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File: 2007261

September 22, 2020

Mayne Island Housing Society
Mayne Island BC

Attention: Deborah Goldman

Re: Preliminary Assessment of Groundwater Supply for Proposed Affordable Housing Project, Mayne Island

As requested, Hy-Geo Consulting has completed a desktop assessment of the groundwater conditions for the property being considered for your proposed affordable housing project along Village Bay Road on Mayne Island. This report summarizes available information on the groundwater conditions, the prospects for developing an adequate and potable water supply and the potential effects of the development on neighbouring properties, existing wells and surface water supplies.

Site Location

The property under consideration is situated along the north side of Village Bay Road approximately 0.5 km south of Miners Bay (Figure 1). The development is being planned for a proposed subdivided parcel along the western portion of the property (PID 2552256). Reported wells from the *British Columbia Water Resources Atlas* (Province of British Columbia 2020) are shown for the region in Figure 1. Those shown do not necessarily comprise all existing wells in the area. Several of the neighbouring wells are situated downslope of the subject property.

Topography across the property slopes uniformly down towards the north with elevations falling from 50 m along Village Bay Road to approximately 32 m along the northern boundary (Figure 2). A localized depression occurs below the northern boundary of the property.

Climate

Mayne Island is situated in a cool Mediterranean climatic zone with mild wet winters and dry summers. The island receives about 842 mm of precipitation on an annual basis (Government of Canada, 2020a). Monthly normal precipitation for Mayne Island for the 1981-2010 period has been reported by the Government of Canada (2020a) for climate station 1014931 is shown in Figure 3. Precipitation normally follows a seasonal

cycle, with highest rainfall during the fall, winter and early spring months while the summer months are subject to drought conditions. Global climate models (Allen *et al*., 2008) suggest precipitation may increase slightly in the future, particularly during the winter months.

