

Note new address:
1632 McGuire Avenue
NORTH VANCOUVER
British Columbia

ROBINSON, ROBERTS & BROWN LTD.

GROUND WATER GEOLOGISTS
~~4421 PATERDALE DRIVE~~
NORTH VANCOUVER, BRITISH COLUMBIA
TEL. 986-1293

AFFILIATED OFFICES
TACOMA, WASHINGTON
PORTLAND, OREGON

Completion Report

GROUNDWATER DEVELOPMENT

Middlepoint Property

Lots 6235 and 5864 on

Sechelt Peninsula, British Columbia

for

Joni Mitchell

by

W. L. Brown, P.Eng.
R. A. Dakin, P.Eng.

October, 1971

INTRODUCTION

This report covers the drilling and development of two wells to supply the three houses proposed for the subject property. The first well is capable of an approximate yield of 25 gpm but the water is highly alkaline and is not potable. The alkalinity of this water is decreasing with time, and may become potable, but for the present the well is not suitable as a drinking water supply.

The second well is capable of delivering 20 gpm of potable water. This well will be used as the drinking water source.

CONSTRUCTION

The drilling of the No. 1 well was started by Kens Drilling Ltd. on the 14th of June 1971. The well is located on the edge of the creek, which flows past the cottage at the entrance of the property. An 8-inch hole was drilled to 30 feet and 6-inch casing was set, concentrically in the hole. Drilling was then continued to a depth of 403 feet. The major fracture was encountered at a depth of 383 feet. (See details of fractures encountered in Figure 1).

On September 2nd the surface casing for well No. 2 was drilled and set by Western Water Wells Ltd. This well is sited to the West of the swamp in the centre of the property. On September 21st Tri-K Drilling Ltd. completed the drilling of the well to a depth of 250 feet where the main fracture was encountered.

TESTING

Well Hydraulics

Neither of the two wells were pump tested with accompanying water level measurements. When the major fracture was first encountered in No. 1 well a flow of 25 gpm could be blown from the well. Similarly for No. 2 well 20 gpm was blown. The No. 1 well was allowed to free flow at a rate of 10 gpm over a period of four months and showed no signs of decreasing in flow. The No. 2 well was pumped continuously at 10 gpm for about 7 days. The pump suction was set at 230 feet below ground and suction was not broken during the test.

Inorganic Water Quality

Samples of the water were taken from each of the drilled wells. These samples were submitted for chemical analysis. Copies of these analyses are given in the back of this report.

Well No. 1

This water is an alkaline water with a high sodium chloride (salt) content. A close comparison of this water with a typical sea water sample taken from the Georgia Straight shows that the well water is not diluted sea water. This is significant as it proves that the salinity is not derived from sea water

intruding into the ground. One possible explanation is that the fractures have been open to salt water intrusion at some time during the last 10,000 years. This water has since been sealed in by marine muds and has never been completely flushed out by fresh groundwater. This theory would require that the chloride content of the free flowing well be gradually reduced with time. Figure 3 shows this trend and if it continues the water will be potable by June of 1972.

Well No. 2

The water from this well is potable and will be suitable for domestic use.

CONCLUSIONS AND RECOMMENDATIONS

No. 1 Well

1. This well is capable of a yield of approximate 25 gpm.
2. The well is artesian and will free flow continuously at a rate of 10 gpm.
3. Presently the water is highly alkaline but we expect that this will drop in time. If the present trend continues the water will be potable by June of 1972. With your permission we would like to sample this water sometime in the spring of 1972.

No. 2 Well

1. This well is capable of a yield of approximately 20 gpm.
2. The water is potable and should be used as the source of drinking water.

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Report On Chemical Analysis File No. 1766 A
Well No: 1 Report No. _____
Reported to Robinson, Roberts & Brown Date July 28, 1971
1632 McGuire
North Vancouver, B.C.

We have tested the water sample submitted by you on July 28, 1971 and report as follows:

Sample Identification

The sample was labelled "Jonl Mitchell #2", July 27, 1971.

