Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

MEMORANDUM

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

Date: November 30, 1983

File: 92B/14

Re: Campbell-Bennett Bay Improvement District-Groundwater Evaluation

Introduction

As requested by R.A. Pollard, Community Water Supply Section, a groundwater evaluation of the above has been completed. The purpose is to examine the hydrogeology and site conditions around the district's proposed well site. The evaluation has been based solely on an office review of existing well log information, hydrogeologic reports, and air photos. This memorandum summarizes the hydrogeology, provides comments on the local site conditions, and outlines recommendations on well construction and testing.

Hydrogeology

Hydraulically, Mayne Island can be viewed as a groundwater mound situated atop a seawater basement. Table 1 summarizes the existing well log information and Figures 1 and 2 illustrate the hydrogeology of the area. The area contains a moderate density of wells; the highest density occurs at Bennett Bay (Figure 1). Most of the wells are less than 200 feet deep, yield less than 10 gpm, and are completed into bedrock (Table 1).

Bedrock comprises mainly gently northeast dipping shale and some sandstone (Figure 2). Major permeability of these rocks comes from fractures, faults, bedding surfaces, and other structural discontinuities of the rocks; permeability of the intergranular pore spaces of these rocks is extremely low. Groundwater flows primarily through the structural discontinuities. The hydraulic head level measured in wells estimated by subtracting the static water level from the well collar elevation suggests the groundwater flow to be in a northeasterly direction from a ridge in the southwest towards Bennett Bay and Campbell Bay (Figures 1 and 2).

Intermittent overburden drift up to about 20 feet thick covers the area (Figure 2). Although some drift deposits are permeable and saturated, their groundwater potential is believed to be small because of their probable limited areal extent and thickness. Fractured bedrock forms the principal aquifer in the area.

Static water level in wells varies from 110 feet below ground to above ground depending on the well location (Table 1). Most wells in low-lying areas have static water levels of a few tens of feet below ground. These levels were measured as each well was constructed. With the subsequent construction of additional pumping wells as in areas like Bennett Bay, the

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water levels may have declined from previous reported values. The amount of decline, if any, is unknown. According to Foweraker (1974), the area's groundwater demand appears to be offsetting the groundwater availability.

General groundwater quality appears adequate. A 1974 survey of the wells by the Groundwater Section revealed a few cases of high values of total dissolved solids (TDS) or conductivity (wells 26 and 33 in Section 9 and well 1 in Section 10) and of high iron values (wells 7 and 22 in Section 9) that exceed those recommended by the Department of National Health and Welfare (1979). All other wells tested had TDS values of less than 500 mg/l and iron values of less than 0.3 mg/l. It appears that shallower wells and wells in recharge areas (hills and ridges) generally tap groundwater from local flow systems and younger groundwater which typically have lower TDS values than groundwater from deeper wells and wells in discharge areas (Heisterman, 1974).

Salty water in wells is a potential problem especially in low-lying coastal areas. An excessively deep well may encounter salty water by intercepting the underlying seawater basement or by inducing seawater to flow to the well by pumping. About half of the wells are completed below sea level. Most of these are completed less than 100 feet below sea level and have no apparent problems. Only well 1 in Section 10 is completed more than 200 feet below sea level and this may explain the high TDS and chloride content of the well.

Recharge comes from precipitation falling on the area, most of which falls during winter. Recharge in the summer is limited.

Local Site Conditions

The proposed well site is situated beside a road right-of-way in the low-lying valley northwest of the high well density area of Bennett Bay (Figure 1). The site elevation is roughly 80 feet above sea level. The nearest well is about 290 feet to the northeast. Other nearby wells are about 475 feet north, 750 feet south, and roughly 850 feet east of the site.

