1 **Ground Water Assessment**
Investigation and Protection

OAC 3745-300-07

Certified Professional
8-Hour Training

2 **Investigating Ground Water: Discussion Topics**

- Conceptual Site Model
- Identification and Protection of Ground Water Zones
- Soil/Leaching Investigations

3 **Conceptual Site Model (CSM)**

- Helps focus and streamline your ground water investigation and reduce costs
- Illustrates the relationships between, contaminants, transport media, and receptors
- Identifies exposure scenarios, COCs, and land uses
- Should be updated during the Phase II investigation

4 **Data Quality Objectives**

- Include laboratory analyses and field methods
- Guidance documents:
  - Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring (TGM)
  - VAP Technical Guidance Compendium (TGC)

5 **Protecting "Clean" Ground Water**

- Protection of Ground Water Meeting UPUS
- "Clean" ground water must be protected from exceeding UPUS in the future
- Cannot assume without testing that ground water beneath site *is* contaminated

6 **Where to begin?**

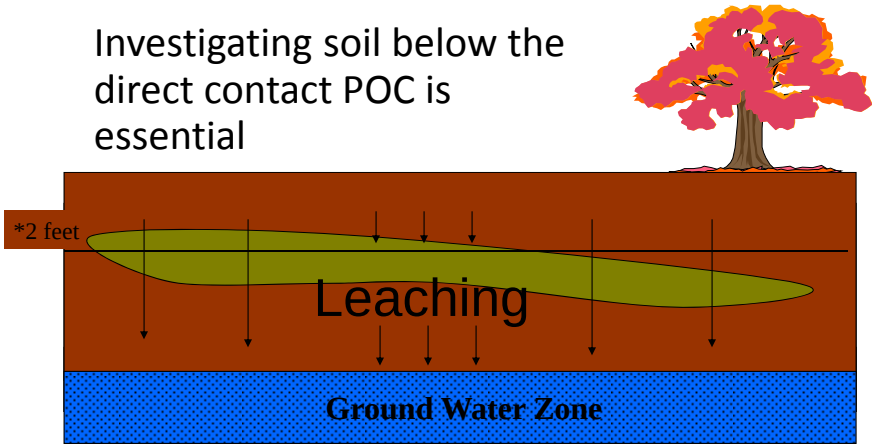
- Is ground water even an issue for my property?
- Does ground water meet or exceed unrestricted potable use standards (UPUS)?
- If it exceeds UPUS- what are the concentrations of COCs in ground water?
- If it meets UPUS – will it continue to meet?

7 **Evaluating Leaching Potential**

- Comparison to Leach-Based Soil Values
  - Use Generic Ohio EPA Derived LBSVs
  - Calculate Property Specific LBSVs
- Weight-of-Evidence Demonstration

Soil Impacts to Ground Water

Investigating soil below the direct contact POC is essential



*commercial/industrial direct contact point of compliance

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Table I: Generic Leach-Based Soil Values for Organic Chemicals

Chemical (Organics)	Soil Type I* (mg/kg)	Soil Type II* (mg/kg)	Soil Type III* (mg/kg)
Benzene	0.017	0.0090	0.015
Toluene	6.8	4.1	7.7
Ethylbenzene	12	7.9	16
Total Xylenes	156	96	191
Styrene	0.46	0.37	0.62
Naphthalene	0.27	0.28	0.36
n-Hexane	121	111	104
Methyl Ethyl Ketone	1.8	1.8	1.8
Phenol	1.1	1.1	1.2
Carbon Tetrachloride	0.25	0.25	0.28
1,2-Dichloroethane	0.0030	0.0020	0.0030
1,1,1-Trichloroethane	1.2	0.74	1.3
Vinyl Chloride	0.0090	0.0050	0.012
1,1-Dichloroethene	0.28	0.10	0.24
cis-1,2-Dichloroethene	0.12	0.070	0.12
trans-1,2-Dichloroethene	0.41	0.23	0.40
Trichloroethene	0.036	0.023	0.048
Tetrachloroethene	0.15	0.11	0.27

* The leach-based soil values contained in Table I assume a dilution factor of 1.0.

