DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

Technical Bulletin
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Groundwater Quality Analysis

1- Vulnerability

Vulnerability Assessment and Delineation (R:37): one or more of the methods mentioned below:

1- Intrinsic susceptibility index (ISI).
2- Aquifer vulnerability index (AVI).

(R:38{1,3})

High vulnerability:	Score < 30
Medium vulnerability:	Score ≥ 30 and < 80
Low vulnerability:	Score ≥ 80

3- Surface to aquifer advection time (SAAT).
4- Surface to well advection time (SWAT).

(R:38{2,3})

High vulnerability:	results < 5yr
Medium vulnerability:	results ≥ 5yr and < 25yr
Low vulnerability:	results ≥ 25yr

Vulnerability areas can change from low to medium or high (R:39) and from medium to high (R:40) if transport pathways exist with the following factors that shall be considered (R:41): hydro-geological conditions; type and design of any transport pathways; cumulative transport pathways; and/or any other assumptions.

5- Another method that in the opinion of the director is equivalent or better than the methods mentioned above with applicability of (R38{1,2,3}).

2- Delineation

Recommended Methods (R:42):

1- 3D-GW flow model; 2- 2D analytical model; 3- Uniform flow method; 4- Fixed radius method; or 5- Other method that is better or equivalent than methods (1 - 4) in the opinion of the director.

Highly Vulnerable Aquifers (HVA)	Significant Groundwater Recharge Areas (SGRA)	Wellhead Protection Areas (WHPA)	
		Drinking Water System I	Drinking Water System II and III
It is an area according to Rule 38 and the subsurface zone beneath that area (R:43).	If an area recharges to an aquifer at a rate of ≥ 15% of the whole area related GW recharge rate (R:44{1}); or If the annual recharge of an area is ≥ 55% of the volume of (Precipitation – Evaporation) of the whole GW recharge area (R:44{2}). *And* (R:45): where there is a hydrological connection to surface water body or aquifer that is a source of Drinking Water for a Drinking Water system. *Considerations* (R:46): SGRAs are delineated using model(s) developed for the purpose of a water budget(s), Part (III), such as topography, surface geology, and effects of interacting the GW and SW.	Areas are (R:47): WHPA-A→ Radius=100m @centre of well WHPA-B→ Time of Travel (ToT) ≤ 2yr (excluding WHPA-A) WHPA-C→ Time of Travel (ToT) > 2yr but ≤ 5yr WHPA-D→ Time of Travel (ToT) > 5yr but ≤ 25yr WHPA-E→ same as IPZ-2 (1- at the interaction point between GW and SW; or 2- at the point that SW connects to GW) WHPA-F→ same as IPZ-3 (at the point where the SW affects the GW) *Or* (R:48): If delineation is done before April 30th 2005 then the following applies: All WHPAs are delineated as in Rule 47 except the WHPA-C1 which is based on ToT > 2yr but ≤ 10yr. *Additional Areas*: For WHPA-E: (R:49{a,b}) only added for GUDI wells (Groundwater wells Under the Direct Influence of Surface Water) as per the Safe Drinking Water Act and if the well receives raw water from an area that is influenced by the interaction between GW and SW and reduces the ToT to the well (R:49{c}). For WHPA-F (R:50): only for areas that contain WHPA-E; issue contributing area to the drinking water; issue contributing areas outside the WHPA-A,B,C,C1,D,E.	If the system is registered in the SDWA, the areas to be delineated are (R:51): WHPA-A→ R=100m @centre of well WHPA-B→ ToT ≤ 2yr (excl. WHPA-A) WHPA-C→ ToT > 2yr but ≤ 5yr WHPA-D→ ToT > 5yr but ≤ 25yr If the system is not registered (R:52): then an area of WHPA is delineated as a combination of WHPA-A and WHPA-B only.

3- Scoring

Highly Vulnerable Aquifers (HVA)	Significant Groundwater Recharge Areas (SGRA)	Wellhead Protection Areas (WHPA)
If the area does not overlap with a WHPA, the score shall be 6 (R:79).	SGRA areas shall be divided into sub-areas of GW vulnerability according to Rule 38 (R:80) and can be scored as (R:81): High Vulnerability → 6 Medium Vulnerability → 4 Low Vulnerability → 2	An area of WHPA shall be divided into sub-areas (R:82) and scored as follows: If the vulnerability is based on Rule 37 (1 or 2) and Rule 84 and Rule 85, then apply table 2a. If the vulnerability is based on Rule 37 (3 or 4) and Rule 84 and Rule 85, then apply table (2b).

Table 2a	WHPA-A	WHPA-B	WHPA-C	WHPA-C1	WHPA-D	WHPA-E	WHPA-F
High	10	10	8	8	6	Same as IPZ-2	Same as IPZ-3
Medium	10	8	6	6	4		
Low	10	6	4	4	2		

Table 2b	WHPA-A	WHPA-B	WHPA-C	WHPA-C1	WHPA-D	WHPA-E	WHPA-F
High	10	10	8	8	6	Same as IPZ-2	Same as IPZ-3
Medium	10	8	6	6	4		
Low	10	6	2	2	2		

4- Overview of Threat Identification

Drinking Water Threat: Activities (R:118-125) or conditions (R:126) that could affect the quality of drinking water. New threats can be added by Source Protection Committee with approval of the director.

Approaches:
Threats Approach (R:127 to 137), i.e. activities in the list of drinking water threats, new drinking water threats/circumstances can be added by SPC with approval of the director.
Event Based Approach (R:130), i.e. activities where models show activities can cause an issue at a well.
Issues Approach (R:131), i.e. activities that are located in an issue contributing area and can contribute to that issue.

Risk score = Hazard rating * Vulnerability score

	Activities	Conditions
Significant	Hazard rating > 4 + Risk Score ≥ 80 (R:128)	Hazard rating =10 + Risk Score ≥ 80 (R:139,140)
Moderate	Hazard rating > 4 + Risk Score ≥ 60 to < 80 (R:132)	Risk Score ≥ 60 to < 80 (R:139,142)
Low	Hazard rating > 4 + Risk Score ≥ 40 to < 60 (R:136)	Risk Score ≥ 40 to < 60 (R:139,143)