

WATER WELL DESIGN - LINKS RANCH

May 25, 1966

By G. M. Gabert
Groundwater Division, Research Council of Alberta
Edmonton, Alberta.

Introduction

The desired yield from the well is 100 imperial gallons per minute. The well is designed to yield this amount of water with a minimum of hydraulic head loss resulting from turbulent flow in the zone outside the well, through the well screen, and in the well casing.

The design is based on an analysis and interpretation of aquifer characteristics, and gradation of aquifer materials as outlined by Ahrens (1957), Smith (1961), and Walton (1962). Design of the well includes determination of screen length, "gravel pack" size, screen slot size, and screen diameter.

Required Open Area

The required open area of the screen is based on a critical entrance velocity of 6 feet per minute which should result in laminar flow through the screen openings.

The required open area is calculated with the following equation:

$$A = 288 \frac{Q}{V}$$

where A = required open area in square inches

Q = desired rate in cubic feet per minute

V = critical velocity in feet per minute

A factor of 2 is introduced into the equation since it is assumed that 50 per cent of the openings will be blocked by the material around the screen.

$$A = 288 \left(\frac{16}{6} \right)$$

$$= 768 \text{ square inches}$$

Length of Screen

The length of screen is determined by an interpretation of information obtained by mechanical analysis of the sand samples from the well and an electric log of the formations penetrated during drilling. On this basis the most permeable interval is considered to be from 30 to 40 feet in depth. The design length of screen is a minimum of ten feet in order to maintain a well of reasonable diameter.

"Gravel Pack" Size

Based on Ahren's (1957) criteria for choice of pack material, a cardium 8-16 frac. sand is a suitable pack for the aquifer material (see the sand analyses for the intervals 30 to 35 and 35 to 40 feet in depth).

Screen Slot Size

The slot size necessary is one that will retain approximately 90 per cent of the pack material (Smith, 1961). This is a slot width of 0.060 inches or a #60 slot screen.

Screen Diameter

From tables of intake areas for selected slot openings (see table 2), 10 feet of #60 slot screen with a nominal screen size of 6 inches (5 5/8 O.D. screen) would supply the required open area.

Additional Notes

It is suggested that an additional 5 feet of screen be installed in the well to insure maximum open area.

References for Well Design Criteria

Ahrens, T. P.: Well Design Criteria. Reprint, Water Well Journal, September and November, 1957. Water Well Journal, Urbana, Illinois.

American Water Works Association: AWWA Standards for Deep Wells, 1958.
2 Park Avenue, New York 16, N.Y.

Handbook of Chemistry and Physics, 29th Edition, 1945. Chemical Rubber Publishing Company.

Smith, Harmon F.: Modern Water Well Design and Construction Procedures.
Paper presented before the Tenth Annual Conference ASCE Hydraulics Division, Urbana, Illinois, August 16, 1961.

Walton, William C.: Selected Analytical Methods for Well and Aquifer Evaluation.
Bulletin 49, Illinois State Water Survey, Urbana, Illinois, 1962.

Acknowledgments for Technical Assistance and Services

Cardium Supply Limited, 6825 - 104th Street, Edmonton, Alberta.

Grain size distribution of Cardium 8-16 frac. sand.

McAllister Drilling, Lloydminster, Alberta.

Drilling, sampling, and electric logging of materials at well site.

Railway & Power Engineering Corporation Limited, 10525 - 104th Street, Edmonton, Alberta.

Representatives for Edward E. Johnson, Inc., 315 North Pierce Street,
Saint Paul 4, Minnesota. Mechanical analysis of sand samples.

APPENDIX

Sand analyses; Table of intake areas for selected slot openings;

Dimensions of Johnson well screens.

TABLE I
DIMENSIONS OF JOHNSON WELL SCREENS

<u>Nominal Size (inches)</u>	<u>Outside Diameter Size (inches)</u>
2	2 7/16
3	2 3/4
3 1/2	3 1/4
4	3 3/4
4 1/2	4 1/4
5	4 3/4
5 5/8	5 1/4
6	5 5/8
8	7 1/2
10	9 1/2
12	11 1/4
15	13 1/4
16	14 1/4
<u>Slot Size</u>	<u>Per Cent Open Area Per Foot*</u>
6	6.25
7	7.21
8	8.15
10	10.0
12	11.75
14	13.45
15	14.30
16	15.1
18	16.65
20	18.15
25	21.70
30	25.0
35	28.0
40	30.8
45	33.3
50	35.7
60	40.0
70	43.8
80	47.1
90	50.0
100	52.6
125	58.0
150	62.5
175	66
200	69
225	71.4
250	73.5

TABLE 2
Telescope-Size Johnson Welded Well Screens
Dimensions and Open Areas

Nominal Screen Size (Diameter of well casing)	INTAKE AREAS FOR SELECTED SLOT OPENINGS						
	Square Inches of Open Area per Foot of Screen						
	Slot No. 10	Slot No. 20	Slot No. 40	Slot No. 60	Slot No. 80	Slot No. 100	Slot No. 150
3"	10	19	32	42	43	55	65
3 1/2"	12	22	37	49	50	64	77
4"	14	25	44	57	58	74	88
4 1/2"	16	29	49	64	66	84	100
5"	18	33	55	72	73	94	112
5 5/8"	20	36	61	79	81	104	124
6"	21	39	65	85	87	111	132
8"	28	51	87	113	116	131	160
10"	36	65	110	143	147	166	203
12"	42	77	130	170	174	180	223
14" O.D.	38	71	123	163	177	198	251
15" O.D.	39	76	132	175	190	217	268
16" O.D.	35	69	123	164	171	198	250
16" Special	38	71	125	168	175	203	256
18" O.D.	39	78	139	186	193	224	283
18" Special	42	79	141	189	196	227	287
20" O.D.	47	88	156	209	218	252	318
24" O.D.	46	87	158	217	266	307	389
26" O.D.	49	91	166	227	278	321	406
30" O.D.	57	108	192	268	329	379	480
36" O.D.	65	124	224	307	376	434	550

Note: Open areas may vary slightly from these figures in special cases.

RELATION OF WELL DIAMETER TO YIELD

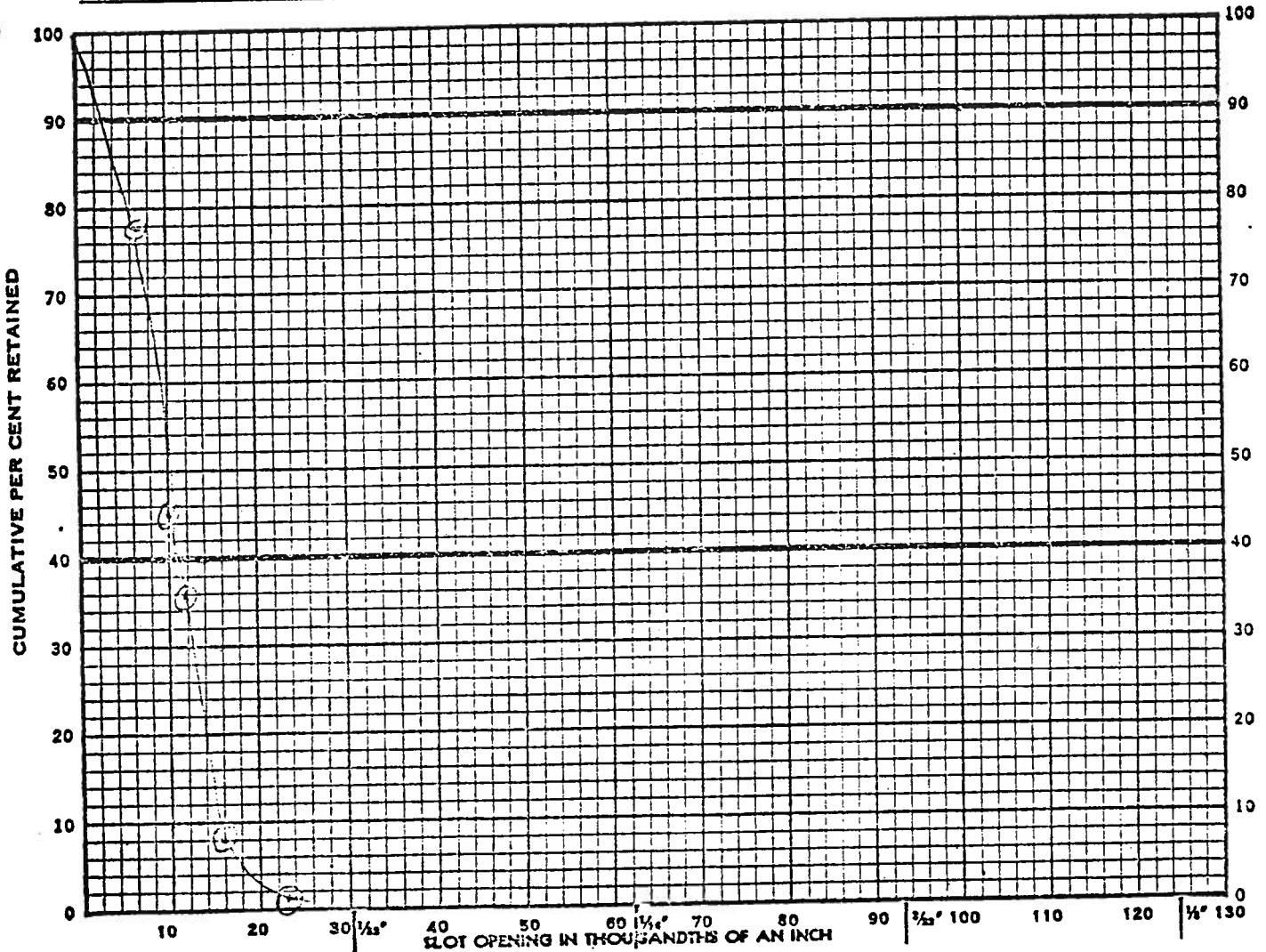
Well Diameter (Inches)	Relative Yield	Well Diameter (Inches)	Relative Yield
4	1.00	24	1.27
6	1.04	48	1.42
8	1.08	120	1.65
12	1.15	240	1.92

SAND ANALYSIS

EDWARD E. JOHNSON, INC.

