

**Brickhouse
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Preliminary Hydrogeologic Investigations: Regulation, Policy, and Practice in Pennsylvania

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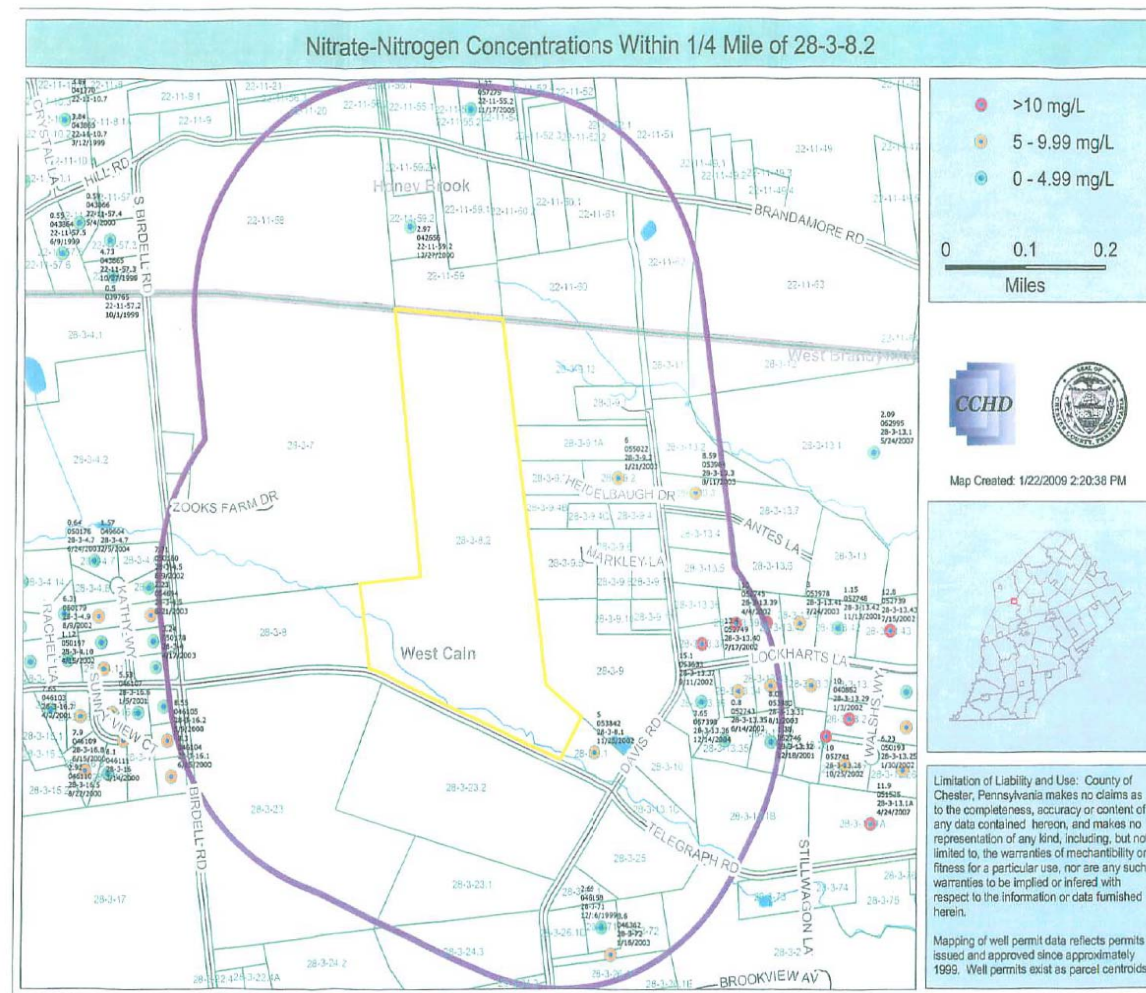
PHI Triggers: PA CODE Chapter 71.62 (c) (2) i-iv

- (2) A preliminary hydrogeologic evaluation is required when the use of subsurface soil absorption areas is proposed and one of the following exists:
 - (i) A large volume on-lot sewage system will be used.
 - (ii) A subdivision of more than 50 equivalent dwelling units with a density of more than one equivalent dwelling unit per acre is proposed.
 - (iii) The Department has documented that the quality of water supplies within 1/4 mile of the proposed site exceed five parts per million (ppm) nitrate-nitrogen.
 - (iv) The Department has determined that known geological conditions for the proposed site may contribute to the potential for groundwater pollution from the systems.

