Cherry Point Aquifer (197)

The Cherry Point aquifer has been described by the MOE as comprising about 39 km^2, located on the south side of Cowichan Bay, extending north to Mill Bay, and to Shawnigan Creek in the southwest. Its western (possibly upgradient) boundary is the base of Cobble Hill and the Dougan Lake Aquifer, while to the east (downgradient) is Arbutus Ridge. This poorly sorted sand, gravel and silt aquifer (Vashon Drift origin) is described as having moderate productivity with a reported yield range of 0.01 to 17.35 L/s. A groundwater flow direction has not been determined but is inferred north towards Cowichan Bay. MOE information originally indicated that the Cherry Point aquifer has low vulnerability to surface contamination due to overlying Marine and Glaciomarine deposits, including clay, till and silty sand and gravel. However, this inferred degree of protection may only apply to the lower confined aquifer (see below).

Information from a groundwater characterization study completed by Thurber has lead the MOE to believe that the aquifer is more complex than previously thought, with the deep confined aquifer intersected by the Arbutus Ridge Utility operating well field corresponding to MOE Aquifer 197. Within the Strata Plan 1601 well field area there are two distinct water bearing zones (aquifers) separated by 10 to 25 m of marine clay and silt (aquitard), providing a natural protective barrier to the water bearing materials in the lower aquifer. Two of three adjacent golf course irrigation wells supplying the Arbutus Ridge Golf Course are completed in an upper (unconfined) aquifer zone. The third well is completed in both the upper (unconfined) aquifer and lower (confined) aquifer. The adjacent Granfield farm agricultural irrigation wells tap into the same lower confined aquifer as the Utility wells. Some of the domestic and irrigation wells in the surrounding area appear to penetrate only the upper unconfined aquifer, some only the lower confined aquifer while others may intersect both aquifers. The aquitard separating the shallow and deeper aquifers appears to be missing in the area near some of the Braithwaite Utility and the Cobble Hill Improvement District wells (near the Trans Canada Highway and Fisher Road / Hutchinson Road, about 3 km from Arbutus Ridge). These wells are at least 60 m deep with continuous permeable granular materials from the surface. Water levels are typically 30 to 45 m below surface. As such, the confining layer (aquitard) described above may be discontinuous. .

Groundwater from the Cherry Point aquifer is used for irrigation, commercial, municipal domestic purposes. Several water licenses also exist on many surface water sources in the area. Several residents obtain domestic water supply from the Cobble Hill, and Cowichan Station bedrock aquifers which occur beneath the Cherry Point Aquifer.

Kingburne Aquifer (201)

This is a small confined sand and gravel (Vashon Drift) aquifer of approximately 1.7 km^2 in size, overlain by thick till, clay and hardpan layers and upland swamp deposits, located west of Cobble Hill. The inferred aquifer productivity is moderately high with an estimated yield range of 0.38 to 4.73 L/s. Aquifer vulnerability is low, while groundwater flow direction has not been determined directly but is inferred west towards the Koksilah River, and recharge is hypothesized to derive from precipitation and runoff from the surrounding mountains. Water use is predominantly domestic. Two surface water licenses also exist on Heather Bank Brook.

Carlton Aquifer (205)

The Carlton aquifer is a small (2.6 km^2) confined aquifer comprised of poorly sorted outwash sand, gravel and silts (Vashon Drift) located between Shawnigan Lake and Mill Bay, and is surrounded by bedrock aquifers. Overyling deposits include thick silty sand and gravel, till, hardpan and clay mixtures resulting in low vulnerability to surface contamination. The aquifer is moderately productive with a range of reported yields from 0.19 to 3.16 L/s. Water use is for multiple purposes. Water reliance is conjunctive, water licenses exist on North and South Taggart Creek, Ericson Creek and a few springs in the area.

Mill Bay Aquifer (206)

The Mill Bay aquifer is a small aquifer (2.7 km^2) that is both confined and unconfined and comprised of coarse grained deposits. It is bound to the north by Shawnigan Creek, to the west by Handyson Creek, to the south by an upland area, while to the east it pinches out just before the Saanich Inlet. Productivity is moderate with reported yields ranging from 0.09 to 22.1 L/s. Groundwater flow and availability is concentrated in a bedrock channel where the aquifer is thickest. The vulnerability of the Mill Bay aquifer is variable but is generally classified as highly vulnerable due unconfined conditions in the upslope recharge area. In the northern central portion of the aquifer a clay layer occurs. The clay overlies a portion of the buried channel that creates artesian aquifer conditions in that area. Silty sands and gravels also confine the aquifer to a lesser degree throughout much of the area. Lowen (1994a) has determined the direction of flow as north/northeast and the recharge mechanism as infiltration from precipitation and lateral flow from upslope recharge zones in the southern portion of the aquifer. Groundwater from this aquifer is used for municipal and domestic purposes. Saline groundwater has been noted adjacent to the Trans-Canada highway (Kohut, 1987) and may be due either due to saltwater intrusion from Saanish Inlet induced by groundwater pumping in the aquifer or from application of road salt. Water reliance is conjunctive. Several water licenses exist on Handysen, Wheelbarrow, Bird, Goodhope and Wilkins Creeks. Wheelbarrow Springs are also a source for the municipal water supply. The Bamberton Aquifer (no. 207) occurs beneath the Mill Bay Aquifer and can supply additional domestic and municipal water needs to Mill Bay residents.

