N and P Cumulative Effects
&
Gaining/Losing Surface Water

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Nitrate Cumulative Ground Water Effects

- Nitrate effects between two or more consecutive drainfields

  - Applies to all consecutive on-site drainfields aligned with the ground-water flow direction

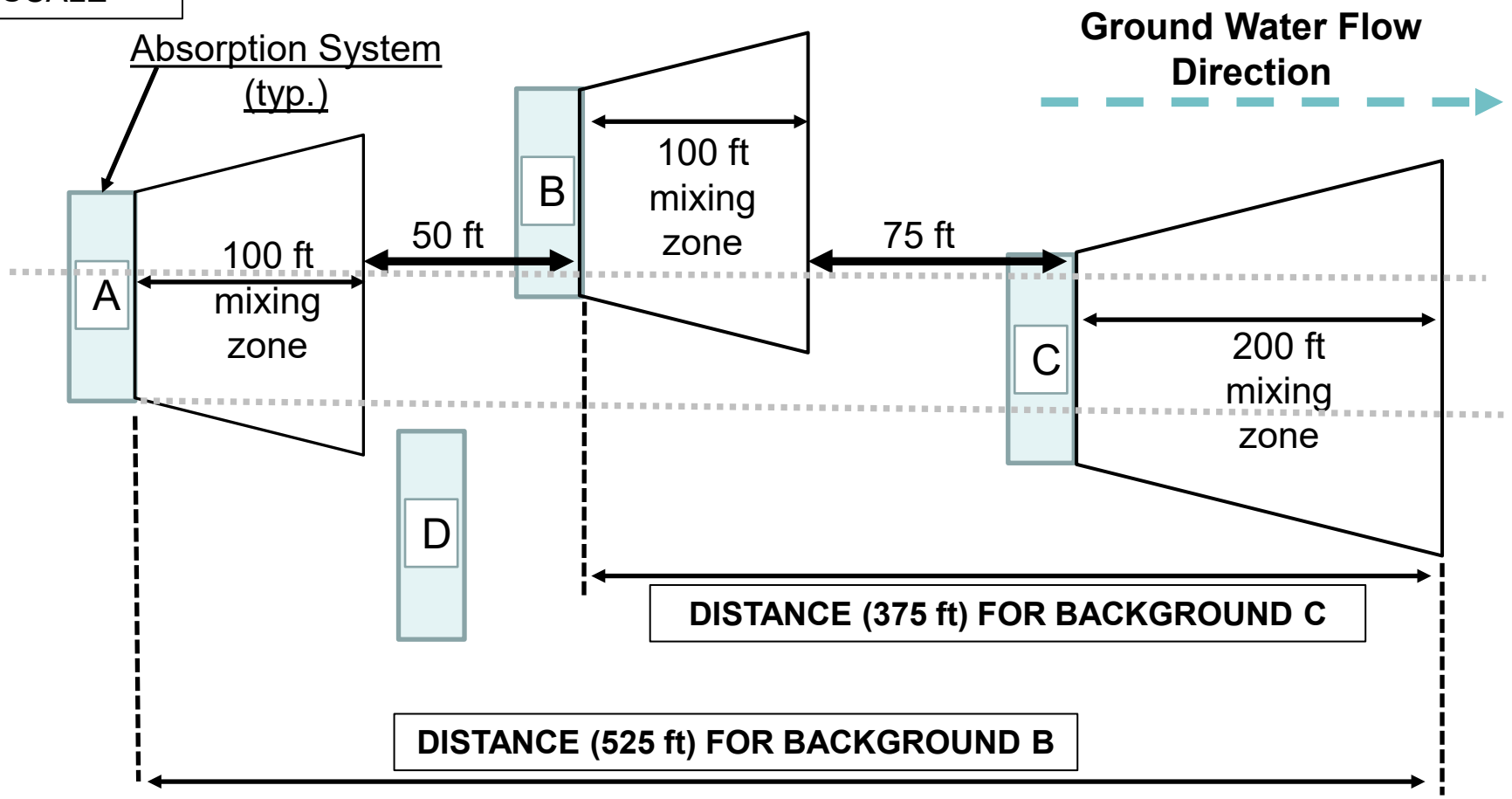
  - May include nearby off-site lots (may not include established upgradient lots due to background N)

