Province of British Columbia | Ministry of Environment, WATER MANAGEMENT BRANCH | MEMORANDUM

To: A.P. Kohut
Senior Geological Engineer
Groundwater Section
Water Management Branch

Date: January 9, 1985

Our File: 92 B/12 #15

Re: A Proposed Groundwater Quality Monitoring Program for the Mill Bay Area in the Shawnigan Land District

This study has been prepared as a result of Mr. Saunders' concerns on the declining well yields during summer months and the possibility of interference by an irrigation well of Mr. Herb Bootsman. The purpose of this study is to assess the need for a groundwater quality monitoring program for the Mill Bay area that is bounded by Hutchinson Road on the north, Solarium Road on the south, Saanich Inlet on the east and Wilkinson Road on the west (see Figure 1). This study was also designed to determine if the hydrochemical analyses that are available for the study area exhibit any temporal trends (increasing or decreasing).

GENERAL GEOLOGY

Most of the study area is underlain by igneous rocks of Jurassic Age termed the Island Intrusions (Muller, 1975). These granitic parent rocks produce hard boulders and sand grains but break down through weathering and other processes into clayey materials. Minor amounts of limestone lentils and volcanic rocks are also found in the region (Clapp, 1917). The underlying granitic rocks which make up most of this area appear to be parallel to the Trans Canada Highway along the coastal belt between Saanich Inlet and Shawnigan Lake (Figure 2).

According to the well logs in the office, several wells in Range 8, Section 4 of Shawnigan Land District were drilled through a limestone layer varying from 25 feet to 230 feet before they terminated in bedrock. Most of the other wells under consideration were drilled in granitic rocks.

In general, the surficial soils in this area are mixtures of particles derived from many different rock sources. Hard boulders and gravel in this area are mostly originated from the granitic and volcanic rocks. Some bedrock exposed near the Trans Canada Highway at Kilmalu Road is covered by a thin layer of glacial materials. Mr. Bootsman's well (Range 8, Section 7, No. 11) is also located in the bedrock with thin patches of overburden.

GROUNDWATER PROBLEM

The 510 foot deep well of Mr. Bootsman, reported to produce 135 USgpm, is located on the west side of the Trans Canada Highway. Whereas Saunders' 208 foot shallow well yielding 15 USgpm is about 1000 feet from Mr. Bootsman's well in a northwesterly direction. Both wells terminate in

94
23/1/85 APK

the same aquifer or interconnected aquifer, but Mr. Bootsman's well is about 302 feet deeper than Mr. Saunders' well. In the summer of 1979, Mr. Saunders' well that experienced a large drop in capacity, was down to 0.5 USgpm. Declines in water levels of the observation well (No. 256) were also noted in the summers of 1980 to 1983 (see Figure 3). This observation well is located about 3000 feet southeast of Mr. Bootsman's well. Mr. Barry, a neighbour of Mr. Saunders, also experienced a dramatic decline in water levels in his well during the summers of 1980 and 1981. Interference at the observation well No. 256 was about 80.8 feet below ground level on August 18, 1980 and 87.5 feet on August 26, 1981 (Kalyn, December 1981).

HYDROCHEMICAL DATA

Most of the shortcomings of this study area are because of insufficient continuous data. Within the study area, 24 chemical analyses of the 22 groundwater wells are listed in Table 1. Only five wells have one complete hydrochemical analysis since installation. Continuous historic data on chemical analyses of groundwater for all the wells in the entire area are not available, except one observation well No. 256 (Range 9, Section 6, No. 17) in the Kilmalu Road area with intermittent records (1981, 1982 and 1984). Other groundwater wells have only one field (Hach) test with limited analyses performed since installation (see Figure 4 for well sites and Table 1 for chemical analyses).

Continuous basic data of groundwater quality for an area that depends heavily on groundwater as a major source of water supply are desirable.

EVALUATION OF CHEMICAL ANALYSES OF GROUNDWATER

Results of 24 chemical analyses on samples taken from 22 wells within the study area indicated that concentrations of dissolved constituents remain at low levels from 1973 to 1984 (see Table 1). The water quality in this aquifer was mainly sodium-calcium-bicarbonate type in which chloride and sulphate ions were also significant (see Appendix I). The calculated dissolved solids concentrations ranged from 98 to 448 ppm. The pH of groundwater varied from 6.5 to 8.5 The hardness covered a wide range of 25 to 238 ppm.

In view of insufficient historic base data, a plot of concentration of chloride ions in ppm versus well depths indicates that the concentration of chloride ions increases with depth (see Figure 5). When the available water quality based on laboratory analyses is shown diagrammatically in the pie diagram as in Figure 6, the size of circle is proportional to the concentration of the total dissolved solids. In general, the shallow groundwaters

TABLE 1 — SUMMARY OF HYDROCHEMICAL ANALYSES OF WELLS, MILL BAY AREA

WELL NO. R	Sec.	No	SAMPLING DATES YY MM DD	WELL DEPTH (FT.) LOCAL DATUM	Na^+ ppm	Ca^+ ppm	Mg^{2+} ppm	K^+ ppm	Fe^{3+} ppm	HCO_3^- ppm	SO_4^{2-} ppm	Cl^- ppm	$NO_3^- \cdot NO_2$ ppm	F^- ppm	HARDNESS ppm	TOTAL ALKALINITY ppm	pH	T.D.S. (1) ppm
9	6	17	84 09 26	855	103	27.7	3.73	0.3	0.01	167.1*	80.5	65.5	0.06	0.2	84.5	137	8.1	461
9	6	17	83 09 13	855	105	21.8	2.2	0.3	0.08	168.4*	71.9	57.0	0.34	0.13	63.2	138	8.1	442
10	10	9	82 07 19	80					0.4			15.0			102.0		8.0	154
9	9	9	82 07 18	110 –					0.4			15.0			85.0	68	6.5	130
8	10	6	82 07 16	510					0.7			15.0			102	102	7.0	175
9	7	9	82 07 16	450					0.4			7.6			68	85	8.5	144
9	7	3	82 07 16	205					5.0			7.6			238	238	7.0	340
10	8	13	82 07 16	200					1.1			15.0			102	102	7.0	200
10	4	4	82 07 16	107					0.4			15.0			170	153	8.0	238
8	9	5	82 07 16	80 –					1.0			7.6			102	102	7.7	168
10	5	2	82 07 16	100 –					0.2			15.0			102	62	7.7	—
9	6	24	82 07 15	230					0.6			7.6			153	136	8.0	217
8	6	5	82 07 15	200					0.5			22.0			187	119	7.2	280
7	7	1	82 07 15	150					0.3			15.0			204	170	7.5	273
8	7	10	82 07 15	146					0.4			30.0			153	119	7.5	238
9	6	17	81 05 04	855	116	10.7	2.1	0.5	0.2	117.6*	36.6	107.0	0.02	0.35	35.4	106	8.6	443
8	4	12	79 08 22	165	—	59.8	15.5	—	0.2		—	—	0.12	0.1	213.0	200	7.8	294
10	7	2	78 12 01	650	77.5	22.6	1.17	0.43	0.03	168.0	12.0	62.0	0.076	—	61.3	—	8.1	362
10	7	1	78 11 22	164	5.7	17.0	6.63	0.5	0.03	75.0	5.0	7.0	3.50	—	69.7	—	7.6	125
9	6	20	77 11 28	390	16.4	20.4	4.0	0.9	—	104.4*	10.2	4.9	0.52	—	67.4	85.6	7.7	140
9	6	21	76 10 22	410					0.2			1.0	0.5		25	110	8.8	—
7	4	2	75 04 11	400					0.03		8.4	20.0	0.6		55	135	6.6	—
8	7	9	74 12 06	450					0.08		4.0	5.0	0.09		130	165	8.2	—
9	6	16	74 12 02	290					0.5		10	60.0	0.5		70	140	6.8	—
10	8	11	73 03 09	169	5.0	8.5	7.3	1.0	0.05	68	—	6.5	1.43		51.2	—	7.0	—

NOTES:– BEDROCK NOT REACHED
* CALCULATED
(1) T.D.S. = 0.7 SP. CONDUCTANCE

are lower in total dissolved solids and of the calcium-magnesium-bicarbonate type, while deeper groundwaters are higher in total dissolved solids and of the sodium-bicarbonate-chloride type.

