THE MÝVATN DIATOMITE PROJECT

Technical Summary

June 1960

The State Electricity Authority and
The National Research Council

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Introduction

The present memorandum is a summary of the technical considerations contained in a larger report entitled "Kísilgúrverksmiðja við Mývatn" (The diatomite project at Mývatn) dated in March 1961. This report was prepared jointly by the National Research Counsil and the State Electricity Authority under the supervision of Director Steingrimur Hermannsson and Director Jakob Gislason.

Mr. Baldur Lindal, chemical engineer, was in charge of the processing estimates and the coordination of the project while Mr. Rögnvaldur Þorlaksson, civil engineer, was in charge of estimates and transportation, raw material supply and buildings. Director Eirikur Briem, made an estimate for electrical supply, Mr. Sveinn Einarsson and Mr. Guðlaugur Hjörleifsson, mechanical engineers, made estimates for steam and hot water pipelines. Mr. Þorbjörn Karlsson estimated steam drilling and steam supply.

The present report is to a large extent based upon former reports by Prof. Dr. K. Richter, Dipl. Ing. H. Trenne and Dr. Ing. F. Illner who came to Iceland through the Technical Assistance of the Federal Republic of Germany.

The present estimate is priliminary, since basic studies are still lacking in some respects. It is, however, believed that resulting cost figures are on the high side, and that a further study may show a more favourable picture.

THE MÝVATN DIATOMACEOUS EARTH DEPOSIT

Lake Mývatn, which has an area of some 38 km^2, is in Northern Iceland at an altitude of 277 meters above sealevel. The lake is shellow, the Northern section being about 1 meter deep and the Southern section about 3 meters deep. At the bottom is a deposit of diatomaceous earth which has a thickness of 3-5 meters in the greater part of the lake.

The extensiveness of this deposit and the quality of the diatomaceous earth has drawn attention to the possibilities for recovery and processing of commercial diatomite by Mývatn. Conditions are, however, unusual in many respects, one of them being the unusually high water content of this naturally occurring material. This disadvantage may, however, be ofset by the use of natural steam which may be obtained at a low cost almost close to the Northern section of the lake.

Due to the unusual conditions the working process has to differ a good deal from what is done elsewhere. A certain amount of engineering development must therefore be undertaken. The present estimate is being made on a purely preliminary basis.

The Process

The raw material may be obtained by suction dredging of the diatomaceous earth from the bottom of the lake Mývatn and then pumped to storage tanks on the shore. The suction dredging may be aided by a rotary knife arrangement at the intake. Estimates are based on a 500 meters of 12" diameter pipeline to the shore. The present basis assumes a transportation of 110,000 cubic meters of mud based on its original volume. It is assumed that a considerable amount of water will be mixed with the mud during this process. The pumping proceeds alternatively into two 200 cubic meters tanks at Helgavogur.

The following process is performed in two main steps in such a way that the first part takes place during the summer only and the second part during the whole year. The first part is designated here as the primary processing but the second part as the main processing.

The primary processing plant is situated at Helgavogur, where the essential machinery is in a 2000 cubic meters concrete building. The first operation is a separation of sand from the mud in hydro-cyclones. Then the following operation is a separation of water by thickeners. The thickened mud is then pumped to vacuum filters which remove still more water. The cake is continuously moved by trucks to Bjarnarflag by Námaskarð where the main processing occurs, and where it is dried by natural steam. This primary drying is performed as soon as the raw material arrives and would therefore be operated only during the summertime like other parts of the primary processing.

The primary drying consists of palletizing of the raw material and a subsequent drying on a through circulation conveyor belt. A part of the material is then stored in a bin as a winter supply for the main operation.

The main processing begins with grinding and further drying in a steam tube rotary drier. The material is then moved by conveyor belts to calcining furnaces where it is heated to 700-800 degrees centigrade whereby organic materials burn away. It is proposed that this calcination takes place in two furnaces of the German Teller type. These furnaces are arranged in a building which has a ground area of 10 x 20 meters and 14 meters in height.

The material is then ground and purified further in an Alpine type grinding separator and then either bagged for immediate sale as calcined diatomite or treated further as flux calcined diatomite. The trailings from this machine are intended for fertilizer dusting.

In the estimates for this plant three alternatives have been considered from this point on. The first one is to produce the same amount of both calcined and flux calcined material, i.e. 5,000 tons of each yearly.

The second alternative is to produce only calcined material and then 11,000 tons per year. The third one is to produce only flux calcined material and then 9,000 tons yearly.

Alternative I assumes that the calcined and refined material is bagged directly almost half the year but that the material is carried through the flux calcining process the rest of the year. Before the material is carried through the flux calcining furnace about 4 per cent of salt is added. In the flux calcining furnace the material is heated to temperatures exceeding 1100 degrees centigrade, then it is ground and classified with the aid of cyclones and subsequently bagged.

Alternative II assumes direct bagging of calcined material amounting to 11,000 tons a year. The flux calcining section is entirely omitted in this alternative.

Alternative III involves the entire train of machinery which is run at full capacity all the year around.

The estimates assume storage facilities at the plant for at least 1,000 tons of the bagged product. Buildings for office and laboratory are also included. Further, three houses are provided as residence quarters for the staff.

A hot water pipe line carrying 10 liters per second down to the shore of Mývatn has been assumed. Also included in the first cost are steam drillings for sufficient steam for the plant and an electrical supply line from the Laxá power plant carrying 400 kW.

Transportation to Húsavík is accomplished by stacking the bags on wooden supports. These stacks are then put on trucks and carried to storage in Húsavík which has a capacity of more than 2500 tons.