  - Only consecutive drainfields in a straight line downgradient are included (5° spread on either side of mixing zone is not accounted for)

Mixing Zone Schematic

Cumulative Nitrogen Impacts

NOT TO SCALE



1. The background concentration for A is based on groundwater sample
2. Calculate the background concentration for B and C (updated spreadsheet) using distances shown above using nitrate spreadsheet. These calculations are ONLY used to determine the background for each drainfield downgradient of A.
3. Use those background values for A, B and C to calculate final concentration at end of each mixing zone to determine if it meets the applicable criteria (e.g. 5, 7.5 mg/L)

DRAFT NITROGEN SPREADSHEET

TABLE 1. Appendix B Example. Calculation of Background Concentrations for use in the Cumulative Effects Calculations in Table 2 (below).

Variable	(K)	(I)	(D)	(L)	(Y)	(Ng)	(Nr)	(Ne)	(#I)	(QI)	~~(P)~~	~~(V)~~	(W)	(Am)	(As)	(Qg)	~~(Qr)~~	(Qe)	Nb
drainfield	Hydr. cond. (ft/day)	Hydr. grad. (ft/ft)	Mix zone thick (feet)	Distance to end of last (most downgradient) mixing zone (feet)	Drain-field width (feet)	Back-ground nitrate (mg/l)	Nitrate in precip (mg/l)	Effluent Nitrate conc. (mg/l)	# of single family homes	Effluent per drain. (ft3/day)	Annual precip. (in/yr)	Percent precip. recharge	Down-grad. width (feet)	Mix zone area (ft^2)	Mix. zone surface area (ft^2)	Ground water flow (ft3/day)	Recharge flow (ft3/day)	Effluent flow (ft3/day)	Background Nitrate (as N) concentration for next downgradient absorption system (mg/L)
A	20.00	0.010	15.0	525	100.0	0.30	1.0	50.0	1.0	26.70	12.0	0.2	191.88	2878.13	100734.38	575.63	55.20	26.70	2.50
B	20.00	0.010	15.0	375	100.0	2.50	1.0	50.0	1.0	26.70	12.0	0.2	165.63	2484.38	62109.38	496.88	34.03	26.70	4.93
C	20.00	0.010	15.0	200	100.0	4.93	1.0	50.0	1.0	26.70	12.0	0.2	135.00	2025.00	27000.00	405.00	14.79	26.70	7.71
						7.71					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
						#DIV/0!					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
						#DIV/0!					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
						#DIV/0!					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
						#DIV/0!					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
						#DIV/0!					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
						#DIV/0!					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
						#DIV/0!					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
						#DIV/0!					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!

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TABLE 2. Appendix B Example. Cumulative Drainfield Calculations (after correct background values calculated in Table 1).