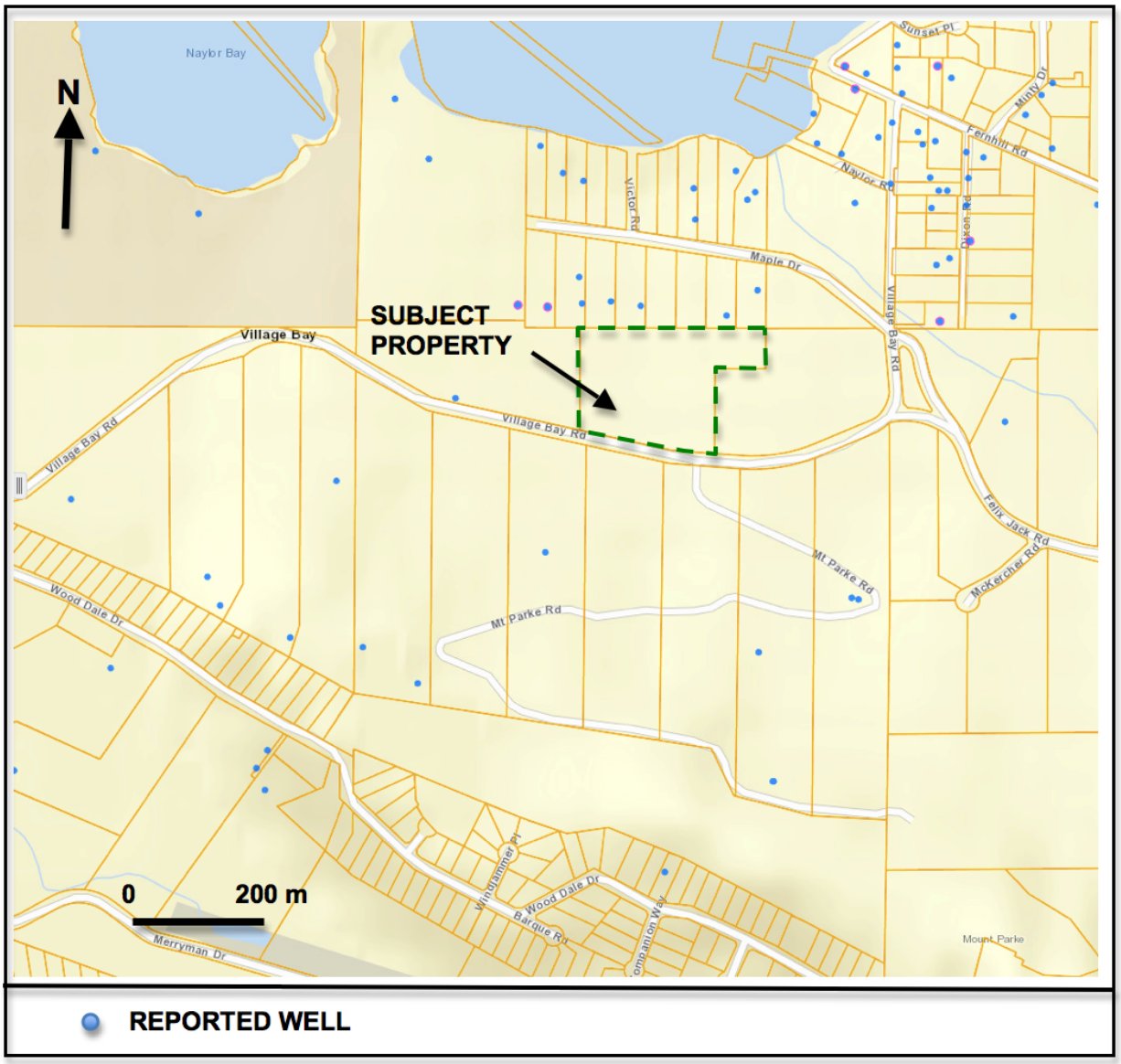

Figure 1. Location of subject property and reported neighbouring wells. Basemap from Province of British Columbia (2020a).

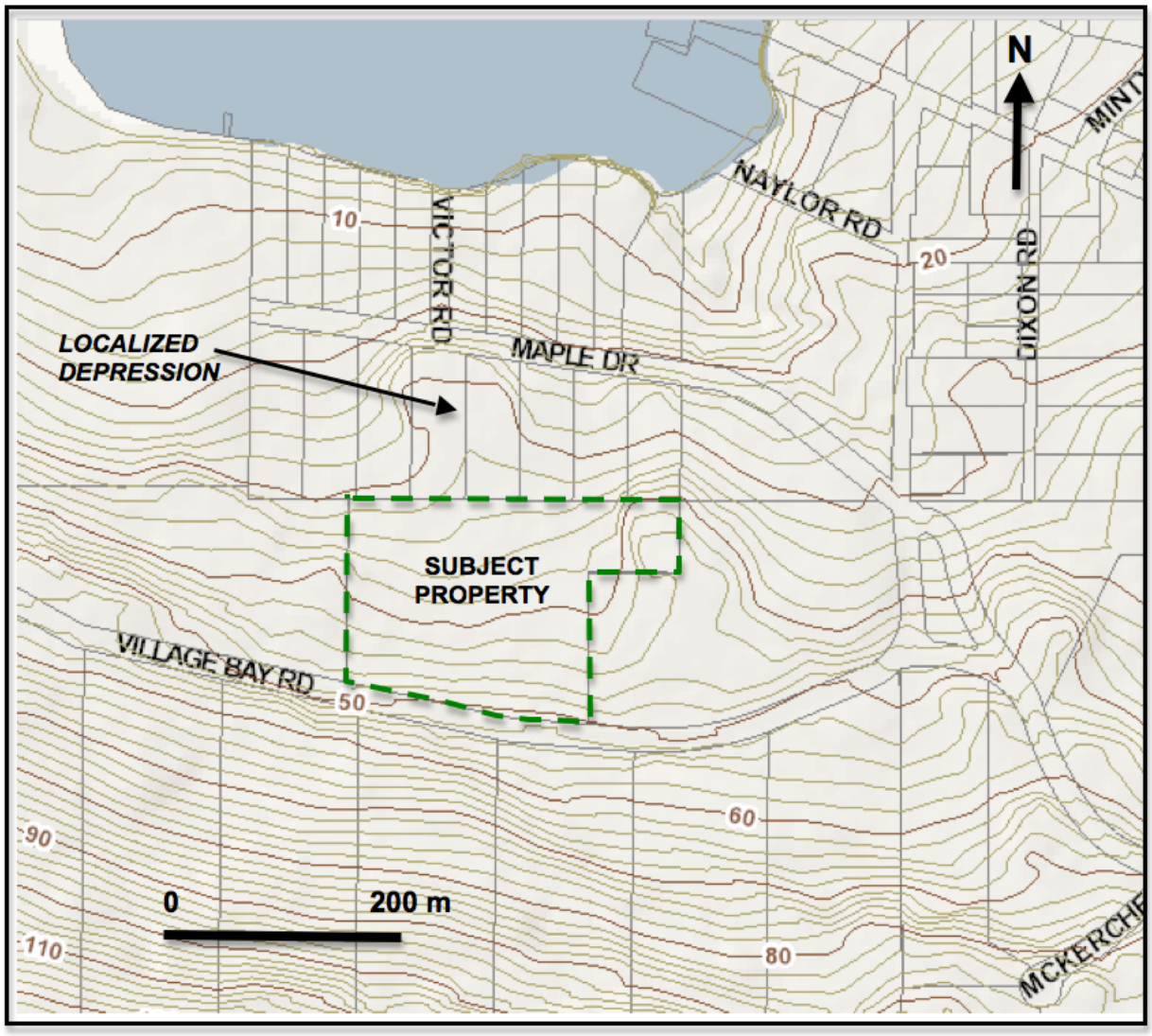

Figure 2. Topography in the region. Contour interval 2m, from Islands Trust (2020).