In order to assess the temporal trend of groundwater quality for the observation well (No. 256), concentrations of dissolved constituents are correlated with time. The concentration of total dissolved solids (T.D.S.) is increasing with time at a slow rate in the plot of T.D.S. versus time (see Figure 7). Other major ions such as calcium and bicarbonate display a similar trend. The concentration of chloride ions declines from 1981 to 1983, but increases slightly in 1984. Hardness in the groundwater of the observation well has increased slightly from 106 ppm to 137 ppm in 1981 to 1984 since the pumping of Mr. Bootsman's well has been operated.

DISCUSSIONS

1. Dissolved Solids

The dissolved calcium ions in the groundwater of the observation well replaces the sodium ions as a result of the migration of groundwater furnished by pumping in this area and the electrochemical characteristics of these ions. The chemical equilibrium of the groundwater is only maintained when the rate of increase in calcium ions balances the rate of decrease in sodium ions. The graph of dissolved solids versus time exhibits such interaction.

From the hardness distribution map (Figure 8) established for the study area, the hardness of groundwater concentrates around Mr. Bootsman's well which yields 135 USgpm. During irrigation period, reduction in groundwater volume by pumping may cause an increase in concentration of dissolved solids when little direct runoff is available for recharging the aquifer.

2. Seawater Intrusion

Since the study area is situated next to the Saanich Inlet, excessive groundwater utilization by pumping may lower the water table. If the water table is lowered, equilibrium between fresh and salt groundwater along the coastlines may be disturbed and an inverted cone of salt water may rise under those wells adjacent to the Saanich Inlet. Also, overdraft of the groundwater may reduce the seaward gradient and permit the seawater to advance inland. This effect requires continuous monitoring to substantiate such intrusion.

3. Water Demand

Many wells drilled recently in the Mill Bay area produce significant amounts of groundwater for some individual users, for example, Mr. Bootsman and Mr. Horton. In addition, the Mill Bay Waterworks extract groundwater as their major source of supply instead of surface water from Shawnigan Creek. Due to increase in pumping rate, the water levels will be declining and the field of interference will be extended.

CONCLUSIONS

Available hydrochemical data of the groundwater indicate that the concentrations of dissolved solids, calcium, chloride and bicarbonate increased slightly after the rate of pumping has been increased. Such increase in pumping rate could change the water quality and could overdraft the capacity of the aquifer during irrigation seasons. Incidental increase in hardness centering around Mr. Bootsman's well (Q = 135 USgpm) could be linked to the overdraft of the aquifer by pumping in this area (see Figure 8).

Based on the short-term data of the observation well (No. 256), the analyses suggest that groundwater quality in the bedrock is changing with time. A complete groundwater quality evaluation for this Mill Bay area is recommended to monitor the changes.

Since groundwater utilization in this area is increasing and interference has been experienced by some users, management of groundwater would be required to ensure an optimal development of groundwater resource without endangering the water quality.

RECOMMENDATIONS

On the basis of this study, the following groundwater quality monitoring program is recommended.

1. A long-term groundwater monitoring program is proposed to collect continuous data in order to assess chemical, physical and bacteriological characteristics of groundwater and the acceptability of concentrations of ions for domestic, industrial and agricultural uses. With the evaluation of hydrochemical analyses, we hope to understand geochemical and hydrologic relationships in the aquifer and to evaluate the effect of man's activities on the aquifer.

   Approaches for groundwater quality monitoring program are proposed as follows:

(i) Sampling sites selection
(ii) Sampling depth
(iii) Method of collection for laboratory or field test
(iv) Frequency of sampling
(v) Evaluation of collected data
(vi) Development of an areal water-quality pattern to review sampling sites for comprehensive analyses
(vii) Key constituents selection for additional sampling
(viii) Repeat (ii) to (v) until all important water quality changes can be identified, because changes to pumping rate, chemical composition of recharge and inflow from surrounding area may affect the groundwater quality.

2. A short-term monitoring program similar to the above approaches should be undertaken until an assessment of temporal variations in groundwater can be determined. Among all previous sampling sites, five of these had a laboratory analysis on major constituents, one had a limited chemical analysis performed and 17 had a simplified field test completed (Figure 4). Of the 52 proposed sampling sites as shown in Figure 9, seven sampling sites with a well depth in excess of 400 feet below ground level and 10 sampling sites with a well depth less than 400 feet shall have a chemical analysis performed in the laboratory. Whereas supplemental samples shall be provided by the remaining 35 proposed sampling sites. For the supplemental sampling, field tests including alkalinity, chloride, iron, hardness, pH and specific conductance shall be performed on the collected samples in the field.

   Pending on the establishment of temporal trend in groundwater quality, the proposed groundwater quality monitoring program will last a minimum of 2 to 3 years. During the first year of monitoring, sampling on all proposed sites should be carried out twice a year: once during recharge period (e.g., April or May) and the other at the end of irrigation season (e.g., August or September). Duration of sampling will take about two to three weeks to cover all the proposed sites. Frequency of sampling may be reduced to once a year during the following years. Chemical analyses shall be evaluated whenever they are made available. Other analyses or sites may be added if there is any reason to suspect that other effluents such as herbicides, insecticides, gasoline and detergents, are affecting water quality.

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Groundwater Section
Water Management Branch

