

WELL DRILLING ADVISORY

Flowing artesian conditions:

Vancouver, Burnaby and New Westminster, BC

Flowing artesian conditions potentially exist along the south slopes of Vancouver, Burnaby and New Westminster. Well drillers and home owners should be aware of potential complications and costs of flowing artesian wells.

Where do artesian conditions occur?

The potential area under artesian pressure is located where the ground slopes to the south towards the Fraser River in the southern area of Vancouver and Burnaby and the southeastern area of New Westminster.

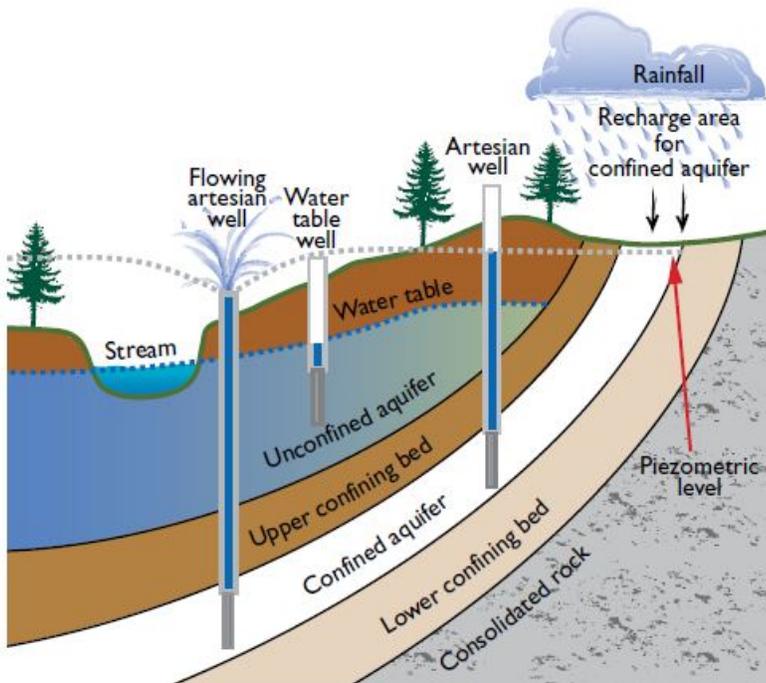


Figure 1: Geological and topographical controls affecting artesian and flowing artesian wells.

What is a flowing artesian well?

Flowing artesian wells occur when a well is drilled into an aquifer under pressure that is high enough to force the water level in the well to rise above the ground surface and flow over the top of the well (Figure 1).

It is important to properly construct the well to control this flow. Controlling artesian flow conserves groundwater resources, preserves the pressure within the aquifer, and prevents damage to the natural environment (i.e., property damage, flooding, erosion and impacts to surface water). A flowing artesian well can cause substantial damage and incur significant and unexpected costs if not carefully planned and constructed. Well drillers and well owners should be prepared in advance in case flowing artesian conditions are encountered.

Why is there potential for flowing wells in Vancouver, Burnaby and New Westminster (aquifer #49)?

Aquifer #49 underlies most of Vancouver, Burnaby and New Westminster, and it is comprised of the glaciomarine sands and gravels of the Quadra Sands formation. In 2015, an uncontrolled flowing artesian well was drilled into this aquifer on a residential lot on Beechwood Street in the Kerrisdale area of Vancouver, resulting in significant costs to control and decommission the well. The hydrogeological conditions for this aquifer are not well-defined due to the limited number of well records available. However, there is potential for the conditions that exist at the Beechwood Street well to exist in other areas of the aquifer, in particular where the aquifer is confined and the ground slopes towards the Fraser River (Figure 2).