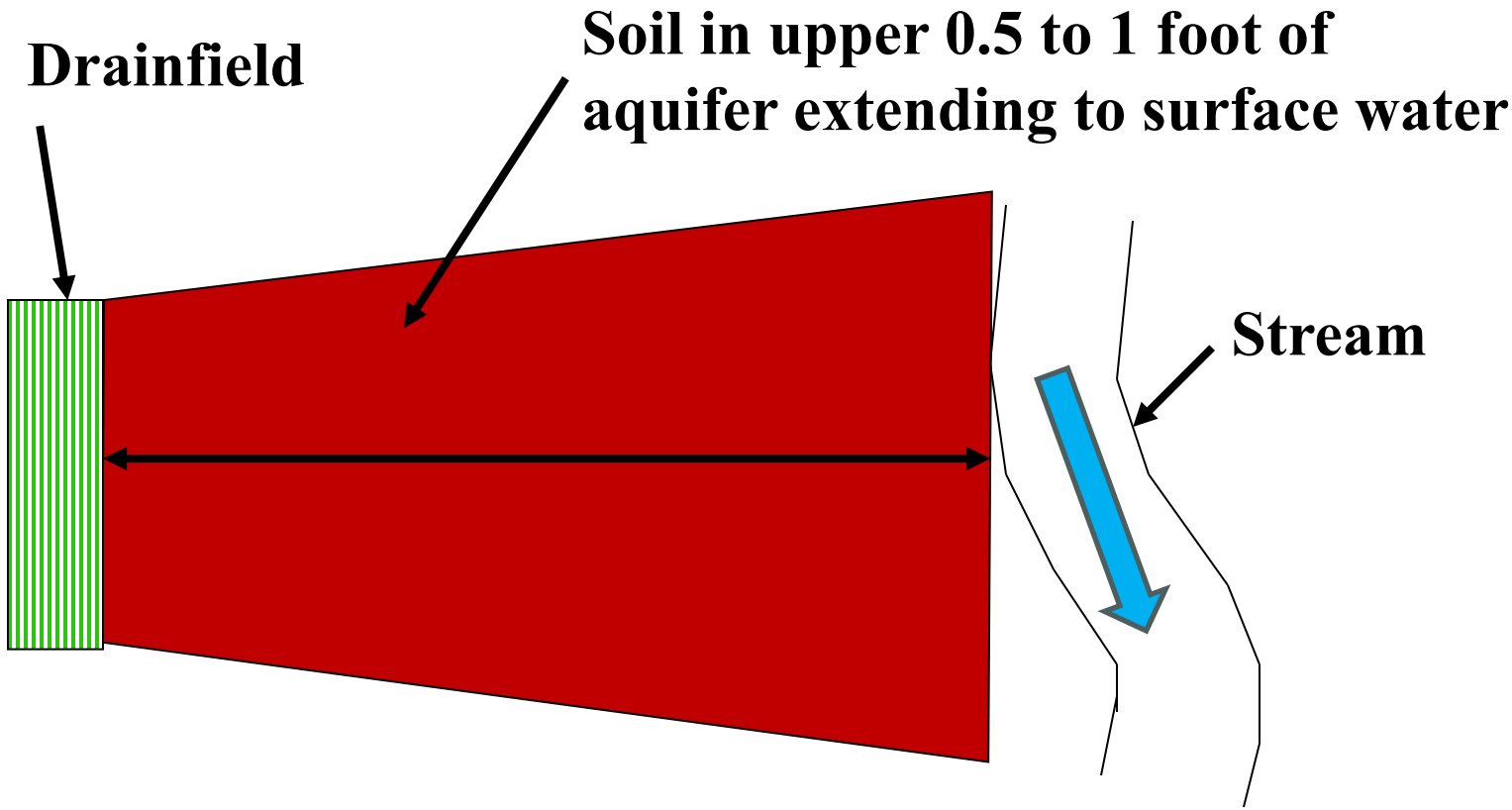
Variable	(K)	(I)	(D)	(L)	(Y)	(Ng)	(Nr)	(Ne)	(#I)	(QI)	~~(P)~~	~~(V)~~	(W)	(Am)	(As)	(Qg)	~~(Qr)~~	(Qe)	Nt
drainfield	Hydr. cond. (ft/day)	Hydr. grad. (ft/ft)	Mix zone thick (feet)	Mixing zone length (feet)	Drain-field width (feet)	Back-ground nitrate (mg/l)	Nitrate in precip (mg/l)	Effluent Nitrate conc. (mg/l)	# of single family homes	Effluent per drain. (ft3/day)	Annual precip. (in/yr)	Percent precip. recharge	Down-grad. width (feet)	Mix zone area (ft^2)	Mix. zone surface area (ft^2)	Ground water flow (ft3/day)	Recharge flow (ft3/day)	Effluent flow (ft3/day)	Nitrate (as N) concentration at end of mixing zone (mg/L)
A	20.00	0.010	15.0	100	100	0.30	1.0	50.0	1.0	26.70	12.0	0.2	117.50	1762.50	11750.00	352.50	6.44	26.70	3.80
B	20.00	0.010	15.0	100	100	2.50	1.0	50.0	1.0	26.70	12.0	0.2	117.50	1762.50	11750.00	352.50	6.44	26.70	5.84
C	20.00	0.010	15.0	200	100.0	4.93	1.0	50.0	1.0	26.70	12.0	0.2	135.00	2025.00	27000.00	405.00	14.79	26.70	7.72
						7.71					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
						#DIV/0!					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
						#DIV/0!					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
						#DIV/0!					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
						#DIV/0!					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
						#DIV/0!					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
						#DIV/0!					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
						#DIV/0!					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
						#DIV/0!					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
						#DIV/0!					12.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!


