



# WELL DRILLING ADVISORY

## Flowing artesian conditions

### Vernon-Armstrong Area, British Columbia

**Flowing artesian conditions exist in the Vernon-Armstrong Area, BC. Well drillers and property owners should be aware of potential complications and costs of flowing artesian wells.**

#### Occurrence of flowing artesian wells

According to Johnson et al. (2022), more than 40 flowing wells are known to exist in unconsolidated deposits in the area between Vernon and Armstrong (Aquifers 102, 348, 349, 356, 1150, 1153, 1154, 1155, 1156). More than 90% of unconsolidated flowing wells occur within areas mapped as confined aquifers. The report indicates a further 11 flowing wells are located in bedrock in the Armstrong area. These occur primarily near the margins of confined aquifers.

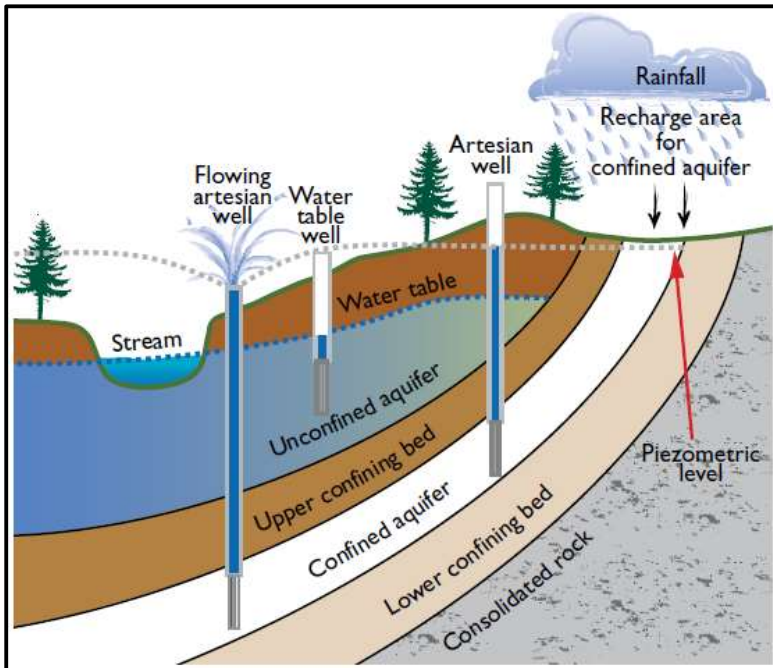
#### What is a flowing artesian well?

A flowing artesian well is one that has been drilled into an aquifer where the pressure within the aquifer forces the groundwater to rise above the land surface naturally without using a pump. A flowing artesian well may flow on an intermittent or a continuous basis.

It is important to properly construct the well to stope the release of groundwater from the artesian aquifer. 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 property owners should be prepared in advance in the event flowing artesian conditions are encountered.

#### Why are there flowing wells in the Vernon-Armstrong Area?

When unconsolidated sand and gravel aquifers and/or bedrock aquifers are overlain by tills and lacustrine clays, 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. The aquifer receives recharge through precipitation and surface water infiltration at higher elevations, and the piezometric level of the groundwater in the aquifer is likely controlled by the water levels in the recharge area. Figure 1a shows a conceptual model for this occurring in unconsolidated deposits. Bedrock aquifers may similarly possess the potential for artesian conditions when overlain by a clayey confining layer, and/or through the nature and orientation of the fracture network. Figure 1b shows a conceptual model for this occurring within bedrock of the Vernon-Armstrong area.



**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.**

Figure 1a - 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. Since 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**.