South Cowichan Aquifer (196)

This 45.8 km^2 shale and sandstone bedrock aquifer includes the area south of the Cowichan River to the base of the Koksilah Ridge. The eastern boundary is the Lower Cowichan River floodplain and the western boundary extends to Holt Creek. Overlying deposits include marine and glaciomarine sediments, ground moraine and glaciofluvial deposits. The aquifer is characterized by low productivity with reported well yields of 0.02 to 0.63 L/s. The direction of flow has not been determined but it is hypothesized to flow toward the Cowichan River. Recharge is suggested by precipitation, runoff from the mountains to the south and/or inflows from surficial water bearing zones. Water use is domestic while water reliance is conjunctive. Several water licenses exist on Glenora, Vaux, Holt, Motek and Kelvin Creeks. Water licenses also exist on Tattum Brook, Vaux Swamp, springs and other unnamed streams in the area. The Glenora aquifer is a confined surficial aquifer that overlies the South Cowichan bedrock aquifer.

Cowichan Station Aquifer (198)

Cowichan Station is a 6.1 km^2 predominant shale bedrock aquifer with some sandstone layers, south of the Cowichan River estuary, and east of the Koksilah River floodplain. The eastern boundary of this aquifer occurs below the Cherry Point aquifer. Cowichan Station aquifer is described as having low productivity with a reported yield range of 0.06-1.26 L/s. This aquifer is described as having low vulnerability, and the direction of flow has not been determined. Water use is domestic while water reliance is conjunctive. Water licenses exist on Treffery Creek, Koksilah River, Webb Brook and Giese Brook. Many wells in the area are completed in the overlaying Cherry Point aquifer.

Kelvin Creek Aquifer (200)

This is a 27.7 km^2 bedrock upland aquifer comprised of crystalline and volcanic rock, south of the Cowichan River valley between Koksilah River and Kelvin Creek. The western boundary is hypothesized to extent to the Koksilah Ridge. Overlaying sediments are predominantly ground moraine. This aquifer has low productivity with a yield of from 0.02 to 1.58 L/s. The aquifer has moderate vulnerability with about one third of reported wells having indicating no confining cover. The direction of flow and recharge mechanisms have not been determined. Water use is domestic and water reliance is conjunctive. Several water licenses exist on Koksilah River and Kelvin Creek. Water licenses also exist on springs and unnamed streams in the area.

North Shawnigan Aquifer (202)

The 20 km^2 North Shawnigan aquifer is comprised predominantly by volcanics and divided by the San Juan Fault with bedrock being older to the north of the fault. The aquifer is located north of the Shawnigan lake watershed basin, and bounded to west by the Koksilah River, east by Shawnigan Creek and to the north and east by Cobble Hill. This aquifer is determined as having low productivity with a range of yields from 0.02 to 5.68 L/s. The direction of flow and recharge mechanisms have not been determined. Groundwater wells in this aquifer are used for municipal and commercial purposes, water reliance is conjunctive. Numerous water licenses exist on Shawnigan Lake and other creeks, streams and springs in the area. The Kingburne aquifer occurs above the northern central part of the North Shawnigan Aquifer.

Shawnigan Lake Aquifer (203)

This 30.5 km^2 predominant gneiss aquifer is located in the Shawnigan Lake watershed basin. The productivity is reported as low with a range in yield from 0.01 to 4.42 L/s. The vulnerability of this aquifer is high with about half of the reported wells indicating no protective overburden cover. Direction of flow has not been determined however it is probable that the direction of flow is toward Shawnigan Lake. Recharge has not been determined but it has been hypothesized that precipitation and runoff from surrounding mountains provide recharge for this aquifer. Groundwater wells in this aquifer are used for irrigation and for community water supply. Water reliance is conjunctive with several licenses on Shawnigan Lake, creeks, streams and springs in the area.