What Does This Mean In Practice?

- A large volume on-lot sewer system is an individual or community on-lot system designed to manage at least 10,000 gallons of wastewater per day.
- A subdivision of 50 EDU's located on less than 50 acres is self explanatory (excepting the loose definition of an EDU) Under current policy and guidelines, it is nearly impossible to permit on lot systems at this density making this rule mute.
- The $\frac{1}{4}$ mile rule assumes the distance is measured from the outer edge of the Site, and the offending water supply must be clearly outside the $\frac{1}{4}$ mile distance i.e. the tie goes to PADEP. Hydrogeologic divides located between the offending water supply and the Site are irrelevant.
- Known geologic features include karst topography, sinkholes, large scale faults, etc. that could feasibly result in the rapid transport of effluent to water users.

In practice, water supplies within ¼ mile exceeding 5 mg/L Nitrate is the most common trigger requiring a preliminary hydrogeologic assessment for on-lot wastewater systems



PHI Minimum Requirements:

Chapter 71.63 (c) (3) (i-iii)

(3) A preliminary hydrogeologic evaluation shall include ***as a minimum***, in map and narrative report form:

(i) The topographic location of the proposed systems in relation to groundwater or surface water flow, or both.

(ii) Estimated wastewater dispersion plume using an average daily flow of 262.5 gallons per equivalent dwelling unit per day or other flow supported by documentation.

(iii) Identification and location of existing and potential groundwater uses in the estimated area of impacted groundwater.

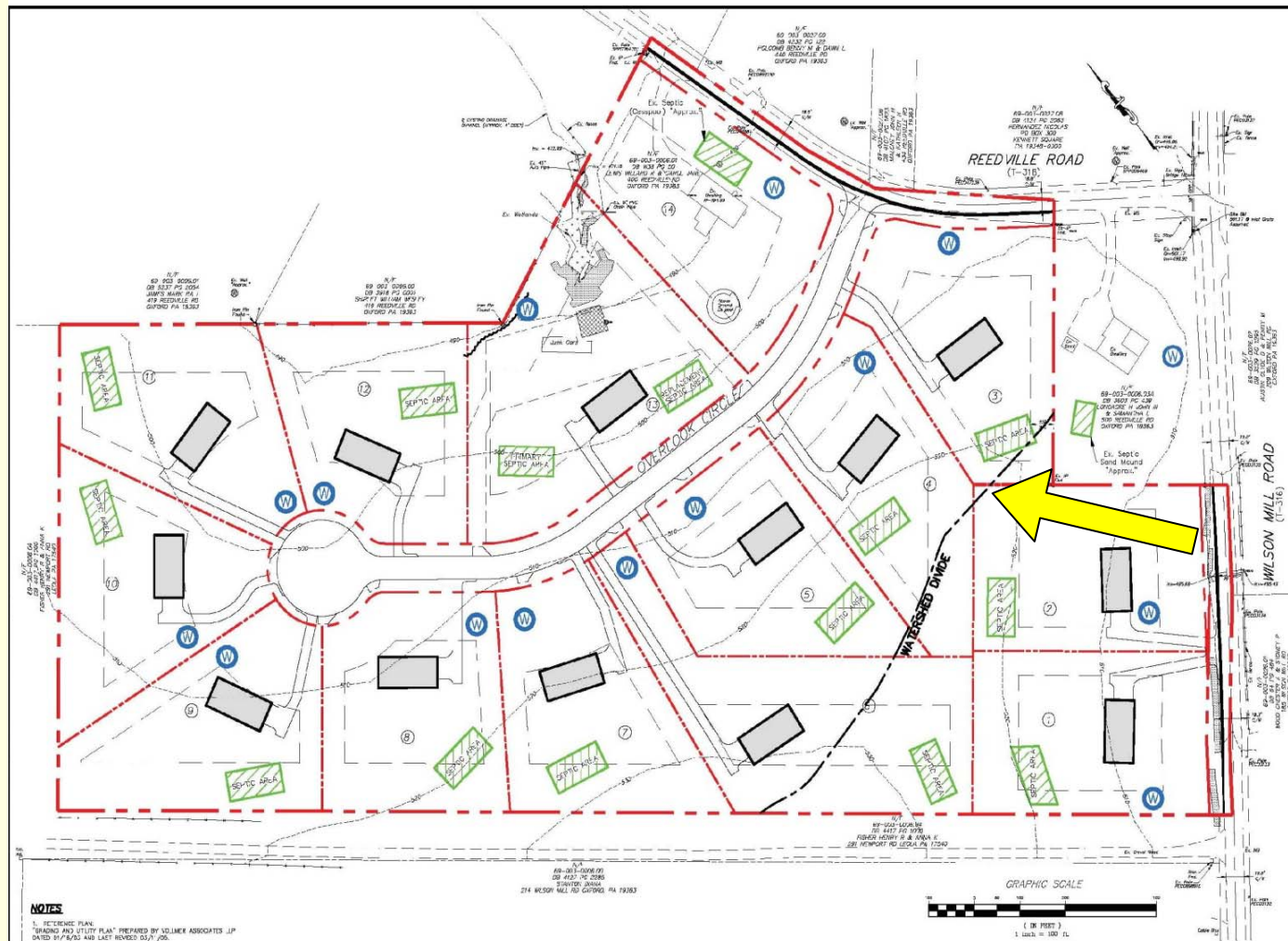
What Does This Mean In Practice?