Bedrock Geology

Mayne Island is underlain by Upper Cretaceous fractured bedrock formations comprised of sandstone, shale, siltstones and conglomerate of the Nanaimo Group (Muller and Jeletzky, 1970, England and Hiscott, 1991 and Mustard,1994). Figure 4 shows the bedrock geology as depicted by (Allen and Kirste, 2012). The property area appears to be situated close to the geologic contact between the Geoffrey Formation on the west and the Spray Formation to the east. The Geoffrey Formation is comprised mainly of sandstone while the Spray Formation consists mainly of mudstone and siltstone. Regionally the Cretaceous strata are gently folded with a uniform direction of dip towards the northeast into the Georgia Basin (Figure 5).

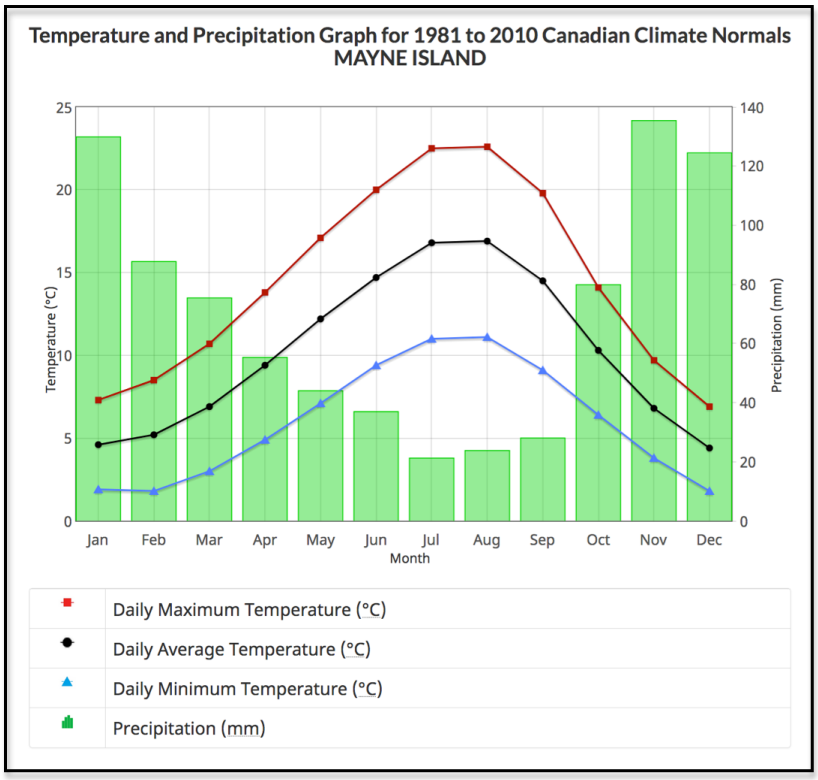

Figure 3. Graph of monthly normal precipitation for Mayne Island station (Climate ID. 1014931). Graph from Government of Canada (2020a).

Hydrogeologic Setting

The general groundwater conditions of Mayne Island have been reported by several authors including; Foweraker (1974), Moncur (1974), Heisterman (1974), Dakin (1975), Dakin *et al.,* (1983), and Allen and Kirste (2012). Groundwater on the island is found primarily in open fractures in the bedrock formations as they are encountered during drilling of water wells. These fractures constitute the major zones for groundwater storage and movement.

The property is underlain by the fractured sedimentary bedrock aquifer designated as Aquifer 619 (Province of British Columbia, 2020a). Aquifer 619 is situated in the central portion of the island between Miners Bay and Bennett Bay. It has been classified as a IIB aquifer with a moderate level of development and moderate level of vulnerability to contamination from surface sources (Province of British Columbia, 2020c).

Groundwater is likely recharged by infiltration of precipitation on Mount Parke and local upland areas west of Bennett Bay with groundwater moving laterally towards Miners Bay to the west and Bennett Bay to the east. Flowing artesian conditions occur locally within the valley area. The geometric mean of 122 reported well yields distributed throughout the lower lying area of the aquifer is 0.20 L/s (3.2 USgpm) and the median well yield is 0.25 L/s (4.0 USgpm). The median depth of wells is 38.10 metres (125.0 feet) and the range of well depths is from 4.27 to 157.89 metres (14 to 518 feet).