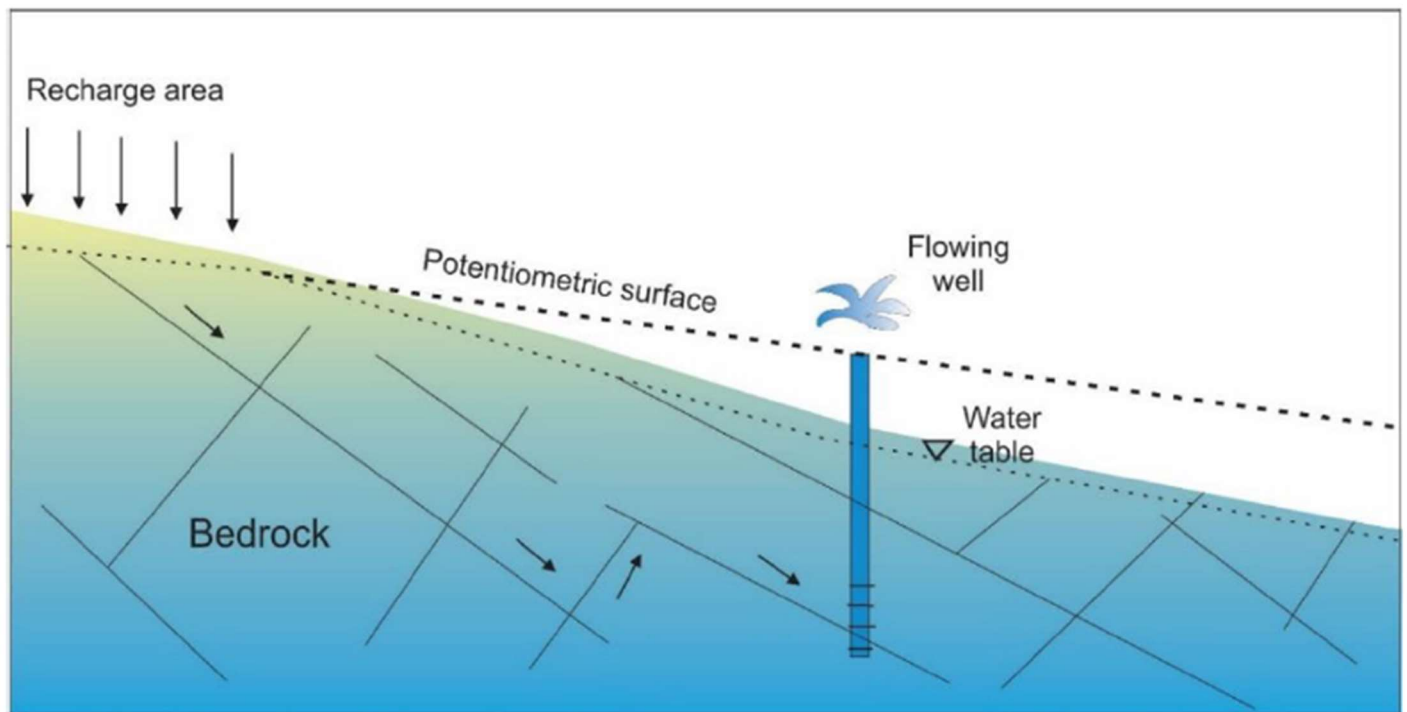


Figure 1b - Flowing artesian wells in the Armstrong Area in bedrock. See Johnson et al, 2022 for more information regarding probability of flowing artesian conditions and to access a KMZ file viewable in online geospatial tools. Figure from Johnson et al., 2022.

## Do all wells in the area encounter flowing artesian conditions?

Flowing artesian conditions have been identified throughout the study area. In general, wells located at lower elevations have higher likelihood of experiencing flowing artesian conditions. Within the study area a greater number of flowing artesian wells have been identified within and surrounding the mapped extents of confined aquifers.

## Flowing artesian wells in the Vernon-Armstrong Area

Johnson et al. (2022) indicates there are 11 bedrock wells and 42 wells in unconsolidated sediments in the Vernon-Armstrong area with reported flowing artesian conditions at the time of drilling. The one artesian well that is noted to exist in Aquifer 1156 is outside of this area near Enderby and screened more than 250 m below grade. Figure 2 shows the location of registered flowing and non-flowing wells in the Vernon-Armstrong area.