315 NORTH PIERCE STREET
SAINT PAUL 4, MINN.

Sample sent in by McAlister Drilling
Town Lloydminster State Alta Date May 25/66
From well of D. H. LINKS
Remarks 5' level



SIEVE OPENINGS	CUMULATIVE PER CENT RETAINED	
.191	GRAMS	%
.093		
.065		
.046		
.033		
.023	6	1.58
.016	27	2.6
.012	171	31.3
.010	373	78
.007	373	78
SCREEN SLOT	477	100

NOTES:

SLOT OPENING RECOMMENDED: 10

RECOMMENDED SCREEN: DIA. _____ IN. LENGTH _____ FT.

ANALYSED & POWERED BY EDWARD E. JOHNSON, INC. BY [Signature]

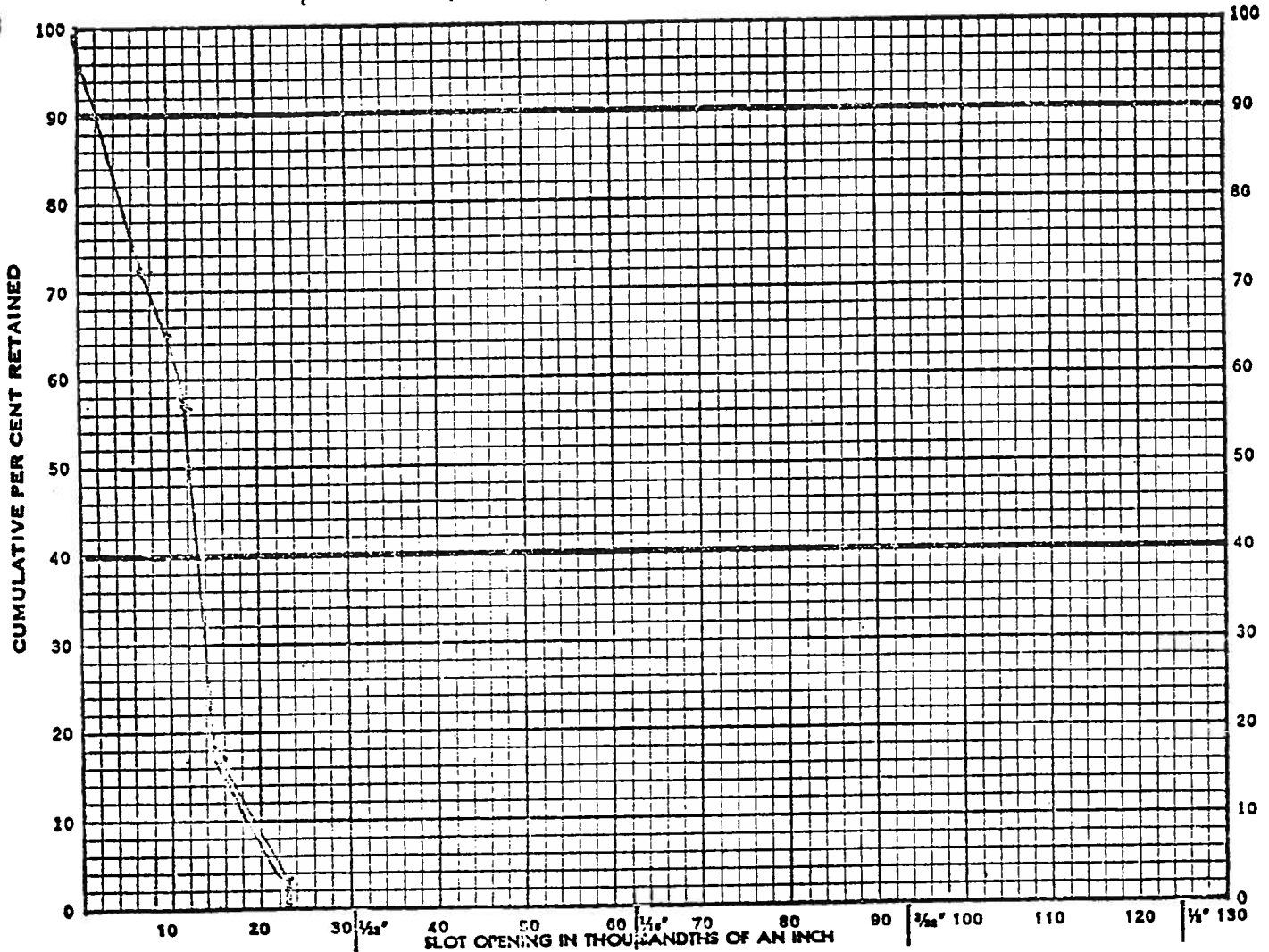
SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS

SAND ANALYSIS

EDWARD E. JOHNSON, INC.

315 NORTH PIERCE STREET
SAINT PAUL 4, MINN.

Sample sent in by Mc Miller Drilling
Town Hydromer State Alta Date May 25/66
From well of Dr H. Links
Remarks 10'-0 level



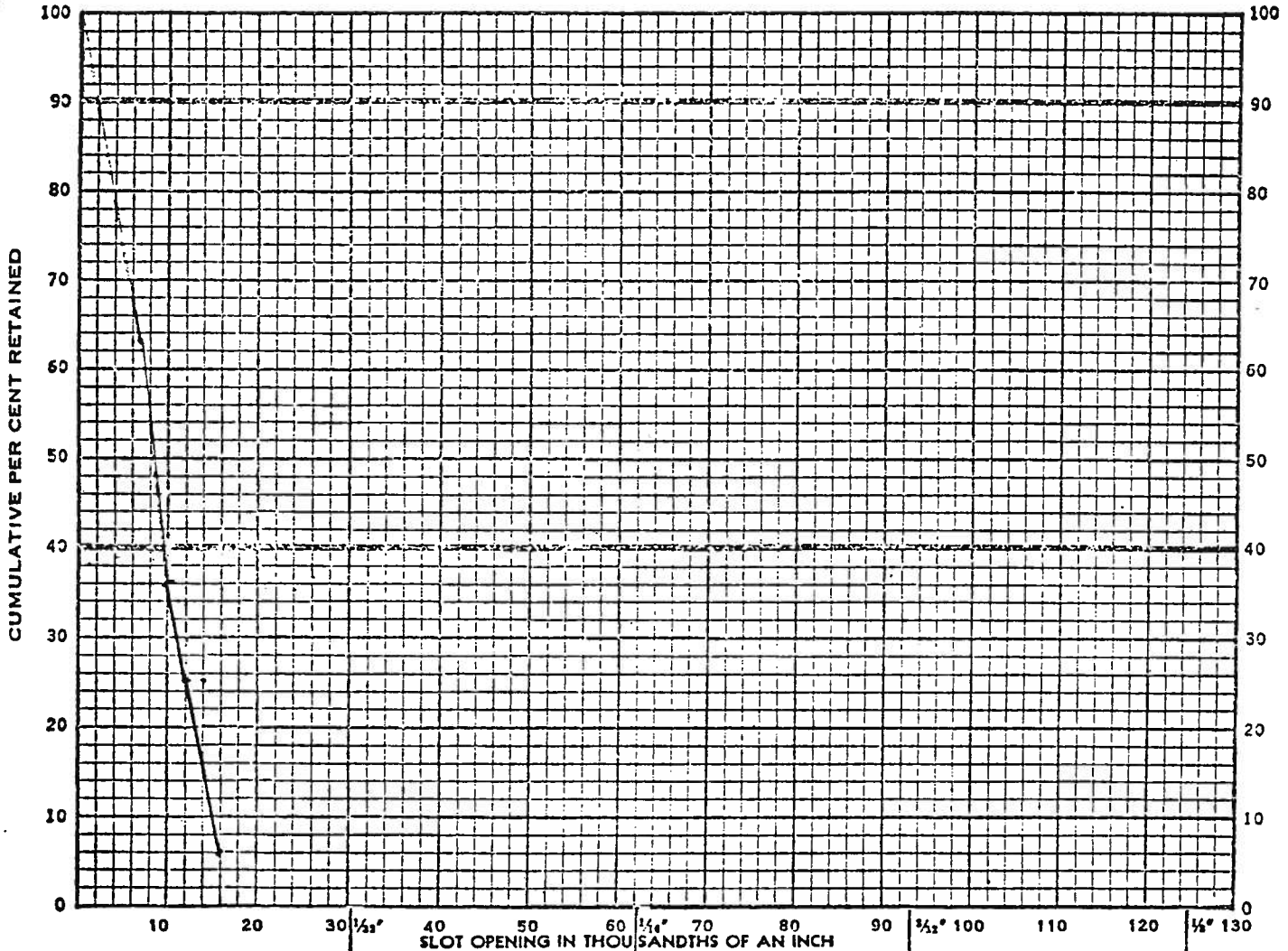
SIEVE OPENINGS	CUMULATIVE PER CENT RETAINED		
.151			
.093			
.065			
.046			
.033			
.023			
.016	30	33	
.012	330	37	57
.009	373	63	
.007	374	72	
SCREEN SLOT	569	100	

