T. LIVINGSTON, P. Eng.
A. BADRY

PACIFIC HYDROLOGY CONSULTANTS LTD.
CONSULTING GROUNDWATER GEOLOGISTS

1401 WEST BROADWAY
VANCOUVER, B.C. V6H 1H6
TELEPHONE: 738-9232

September 10, 1980

Rutland Waterworks District,
160 Highway 33 West,
Kelowna, B.C.
V1X 1X7

Attention: Mr. G.B. Sloane,
Secretary-Treasurer

Dear Sirs,

Re: Construction and Testing of Well No. 11

The purpose of this letter-report is to put on record the results of the construction and testing of the District's new Well No. 11 located in the Works Yard between existing Wells No. 5 and No. 8. A dry testhole was drilled east of the Village before constructing the new well. The work was carried out by A.C. Drillers using a cable tool drill.

TEST DRILLING, WELL CONSTRUCTION AND TESTING

The log of the dry testhole is as follows:

0	-	1 ft.	soil
1	-	37 ft.	coarse dry bouldery gravel
37	-	80 ft.	light grey clay (?) becoming darker
80	-	81 ft.	sand with pebbles, making water
81	-	99 ft.	compact grey clay
99	-	106 ft.	grey sandy till (?)
106	-	108 ft.	choclate brown clay shale
108	-	109 ft.	fresh granite rock

Following the drilling of the unsuccessful testhole and in light of decreased capacity of Well No. 5, the decision was made to construct a well in the pipe yard between existing Wells No. 5 and No. 8. Well No. 11 was drilled between the two wells, slightly closer to No. 5. Wells No. 5 and No. 8 are approximately 325 ft. apart.

The log of Well No. 11 is as follows:

0	-	17 ft.	coarse gravel, cobbles, till (?)
17	-	23 ft.	till, tan
23	-	43 ft.	till (?), very silty, sandy, tan
43	-	62 ft.	gravel, bouldery
62	-	78 ft.	gravel, more sandy, looser with boulders at 78 ft.
78	-	96 ft.	sand, gravelly, cobbly with water below 80 ft.
96	-	141 ft.	sand, gravelly becoming grey at bottom
141	-	143 ft.	sand with silty interbeds
143	-	150 ft.	sand, gravelly
150	-	166 ft.	gravel, very sandy, colour changes from tan to dark brown
166	-	171 ft.	silt, compact with thin sand interbeds

The static level at the time of testing was approximately 70 ft. below ground.

Drilling was started with 12 inch diameter casing. The well is completed as a 10 inch diameter well with 10" nominal diameter Johnson's stainless steel well screen as follows:

at top (142' 11") 143	type K packer
2 ft.	0.030" slot screen
10 ft.	0.040" slot screen
2 ft.	0.030" slot screen
8 ft.	0.020" slot screen
at bottom (166 ft.)	bail bottom

The slot sizes were selected on the basis of sieve analyses of samples collected every few feet in the water-bearing sands and gravels. Copies of the analyses are appended. The 10" drive shoe is located at 143' 11" below ground.

Following well construction development by bailing was carried out for a short time. The water cleaned up quite quickly. Because of the difficulty with development of the two existing wells it was felt that vigorous development methods should be avoided.

Additional development by backwashing was carried out by Aqua-Flo following a short pump test. One day of backwashing improved the performance of Well No. 11 by 15-20%. Additional development is likely to result in further increases. The performance of Well No. 5 was improved considerably by backwashing for several days at the time of construction but it has gradually declined with use. Considerable

cont'd... 3

time spent on redevelopment was unsuccessful in restoring original well performance. Well No. 8, however, performed considerably better at the time of construction and very little development was carried out.

Pump Testing

The pump testing and backwashing were carried out by Aqua-Flo Testing and Equipment. The purpose of the testing was to establish well performance; aquifer characteristics were known from testing of the existing wells. Data collected during the two short pump tests are included in the Appendix to this letter.

A short pump test of the new well to check the well performance was carried out on July 16 starting at 15:50. The two existing wells had been shut off at 08:45 in order that well interference could be monitored. The pumping level became stable quite quickly after the start of pumping so the test was terminated at 90 minutes and observations of the recovering water level were taken. The well performance of 5.37 USgpm/ft. of drawdown calculated at 90 minutes of pumping at 305 USgpm, was less than half the specific capacity of the poorest of the two existing wells, Well No. 5 , calculated at a pumping rate twice as high. Further, most of the drawdown occurs as well loss in the first few minutes after the start of pumping. For this reason, testing was terminated and backwashing carried out in an attempt to improve well efficiency.

