for a 5800 TPD Lead and Zinc Concentrator to be located near Whitehorse in the Yukon Territory, Canada.

RECOMMENDATIONS

1. Use coal for all fuel requirements, in conjunction with direct fired dryers.

2. Use high temperature hot water boilers and associated system for plant heating purposes.

3. Provide 3 high temperature hot water boilers, each with a capacity of 50% peak plant heating requirements.

The recommendation in paragraph 1 is subject to confirmation from Anvil Mining Corporation that the ash contamination is acceptable to the smelter schedule, and that any associated penalties are not of significant magnitude. In the event that the ash content is objectionable, we recommend:

1a. Use coal for the fuel requirements of the boilers and lime kiln, and Bunker "A" fuel oil in direct fired concentrate dryers.

SUMMARY OF CONCLUSIONS

1. Coal is the most economical fuel and costs 50 cents less per million btu delivered at plant site than any other fuels considered practical for this plant.

2. The capital cost of a high temperature hot water plant heating system is less than a steam plant heating system, but more than oil fired warm air heaters.

3. The capital cost of three high temperature hot water boilers, (combined capacity 150% of peak need) is $6,000.00 more than two boilers (combined capacity 160% of peak need). In the former case, the plant is not jeopardized in the event that one boiler is not available and in the latter case, loss of one boiler exposes the plant to freezing conditions for approximately 2 winter months.

4. The scheme requiring the lowest capital investment consists of No. 2 fuel oil fired warm air heaters for plant heating, and direct fired concentrate dryers and lime kiln using Bunker "A" fuel oil.

5. The lowest annual fuel cost is obtained by using coal for all applications.

6. The lowest combined capital and annual fuel operating cost is obtained by the use of:

   a. No. 2 fuel oil fired warm air heaters for plant heating, and direct fired concentrate dryers and lime kiln using Bunker "A" fuel oil, for the period between plant start-up and 2 years after plant start-up.

b. No. 2 fuel oil fired warm air heaters for plant heating, and direct fired concentrate dryers and lime kiln using coal, for the period between 2 years and 6 years after plant start-up.

c. Coal fired high temperature hot water boilers for plant heating and direct fired concentrate dryers and lime kiln using coal 6 years after plant start-up and thereafter.

GENERAL

The capital cost figures used may not include all equipment and all direct labor costs. However, the cost differences are considered realistic and therefore valid for the purposes of this study.

All cost figures are in Canadian dollars.

FUEL: - SPECIFICATIONS AND COSTS

The fuels considered are:

No. 2 Fuel oil
Bunker "A"
Bunker "C"
Coal

Unit price delivered at jobsite, btu content, and cost at jobsite per million btu are stated in Appendix "A1." Typical characteristics of No. 2 fuel oil Bunker "A" and Bunker "C" fuel oils are listed in Appendix "A2", and an extract from Whitepass Yukon Railroad TWX dated August 23, 1967 concerning probable practical limitation of usage of Bunker "C" fuel oil to locations close to tidewater accessible to ocean tanker is contained in Appendix "A3".

For the purposes of this study, Bunker "C" fuel oil is not considered further because of doubtful availability at the jobsite, possible usage problems, and nominal price differential between Bunker "A" and Bunker "C" fuel oils.

Samples of the coal under consideration were submitted to Babcock & Wilcox Company for laboratory analysis for the Preliminary Feasibility Study dated April 26, 1966. A copy of the laboratory analysis, report on the laboratory findings, and transmittal letter are contained in Appendix "A4". The report indicates that the coal does not require upgrading by mechanical cleaning, can easily be burned with any type of conventional firing equipment, and should provide trouble-free operation in furnaces having heat releases rates which will avoid slagging of the low fusion temperature ash.

FUELS - ANNUAL REQUIREMENTS AND COSTS

The annual fuel requirements and fuel costs for:

Plant heating
Concentrate drying
Lime kiln
Trucks

are listed in Appendix "B1"

Peak fuel requirements in btu per hour for plant heating, and estimated average fuel requirements for concentrate drying and calcining of the lime, in btu per hour, are tabulated in Appendix "B2".

COST COMPARISONS

A. PLANT HEATING

Capital Cost

Comparisons of capital cost are made in Appendix "C1" to determine:

Number of boilers for plant heating
Type of boilers and plant heating system

The comparisons show:

Case 1. The capital cost of 3 boilers, each having a capacity of 50% plant peak heating requirement, is approximately 2% higher than the capital cost of 2 boilers, each having a capacity of 75% plant peak heating requirement.