Test Results

Total Chloride (Cl) = 930 ppm

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D. Timuss
Laboratory Supervisor

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Report On Water Analysis File No. 1816 A
Well No:1 Report No. _____
Reported to Robinson, Roberts & Brown Date August 6, 1971
1632 McGuire
North Vancouver, B.C.

We have tested the sample of water submitted by you and report as follows:

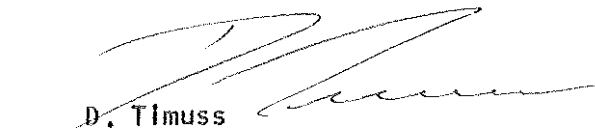
Sample Identification

The sample was labelled - Mitchell, A-Well North, August 5, 1971.

Test Results

Total Chloride - 899 ppm.

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D. Timuss
Laboratory Supervisor

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Report On Water Samples for Chemical Analysis File No. 1929 A
Well No: 1 Report No. _____
Reported to Robinson, Roberts & Brown Date August 30, 1971
1632 McGuire
North Vancouver, B.C.

We have tested the sample of water submitted by you on August 30, 1971 and report as follows:

Sample Identification

The sample was submitted in a plastic bottle labelled "Mitchell Well No. 4, August 26, 1971".

Method of Testing

The sample was tested in accordance with the procedures set down in "Standard Methods for the Examination of Water and Waste Water" - 12th Edition, published by the American Public Health Association, 1965.

Results of Testing

Chlorides (Cl) 875. ppm

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Report On Water Samples for Chemical Analysis File No. 3054 A
Reported to Robinson, Roberts & Brown Report No. _____
1632 McGuire Date May 9, 1972
North Vancouver, B.C.

We have tested two samples of water submitted by you on May 1, 1972 and report as follows:

Sample Identification

The samples were submitted in plastic bottles labelled -

Sample 1 Joni Mitchell #1 - April 27, 1972

Sample 2 Joni Mitchell #2 - April 26, 1972

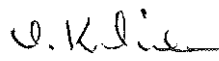
Method of Testing

The samples were tested in accordance with the procedures set down in "Standard Methods for the Examination of Water and Waste Water" - 13th Edition, published by the American Public Health Association, 1971.

Results of Testing

	<u>Sample 1</u>	<u>Sample 2</u>	
pH	8.5	7.4	
Chlorides	630.	405.	ppm

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Report On Water Samples for Chemical Analysis File No. 3054 A
Reported to Robinson, Roberts & Brown Report No. _____
1632 McGuire Date May 9, 1972
North Vancouver, B.C.

We have tested two samples of water submitted by you on May 1, 1972 and report as follows:

Sample Identification

The samples were submitted in plastic bottles labelled -

Sample 1 Joni Mitchell #1 - April 27, 1972

Sample 2 Joni Mitchell #2 - April 26, 1972

Method of Testing

The samples were tested in accordance with the procedures set down in "Standard Methods for the Examination of Water and Waste Water" - 13th Edition, published by the American Public Health Association, 1971.

Results of Testing

	<u>Sample 1</u>	<u>Sample 2</u>	
pH	8.5	7.4	
Chlorides	630.	405.	ppm

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Report On Water Samples for Chemical Analysis File No. 3054 A
Reported to Robinson, Roberts & Brown Report No. _____
1632 McGuire Date May 9, 1972
North Vancouver, B.C.

We have tested two samples of water submitted by you on May 1, 1972 and report as follows:

Sample Identification

The samples were submitted in plastic bottles labelled -

Sample 1 Joni Mitchell #1 - April 27, 1972

Sample 2 Joni Mitchell #2 - April 26, 1972

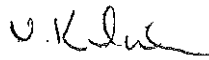
Method of Testing

The samples were tested in accordance with the procedures set down in "Standard Methods for the Examination of Water and Waste Water" - 13th Edition, published by the American Public Health Association, 1971.

