

streams or springs, and prevents damage to the natural environment (i.e., property damage, flooding, and erosion). A flowing artesian well can cause substantial damage and incur significant and unexpected costs if not carefully planned and constructed. Well drillers and property owners should be prepared in advance in case flowing artesian conditions are encountered.

Why is there potential for flowing wells on the Southern Peninsula of Quadra Island?

AQ751 underlies the Southern Peninsula of Quadra Island. The aquifer is comprised of layered coarse gravel to fine sand. These unconsolidated sediments (Figure 2) are associated with the Quadra Sand formation deposited during the Fraser Glaciation (Hinnel, et al., 2020; Clague, 1977). AQ751 is partially confined and the sediments overlying the aquifer vary spatially, including permeable materials such as sand and gravel and low permeability



Figure 2: Photo of glaciofluvial sand and gravel comprising AQ751 exposed in an excavation in a gravel pit off Heriot Bay Road.

materials such as till or clay. The low permeability sediments overlying the aquifer act as a confining layer, which creates a buildup of pressure by restricting flow of water out of the aquifer. Groundwater is recharged through infiltration of precipitation at higher elevations in the center of the Peninsula, causing confined areas of the aquifer near the coast to be under pressure.

In the areas of Quathiaski Cove and Heriot Bay, well construction records indicate that the aquifer is confined by overlying layers of silt, clay or till (glaciomarine sediments). In these coastal areas, located at lower elevations relative to the surrounding landscape, some wells are drilled into pressurized groundwater, leading to flowing artesian conditions (Figure 3). Natural springs are found in groundwater discharge areas near the shoreline in other areas of the Peninsula, such as near Yaculta, indicating that there may be potential for flowing artesian conditions in other areas of the aquifer.

Known flowing artesian wells on the Southern Peninsula of Quadra Island

The GWELLS database indicates 19 wells that have reported flowing artesian conditions within AQ751 (Figure 1). Fifteen flowing artesian wells have been identified within the area of Quathiaski Cove, where the ground elevation is lower compared to other areas of the aquifer. Three flowing artesian wells have also been identified in the Heriot Bay area of AQ751. It is possible that other flowing artesian wells exist within the aquifer but have not been registered or identified as flowing artesian in GWELLS. Artesian pressures have been recorded between 0.1 and 9 psi and artesian flow has been recorded between 0.1 and 3 gallons per minute. Locations of known artesian wells can be accessed through [iMapBC](#).

Do all wells in the area encounter flowing artesian conditions?