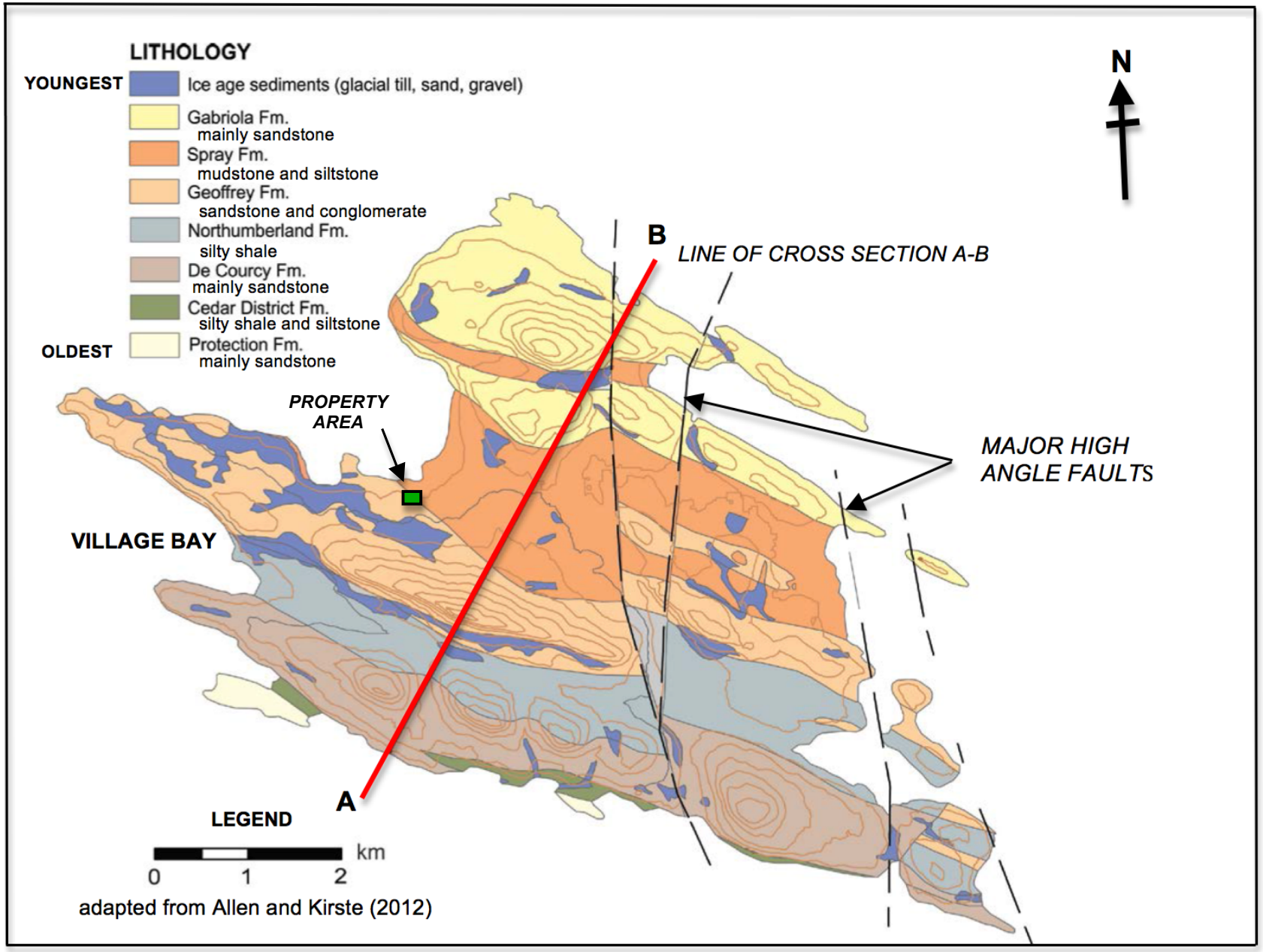

Figure 4. Bedrock geology, Mayne Island.