Cobble Hill Aquifer (204)

The Cobble Hill aquifer is a 21.4 km^2 predominant granodiorite and quartz aquifer in the Mill Bay and Cobble Hill area. Its southern boundary is Shawnigan Creek, the western boundary is the base of Cobble Hill and the eastern boundary is Saanich Inlet, while the northern

boundary has not been delineated. Thick overburden occurs in the northern part of the aquifer. It is therefore classified as moderately vulnerable although overburden is much thinner in the southern and eastern portions of the Cobble Hill Aquifer. This is a moderately productive aquifer with a yield range of 0.03 – 8.52 L/s. The direction of flow has not been determined however it is anticipated that flow is toward the Saanich Inlet. Recharge mechanisms have not been determined, but is probably from precipitation. There are multiple users of this aquifer including domestic, irrigation, and community water supply. Water reliance is conjunctive. Several water licenses exist on rivers, creeks, and springs in the area. The Cherry Point Aquifer overlies the Cobble Hill Aquifer in the northern area of the aquifer.

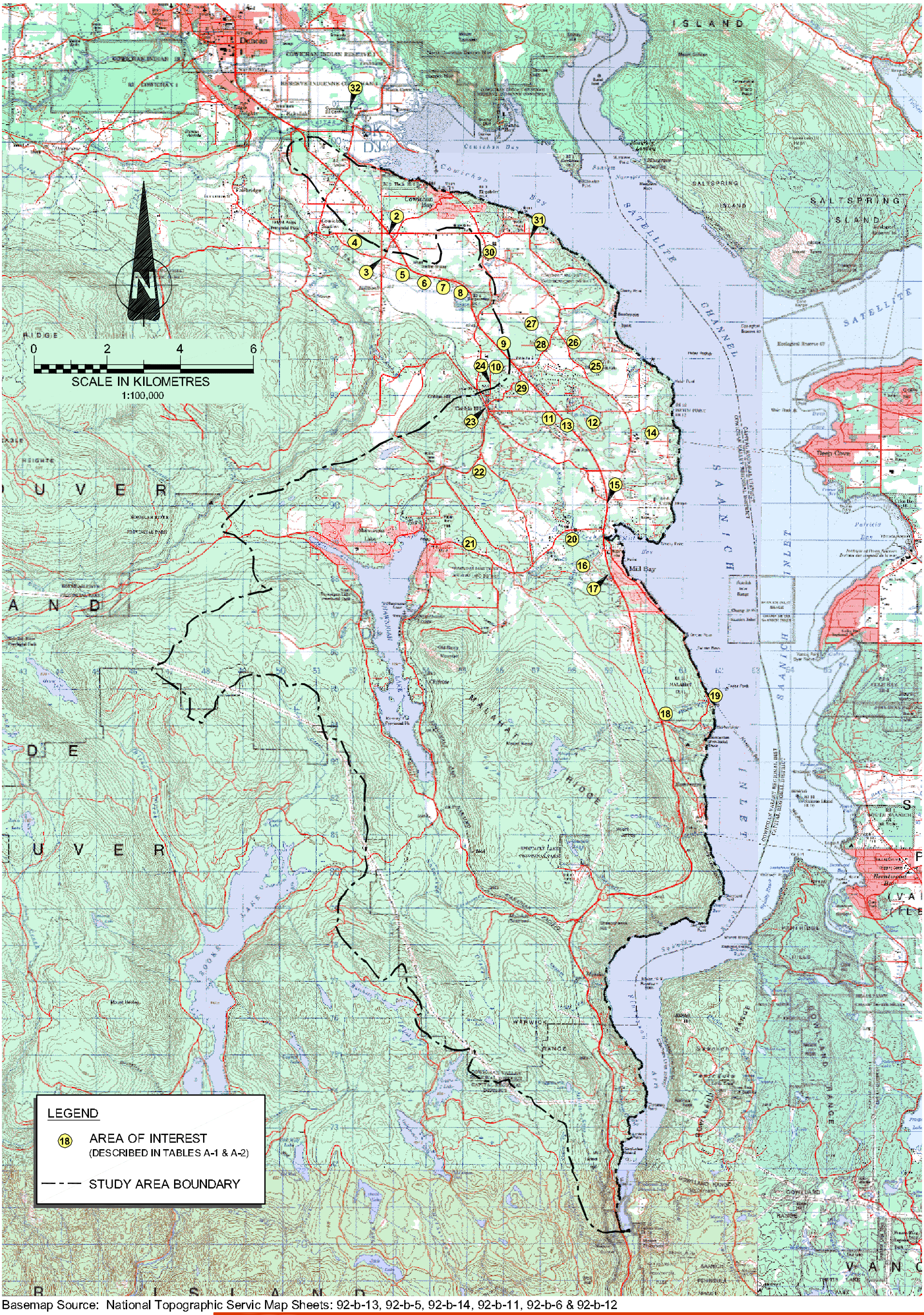
Bamberton Aquifer (207*)*

The 27 km^2 Bamberton aquifer is comprised of volcanic intrusives and occurs east of the Shawnigan Lake watershed. It extends to Bamberton Park in the south, Saanich Inlet to the east and Shawnigan Lake to the north. Productivity is low to moderate with a reported yield range of 0.02 to 12.62 L/s. Aquifer vulnerability is moderate. Thicker deposits including marine and glaciomarine clays and silts, and glacio-fluvial deposits of Vashon drift occur in the northern and eastern portions of the aquifer. The Mill Bay Aquifer (206) occurs above the bedrock aquifer near Mill Bay. Neither direction of flow or recharge have been fully determined, however it is assumed that the direction of flow would be east towards the Saanich Inlet and north into the Mill Bay aquifer, while recharge is likely from precipitation. Wells are used for domestic, municipal, irrigation and commercial purposes. Water reliance is conjunctive, several water licenses exist on springs and streams in the area.