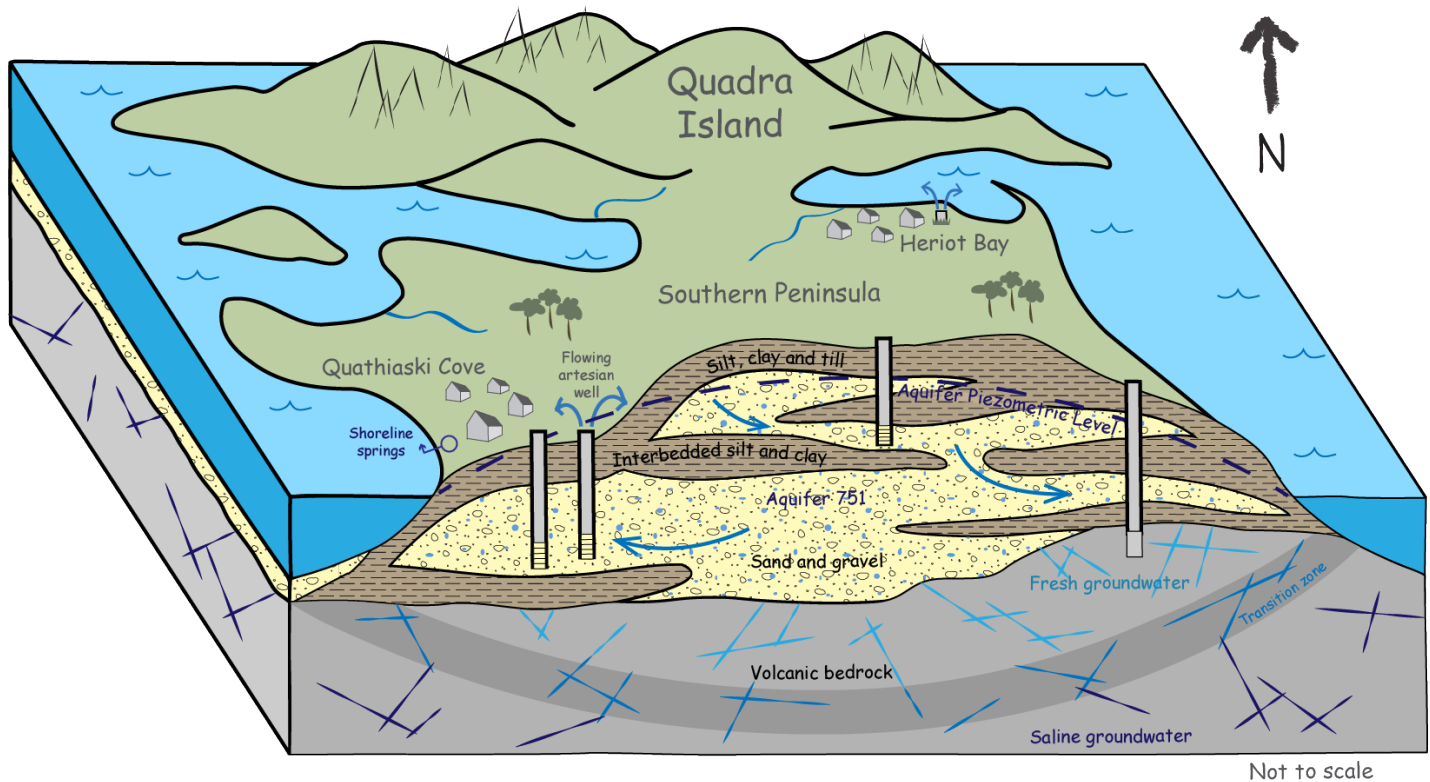


Figure 3 Conceptual drawing showing the geologic and topographic controls on artesian conditions and flowing artesian wells in AQ751. The piezometric level is the imaginary height that the water level will rise in a well penetrating a confined aquifer.

There are 230 wells associated with AQ751 in GWELLS. Some well records report the static water level below the ground surface indicating that flowing conditions are not present, while some have insufficient information to rule out the potential for flowing artesian conditions. The aquifer stratigraphy is complex due to the geologic history of the area, making it challenging to predict the distribution of flowing artesian conditions.

When drilling into areas of AQ751 with confined conditions, it is important to be prepared for flowing artesian conditions. Extra precaution should be taken when drilling in the areas with known flowing artesian wells and in areas of lower ground elevations, which might increase the potential for flowing artesian conditions. Furthermore, it is important to understand that artesian pressure can vary seasonally, thus a well not flowing to surface at time of drilling may begin to flow at times of increased water pressure (e.g. following seasonal rains).

Depth to water in AQ751 ranges from 0 m to 80 m (262 ft). The depth to water is generally larger in the center of the Peninsula and smaller near the shoreline.

Preparing for drilling in the on the Southern Peninsula of Quadra Island

Qualifications and experience

In B.C., anyone constructing a well¹ (with some exceptions for shallow excavated wells) must be registered as a well driller or be working under the supervision of a registered well driller or a professional (engineer or geoscientist, with competency in hydrogeology or geotechnical engineering). Registered well drillers must also be classified and have the qualifications required to work on the class of well that they are working on (e.g., water supply wells, geotreatment wells, dewatering wells, etc.)

Water well drillers in BC must be registered and must be qualified to work on the particular class of well that they are working on.

Regardless of the class of well being drilled, if artesian conditions are encountered and the well has the likelihood to flow, a well driller or a professional who is qualified in respect of the activity must be engaged to stop or control the flow. To be qualified, a well driller or professional must have competency in stopping or controlling artesian flow (as a result of training, experience, knowledge and skills) and have the equipment required to deal with flowing artesian conditions. A well driller may also undertake that activity if supervised by another registered well driller or a professional, who has competency in stopping or controlling artesian flow.

If a person constructing a well (other than a qualified well driller or professional) encounters flowing artesian conditions that person, or the property owner, must engage a qualified well driller or professional to ensure that any artesian flow is stopped or brought under control. Controlling artesian flow is defined under [Sec. 52 of the Water Sustainability Act](#) and described below.

Controlling artesian flow means that the entire flow:

- Must be conveyed through the well's production casing;
- Can be stopped indefinitely without leakage outside of the production casing;
- Is clear of sediment;
- Must not pose a threat to property, public safety, or the environment.

Flow is not considered controlled if:

- Water is surfacing outside the well casing or in another location nearby;
- The flow cannot be stopped (e.g., with a valve shut-off or packer assembly);
- There is subsurface erosion (i.e., evident if flowing water is muddy or murky).

¹ A well is defined in the *Water Sustainability Act* as: an artificial opening in the ground made for the purpose of (a) exploring for or diverting groundwater, (b) testing or measuring groundwater, (c) recharging or dewatering an aquifer, (d) groundwater remediation, (e) use as a monitoring well, (f) use as a closed-loop geotreatment well, or (g) use as a geotechnical well.