Case 2. The capital cost of 3 high temperature hot water boilers and associated heating system is 11% less than the capital cost of 3 steam boilers and associated heating system.

The following recommendations are made:

1. Use 3 boilers, each having a capacity of 50% plant peak heating requirements.

2. Use high temperature hot water boilers and heating system.

GENERAL

The plant heating calculations do not provide any appreciable safety margin because of the close relationship between freezing temperature and design ambient temperature of the principal buildings.

The use of 2 - boilers, each having a capacity of 80% plant peak heating requirement will expose the plant to freezing conditions should one boiler not be available during the two coldest months of the year.

The structural costs connected with the controlling of movement of the H.T.H.W. and steam boiler piping systems are not included in this study.

COMBINED CAPITAL AND FUEL COST

Comparisons of combined capital cost and annual fuel cost are made in Appendix "C2" for:

Warm air heaters fired with No. 2 fuel oil.
High temperature hot water boilers with Bunker "A" fuel oil.
High temperature hot water boilers fired with coal.

The comparisons show:

1. Warm air heaters require the lowest capital investment.
2. The lowest corrected annual fuel cost is obtained by using coal fuel.
3. The combined capital and fuel cost of a coal fired HTHW plant heating system equalizes with the No. 2 fuel oil fired warm air heaters after 6.4 years, excluding mine capital cost, or 8.7 years, including mine capital cost, and in both cases saves $135,000 per annum thereafter.

B. <u>CONCENTRATE DRYING</u>

<u>Combined Capital and Fuel Cost</u>

Comparisons of capital cost and annual fuel cost are made in Appendix "D1" for:

Concentrate dryers fired directly with No. 5 fuel oil
Concentrate dryers fired directly with coal
Concentrate dryers furnished with steam from coal fired facilities.

The comparisons show:

1. Capital cost of steam tube dryers is $385,000 greater than for dryers fired directly with coal.

2. Annual fuel cost for steam tube dryers is $90,000 more than for directly fired dryers using coal.

3. The capital cost difference of steam tube dryers cannot be regained by fuel savings when compared with dryers direct fired with coal, and takes 9.7 years when compared with dryers, direct fired with Bunker "A" fuel oil. This period is extended to 16.2 years in the event that the full burden of mine capital cost is charged to the concentrate drying operation.

<u>ASH</u>

Appendix "D1" shows the percentage of ash by weight in the concentrates, assuming 100% of the ash reports to the concentrates, to be:

Lead	0.52%
Zinc	0.64%

In practice, the percentages will vary with the type of coal firing used and design of combustion chamber. The use of a spreader stoker using coal suitably sized, together with a traveling grate for continuous removal of ash will effect a major reduction in ash carry over and associated carbon fines.

The following recommendations are made:

1. Use concentrate dryers fired directly with coal, providing the constituents of the ash are acceptable to the smelter schedule without payment of a penalty of any significant magnitude.

1A. Use concentrate dryers fired directly with Bunker "A" fuel oil should the conditions of paragraph 1 not be satisfied.

GENERAL

The capital cost of the indirect fired dryers is based on the use of steam tube dryers furnished with 120 psig saturated steam from a H.T.H.W. to steam exchanger. A coal fired 25 x 10^6 btu per hour H.T.H.W. boiler, identical to the plant heating boilers, is adequate for this service, and permits use of the plant heating standby boiler. The capital cost of the H.T.H.W. boiler and heat exchanger type steam generator is less than the cost of a steam boiler and identical standby unit.

C. LIME CALCINING

Combined Capital and Fuel Cost

Comparison of capital cost and annual fuel cost are made in Appendix "E1" for:

Lime kiln fired with coal
Lime kiln fired with Bunker "A" fuel oil

The comparison shows that the coal fired lime kiln costs $98,000 more than for a lime kiln fired with Bunker "A" oil, and that the capital cost difference is regained in less than one year by fuel savings of $101,000 per annum.

The following recommendation is made:

1. Use a coal fired lime kiln.

COMPOSITE COST COMPARISONS

Combined Capital and Fuel Cost

The capital cost and annual fuel cost of various combinations of equipment and fuels for plant heating, concentrate drying and lime calcining are tabulated in Appendices "F1" and "F2".

Scheme	Fuel	Plant Heating		Concentrate Dryers		Lime Kiln
	General	System	Fuel	Firing method	Fuel	Fuel
I	Oil	HTHW	Bunker "A"	Direct	No. 5 Oil	No. 5 Oil
II	Oil	Warm air	No. 2 fuel oil	"	"	"
III	Coal	HTHW	Coal	"	Coal	Coal
IV	Coal	"	"	Indirect	"	"
V	Oil & Coal	"	"	Direct	Bunker "A"	"
VI	" "	Warm air	No. 2 fuel oil	"	Coal	"
VII	" "	" "	"	"	Bunker "A"	"

The lowest capital cost is for Scheme II, and the lowest annual fuel cost is obtained by using Scheme III.