10 **Assumptions for Use of Generic LBSVs**

Organics

- COCs in unconsolidated materials
- Depth to ground water is greater than 5 feet
- Saturated K_v of vadose zone is less than $1x10^{-3}$ cm/sec
- Thin soils (< 5 feet) do not overlay bedrock

Inorganics

- Soil pH is between 5 and 9
- Soil contains at least 10% fines

11 **Dilution / Attenuation Factors**

Inorganics (Dilution/Attenuation Factor)

- Based on US EPA Soil Screening Guidance
- Multipliers of 10 (source > ½ acre) or
  20 (source < ½ acre)

Organics (Dilution Factor only)

- Assumptions used for SESOIL modeling already account for attenuation
- Derived using Summer's Equation

Ohio EPA Derived Dilution Factors for Organics
Example Table:

Table IV: Dilution Factors for Soil Category 2: Silty Sand. (Recharge rate = 8.0 in/yr)

Hydraulic conductivity of the aquifer (cm/sec)	Size of source area (acres)			
	≤ 0.5	> 0.5 to 1	>1 to 5	> 5 to 10
≥ 1.0×10^{-1}	22	16	7.6	5.7
≥ 1.0×10^{-2} but < 1.0×10^{-1}	3.1	2.5	1.7	1.5
≥ 1.0×10^{-3} but < 1.0×10^{-2}	1.2	1.1	1.1	1.0

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Partitioning Equation for Organics

$$C_s = C_w\left(K_{oc} \times f_{oc} + \frac{\theta_w + \theta_a H'}{\rho_b}\right)$$

- C_s = screening level in soils, mg/kg
- C_w = target ground water concentration, mg/L
- K_{oc} = soil organic carbon-water partitioning coefficient, L/kg
- f_{oc} = fraction of organic carbon content, mg/mg
- H' = Henry's law constant
- θ_w = water-filled porosity
- θ_a = air-filled porosity
- ρ_b = bulk density, kg/L

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Partitioning Equation for Metals

$$C_s = C_w\left(K_d + \frac{\theta_w}{\rho_b}\right)$$

- C_s = screening level in soils, mg/kg
- C_w = target ground water concentration, mg/L
- K_d = soil-water partitioning coefficient, L/kg
- θ_w = water-filled porosity
- ρ_b = bulk density, kg/L

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15 **Geotechnical Testing**

- Site-specific values can be used in lieu of default or conservative values
- VAP does not certify labs for geotechnical testing (i.e. use of a CL is not applicable)
- VAP TGC documents and DDAGW's Technical Guidance Manual provides some guidance on parameter testing

16 **Weight-of-Evidence Demonstration**

- Nature and age of release
- Type and concentration of COCs
- Separation distance between COCs and ground water
- Physical characteristics of soil
- Man-made structures/preferential pathways
- Impacts from off-property sources

17 **Man-made structures**

- If relying upon man-made structures for protection of ground water meeting UPUS, you must consider that structure an engineering control.
- Requires an Operation and Maintenance Plan and Agreement per OAC 3745-300-11

18 **Evaluating Leaching Potential**

- Comparison to Leach-Based Soil Values
  - Use Generic Ohio EPA Derived LBSVs
  - Calculate Property Specific LBSVs
- Weight-of-Evidence Demonstration

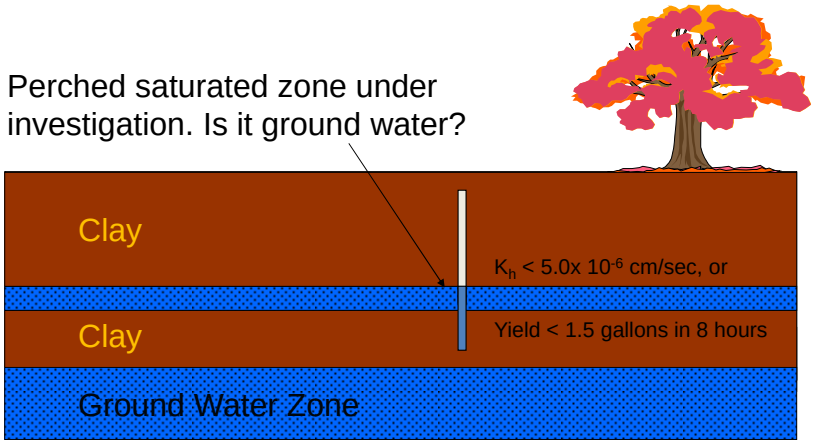
19 **Protecting "Clean" Ground Water**

- Protection of Ground Water Meeting Unrestricted Potable Use Standards
- "Clean" ground water must be protected from exceeding UPUS in the future