NOTES: _____

 SLOTTING RECOMMENDED: 13 Mesh
 RECOMMENDED SCREEN: DIA. _____ IN. LENGTH _____ FT.
 EDWARD E. JOHNSON ENGINEERING CO., INC. BY: _____

SAND ANALYSIS
EDWARD E. JOHNSON, INC.
 315 NORTH PIERCE STREET
 SAINT PAUL 4, MINN.

Sample sent in by Hi-Rite Drilling Co. Drilling
 Town _____ State Ill. Date Research Council
 From well of 15
 Remarks _____



SIEVE OPENINGS	CUMULATIVE PER CENT RETAINED	
.131		
.093	0	0
.066	0	0
.047	0	0
.033	0	0
.023	0	0
.016	0	0
.012	0	0
.010	1.30	36
.0075	2.26	63
SCREEN SLOT	3.55	100

NOTES: _____

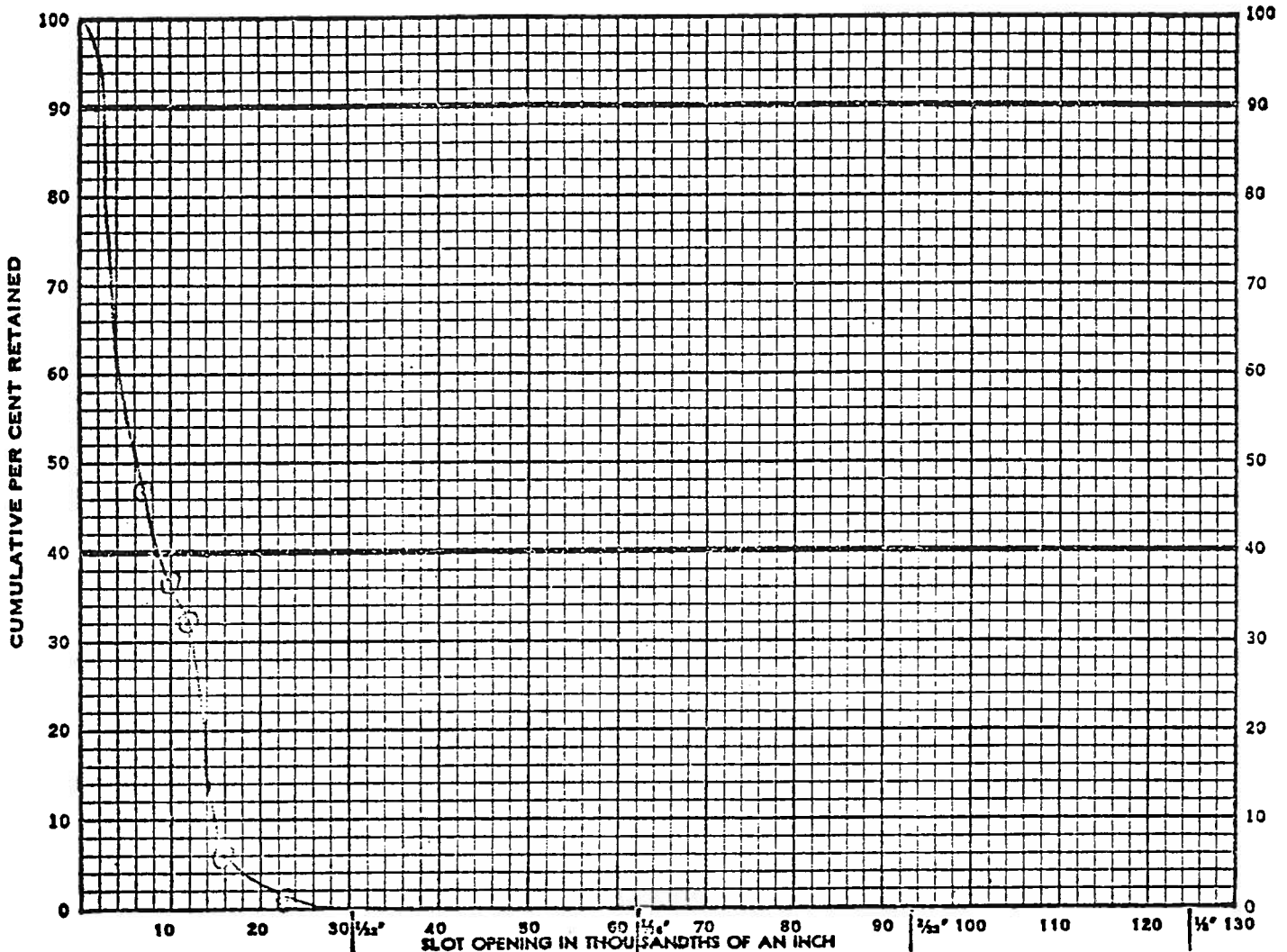
SLOT OPENING RECOMMENDED: 10 Slot

RECOMMENDED SCREEN: DIA. _____ IN. LENGTH _____ FT.

RAILWAY & POWER ENGINEERING CORP. LTD. BY: _____

SAND ANALYSIS
EDWARD E. JOHNSON, INC.
 315 NORTH PIERCE STREET
 SAINT PAUL 4, MINN.

Sample sent in by Mc Alister & Co
 Town _____ State _____ Date May 25/46
 From well of Dr H Smith
 Remarks #26



SIEVE OPENINGS	CUMULATIVE PER CENT RETAINED	
.131		
.093		
.065		
.046		
.033		
.023	4	8
.016	30	6
.012	150	32
.008	110	3
.007	476	47
SCREEN SLOT	458	100

NOTES: _____

SLOT OPENING RECOMMENDED: 8 Slot

RECOMMENDED SCREEN: DIA. _____ IN. LENGTH _____ FT.

RAILWAY & POWER ENGINEERING CORP. LTD. BY: [Signature]

SAND ANALYSIS

EDWARD E. JOHNSON, INC.