JK/dma

REFERENCES

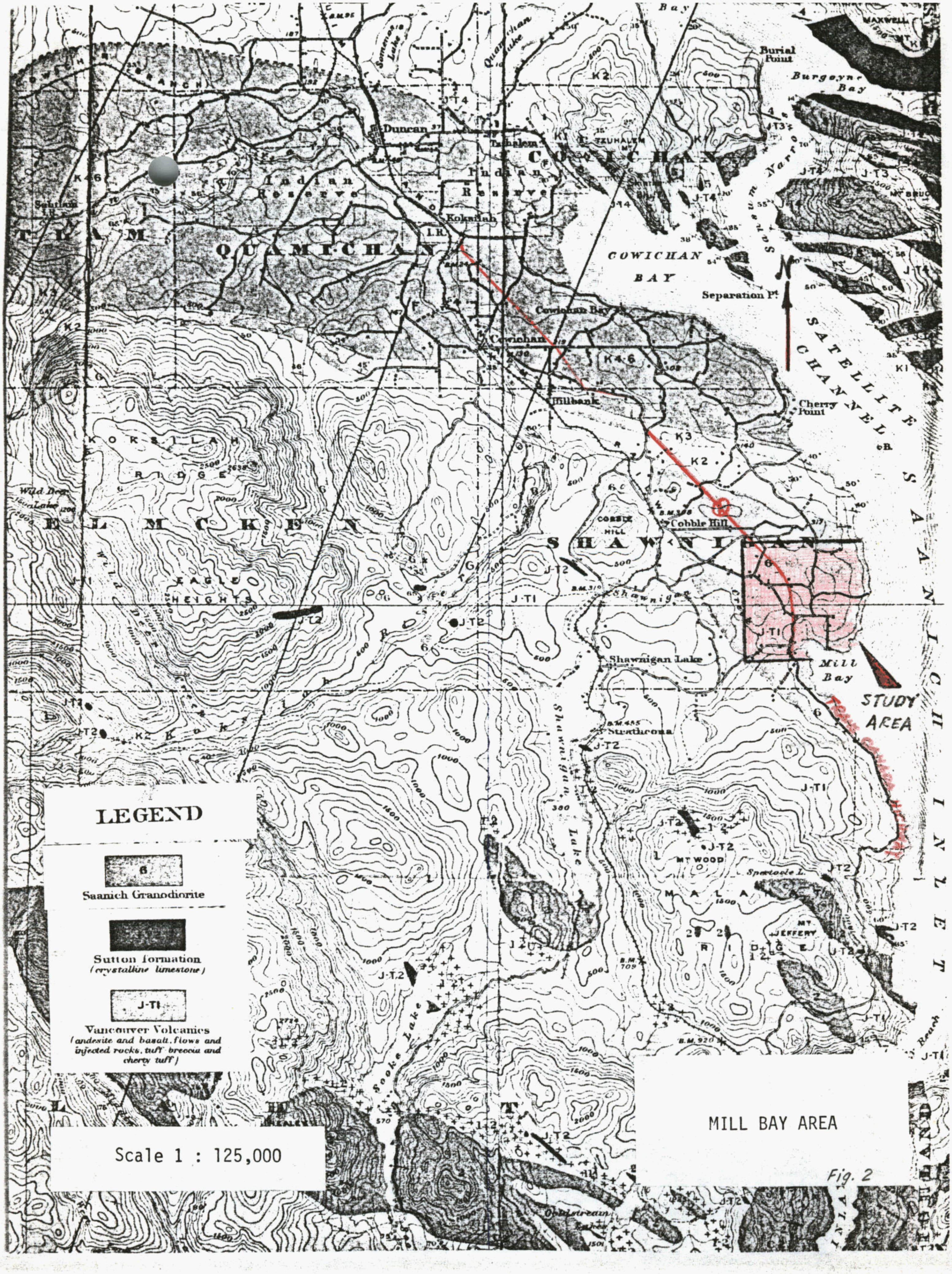
Clapp, C.H. 1917. Sooke and Duncan Map-areas, Vancouver Island. Geological Survey of Canada, Memoir 96, pp. 10-18.

Kalyn, D. 1981. Saunders' Well - Cobble Hill-Mill Bay Area. Ministry of Environment, Water Management Branch, File 92B/12 #15.

Muller, J.E. 1975. Victoria Map-area, British Columbia (92B). In Report of Activities, Geological Survey of Canada, Paper 75-1, Part A, pp. 21-26.

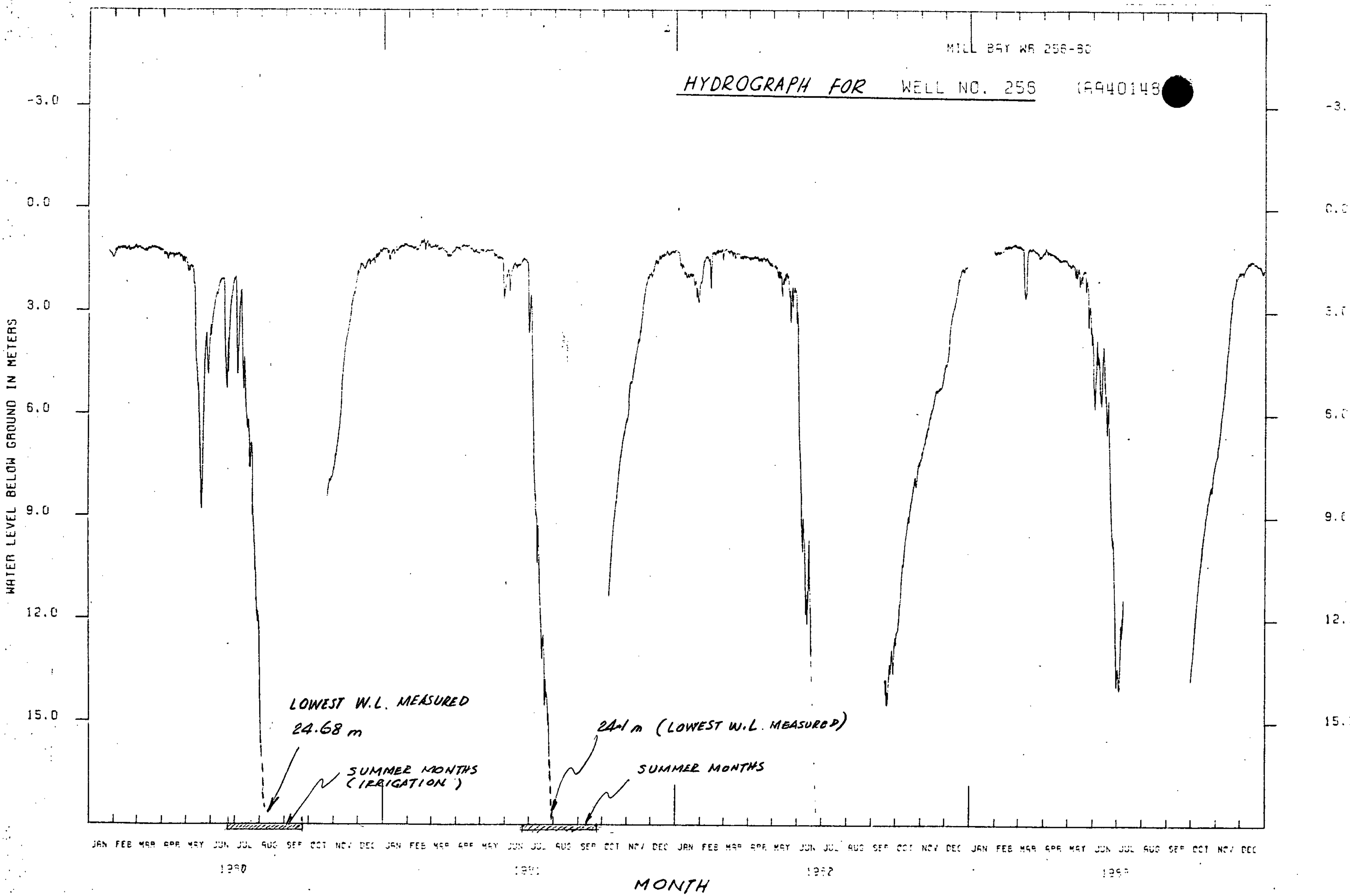
FIGURES


STUDY AREA
SCALE 1 : 125000
MILL BAY AREA
Shawnigan Land District
FIG. 1
NOV. 1984