20 **Protection of Ground Water – Which Zones?**

- Work from the top and move down sequentially
- Group or separate saturated zones into ground water zones
- Identify confining units, and how they may separate ground water zones
- Must assume the upper most saturated zone contains ground water, or make a demonstration that the zone does not meet the definition of ground water

Determining if it is Ground Water



Well: minimum of 2-inch well/6-inch borehole and a 5 foot long screen

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Protection of Ground Water Zones

- Investigate each layer from the surface down, as needed
- Determine which zones exceed UPUS
- Determine which zones meet UPUS and need to be protected

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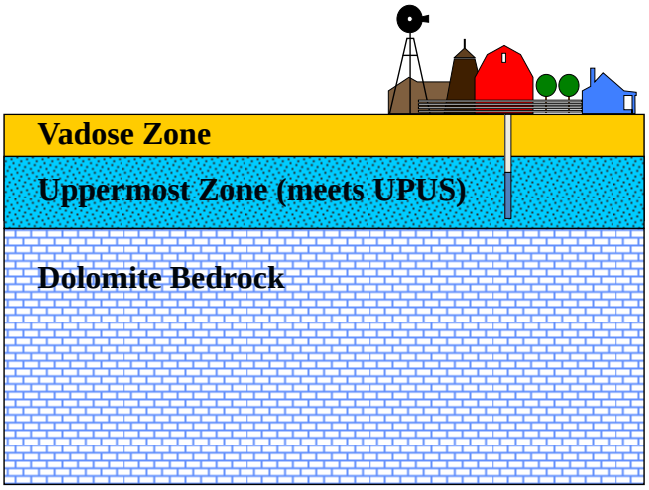
Protection of Ground Water Meeting Unrestricted Potable Use Standards



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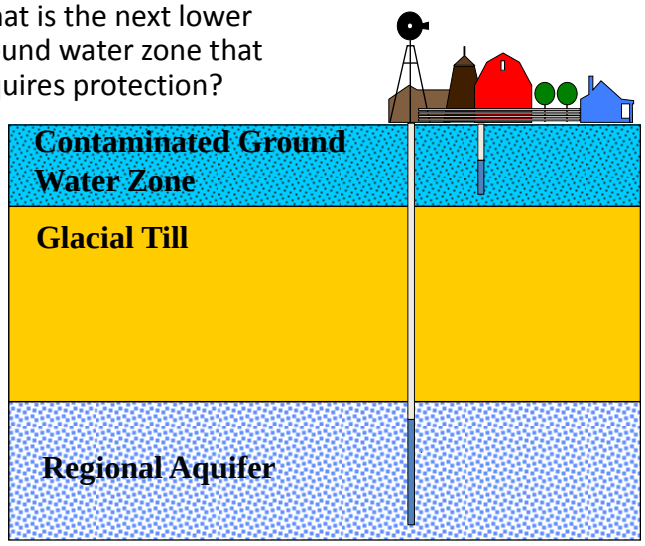
Protection of "Clean" Ground Water

- What is the next lower ground water zone that requires protection?