Following about one day of backwashing the performance of Well No. 11 was 6.48 USgpm/ft. of drawdown calculated at 50 minutes of pumping at 314 USgpm. This shows that the backwashing was successful in improving well performance by about 15 to 20%. If further work to improve well performance is carried out, it should consist of methods other than backwashing. This is discussed later in this report.

cont'd... 4

During the second test the pumps in Wells No. 5 and No. 8 were turned on one at a time to observe well interference. Sixty minutes after the start of pumping No. 11 at a rate of 314 USgpm, the drawdowns were as follows:

Well No.	ON or OFF	Pump Rate (USgpm)	Water level (ft.)	Drawdown (ft.)
11	on	314	121.13	48.46
5	off		72.57	2.28
8	off		75.47	1.19

At 60 minutes after the start of pumping, Well No. 8 was turned on at 510 USgpm. After pumping Wells No. 11 and No. 8 simultaneously the drawdowns in the wells were as follows:

Well No.	ON or OFF	Pump Rate (USgpm)	Water level (ft.)	Drawdown (ft.)
11	on	314	122.30	49.63
5	off		73.27	2.98
8	on	510	121.38	47.10

At 90 minutes after the start of pumping, Well No. 5 was turned on at a rate of 270 USgpm. With all three wells pumping simultaneously the drawdowns in the wells after 10 minutes of pumping were:

Well No.	ON or OFF	Pump Rate (USgpm)	Water level (ft.)	Drawdown (ft.)
11	on	314	123.45	50.78
5	on	270	110.53	38.14
8	on	490	120.12	45.84

When Well No. 8 was turned on it caused an interference effect in Well No. 11 of 1.17 ft. When Well No. 5 was turned on it caused an additional interference effect of 1.15 ft. for a total of 2.32 ft. These interferences are not very significant in terms of the total drawdown, but should be considered in rating the well capacity. The small interference between wells is a result of the relatively high transmissivity of the aquifer indicated by former pump testing of Wells No. 5 and No. 8.

cont'd... 5

Well Capacity

The total available drawdown in Well No. 11 is 72.5 ft. or about 70 ft. allowing for the effects of well interference when pumping Wells No. 5 and No. 8. Based on use of 70% of the available drawdown and a specific capacity of 6.48 USgpm/ft. of drawdown, the capacity of Well No. 11 is 317 USgpm. Coincidentally the rate during the final test was 314 USgpm.

DISCUSSION

A comparison of the logs of Wells No. 5, No. 8 and No. 11 shows that it is not possible to correlate between the logs of the wells other than in a general way. The bottom of the aquifer in all three wells is marked by a lithologic change to silt. The water-bearing sand and gravels in the three holes varies in thickness, the thickest section being located in Well No. 8. The bottom of the water-bearing sand and gravel in Wells No. 5, No. 8 and No. 11 is 152 ft.,188 ft. and 166 ft. respectively. All indications are that the performance of Well No. 11 should be considerably better. We believe that the poor performance is probably mostly related to incomplete development. The aquifer is finer at the site of Well 11 however, and the finer screen slot sizes are a reflection of this.

The development carried out to date on the well consists of about one day of bailing by the drilling contractor and one day of backwashing by the pump testing contractor. More work on development is certainly justified. The backwashing technique did not seem to be having any effect near the end so other methods should be tried. From past experience surging has a detrimental effect and should be avoided. A.C. Drillers have proposed using a double packer arrangement in conjunction with a 6" Sochris pump in 6" pipe. This method should be considered in future if development is carried out to improve the performance. The poor performance should not affect the use of the well but the well should obviously be monitored in light of the situation at Well No. 5.

cont'd... 6

We understand from our discussions with you following the testing of Well No. 11, that at present the size of the main which conveys water to the reservoir is a constriction to the amount of water which can be put into the system at this location. For this reason there is no reason to carry out further development work at present.

SUMMARY

1. Well No. 11 is constructed between Wells No. 5 and No. 8 in the pipe yard. It is completed with 22 ft. of screen set from 144 to 166 ft.
2. The performance of Well No. 11 is considerably less than that of the two existing wells.
3. At present well performance and by utilizing 70% of the available drawdown, the capacity of Well No. 11 is 317 USgpm.
4. Poor well performance is probably mostly related to incomplete development, although the aquifer is somewhat finer at this location.
5. Further development of Well No. 11 can probably increase its capacity if more water is required for the system in future.

Yours truly,
PACIFIC HYDROLOGY CONSULTANTS LTD

A. Badry

AB:jb
encl.

A. Badry, Geologist

A P P E N D I X

UOP Inc.