The site area lies in a discharge area and is apparently underlain by shale. The static water level here is expected to be roughly 30 feet below ground. A flowing artesian condition is not anticipated. The local groundwater chemistry is expected to be adequate provided that the well is not drilled excessively deep thereby encountering salty and poor quality groundwater. Drilling should be undertaken in the range of 150 to 200 feet below ground. These site specific hydrogeologic conditions have been

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interpolated from the hydrogeology as presented in Figures 1 and 2. The prospects for completing a well in the site area capable of yielding 5 to 10 gpm appear good but there are no guarantees against drilling a dry hole because the hole may not intercept any significant water bearing zones. Virtually nothing can be done to guard against this however.

The exact site location should take into account the local topography and drainage, overhead and underground obstructions, and possible pollution sources. These must be determined in the field. Generally, the site should be located:

1) on locally higher ground and away from drainage ditches to guard against any contaminated surface water from reaching the well head and entering the well

2) a safe distance away from overhead and underground obstructions such as telephone lines, power poles, water and sewer lines, etc. and from possible pollution sources such as dumps, septic tanks, etc. (particularly any up-valley and along the hillside from the site).

The proximity of the site to other wells makes well interference a possibility (particularly with the well 290 feet to the northeast). Because the site is relatively fixed, possible pollution sources and any additional nearby wells should be pinpointed. If pollution or well interference appears to be a real problem, consideration should be given to selecting another site in the general area.

Recommendations

Prior to drilling, a preliminary field survey should be carried out in the site area which would involve:

1) checking local hydrogeologic conditions

2) pinpointing the exact site location taking into consideration the local topography and drainage, overhead and underground obstructions, and possible pollution sources

3) a well inventory to locate nearby wells and determine well use (nearby wells that are inoperative would not present well interference problems)

4) checking the background groundwater conditions of at least two of the closest wells (if possible)-a simple field analysis involving water level and conductivity measurements would be adequate.

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During drilling the water quality should be monitored to detect the presence of salty and poor quality water. This can be done by measuring the conductivity in the well as drilling proceeds and where water-bearing zones are encountered. If salty water is encountered, the water-bearing zone should be sealed with grout. Based on existing well information, the well should not be deeper than roughly 200 feet (not greater than 120 feet below sea level) to guard against encountering salty water at depth.

Well construction should conform with the well construction guidelines set out by the Ministry of Environment (1982). The completed well should have a sanitary grout seal extending to a minimum depth of 15 feet and should be pump tested at a constant rate at or in excess of the expected requirements for a period of at least 72 hours. The test should be done in late summer when the water level is near its seasonal low. The pump should be set above the water bearing zone(s) to avoid pumping the water level to below the water bearing zone(s) thereby dewatering the zone(s). A water sample should be collected near the end of the pump test and promptly sent for lab testing. Table 2 shows a recommended list of parameters to be lab tested.

During the pump test, water levels of nearby wells should be monitored to assess the effects of any well interference. Water quality monitoring of the closest wells field tested prior to drilling should continue during the pump test to detect any water quality changes related to the pumping.

The preliminary field survey as well as the design, construction, testing, and sampling of the well should be done under the supervision of a groundwater engineer.

References

Foweraker, J.C. 1974. Evaluation, Development, and Management of the Groundwater Resource on Mayne Island. Report No. 1, Groundwater Investigations on Mayne Island. Ministry of Environment, Groundwater Section, Victoria, B.C. File 92B/14

Heisterman, J.C. 1974. Groundwater Chemistry and Movement on Mayne Island. Report No. 2, Groundwater Investigations on Mayne Island. Ministry of Environment, Groundwater Section, Victoria, B.C. File 92B/14.

Ministry of Environment. 1982. Guidelines for Minimum Standards in Water Well Construction, Province of British Columbia. Groundwater Section, Victoria, B.C.

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Department of National Health and Welfare. 1979. Guidelines for Canadian Drinking Water Quality, 1978. Federal-Provincial Advisory Committee on Environmental and Occupational Health, Ottawa, Ont.

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Table 1 Summary of Existing Well Log Information, Campbell-Bennett Bay Area, 1983.

