

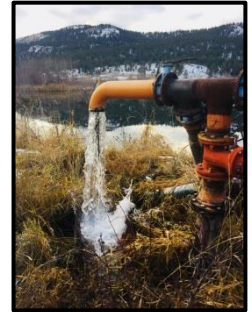
WELL DRILLING ADVISORY

Flowing artesian conditions

Vernon Creek, BC



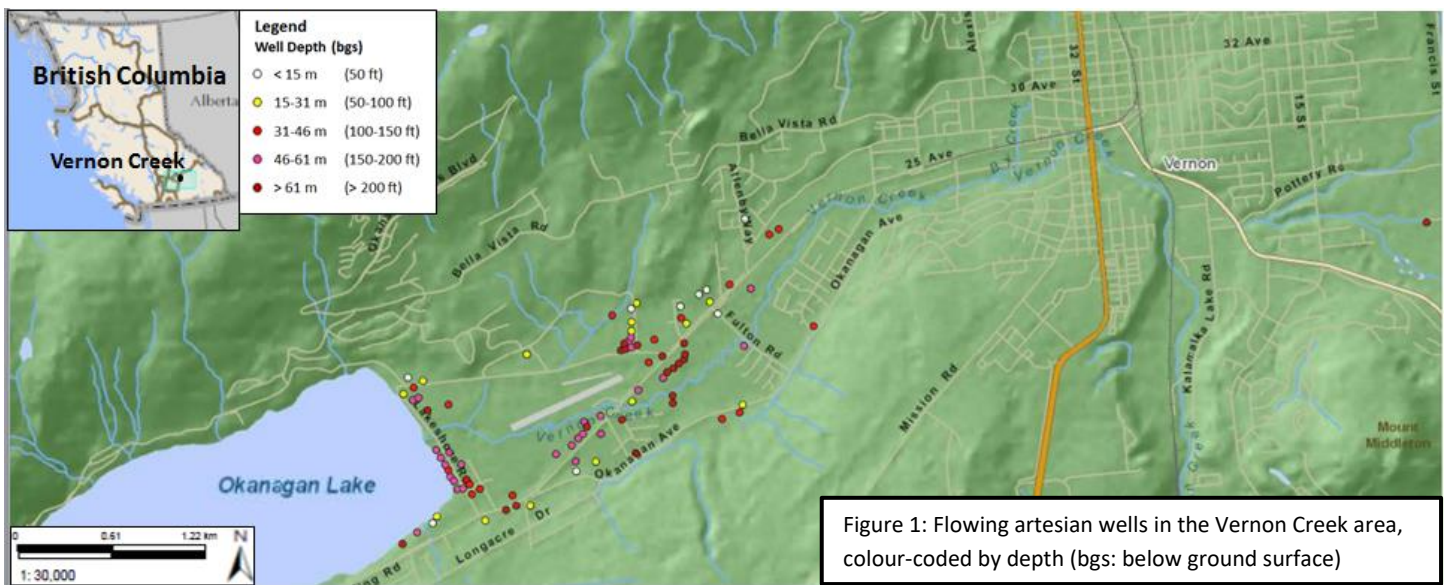
Flowing artesian conditions exist between Okanagan Lake and Vernon, BC. Well drillers and home owners should be aware of potential complications and costs of flowing artesian wells.



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 2).

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.



Where do artesian conditions occur?

Groundwater in the valley between the city of Vernon and Okanagan Lake has the potential to be under flowing artesian conditions (Figure 1). Within this area, flowing artesian conditions have been encountered at a wide range of depths, in both unconsolidated sand and gravels and the underlying bedrock.

Why are there flowing wells around Vernon Creek?

The surficial geology in the valley between Vernon and Okanagan Lake consists of deposits of sand and gravel, comprising the aquifers, interbedded with deposits of fine-grained materials such as clay, silt and till, a mixture of clay to boulder-sized materials deposited by glacial ice. Underlying the valley sediments is bedrock with water-bearing fractures. As the fine-grained materials are poor transmitters of water (see Figure 2: confining bed), underlying aquifers likely receive recharge as leakage through the overlying confining unit and from areas of high relief along the margins of the valley. The combination of confining beds with the influx of recharge causes the aquifer systems to be under confined pressure, which can cause groundwater to naturally flow upward in unconfined areas or wells. A well drilled in this valley has the potential to become a flowing artesian well, where groundwater rises through the well above the land surface (see Figure 2: flowing artesian well).