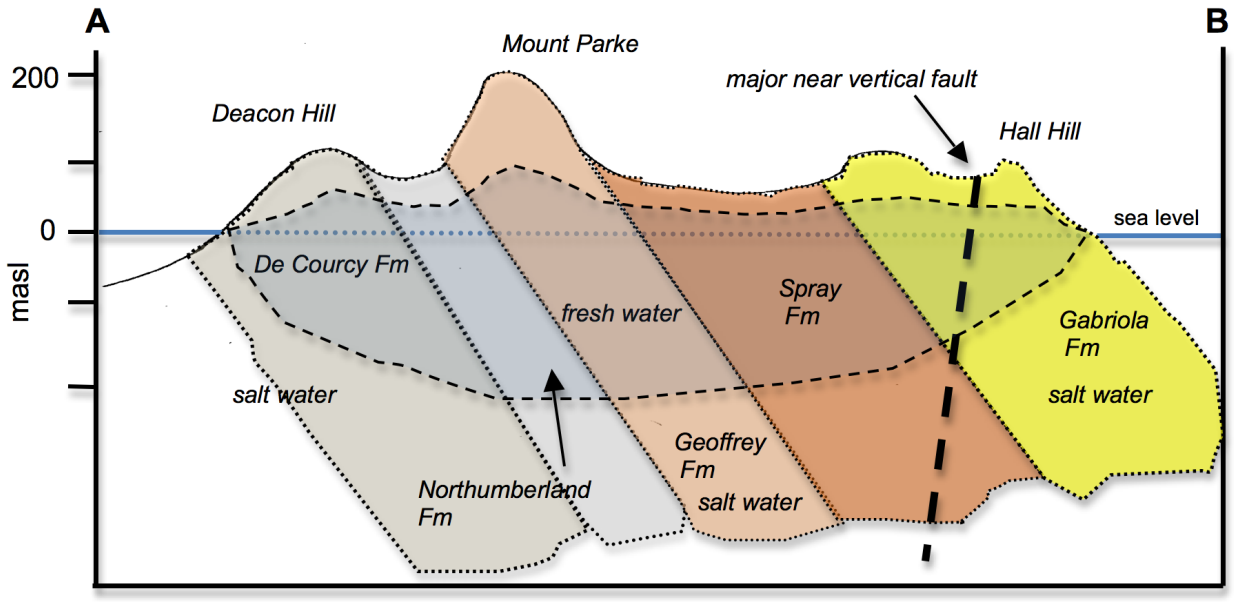

Figure 5. Schematic geologic cross section A-B looking northwesterly showing general dip of bedrock formations towards the northeast and concept of fresh water lens overlying salt water. Adapted from Ministry of Environment (2015)

Localized water quality concerns include salt water, sulphurous taste and odour, and bacteriological contamination particularly in shallower and older wells in the Village Bay area. Based on previous groundwater quality studies it is anticipated that groundwater in the bedrock to depths up to 300 feet (91.4 m) at the property may contain moderate levels of dissolved mineralization with total dissolved solids in the range 200 to 400 mg/L (Heisterman, J.C., 1974).

In 2015, a preliminary water budget for the fractured bedrock aquifers on Mayne Island was developed (Ministry of Environment, 2015). Results of that study indicated that overall groundwater use on the island appears to be only a small percentage (1.9 to 5.0 percent) of the potential recharge that is occurring on an annual basis. More recent water budget studies in the Gulf Islands, estimate groundwater use at 14.3% of the recharge in the Center 1 West groundwater region surrounding Miners Bay (pers, comm., W. Shulba, Islands Trust 2020). While overall groundwater use appears to be relatively low it is not uniform but concentrated in areas of high density lots in proximity to coastal areas where deteriorating water quality, well interference and salt water intrusion issues can occur. These conditions may also be exacerbated during periods of drought that often correspond with periods of highest water demand.

Regional Water Level Fluctuations

From historic observation well data in the Gulf Islands, groundwater levels in bedrock wells generally rise and fall with the seasons, in response to available precipitation, becoming highest during the late fall and winter months. Water levels then normally decline during the dry summer months reaching seasonal lows in the late fall months (Kohut *et al*.,1984).

Figure 6 shows the historic range of annual water level fluctuations for Observation Well 125 on Mayne Island since it was established in 1971. The seasonal variation in water level for this well has been less than 1 m over the past 49 years.