(COARSE)

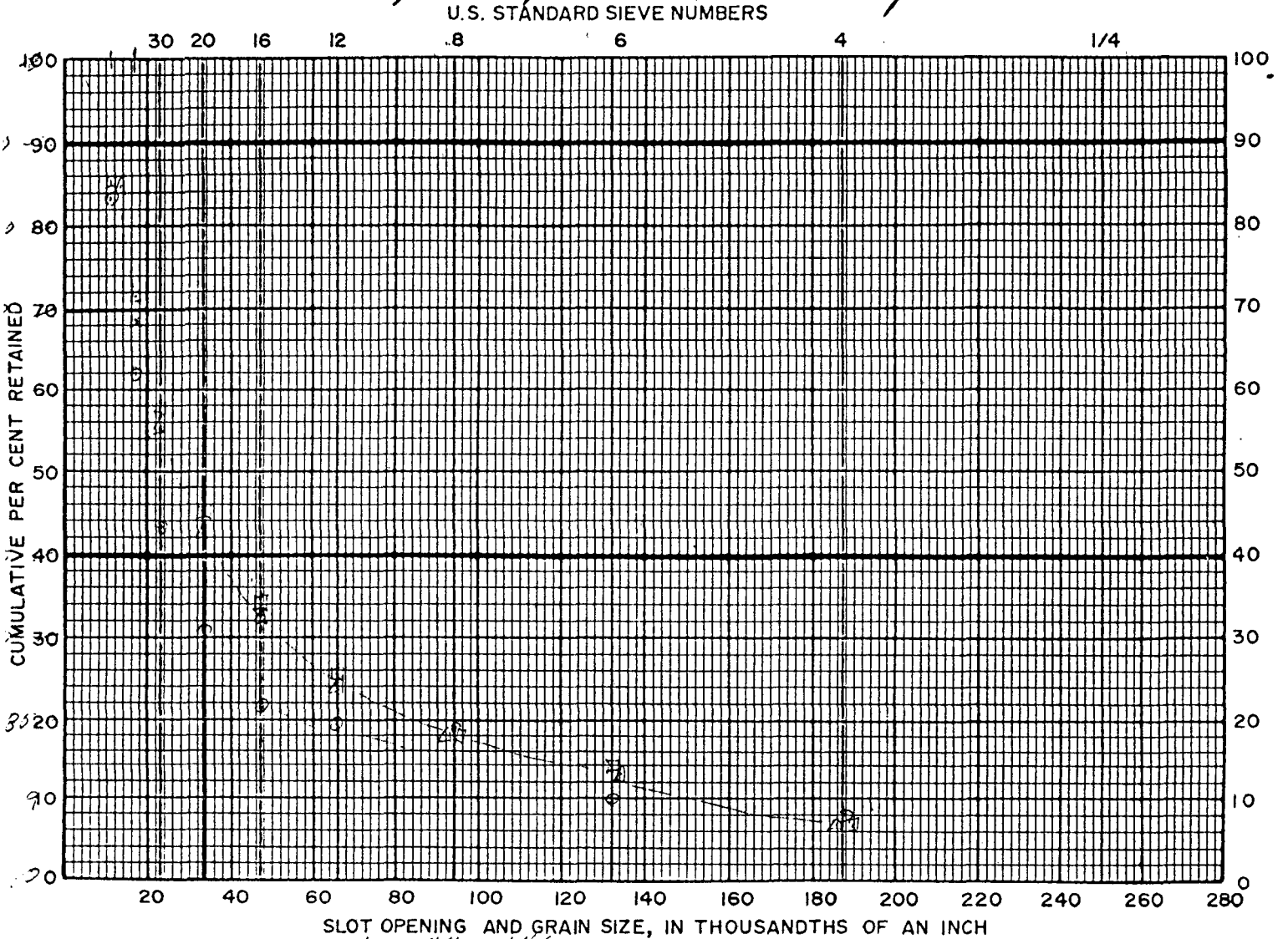
MAILING ADDRESS: P.O. BOX 3118
ST. P[illegible], MINNESOTA ▪ 55165

Sample sent in by [illegible]

Town _____ State _____ Zip _____ Date June/80

From well of Rutland W/U Dist Well No. 11

Remarks: Analyses by Interior Testing Services



141 144 146

U.S. SIEVE NO	SIEVE OPENING INCHES	SIEVE OPENING MM	CUMULATIVE % RETAINED		
¼	.265	6.73			
4	.187	4.76	92	93	95
6	.132	3.36	90	91	87
8	.094	2.38	82.9	83.3	81.4
12	.066	1.68	80.5	74.3	75.6
16	.047	1.19	78.6	66.1	67.4
20	.033	0.84	69.5	55.7	57.2
30	.023	0.60	57	41.4	43.9
45	.017		38	28.5	31.3
60	.010		17	17.7	15.2
100	.006		5.7	5.5	7.5
200					

25 35 25
(34) (50) (50)

Notes: _____

Recommended Slot Opening: _____

Recommended Screen: Dia. _____ in. Length _____ Ft.

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.

Johnson Division
P.O. Box 3118 • St. Paul, Minnesota 55165
Telephone 612-636-3900 • Telex 29-7451
UOP Inc.