Material Balance

In the process the following assumptions have been made:

Hydrocyclone separators:

In

Water	56 kg/sec.
Solids	1.73 "
Total	57,7 "

Out, up

Water	55,0 kg/sec
Solids	1,21 "
Total	56,2 "

Out, down

Water	1,0 kg/sec
Solids	0,52 "
Total	1,52 "

Thickener

In

Water	55 kg/sec
Solids	1,21 "
Total	56,2 "

Out, down

Water	16,2	kg/sec.
Solids	1,21	"
Total	17,4	"

Vacuum filters

In

Water	16,2	kg/sec
Solids	1,21	"
Total	17,4	"

Out

Water	15,25	tons/hr
Solids	4,36	"
Total	19,61	"

Primary drier

In

Water	15,25	tons/hr
Solids	4,36	"
Total	19,61	"

Out

Water	8,28	tons/hr
Solids	4,36	"
Total	12,64	"

Secondary drier (all year operation)

In

Water	3,72	tons/hr
Solids	1,96	"
Total	5,68	"

Out

Water	0,39	tons/hr
Solids	1,94	"
Total	2,33	"

Teller furnaces

In		
	Water	0,39 tons/hr
	Solids	1,94 "
	Total	2,33 "
Out		
	Solids	1,61 tons/hr

Alpine grinding separator

In		
	Solids	1,61 tons/hr
Out		
	Solids	1,53 tons/hr

Flux calcining furnace

In	1,53 tons/hr
Out	1,39 "

Cyclone separators

In	1,39 tons/hr
Out	1,32 "

PRELIMINARY ESTIMATES

First cost of completed plant, Mkr.

Alternative		I		II		III	
Production of tons per year	1) calcined	5000		11000			
	2) fluxcalcined	5000				9000	
	3) fertilizer grade	800		800		800	
Raw material supply			8.0		8.0		8.0
Primary Processing							
a) Machinery		12.1		12.1		12.1	
b) Buildings		3.7		3.7		3.7	
c) Transportation facilities		1.5	17.3	1.5	17.3	1.5	17.3
Main Processing							
a) Machinery		34.6		17.7		34.6	
b) Buildings		9.9	44.5	7.2	24.9	9.9	44.5
Steam well drilling			3.5		3.5		3.5
Electrical supply			3.1		3.1		3.1
Hot water pipeline			1.2		1.2		1.2
Office and residential quarters			3.8		3.8		3.8
The Húsavik transportation system							
a) Trucks		1.0		1.0		1.0	
b) Storage in Husavik		8.0	9.0	8.0	9.0	8.0	9.0
			90.4		70.8		90.4
Contingencies, 15%			13.6		10.6		13.6
			104.0		81.4		104.0
Engineering, 5%			5.2		4.1		5.2
			109.2		85.5		109.2
Interest charges during construction, 7%			7.6		6.0		7.6
Total cost			116.8		91.5		116.8

Manufacturing cost, Mkr.

Alternative	I		II		III	
Raw material supply, direct cost		0.7		0.7		0.7
Energy supply						
a) Electricity	1.6		1.5		1.7	
b) Natural steam	0.7		0.7		0.7	
c) Fuel oil	1.0	3.3	0.5	2.7	1.4	3.8
Operating supplies						
a) Paper bags	2.5		2.8		2.2	
b) Maintainance supplies	1.1		0.8		1.1	
c) Other	0.3	3.9	0.1	3.7	0.5	3.8
Transportation cost, direct						
a) At the plant	0.6		0.6		0.6	
b) To Húsavík + storage	1.0	1.6	1.1	1.7	0.9	1.5
Personnel						
a) Management + inspection	0.6		0.6		0.6	
b) Wages of operators	2.9		2.1		3.1	
c) Other	0.4	3.9	0.3	3.0	0.4	4.1
Interest on capital, 7%		7.6		5.8		7.6
Depreciation						
a) Transportation facilities, 10%	0.3		0.3		0.3	
b) Raw material supply equipment, 8%	0.8		0.8		0.8	
c) Machinery, 8%	4.8		3.1		4.8	
d) Buildings, 5%	1.7	7.6	1.6	5.8	1.7	7.6
Other items, 10%		2.9		2.3		2.9
Loading of ships at Húsavík		0.5		0.5		0.5
Freight		3.3		3.6		3.0
Total manufacturing and transportation cost		35.3		29.8		35.5
Average per ton, Kr.		3530		2710		3950

Personnel

Alternative	I		II		III	
Temporary staff (5 months)						
1) Raw material supply	8		8		8	
2) Primary processing	11		11		11	
3) Transportation in primary processing	6	25	6	25	6	25
Permanent staff						
1) Main processing	30		20		33	
2) Transportation to Húsavík	10		10		10	
3) Managem. and inspection	5	45	5	35	5	48
Total staff		70		60		73

A P P E N D I X

SUPPLEMENTARY ESTIMATES

Alternative I and III

First cost estimate of installed process machinery.