- “As a minimum” is a critical phrase in the language of the regulation as this has been interpreted to mean that the PADEP Geologist has broad powers to require an unlimited amount of additional data beyond the minimum.
- Nowhere is it written in any regulation or policy document that an applicant must collect groundwater samples from the Site in order to prepare a PHI, yet this is in fact the practice.
- Nowhere in any regulation or policy document is it written that a PHI include a “Nitrate Mass Balance Assessment” as part of a PHI, yet this is in fact the practice.

Mapping Requirement in Practice

- Plotting the location of proposed wastewater systems on a Site plan in relation to surface water and groundwater flow is a requirement of the PHI.
- A determination of the groundwater piezometric surface (which in the practice of hydrogeology, is used to determine the direction of groundwater flow) does not trump surface water divides determined from surface topography.
- It is assumed by the department that groundwater flow directions are equivalent to surface water flow directions determined by Site topography.

Surface Water Drainage Shed Divide



Wastewater Dispersion Plume Mapping

- Both the PADEP and the EHB have ruled that it is not necessary to determine groundwater dispersion plumes for individual on-lot systems, as this is considered both impractical and irrelevant.
- The Nitrate Mass Balance Assessment, which is intended to be a drainage shed wide alternative to plotting individual dispersion plumes, has been determined to be more practical and at least as protective of existing and potential future users of groundwater.

Applicable Policies

The EHB in Lewis vs. PADEP determined as a “Finding of Fact”, that the following PADEP Policies are applicable to conducting PHI’s for on lot wastewater systems:

- Impact of the Use of Subsurface Disposal Systems on Groundwater Nitrate Nitrogen Levels (DEP Document # 362-2207-004)
- Policy and Procedure: Wastewater Discharge to Groundwater: Individual and Community On-Lot Disposal Systems (July 9, 1982)

Nitrate Mass Balance Assessment

- EHB has ruled that the Nitrate Mass Balance Assessment equation as mandated by PADEP, is a reasonable method determining the potential for nitrate contamination, and that the specific values PADEP mandates for the purpose of solving are also reasonable.
- While there may be other methods and values that are also reasonable, and potentially more accurate, PADEP has no obligation to consider or accept them.

Nitrate Mass Balance Equation

as published in the Lewis vs. EHB, Findings of Fact

$$[(C_p \times Q_p) + (C_{gw} \times Q_r)] / (Q_p + Q_r) = C_{mix}$$

C_{mix} = Nitrate concentration in groundwater after installation of septic tank (mg/L)

C_p = Nitrate concentration in percolate wastewater (mg/L)

Q_p = Volume of percolate wastewater (gallons/day)

C_{gw} = Nitrate concentration in groundwater from shallow aquifer site specific wells (mg/L)

Q_r = Volume of precipitation recharge (gallons/day)

Qr = Volume of Precipitation Recharge

- Define the size of the area of interest, which is the acreage of the smallest definable surface water drainage shed.
- Determine the underlying geologic formation from published maps (PA Atlas of Geologic Quad Maps).
- Determine the published average recharge rate from Stream Stats or other published USGS reports.
- http://pa.water.usgs.gov/recharge/state_map.html
- Value is typically in inches of water per year. Convert to gallons/day/acre to allow direct comparisons to wastewater flows.
- Multiply the recharge rate by the number of acres on site within each surface water drainage shed.