Assuming artesian flow

It is important to understand that geologic conditions are highly variable, and information may not be available near the proposed drilling location(s). The presence of flowing artesian conditions cannot be predicted with certainty prior to drilling. Therefore, when drilling into AQ751, where confined conditions are known or expected to occur, drillers should assume that they will encounter artesian conditions and use a precautionary approach (e.g., installing and sealing a surface casing of sufficient length). The well driller and property owner must be prepared for the resulting costs, planning time, materials, expertise and equipment needed to construct the well to control or stop any artesian flow.

To manage the uncertainty, well drillers should always conduct a pre-drilling assessment. This could include:

- Assessing the physical setting of the proposed well (e.g., in a valley or a groundwater discharge zone based on the presence of wetlands, springs or streams).
- Consulting with local groundwater professionals, experienced well drillers, or residents to learn of other flowing wells or springs in the area.
- Examining well records from the [GWELLS](#) database (available at apps.nrs.gov.bc.ca/gwells/) and the Groundwater Wells layer using mapping tools (e.g., [BC Water Resources Atlas](#) or [iMapBC](#)).
- Reviewing professional hydrogeologic reports in the Ecological Reports Catalogue (EcoCat) that may identify artesian aquifers (www.env.gov.bc.ca/ecocat/).

Preparing and budgeting

It is the responsibility of the well driller to advise the property owner of potential hazards associated with uncontrolled artesian flow (e.g., potential for erosion, flooding, subsidence) and the associated costs. The property owner and well driller should always have an agreement in place ahead of time to minimize any misunderstandings in the event that flowing artesian conditions are encountered.

Although preparing and constructing a well for flowing artesian conditions costs more than one in non-flowing conditions, it is substantially less than potential costs to repair damages or to decommission an uncontrolled flowing well. In B.C., the cost to decommission a high pressure, high flow well that was not constructed to handle flowing artesian conditions can easily reach hundreds of thousands of dollars and

Considerations for Property Owners

- Ensure the [driller](#) or [professional](#) you hire is registered with the Province, qualified and experienced with flowing artesian conditions.
- Have an agreement in place with the driller to deal with flowing artesian conditions.
- Recognize the real risks and your liability to neighbours and others if uncontrolled flows cause damage.

Considerations for Well Drillers

- Ensure you have experience and equipment to deal with flowing artesian conditions.
- Assume flowing artesian conditions will be encountered in the subject area (Figure 1).
- Inform property owners of potential risks and associated costs of flowing artesian wells prior to drilling.

possibly millions of dollars; in comparison, installing a permanent surface casing of sufficient length to control the flow before drilling into the flowing artesian aquifer can cost tens of thousands of dollars.

Constructing a well for flowing conditions

Assessing the geological and hydrogeological environment will help determine the best construction process for wells that may encounter flowing artesian conditions:

- For bedrock aquifers, the bottom of the casing should be sealed securely into the bedrock to ensure the flowing water can not rise up through the annular space of the well.
- For sand and gravel aquifers, a permanent outer casing should be grouted into the lowest confining layer before the inner production casing is drilled into the aquifer. A seal should be installed between the two casings to ensure flowing water can not rise up between the casings.

Drilling methods including cable tool, air rotary and mud rotary methods have been used more successfully than digging, boring, driving, augering and jetting methods. Plastic casings are not recommended for use in flowing artesian conditions.

Additional information on assessing, controlling, or decommissioning a flowing artesian well:

- Province of B.C.'s Flowing Artesian Well Brief for The Well Owner:
www2.gov.bc.ca/assets/gov/environment/air-land-water/water/water-wells/flowing_artesian_wells.pdf
- Government of Ontario, Water Supply Wells – Requirements and Best Management Practices Handbook (Chapter 12): www.ontario.ca/page/water-supply-wells-requirements-and-best-practices
- Michigan Department of Environmental Quality's Flowing Well Handbook:
www.michigan.gov/documents/deq/deq-wb-dwehs-wcu-flowwellhandbook_221323_7.pdf

Legislation and regulatory information

To learn more about the applicable regulations, please see:

- *Water Sustainability Act*, Sections 52 and 53:
www.bclaws.ca/civix/document/id/complete/statreg/14015
- Ground Water Protection Regulation Guidance Manual (June 2019):
www2.gov.bc.ca/assets/gov/environment/air-land-water/water/water-rights/gwpr_guidance_manual_signed.pdf

References

- Hinnel, A., Lengyel, T., Funk, S. and Hammond, Z. 2020. West Coast Region Foundational and Detailed Aquifer Mapping Studies. Victoria, BC: Water Science Series WSS 2020-04.
a100.gov.bc.ca/pub/acat/documents/r58705/WSS2020-04_AqMapping_1593814318516_3813257545.pdf
- Clague, J.J. 1977. Quadra Sand: A Study of the Late Pleistocene Geology and Geomorphic History of Coastal Southwest British Columbia. Ottawa, ON: Geological Survey of Canada, Paper 77-17.

Contact for more information

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