		Mkr.
Primary processing		
Hydrocyclones	0,3	
Thickener	0,5	
Filters	4,2	
Conveyor belt, electric and water supply	0,4	
Primary drier	6,7	12,1
Main processing		
Secondary drier	3,0	
Teller furnaces	9,3	
Grinders, separators, cyclones and bagging equipment for calcined diatomite	3,2	
Flux calcining furnace	11,0	
Grinders, separators, and bagging equipment for flux calcined diatomite	3,4	
Silos	0,9	
Piping, conveyor belst and electrical system	3,8	34,6
	Total	46,7

Alternative II

First cost estimate of installed process machinery

	Mkr.	
Primary processing		12,1
Main processing		
Secondary drier	3,0	
Teller furnaces	9,3	
Grinders, separators, cyclones and bagging equipment	3,2	
Silos	0,3	
Piping, conveyor belst and electrical system	1,9	17,7
	Total	29,8

ESTIMATES ON BUILDINGS AND TRANSPORTATION

Alternative I and III

First cost

		Mkr.
Primary processing		
Pier at Helgavogur	0,37	
Storage tanks	0,32	
Building for primary operations	1,70	
Building for primary drier	0,95	
Roads at Mývatn area	0,40	3,74
Main processing		
Building for secondary drier, etc.	4,24	
" " Teller calcining furnaces	1,45	
Storage for products	3,75	
Chimney	0,22	
Storage yard	0,23	9,90
Office and residential quarters		
Building for office, laboratory and dining hall	1,20	
Residential quarters	2,10	
Temporary living and dining quarters	0,50	3,80
Húsavík		
Storage, elevator and transport facilities	8,00	8,00
	Total	25,44

Alternative II

First cost

		Mkr.
Primary processing		
Same as alternative I and III		3,74
Main processing		
Building for secondary drier, etc.	1,50	
Other items same as alt. I and III	5,66	7,16
Office and residential quarters		
Same as alt. I and III		3,80
Húsavík		
Same as alt. I and III		8,00
	Total	22,70

First cost of transportation facilities for alternative I, II or III		
Suction dredge and pipeline		8,00
Trucks for transportation of process materials		1,50
Trucks for transportation of finished products		1,00
	Total	10,50

Alternative I

Operating staff

Primary processing, 5 months

	Operators per shift	No of shifts	Total
Hydrocyclones	1	2	2
Filters	1	3	3
Primary drier	1	3	3
Foreman			1
Replacement operators			1
			11

Main processing

Feeding	1	3	3
Teller furnaces	1	3	3
Grinder	1	3	3
Flux calcining furnace	1	3	3
Bagging	1	3	3
Storage	1	3	3
Maintenance staff	3	2	6
Foreman	1	3	3
Replacement operators			3
		Total	30

Alternative II

Operating staff

Primary processing, 5 months

	Operators per shift	No of shifts	Total
Hydrocyclones	1	3	3
Filters	1	3	3
Primary drier	1	3	3
Foreman			1
Replacement operators			1
			11

Main processing

Feeding	1	3	3
Teller furnaces	1	3	3
Bagging and classification	1	3	3
Storage	1	3	3
Maintenance staff	3	2	6
Replacement operators			2
			20

Alternative II

	Total
Primary processing, 5 months	11
Main processing	33

Transportation personnel

	Operators per shift	No of shifts	Total
Suction dredge	4	2	8
Transportation of process materials	2	3	6
		Total	14
Transportation of finished products to Húsavík	3	2	6
Storage at Húsavík	1	2	2
[illegible]	2	1	2
		Total	10

Alternative I

Direct processing cost

Primary processing		Mkr.
Electricity	0,4	
Natural steam	0,3	
Wages, 11 men for 5 months	0,5	
Maintenance materials	0,3	1,5
Main processing		
Operating supplies	0,3	
Electricity	1,2	
[illegible]	0,4	
[illegible]	1,0	
Paper bags	2,5	
Wages, 30 men	2,4	
Maintenance materials	0,8	8,6
[illegible]	Total	10,1

Alternative II

Direct processing cost		Mkr.
Primary processing		1,5
Main processing		
Operating supplies	0,1	
Electricity	1,1	
Natural steam	0,4	
Fuel oil	0,5	
Paper bags	2,8	
Wages, 20 men	1,6	
Maintenance materials	0,5	7,0
	Total	8,5

Alternative III

Direct processing cost		
Primary processing		1,5
Main processing		
Operating supplies	0,5	
Electricity	1,3	
Natural steam	0,4	
Fuel oil	1,4	
Paper bags	2,2	
Wages	2,6	
Maintenance materials	0,8	9,2
	Total	10,7