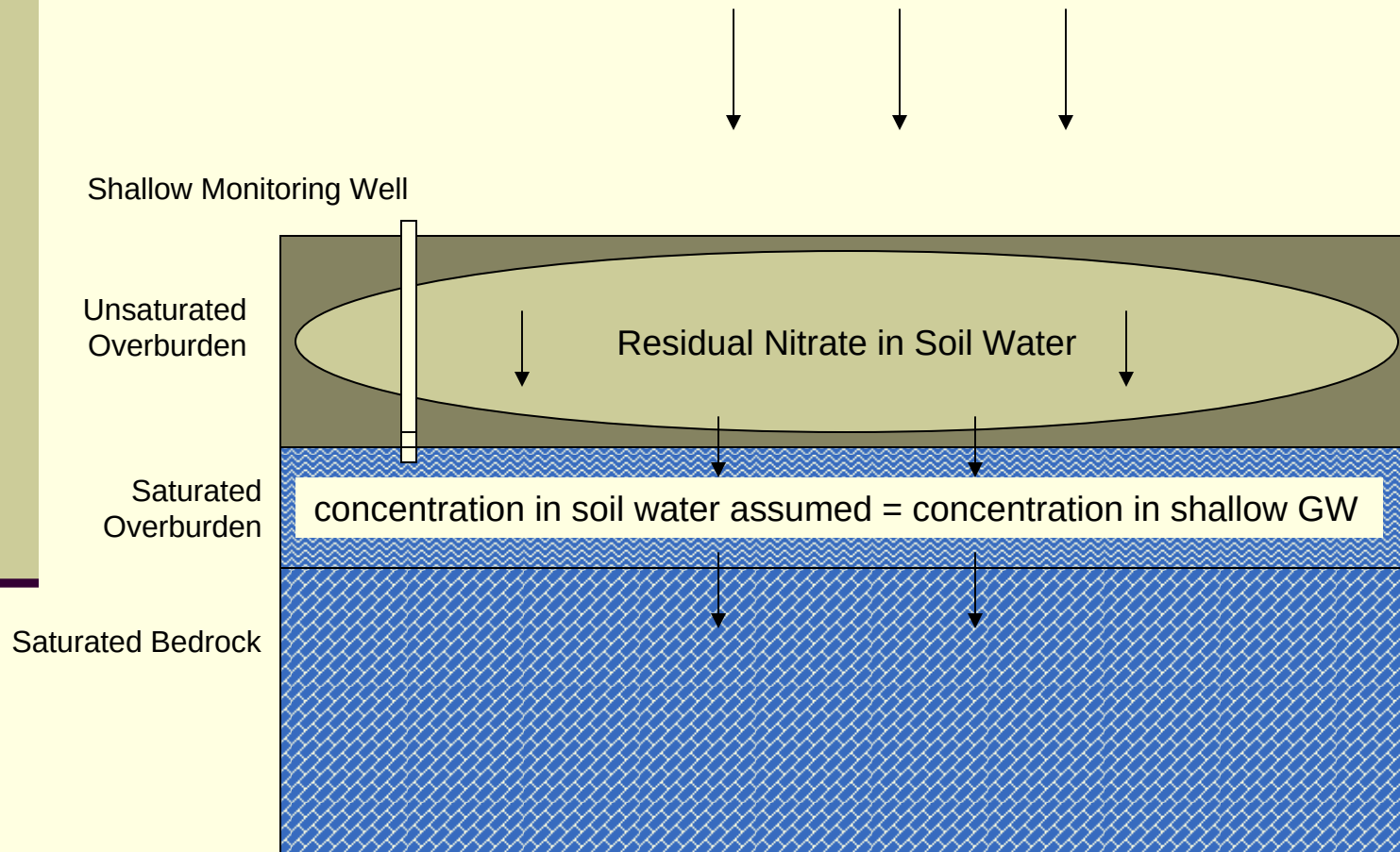
Qgw = Recharge Quality

(assumed equal to existing shallow groundwater quality)