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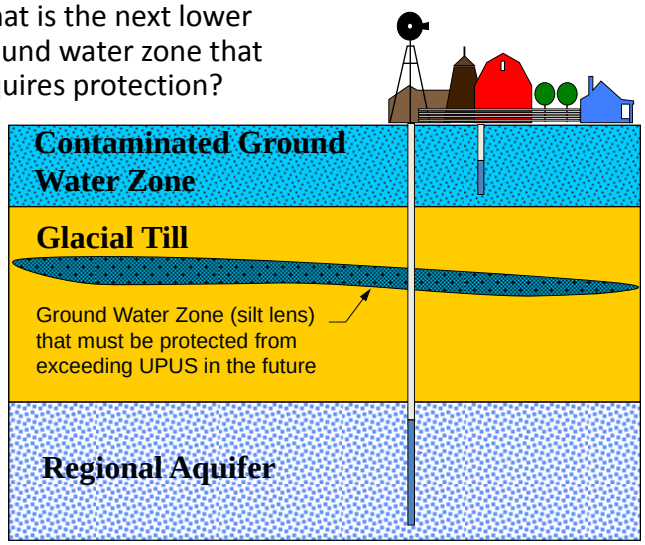
Protection of "Clean" Ground Water

- What is the next lower ground water zone that requires protection?



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Determination of ground water zones includes:

- Identification of ground water zones beneath the property
- Identification and characterization of confining zones that may separate ground water zones
- Identification of anthropogenic influences that may affect or alter the natural geology or hydrogeology

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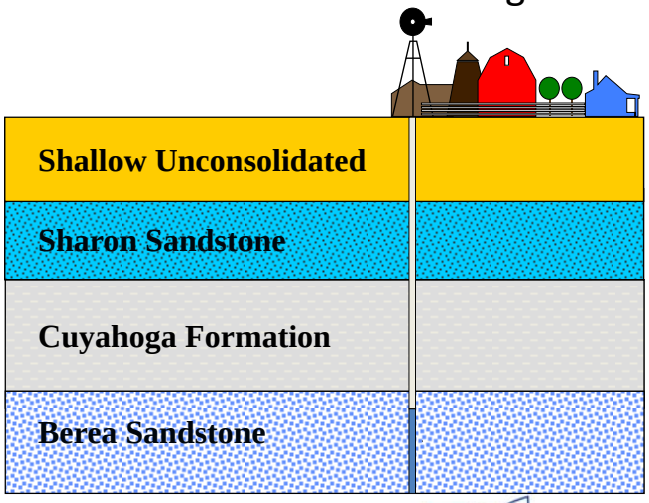
Which Zones Do I Investigate?



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Evaluating Ground Water Contamination

- Proper placement of wells is essential
  - What is your ground water flow direction?
  - Appropriate numbers of well are needed
  - Sampling needed downgradient of source areas and at points of compliance
  - Double casing may be necessary to protect ground water zones