SAND ANALYSIS

(FINE)

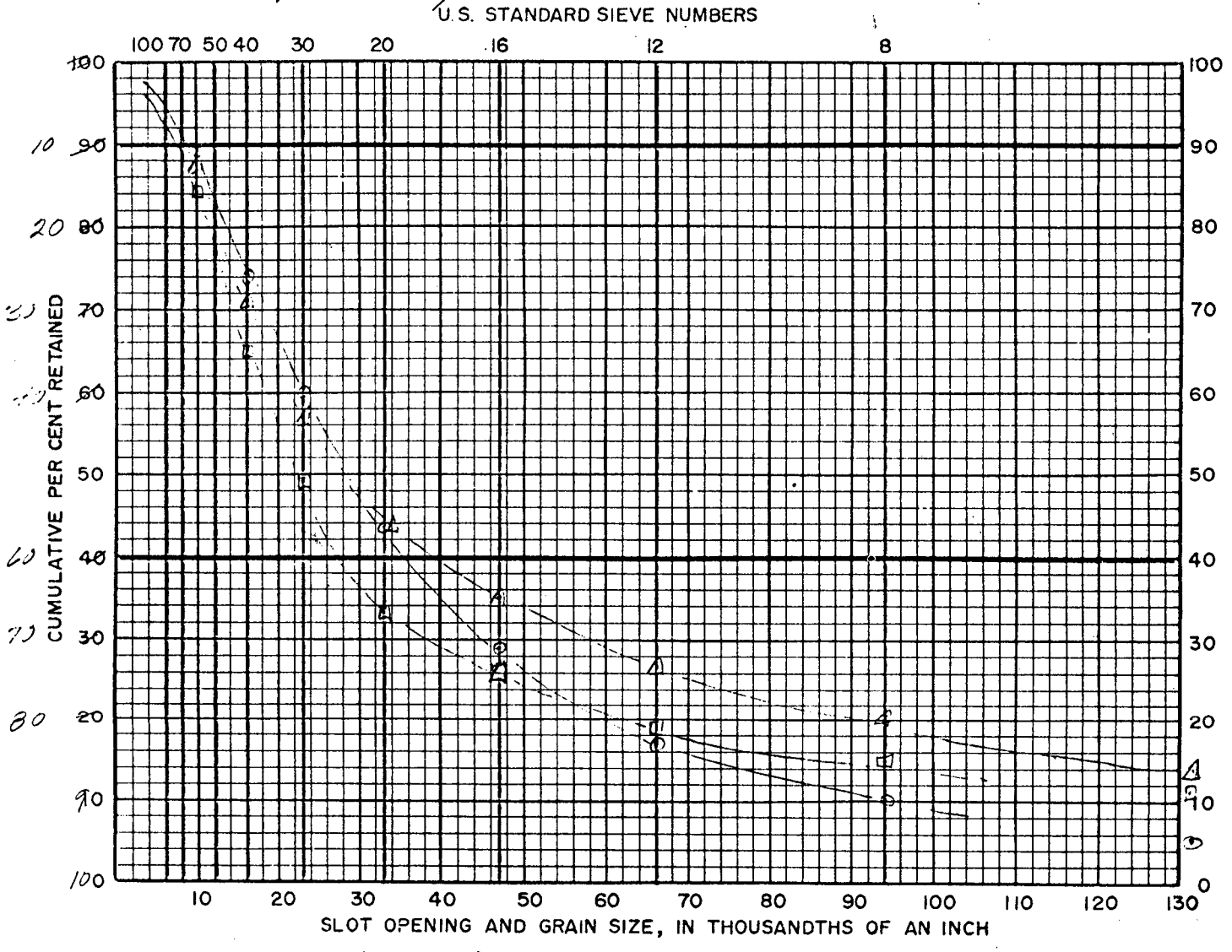
MAILING ADDRESS: P.O. BOX 3118
ST. PAUL, MINNESOTA • 55165

Sample sent in by J.C. Drillers

Town _____ State _____ Zip _____ Date June/80

From well of Rutland Water Works Dist Well no. 11

Remarks: Analyses by Int. Test Serv.



○143 □151 △153

U.S. SIEVE NO.	SIEVE OPENING INCHES	SIEVE OPENING MM.	CUMULATIVE % RETAINED		
6	.132	3.36	[illegible]	[illegible]	[illegible]
8	.094	2.38	90	85	79.5
12	.066	1.68	82.5	81	74
16	.047	1.19	71	74	65
20	.033	0.84	56.5	67	56
30	.023	0.60	43	51	43
40	.016	0.42	[illegible]	[illegible]	29
50	.010	0.30	11.4	15.7	12
~~70~~	~~.008~~	~~0.21~~			
100	.006	0.15	4.2	5.4	4

35 (45) 25 (40) 40 (58)

Notes: _____

Recommended Slot Opening: _____

Recommended Screen: Dia. _____ in. Length _____ Ft.

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.