Operating cost of transport facilities

Alternative I

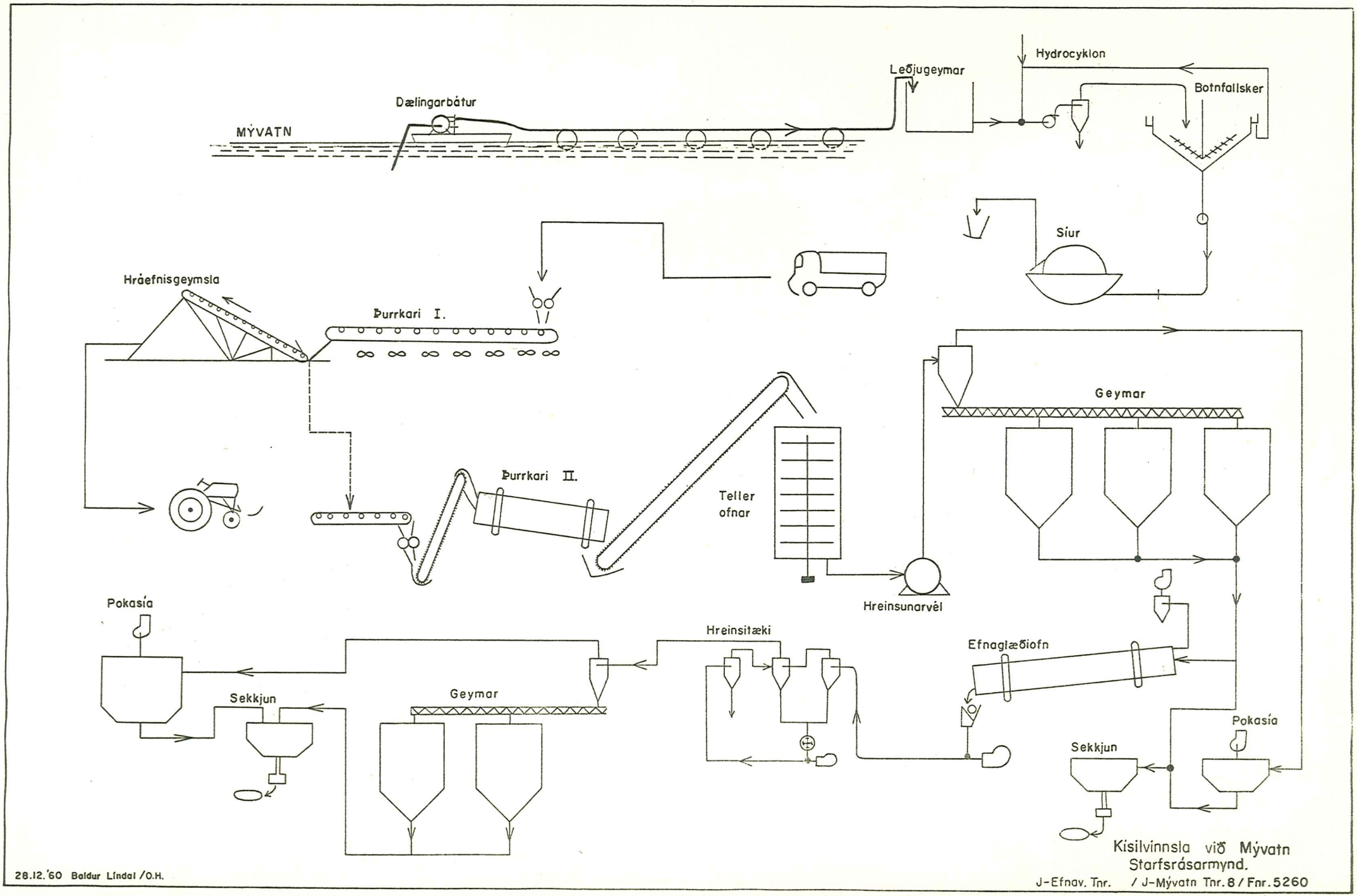
		Mkr.
Suction dredge		
Wages	0,41	
Repairs, sparepart, fuel	0,25	
Depreciation	0,64	1,30
Transportation of process materials		
Wages	0,27	
Repairs, spare parts, fuel	0,28	
Depreciation	0,15	0,70
Transportation of finished products		
Wages	0,54	
Repairs, spare part, fuel	0,28	
Depreciation	0,10	0,92
Storage at Húsavík	0,16	
Ship loading	0,50	0,66
	Total	3,58

Alternative II

		Mkr.
Suction dredge		
Same as alt. I		1,30
Transportation of process materials		
Same as alt. I		0,70
Transportation of finished products		
Wages	0,582	
Repairs, spare parts, fuel	0,300	
Depreciation	0,108	0,99
Storage at Húsavík	0,16	
Ship loading	0,55	0,71
	Total	3,70

Alternative III

		Mkr.
Suction dredge		
Same as alt. I		1,30
Transportation of process materials		
Same as alt. I		0,70
Transportation of finished products		
Wages	0,513	
Repairs, spare parts, fuel	0,262	
Depreciation	0,095	0,87
Storage at Húsavík	0,16	
Ship loading	0,45	0,61
	Total	3,48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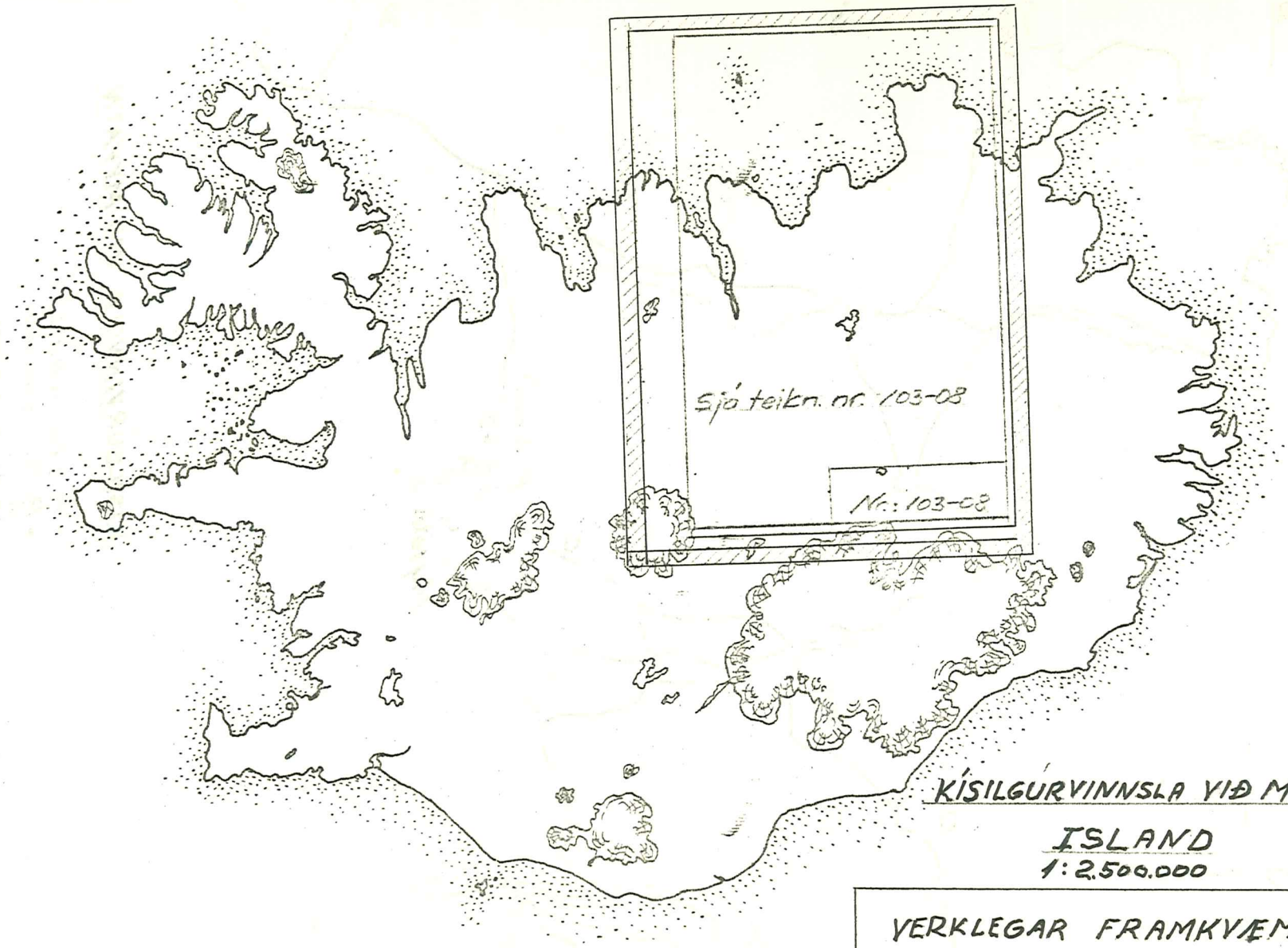
Leðjugeymar
Hydrocyklon
Botnfallsker
Sían
Hráefnisgeymsla
Þurrkari I.
Þurrkari II.
Teller ofnar
Hreinsunarvél
Geymar
Pokasía
Sekkjun
Hreinsitæki
Efnaglæðiofn
Geymar
Pokasía
Sekkjun
Kísilvinnsla við Mývatn
Starfsrásarmynd.
J-Efnav. Tnr. / J-Mývatn Tnr. 8 / Fnr. 5260
28.12.'60 Baldur Líndal /O.H.