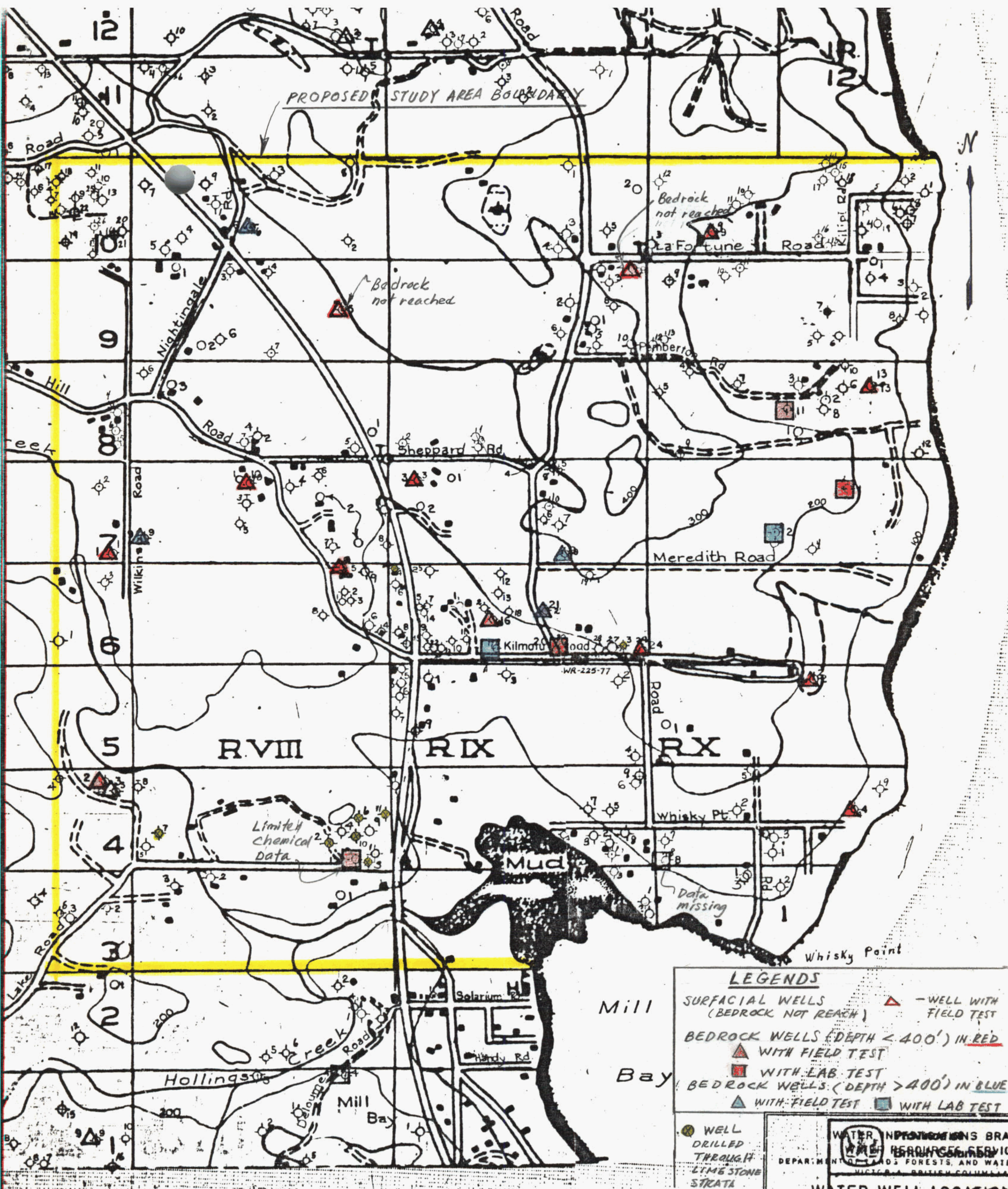
MILL BAY AREA

Fig. 2



MILL BAY WR 256-80
HYDROGRAPH FOR WELL NO. 256
WATER LEVEL BELOW GROUND IN METERS
-3.0
0.0
3.0
6.0
9.0
12.0
15.0
LOWEST W.L. MEASURED
24.68 m
SUMMER MONTHS
(IRRIGATION)
24.1 m (LOWEST W.L. MEASURED)
SUMMER MONTHS
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
MONTH