Johnson Division
P.O. Box 3118 • St. Paul, Minnesota 55165
Telephone 612-636-3900 • Telex 29-7451
UOP Inc.

SAND ANALYSIS
(FINE)

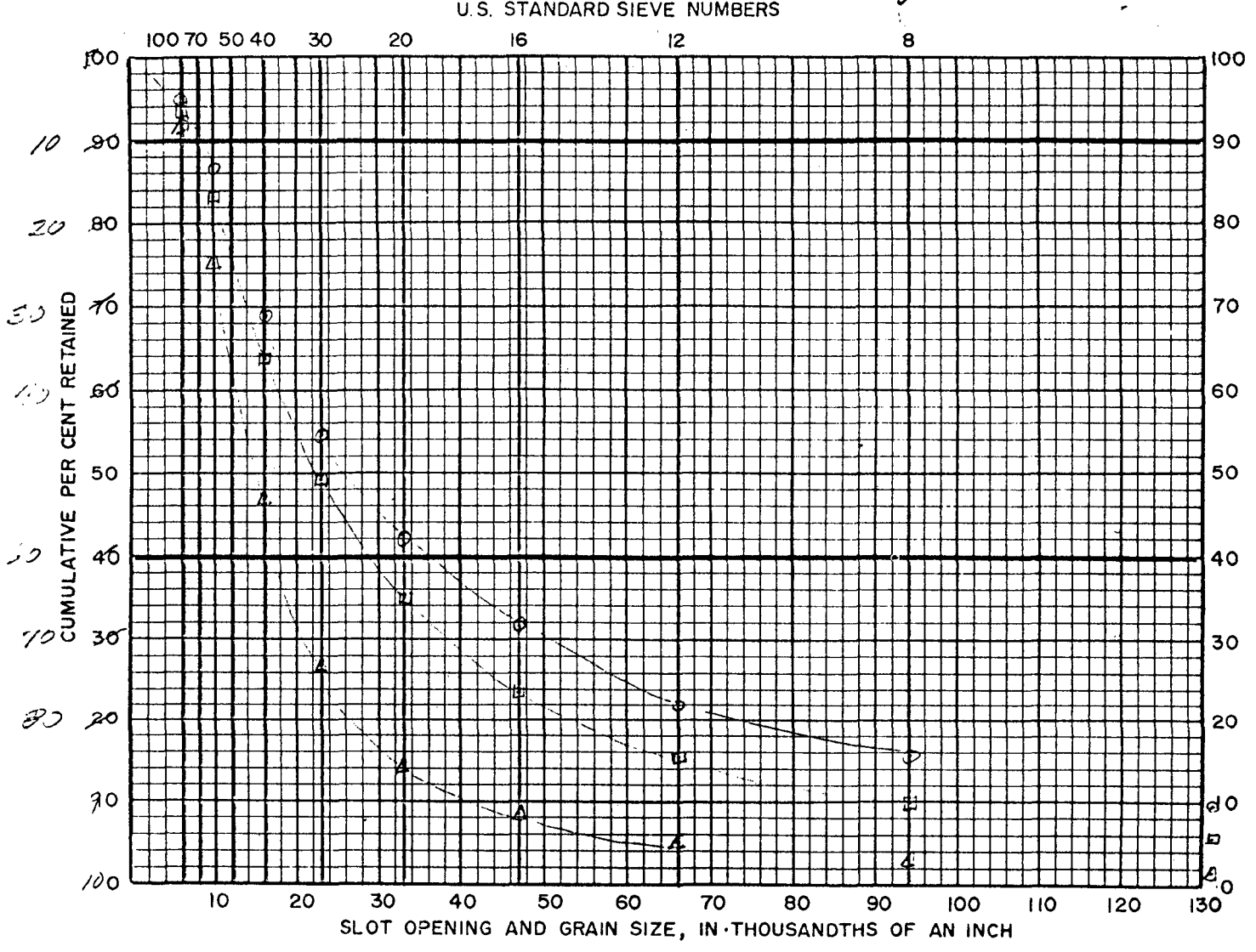
MAILING ADDRESS: P.O. BOX 3118
ST. PAUL, MINNESOTA ■ 55165

Sample sent in by A. C. Dickens

Town _____ State _____ Zip _____ Date June 1980

From well of Rutland Waterworks District Well No 11

Remarks: Analyses by Intercon Testing



○ 155 □ 158 △ 160

U.S. SIEVE NO	SIEVE OPENING INCHES	SIEVE OPENING MM.	CUMULATIVE % RETAINED		
4			95.4	97.5	97.5
6	.132	3.36	92.2	92.5	92.5
8	.094	2.38	90.2	90.1	97.0
12	.066	1.68	77.9	84.6	95.1
16	.047	1.19	69.2	77.3	91.9
20	.033	0.84	58.3	65.1	85.6
30	.023	0.60	45.3	50.9	73.1
40	.016	0.42	30.4	34.2	53.6
50	.012	0.30	13.2	16.1	25
70	.008	0.21			
100	.006	0.15	4.5	5.3	7.5

36 (50) 30 (38) 18 (20)

Notes: _____

Recommended Slot Opening: _____

Recommended Screen: Dia. _____ in. Length _____ Ft.