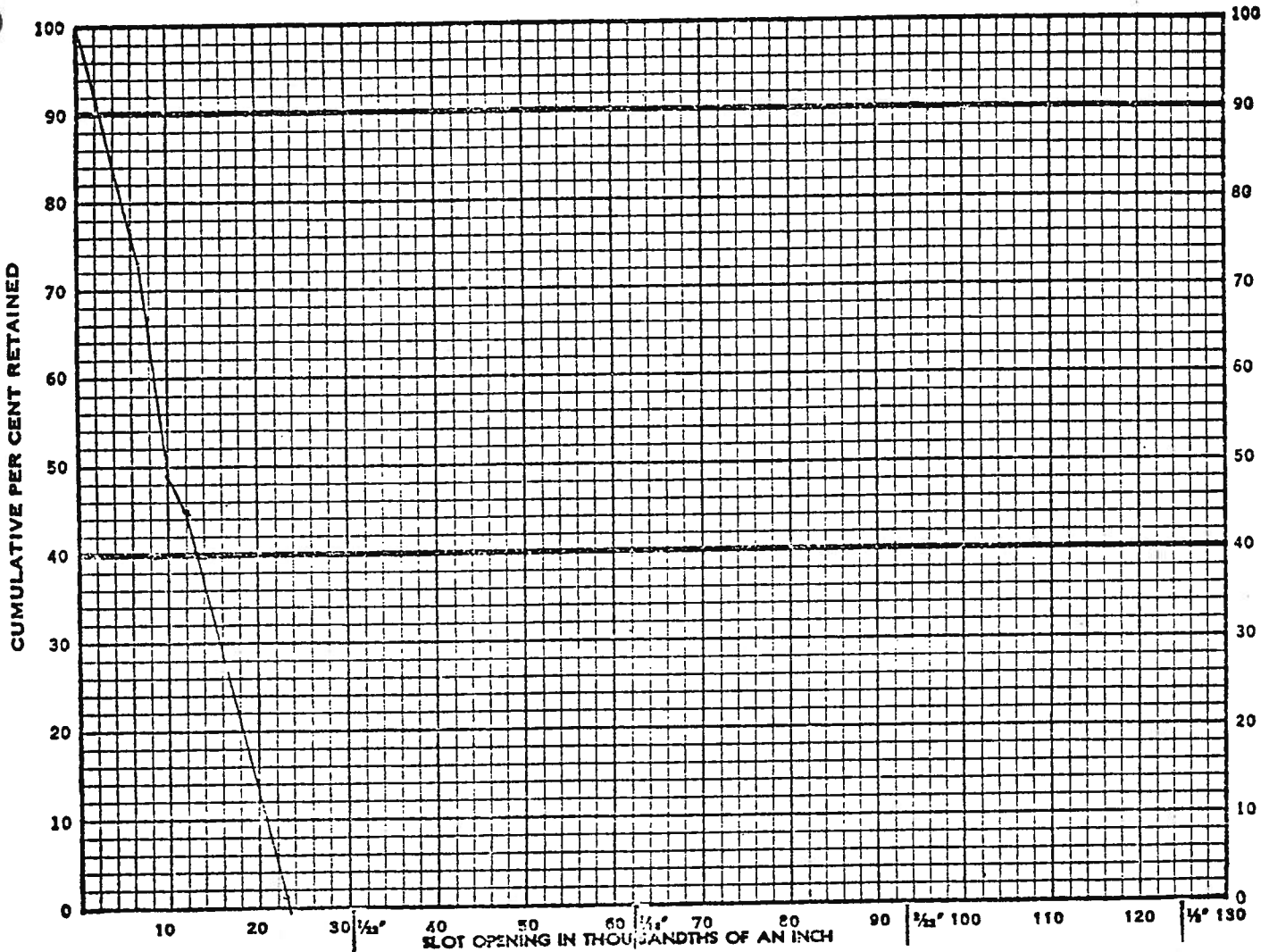
315 NORTH PIERCE STREET
SAINT PAUL 4, MINN.

Sample sent in by McWhorter & Co.

Town _____ State _____ Date May 25/66

From well of E. H. Lynch

Remarks # 25



SIEVE OPENINGS	CUMULATIVE PER CENT RETAINED	
.131		
.093		
.065		
.046		
.033		
.023		
.016	8	12
.012	15.6	40
.010	31.2	47
.007	32.0	72
SCREEN SLOT	434	100

NOTES: _____

SLOT OPENING RECOMMENDED: 13 Slot

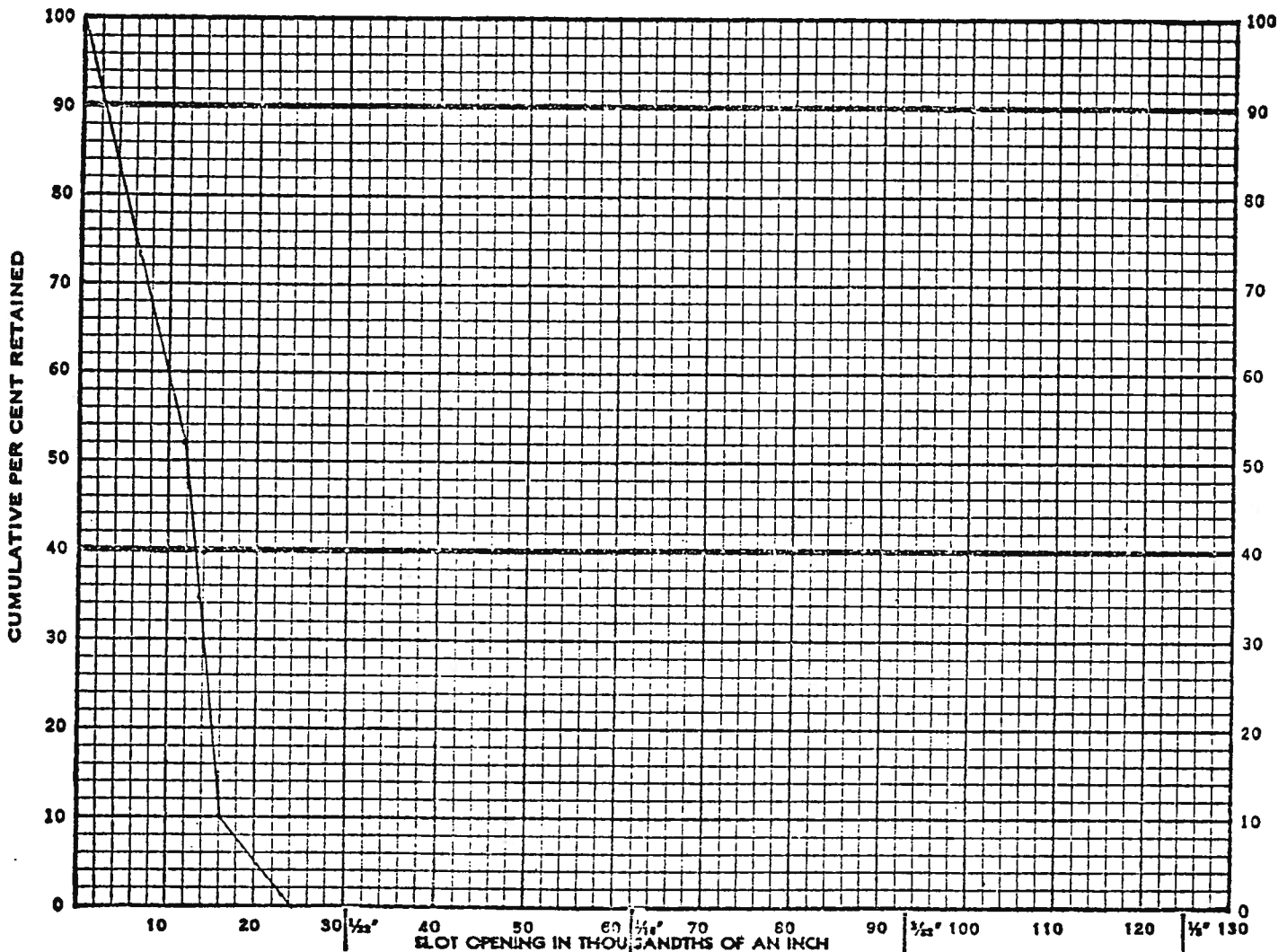
RECOMMENDED SCREEN: DIA. _____ IN. LENGTH _____ FT.

WAY & POWER ENGINEERING CO., LTD. BY: _____

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS

SAND ANALYSIS
EDWARD E. JOHNSON, INC.
 315 NORTH PIERCE STREET
 SAINT PAUL 4, MINN.

Sample sent in by McAllister Dwy
 Town _____ State _____ Date May 25/56
 From well of Dr. H. Linder
 Remarks #30



SIEVE OPENINGS	CUMULATIVE PER CENT RETAINED	
.131		
.093		
.065		
.046		
.033		0
.023	6	1
.016	48	15
.012	85	52
.010	96	85
.007	99	93
SCREEN SLOT	480	100