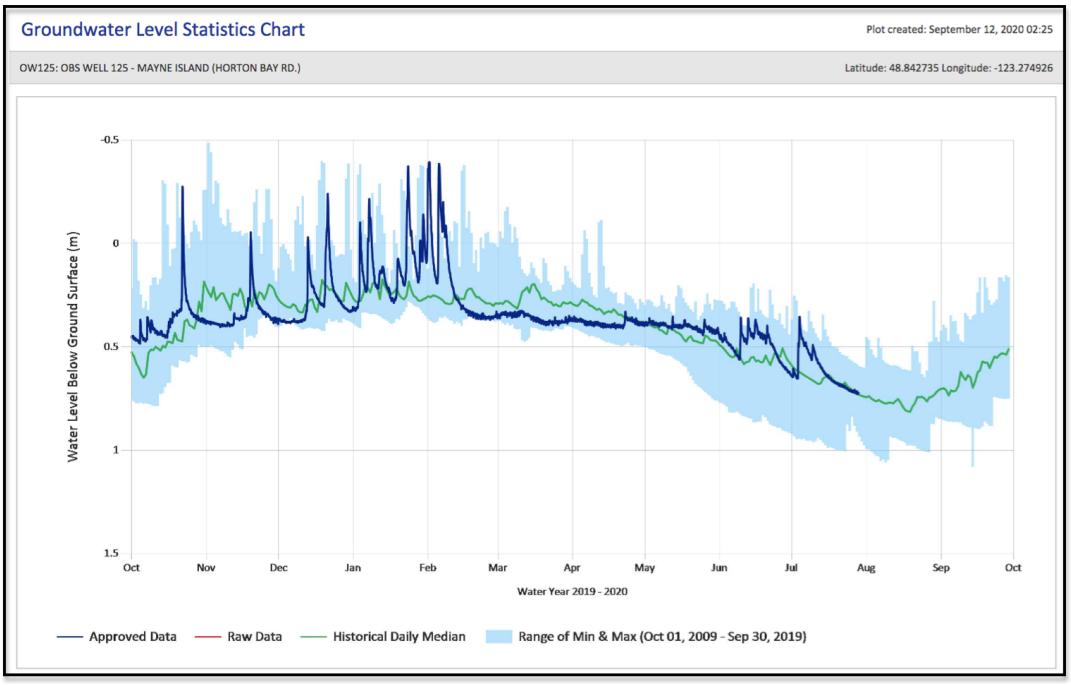

Figure 6. Groundwater level trend in 2019 - 2020 compared to historic maximum, minimum and median data for Observation Well 125, Mayne Island. Adapted from Province of British Columbia (2020b).

Reported Wells and Springs

Figure 7 shows the location of reported water wells and springs in and within the vicinity of the property. Since historic reporting of water wells to the province was voluntary prior to 2016, it is possible that additional wells may be located in the region. Table 1 provides a brief description of the closest wells and springs to the property. Wells currently within the Ministry of Environment's WELLS database (2020a and 2020c) are identified with a Ministry well tag number (WTN) that is a unique computer generated identification number. In recent years, the Ministry has also provided well identification plate (WID) numbers to well drillers for attaching to the casing of new wells for identification in the field.