The combined capital and fuel costs are shown graphically in Appendix "F3" for each of the above schemes for a period of 12 years. It was assumed nothing would be gained by extending the period of consideration to the plant life of 17 years.

The graphical representation permits the schemes providing minimum combined capital and fuel costs to be readily identified, as follows:

Write-off period	Scheme
2 years	VI
6.4 years	III

The following recommendation is made:

1. Use Scheme III, consisting of H.T.H.W. boilers, direct fired dryers and lime kiln, all using coal fuel.

GENERAL

No differences in unit costs of coal have been used for the various total annual requirements. It would be assumed that use of coal for all fuel requirements can be expected to reduce the unit cost of coal at the plant site and thereby make more financially attractive the use of this fuel.

COMMENTS REGARDING USE OF COAL FROM OTHER MINING OPERATIONS IN THE YUKON TERRITORY

During the course of developing the fuel study, Mr. Thurmond of Anvil Mining Corp., Ltd. made RMPCo. aware of the fact that two (2) mine operations (United Keno Hill and Cassiar-Asbestos) located in the Yukon Territory had originally fueled their operations with coal, but subsequently changed over to oil.At his request, RMPCo. contacted representatives of both mine operations to determine their reasons for the changeover in regard to their effect upon our study.

Following is a brief summary of the reasons concerned with the changeover on the part of each operation:

A. United Keno Hill - located at Elsa, Yukon Territory - Contacted Mr. M. Stoner, General Manager.

   The mine operation is approximately 180 miles northeast of the Carmacks coal deposit or roughly 80 miles further east than the Anvil operation. The Carmacks coal deposit was under ownership of the Yukon Coal Co., a joint subsidiary of United Keno Hill and Con-sol.

   The problems concerned with their use of coal as a fuel for plant heating and concentrate drying were as follows:

   1. Primitive coal handling facilities for unloading and handling coal such as use of wheelbarrows, laborers, etc.

   2. Use of concentrate trucks to backhaul coal involved extensive delays during coal unloading operations.

   3. Coal fired boilers were antiquated with high inefficiency and required extensive and costly overhauls to upgrade.

4. Control of coal feed to boilers and dryers was difficult to maintain and involved high labor costs.

5. High dust content of coal created human relations problem with townsite personnel located adjacent to minesite during coal handling operations.

6. Carmacks mine operation utilized Indian labor, lack of which presented a problem during the trapping season.

The decision to changeover to oil fuel provided economic gains as well as reducing labor and human relation problems. The cost of developing an adequate coal handling operation, upgrading the coal fired boilers and installing adequate control equipment greatly exceeded the cost of installing automated fuel oil fired facilities.

Installation of the oil facilities reduced their handling problems; eliminated much of their labor costs and provided flexibility of concentrate truck operations through the use of belly tanks for backhauling oil. A representative figure quoted by Mr. Stoner as indicating the economy gained, reflected a heating cost for the month of January, 1967 using oil of $13000 as compared to the month of January, 1966 using coal of $22000. The value gained however cannot be attributed to oil only, but also reflects the large saving gained through less labor and maintenance requirements.

B. Cassiar-Asbestos - located at ~~Watson Lake~~ Cassiar, British Columbia - Contacted Mr. A. C. Beguin, General Superintendent.

This mine operation is located approximately 350miles southeast of the Carmacks coal deposit, and approximately 200 miles east of Whitehorse. The difference in costs required to obtain coal or oil for their operations was almost negligible when compared to the prices quoted to Anvil. The economies to be gained in their decision to changeover to oil was not so much based upon cost of fuel savings, but rather on maintenance, labor and handling savings. Transportation of coal to the mine operation was by way of product hauling trucks and involved a double-transfer. In addition, the use of the trucks for common haulage led to contamination of product shipments from the coal characteristics.

Other points concerned with their decision consisted of the inadequate labor supply available at the coal mine during trapping season; diminishing reserves of the coal deposit; availability of spare parts to service or changeout the coal firing equipment; problems with controlling feed to firing points; and labor and equipment required to remove ash.

Summarizing the above, it would appear the only comment having any great bearing on our study or recommendations would be the possible problems arising from an inadequate labor supply to operate the coal mine. This problem could be overcome by providing sufficient storage either at the mine or the mill, to override the period encompassing the trapping season.