NOTES: _____

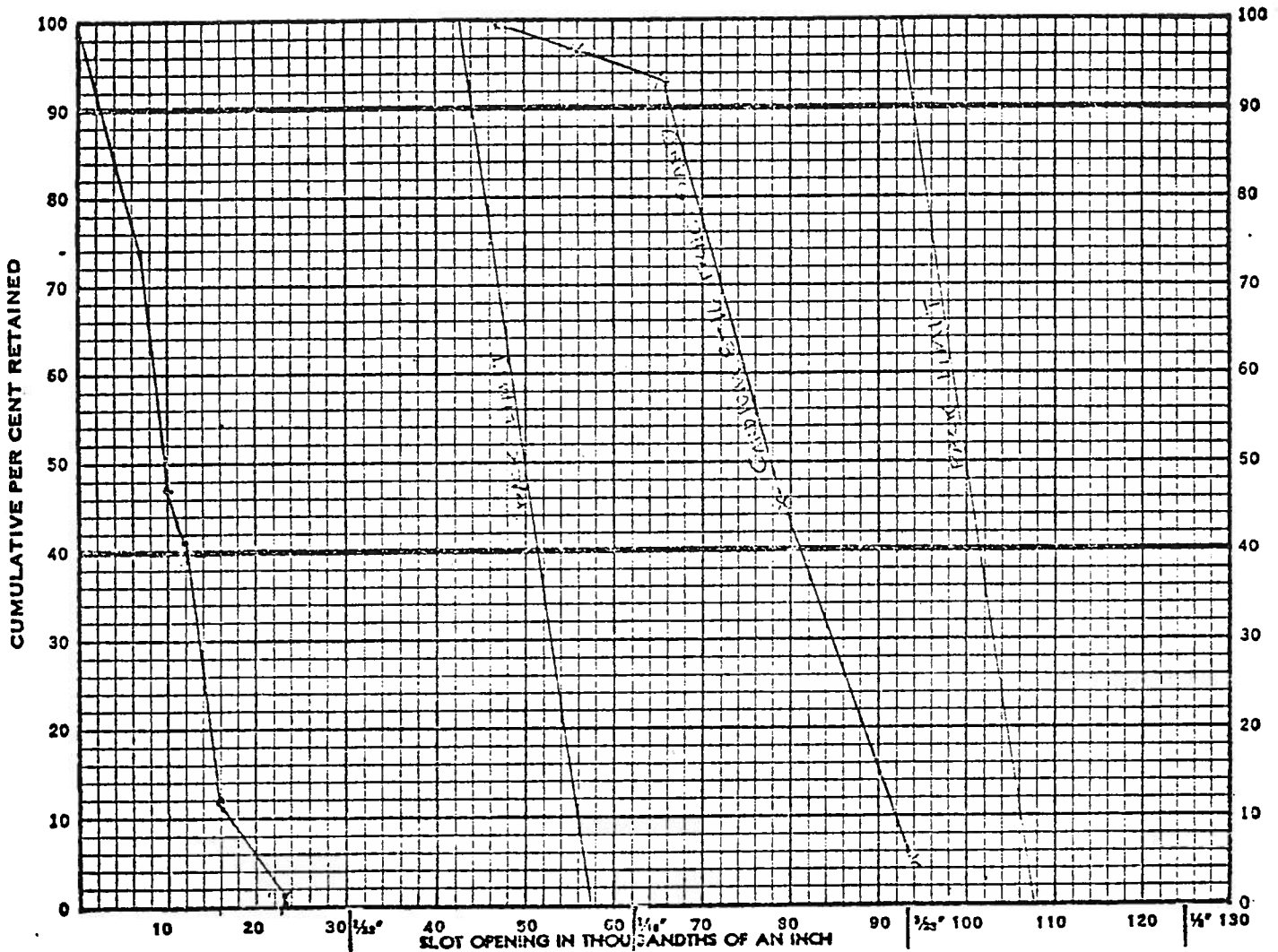
SLOT OPENING RECOMMENDED: 13 Slot

RECOMMENDED SCREEN: DIA. _____ IN. LENGTH _____ FT.

RAILWAY & POWER ENGINEERING CORP. LTD. BY: _____

SAND ANALYSIS
EDWARD E. JOHNSON, INC.
 315 NORTH PIERCE STREET
 SAINT PAUL 4, MINN.

Sample sent in by Mc Allister Drilling
 Town Lloydminster State Alta Date May 25/66
 From well of Dr. H. Links
 #35
 Remarks _____
30-35' INTERVAL



SIEVE OPENINGS	CUMULATIVE PER CENT RETAINED	
.131		
.093		
.065		
.046		
.033		
.023	8	1
.016	37	12
.012	186	41
.0085	212	47
.0075	335	77
SCREEN SLOT	450	100

NOTES: _____

 SLOT OPENING RECOMMENDED: 1.2

 RECOMMENDED SCREEN: DIA. _____ IN. LENGTH _____ FT.

 RAILWAY & POWER ENGINEERING CORP. LTD. BY: _____

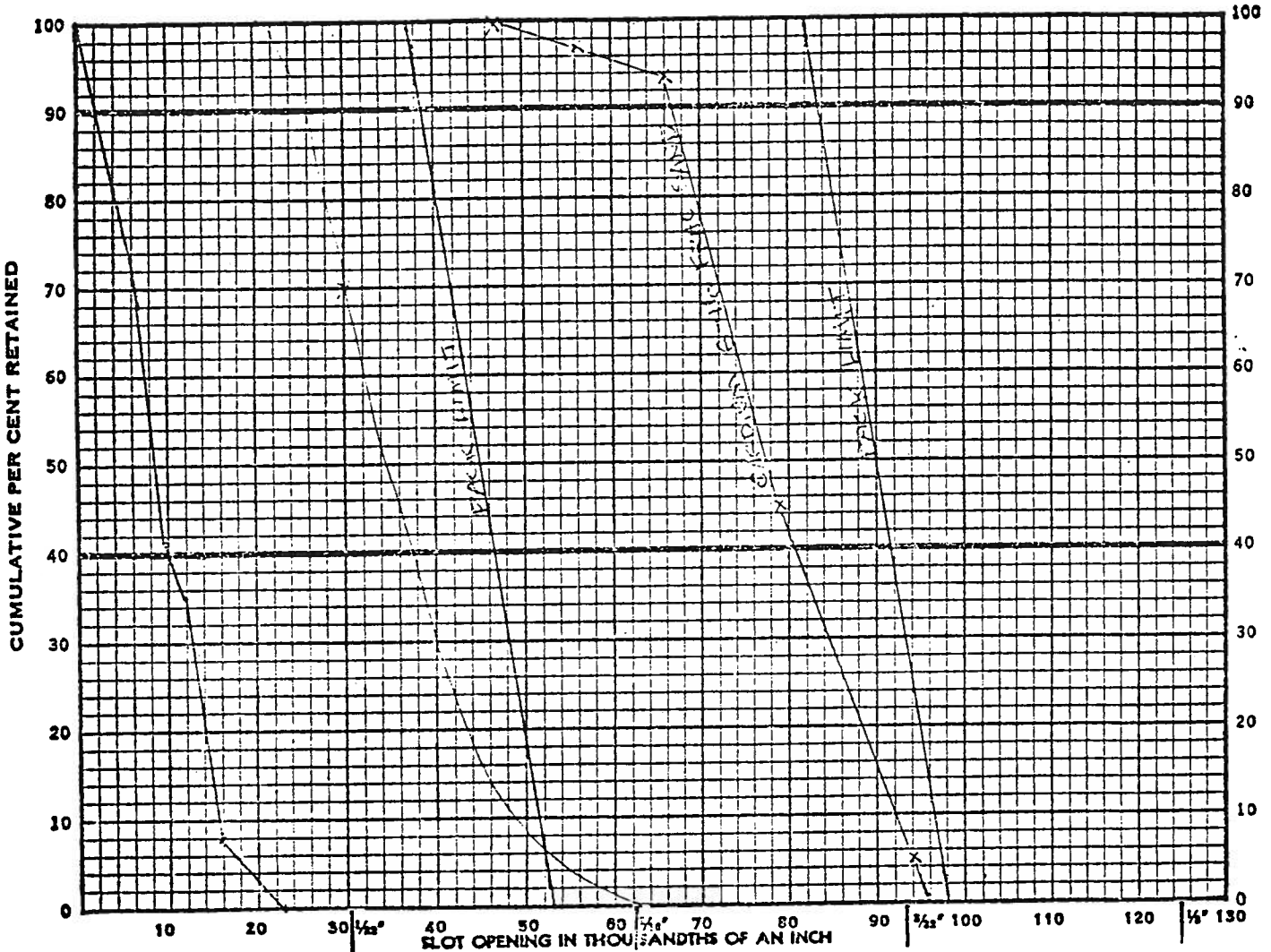
SAND ANALYSIS

EDWARD E. JOHNSON, INC.

315 NORTH PIERCE STREET
SAINT PAUL 4, MINN.

Sample sent in by McAllister Drilling
Town Lloydminster State Alta Date May 25/66
From well of Dr. H. Links
Remarks #40

35-40' INTERVAL



SIEVE OPENINGS	CUMULATIVE PER CENT RETAINED	
.131		
.093		
.065		
.046		
.033		
.023	3	0
.016	41	8
.012	72	35
.008	100	41
.006	316	65
SCREEN SLOT	460	100

NOTES:

SLOT OPENING RECOMMENDED: 10 Slot

RECOMMENDED SCREEN: DIA. _____ IN. LENGTH _____ FT.

RAILWAY & POWER ENGINEERING CO., LTD. BY: _____

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT-SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS

SAND ANALYSIS

EDWARD E. JOHNSON, INC.

315 NORTH PIERCE STREET

SAINT PAUL 4, MINN.