- The Mass Balance equation requires an estimate of groundwater recharge quality “at the water table”. It is assumed that this number is fixed and will not change over time after the development is constructed.
- For subdivisions of ten or fewer systems, sampling of existing on site water supply wells for Nitrate can be used to quantify recharge quality (this policy decision is not found anywhere, it is an unwritten SERO policy). It is unknown if this would apply to other regions.
- For subdivisions of greater than 10 systems, the drilling and sampling of on site groundwater monitoring wells is necessary.
- Loose rule of thumb is one shallow groundwater sample for each drainage shed, but fewer wells may be acceptable, or in some circumstances, DEP may request additional wells. Consult with the PADEP regional geologist if questionable.

Rational for Recharge Quality Value

Rainfall Recharge = 1.0 mg/L Nitrate



Temporary Well Points via Geoprobe

Pros

- Less expensive (\$750 to \$1,000 per well point for contractor costs)
- Can be sampled and abandoned the day of installation

Cons

- Can't be used if depth to groundwater is below firm overburden/semi-competent or competent rock
- May be influenced by leakage of shallow perched water zones
- Yields may be insufficient to obtain representative samples
- PADEP may question data validity

Installation of Temporary Well via Geoprobe



Permanent Monitoring Wells via Air or Mud Rotary Drilling

- Pros
 - Can penetrate any geologic formation
 - Have greater control over sample collection depth
 - Yields generally sufficient for sample collection
 - Can sample more than once to evaluate seasonal fluctuations/trends over time
 - Can be used for additional hydrogeologic testing (pump and/or slug testing)
- Cons
 - Grout must set for minimum 72 hours prior to purging and sampling
 - More expensive (\$2,000-\$3,000 per well for contractor costs)
 - Driller must return after sampling to abandon well

Installing PVC casing in Monitoring Well after drilling borehole with Air Rotary Rig



Sample Collection Guidance

- Screen well across first water bearing zone. PADEP requires samples to be collected from as close as possible to the top of the water table. This represents the quality of existing recharge water. Deeper groundwater generally has lower Nitrate results, but PADEP's goal is to determine recharge quality at the water table.
- Develop well to remove drilling fluids/excessive sediment. A submersible type pump is typically used.
- Place samples in laboratory prepared bottleware, cool to 4°C, follow standard chain of custody documentation, and submit to a Pennsylvania certified laboratory. Hold time on Nitrate (EPA Method 353.2) is 48 hours!

Transfer of GW Sample from disposable bailer to lab supplied plastic bottleware



Sample preservation on ice in hard plastic cooler



Q_e = Effluent Flow Volume

- Determine the number of proposed wastewater systems located in each surface water drainage shed.
- Multiply the number of systems by 262.5 gallons per day for single family residential homes (the EHB has ruled that while supporting data may show that actual long term flows from residential homes are lower than 262.5, they have no obligation to consider or use alternative flow values).