Results of Testing

	<u>Sample 1</u>	<u>Sample 2</u>	
pH	8.5	7.4	
Chlorides	630.	405.	ppm

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Report On Water Samples for Chemical Analysis File No. 2050 A
Well No : 1 Report No. _____
Reported to Robinson, Roberts & Brown Date September 22, 1971
1632 McGuire
North Vancouver, B.C.

We have tested the sample of water submitted by you on September 22, 1971 and report as follows:

Sample Identification

The sample was submitted in a plastic bottle labelled "Mitchell Well No. 5, September 21, 1971".

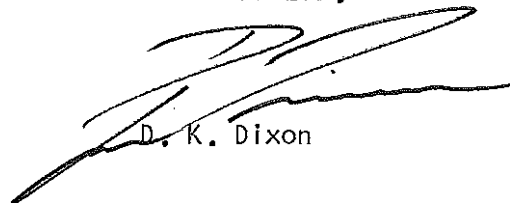
Method of Testing

The sample was tested in accordance with the procedures set down in "Standard Methods for the Examination of Water and Waste Water" - 12th Edition, published by the American Public Health Association, 1965.

Results of Testing

Chlorides (Cl) 791. ppm

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Chemical Analysis of Water Samples

<u>Test</u>		<u>1</u>		
pH (electrometric)		9.10		
Suspended Matter		30.2		ppm
Volatile		4.9		ppm
Fixed		25.3		ppm
Hardness (Calculated)		76.8		ppm
Dissolved Anions				
Alkalinity				
Bicarbonates	HCO ₃	44.		ppm
Carbonates	CO ₃	19.0		ppm
Hydroxyl Ion	OH	nil		ppm
Chlorides	Cl	875.		ppm
Sulfates	SO ₄	111.9		ppm
Nitrates	NO ₃	L 0.4		ppm
Dissolved Cations				
Iron	Fe	L 0.05		ppm
Calcium	Ca	28.0		ppm
Magnesium	Mg	1.7		ppm
Sodium	Na	680.		ppm
Potassium	K	3.1		ppm
Total Iron	Fe	3.6		ppm
Total Dissolved Solids		1765.		ppm
Volatile Solids		22.		ppm
Fixed Solids		1743.		ppm excluding SiO ₂

L = less than

Remarks

Examination of the above results indicated that the water as represented by the submitted sample was an alkaline water containing high amounts of sodium chloride.

The analysis showed that the water was above the American Public Health Association standards for pH, sodium chloride, and total dissolved solids.

The results obtained indicated that the well water has been contaminated with sodium chloride. However, this may not have been intrusion of sea water since sea water normally has the following analysis.

Chloride	18,980 ppm	Sulphate	2,652 ppm
Sodium	10,561 ppm	Sulfur	400 ppm
Magnesium	1,271 ppm	Potassium	380 ppm

The results obtained for magnesium, sulfate and potassium were not correspondingly higher in the well water as would be expected from intrusion by sea water.

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Report On Water Samples for Chemical Analysis File No. 1751 A
Well No:1 Report No. _____
Reported to Robinson, Roberts and Brown Date July 29, 1971
1632 McGuire
North Vancouver, B.C.

We have tested the samples of water submitted by you on July 23, 1971 and report as follows:

Sample Identification

The sample was submitted in a glass bottle labelled -
Mitchell No. 1 Well (Flowing) July 22, 1971.

Method of Testing

The samples were tested in accordance with the procedures set down in "Standard Methods for the Examination of Water and Waste Water" - 12th Edition, published by the American Public Health Association, 1965.

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Report On Water Samples for Chemical Analysis File No. 2081 A
Well : No : 2 Report No. 1
Reported to Robinson, Roberts & Brown Date October 5, 1971
1632 McGuire
North Vancouver, B.C.

We have tested the samples of water submitted by you on September 29, 1971 and report as follows:

Sample Identification

The sample was submitted in a plastic bottle labelled - "Joni Mitchell Well" - September 29, 1971.

Method of Testing

The samples were tested in accordance with procedures laid down in "Standard Methods for the Examination of Water and Wastewater" - 12th Edition, published by the American Public Health Association, 1965.