Sample sent in by

M. J. J. J. J.

Town

State

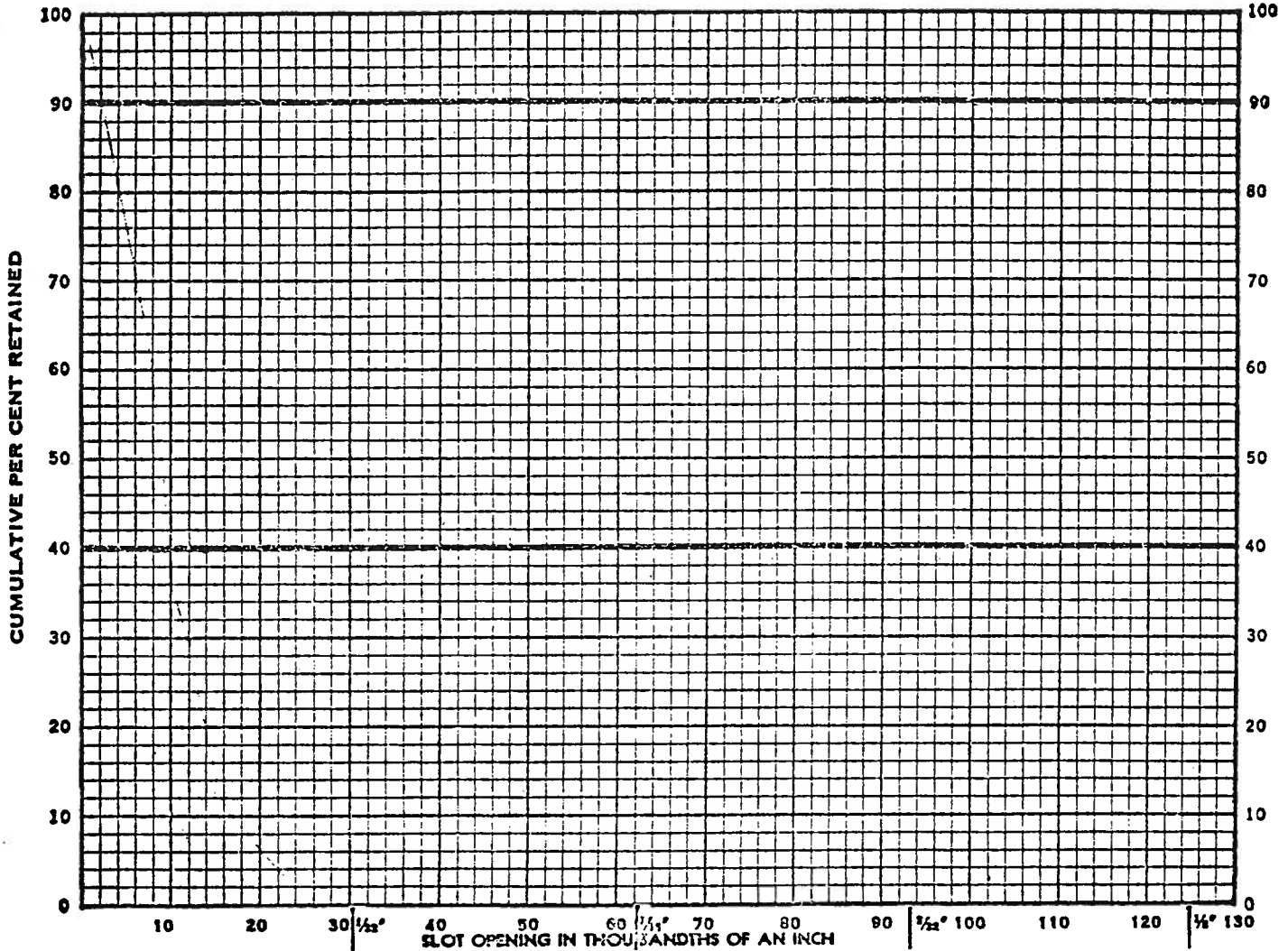
Date

From well of

Dr. J. J. J.

Remarks

115



SIEVE OPENINGS	CUMULATIVE PER CENT RETAINED		
.131			
.093			
.065			
.046			
.033			
.023			
.016			
.012			
.009			
.005			
SCREEN SLOT			

NOTES:

SLOT OPENING RECOMMENDED:

RECOMMENDED SCREEN: DIA. IN. LENGTH FT.

RAILWAY & POWER ENGINEERING CORP. LTD.

BY:

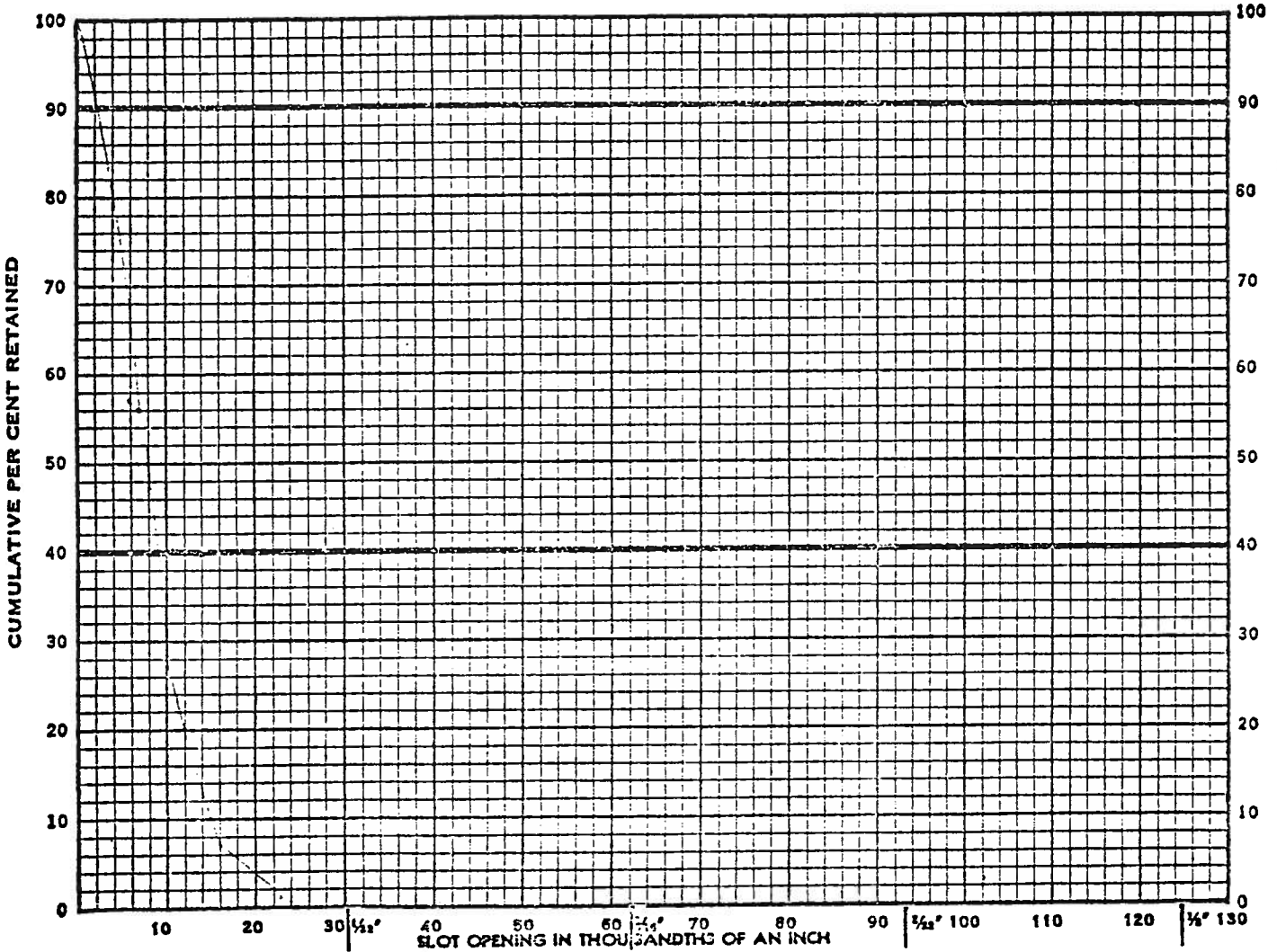
SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS

SAND ANALYSIS

EDWARD E. JOHNSON, INC.

315 NORTH PIERCE STREET
SAINT PAUL 4, MINN.

Sample sent in by Mr. Miller July
Town _____ State _____ Date July 25/56
From well of Dr. H. Links
Remarks # 50



SIEVE OPENINGS	CUMULATIVE PER CENT RETAINED		
.191			
.085			
.065			
.046			
.033			
.023	5	1	
.016	10	2	
.012	15	3	
.0085	20	4	
.0075	25	5	
SCREEN SLOT	30	6	

NOTES:

SLOT OPENING RECOMMENDED: 9 slot

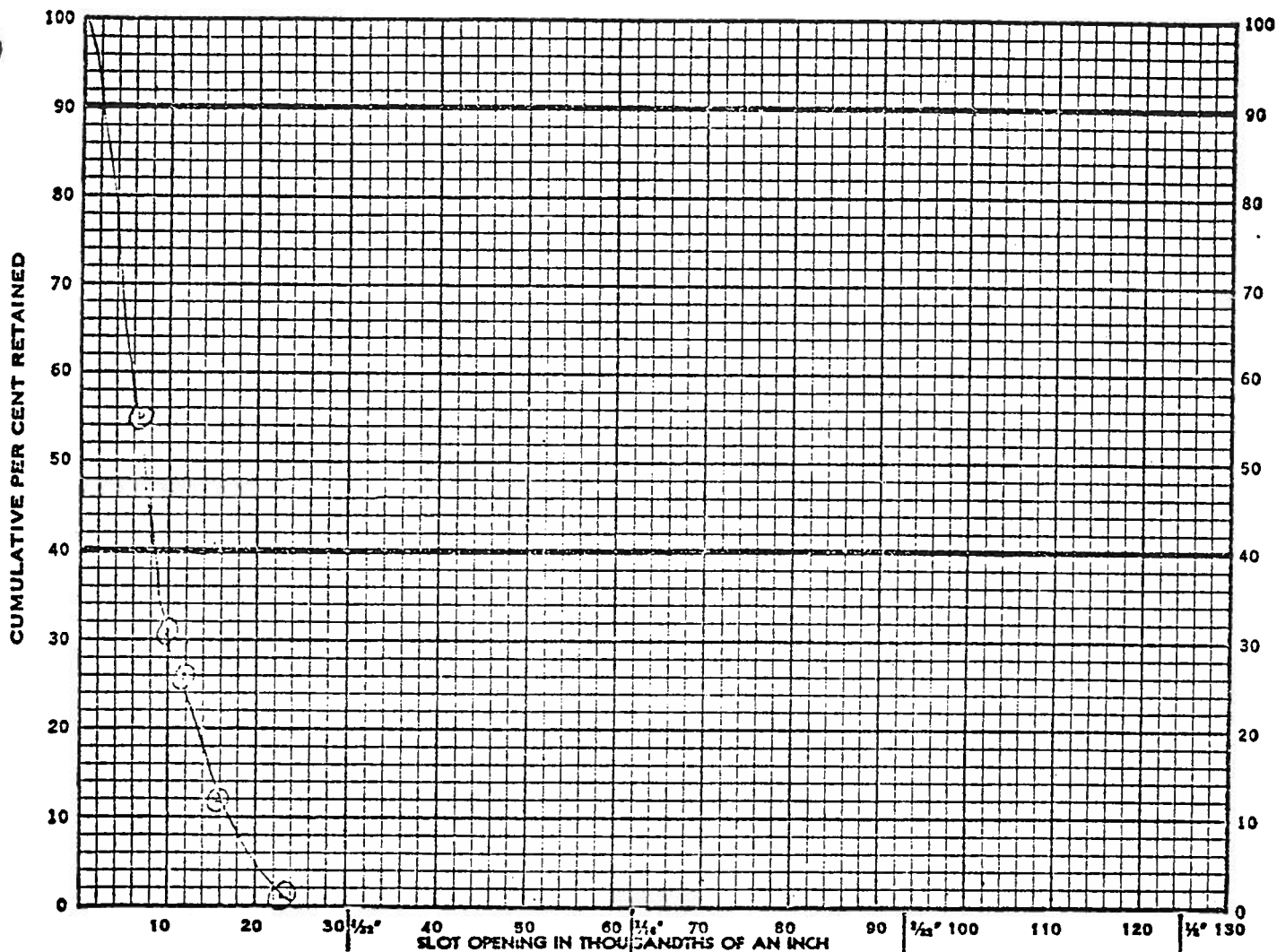
RECOMMENDED SCREEN: DIA. _____ IN. LENGTH _____ FT.

BY: [Signature]

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS

SAND ANALYSIS
EDWARD E. JOHNSON, INC.
315 NORTH PIERCE STREET
SAINT PAUL 4, MINN.

Sample sent in by McCallister Drilling
Town Hopkinton State _____ Date May 25/66
From well of Dr. H. Links
Remarks 55'-0 inch

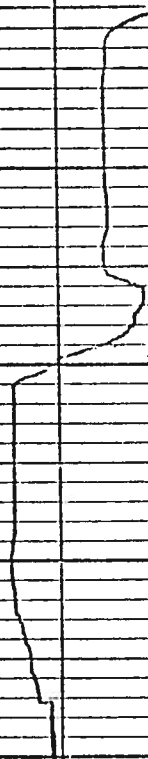


SIEVE OPENINGS	CUMULATIVE PER CENT RETAINED	
.131		
.093		
.065		
.046		
.033		
.023	25	1
.016	87	1/2
.012	182	25
.0075	217	31
.005	382	25
SCREEN SLOT	694	100

NOTES: _____

SLOT OPENING RECOMMENDED: 8
RECOMMENDED SCREEN: DIA. _____ IN. LENGTH _____ FT.
RAILWAY & POWER ENGINEERING CORP. LTD. BY [Signature]

7	1	1	1
---	---	---	---

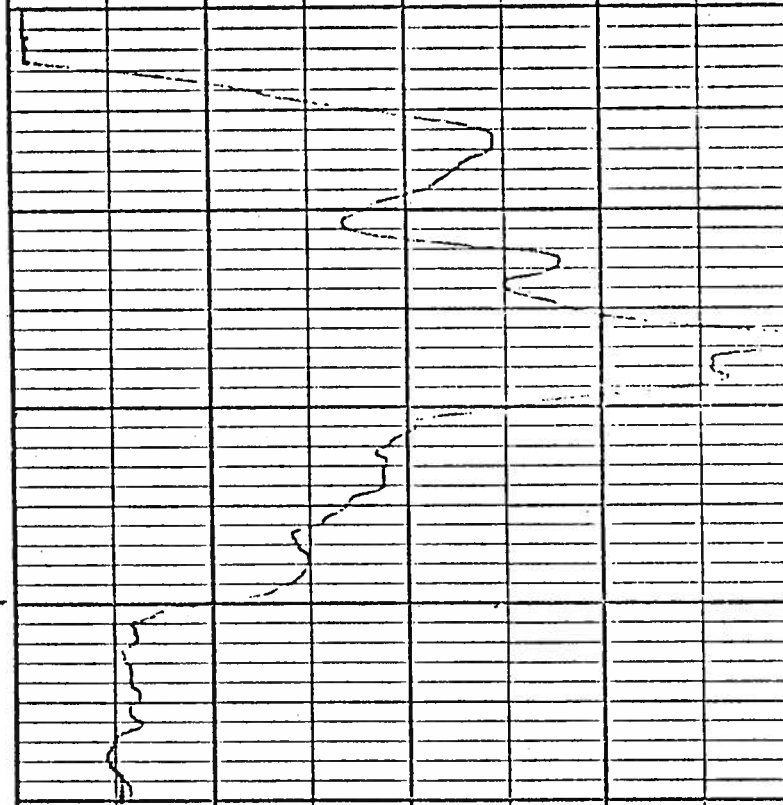


20

40

60

50





RESEARCH COUNCIL OF ALBERTA

10302 - 107TH STREET
EDMONTON, ALBERTA, CANADA

GROUNDWATER DIVISION

OUR REF:

June 10, 1966.

Re: Pumping Tests on McAllister Well

The pumping test data on the above well had to be rejected because reliable interpretation of time-drawdown data requires that the pumping rate be constant throughout the test period. A maximum variation of 5 per cent in pumping rate is allowable. The variation in the pumping rate for pump tests numbers 1 and 2 was 29 per cent.

A plot of time-drawdown data resulting from a variation of this magnitude would give results similar to effects created under leaky artesian conditions and could be misleading.

An attempt to calculate a transmissibility and storage coefficient for the aquifer was carried out using the leaky artesian formula. The aquifer coefficients are average values of the transmissibility and the storage coefficient for materials within the cone of depression created by pumping a well. The analytical procedure is outlined in Bulletin 49 (1962) of the Illinois State Water Survey.

The transmissibility calculated was in the order of about 2,000 imperial gallons per day per foot.

A transmissibility of this magnitude indicates materials of low permeability at the well site, but a conclusive statement regarding the aquifer coefficients could only be made if a long pumping test properly conducted was carried out at the site.

Enclosed is a copy of the basic data from the pumping tests carried out by McAllister Drilling.

Yours truly,

G. M. Gabert,
Groundwater Geologist.

GMG/dc
Encl.