INDEX TO APPENDICES

COST OF FUELS

	Unit Price at Jobsite	B.T.U. Content	Cost/10^6 B.T.U.
No. 2 Fuel Oil	$0.240/gal.	161,500/gal.	$1.48
Bunker "A"	$0.185/gal.	178,800/gal.	$1.04
Bunker "C"	$0.168/gal.	183,100/gal.	$0.92
Coal	$11.25/ton	11,500/lb.	$0.49

NOTE:

1. Gallons are Imperial gallons.
2. Tons are Short tons (2,000 lbs.)
3. No. 2 fuel oil unit price based on 2 million gallons per year consumption.

FUEL OIL SPECIFICATIONS

Information Source	British American Oil Co.		Standard Oil Co.	
ASTM commercial fuel oil	No. 2	No. 5	No. 5	No. 6
fuel category	diesel fuel	Bunker "A"	Bunker "A"	Bunker "C"
fuel trade name	solar heat	Standard light fuel oil	Standard light fuel oil	
Oil Source		Ex Stanovan	Ex Richmond Calif.	Ex Standard Oil Co., C
A.P.I. Gravity	38.0	15.6	14.0	7.8
Specific gravity		0.962	0.972	
Viscosity at 122°F SSF	(35.5SSU at 100°F)	35	33	171
" " 77°F "				2,1
Flash point °F	150	230	170	20
B.S. and W. %	0	0.1	0.2	0.4
Pour point °F	0	0	-20	+35
Sulphur %	0.38	0.85	0.90	1.4
Ash %	0.01			0.6
Sediment by extraction %				0.1
Carbon residue %				17.5
Gross btu per pound		18.640	18.350	18.[illegible]
" " " imp. gallon	172.500	179.298	178.454	183.1

NOTE:

1. See TWX dated August 23, 1967 regarding Bunker "C" fuel oil.

Extract from Whitepass Yukon Railroad TWX dated August 23, 1967 to Parsons Jurden Corporation, New York, Att. Mr. Van De Voort:

AS INFORMATION FOR YOU IT HAS BEEN FOUND IMPRACTICAL TO HANDLE THIS HEAVY BLACK OIL IN SMALL TANKS FOR ROAD OR RAIL DELIVERY TO INTERIOR YUKON OR ALASKA. NONE OF THE OIL COMPANIES OPERATING IN YUKON OR ALASKA PRESENTLY DELIVERY BUNKER C TO INTERIOR POINTS. I KNOW OF ONLY TWO INDUSTRIAL INSTALLATIONS IN ALASKA WHICH USE BUNKER C OR EQUIVALENT AND BOTH ARE LOCATED ON TIDE WATER AND TAKE DELIVERY DIRECTLY AND IN LARGE QUANTITIES FROM OCEAN TANKER

FRIESEN

WHITEPASS VCR

The Babcock & Wilcox Company

Established 1867

DIVISION
GENERAL OFFICE
BARBERTON, OHIO

BOILER DIVISION
DISTRICT OFFICE
161 EAST 42nd STREET
NEW YORK 17, N. Y.

CABLE ADDRESS
GLOVEBOXES
TELEPHONE
MURRAY HILL 7-6700

February 7, 1966

Parsons-Jurden Corp.
26 Broadway
New York, N.Y.

Attention: Mr. M.S. Umbenhauer

Re: Coal Analyses
Yukon Territory Coal
Our Reference - ES-8596

Gentlemen:

Attached hereto you will find four (4) copies of a report by our Mr. A.F. Duzy Fuel Specialist, dated, February 4, 1966. This report is based on the analytical work done by our Alliance Fuels Laboratory on the samples of coals forwarded us by Mr. N.G. Grant and identified in his letter of December 2, 1965.

You will note from this report that the coal appears to be an excellent one for providing steam, and the only requirement would be that the boiler furnace should be adequately sized to prevent slagging with the low temperature fusing characteristics of the ash. If you have any questions in connection with this report please let us know.

In so far as the use of this fuel for metallurgical purposes, would you be kind enough to advise us whether you wish to forward samples for further tests.

Very truly yours,

THE BABCOCK & WILCOX COMPANY
New York District

S.H. Reid

SHR:hk
Encs.

CYPRESS MINE COAL
Near Carmacks, Yukon Territory, Canada

This report is divided into two main sections in order to separate steam coal and metallurgical coal usage. No information has been supplied pertaining to method of sampling the mine run coal or the channels. Therefore, the following comments are based upon the assumption the sampling methods used represent the as-mined coal.