KÍSILGÚRVINNSLA VIÐ MÝVATN

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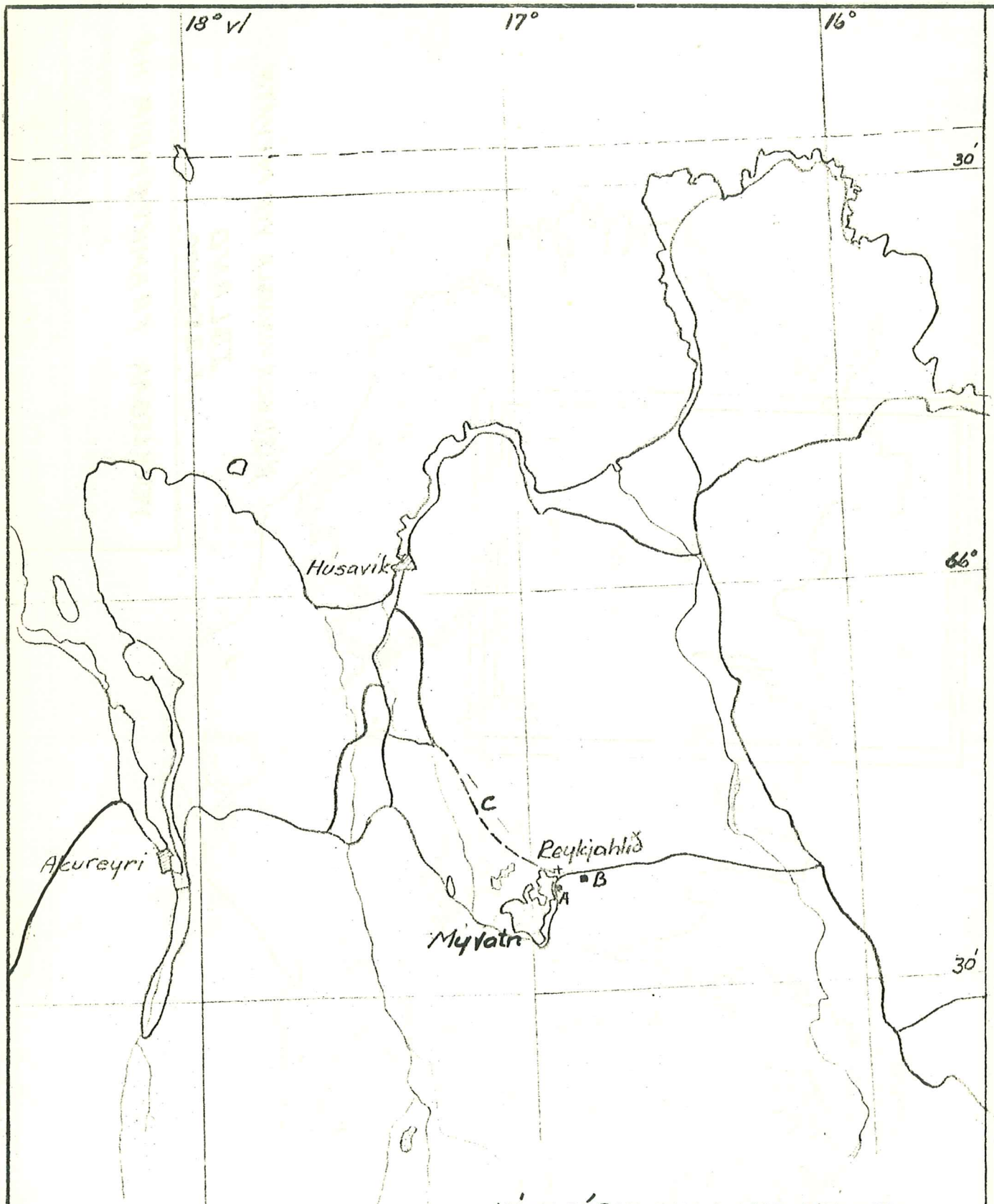