FIG. 3



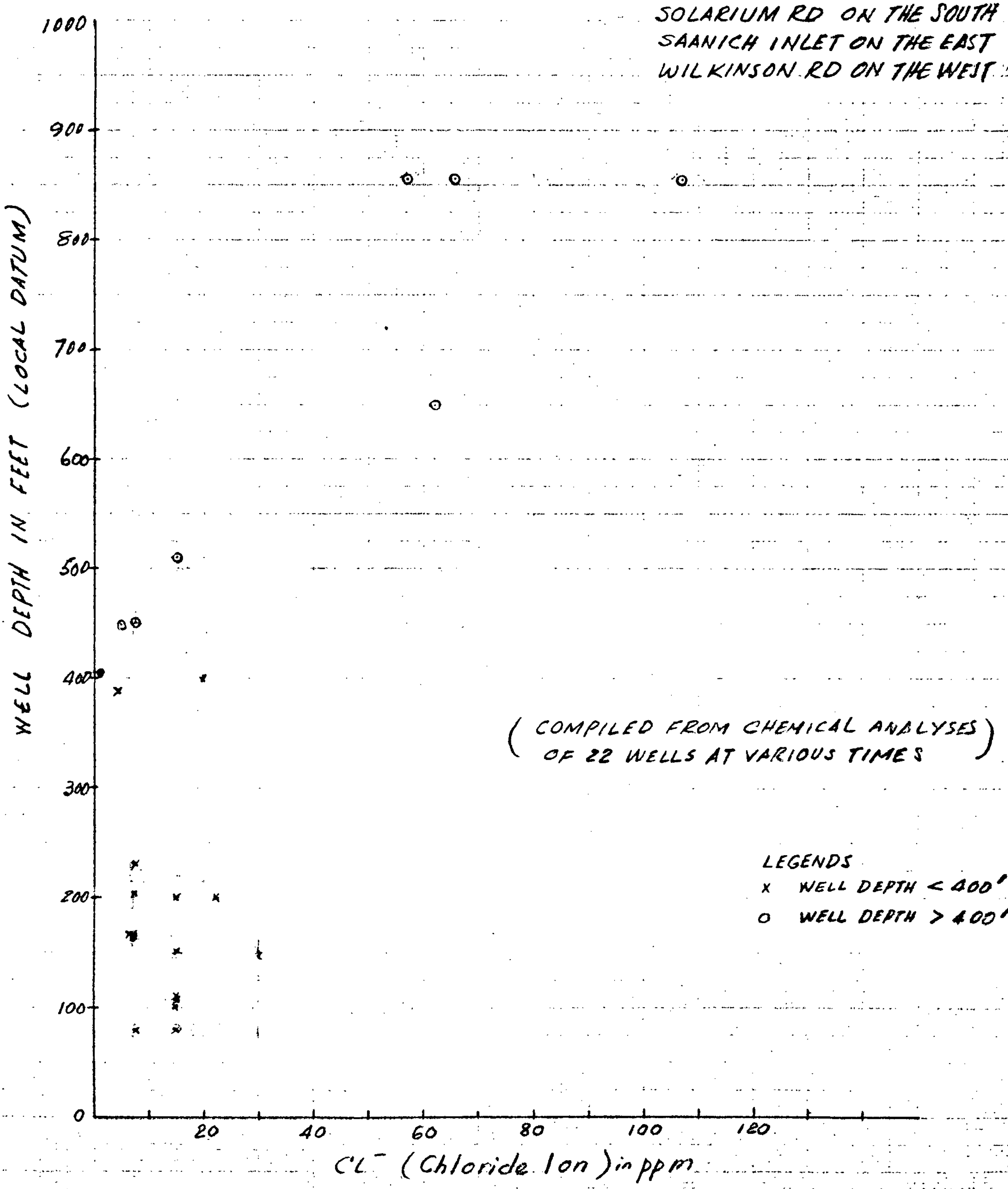
PREVIOUS SAMPLING SITES

MILL BAY AREA

FIG. 4

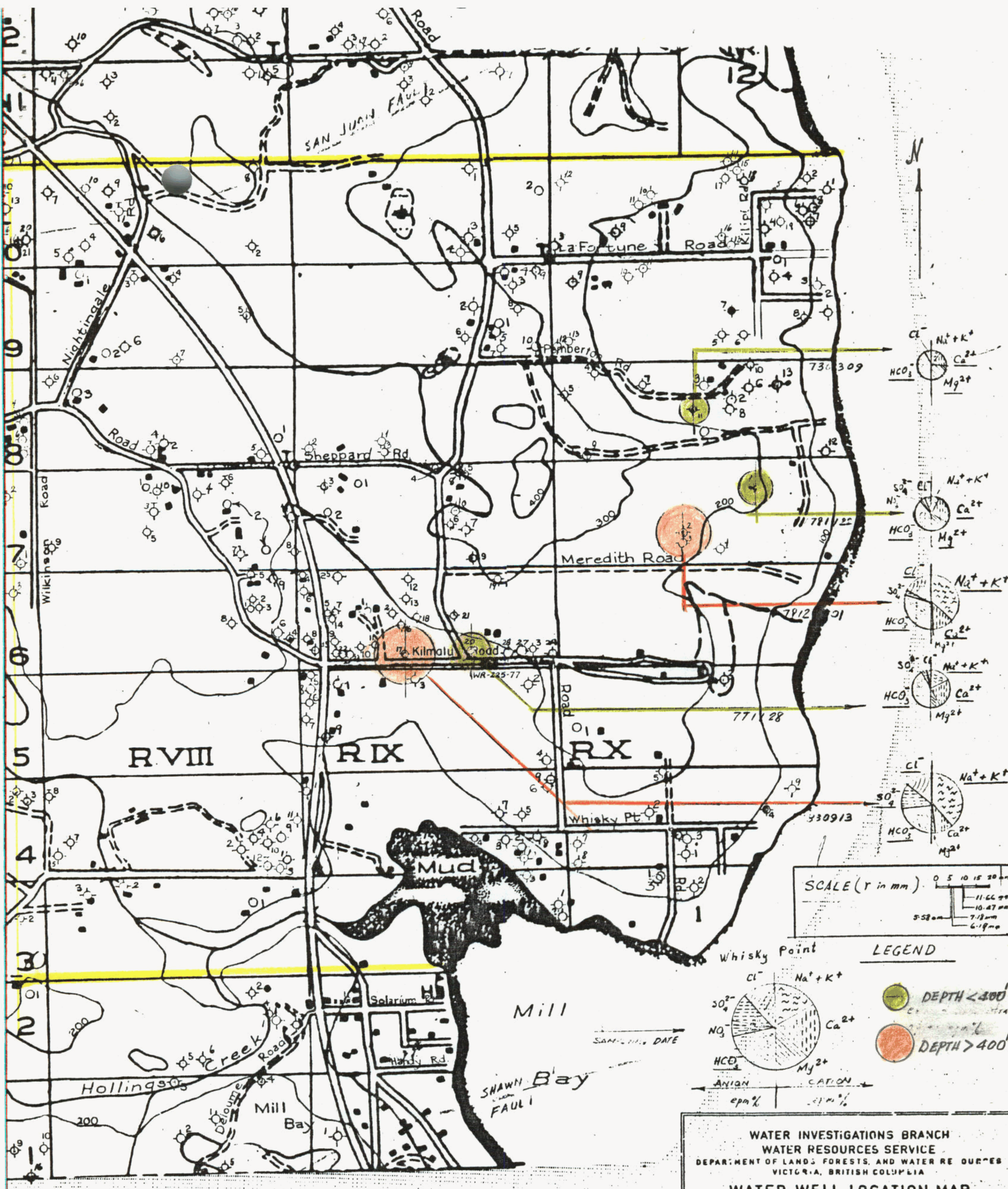
CONCENTRATION OF CHLORIDE IONS V.S WELL DEPTH

MILL BAY AREA – BOUNDED BY HUTCHINSON RD. ON THE NORTH
SOLARIUM RD ON THE SOUTH
SAANICH INLET ON THE EAST
WILKINSON RD ON THE WEST



NOV. 1984

FIG 5



- ARTESIAN (FLOWING)
- ARTESIAN (NON FLOWING)
- SPRING

HYDROCHEMICAL QUALITY

MILL BAY AREA

FIG 6

WATER INVESTIGATIONS BRANCH
WATER RESOURCES SERVICE
DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
VICTORIA, BRITISH COLUMBIA