CHEMICAL ANALYSIS OF WATER SAMPLES

<u>TEST</u>	<u>1</u>	
pH (electrometric)	8.70	
Color (Pt-Co scale)	2.0	ppm
Turbidity (SiO ₂ scale)	13.9	ppm
Suspended Matter	26.9	ppm
Volatile	4.9	ppm
Fixed	22.0	ppm
Hardness (Calculated)	13.8	ppm
Dissolved Anions		
Alkalinity		
Bicarbonates	HCO ₃ 148.5	ppm
Carbonates	CO ₃ 9.0	ppm
Hydroxyl Ion	OH nil	ppm
Chlorides	Cl 362.	ppm
Sulfates	SO ₄ 66.4	ppm
Phosphates	PO ₄ L 0.1	ppm
Nitrates	NO ₃ L 0.1	ppm
Dissolved Cations		
Silica	SiO ₂ 11.6	ppm
Iron	Fe 0.10	ppm
Aluminum	Al L 0.05	ppm
Calcium	Ca 5.5	ppm
Magnesium	Mg L 0.1	ppm
Sodium	Na 332.	ppm
Potassium	K 0.9	ppm
Manganese	Mn L 0.05	ppm
Copper	Cu L 0.01	ppm
Lead	Pb L 0.01	ppm
Zinc	Zn L 0.01	ppm
Total Iron	Fe 8.2	ppm
Total Silica	SiO ₂ 14.2	ppm
Total Dissolved Solids	935.	ppm
Volatile Solids	74.	ppm
Fixed Solids	861.	ppm

L = less than

Remarks

Examination of the above results indicated that the water as represented by the submitted sample was a very soft, alkaline and highly mineralized water. The dissolved mineralization was primarily in the form of sodium bicarbonate, chloride and sulfate.

The water also contained 26.9 ppm suspended matter, of which 8.1 ppm was iron.

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Report On Water Samples for Chemical Analysis File No. 2081 A
Well No: 2 Report No. 2
Reported to Robinson, Roberts & Brown Date October 5, 1971
1632 McGuire
North Vancouver, B.C.

We have tested the samples of water submitted by you on September 29, 1971 and report as follows:

Sample Identification

The sample was submitted in a glass bottle labelled "Joni Mitchell Well" - September 29, 1971. The sample contained a considerable amount of black suspended material.

Method of Testing

The sample was evaporated dry, ashed and analyzed spectrographically.

Results of Testing

See the attached spectrographic analysis.

Remarks

The spectrographic analysis indicated that the solids had a similar analysis to that obtained from silt, clay or rock. The clay like material was very finely divided and difficult to filter.

The suspended matter was very slow to settle but after 48 hours a clear supernatant liquor was obtained.

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D. K. Dixon

To:

CAN TEST LTD.

CHEMISTS, ANALYSTS AND CONSULTANTS

1650 PANDORA STREET, VANCOUVER 6, B.C.

Telephone 254-7278
Telex 04-507737

Robinson, Roberts & Brown

1632 McGuire

North Vancouver, B.C.

SEMI QUANTITATIVE SPECTROGRAPHIC ANALYSES CERTIFICATE

File No. 2081 A - 2

Date October 5, 1971

I hereby certify that the following are the results of semi quantitative spectrographic analyses made on water samples submitted.

Sample Identification

Sample 1: Total Solids in Water Sample
 Sample 2: Filtered
 Sample 3: Filtered
 Sample 4: Filtered
 Sample 5: Filtered

