



Guidance for Delineation of Wellhead Protection Areas (WHPAs) For Municipal Groundwater Supply Wells

Government of Newfoundland and Labrador
Water Resources Management Division

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1. OBJECTIVE

The purpose of this document is to provide guidance regarding delineation of wellhead protection areas (WHPAs) around municipal groundwater supply wells. The accurate knowledge of such areas is an important factor to ensure drinking water safety as these areas are under pressure for development. Accordingly, there may be a need for restrictions on certain types of land use and/or introduction of other measures to prevent and manage risks from human activities relating to the use, manufacture, production, storage, and release of biological or chemical contaminants.

2. LEGISLATION

- *Water Resources Act (SNL 2002 cW-4.01).*

3. BACKGROUND

Pollutants from a variety of contaminant sources can seep into the ground and move toward a well. Wellhead protection areas (WHPAs) are zones surrounding municipal groundwater supply wells where contaminants are reasonably likely to move toward or reach a well. The amount of land involved in a WHPA is determined by a variety of factors, including: topography, the quantity of water being pumped, the type of aquifer, the type of soil and rock surrounding a well, as well as the direction and speed the groundwater travels. General activities, including land uses, in WHPAs must be carefully planned and controlled to protect the quality of the groundwater supply.

The Water Resources Management Division regulates public water supplies throughout the province, including municipal groundwater supply wells. The quality of groundwater from any water well is dependent on (1) the natural quality of the groundwater in the supply aquifer, and (2) impacts due to human activities that alter the quality of the groundwater from its natural state within the capture zone of the well. Notably, future well water quality cannot be predicted by looking at current well water quality alone. As such, in order to predict future well water quality it is necessary to understand the following:

- The source(s) of groundwater supplying the well
- Any sources of contamination that could potentially impact the well water quality
- The degree of risk posed by the potential sources of groundwater contamination

Wellhead protection is a good way to prevent municipal groundwater supply wells from becoming polluted because it restricts land use activities that could serve as potential sources of contamination in the area supplying water to a well. Protecting the area surrounding a well helps to safeguard a healthy supply of groundwater now and in the future.

4. DEFINITIONS

Act – The *Water Resources Act* (SNL 2002 cW-4.01)

Activity – The carrying out of an action, undertaking, or development, on, through, over, or under land or water

Aquifer – An underground layer of water-bearing permeable rock or unconsolidated sediments (i.e., gravel, sand, or silt) from which *groundwater* can be usefully extracted

Capture Zone – The land area around a pumping well which contributes water to the well. This is also known as the recharge area for the well.

Department – Department of Environment.

Draw down – The difference between the static water level and the pumping water level. Drawdown is expressed in metres (m) or feet (ft).

Draw down Cone – The difference between the pumping water level and the static water level decreases exponentially with distance in all directions away from a pumping well. The pumping water level forms a cone shape around the pumping well.

Groundwater – Water stored in an *aquifer* beneath the land surface, often between saturated rock and sediments.

Hydrogeology – Hydrogeology is the study of the flow of water and chemicals through the geological formations.

Municipal Authority – as defined by Section 2.1(o) of the Water Resources Act

Province – Newfoundland and Labrador

Public Groundwater Supply Source – The wellhead(s), well(s) and groundwater supply source operated by a municipal authority.

Time of Travel (TOT) – The capture zone can be divided into sub-areas based on “time of travel”: the time it takes water to flow from a given point to the well. Usually, the capture zone is divided into one-year, five-year and ten-year time of travel (TOT) areas. The one-

year TOT area is normally closest to the well; the five- and ten-year TOT areas are further away

Water Table – The water table is the level of standing water in the ground and is the upper boundary of the unconfined aquifer. Where the water table comes to the surface, lakes and wetlands form.

Water Well – An anthropogenic hole in the ground created by digging, driving, boring, or drilling to access *groundwater* stored in an underground *aquifer*

Wellhead – The physical structure of the well above ground

Wellhead Protection Area – The area surrounding the *wellhead* where land use activities have the potential to affect the quality of water that flows into the well, thereby requiring regulation to prevent contamination of a municipal groundwater supply source

5. APPLICATION OF THE GUIDANCE

This guidance shall apply to the protection of any well or well field Section 61 of the *Act*.