Malahat Aquifer (208)

This 20.5 km^2 gneiss aquifer is located between Spectacle Lake on the north and Arbutus Creek on the south. The eastern boundary is Saanich Inlet and western boundary is the Malahat Ridge. The productivity of this aquifer is moderately low with a yield range of 0.03 to 3.79 L/s. The vulnerability of this aquifer is classified as high, with bedrock predominantly outcropping (76% of reported wells) or being overlain by a thin cover of ground moraine. The direction of flow has not been established but it is believed that water flows east toward the Saanich Inlet, and recharge is likely from precipitation and runoff from mountains to the west. This aquifer is being used for domestic purposes. Water reliance is conjunctive with several water licenses on creeks, streams, lakes and springs in the area.

Appendix 2 Summary Information from Meeting with Drillwell



Source: Information from meeting with drillwell driller: Mr. David Slade.

Infrastructure & Environment

COWICHAN VALLEY REGIONAL DISTRICT
SOUTH COWICHAN WATER STUDY PLAN

DRILL WELL TOUR MAP

WorleyParsons
resources & energy

2009-02-11	date	KM	edited by		drawn by	DB	app by

PROJECT NUMBER: V19830100

FIGURE: A

FILE: J:\1976-1995\V19830100_Cowichan District - Water Plan Study\DRAWINGS\FIGURES\FIGURE A.dwg Issued By: Victoria CAD

Map #	Description	Overburden or Bedrock	Yield (All units imperial)	Well deepening/Water Level Decline	Notes
1					
2	Hillbank Rd. 3 Wells, corner of trailer Park		30 g/min		
3	Hillbank and Lakeside	Bedrock			Modest flow. South of this area the aquifer disappears, bedrock at surface.
4	Aquifer almost non-existent.	Shale Ridge	2 g/min		Shale ridges, 400 ft of low permeability material, stinky & cloudy water
5	On west side excellent wells	Overburden	50g/min at 200 ft		
6	Good Aquifers	Overburden	50-100 g/min		
7	Well at 300 ft depth (1965)	Overburden			plugged with silts and clays, low transmissivity
8	Dougans Lake	Overburden			Water Levels don't change at Dougans lake. Example of Cobble Hill Aquifer- across from Lake, gravel pit on Indian Reserve. Layered Sands
9	Edge of Aquifer.	Overburden	Valley View: 300 g/min Seed Orchard: 200 g/min Blue Rose: 10 g/min		Contentious well in Valley View at Cowichan Bay road (300g/min) It is in the Cobble Hill municipality/aquifer and they don't want to lose it
10	Edge of Cobble Hill Water District.		200 g/min		Behind bakery putting in a production well guessed to yield 200g/min and tied into CH system
11	Decline in Cobble Hill Aquifer:	Overburden		3 wells deepened on Hutchinson Rd 3 wells were deepened (Ravencrest) Deepening wells (decline approx 25 feet in 20 years)	E on Highway 1 on Hutchinson Rd Corner of Hutch and Cowerd Rd, Cedarwood place and Cowerd #1017, #1008 200-300 feet overburden Braithwaite water system loops around Cowerd subdivision
12	Ravencrest and Chapman Road	Edge of Overburden and into bedrock		Biggest depression in Water Levels: North; Braithwaite and Agricultural users. East; Arbutus Ridge. West; Cobble Hill. Ten years ago one well went dry in this area	Edge of Cobble Hill overburden aquifer had to go into bedrock (heading S) Adjacent to Ravencrest Rd bedrock instead of sedimentary formation No snowmelt , local precip only and 2008 was a dry year
13	All wells south of here are bedrock wells (granite/limestone/volcanics) 500 ft depth	Bedrock	20g/min		
14	Mill Bay (Some Cobble Hill type ground)	Bedrock			Dairy farms in Mill Bay are the big users of the bedrock aquifer.
15	Bedrock very close to surface, exposed.	Bedrock	Petrocan Wells: 50g/min at 400 and 500 ft depth		Cobble Hill Rd. Agriculture – sprinklers George Bonner School – 400 ft well
16	Deloume Street – Well in Football Field	Overburden	200 g/min in 200 ft		Mill Bay used springs for years – artesian Bedrock is exposed 20 feet away High in Iron
17	Flowing Artesian Wells – not practical	Bedrock Perched overburden aquifers at the end of the rd	New MB Well 100 g/min at 500 ft Aerie Hotel (5 wells) 9 g/min at 1000 ft depth Stebbings Rd. 2 g/min static water level is 100 feet		300 feet away from the football field well Reaches the extent of the Mill Bay Water District South from the Aerie it is mostly bedrock, with pockets of 80 ft of overburden on hillsides Some fractured bedrock with highly productive zones Bottom part of Mill Bay is dry seasonally!

