DEPARTMENT OF HEALTH

Vulnerability Assessment Parameters Factsheet

The Source Water Protection Unit commonly samples raw groundwater for the following parameters as these help determine the aquifers vulnerability to contamination. Table 1 details the organic and inorganic chemicals used in this assessment. Table 2 details the isotopic signatures that are commonly detected.

Abbreviations: milligrams per liter (mg/L), micrograms per liter (µg/L), Maximum Contaminant Level (MCL), Environmental Protection Agency (EPA).

Table 1 – Chemical Analysis

Chemical Parameter	Where does it usually come from?	What do the results mean?
Ammonia	Environment (e.g., decaying organic matter) Human activity (e.g., waste, agricultural or feedlot runoff)	Long term ingestion of water containing more than 1 mg/L may damage internal organs. There is no MCL for ammonia in drinking water. The National Academy of Science recommends a drinking water standard of 0.5 mg/L. In 1990 the EPA issued a lifetime exposure advisory of 30 mg/L.
Arsenic	Environment (e.g., soils and rocks) Human activity (e.g., pesticides and wood preservatives)	Drinking water with low levels of arsenic over a long time is associated with diabetes and increased risk of cancers of the bladder, lungs, liver, and other organs. The MCL for arsenic in drinking water is 10 µg/L. However, drinking water with arsenic at levels lower than the EPA standard over many years can still increase cancer risk.
Bromide	Environment (e.g., salt-bearing soils and rocks). Human activity (e.g., road and water softener salt, fertilizer, wastewater)	Naturally occurring bromide in groundwater typically has a concentration of less than 0.06 mg/L and at that concentration bromide itself is typically not a risk to humans. The World Health Organization recommends less than 6 mg/L for adults and 2 mg/L for children.
Chloride	Environment (e.g., salt-bearing soils and rocks). Human activity (e.g., road and water softener salt, fertilizer, wastewater)	Chloride toxicity has not been observed in healthy humans. Concentrations in excess of about 250 mg/L may impart a bad taste to water. The Environmental Protection Agency (EPA) non-enforceable secondary standard for chloride in drinking water is 250 mg/L.
Chloride/Bromide Ratio	-	Ratio of chloride to bromide is a useful indicator of the source of the salt. Typically, a ratio less than 300 indicates a natural source and greater than 300 indicates a human source.
Manganese	Environment (e.g. soils and rocks)	Manganese occurs naturally in groundwater across Minnesota. 1) If you have an infant who drinks tap water or drinks formula made with tap water, a safe level of manganese in your water is 100 micrograms of manganese per liter of water (µg/L) or less. 2) If you have an infant who never drinks tap water or formula made with tap water, a safe level of manganese in your water is 300 µg/L or less. 3) If everyone in your household is more than one year old, a safe level of manganese in your water is 300 µg/L or less.

Chemical Parameter	Where does it usually come from?	What do the results mean?
Nitrate	Environment (e.g., some foods) -typically 1-3 mg/L Human activity (e.g., Fertilizers, discharge from sewage systems and animal waste) -typically greater than 3 mg/L	Consuming too much nitrate can affect how blood carries oxygen and can cause methemoglobinemia (blue baby syndrome). Methemoglobinemia can result in serious illness or death. Levels above 3 mg/L suggest human-made sources of nitrate have contaminated the water. The MCL for nitrate in drinking water is 10 mg/L of nitrate (measured as nitrate-nitrogen) of drinking water.
Sulfate	Environment (e.g., soils and rocks)	People unaccustomed to drinking water with elevated levels of sulfate can experience diarrhea and dehydration. Infants are often more sensitive to sulfate than adults. As a precaution, water with a sulfate level exceeding 500 mg/L should not be used in the preparation of infant formula. Older children and adults become accustomed to high sulfate levels after a few days. If sulfate in water exceeds 250 mg/L, a bitter or medicinal taste may render the water unpleasant to drink. The EPA non-enforceable secondary standard for sulfate in drinking water is 250 mg/L.

Table 2 – Isotopic Analysis

Chemical Parameter	Where does it usually come from?	What do the results mean?
Oxygen-18 and Deuterium	Environment (e.g., precipitation)	The variations of deuterium and oxygen-18 compositions support conclusions about the climatic conditions and water sources during groundwater recharge. Values of precipitation that have not been evaporated are linearly related and plot on the Global Meteoric Water Line. If well water plots on the meteoric water line it was recharged directly from local precipitation. If well water plots significantly off of this line an evaporative process (e.g., infiltration of lake or stream water) has occurred.
Tritium	Environment (e.g., precipitation)	Tritium is a radioactive isotope of hydrogen with a half-life of 12.4 years. Tritium concentrations are measured in tritium units (TU). Natural atmospheric tritium is also generated by secondary neutron cosmic ray bombardment of nitrogen, which then decays to carbon-12 and tritium. Tritium atoms then combine with oxygen, forming water that subsequently falls as precipitation. Prior to atmospheric nuclear bomb testing in the 1950s, tritium's natural average concentrations ranged from approximately 2 to 8 TU. Massive amounts of tritium were added in the northern hemisphere from atmospheric nuclear bomb testing with the largest tritium concentrations peaking in 1963. Since cessation of atmospheric nuclear tests, tritium concentrations have dropped to about 8 TU in Minnesota, although small contributions from nuclear power plants may occur locally. Because most tritium is disseminated in the environment as water, it enters the hydrologic cycle as precipitation and eventually becomes concentrated in levels detectable in groundwater. Non-detect or low values indicate mostly old (pre-1954) water. Higher values can indicate younger water.

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