CUMULATIVE EFFECTS?

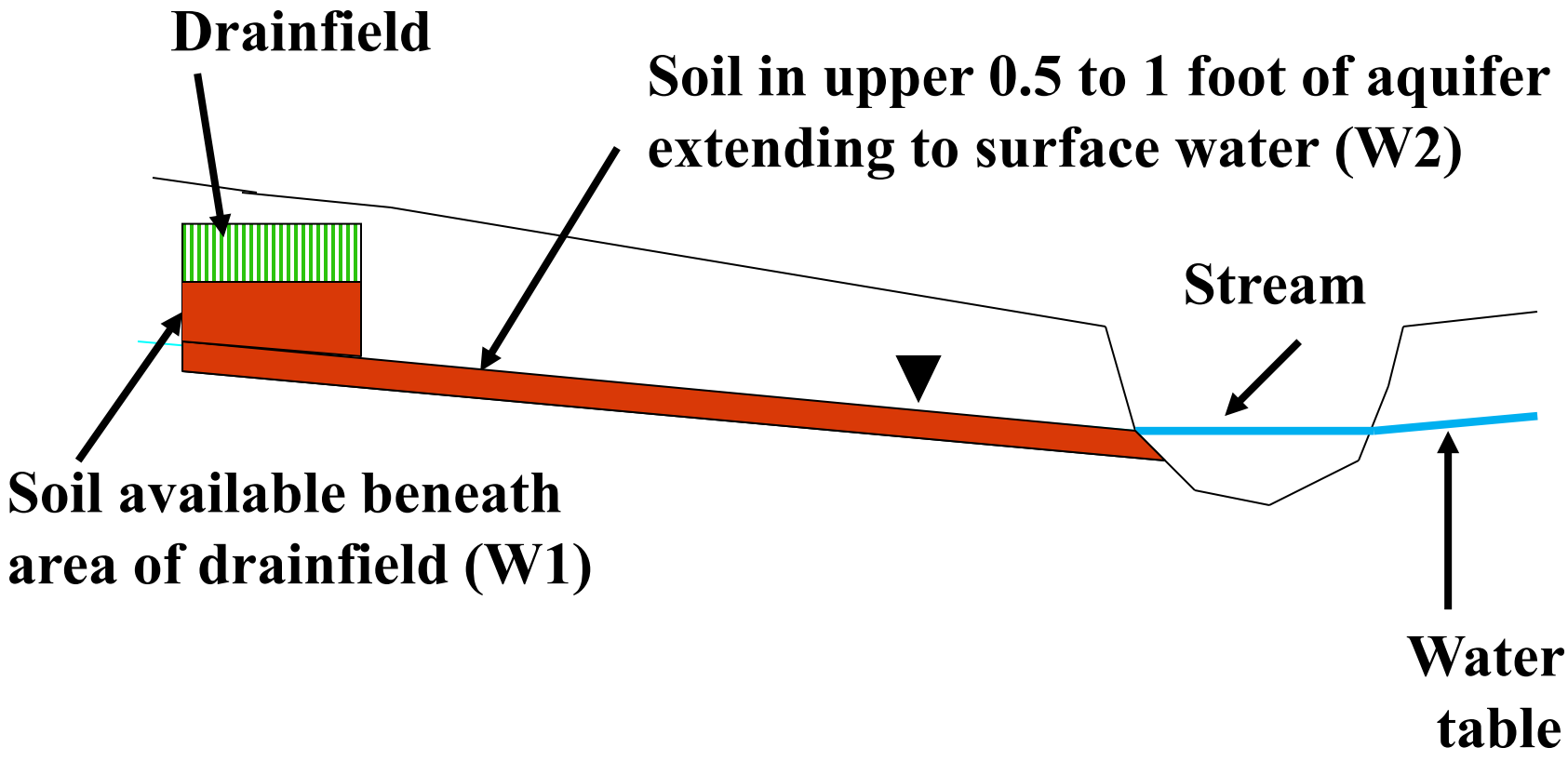
Phosphorous Breakthrough

- Must be calculated for all drainfields to nearest impacted high-quality surface water. High quality does not include (75-5-103, MCA):
    - Doesn't flow or no surface expression for more than 270 days in most years, or
    - is an irrigation ditch that does not return to state waters,
- Distance to surface water from drainfield
    - Along hydraulic gradient if measured on site or defined in hydrologic report
    - Along shortest distance to surface water if gradient estimated from topography