Source: Information from Drillwell driller : Mr. David Slade.

* Numbers coincide with numbers on the accompanying map.

* Please note that is information was collected from Mr. Slade's memory, and I did not see drill logs.

* Mr. Slade uploads all his information to WELLS - Ground Water Wells database (BC MOE)

Infrastructure & Environment

COWICHAN VALLEY REGIONAL DISTRICT
SOUTH COWICHAN WATER STUDY PLAN

DRILL WELL TOUR TABLE
PART 1 OF 2

WorleyParsons
resources & energy

2009-02-11 date	KM edited by	drawn by	DB app by	PROJECT NUMBER:	FIGURE:
				V19830100	A-1

Map #	Description	Overburden or Bedrock	Yield (All units imperial)	Well deepening/Water	Notes
18	Cement Plant for 50 years in the area	Bedrock			Poor bedrock aquifers May have not gone deeper than 500 ft Never found good yield from here to the crest of the malahat Nothing but domestic water wells
19	19).Inlet Dr.	Bedrock	In overburden: 20 g/min Many 1-2 g/min		Some salt water intrusion Perched aquifer on hillside at Mill Bay- Brentwood Ferry Many 4-500 ft 1-2g/min wells
20	Kelseys School	Overburden	Kelsey's School: 4 g/min, hydrofractured to 25 g/min Kerry Park at Wilkinson: 3 g/min		30m away from Kerry Park artesian, overburden at 100ft used for farm irrigation. 20 feet away on ridge wells are 300 ft deep in overburden ▪ Some personal wells are hand dug to 100 feet ▪ NEW water main going in here – possible major new development? ▪ Still fair way from Shawnigan Lake Water District Private well area is still pretty much bedrock outcrops
21	Fire Department in Shawnigan Lake district				New business centre 2 miles W edge of SL district High density of houses around
22	Between Cameron-Taggert and private Rd. (NW of Mill Bay)	Overburden	2g/min at 100 ft At 500 ft good producers		High iron
23	Cobble Hill Rd / Hutchinson Rd				Aquifer does not exist on the corner, wells were not successful
24	Holland and Gallier Rd	Overburden	200 g/min at 200 feet		Galliers Green subdivision with 14 homes to go in. **Best #1 Well in Cobble Hill**
25	Part of Cobble Hill Aquifer on the West side of telegraph Rd.	Overburden	Highly productive and deep		On the E side the aquifer does not exist – bedrock outcrops
26	Aros (granite) by trailhead – gravel aquifer	Overburden (Gravel Aquifer)			Between Aros and Braithwaite on East Side of telegraph Rd. Aquifer does not exist – some successful wells - shale outcrop
27	Wilder Rd. well at 70 feet deep (in field by tree line)	Bedrock 200 feet	150g/min		Artesian (3 feet above ground level) Well downslope of maine clays to 500 ft
28	**Braithwaite District Well 250 feet deep #1 WELL** • Cobble Hill Wells to the W, And Arbutus Ridge to the E = Pinch	Overburden		In the North, this well is effecting the Cobble hill Aquifer and showing local drawdown	Braithwaite Farm is a big user Densification of Cobble Hill Core by the newly proposed well at the corner of the bakery (#10) at Fisher road and Trans Canada Hwy
29	Big Greenhouse complex on Fisher Road down from the bakery (#10)	Overburden 116-137 feet			Furthest well from the local problem
30	Corner of Cowichan Bay and Telegraph Rd.		Telegraph Rd: Irrigation well – 250 ft deep 60-80 g/min		Bench Elementary School, two wells drilled one by fence 300 feet depth
31	Cherry Point Road	170 ft to Bedrock in Cow Bay (marine clays) Cherry Pt. Rd. good gravel aquifer			Cow Bay - Salty

Source: Information from Drillwell driller : Mr. David Slade.

* Numbers coincide with numbers on the accompanying map.

* Please note that is information was collected from Mr. Slade's memory, and I did not see drill logs.