5.1. *Delineation of Wellhead Protection Areas*

There are a number of methods that can be used to delineate a Wellhead Protection Area. These include:

- Arbitrary Fixed Radius (AFR) and Calculated Fixed Radius (CFR);
- Hydrogeologic Mapping; and
- Numerical Flow Modelling.

5.1.1. *Arbitrary Fixed Radius (AFR) and Calculated Fixed Radius (CFR)*

Both the Arbitrary Fixed Radius (AFR) and Calculated Fixed Radius (CFR) methods define the capture zone by drawing a circle around the wellhead. The difference between the two methods is that the circular AFR area is based solely on a fixed distance from the wellhead, while the area for the CFR is calculated using the volume of water pumped. The AFR usually covers the area within 100 to 300 metres of the wellhead. This capture zone covers land beyond the immediate area of the well, but is not so large that management of the well protection area becomes too difficult. Major disadvantages of this method are that it is arbitrary, and the circular area cannot be subdivided into time of travel areas. The AFR should be used only where no information exists on the water use, well, or the aquifer.

The CFR calculates a circular area based on the volume of water pumped by the well over a specified period of time (e.g. one, five or ten years). This reflects the time it takes a contaminant to travel from the CFR boundary to the well, based on the pumping rate.

Most of the smaller communities in Newfoundland and Labrador using groundwater for municipal supply use either AFR or CFR method. Examples include Holyrood, Bay St. Georges, and others.

5.1.2. Hydrogeological Mapping

Hydrogeologic mapping locates and maps the groundwater flow. The capture zone is defined by identifying the aquifers and aquitards, mapping the groundwater levels, and then determining flow directions from water level contours. This method requires considerable expertise and should be carried out with the assistance of a professional hydrogeologist. Examples of communities in Newfoundland and Labrador that used this method include Colliers and Chance Cove.

5.1.3. Numerical Flow Modeling

Numerical modelling develops and uses computer models of the groundwater flow system. Information on the hydrogeology of the area is entered into a computer program, which calculates the water level, flow rates, and flow directions. This information is used to define the capture zone for the well and time of travel of the contaminants. Communities in Newfoundland and Labrador that used this method to define their WHPA include Stephenville, Badger, and St. Albans.

5.2. WHPA Zones

Delineation of a WHPA can be determined using a computer model that estimates the time it takes groundwater to travel to a well based on the rate the water is pumped out of the well, the type of geological materials surrounding the well, and the speed at which the groundwater travels. For each municipal groundwater supply well in the province, WHPAs will be determined for at least three separate protection zones:

- **Zone 1** – a radius of at least 100 meters surrounding the well, the area where the risk is highest and the greatest care in handling any potential contaminant is required. This Zone may encompass the entire WHPA for smaller systems. This zone has the highest restrictions, and in many communities, the zone should be identified with a fence around the perimeter of the wellhead.
- **Zone 2** – the area where the groundwater is estimated to take up to ***1 year or less*** to reach the well within the aquifer. This zone is important to protect the well from hazardous chemicals, bacteria, and viruses from human and animal wastes. This zone is immediately adjacent to Zone 1, and any land use development be strictly curtailed. Smaller community systems that use hydrogeologic mapping to determine their WHPA zones could be limited to two zones.
- **Zone 3** – the area where the groundwater is estimated to take up to ***20 years or less*** to reach the well within the aquifer. This zone is important to protect the well from the most persistent and hazardous pollutants that remain a concern. Therefore, any land use development that could pose a long-term and durable threat to groundwater quality, or which could adversely affect long-term recharge to the well, should be restricted.

A community could have more than three WHPA zones, depending on their local hydrogeologic setting or based on results of numerical modeling.

6. Guidance for Development within a WHPA

Developing protection strategies should be specific to the community and will depend on the number of WHPA Zones that have been delineated. Activities, processes and installation that are not acceptable within the various protection zones must be identified. A well protection plan allows communities to identify land use activities that may threaten the quality of their well water, and to develop a strategy to avoid or minimize these threats.