Total Solids = 135, 134, 128, 778, 693, 560 ppm

Element	1	2	3	4	5
Aluminum	8.	ND	ND	ND	ND
Antimony	ND	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	ND
Barium	0.01	ND	ND	ND	ND
Beryllium	ND	ND	ND	ND	ND
Bismuth	ND	ND	ND	ND	ND
Boron	0.01	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND
Calcium	5.	ND	ND	ND	ND
Chromium	0.001	ND	ND	ND	ND
Cobalt	ND	ND	ND	ND	ND
Copper	0.001	ND	ND	ND	ND
Gallium	ND	ND	ND	ND	ND
Gold	ND	ND	ND	ND	ND
Iron	5.	ND	ND	ND	ND
Lead	ND	ND	ND	ND	ND
Magnesium	5.	ND	ND	ND	ND
Manganese	ND	ND	ND	ND	ND
Molybdenum	ND	ND	ND	ND	ND
Niobium	ND	ND	ND	ND	ND
Nickel	0.003	ND	ND	ND	ND
Silicon	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND
Strontium	0.01	ND	ND	ND	ND
Tantalum	ND	ND	ND	ND	ND
Tin	ND	ND	ND	ND	ND
Titanium	0.5	ND	ND	ND	ND
Tungsten	ND	ND	ND	ND	ND
Vanadium	0.01	ND	ND	ND	ND
Zinc	ND	ND	ND	ND	ND
Sodium	2.	ND	ND	ND	ND
Potassium	0.5	ND	ND	ND	ND

percent of dry total solids

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All results expressed as percent of dry total solids

Note: Pulps retained one week.

Form No. 12

Spectroscopist

Handwritten signature

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Report On Water Samples for Chemical Analysis File No. 2123 A
Well No: 2 Report No. _____
Reported to Robinson, Roberts & Brown Date October 8, 1971
1632 McGuire
North Vancouver, B.C.

We have tested the sample of water submitted by you on October 7, 1971 and report as follows:

Sample Identification

The sample was submitted in a plastic bottle labelled - "Joni Mitchell #2 - 12:00, October 6, 1971".


Method of Testing

The sample was tested in accordance with procedures laid down in "Standard Methods for the Examination of Water and Wastewater" - 12th Edition, published by the American Public Health Association, 1965.

Results of Testing

Sodium (Na)	323. ppm
Chlorides (Cl)	320. ppm

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Report On Water Samples for Chemical Analysis File No. 2170 A
Well No: 2 Report No. _____
Reported to Robinson, Roberts & Brown Date October 20, 1971
1632 McGuire
North Vancouver, B.C.

We have tested the samples of water submitted by you on October 18, 1971 and report as follows:

Sample Identification

The sample was submitted in a plastic bottle labelled "Joni Mitchell No. 2 - October 13, 1971".

Method of Testing

The sample was tested in accordance with procedures laid down in "Standard Methods for the Examination of Water and Wastewater" - 12th Edition, published by the American Public Health Association, 1965.

Results of Testing

pH	7.60	
Sodium (Na)	118.	ppm
Chlorides (Cl)	14.5	ppm
Bicarbonates (HCO ₃)	287.	ppm
Total Iron (Fe)	0.60	ppm
Dissolved Iron (Fe)	0.41	ppm