KÍSILGÚRVINNSLA VIÐ MÝVATN

- A. Frumvinnsla
- B. Aðalvinnsla
- C. Nýr vegur

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REYKJAVÍK SÍMNEFNI: VERKIR

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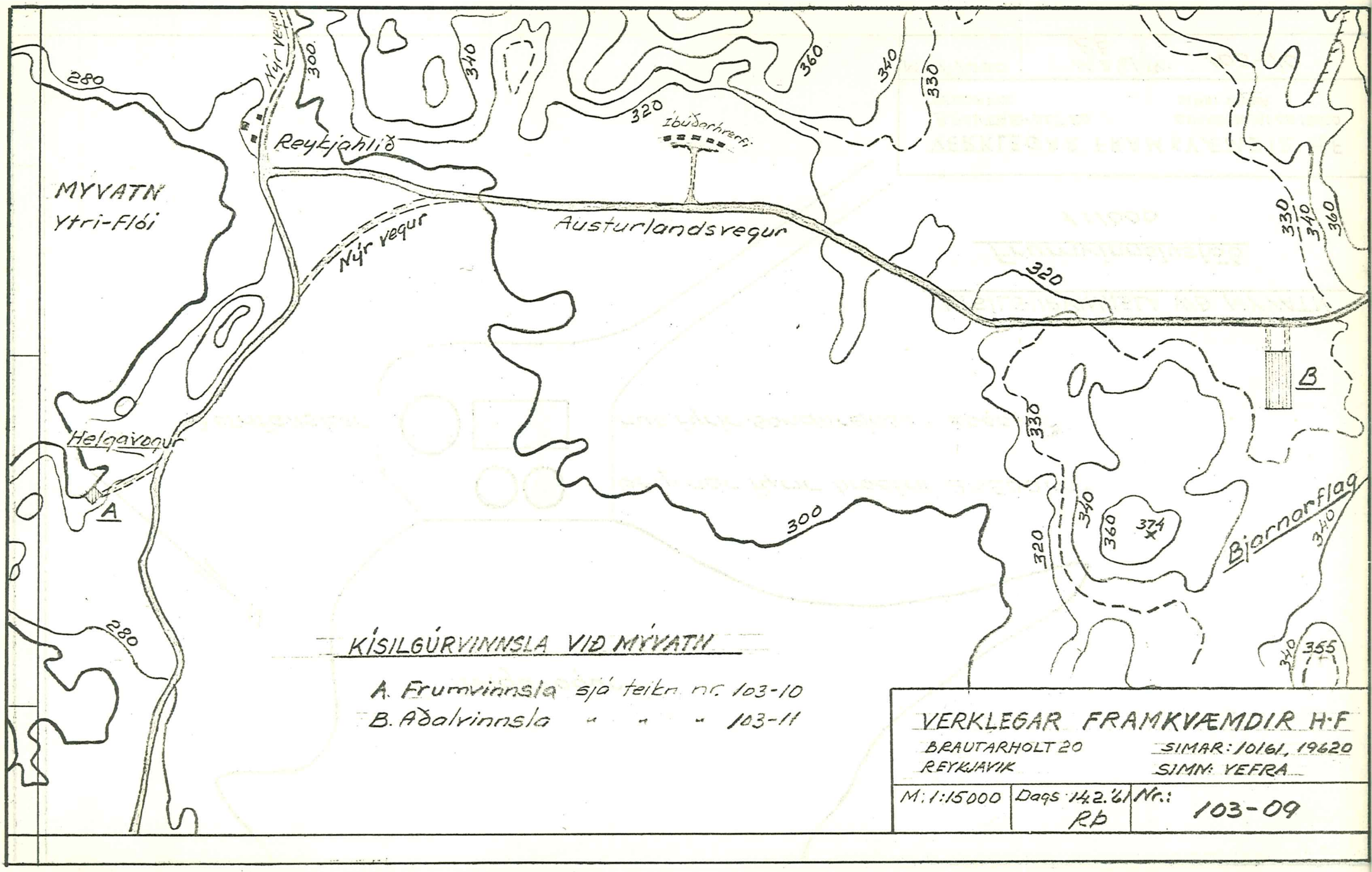