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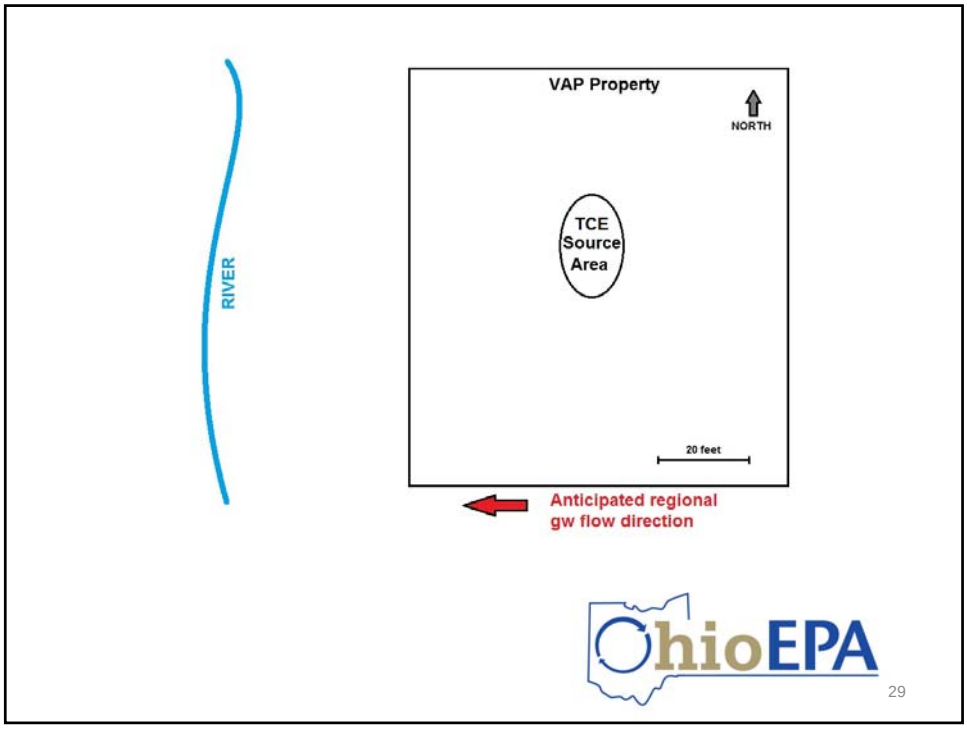
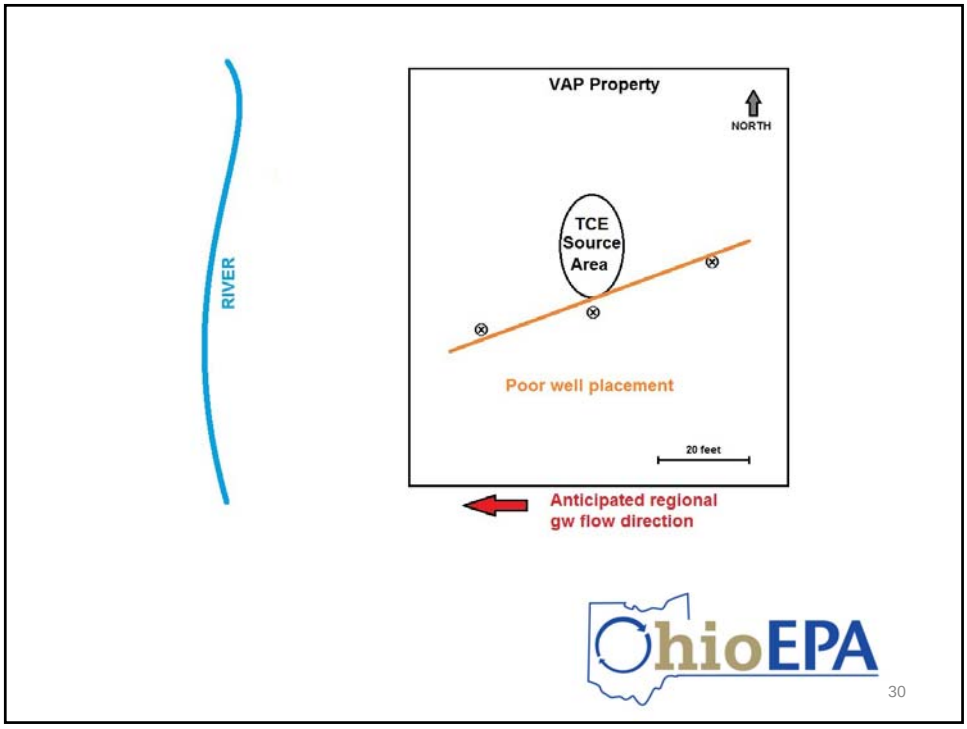
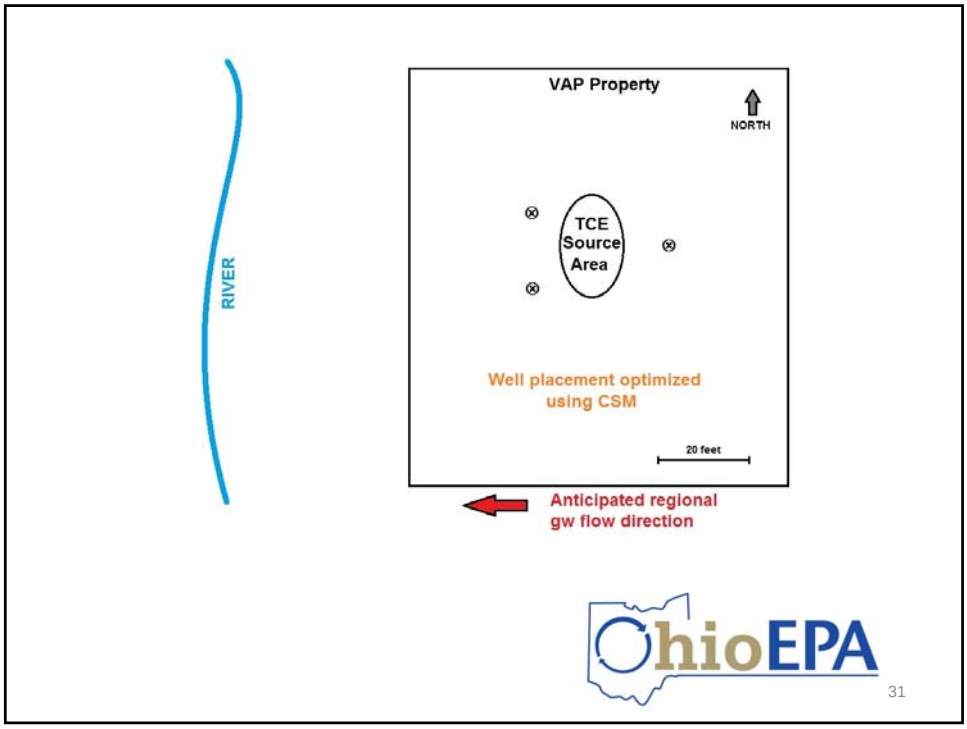