Ce = Effluent Quality

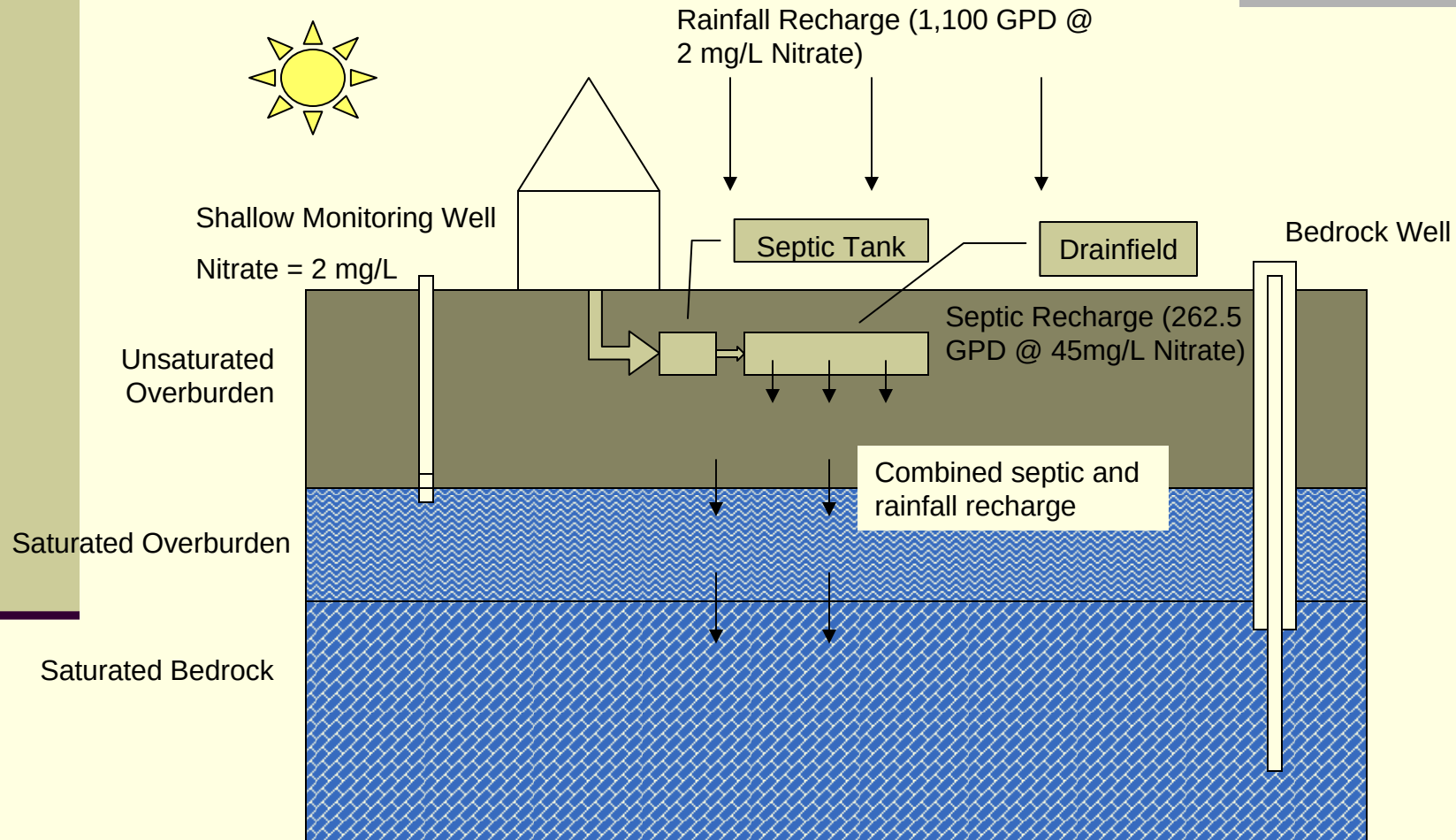
- The effluent quality is an estimate of the nitrate concentration in effluent recharging the groundwater through the drainfield.
- For conventional on-lot wastewater systems, the nitrate concentration is set equal to 45 mg/L (The EHB has ruled that while a variety of data is available indicating that nitrate concentration in effluent beneath the drainfield is less than 45 mg/L, they have no obligation to consider or use alternative effluent quality values.
- For Bio-Microbics Systems, PADEP allows Ce of 20 mg/L.