Well No.	Sec.	Meth. of Well Const.	Depth (ft)	Est. Collar Elev. (ft)	Well Dia. (in)	SWL (ft)	Est. Hyd. Hd Lev. (ft)	Est. Yield (gpm)	Aquifer	Source of Water (ft)
1	9	drilled	119	136	6	32	104	1	bedrock	20, 55, 97
2	"	"	50	50						
3	"	dug	17	30	72				bedrock	
4	"	drilled	60	59	6	26	33	2.5	"	51
5	"		45	86		20	66	0.4	"	23, 43
6	"	drilled	~200	66		15.5	50.5	2	"	
7	"	"	150	50	10	17.5	32.5			
8	"	"	155	35	6	29.8	5.2	1.5	bedrock	28
9	"	"	150	25	5	25	0	0.33	"	32, 42
10	"	"	235	60	5	20	40	0.25	"	148
11	"	"	123	170				5	"	46, 118
12	"	"	113	25	5			1.5	"	53
13	"	"	50	20	6	14	6	7	"	
14	"		155	85	6	11	74	5	"	63, 147
15	"		285	210	6	58	152	2	"	269
16	"	drilled	39	40	6	0	40	4	"	33
17	"		191	70	6	27	43	1	"	184
18	"	drilled	100	60	6	10	50	7	"	58, 87
19	"	"	50	60				3	"	31
20	"	"	50	65	6			6	"	43-46
21	"	"	200	70	6	4	66	2	"	175
22	"	"	150	245		91.8	153.2	3	"	137-140
23	"	"	100	120	6			2	"	68
24	"		80	130	6	Fl	130+	16	"	75
25	"			120			120			
26	"	drilled		120						
27	"	dug	20	125						
28	"			65			65			
29	"	dug	20	100		18	82			
30	"	"		100						
31	"	"	20	125		10	115			
32	"	drilled	110	55				10		
33	"	"	~250	175						
34	"	dug		110						
35	"	drilled	50	120	6	9	111	10	"	18, 37
36	"	"	95	25	6	16	9	2	"	60, 80
37	"	"	172	140				12	"	147-148, 155-157
38	"	"	150	40	6.25			2	"	37, 142
39	"	"	150	40	6.25			4.5	"	60, 80
40	"	"	125	60	6.25			3	"	40
41	10	"	340	170	6	110	0	3.5	"	