RIVER
VAP Property
NORTH
TCE Source Area
20 feet
Anticipated regional gw flow direction

29


RIVER
VAP Property
NORTH
TCE Source Area
Poor well placement
20 feet
Anticipated regional gw flow direction

30


VAP Property
NORTH
TCE Source Area
RIVER
Well placement optimized using CSM
20 feet
Anticipated regional gw flow direction

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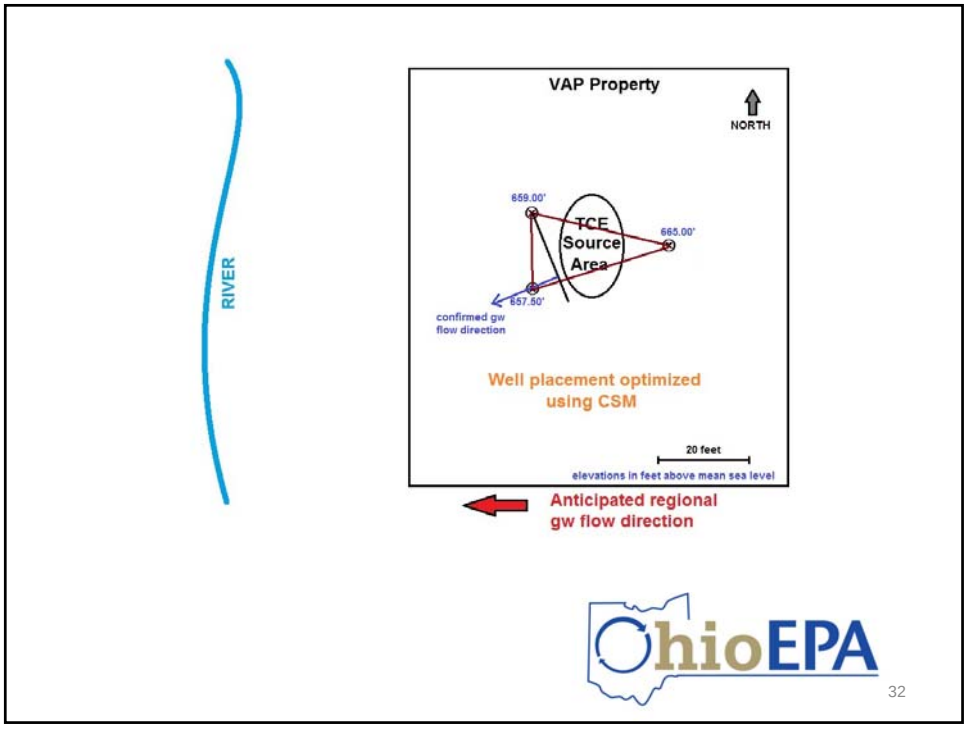
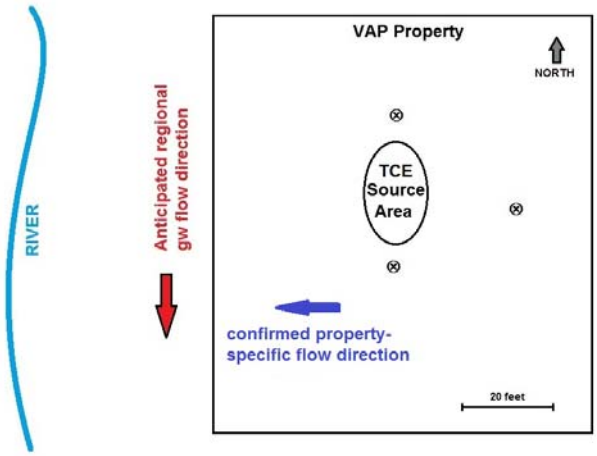