* Mr. Slade uploads all his information to WELLS - Ground Water Wells database (BC MOE)

Infrastructure & Environment

COWICHAN VALLEY REGIONAL DISTRICT
SOUTH COWICHAN WATER STUDY PLAN

DRILL WELL TOUR TABLE
PART 2 OF 2

WorleyParsons
resources & energy

2009-02-11 date	KM edited by	drawn by	DB app by	PROJECT NUMBER: V19830100	FIGURE: A-2

Appendix 3 MOE Hydrogeologist Review of Evidence for Declining Well Water Levels

BRITISH COLUMBIA

January 23, 2007

Gerry Giles
Director-Electoral Area C Cobble Hill
Cowichan Valley Regional District

Dear Gerry:

Re. Review of information suggesting declining groundwater levels in the Cobble Hill Aquifer

At a meeting in Duncan on June 9, 2006 I agreed to review some of the available groundwater levels in the Cobble Hill aquifer that suggested the groundwater level in the aquifer is declining presumably to unsustainable use of the groundwater resource. Subsequently, on July 4, 2006, Dave Slade (Drillwell Enterprises), Jens Liebgott (Cobble Hill Improvement District) and I spent the morning touring the area in Cobble Hill which uses the Cobble Hill Aquifer. Dave Slade has also provided me with water levels for three domestic wells that have recently been deepened, the Cobble Hill Improvement District main well and the monitoring well at the Cobble Hill Elementary School. Additionally, the Ministry has two observation wells in the aquifer (Arbutus Ridge and Braithwaite Estates) in which data is complete to the end of 2006. A report outlining the data I have examined will be forthcoming shortly.

Briefly, the three domestic wells which were deepened (located in the Cowerd Rd/Raeview Cres. Area) show declines in static level between 1.5 m and 4.0 m over 23-28 years. The Cobble Hill Improvement District well shows a drop of 2.1 m over 22 years and the elementary school well shows a drop of 0.9 m in 5 years. The Braithwaite Estates observation well (Well No. 320) between 2001 and 2006 showed a drop in peak values of 0.9 m (similar to the school well). Lastly, our observation well at Arbutus Ridge development shows a drop in peak annual values of 1.3 m over the last 4 years. While at first glance all of the data mentioned above suggests a drop in groundwater levels, it is important to note that Well 320 at Braithwaite Estates (the longest continuous record in the aquifer) also indicates a longer cycle likely related to precipitation where peak annual levels increased between 1995 and 2000, decreased between 2000 and 2003 and have been fairly steady since 2003. Clearly, this needs to be analysed further to better understand the natural fluctuations in the aquifer. Our current observations are based on very limited data and levels in the two observation wells are impacted by pumping in neighbouring wells.

Considering the possible development pressures in the region, a study examining the 'state of the aquifer' would be appropriate and timely. The scope of the study might include:

(1) Examining available groundwater levels and their change with time.
(2) Relating groundwater levels with precipitation records.

Ministry of Environment
Vancouver Island Region
Watershed Stewardship Division
Mailing Address:
2080A Labieux Rd
Nanaimo BC V9T 6J9
Telephone: 250 751-3100
Facsimile: 250 751-3103
Website: www.gov.bc.ca/env

(3) Estimating groundwater usage (including groundwater used for irrigation, industry, domestic water supply etc.)
(4) Revisiting the aquifer boundaries and delineation.
(5) Assessing where the aquifer is being recharged.
(6) Developing a general water budget for the aquifer to better understand the sustainable capacity of the aquifer.
(7) Integrating projected water demand with potential capacity.
(8) Assessing measures to reduce demand on the aquifer if necessary.

Issues related to threats to groundwater quality should also be addressed; however I note that the "Vancouver Island Water Resources Vulnerability Mapping Project" which the CVRD is supporting will assess potential threats to the aquifer.

I believe that the groundwater of the Cobble Hill Aquifer is a valuable resource to residents in the Cobble Hill area and would like to assist in proactive initiatives which aim to ensure that the aquifer is used in a sustainable manner now and in the future.