PUMPING TEST #12 OBSERVATION WELL DRAWDOWN

$$= 2292 \text{ gpd/ft}$$

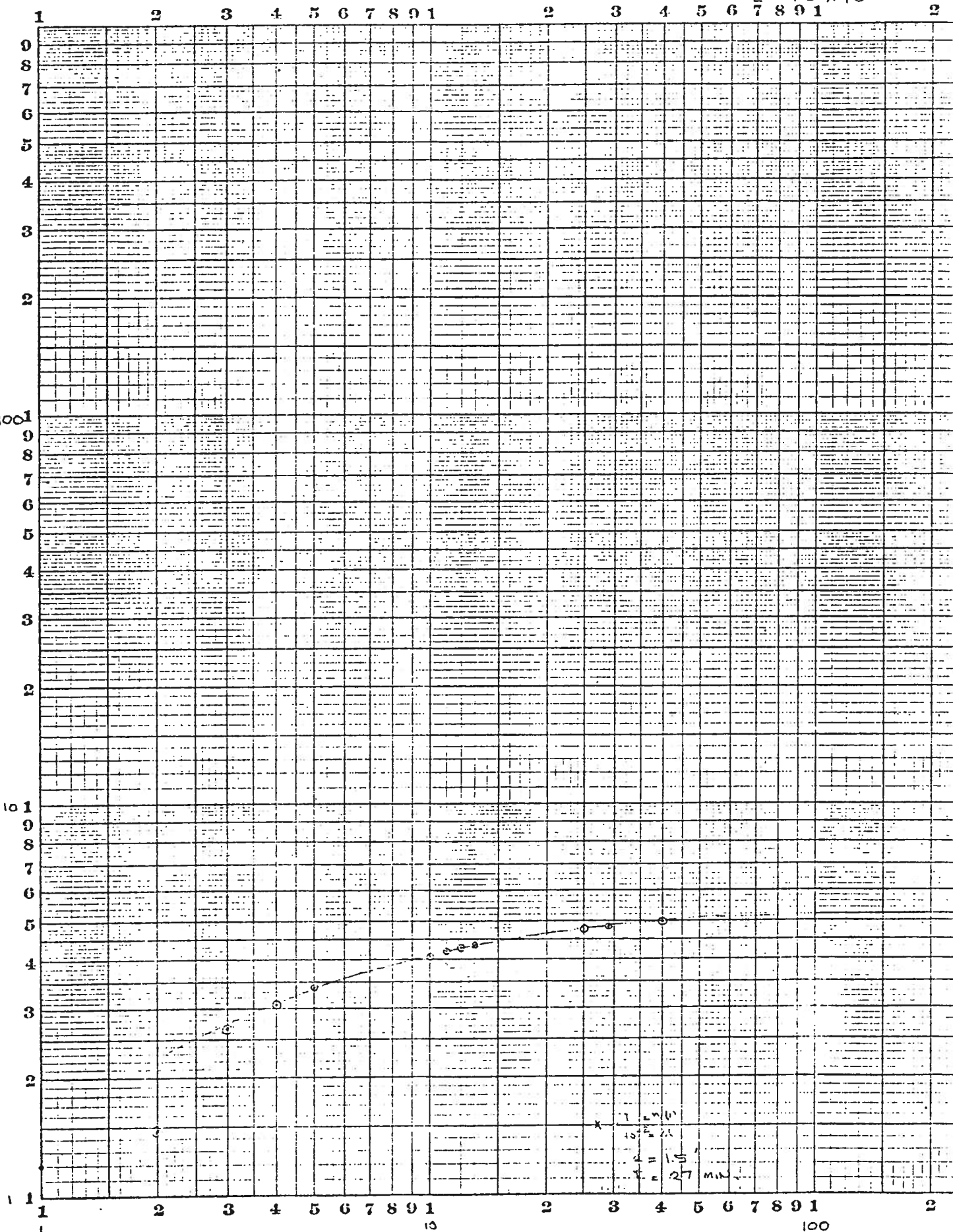
$$= \frac{2693 r^2}{2292 \times 10^{-2} \times 2.7} = \frac{2242 \times 4.0 \times 140}{1.73 \times 10^{-4}}$$

INDEX COMP. NO. 1000, PRINTED S.A.



NO. 412 LOGARITHMIC 5 BY J. J. H. C. G. 1961

DRAWDOWN IN FEET



TIME IN MINUTES SINCE PUMPING BEGAN

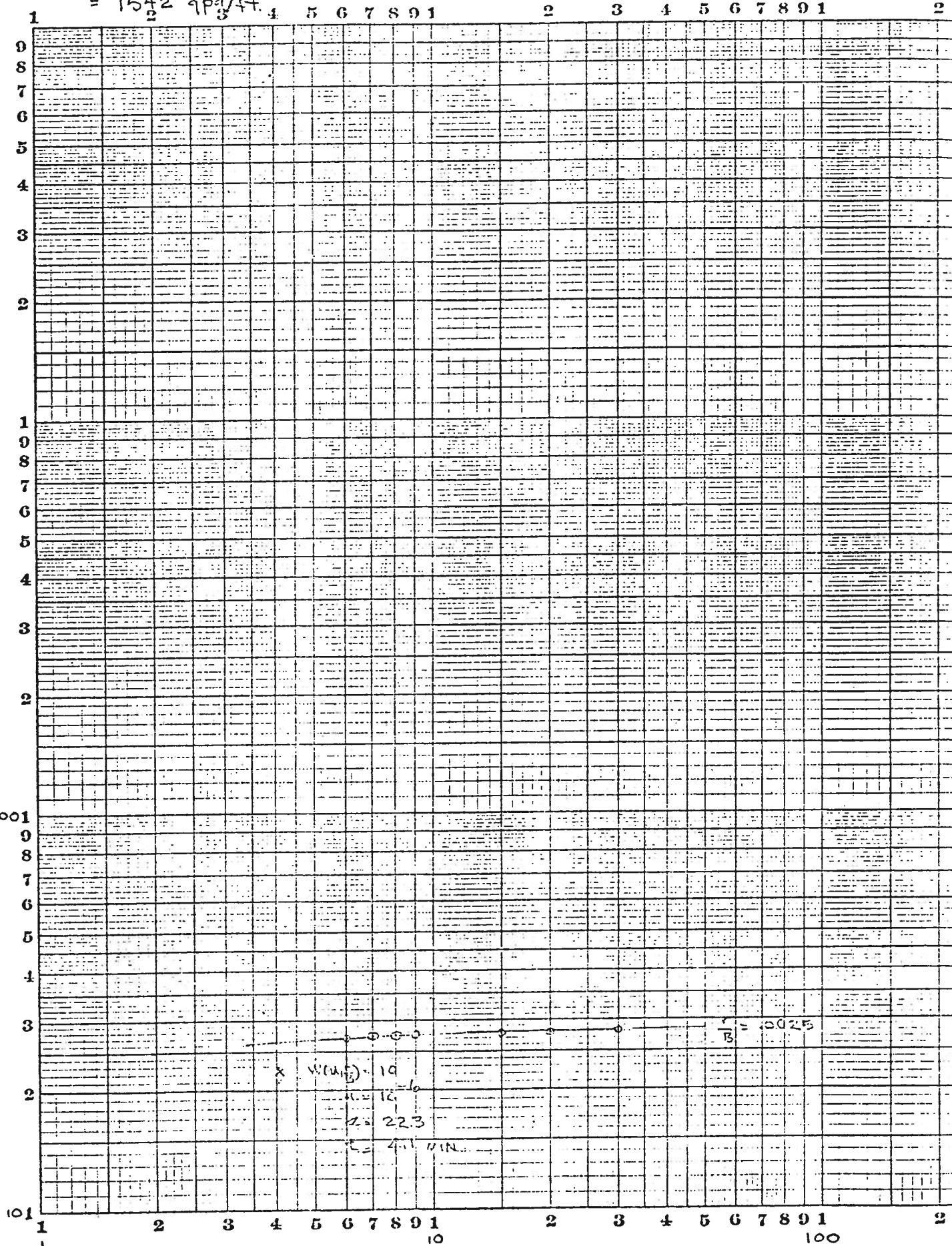
PUMPING WELL DRAWDOWN

$$= \frac{1.46 \times 10^2 \times 3.0 \times 10^1 \times 10^1}{223 \times 10^1}$$

$$= 1542 \text{ gpd/ft.}$$

$$Q_2 = 96 \text{ I gpm}$$

DRAWDOWN IN FEET



TIME IN MINUTES SINCE PUMPING BEGAN

THEORETICAL SAFE PUMPING RATE

$$U = \frac{2292 \cdot r^2 S}{T t}$$

$$= \frac{2.242 \times 10^3 \times 6.25 \times 10^{-2} \times 1.73 \times 10^{-4}}{2.292 \times 10^3 \times 2.0 \times 3.65 \times 1.440 \times 10^6}$$
$$= 1.006 \times 10^{-12}$$

$$r = 0.25'$$

$$T = 2292 \text{ lqpm}$$

$$t = 20 \text{ YEARS}$$

$$S = 1.73 \times 10^{-4}$$

$$W(u, \frac{r}{B}) = 3.5054 \quad (\text{FROM TABLES})$$

$$Q_s = \frac{2.5 \times T}{114.6 \cdot W(u, \frac{r}{B})}$$

$$r_t = 25'$$

$$= \frac{2.5 \times 10^1 \times 2.292 \times 10^3}{1.146 \times 10^2 \times 3.5054}$$

$$= 143 \text{ lqpm}$$

Test conducted by: McAllister Drilling Measured by: _____

Status Pumping well R = _____ Date May, 1966 Page 1 of 1

(pumping or observation well)

[illegible]

Test conducted by: McAllister Drilling

Measured by:

Well location: Lsd. or 1/4 _____ Sec. _____

Tp. R. Mer.

R = 40 feet

Date May, 1966

Page 1 of 1

(pumping or observation well)

(distance from pumping well in feet and direction)

[illegible]

Water Level Measurements (field)

Test conducted by: McAllister Drilling Measured by: _____

Location of project Linds Ranch Well location: Lsd. or 1/4 Sec. Tp. R. Mer.

Status Pumping well R = _____ Date May, 1966 Page 1 of 1

(pumping or observation well) (distance from pumping well in feet and direction)

[illegible]