Areas Susceptible to Groundwater Contamination

Assumptions:

- Focus on fractured dolomite/limestone as the primary bedrock type of concern.
- Focusing primarily on bacteria/pathogen and nitrate contamination.
- Source of contaminates includes but are not limited to: manure, industrial/municipal/septage wastes, septic systems, fertilizers (agricultural and residential).
- Focus on those materials that are applied to the landscape (liquid or solid forms).
- Focus upon sandy soils, where present

Factors to identifying areas susceptible to groundwater contamination:

1. **Depth to Bedrock or Groundwater:** The depth to either bedrock or groundwater (whichever is more limiting) greatly influences the potential for groundwater contamination as there is less soil depth available for treatment purposes.

2. **Soil Type and Characteristics:** The type of soil and characteristics of that soil determine the filtering and water holding capacity of the soil. Sandier soils will have less filtering capacity, and therefore less treatment capability, than clay soils impacting the drainage and permeability ratings these soils have. Increasing soil health, organic matter and tilth can increase the water holding and filtering capacity of some soils.

3. **Land Use:** The land use will play a critical role as to whether or not an area is susceptible to groundwater contamination. Agricultural and residential land uses may have higher susceptibility due to activities occurring on the land versus natural/undeveloped landscapes where little to no disturbance is occurring. Urbanized areas may have factors that fall in both categories and would need to be reviewed on in further detail depending on the contaminant.

Over-riding Considerations:
Regardless of the factors listed above, certain elements have the potential to increase (or decrease) the potential of an area to be susceptible.

- **Conduits to Groundwater:** The presence of a direct conduit to groundwater regardless of items 1 through 3 above can increase the potential for a site to be susceptible. These areas may include: a geologic feature (i.e. sinkhole), a manmade feature (i.e. well), channels or drain tile outlets that drain to direct conduits to groundwater, and associated drainage areas that contribute to those features (i.e. watershed associated with a closed depression).

  - An example of this may be the presence of a sinkhole in a forested lowland on the edge of a field where the soils are generally more clay and there is a greater depth to bedrock or groundwater. While the conduit is located in a forested area which typically would have a lower chance of susceptibility, the drainage to that sinkhole encompasses the neighboring agricultural field which increases the potential susceptibility. While the soils may be less likely to infiltrate water and the depth to bedrock or groundwater is greater, the presence of the sinkhole acts like a pipe providing a direct "pipe" to groundwater and reducing or eliminating the potential treatment effects the surrounding soils may provide.

- **Water Supply Well - Wellhead Protection Area (WHPA):** The land and subsurface area surrounding a water supply well through which contaminants are reasonably likely to be transported, and potentially enter, a well. This would include formally defined public water system WHPAs and designated protection areas around private home water supply wells.

- **Weather:** Atmospheric conditions can play an important role in determining whether a site is susceptible to groundwater contamination. Weather can change soil characteristics making it more or less susceptible.
  - Drought: While clay soils typically have the ability to retain water and provide soil treatment, in drought conditions, these soils have a tendency to dry and crack opening conduits to more permeable soils or fractured bedrock below. In these situations, the fractures in a clay soil can act almost like a bedrock fracture at the surface and allow rapid transport of material down to groundwater.
  - Frozen Conditions: When soils are frozen, there is less chance for material to infiltrate. However, in spring when the frost comes out of the ground, large pools of liquid that have built up behind closed depressional areas or in shallow bedrock/groundwater areas have a tendency to drain rapidly causing a large volume of material to flush through the system.
  - Precipitation: Heavy precipitation events can force material to move through the soil profile more rapidly than normal or saturate soil and generate surface runoff. In general, soils with less permeability (i.e. clay) have more surface water runoff and soils with increased permeability (i.e. sand) allow water to infiltrate at a rapid rate reducing the soil's treatment ability. In addition, soil saturation may also play a role in diminishing the soil's treatment capability.

Karst Report Recommendations:
The "Contamination Vulnerability Ranking" table in the Northeast Wisconsin Karst Task Force report provides a good basis for categorizing bedrock for factor #1 listed above.

Level of protection required	**Criterion**	**Relative vulnerability to contamination**
1	Less than 5 feet (60 inches) to carbonate bedrock, *and/or* closed depressions or any drainage areas that contribute water to sinkholes/bedrock openings.	Extreme
2	5-15 feet to carbonate bedrock	High
3	>15-50 feet to carbonate bedrock	Significant
4	Greater than 50 feet to carbonate bedrock	Moderate

In addition to bedrock, groundwater should also be added to the criterion definitions to account for those areas where the restricting feature could be the water table as opposed to bedrock.

Existing Definitions:

The following definitions are from DNR regulatory programs:

- **"Site that is susceptible to groundwater contamination"** under s. 281.16 (1)(g) , Stats, means any one of the following:
  - (a) An area within 250 feet of a private well.
  - (b) An area within 1000 feet of a municipal well.
  - (c) An area within 300 feet upslope and 100 feet downslope of a direct conduit to groundwater.
  - (d) A channel that flows to a direct conduit to groundwater.
  - (e) An area where the soil depth to groundwater or bedrock is less than 2 feet.
  - (f) An area where the soil does not exhibit one of the following soil characteristics:
    1. At least a 2-foot soil layer with 40% fines or greater above groundwater and bedrock.
    2. At least a 3-foot soil layer with 20% fines or greater above groundwater and bedrock.
    3. At least a 5-foot soil layer with 10% fines or greater above groundwater and bedrock.

  Chapter NR 151.015 (18), Wis. Adm. Code

- **"Direct conduits to groundwater"** means wells, sinkholes, swallets, fractured bedrock at the surface, mine shafts, non-metallic mines, tile inlets discharging to groundwater, quarries, or depressional groundwater recharge areas over shallow fractured bedrock.

  Chapters NR 151.002 (11m) and NR 243.03 (20), Wis. Adm. Code

- **"Water quality management area" or "WQMA"** means [surface water references]… a site that is susceptible to groundwater contamination, or that has the potential to be a direct conduit for contamination to reach groundwater.

  Chapter NR 151.015 (24), Wis. Adm. Code

The following definitions are from NRCS Technical Standard 590 for Nutrient Management:

- **Apparent Water Table** – Continuous saturated zone in the soil to a depth of at least 6 feet without an unsaturated zone below it.
- **Direct Conduits to Groundwater** – Wells, sinkholes, swallets (a sinkhole or rock hole that intercepts a stream, diverting all or a portion of it to the groundwater), fractured bedrock at the surface, mine shafts, non-metallic mines, tile inlets discharging to groundwater, quarries, or depressional groundwater recharge areas over shallow fractured bedrock.
- **High Permeability Soils** – Equivalent to drained hydrologic group A that meet both of the following criteria:
  1. Permeability = 6 inches/hour or more in all parts of the upper 20 inches and
  2. Permeability of 0.6 inches/hour or more in all parts of the upper 40 inches

  Use the lowest permeability listed for each layer when evaluating soil. For a multi-component map unit (complex), evaluate each component separately. If the high permeability components meet the criteria and cannot be separated, the entire map unit should be considered as high permeability.