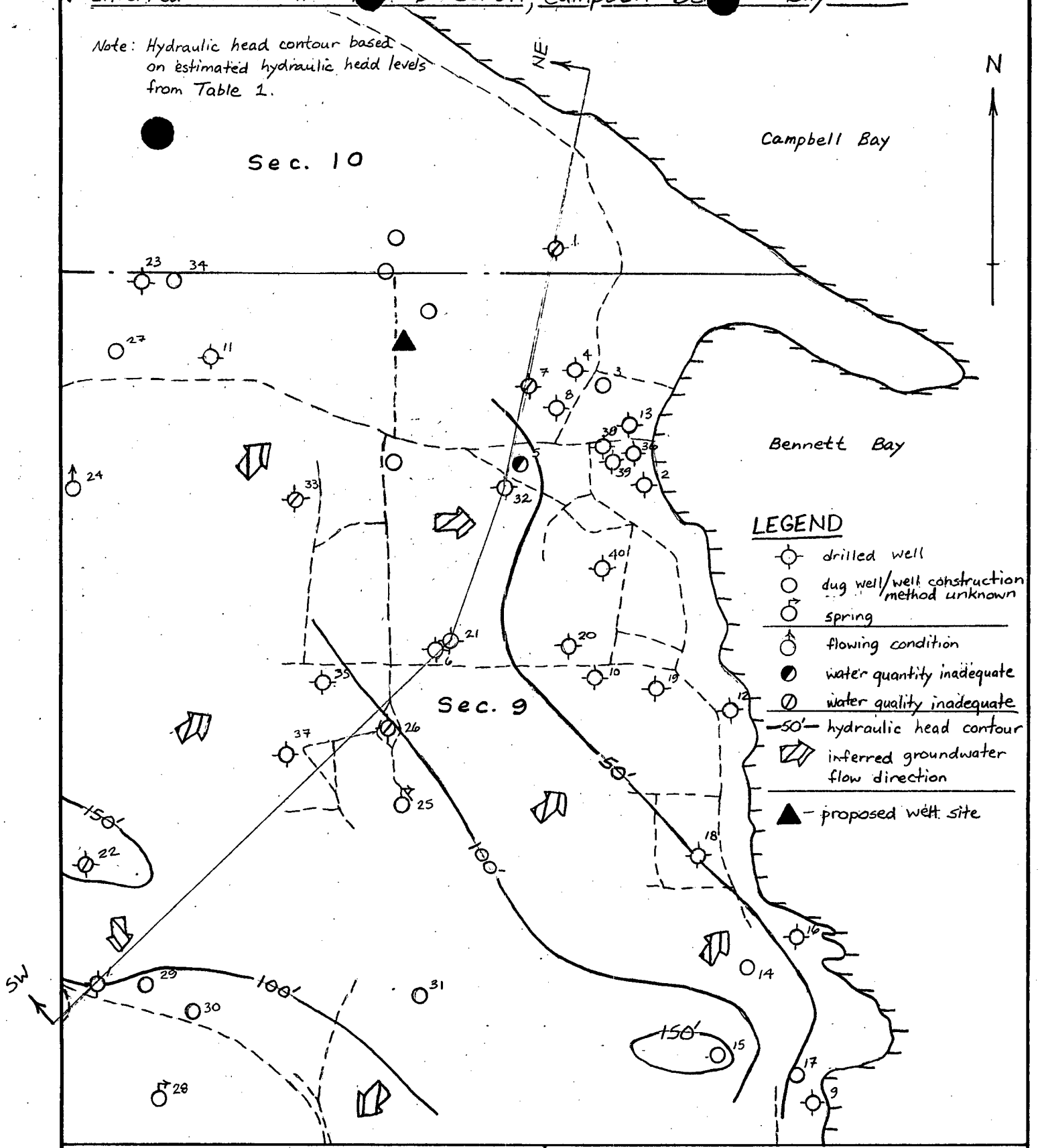
Note: The hydraulic head level is estimated from the estimated collar elevation minus the static water level

Table 2: Recommended List of Parameters to be Lab Tested

Alkalinity - Phen.
Alkalinity - Total
Bicarbonate
Calcium
Chloride
Coliform Bacteria
Flouride
Hardness
Iron, Total and Dissolved
Magnesium
Manganese, Total and Dissolved
Nitrate and Nitrite
Nitrogen
pH
Phosphorous
Potassium
Sodium
Sulfate
Total Dissolved Solids

Inferred Groundwater Flow Direction, Campbell-Bennett Bay Area

Note: Hydraulic head contour based on estimated hydraulic head levels from Table 1.



Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

TO ACCOMPANY REPORT ON
CAMPBELL-BENNETT BAY IMPROVEMENT DISTRICT - GROUNDWATER EVALUATION

SCALE: VERT. N/A
HOR. 1" = 770'