The coal rank is high volatile B bituminous. This is based on an average 36 per cent volatile matter content (mineral-matter-free, dry basis) and 13,700 Btu/lb (mineral-matter-free, moist basis). The coal is thus similar in rank to that from some of the higher rank seams in western Kentucky, Illinois and Indiana. Analyses of all samples appear in the attached compilation.

STEAM COAL

Coal Preparation

The moderate ash content of 12 to 16 per cent, low sulfur content of the coal and the ash characteristics preclude any consideration of upgrading the coal by mechanical cleaning.

If dry mining conditions prevail, the only preparation facilities required will be crushing, dustproofing and/or freezeproofing for transport, and conveying and storage facilities. If dustproofing or freezeproofing is required it is recommended that light oil treatment be used in accordance with accepted procedures.

Moisture Content

The equilibrium moisture content of this coal is quite low, ranging from 3.8 to 4.6 per cent; this is the inherent or bed moisture of the coal.

Air drying the coal to one to three per cent moisture content is readily attained; this is the residual moisture.

Sulfur Content

The sulfur content of the coal is very low ranging from only 0.3 to 0.4 per cent on a dry basis. The low level of this impurity is also indicated by the low iron oxide content of the ash.

Volatile Matter and Hydrogen Content

The volatile and hydrogen contents of the coal appear to be low for coal of this rank. The dry, ash-free values are about 37 and 5 per cent, respectively. One might consider these to be about 10 per cent lower than anticipated (40 and 5.5).

Ash Fusibility

This coal has a lignite type ash, that is, the CaO plus MgO content exceeds, the Fe_2O_3 content. There is, however, a sufficient amount of acidic constituents in the ash, as indicated by the low fusion temperature ranging from 2170 to 2290F.

The temperature spread between the reducing and oxidizing fusibility points is small because of the low iron oxide content.

Ash Viscosity

The calculated viscosity of the coal ash-slag is also low. The 250 poise viscosity occurs at temperatures ranging from 2190F to 2320F.

The basic constituents are composed mainly of lime and magnesium oxide. The dolomite ratio;

$$\frac{(CaO + MgO)\ 100}{Fe_2O_3 + CaO + MgO + Na_2O + K_2O}$$

is also high, ranging from 70 to 80, comparable to a typical lignite type ash. This ash-slag would be expected to be a "short" slag, i.e. the fluid temperature range of the slag will be smaller compared with a non-lignite type ash having the same 250 poise viscosity temperature range.

Ash Fouling Characteristics

This coal ash may be considered as a low fouling type. The troublesome constituents that indicate potential ash fouling are the Na_2O, K_2O and chlorine content. These troublesome constituents are all quite low.

Grindability and Abrasiveness

The grindability values of 58 to 80 are somewhat higher than expected for coal of this rank. Considering the low sulfur content and the amount and type of ash, this coal should be relatively non-abrasive.

Burning Characteristics

The coal is weakly agglomerating as evidenced by the low free swelling index. It should be a relatively free burning coal and also have good ignition characteristics.

Utilization-Stoker Firing

This coal properly sized should be entirely suitable for firing in underfeed, overfeed or spreader stoker type equipment.

Care should be used in furnace design for selecting heat

FUEL

ANNUAL QUANTITIES & COSTS

PLANT HEATING

	Coal		Oil	
	Tons	$	Gallons	$
Plant Boilers	9,020	101,000.	1,090,000	202,000.
H.T.H.W. Boilers	8,400	94,200.	1,010,000	187,000.
Warm Air Heaters	-	-	1,120,000	269,000.

PROCESS

Concentrate Dryers:				
Direct Fired	10,800.	121,000.	1,390,000	257,000.
Steam Tube	18,700.	211,000.	=	
Lime Kiln -	8,100	91,000.	1,040,000	192,000.

TRUCKS

TRUCKS			770,000	185,000.

NOTE: See Appendix "B2" for grade of oil.

FUEL REQUIREMENTS-10^6 B.T.U./HR.

	Coal	Oil	PEAK
PLANT HEATING			
Steam Boilers	78.3	73.2	(Bunker "A")
H.T.H.W. Boilers	72.7	68.1	(Bunker "A")
Warm Air Heaters	-	68.1	(No. 2)
			AVERAGE
PROCESS			
Concentrate Dryers:			
Direct Fired	30.0	30.0	(Bunker "A")
Steam Tube	50.0	-	(Bunker "A")
Lime Kiln:	22.5	22.5	(Bunker "A")

NOTE:

1. Flash from high pressure condensate used in heating system.
2. Steam & H.T.H.W. distribution in galleries. Losses considered negligible.
3. Warm air heaters (80% efficiency).
4. Plant heating based on total plant requirements (54.5×10^6 B.T.U./Hr.).
5. Boiler efficiency - 75% coal, 80% oil
6. Steam system flash losses - 7%.
7. Lime kiln requirements based on 10 pounds of free lime per ton ore feed, 50% free lime in limestone, and 9-million B.T.U./Ton limestone.