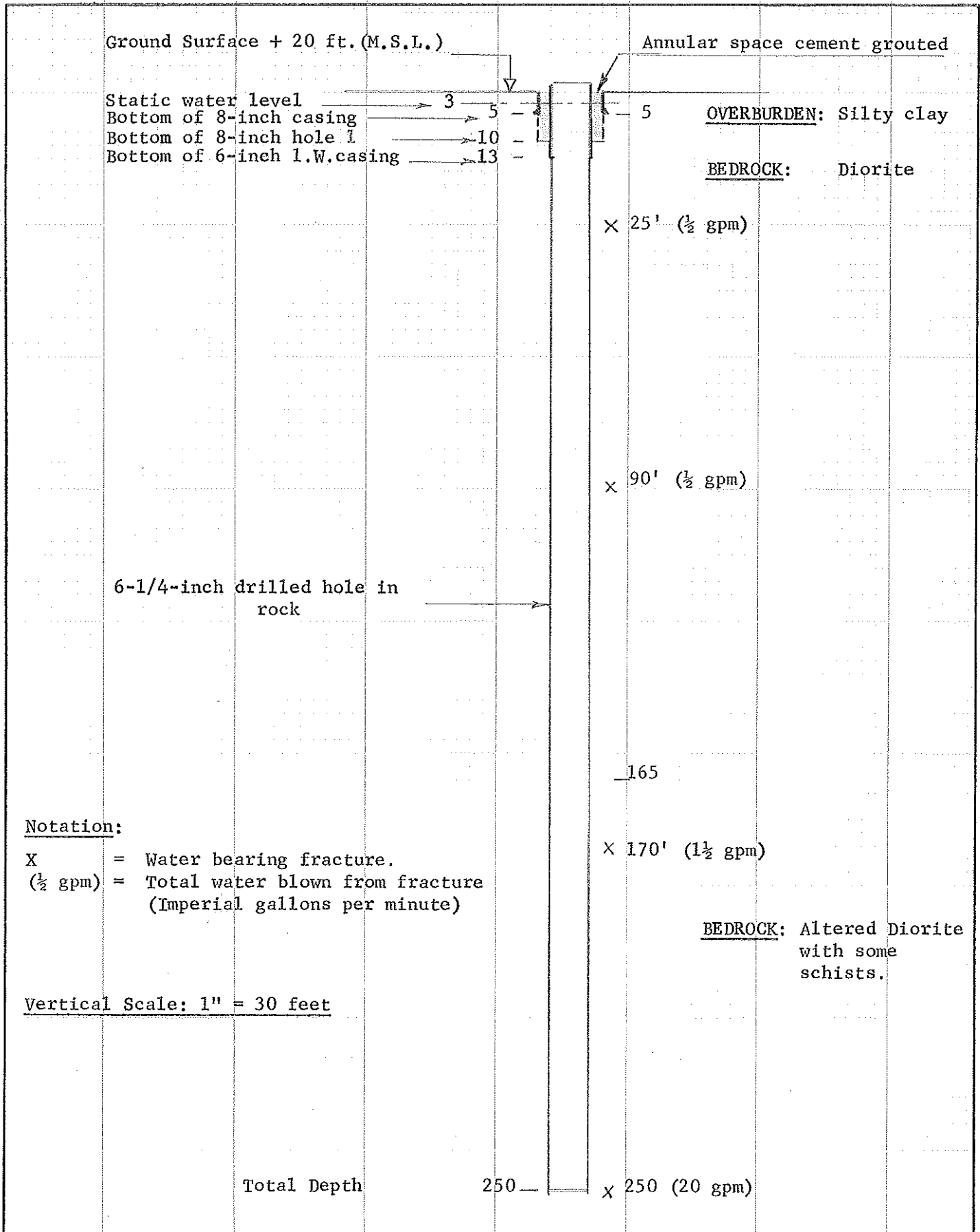
Remarks

The iron content of the water was slightly above the Public Health Standard (0.3 ppm) for domestic water supplies.

