

# **APPENDIX E**

**Assessment Guideline for Groundwater Under the  
Direct Influence of Surface Water (GWUDI)**

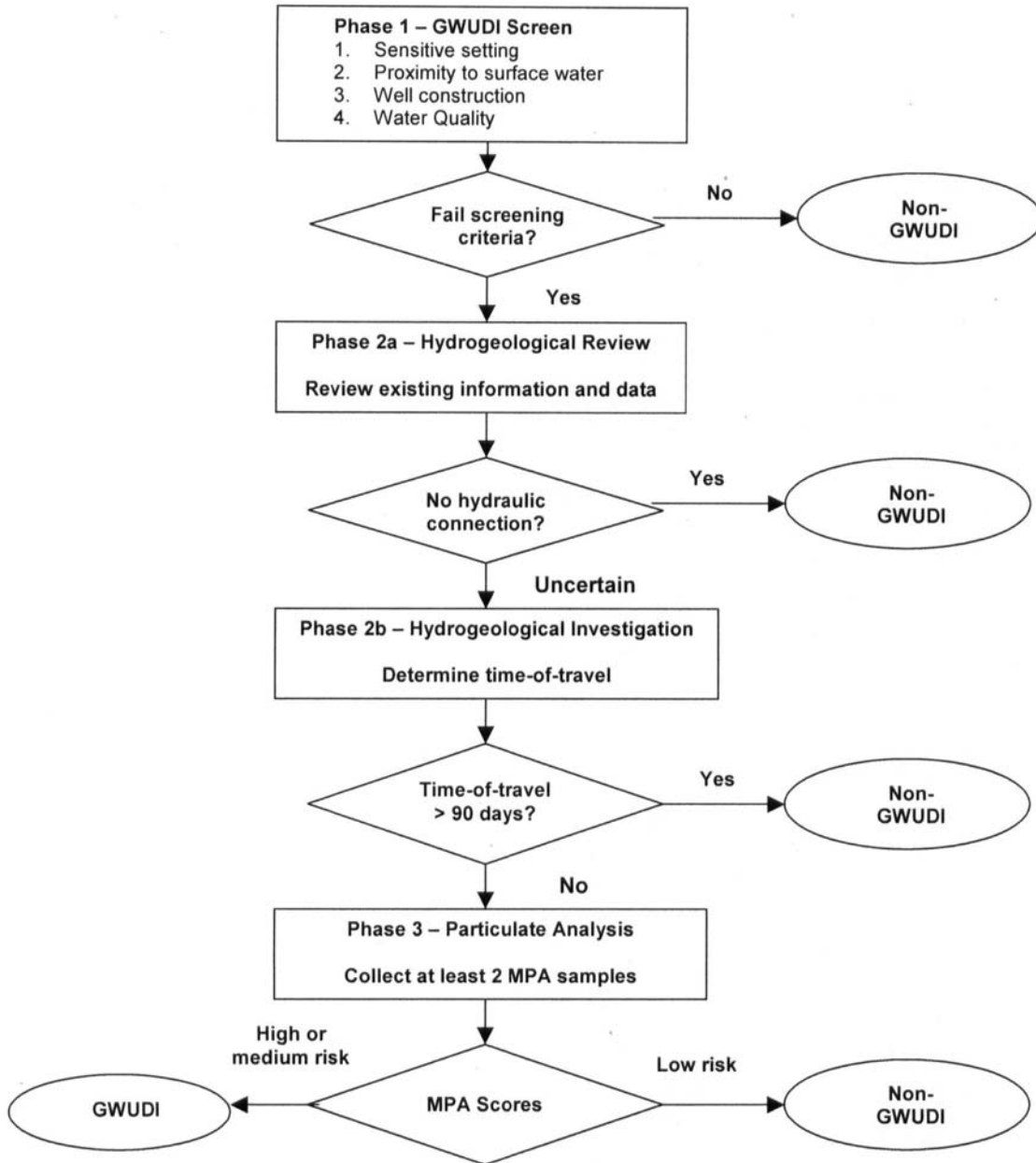


## General

Groundwater under the direct influence of surface water (GWUDI) refers to groundwater supply sources that are vulnerable to contamination by pathogens from nearby surface water or infiltrating precipitation. Groundwater sources that are determined to be GWUDI require treatment equivalent to that required for surface water sources as specified in Section 1.2.1. Waterworks systems using “high quality groundwater” must not be under the direct influence of surface water according to the *Potable Water Regulation (Alberta Regulation 277/2003)*.