WATER WELL LOCATION MAP
SHAWNIGAN DISTRICT 14

SCALE 1"=1500' approx SHEET 1

DATE Nov. 1984 REVISED

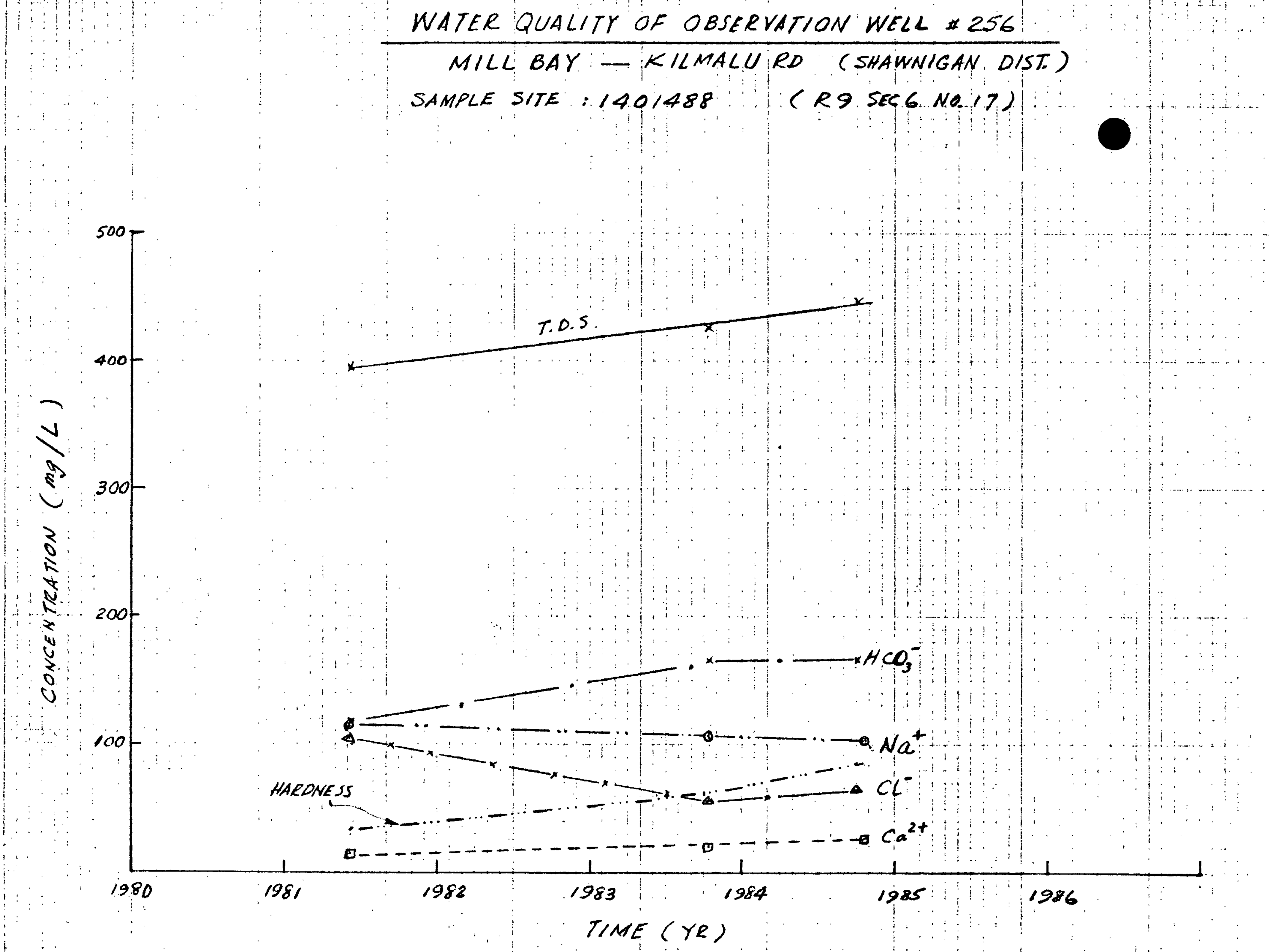
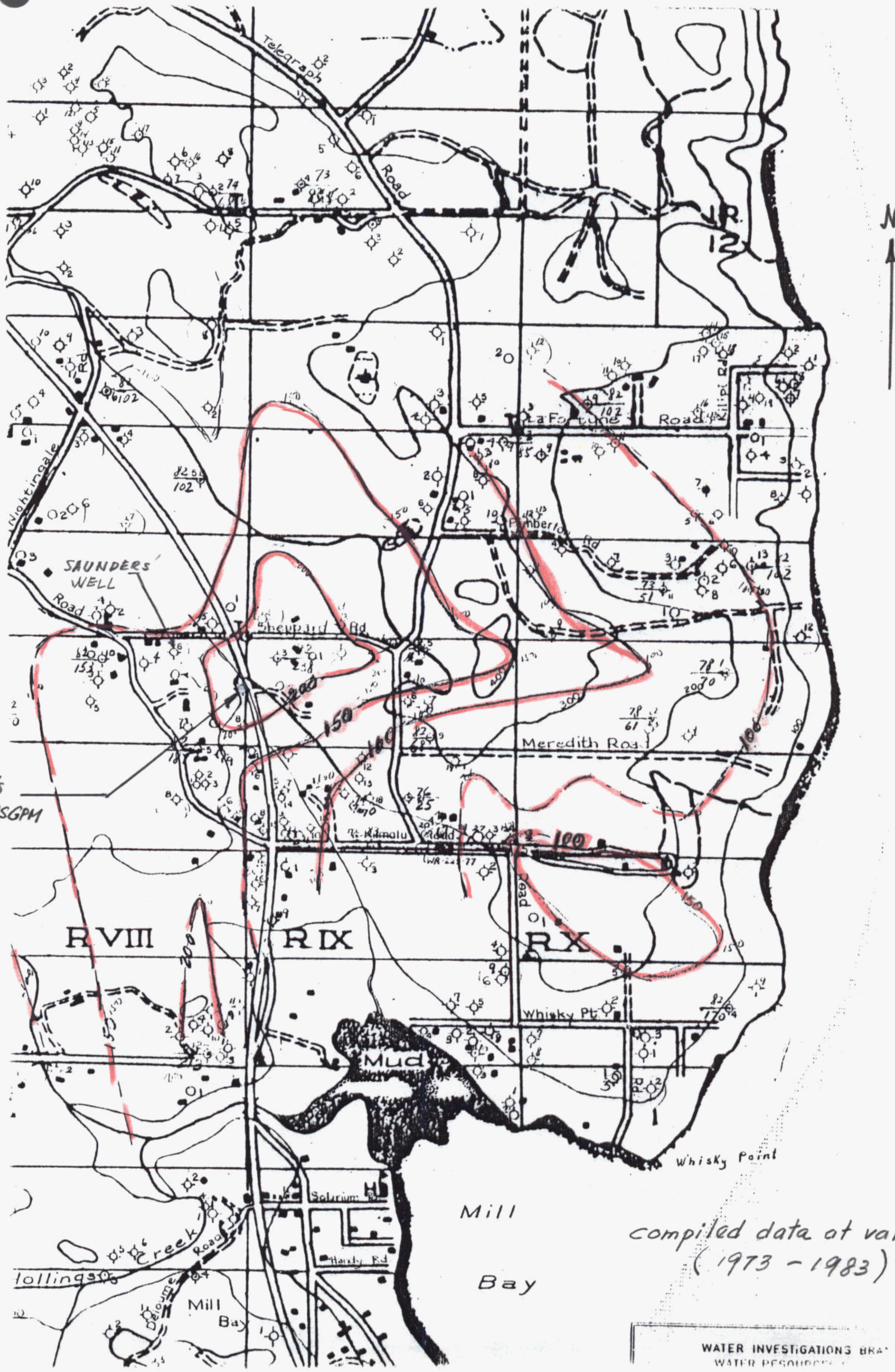

WATER QUALITY OF OBSERVATION WELL # 256
MILL BAY — KILMALU RD (SHAWNIGAN DIST.)
SAMPLE SITE : 1401488 (R9 SEC 6 NO. 17)
T.D.S.
HCO3-
Na+
Cl-
Ca2+
HARDNESS
CONCENTRATION (mg/L)
500
400
300
200
100
1980
1981
1982
1983
1984
1985
1986
TIME (YR)