VAP Property
NORTH
659.00'
TCE Source Area
665.00'
657.50'
confirmed gw flow direction
RIVER
Well placement optimized using CSM
20 feet
elevations in feet above mean sea level
Anticipated regional gw flow direction

32



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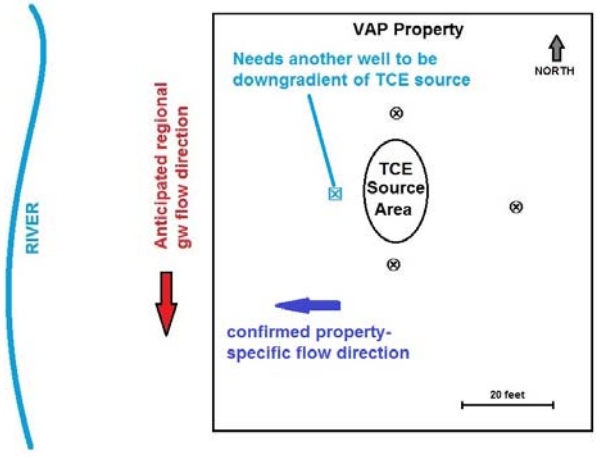

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35 **Determining if UPUS is Exceeded**

Minimum of two samples needed to confirm ground water exceeds UPUS

- Some exceptions are listed in rules
- Second sample must be collected between 48 hours and 90 days after first sample to confirm the exceedence

36 **Determining if UPUS is Exceeded**

Temporal variations must be considered when evaluating the number of samples necessary to make this determination

- Seasonal variations – usually most intense in spring or fall
- Variations resulting from heterogeneity
- Variations resulting from transient nature of contaminant transport

37 **Evaluating Ground Water Contamination**

- Proper well development is crucial for representative ground water sampling
- DDAWG's Technical Guidance Manual (TGM)
  - Minimum development recommendations
  - Not a one-size-fits all development method