Sincerely,

Pat Lapcevic, M.Sc., P.Geo.
Regional Hydrogeologist

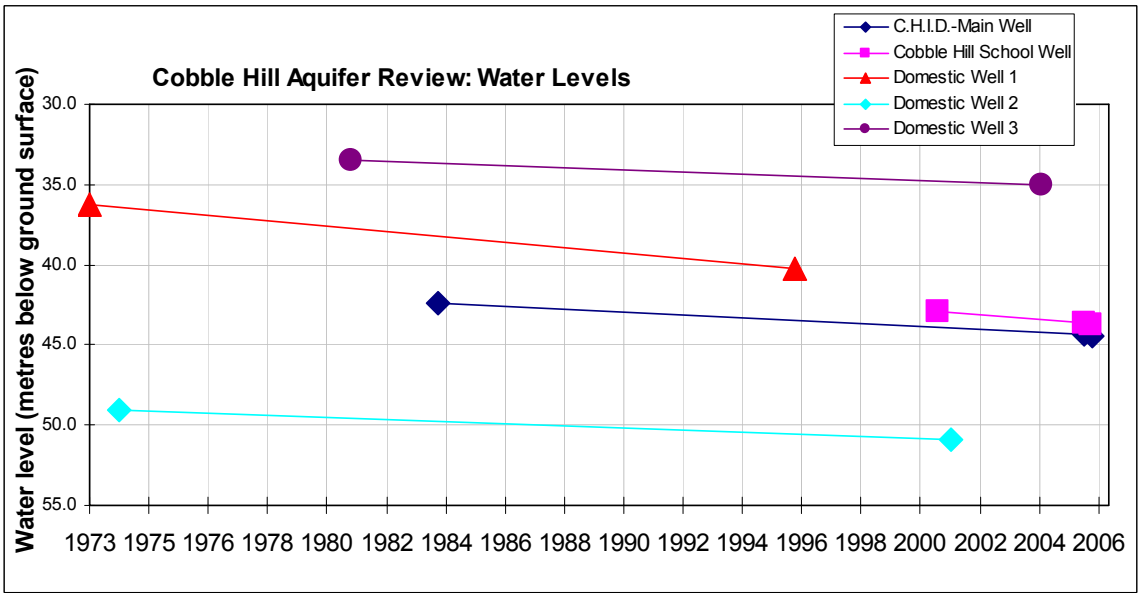


Figure 1. Water level measurements in 5 wells completed in the Cobble Hill Aquifer.

Table 1. Summary of water level changes measured in area wells.

Well Identification	Period of Record (yr)	Total Change in Water Level (m)	Rate (m/yr)
Cobble Hill Improvement District-main well	22	-2.06	0.09
Cobble Hill Public School Monitoring Well	5	-0.85	0.16
Domestic Well #1	24	-3.96	0.17
Domestic Well #2	28	-1.83	0.07
Domestic Well #3	23	-1.52	0.07

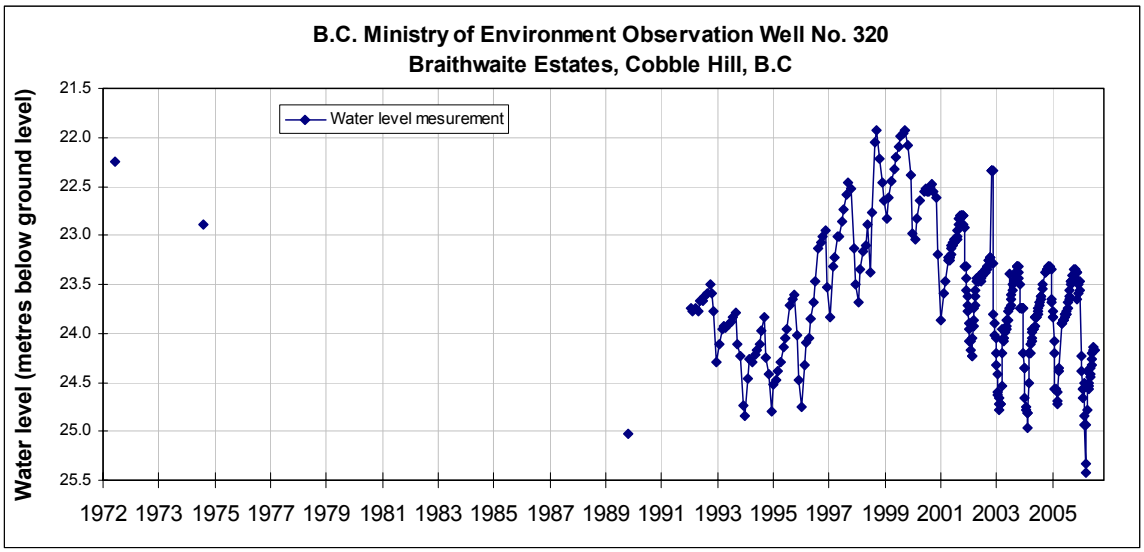


Figure 2. Water level measurements in Braithwaite Estates monitoring well (B.C. Ministry of Environment No. 320) over last 34 years.