Known flowing artesian wells in south Vancouver, Burnaby and New Westminster

A review of the BC WELLS database indicates that four (4) known wells in the area had reported flowing artesian conditions at the time of drilling. It is possible that there are additional flowing wells in the area, but these wells have not been registered in the BC WELLS database (submission of well records for most types of wells became mandatory in 2016. Until this point, well records were submitted on a voluntary basis.) Of the known artesian wells, flow rates range up to 1363 m³/day (250 US gallons per minute). The depths at which these wells have encountered the artesian aquifer range from 25 to 73 m (82 to 239 feet) below ground surface.

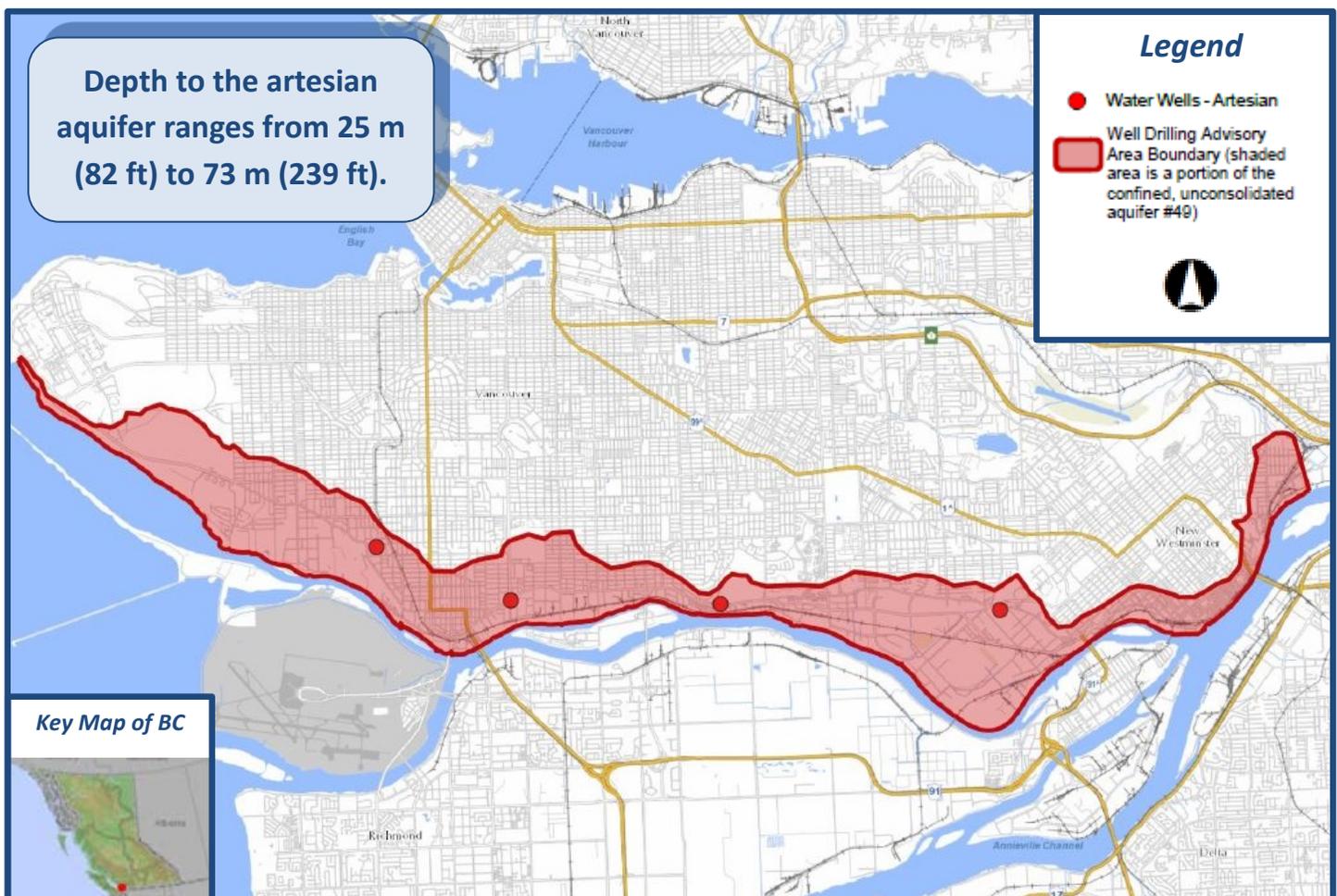


Figure 2: Map of the location of potential flowing artesian conditions (part of aquifer #49) in Vancouver, Burnaby and New Westminster, B.C.