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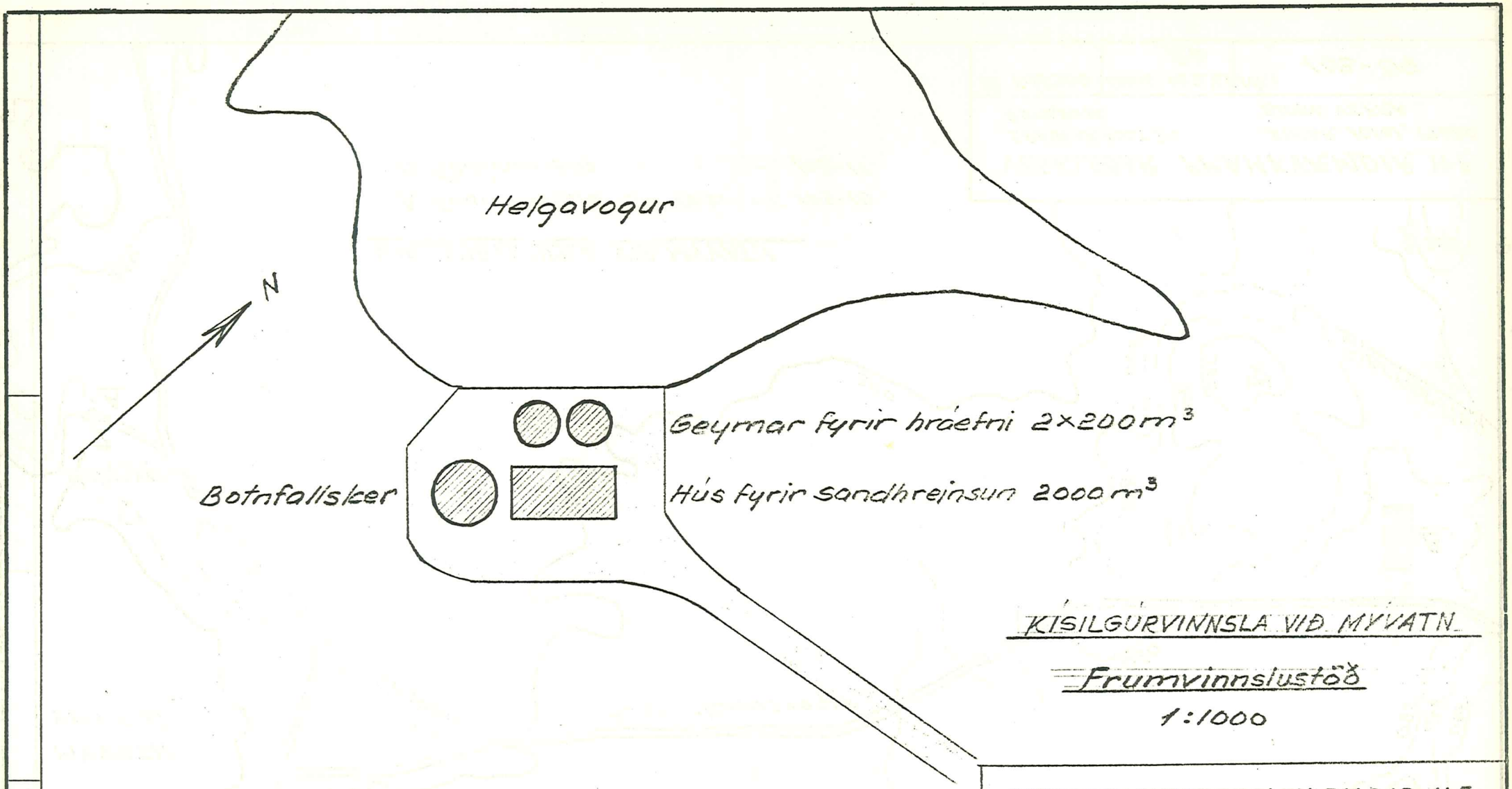