FIG. 8 DISTRIBUTION OF HARDNESS (APPROX.) IN GROUNDWATER

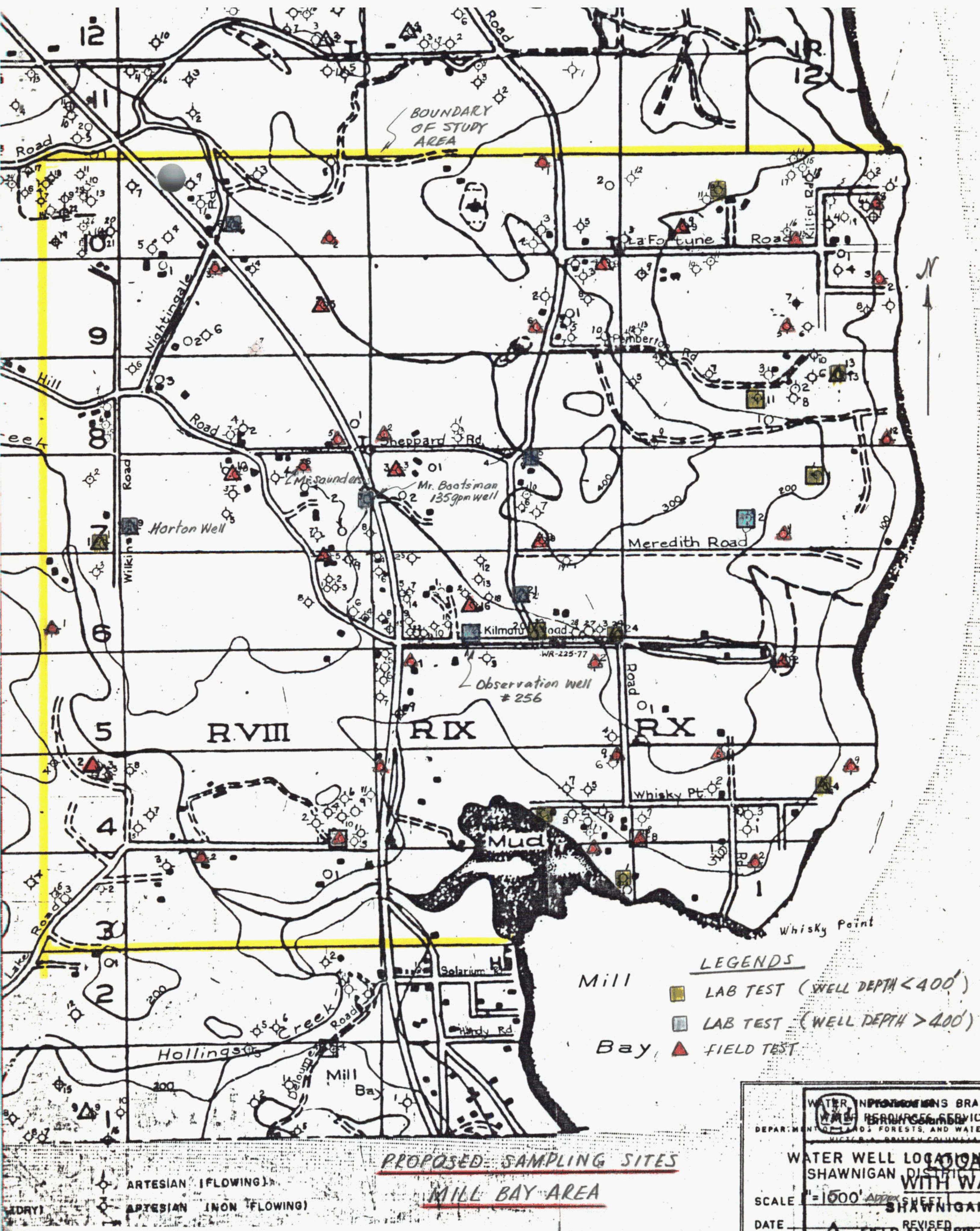
MILL BAY AREA



BOOTSMAN'S WELL 135 USGPM (510')

compiled data at various times (1973 - 1983)

WATER INVESTIGATIONS BRA
WATER RESOURCES



PROPOSED SAMPLING SITES

MILL BAY AREA

FIG 9

APPENDIX I

HYDROCHEMICAL DATA

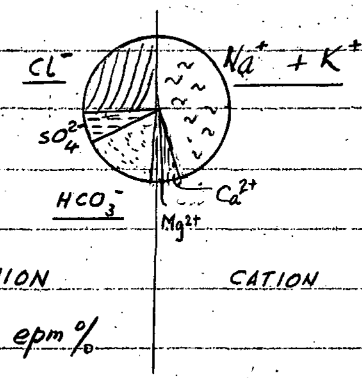
HYDROCHEMICAL DATA

Hydrochemical Pie Diagram

1 : 12000

Q_{Yield} = 7 gpm (U.S.)

Depth = 855 ft.



$\times 10^{-4}$

NaCl

$NaHCO_3$

$r = \sqrt{\frac{T.D.S}{\pi}} = 11.23mm$

WELL NO. R9 Sec 6 No. 17 (Obs. Well 256)	SAMPLING DATE 81 May 4

DIST. SHAWNIGAN — MILL BAY AREA

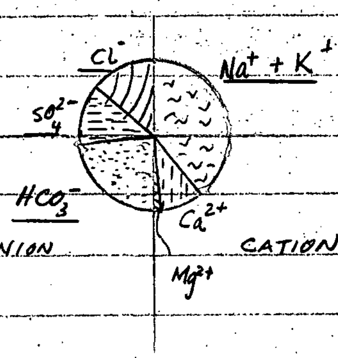
Explanation	ppm	epm	epm %	Remarks
Chloride (Cl^-)	107.0	3.02	51.2	
Sulphate (SO_4^{2-})	36.6	0.76	12.9	
Nitrate (NO_3^-)	—			
Bicarbonate (HCO_3^-)	117.6 *	1.93	32.7	$HCO_3^- = 1.22\ [\overset{106}{Alk} - 2 \times \overset{2\times4.8}{Alk.(Phn)}]$
Carbonate (CO_3^{2-})	5.76 *	0.19	3.2	$CO_3^{2-} = 1.2\ \overset{4.8}{Alk\ (Phn)}$
Total Anions (A)	266.96	5.9	100.0	* calculated
				— exceed 20 epm %
Sodium (Na^+)	116.0	5.04	87.6	
Potassium (K^+)	0.5	0.01	0.2	
Calcium (Ca^{2+})	10.7	0.53	9.2	
Magnesium (Mg^{2+})	2.1	0.17	3.0	
Total Cations (B)	129.3	5.75	100.0	
Total Dissolved Solid (T.D.S.) (A)+(B)	396.26			
Total hardness	35.4			pH = 8.6

HYDROCHEMICAL DATA

Hydrochemical Pie Diagram

1 : 12000

Q = 7 gpm (US)
yield
Depth = 855 ft



$\times 10^{-4}$

$NaHCO_3$
$NaCl$
Na_2SO_4

$r = \sqrt{\frac{T.D.S.}{\pi}} = 11.66$ mm

WELL NO. R9 Sec 6 No. 17 (OBS. WELL No. 256) — 1401488	SAMPLING DATE 83 SEP 13

DIST. SHAWNIGAN — MILL BAY AREA

	Explanation	ppm	epm	epm %	Remarks
decr. (81)	Chloride (Cl^-)	57.0	1.61	27.4	
incr. (81)	Sulphate (SO_4^{2-})	71.9	1.50	25.5	
	Nitrate (NO_3^-)	0.56	0.01	0.2	
incr. (81)	Bicarbonate (HCO_3^-)*	168.4 *	2.76	46.9	$HCO_3^- = 1.22$ (Alk) $= 168.36$ (Alk = 138)
	Carbonate (CO_3^{2-})	—	—		
	Total Anions	297.86 (A)	5.88	100.0	
	Sodium (Na^+)	105.0	4.56	78.1	
	Potassium (K^+)	0.3	0.01	0.2	$\Sigma(Na^+ + Ca^{2+})_{83}$
	Calcium (Ca^{2+})	21.8	1.09	18.7	$= \Sigma(Na^+ + Ca^{2+})_{81}$
	Magnesium (Mg^{2+})	2.2	0.18	3.0	
	Total Cations	129.3 (B)	5.84	100.0	
	Total Dissolved Solid (T.D.S.) (A)+(B)	427.16			
	Total hardness	63.2			pH = 8.1

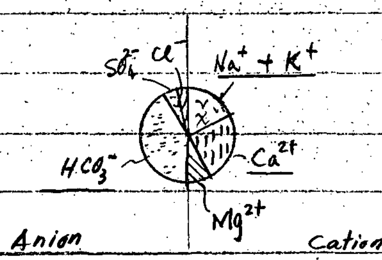
HYDROCHEMICAL DATA

Hydrochemical Pie Diagram

1 : 12,000

Q_{yield} = 20 gpm (U.S.)

Depth = 390 ft



$\times 10^{-4}$

epm %

$\frac{Ca(HCO_3)_2}{NaHCO_3}$ Ca^{++} slightly higher than Na^+

$r = \sqrt{\frac{T.D.S}{\pi}} = 7.18$ mm

WELL NO. R9 Sec 6 No. 20 (OBS. WELL No. 225) 1401434

SAMPLING DATE 77 Nov. 28

DIST.