PLANT HEATING

Case 1 - Number of Boilers		Total Cost	
		2 boilers	3 boilers
H.T.H.W.	25,000 Mbtu per hr.		$533,000
	40,000 " " "	$527,000	
Steam	30,000 Mbtu per hr.		554,000
	45,000 " " "	544,000	

Case 2 - Type of Plant Heating System	Type of System	
	H.T.H.W.	Steam
Three Boilers	$533,000	$554,000
Distribution System	64,300	52,000
Piping - installed		
Air heater units	210,000	352,400
(labor not included)		
Total	$807,300	$911,600

PLANT HEATING

Case 3 - Comparison of Combined Capital and Annual Fuel Cost

	Heating System	Capital Cost	Annual Fuel Cost	Fuel
1.	Warm air heaters	$412,000	$269,000 ✓	(No. 2 fuel oil)
2.	H.T.H.W.	892,000	227,000 *	(Bunker "A" fuel oil)
3.	H.T.H.W.	1,280,000	134,200 *	(Coal)
3.**	H.T.H.W.	1,580,000 **	134,200 *	(Coal)

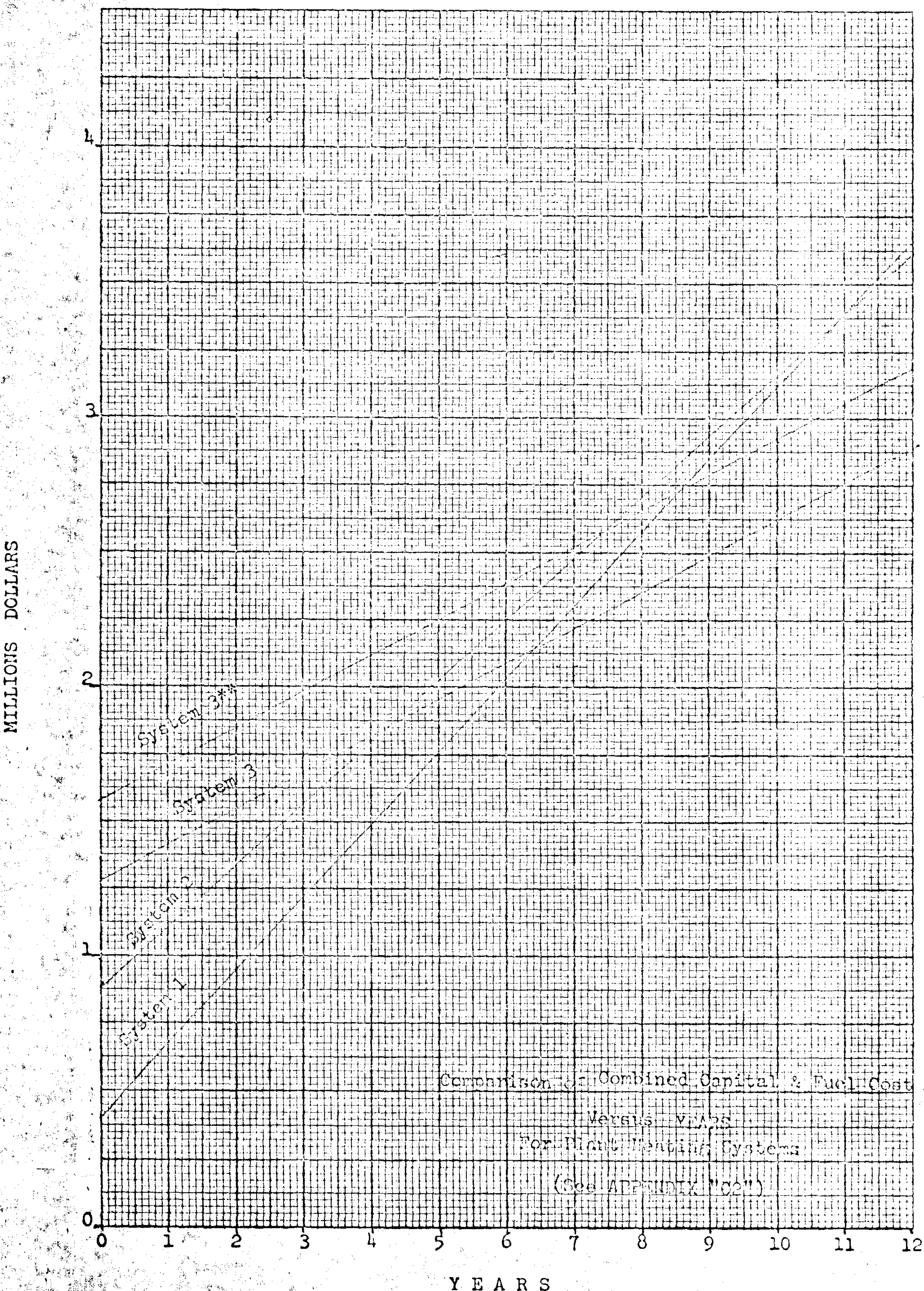
In the table below, the combined capital and fuel cost of the system in column A equalizes with the system in column B after the years stated, and subsequently saves annually the dollars listed.