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.

UOP 14 2155

Johnson Division
P.O. Box 3118 • St. F ., Minnesota 55165
Telephone 612-636-3900 • Telex 29-7451
UOP Inc.

SAND ANALYSIS
(FINE)

MAILING ADDRESS: P.O. BOX 3118
ST. PAUL, MINNESOTA • 55165

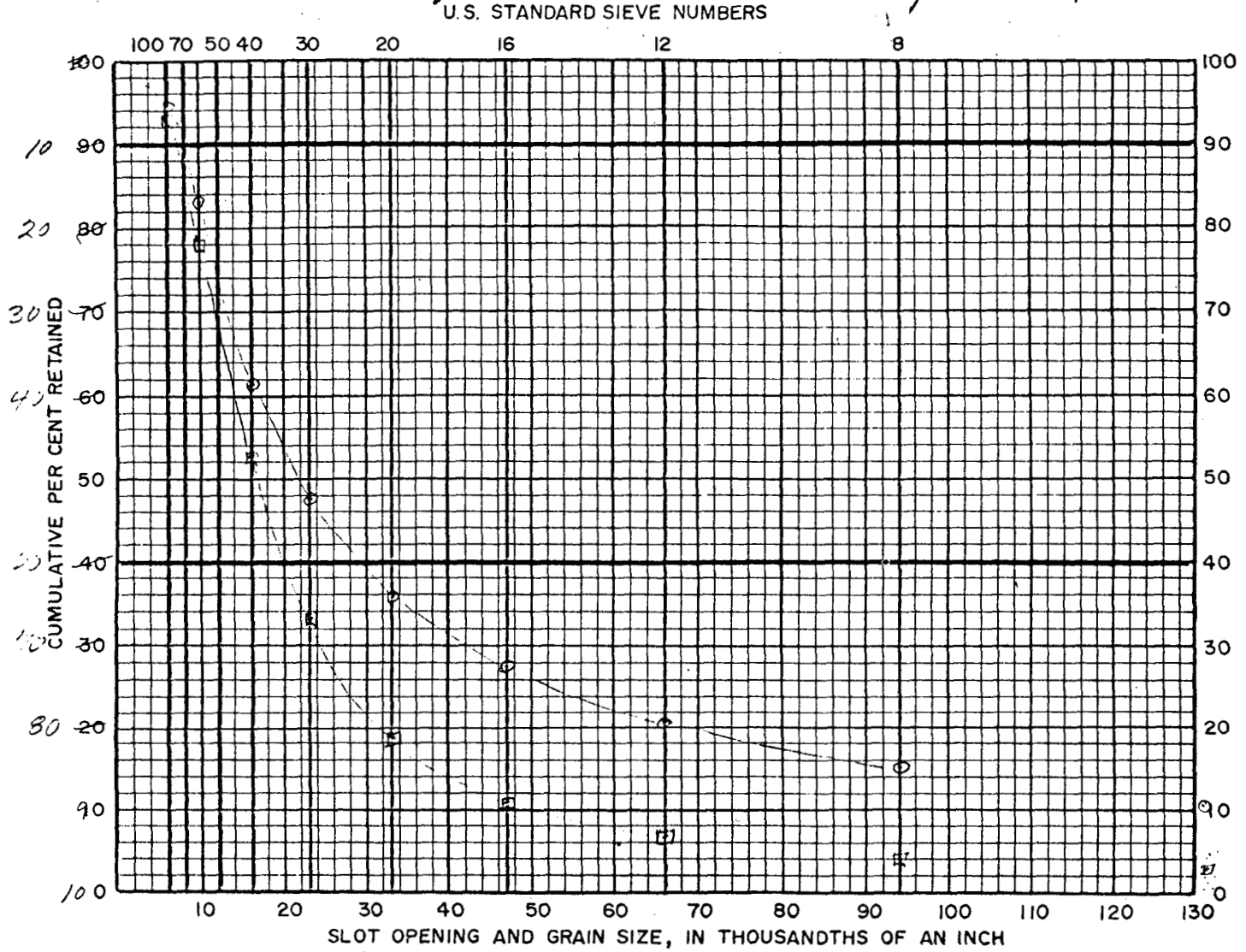
Sample sent in by A. C. Dillard

Town _____ State _____ Zip _____ Date June/80

From well of Rutland Waterworks District Well No. 11

Remarks: _____

Analyses by Interior Testing



○ 162 □ 165

U.S. SIEVE NO.	SIEVE OPENING INCHES	SIEVE OPENING MM.	CUMULATIVE % RETAINED		
6	.132	3.36	95.6	9.2	
8	.094	2.38	54.5	3.	
12	.066	1.68	79.7	02.7	
16	.047	1.19	72.4	27.6	
20	.033	0.84	64.3	31.6	
30	.023	0.60	52.9	47.1	
40	.016	0.42	38.5	41.2	
~~60~~ 50	.012	0.30	17	21	
70	.008	0.21	5.5	7.0	
100	.006	0.15			

30 (40) 20 (24)

Notes: _____

Recommended Slot Opening: _____

Recommended Screen: Dia. _____ in. Length _____ Ft.