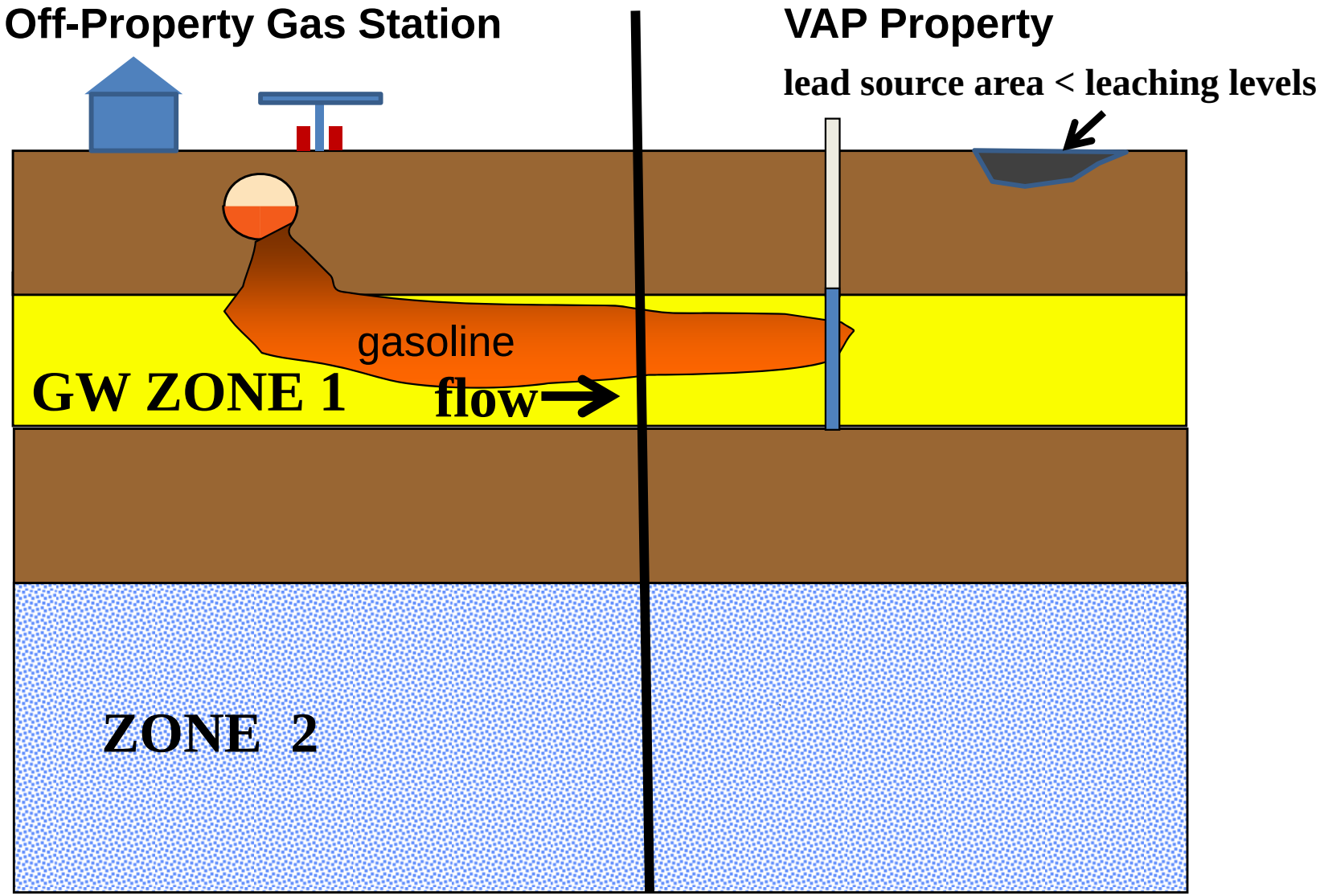
38 **Evaluating Ground Water Contamination**

- Ground water sample filtration for metals
  - Low-flow or micro-purge techniques may be used
  - Filtering for metals analysis is allowed in certain circumstances (TGC document)

39 **Evaluating Off-Property Sources of Contamination**

- The Phase I evaluated the likelihood of off-property impacts to the site
- Any potential impacts assessed during the Phase II must distinguish between contamination from on- vs. off-property sources

Evaluating Off-Property Sources



41 **Evaluating Off-Property Sources of Contamination**

- On property receptors will have to be protected even if the source is off property
- Contamination will receive a "pass-through"
  - The evaluation and/or protection of off property receptors is not required

42 **Ground Water Classification**

- Each zones that meets UPUS is not classified but must be protected
  - Protection of next lower zone generally means deeper zones are also protected
- Ground water classification determines the applicable response requirements for that zone per rule 10

43 **Ground Water Classification**

- Each zone that exceeds UPUS must be classified (Critical Resource, Class A, Class B)
- Different zones may have different classifications depending on their characteristics

44 **Determination of Yield**

- Yield testing may be necessary to determine the ground water classification
- VAP rules have minimum well construction and testing requirements for determining yield for ground water classification

45 **Determination of Yield**

Minimum well construction requirements to determine if yield falls below the yield criteria for:

- Critical resource = 8-inch well/ 12-inch borehole
- Class A = 4-inch well/ 8-inch borehole or 2-inch well/6-inch borehole with 1.15x correction factor
- All screened through ≥ 80% of the saturated zone (or corrected for <80% - See TGC document)

46 **Class B Ground Water Zones**

- Classifying ground water Class B requires yield testing
- If ground water determined to be Class B, assumes there is no potable use of that zone
- Evaluate compliance for all other non-potable exposure pathways