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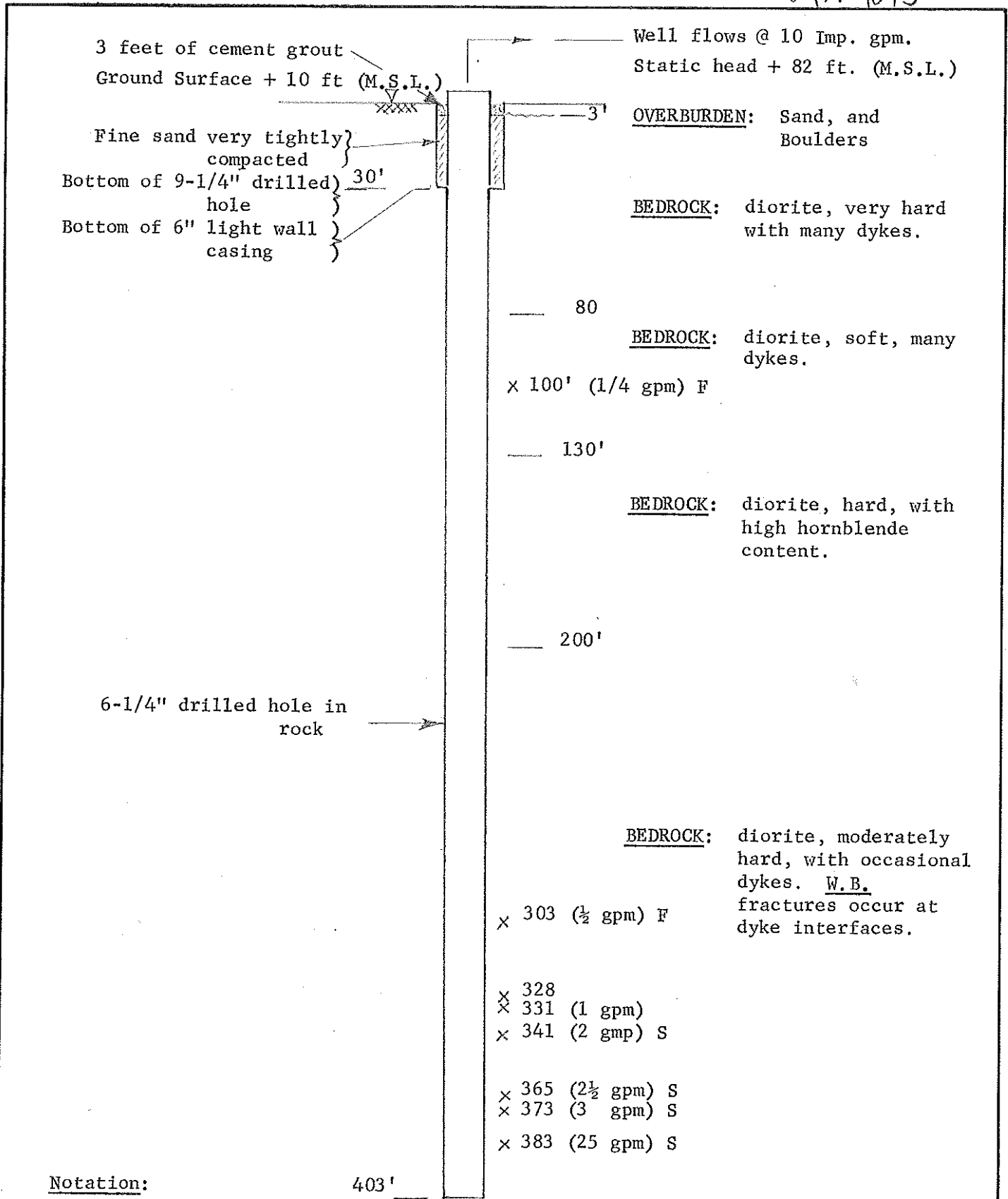


Notation:
 X = Water bearing fracture.
 (1/2 gpm) = Total water blown from fracture
 (Imperial gallons per minute)

Vertical Scale: 1" = 30 feet

Joni Mitchell Middle Point Property	PRODUCTION WELL No. 2	ROBINSON, ROBERTS & BROWN LTD. CONSULTING GROUNDWATER GEOLOGISTS NORTH VANCOUVER, CANADA	
Sechelt, British Columbia	(near swamp)	September 1971	Fig: 2