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.

UOP 14 2155

PUMP TEST WELL No. 11 IN PIPE YARD

RUTLAND WATERWORKS DISTRICT

JULY, 1980

Time	Mins Since Start	PUMPED WELL No. 11 Depth to water (ft.)	PUMPED WELL No. 11 Drawdown (ft.)	OBS. WELL No. 5. Depth to water (ft.)	OBS. WELL No. 5. Drawdown (ft.)	OBS.WELL No. 8 Depth to water (ft.)	OBS.WELL No. 8 Drawdown (ft.)	Pumping Rate (USgpm)	Remarks
July 14 08:45									Pump off. Wells #5 & #8
July 14 15:50		72.67		72.39		75.25			Static levels
15:50½	½	108.03	35.36						4" orifice on 6"pipe
15:51	1			73.07	0.68				
15:52	2			73.78	1.39				Datum for measure-
15:53	3	134.67	62.00	74.23	1.84				ments in all wells
15:54	4	133.19	60.52	74.39	2.00				is approximately
15:54½	4½	131.48	58.81						2 ft. above ground
15:55	5	130.05	57.38	74.37	1.98			305	Orifice Press = 23"
15:56	6	128.20	55.53	74.36	1.97				
15:57	7	128.21	55.54	74.33	1.94				
15:58	8	129.04	56.37	74.34	1.95				
15:59	9	129.06	56.39	74.36	1.97				
16:00	10	129.12	56.45	74.39	2.00				
16:02	12	129.16	56.49	74.39	2.00				
16:04	14	129.10	56.43	74.39	2.00	77.00	1.75		
16:06	16	129.22	56.55	74.41	2.02				
16:08	18	129.26	56.59	74.42	2.03				
16:10	20	129.22	56.55	74.42	2.03				
16:15	25	129.42	56.75	74.45	2.06				
16:20	30	129.53	56.86	74.46	2.07	77.07	1.82		
16.25	35	129.48	56.81						
16:30	40	129.48	56.81	74.48	2.09				
16:35	45	129.52	56.85						
16:40	50	129.50	56.83	74.49	2.10				
16:50	60	129.48	56.81	74.47	2.08				
17:00	70	129.62	56.95	74.48	2.09				
17:10	80	129.51	56.84	74.51	2.12				
17.20	90	129.49	56.82	74.47	2.08	77.09	1.84		

RECOVERY

Time	Mins Since Start	PUMPED WELL No. 11 Depth to water (ft.)	PUMPED WELL No. 11 Drawdown (ft.)	OBS. WELL No. 5 Depth to water (ft.)	OBS. WELL No. 5 Drawdown (ft.)	OBS. WELL No. 8 Depth to water (ft.)	OBS. WELL No. 8 Drawdown (ft.)	Mins since stop	t/t
17:21	91	77.94	5.27	74.28	1.89			1	91
17:22	92	76.38	3.71					2	46
17:22½	92½	75.87	3.20					2½	37
17:23	93	75.60	2.93					3	31
17:23½	93½	75.39	2.72					3½	26.7
17:24	94	75.34	2.67					4	23.5
17:24½	94½	75.29	2.62					4½	21
17:25	95	75.25	2.58					5	19
17:26	96	75.13	2.46					6	16
17:27	97	75.06	2.39					7	13.86
17:28	98	75.02	2.35					8	12.25
17:29	99	74.98	2.31					9	11
17:30	100	74.96	2.29					10	10
17:32	102	74.91	2.24					12	8.5
17:34	104	74.87	2.20					14	7.43
17:36	106	74.86	2.19					16	6.62
17:38	108	74.85	2.18					18	6
17:40	110	74.85	2.18					20	5.5

July 16

PUMPING

08:40		72.67		70.29		74.28		Static levels; start pump on in Well No. 11 4" orifice on 6" pipe Pumping Rate= 314USgpm
08:41	1	113.06	40.39					
08:42	2	117.66	44.99					
08:43	3	118.97	46.30					
08:44	4	119.21	46.54					
08:45	5	119.49	46.82					
08:46	6	119.64	46.97					
08:47	7	119.99	47.32					
08:48	8	120.13	47.46					
08:49	9	120.07	47.40					
08:50	10	120.29	47.62	72.35	2.06	75.35	0.10	