Do all wells in the area encounter flowing artesian conditions?

Aquifer #49 ranges from unconfined to confined and based on limited well records available, there are areas that are not likely under artesian pressure (e.g., areas of the aquifer outside the boundary on Figure 2). In addition, a shallow unconfined aquifer within the subject area (aquifer #45, which is comprised of recent Fraser River sands and gravels) likely does not have artesian conditions; however, if you drill through aquifer #45 into an underlying confined aquifer, there is an increased likelihood of encountering flowing artesian conditions.

Preparing for drilling in the south areas of Vancouver, Burnaby and New Westminster

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 particular class of well that they are working on (e.g., water supply wells, geoexchange wells, dewatering wells, etc.)

If artesian conditions are encountered and the well has the likelihood to flow, a well driller who is qualified in respect of the activity, or a professional, must be engaged to stop or control the flow regardless of the class of well. The 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 well driller or professional) encounters flowing artesian conditions that person, or the home owner, must engage a well driller who is qualified, or a professional, to ensure that any artesian flow is stopped or brought under control.

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.

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;
- 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 geoexchange 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); therefore, neither the presence nor absence of flowing artesian conditions can be known with certainty prior to drilling. Therefore, when drilling into the in the south portion of aquifer #49 as it slopes towards the Fraser River (see Figure 2) in Vancouver, Burnaby and New Westminster, it should always be assumed that flowing artesian conditions will be present and assume a precautionary approach (e.g., installing and sealing a surface casing of sufficient length). The well driller and home 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 area where nearby water is at a higher elevation),
- 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 BC WELLS database and the Flowing Artesian Wells layer using Mapping Tools (e.g., BC Water Resources Atlas or iMapBC available online at: <https://apps.nrs.gov.bc.ca/gwells/>)
- Reviewing professional hydrogeologic reports in the Ecological Reports Catalogue (EcoCat) that may identify artesian aquifers (<http://www.env.gov.bc.ca/ecocat/>).

Considerations for Home 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 2).
- Inform home owners of potential risks and associated costs of flowing artesian wells.

Preparing and budgeting

It is the responsibility of the well driller to advise the home owner of potential hazards associated with uncontrolled artesian flow (e.g., potential for erosion, flooding, subsidence) and the associated costs. The home 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 the ensuing costs to repair damages or to decommission an uncontrolled flowing well. In BC, 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 possibly millions of dollars; in contrast, installing a permanent surface casing of sufficient length to control the flow before drilling into the flowing artesian aquifer costs only 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 such as digging, boring, driving, augering and jetting are not typically sufficient where flowing conditions may be encountered; cable tool, air rotary, or mud rotary methods have been used more successfully. Plastic casings are not recommended for use in flowing artesian conditions.

For additional information on assessing, controlling or decommissioning a flowing artesian well refer to the:

- Province of B.C.'s brochure on Flowing Artesian Wells:
www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/flowing_artesian_wells.pdf
- Government of Ontario's, Water Supply Wells – Requirements and Best Management Practices Handbook (Chapter 12): <https://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: <http://www.bclaws.ca/civix/document/id/complete/statreg/14015>

Groundwater Protection Regulation: http://www.bclaws.ca/civix/document/id/complete/statreg/39_2016

Contact for more information

Province of BC's Regional Hydrogeologist in Surrey: 604-586-4400

Ministry of Forests, Lands and Natural Resource Operations and Rural Development
Ministry of Environment and Climate Change Strategy
October 2017