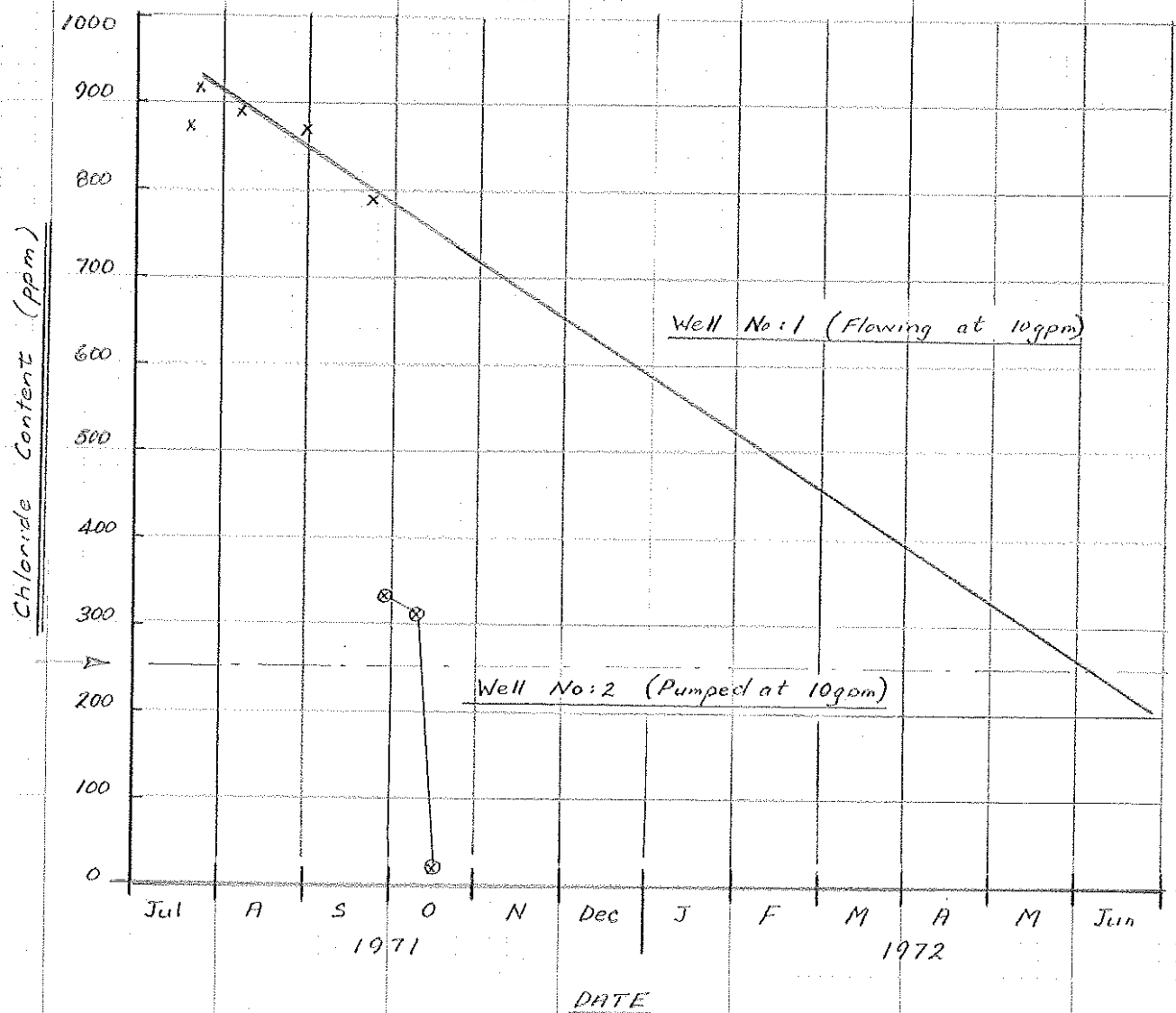
WIN 4043



Notation:

- X = Water bearing fracture.
- (1/4 gpm) = Total water blown from fracture. (Imperial gallons per minute)
- F = fresh water. S = Saline water. Vertical Scale: 1" = 50 feet.

Joni Mitchell Middle Point Property	PRODUCTION WELL No. 1	ROBINSON, ROBERTS & BROWN LTD. CONSULTING GROUNDWATER GEOLOGISTS NORTH VANCOUVER, CANADA	
Sechelt, British Columbia	(near Ole's house)	July 1971	Fig: 1



250

Note: Canadian Drinking Water Std. 250 ppm.

Joni Mitchell Middle Point Property	CHLORIDE DECAY WITH TIME	ROBINSON, ROBERTS & BROWN LTD. CONSULTING GROUNDWATER GEOLOGISTS NORTH VANCOUVER, CANADA	
Sechelt, British Columbia		October 1971	Fig: 3