Column A	Column B	No. of years	Annual saving
2	1	11.4	$ 42,000
3	2	4.1	93,000
3	1	6.4	135,000
3**	2	7.4	93,000
3**	1	8.7	135,000

Note: The above values are shown in graphic form on attached appendix "C3".

* Includes $40,000 annual cost of boiler room operators.

** Includes 100% mine capital cost.


MILLIONS DOLLARS
0
1
2
3
4
YEARS
0
1
2
3
4
5
6
7
8
9
10
11
12
System 1
System 2
System 3
System 3**
Comparison of Combined Capital & Fuel Cost
Versus YEARS
For Plant Heating Systems
(See APPENDIX "C2")

CONCENTRATE DRYING

Capital and Annual Fuel Costs

	Type of dryer	Fuel	Capital Cost	Annual Fuel Cost
1.	Direct fired	Bunker "A"	$430.000	$257.000
2.	" "	Coal	490.000	121.000
2*	" "	Coal	790.000*	121.000
3.	Steam Tube	Coal	875.000	211.000
3*	" "	Coal	1,175.000	211.000

Ash Contamination

Dryers fired directly with coal - figures are per dryer

Ash content in coal 15% by weight

	Lead	Zinc
Btu per/hr.	12×10^6	14×10^6
Coal tons per/hr.	0.52	0.61
Concentrate tons per/hr.	15.0	14.3
Ash in concentrate	0.52%	0.64%

* Includes total mine capital cost of $300.000

LIME CALCINING

	Fuel	Capital Cost	Annual Fuel Cost
1.	Coal	$365.000	$91.000
2.	Bunker "A"	267.000	192.000

PLANT HEATING, CONCENTRATE DRYING AND LIME CALCINING

Scheme I - Fuel Oil

	Fuel	Capital Cost	Annual Fuel Cost
H.T.H.W. plant heating	Bunker "A"	$892.000	$227.000 *
Direct fired dryers	"	430.000	257.000
Lime Kiln	"	267.000	192.000
		1,589.000	676.000

Scheme II - Fuel Oil

	Fuel	Capital Cost	Annual Fuel Cost
Warm air heaters	No. 2 fuel oil	$412.000	269.000
Direct fired dryers	Bunker "A"	430.000	257.000
Lime Kiln	" "	267.000	192.000
		1,109.000	718.000

Scheme III - Coal

	Fuel	Capital Cost	Annual Fuel Cost
H.T.H.W. plant heating	Coal	$1,280.000	$134.200 *
Direct fired dryers	"	490.000	121.000
Lime kiln	"	365.000	91.000
Coal mine	-	300.000	-------
		2,435.000	346,200

