

# Assessing Vulnerability of Groundwater

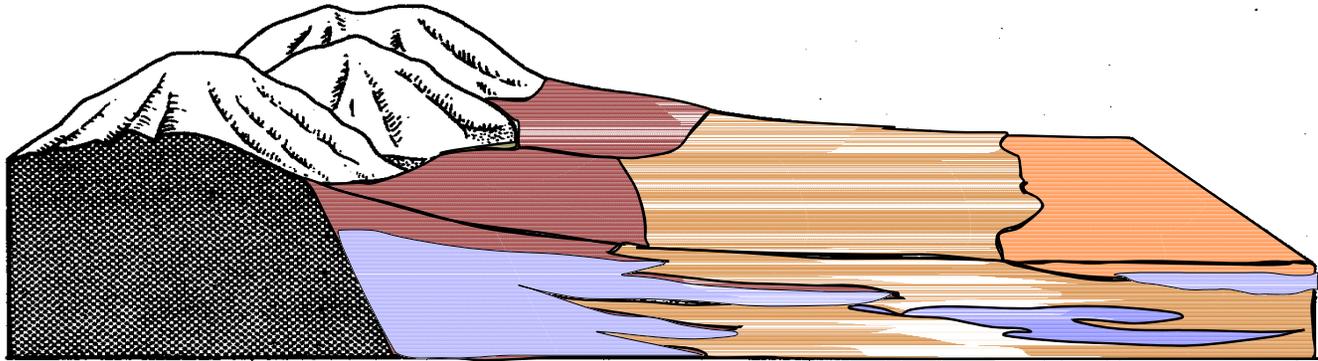


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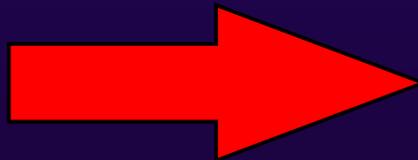
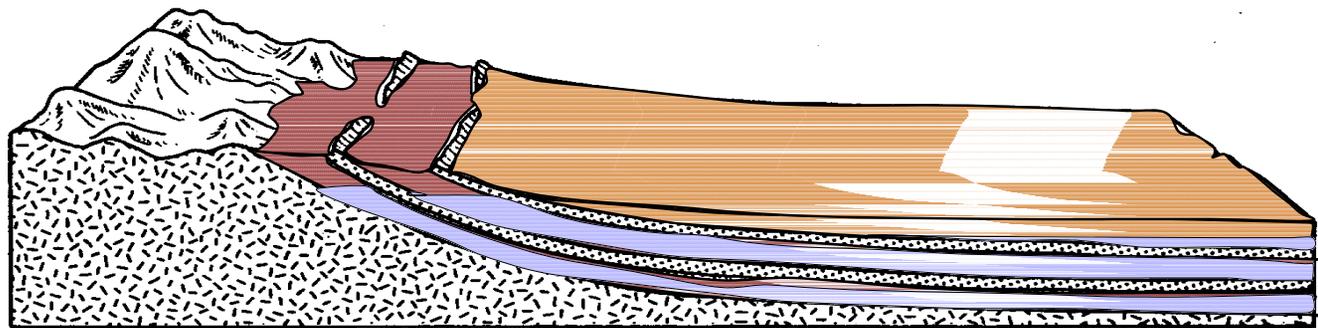
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# Vulnerability Concept



adopted from: Fetter, 1988



Provide a basic planning tool that accounts for and summarizes:

- ✓ potent. contaminating activities
- ✓ physical barrier effectiveness
- ✓ travel time to well

# Overview

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- What is vulnerability?
  - Vulnerability *OF* what?
  - Vulnerability *TO* what?
- Why do it?
- How?
- Which method works best?
- What area should be looked at?
- What if there aren't enough data?
- Limitations & Role in Groundwater Management

# Groundwater Vulnerability: Definitions

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- “Possibility of percolation of contaminants into water table aquifers”
- “Degree of endangerment of an aquifer”
- “Sensitivity of groundwater quality to anthropogenic activities”
- “Likelihood for contaminants to reach a specified location in the groundwater system”
  - ☞ (Specific) Vulnerability (includes assessment of existing sources)
  - ☞ Susceptibility (intrinsic vulnerability, natural vulnerability)

# Why Assess Groundwater Vulnerability?

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National Research Council, 1993

- Facilitate policy analysis and development at the local & regional level
- Provide program management
- Inform land use decisions
- Provide general education and awareness of a region's hydrogeological resources

# First Question to Clarify: Vulnerability *OF WHAT?*

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- Water table?
- Specific aquifer?
- Specific well?

# What Factors Determine Vulnerability?

## Intrinsic Vulnerability

- Precipitation
- Runoff vs. Infiltration (slope, surface roughness, landuse)
- Soil type / unsaturated zone properties: permeability, infiltration capacity, clay content
- Depth to groundwater
- Travel time from recharge at water table to well site
- Aquifer characteristics (hydraulic conductivity, material)

# Appropriate Scale of Investigation

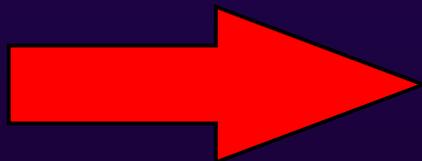
- Regional: mapping vulnerability
- Local: computing vulnerability of specific location



*Warning! Vulnerability is always simplified into a (aerial view) map, but groundwater flow is 3-D!*

DWSAP:

- ✓ vertical movement:  
physical barrier effectiveness
- ✓ horizontal movement:  
travel time to well via Zone A/B5/B10



# Intrinsic Vulnerability in DWSAP Method

## Intrinsic Vulnerability

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Physical Barrier Effectiveness (PBE)

Protection Zone

from:  
 Vrba and Zaporocec (eds.), 1994,  
 Guidebook on Mapping Groundwater  
 Vulnerability, International Association  
 of Hydrogeologist, Volume 16

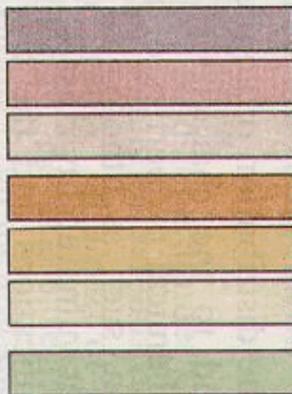
**VULNERABILITY CLASSES**

Geological Classes

Major Aquifer  
 (Highly Permeable)

Minor Aquifer  
 (Variably Permeable)

Non-Aquifer  
 (Negligibly Permeable)



Soil Classes

High (H) 1, 2, 3, U<sup>a</sup>

Intermediate (I) 1, 2

Low

High (H) 1, 2, 3, U<sup>a</sup>

Intermediate (I) 1, 2

Low