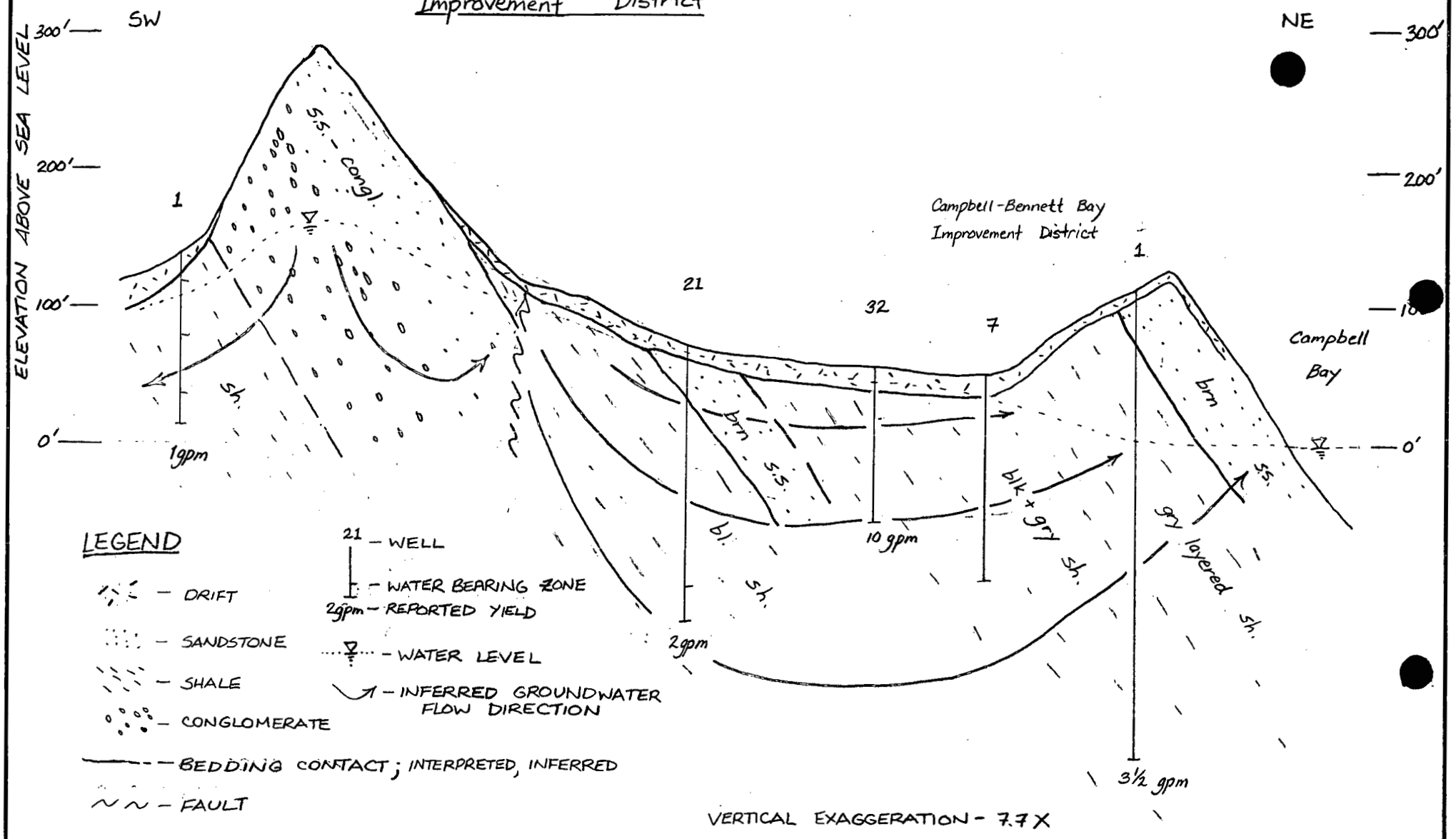
DATE NOV. / 83

M. WEI ENGINEER

FILE No. NTS 92B/14 DWG. No. FIGURE 1

BCIL 7673-M.E.

Hydrogeologic Section Looking Northwest Through Campbell-Bennett Bay Improvement District



Province of British Columbia
Ministry of the Environment
ENVIRONMENTAL AND ENGINEERING SERVICE
WATER INVESTIGATIONS BRANCH

TO ACCOMPANY REPORT ON
CAMPBELL-BENNETT BAY IMPROVEMENT DISTRICT - GROUNDWATER EVALUATION

SCALE: VERT. 1" = 100'
HOR. 1" = 770'

DATE: NOV. /83

M. WEI ENGINEER

FILE No. NTS 92B/14 DWG. No. FIGURE 2

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