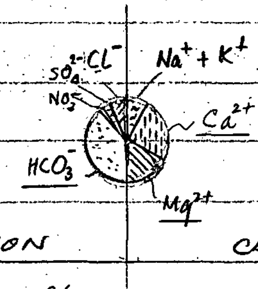
Explanation	ppm	epm	epm %	Remarks
Chloride (Cl^-)	4.9	0.14	6.7	
Sulphate (SO_4^{2-})	10.2	0.21	10.1	
NO_2 NO_3 KJELDAH Nitrate (NO_3^-)	0.93	0.02	1.0	
Bicarbonate (HCO_3^-)*	104.43*	1.71	82.2	$HCO_3^- = 1.22$ (Alk $^{85.6}$) = 104.43
Carbonate (CO_3^{2-})	—			
Total Anions	120.46	2.08	100.0	* calculated
Sodium (Na^+)	16.4	0.71	34.1	
Potassium (K^+)	0.9	0.02	1.0	
Calcium (Ca^{2+})	20.4	1.02	49.0	
Magnesium (Mg^{2+})	4.0	0.33	15.9	
Total Cations	41.7	2.08	100.0	
Total Dissolved Solid (T.D.S.)	162.16			
Total hardness	67.4			pH = 7.7

HYDROCHEMICAL DATA

Hydrochemical Pie Diagram

Q_{yield} = 6 gpm (U.S.)

Depth = 143 ft Sand, clay
= 164 ft Bedrock



$Ca(HCO_3)_2$

$Mg(HCO_3)_2$ & TRACE OF $MgCl_2$

$r = \sqrt{\frac{T.D.S.}{\pi}} = 6.19$ mm

WELL NO. R10 Sec 7 No. 1	SAMPLING DATE 78 Nov. 22

DIST. SHAWNIGAN — MILL BAY AREA

Explanation	ppm	epm	epm %	Remarks
Chloride (Cl^-)	7.0	0.2	12.6	
Sulphate (SO_4^{2-})	5.0	0.1	6.3	
Nitrate (NO_3^-)	3.5	0.06	3.8	
Bicarbonate (HCO_3^-)	75.0	1.23	77.3	
Carbonate (CO_3^{2-})				
Phosphate (PO_4^{3-})	0.049	0.002	—	
Total Anions	90.55	1.59	100.0	
Sodium (Na^+)	5.7	0.25	15.1	
Potassium (K^+)	0.5	0.01	0.6	
Calcium (Ca^{2+})	17.0	0.85	51.2	
Magnesium (Mg^{2+})	6.63	0.55	33.1	
Total Cations	29.83	1.66	100.0	
Total Dissolved Solid (T.D.S.)	120.38			
Total hardness	69.7			pH = 7.6

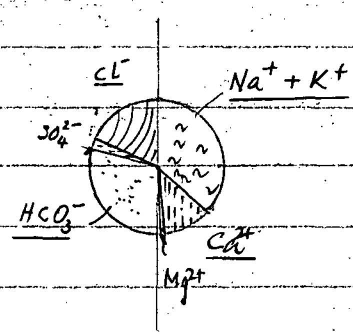
HYDROCHEMICAL DATA

Hydrochemical Pie Diagram

1 : 12,000

Q_{yield} = 9.6 USgpm

Depth = 650 ft.



$\times 10^{-4}$

$NaHCO_3$
$NaCl$, $CaCl_2$

$$r = \sqrt{\frac{T.D.S.}{\pi}} = 10.47 \text{ mm}$$

WELL NO. R10 Sec 7 No 2	SAMPLING DATE 78 DEC 1

DIST. SHAWNIGAN – MILL BAY AREA

Explanation	ppm	epm	epm %	Remarks
Chloride (Cl^-)	62.0	1.75	36.7	
Sulphate (SO_4^{2-})	12.0	0.25	5.2	
Nitrate (NO_3^-)	0.076	—	—	
Bicarbonate (HCO_3^-)	168.0	2.75	57.7	
Carbonate (CO_3^{2-})	—			
Phosphate (PO_4^{3-})	0.34	0.01	0.2	
Flouride (F^-)	0.26	0.01	0.2	
Total Anions	242.68	4.77	100.0	
Sodium (Na^+)	77.5	3.37	73.1	
Potassium (K^+)	0.43	0.01	0.2	
Calcium (Ca^{2+})	22.6	1.13	24.5	
Magnesium (Mg^{2+})	1.17	0.1	2.2	
Total Cations	101.7	4.61	100.0	
Total Dissolved Solid (T.D.S.)	344.38			
Total hardness	61.3			pH = 8.1

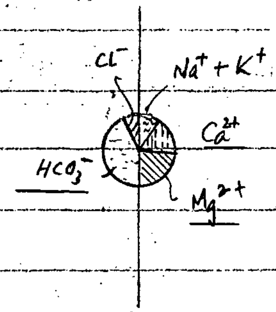
HYDROCHEMICAL DATA

Hydrochemical Pie Diagram

1 : 12,000

Q_{yield} = 9 u.s gpm

Depth = 169 ft



$\times 10^{-4}$

$Mg(HCO_3)_2$
$Ca(HCO_3)_2$
trace NaCl

$r = \sqrt{\frac{T.DS.}{\pi}} = 5.58$ mm

WELL NO. R10 Sec 8 No. 11	SAMPLING DATE 73 Mar. 9

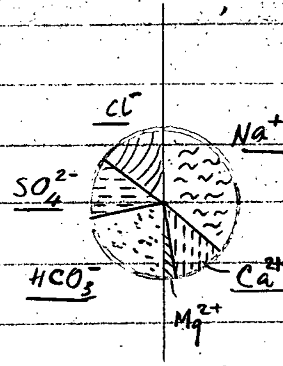
DIST. SHAWNIGAN — MILL BAY AREA

Explanation	ppm	epm	epm %	Remarks
Chloride (Cl^-)	6.5	0.18	13.8	
Sulphate (SO_4^{2-})				
Nitrate (NO_3^-)	1.43	0.02	1.5	
Bicarbonate (HCO_3^-)	68.0	1.11	84.7	
Carbonate (CO_3^{2-})				
Total Anions	75.93 (A)	1.31	100.0	
Sodium (Na^+)	5.0	0.22	17.3	
Potassium (K^+)	1.0	0.03	2.4	
Calcium (Ca^{2+})	8.5	0.42	33.1	
Magnesium (Mg^{2+})	7.3	0.60	47.2	
Silica (SiO_2)	(19.7)	—		
Total Cations	21.8 (B)	1.27	100.0	
Total Dissolved Solid (T.D.S.) (A)+(B)	97.73			
Total hardness	51.2			pH = 7.0

HYDROCHEMICAL DATA

Hydrochemical Pie Diagram

1 : 12,000



Q_{yield} = 7 gpm (u.s.)

Depth = 855 ft.

×10⁻⁴

NaHCO₃

NaCl

CaSO₄

$r = \sqrt{\frac{T.D.S.}{\pi}} = 11.94$ mm

WELL NO. R9 Sec6 #17 140 1488	SAMPLING DATE 84 SEP 26

DIST. SHAWNIGAN – MILL BAY AREA (KILMALU RD.)

Explanation	ppm	epm	epm %	Remarks
Chloride (Cl^-)	65.5	1.85	29.5	
Sulphate (SO_4^{2-})	80.5	1.68	26.8	
Nitrate (NO_3^-)	0.17	0.003	—	
Bicarbonate (HCO_3^-)	167.14 *	2.74	43.7	HCO_3^- = 1.22 (Alk.) (137) = 167.14
Carbonate (CO_3^{2-})	—	—		
Total Anions	313.31 (A)	6.273	100.0	
Sodium (Na^+)	103.0	4.48	72.5	
Potassium (K^+)	0.3	0.01	0.2	
Calcium (Ca^{2+})	27.7	1.38	22.3	
Magnesium (Mg^{2+})	3.73	0.31	5.0	
Total Cations	134.73 (B)	6.18		
Total Dissolved Solid (T.D.S.) (A)+(B)	448.04		100.0	
Total hardness	84.5			pH = 8.1