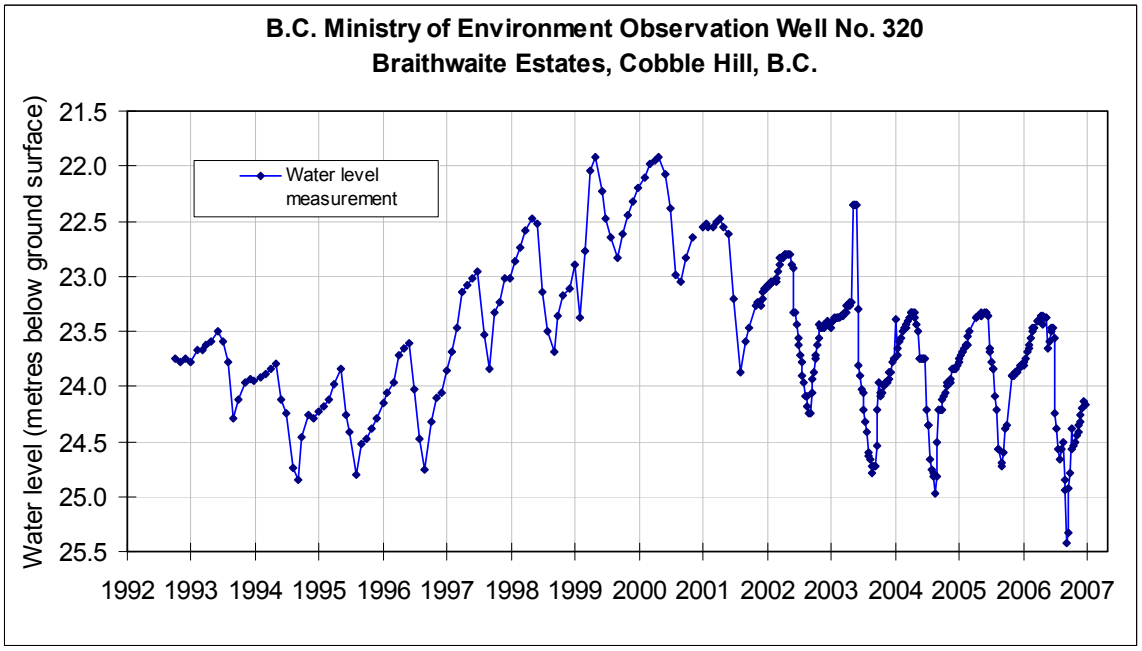


Figure 3. Weekly measurements of water level in Braithwaite Estates monitoring well (B.C. Ministry of Environment No. 320) over last 15 years.

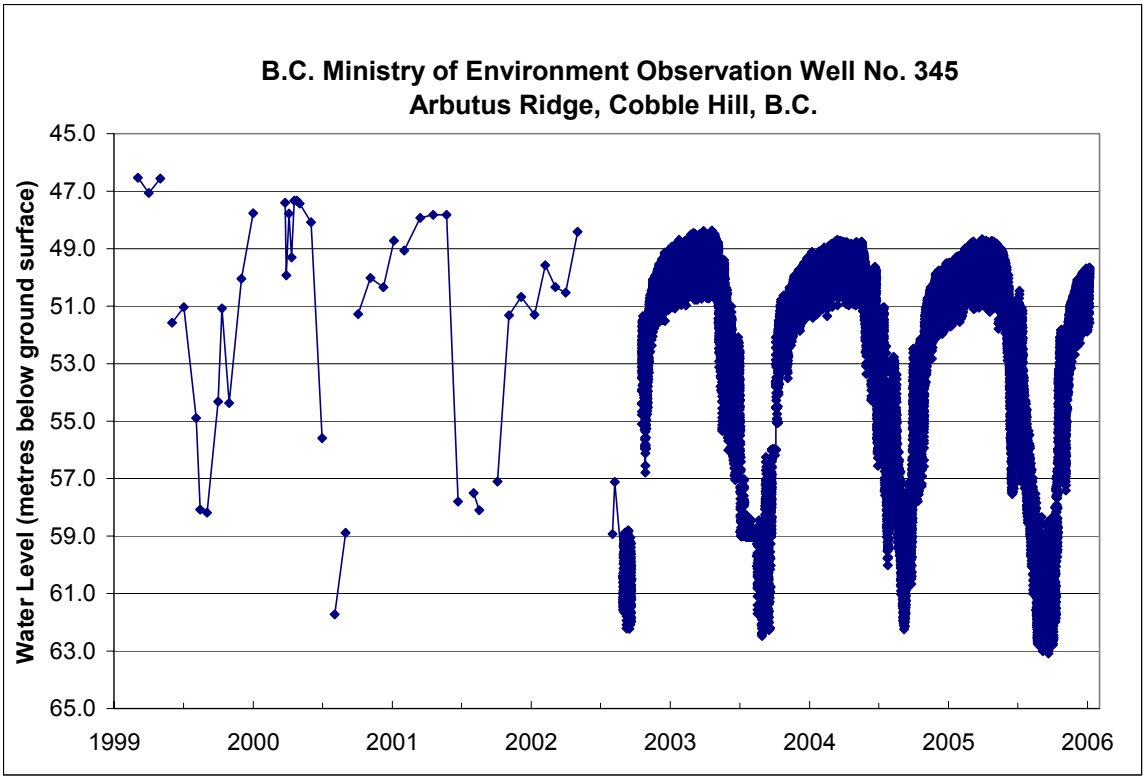


Figure 4. Water level measurements in Arbutus Ridge monitoring well (B.C. Ministery of Environment No. 345) over last 7 years.