Time	Mins since start	PUMPED WELL No. 11 Depth to water (ft.)	PUMPED WELL No. 11 Drawdown (ft.)	OBS. WELL No. 5 Depth to water (ft.)	OBS. WELL No. 5 Drawdown (ft.)	OBS. WELL No. 8 Depth to water (ft.)	OBS. WELL No. 8 Drawdown (ft.)	Remarks
08:52	12	120.43	47.76					
08:54	14	120.70	48.03					
08:56	16	120.68	48.01					
08:58	18	120.79	48.12					
09:00	20	120.69	48.02					
09:05	25	120.84	48.17					
09:10	30	120.98	48.31					
09:20	40	121.15	48.48					
09:30	50	121.10	48.43					
09:40	60	121.13	48.46	72.57	2.28	75.47	1.19	Pump #8 on @ 60 mins @ 510 USgpm
09:50	70	122.38	49.71			121.14	46.86	
10:00	80	122.33	49.66			121.36	47.08	
10:10	90	122.30	49.63	73.27	2.98	121.38	47.10	Pump #5 on @ 90 mins @ 270 USgpm
10:20	100	123.45	50.78	110.53	38.14	120.12	45.84	#8 reduced to 490USgpm
10:30	110	123.53	50.86					

CARO ENVIRONMENTAL SERVICES

102 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3

Telephone (250) 765-9646
Fax (250) 765-3893

CERTIFICATE OF ANALYSIS

July 3, 1997

Rutland Waterworks District
Attention: Kevin Reynolds

Sample Identification: Well #11
Date Sampled: June 18, 1997 Date Received: June 18, 1997

Alkalinity (Total)	53	mg/L as $CaCO_3$
Aluminum	<0.2	mg/L
Arsenic	<0.01	mg/L
Barium	<0.01	mg/L
Boron	<0.1	mg/L
Cadmium	<0.0002	mg/L
Calcium	13.9	mg/L
Chloride	1.1	mg/L
Chromium	<0.01	mg/L
Color (True)	<5	Color Units
Copper	<0.01	mg/L
Cyanide	<0.010	mg/L
Dissolved Solids(Total)	85	mg/L
Fluoride	<0.1	mg/L
Hardness(Total)	51	mg/L as $CaCO_3$
Iron	0.04	mg/L
Lead	0.001	mg/L
Magnesium	3.98	mg/L
Manganese	<0.005	mg/L
Mercury	<0.00005	mg/L
Molybdenum	<0.03	mg/L
Nitrate	0.19	mg/L as N
Nitrite	<0.01	mg/L as N
pH	6.8	pH Units
Potassium	0.71	mg/L
Sodium	4.3	mg/L
Sulphate	6	mg/L
Turbidity	0.30	N.T.U.
Uranium	0.00011	mg/L
Zinc	<0.005	mg/L
Total Coliform	0	Colonies/100mL
Fecal Coliform	0	Colonies/100mL

Certified by:
CARO ENVIRONMENTAL SERVICES
Janice M. Fraser, B.Sc., Lab Manager

CARO ENVIRONMENTAL SERVICES

102 - 3677 Highway 97N
Kelowna, B.C. V1X 5C3

Telephone (250) 765-9646
Fax (250) 765-3893

CERTIFICATE OF ANALYSIS

July 3, 1997

Rutland Waterworks District
Attention: Kevin Reynolds

Sample Identification: Well #13
Date Sampled: June 18, 1997 Date Received: June 18, 1997

Alkalinity (Total)	169	mg/L as $CaCO_3$
Aluminum	<0.2	mg/L
Arsenic	<0.01	mg/L
Barium	<0.01	mg/L
Boron	<0.1	mg/L
Cadmium	<0.0002	mg/L
Calcium	62.3	mg/L
Chloride	12.0	mg/L
Chromium	<0.01	mg/L
Color (True)	<5	Color Units
Copper	<0.01	mg/L
Cyanide	<0.010	mg/L
Dissolved Solids(Total)	307	mg/L
Fluoride	0.2	mg/L
Hardness(Total)	221	mg/L as $CaCO_3$
Iron	<0.03	mg/L
Lead	0.001	mg/L
Magnesium	15.8	mg/L
Manganese	<0.005	mg/L
Mercury	<0.00005	mg/L
Molybdenum	<0.03	mg/L
Nitrate	4.70	mg/L as N
Nitrite	<0.01	mg/L as N
pH	7.3	pH Units
Potassium	2.4	mg/L
Sodium	16.5	mg/L
Sulphate	60	mg/L
Turbidity	<0.10	N.T.U.
Uranium	0.00455	mg/L
Zinc	0.012	mg/L
Total Coliform	0	Colonies/100mL
Fecal Coliform	0	Colonies/100mL

Certified by:
CARO ENVIRONMENTAL SERVICES
Janice M. Fraser, B.Sc., Lab Manager