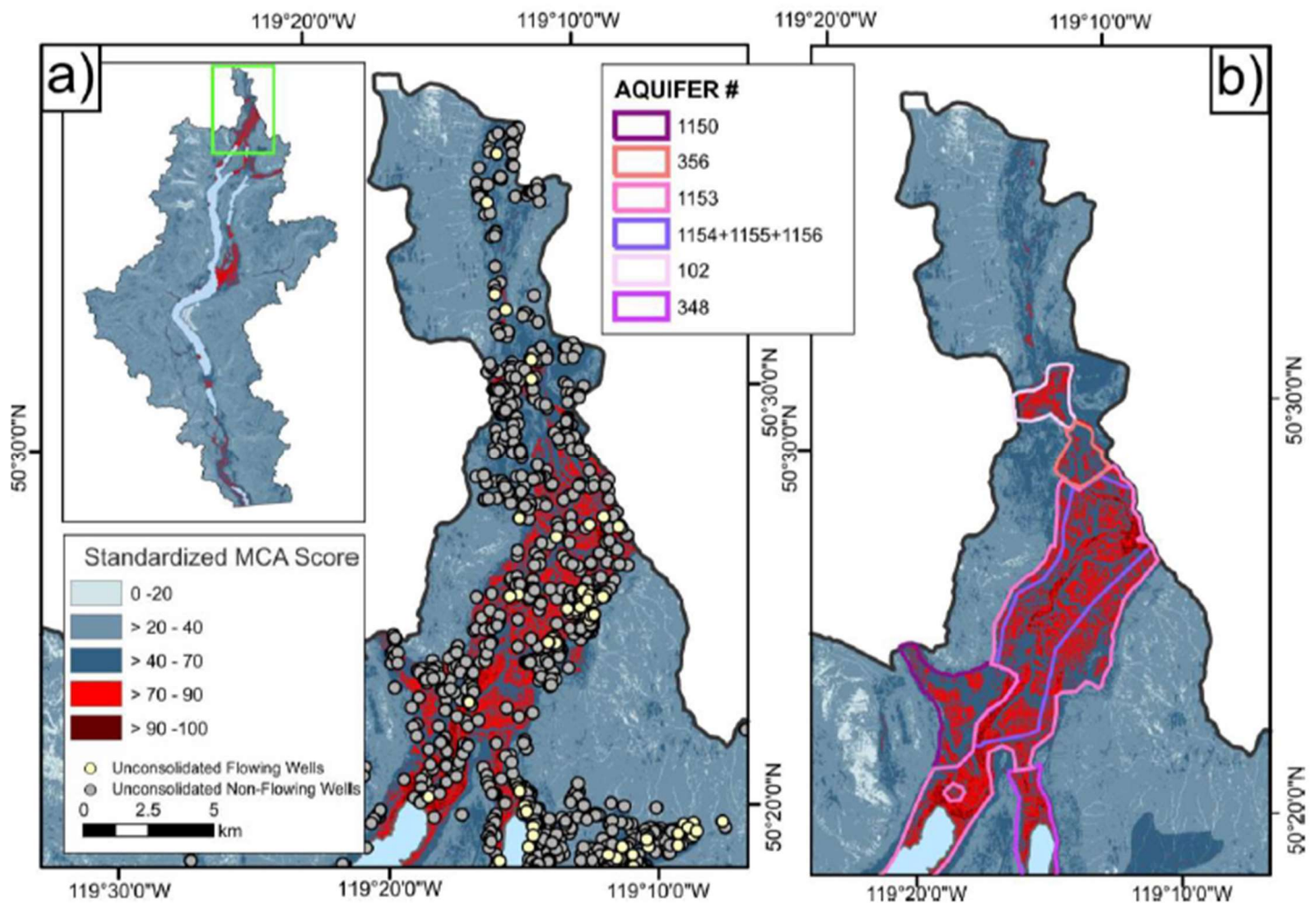


Figure 2 - Location of flowing and non-flowing wells in the Vernon-Armstrong Area, in unconsolidated deposits.

## Preparing for drilling in the Vernon-Armstrong area

### *Qualifications and experience*

In BC, anyone constructing a well <sup>1</sup> (with some exceptions for shallow excavated wells) must be registered as a well driller or be working under the direct 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, geoexchange wells, dewatering wells, etc.).

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 well driller who is qualified, or a professional, to ensure that any artesian flow is stopped or brought under control.

### *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

### **Considerations for Property Owners**

- Ensure the [driller](#) or [professional](#) you hire is registered with the Province, qualified and experienced with flowing artesian conditions. Obtain multiple quotes.
- 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 these aquifers.
- Inform property owners of potential risks and associated costs of flowing artesian wells prior to drilling.

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<sup>1</sup> 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.



artesian conditions can be known with certainty prior to drilling. Therefore, when drilling into the confined aquifer in the Vernon-Armstrong area, it should always be assumed that flowing artesian conditions will be present and move forward with a precautionary approach (e.g., installing and sealing a permanent 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 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 (available at [apps.nrs.gov.bc.ca/gwells/](https://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 flowing artesian aquifers (<https://a100.gov.bc.ca/pub/acat/public/welcome.do>,
- Review the report recommending this advisory at: [https://a100.gov.bc.ca/pub/acat/documents/r59470/FlowingWellsReportFinal\\_1653004378698\\_B4\\_2E0EF375.pdf](https://a100.gov.bc.ca/pub/acat/documents/r59470/FlowingWellsReportFinal_1653004378698_B4_2E0EF375.pdf)

### ***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.

#### **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).

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 the ensuing 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 is not constructed to handle flowing artesian conditions can easily reach hundreds of thousands of dollars and 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. An annular 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 may not be conducive to controlling flowing artesian conditions when 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 flowing artesian wells refer to:

- 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](http://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](http://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](http://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](http://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](http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/water-rights/gwpr_guidance_manual_signed.pdf)

## **Contact**

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## **References**

Johnson, Brynje, Diana M. Allen, and Mike Wei, 2022. Mapping the Likelihood of Flowing Artesian Conditions in the Okanagan Basin and Fraser Valley, British Columbia. Water Science Series, WSS2022-03. Province of British Columbia, Victoria.

Available online at

[https://a100.gov.bc.ca/pub/acat/documents/r59470/FlowingWellsReportFinal\\_1653004378698\\_B42E0EF375.pdf](https://a100.gov.bc.ca/pub/acat/documents/r59470/FlowingWellsReportFinal_1653004378698_B42E0EF375.pdf)

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