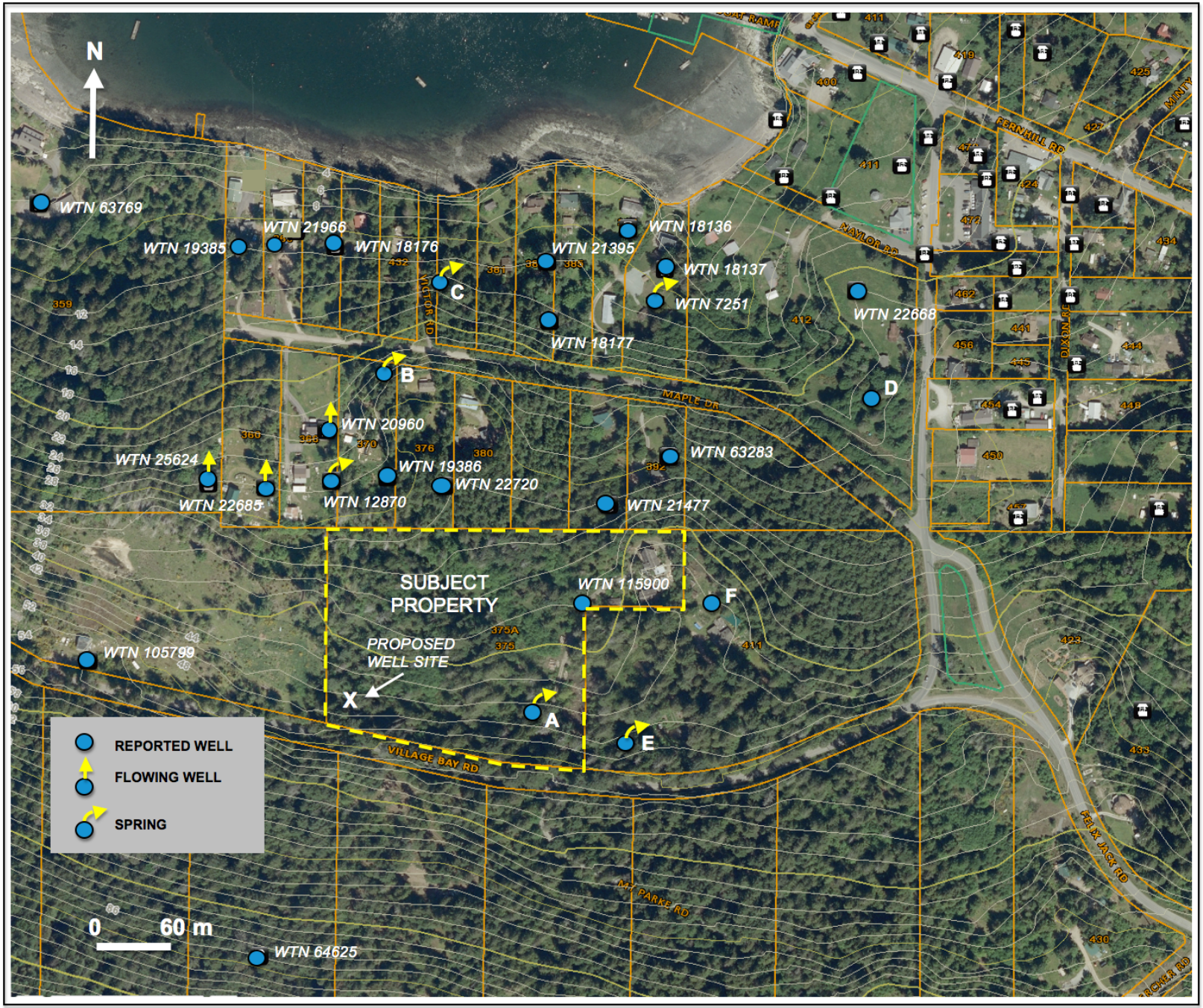

Figure 7. Location of reported wells and springs in and within the vicinity of the subject property.

Table 1. Summary of reported wells and springs in and within the vicinity of the subject property.

Location Coordinates	Well Tag Number or Site	Well ID Plate	Finished Well Depth (ft)	Finished Well Depth (m)	Diameter (in)	Water Depth (ft)	Water Depth (m)	Bedrock Depth (ft)	Bedrock Depth (m)	Well Yield (Usgpm)	Well Yield (L/m)	Comments
	A											licensed spring
	B											licensed spring
	C											licensed spring
	D											reported well
	E											reported spring by landowner
	F											reported well by landowner
X: -13725916.9959358, Y: 6249452.24737743, Z: NaN	7251		10	3.0		7	2.1					spring, sandstone
X: -13726297.0518316, Y: 6249214.05895879, Z: NaN	12870		4	1.2		Flows	Flows			0.35	1.32	spring
X: -13725943.1671318, Y: 6249518.39325863, Z: NaN	18136		50	15.2		6	1.8	10	3.0	1.5	5.68	shale and sandstone
X: -13725898.97338, Y: 6249469.84116862, Z: NaN	18137		50	15.2		8.5	2.6	8	2.4	1	3.79	shale and sandstone
X: -13726293.6009907, Y: 6249495.5550369, Z: NaN	18176		90	27.4		26	7.9	8	2.4	1	3.79	sandstone and shale
X: -13726036.786831, Y: 6249406.90981542, Z: NaN	18177		50	15.2		8	2.4	8	2.4	1	3.79	sandstone and shale
X: -13726392.5639753, Y: 6249575.91175251, Z: NaN	19385		75	22.9		19	5.8	9	2.7	1.5	5.68	hard grey sandstone
X: -13726230.3714953, Y: 6249218.9647734, Z: NaN	19386		73	22.2		19.5	5.9	3	0.9	10	37.85	sandstone and shale
X: -13726303.3970108, Y: 6249274.95870134, Z: NaN	20960		88	26.8		Flows	Flows	26	7.9	2	7.57	hard grey sandstone
X: -13726040.1264721, Y: 6249478.29969257, Z: NaN	21395		120	36.6		26	7.9	3	0.9	5	18.93	sandstone and shale
X: -13725964.6518413, Y: 6249186.48506769, Z: NaN	21477		110	33.5		28	8.5	0	0.0	2	7.57	shaley sandstone
X: -13726340.8004497, Y: 6249513.65638355, Z: NaN	21966		93	28.3		14	4.3	8	2.4	5	18.93	shale and sandstone
X: -13725669.7664882, Y: 6249444.8040196, Z: NaN	22668		60	18.3				23	7.0	15	56.78	sandstone
X: -13726375.9773928, Y: 6249206.1081979, Z: NaN	22685		85	25.9		4	1.2	17	5.2	5.5	20.82	basalt? reported to flow
X: -13726162.0213349, Y: 6249208.47652079, Z: NaN	22720		70	21.3		24	7.3	0	0.0	12	45.42	shaley sandstone
X: -13726444.2162711, Y: 6249210.5063876, Z: NaN	25624		100	30.5		4	1.2	22	6.7	6	22.71	basalt? reported to flow
X: -13725893.5185939, Y: 6249244.67804069, Z: NaN	63283		180	54.9				10	3.0	25	94.64	sandstone
X: -13726648.9328258, Y: 6249545.9681604, Z: NaN	63769		200	61.0				8	2.4	1	3.79	blue shale
X: -13726381.2092602, Y: 6248643.14456928, Z: NaN	64625		300	91.4				1	0.3	10	37.85	hard sandstone
X: -13726587.4844547, Y: 6248996.85320672, Z: NaN	105799	32143	320	97.5	6.63			0	0.0	1.25	4.73	sandstone
	115900	47026	140	42.7	6	26	7.9	25	7.6	15	56.78	

Data from Province of British Columbia (2020a and 2020c), and reports of landowners Sept. 14, 2020.