Solve The Formula

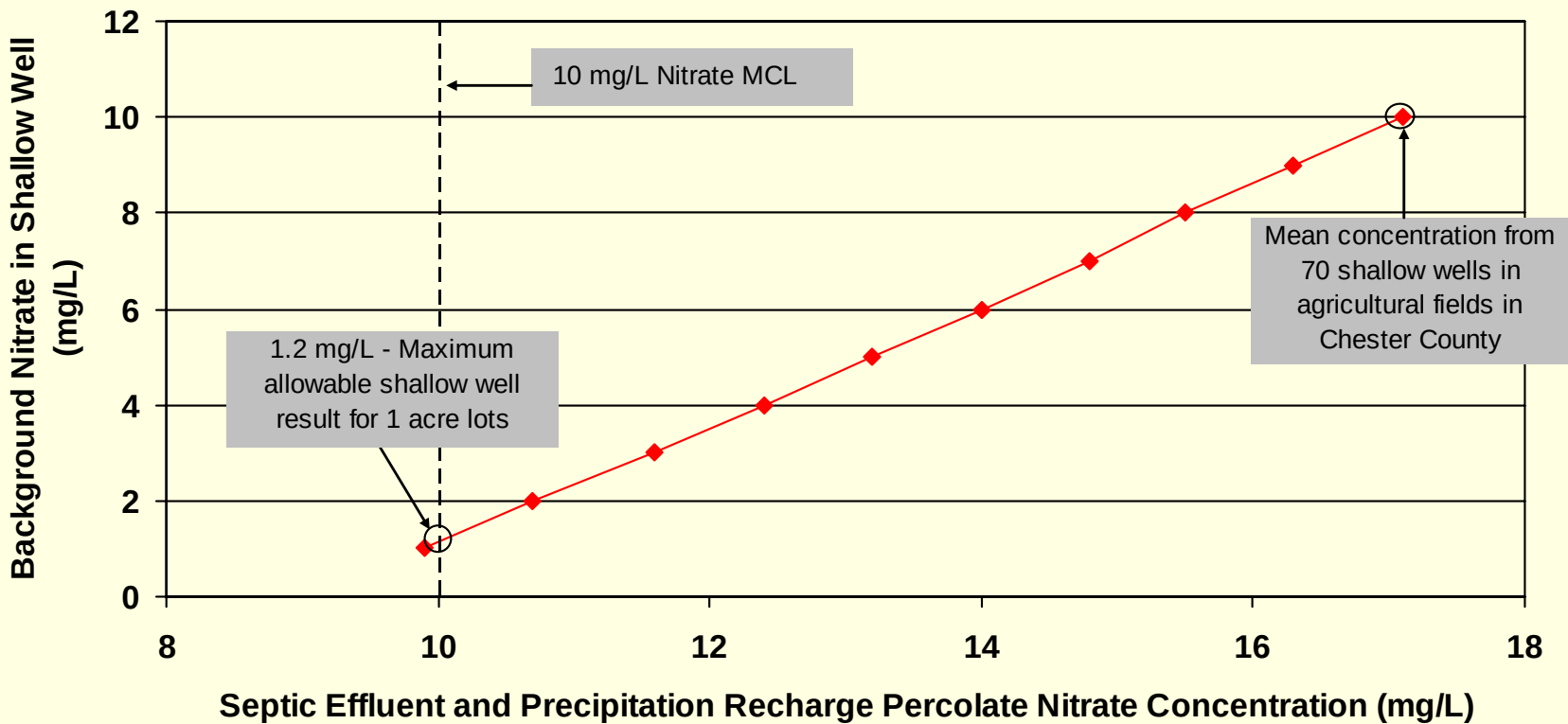
- $$\frac{[(\text{daily recharge volume in gpd}) \times (\text{recharge nitrate concentration in mg/L}) + (\text{daily effluent volume in gpd}) \times (\text{effluent nitrate concentration in mg/L})]}{[\text{daily recharge volume} + \text{daily effluent volume}]} = \text{"X" mg/L nitrate.}$$
- If the result is equal to or greater than 10.0 mg/L, adjust the number of systems or consider use of advanced treatment systems until result is less than 10.0 mg/L.

1 Acre Lot Example

$$\frac{[262.5 \text{ GPD} \times 45 \text{ mg/L}] + [1,100 \text{ GPD} \times 2 \text{ mg/L}]}{(262.5 \text{ GPD} + 1,100 \text{ GPD})} = 10.3 \text{ mg/L}$$



1 Acre Lot Nitrate Mass Balance PADEP Regional Geologist Formula Result as a Function of Shallow Well Nitrate Concentration



Example Mass Balance Assessment Results (10 AC parcel with 1,100 GPD/AC recharge)

- Example Calculation with
Nitrate in Effluent = 45 mg/L

<u>Nitrate (Cr)</u>	<u># Systems</u>
2 mg/L	9
4 mg/L	7
6 mg/L	4
8 mg/L	2
11 mg/L	0

- Example Calculation with
Nitrate in Effluent = 20 mg/L

<u>Nitrate (Cr)</u>	<u># Systems</u>
2 mg/L	33
4 mg/L	25
6 mg/L	16
8 mg/L	8
11 mg/L	0