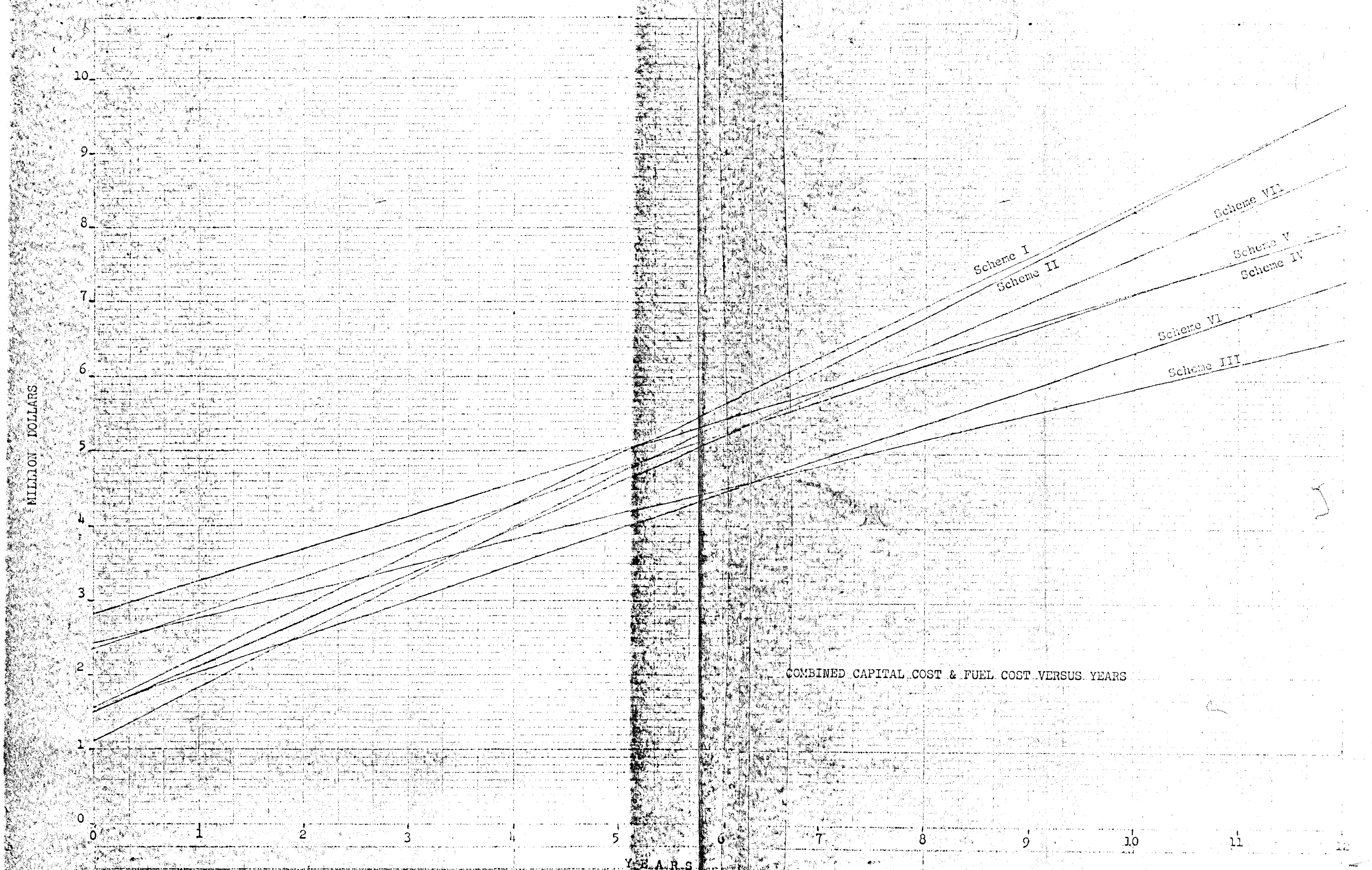
Scheme IV - Coal

	Fuel	Capital Cost	Annual Fuel Cost
H.T.H.W. plant heating	Coal	$1.280.000	$134,200 *
Steam tube dryers	"	875.000	211.000
Lime kiln	"	365.000	91.000
Coal mine	-	300.000	-------
		2,820.000	436.200

PLANT HEATING, CONCENTRATE DRYING AND LIME CALCINING (cont'd.)

Scheme V -	Fuel oil and coal			
	H.T.H.W. plant heating	Coal	$1,280.000	$134.200 *
	Direct fired dryers	Bunker "A"	430.000	257.000
	Lime Kiln	Coal	365.000	91.000
	Coal mine	-	300.000	-
			2,375.000	482.200
Scheme VI-	Fuel Oil and coal			
	Warm air heaters	No. 2 fuel oil	$ 412.000	$269.000
	Direct fired dryers	Coal	490.000	121.000
	Lime kiln	"	365.000	91.000
	Coal mine	-	300.000	-
			1,567.000	481.000
SchemeVII-	Fuel Oil and coal			
	Warm air heaters	No. 2 fuel oil	$ 412.000	$269.000
	Direct fired dryers	Bunker "A"	430.000	257.000
	Lime kiln	Coal	365.000	91.000
	Coal mine	-	300.000	-
			1,507.000	617.000

* Includes $40.000 annual cost for boiler room operating engineers.



COMBINED CAPITAL COST & FUEL COST VERSUS YEARS