This assessment guideline presents the protocol for determining whether a source is GWUDI or non-GWUDI. The assessment is to be carried out by a qualified hydrogeologist or groundwater engineer who is a member of APEGGA. The assessment is divided into three phases, which is outlined in the flow chart in Figure 1. The concept of the guideline is to initially flag potential GWUDI sources, followed by more detailed investigations to determine whether or not a source is GWUDI.

Figure 1: GWUDI Assessment Flowchart



## PHASE 1 – GWUDI Screen

The purpose of the screening is to rapidly identify obvious non-GWUDI sources that do not require a detailed assessment. The screening criteria are as follows:

1. **Sensitive Setting** – the source shall not be a:
  - a. spring, infiltration gallery, shallow collector system, artificial recharge system, bored well or dug well
  - b. well with a production zone less than 15m below ground surface
  - c. well in an unconfined aquifer
  - d. well completed in fractured or karst bedrock exposed at or near the land surface.
2. **Proximity to surface water** – the source shall not be located within 100m of any permanent, intermittent or seasonal surface water body, including ponds, sloughs, lakes, rivers, streams, dugouts, lagoons, reservoirs, irrigation canals or ditches, gravel pits, mining pits or any other open water features.
3. **Well Construction** – The source shall be a drilled well which meets the requirements under the current version of the *Alberta Water (Ministerial) Regulation (Alberta Regulation 205/98)*. A drilled well shall have a surface seal that prevents surface water from migrating down the annulus of the well. A drilled well shall be constructed in a manner such that only water from the producing interval enters the well. The wellhead shall be well graded and drained and show no signs of poor construction or deterioration.
4. **Water Quality** – The raw or treated water from the source shall not exhibit evidence of contamination by surface water. This means significant occurrence of insects, insect parts, and other microorganisms such as total coliforms (on a regular basis), E.coli, algae, *Giardia*, *Cryptosporidium*, or viruses; or significant and relative rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH, closely correlating to climatological or surface water conditions.

Should a drinking water source not meet any of the above criteria, the source is flagged as potentially GWUDI, and the assessment is to proceed to Phase 2 or the source can be declared as GWUDI.

If the criteria under #1 and #2 are met but not the criteria under #3 and #4, instead of proceeding to Phase 2, system owners may modify the well construction to ensure the criteria under #3 and/or #4 are met.

## **PHASE 2a –Hydrogeological Review**

The objective the hydrogeological review is to determine if a water source can be designated as GWUDI or non-GWUDI based on existing data and knowledge. It may identify factors not considered in the screening process. The following information is normally required for this evaluation:

- geological / lithological data, including depth and thickness of production zones, overlying confining beds and other subsurface units
- depth of surface water bodies, penetration of any confining units by surface water bodies
- cross-section(s) showing site stratigraphy in relation to surface water bodies
- any history of flooding
- pumping test results (recharge boundaries , hydraulic connection to surface water)
- hydraulic conductivity testing of confining units
- comparison of any historic groundwater level and surface water level monitoring
- comparison of any historic groundwater quality and surface water quality data
- estimate of time-of-travel between surface water and the source where possible.

*If there is reasonable uncertainty as to whether a source is vulnerable to the direct influence of surface water, further assessment is required. Proceed to Phase 2b or declare the source as GWUDI.*

## **PHASE 2b –Hydrogeological Investigation**

The objective of the hydrogeological investigation is to determine if there is an existing or potential hydraulic connection that could allow rapid recharge of the well by surface water or precipitation. This phase can be combined with Phase 2a under one hydrogeological investigation.