KÍSILGÚRVINNSLA VIÐ MÝVATN

Frumvinnslustöð

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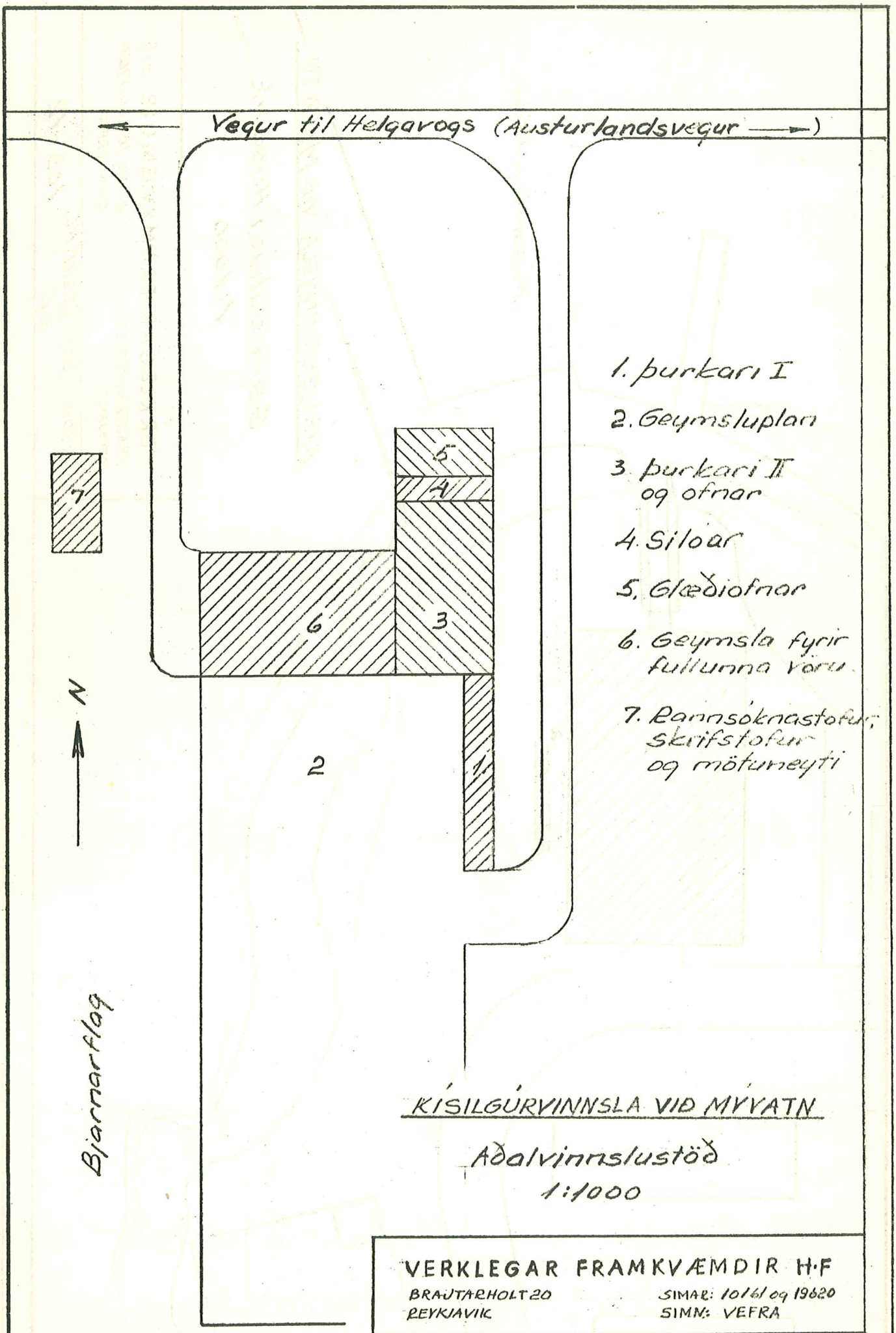
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2. Geymsluplan
3. purkari II og ofnar
4. Siloar
5. Glæðiofnar
6. Geymsla fyrir fullunna vöru
7. Rannsóknastofur, skrifstofur og mötuneyti
N
Bjarnarflag
KÍSILGÚRVINNSLA VIÐ MÝVATN
Aðalvinnslustöð
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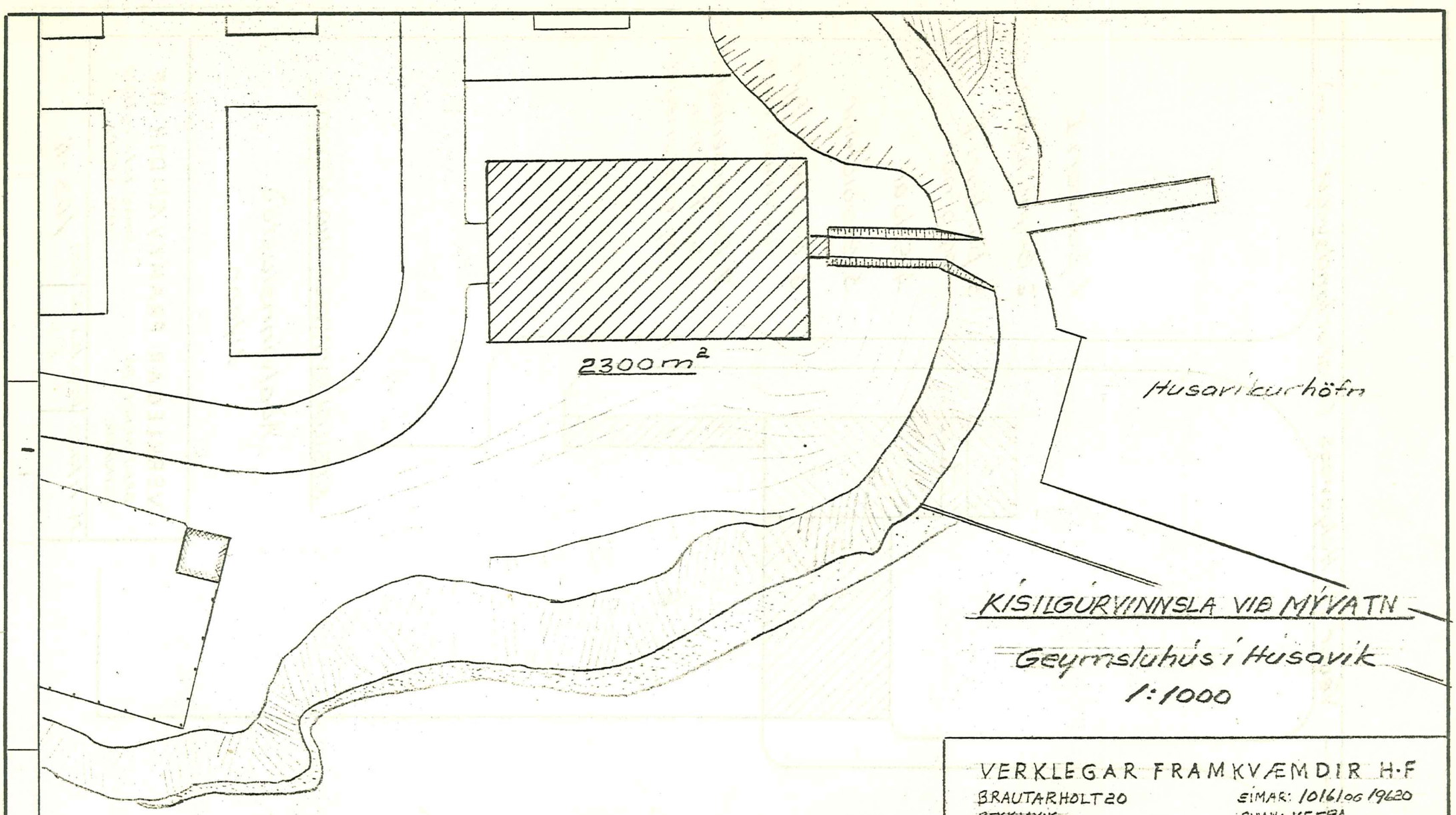

KÍSILGÚRVINNSLA VIÐ MÝVATN

Geymsluhús í Húsavík

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BRAUTARHOLT 20
REYKJAVÍK
SÍMAR: 10161 og 19620
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