6.1.1. Zone 1 has the highest restrictions. Access to this zone should be restricted to the system operators. In most cases this area is protected by a fence. No new land use of any kind should be permitted within 100 meters of the well or well field.

6.1.2. Zone 2 restrictions should be based on attenuation and travel time of recharge to the well or wells. Land use activities should be regulated. Examples of prohibited activities should include, but are not limited to:

- Buildings and associated contents
- Roads and parking lots
- Farms, stables and associated sheds
- Crops and pasture
- Livestock
- Fishponds
- Recreational and camping facilities
- Cemeteries
- Aggregate or other mining
- Wood waste storage or disposal
- Fuel storage
- Sewage disposal or treatment
- Storage, commercial uses or transport of water-endangering substances

6.1.3. Zone 3 is the least restrictive zone; however, land uses need to be evaluated based on attenuation and travel time. Examples of restricted land use in this zone include (but are not limited to):

- Municipal or industrial landfills
- Derelict vehicle storage
- Storage or commercial use of water-endangering substances

7. Activities Regulated in a WHPA

Regulated activities within a WHPA will need to be evaluated on a case-by-case basis and will be dependent on the location within the WHPA and extent of the development activity. Examples of activities to be regulated include:

- Expansion and upgrading of the existing activities, operations or facilities.
- Construction of residential, commercial, industrial and institutional facilities or any other related activity including land clearing or drainage, construction of access roads, servicing of lands for subsequent use, or extension and upgrading of existing buildings or facilities.
- Development of farm lands for crop production, forage production, vegetable production, and blueberry and other fruit production.
- Forest logging, resource road construction and use, stream crossing for controlled access, preparation of skid trails and landing areas, silvicultural

activities, tree farming, and other environmentally acceptable forestry operations.

- Recreational activities or facilities including cottage development, fishing, swimming, boating, hiking, camp grounds, vacation or other camps, or recreational facilities.
- Mineral exploration related activities and aggregate extraction, or any other construction activity incidental to mining and quarrying including access roads, stream crossings, land drainage with adequate treatment, land clearing and excavation.
- Installation of storm or sanitary sewer pipelines, pipelines for transmission of water for hydroelectric generation, agriculture uses, or any other purposes.
- Construction of roads, bridges, culverts, and other stream crossings, and installation of power and telecommunication transmission lines.
- Any other development or activity which, in the opinion of the Minister, has caused impairment or has potential to impair water quality.

8. Development Activity Approval Process

For any development activity proposed within a WHPA, the Department requires application for a Permit for a Development Activity.

- 8.1. When applying for a permit, the proponent shall submit a detailed development plan along with maps, drawings and specifications and other information as required by the Minister for approval.
- 8.2. The Minister may, on the recommendation of his/her officials, issue a permit for the proposed development on such terms and conditions as the Minister considers necessary to protect water quality.
- 8.3. The proponent shall also obtain all other licences, permits or approvals under other acts and regulations as required prior to commencing the approved work.
- 8.4. The proponent of the approved development shall notify the municipal authority or the person responsible for the operation and maintenance of the wellhead by providing a copy of the approval issued under this policy before commencing the work.
- 8.5. The Minister may require the inspection of the approved development from time to time by his/her officials to ensure that the development is carried out in an environmentally acceptable manner and the proponent is complying with the terms and conditions of the approval.
- 8.6. The Minister may require a proponent to monitor water quality according to a monitoring program approved by the Minister in order to evaluate the impact of the approved development on public water supply.

9. Responsibilities of the Municipal Authority

The municipal authority or person responsible for the operation and maintenance of a waterworks shall:

- 9.1.** Ensure that no development activities are undertaken in a designated area without approval from the Minister.
- 9.2.** Ensure that approved development activities are undertaken in strict compliance with the terms and conditions of the approval.
- 9.3.** Where an approval or this policy is violated, serve a stopping order on the violator after obtaining prior approval from the Minister for stopping any work or operation either permanently or temporarily which is not carried out according to the terms and conditions of the approval and has impaired or has potential to impair water quality.