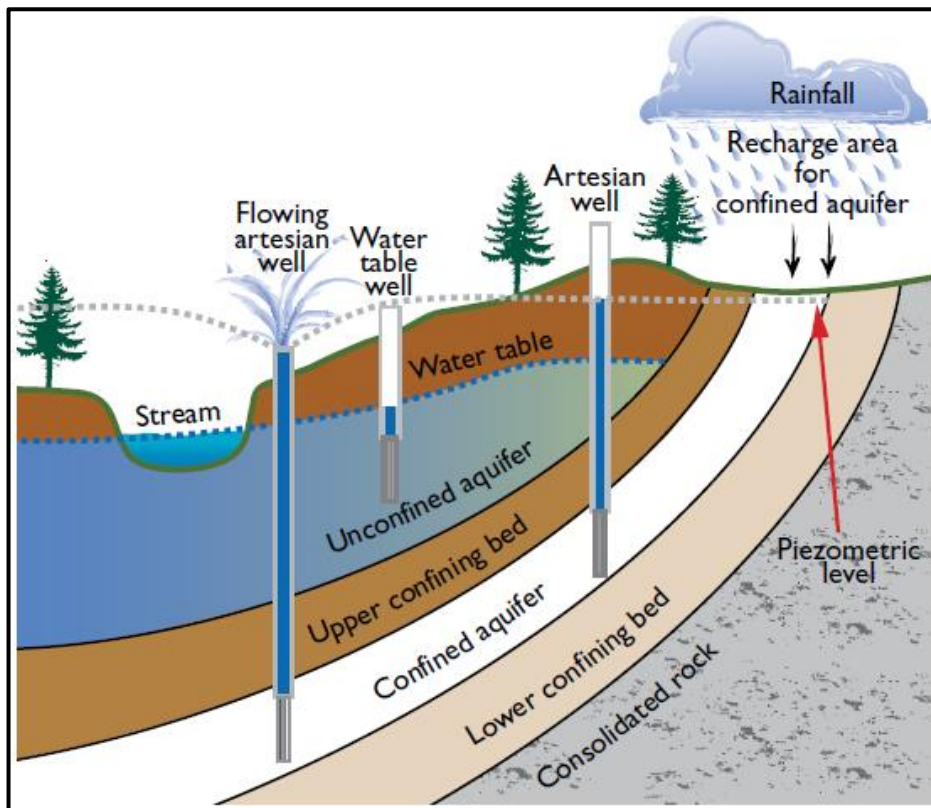


Figure 2: Generalized rendering of the geologic and topographical controls affecting artesian and flowing artesian wells. Water enters exposed portions of an inclined aquifer at high elevation and percolates down through interconnected pore spaces. Because the aquifer is sandwiched between layers of rock or overburden that inhibit water flow (confining beds, bedrock), the water held in the aquifer is under artesian pressure. When a well is drilled into the aquifer, this pressure will cause water to naturally rise without the aid of a pump above the top of the aquifer (**piezometric level**). If groundwater naturally rises above the land surface through the well, it is called a **flowing artesian well**.

Do all wells in the area encounter flowing artesian conditions?

No. Flowing artesian conditions vary within the valley due to variable distribution of confining beds, water-bearing sediments and hydraulic connection of bedrock fractures in the area. 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 at times of increased water pressure (e.g. following seasonal rains). When drilling into confined sediments or bedrock aquifers in this region, it is important to be prepared for flowing artesian conditions.

Flowing artesian wells in the Vernon Creek valley area

A review of the BC WELLS database indicates that 6 known wells in the Vernon Creek valley area reported flowing artesian conditions at the time of drilling, based on voluntarily reported information. Additional flowing wells may be present in the area, as submission of well records for most types of wells was not mandatory prior to 2016. Of the known artesian wells, flow rates range up to 545 m³/day (100 US gallons per minute). The depths at which these wells have encountered the artesian aquifer range from 2 to 113 m (6 to 370 ft) below ground surface.

Depths to artesian aquifer range from 2 m (6 ft) to 113 m (370 ft).

Preparing for drilling in the Vernon Creek valley area

Qualifications and experience

In BC, anyone constructing a well over 4.5 m (15 ft) deep must be registered as a qualified well driller or be working under the supervision of a qualified well driller or professional engineer or geoscientist. If artesian conditions are encountered and the well has the likelihood to flow, a qualified well driller or professional must be engaged to stop or control the flow regardless of the depth or type of the well. These drillers and professionals must be qualified, but also have the experience and equipment required for dealing with flowing artesian conditions.

Water well drillers in BC should be qualified & experienced.

Unregistered drillers may also undertake that activity if supervised by another registered well driller, or a professional, who has competency in stopping or controlling artesian flow and can be engaged should artesian conditions be encountered.

Details about the qualifications to become a qualified well driller (QWD) are set out in Part 2 of the Ground Water Protection Regulation at: http://www.bclaws.ca/civix/document/id/complete/statreg/39_2016

Looking to have a well drilled or well pump installed? Use the new *Register of Well Drillers and Well Pump Installers* search page to find a registered well driller or well pump installer in your area:

<https://apps.nrs.gov.bc.ca/gwells/registries/>

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).

Assuming artesian flow

It is important to understand that geologic conditions are highly variable and information may not be available near the proposed drilling locations; therefore, neither the presence nor absence of flowing artesian conditions can be known with certainty prior to drilling. Therefore, when drilling into the confined aquifers in the Vernon Creek valley area it should always be assumed that flowing artesian conditions will be present and a precautionary approach (e.g. installing and sealing a surface casing of sufficient length) should be taken. 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 GWELLS database and the Flowing Artesian Wells layer in iMapBC (<https://apps.nrs.gov.bc.ca/gwells/>)
- Reviewing professional hydrogeological 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 & 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 & others if uncontrolled flows cause damage.

Considerations for Well Drillers

- Ensure you have experience & equipment to deal with flowing artesian conditions.
- Always assume flowing artesian conditions will be encountered in the South Vernon Confined Aquifer (No. 347) or underlying bedrock.
- Inform home owners of potential risks & associated costs of flowing artesian wells.

Preparing and budgeting

Although preparing and constructing a well for flowing artesian conditions costs more than routine well construction, it is substantially less than the ensuing costs to repair damages or to decommission an uncontrolled well. In BC, the cost to decommission a high pressure, high flow well that was not constructed to handle artesian conditions can easily reach hundreds of thousands of dollars and possibly millions of dollars. In contrast, installing a surface casing of sufficient length to control flowing artesian conditions before drilling into the aquifer costs significantly less.

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.

**Assume flowing
artesian
conditions will
be encountered.**

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 BC'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): www.ontario.ca/document/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

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Ministry of Forests, Lands, Natural Resource Operations and Rural Development
Ministry of Environment
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