It should be noted in Figure 7 that several flowing artesian wells and springs have been identified north of the property and in the Village Bay area. These water sources are indicative of groundwater discharge conditions where groundwater is moving upwards towards the land surface. Locally this may result in high water tables, wetland areas and poor drainage conditions especially during the wet winter months.

Estimated Water Supply Demand

It is my understanding that the proposed development is to be comprised of:

10 residential units with a potential occupancy of 32 persons.

Indoor water use for conventional water systems, based on the *Design Guidelines for Rural Residential Community Systems* (Ministry of Forests, Lands & Natural Resource Operations, 2012) suggests that a minimum of 230 L/capita/day or 50.6 Imperial gallons/capita/day be considered for a water system design. Government of Canada (2020b) reports a similar water use figure of 251 L/day per capita for metered urban household water systems monitored across Canada in 2011.

Maximum day demand (MDD) or the single highest total 24 hour daily water consumption occurring over a one year period would normally include indoor usage, water loss allowance and irrigation demand components. For the proposed development it is intended that the residential demand would be supplied by a new water well to be drilled near the southwest corner of the property (Figure 7). The water loss allowance for system leaks for a new water system would be minimal. It is also proposed that irrigation and community garden watering demands for the proposed development would be met by a rainwater catchment system to be developed.

It is anticipated that residents of the proposed development will practice water conservation measures and water-saving appliances will be incorporated in all of the units including dual-flush toilets, low flow fixtures, water efficient appliances and faucet aerators to reduce water consumption. Overall, water maximum day demand (MDD) per unit, therefore, could be effectively reduced to about 40 Imperial gallons/capita/day (181.84 L/capita/day).

In 2015, Hy-Geo Consulting examined metered water data from 2012 to 2015 for 6 water systems on Mayne Island involving a total of 620 residential connections (Ministry of Environment, 2015). The results of that analysis indicated that the average daily water use per household connection for all systems ranged from 28 to 105 USgals/day (106.0 to 397.5 L/day) with a combined total average ranging from 45 to 56 USgals/day/connection (170.3 to 212.0 L/day/connection). The above metered water use figures would have included all water use on the land parcels including garden watering.

Based on a maximum demand of 230 L/capita/day, potential residential water use at the proposed facility would be 7360 L/day, equivalent to a continuous pumping rate of 5.11 L/min (1.12 Imp gals/minute or 1.35 US gals/minute). The availability of this

quantity would need to be confirmed by adequate testing of a bedrock well on the property. A new well and water system will also need to meet the requirements of: the Mayne Island Local Trust Committee, the Island Health Authority, and the Capital Regional District. It will also require a commercial water licence from the Ministry of Forests, Lands, Natural Resource Operations and Rural Development.

Groundwater Potential and Conclusions

Based on the available groundwater information for the region, the prospects for drilling a successful production well on the property to meet the water supply demands of the proposed facility are excellent. The relatively low estimated maximum demand of 1.35 US gals/minute for the facility should not have any significant impact on neighbouring wells, springs or the overall groundwater regime. The availability of this quantity would need to be confirmed by conducting a constant rate 72 hour pumping test on the well while monitoring groundwater levels in one or more neighbouring wells and/or springs.

Groundwater quality to depths of 300 feet (91.4 m) on the property is anticipated to be moderately mineralized with total dissolved solids in the range of 200 to 400 mg/L. Overall potability would need to be confirmed with laboratory testing of chemical and bacteriological parameters following the sampling and testing requirements of the Island Health Authority.

Recommendations

The following recommendations are provided for consideration:

1. Undertake a field survey to:
   - confirm the local geologic and water drainage conditions, and
   - determine the locations, conditions and use of neighbouring wells and springs.

2. Retain a certified water well drilling contractor to construct a bedrock well to a depth up to 300 feet (91.4 m) on the property at or near the location shown in Figure 7.

3. If drilling proves successful, retain a certified well pump installer to carry out a 72-hour constant rate pumping test on the well, including water level monitoring of one or more neighbouring wells and springs.

4. Collect samples of the groundwater near the end of the pumping test following the requirements of the Island Health Authority and submit for laboratory analysis.

5. Assess the results of the above investigations.

Closure

This report was prepared in accordance with generally accepted engineering, hydrogeological and consulting practices. It is intended for the prime use of Mayne Island Housing Society in connection with its purpose as outlined under the scope of work for this project. This report is based on data and information available to the author from various sources at the time of its preparation and the findings of this report may therefore be subject to revision. Data and information supplied by others has not been independently confirmed or verified to be correct or accurate in all cases. Any errors, omissions or issues requiring clarification should be brought to the attention of the author. The author retains full copyright of the material contained in the report. The author and Hy-Geo Consulting accepts no responsibility for damages suffered by any third party as a result of any unauthorized use of this report.

Respectfully submitted,

Alan P. Kohut PEng.
Principal and Senior Hydrogeologist

HY-GEO CONSULTING

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