The hydrogeological investigation will require determination of the time-of- travel between a surface water body and a source well. Various methods are available to determine time-of-travel, including water quality hydrograph analysis, computer modeling, analytical methods or tracer tests. The choice of method should take into account the proximity of the surface water body and/or anticipated travel times. For instance, hydrograph analysis of water quality parameters such as temperature, conductivity and pH may be the best option for surface water bodies that are very close to a source well in the same aquifer. It is recommended that monitoring of these parameters be collected on a weekly basis for a minimum of one year, unless a hydraulic connection is recognized early in the program.

Computer modeling involves using particle-tracking techniques to determine time-of-travel, in a similar manner to capture zone modeling. This option may be best suited to situation where greater travel times are anticipated and sufficient information is available. Note that this option may require further intrusive work (e.g. drilling, pumping test, monitoring, etc) in order to obtain

suitable information for the modeling work. Model assumptions and sensitivity analysis must be included in the final report.

Should the time-of-travel be determined to be less than 90 days, proceed to Phase 3 or declare the source as GWUDI.

### **PHASE 3 – Microscopic Particulate Analysis**

The results of Phase 2b may determine that there is a hydraulic connection between a source well and a nearby surface water body. However if the subsurface units provide sufficient natural filtration to remove most surface water organisms and debris, the well source may be exempted as GWUDI.

Microscopic Particulate Analysis (MPA) is used to determine if there are significant surface water particulates reaching the well source. The test involves filtering approximately 4,500 litres of water to concentrate organisms and debris, which are then identified and quantified under a microscope by an accredited laboratory. The laboratory shall classify the result as low, medium or high risk.

A minimum of two MPA samples shall be collected, during periods when there is the greatest possibility for surface water to impact a source well (i.e. worst-case situation). This will usually be after a significant storm or snow melt event. The sampling time can only be determined after the time-of-travel has been determined under Phase 2. If lag time is not used to determine the sampling times, there is a strong possibility that the result will not reflect a worst-case situation. It is recommended that at least one sample be collected in the spring.

The MPA analysis and scoring is to be conducted according to the *Consensus Method for Determining Groundwaters Under the Direct Influence of Surface Water Using Microscopic Particulate Analysis* (USEPA, 1992). Under this method, samples are scored as follows:

- <10            low risk
- 10 – 19        medium risk
- >20            high risk.

A water well source shall be declared GWUDI upon a **medium** or **high-risk** score, unless remedial action and/or further sampling demonstrate otherwise.

### **GWUDI Determination**

A qualified hydrogeologist or groundwater engineer who is a member of APEGGA shall conduct GWUDI assessments. Professional judgment shall be used to evaluate all the evidence collected in the final determination of whether a water source is GWUDI or non-GWUDI. Generally, all well sources that do not exhibit any evidence of a current or potential direct connection with surface water or are determined to have a time-of-travel greater than or equal to 90 days to any nearby surface water bodies will be considered non-GWUDI. Evidence for a well source being GWUDI is generally more conclusive than evidence it is not GWUDI. Where uncertainty or doubt exists, it is best to adopt a cautionary approach and consider the source GWUDI.

## References

AWWARF (American Water Works Association Research Foundation). 2001. *Investigation of Criteria for GWUDI Determination*.

Nova Scotia Department of Environment and Labour. 2002. *Protocol for Determining Groundwater Under the Direct Influence of Surface Water*.

Ontario Ministry of Environment. 2001. *Terms of Reference: Hydrogeological Study to Examine Groundwater Sources Potentially Under the Direct Influence of Surface Water*.

Ontario Ministry of Environment. 2001. *Delineation of Wellhead Protection Areas for Municipal Groundwater Supply Wells Under the Direct Influence of Surface Water*.

Saskatchewan Environment. 2004. *Groundwater Under the Direct Influence of Surface Water (GUDI) Assessment Guideline*.

USEPA. 1991. *Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems using Surface Water Sources*.

USEPA. 1992. *Consensus Method for Determining Groundwater Under the Direct Influence of Surface Water Using Microscopic Particulate Analysis (MPA)*.