Available Soil for Phosphorous Adsorption (map view)



Available Soil for Phosphorous Adsorption (cross-section view)

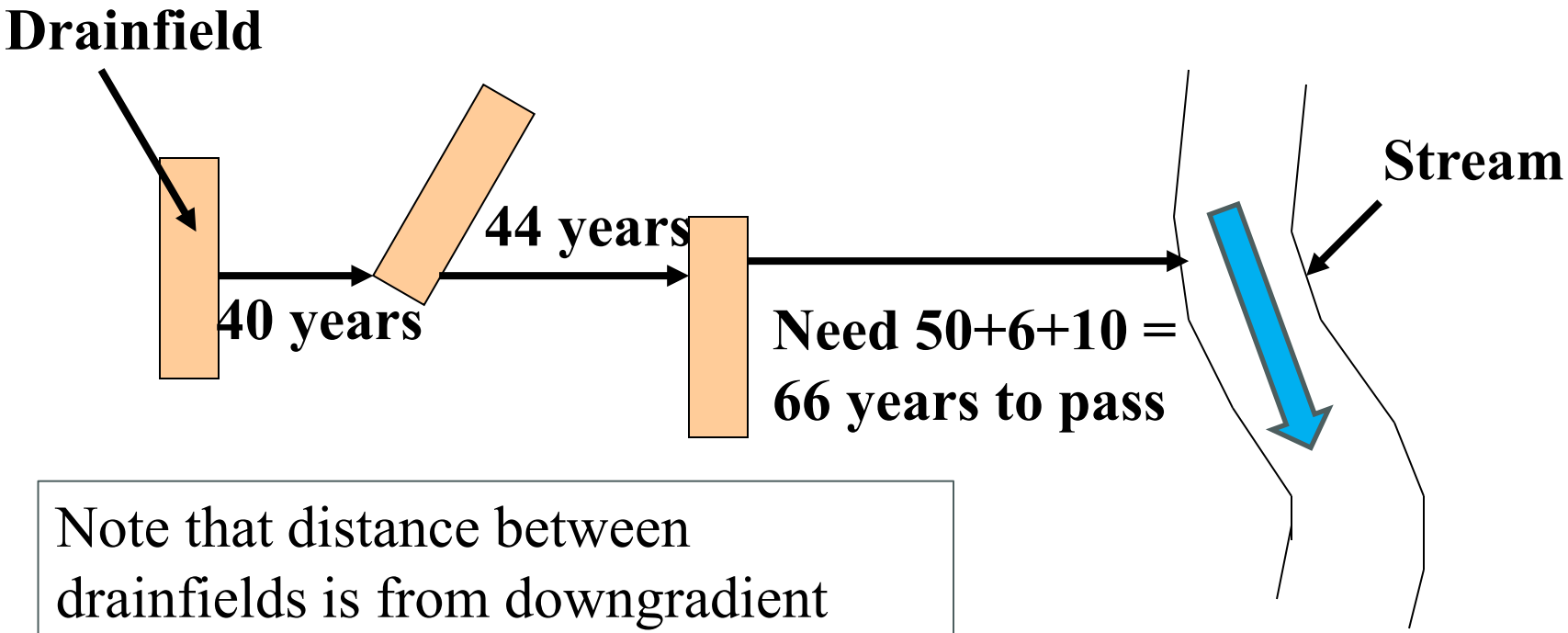


Cumulative Effects for Phosphorous

- Phosphorous effects accumulate between two or more consecutive drainfields
  - Applies to all consecutive on-site drainfields (using assumed or measured groundwater flow)
  - Can Include off-site lots both up and downgradient
  - Only consecutive drainfields in a straight line are included (drainfields within 5° spread on either side not included)
  - Easy for drainfields with same design flow – otherwise call us (draft phosphorus spreadsheet addresses this issue)

Cumulative Effects for Phosphorous

If less than 50 years to breakthrough between consecutive drainfields, final breakthrough to surface water must account for total of extra years required.

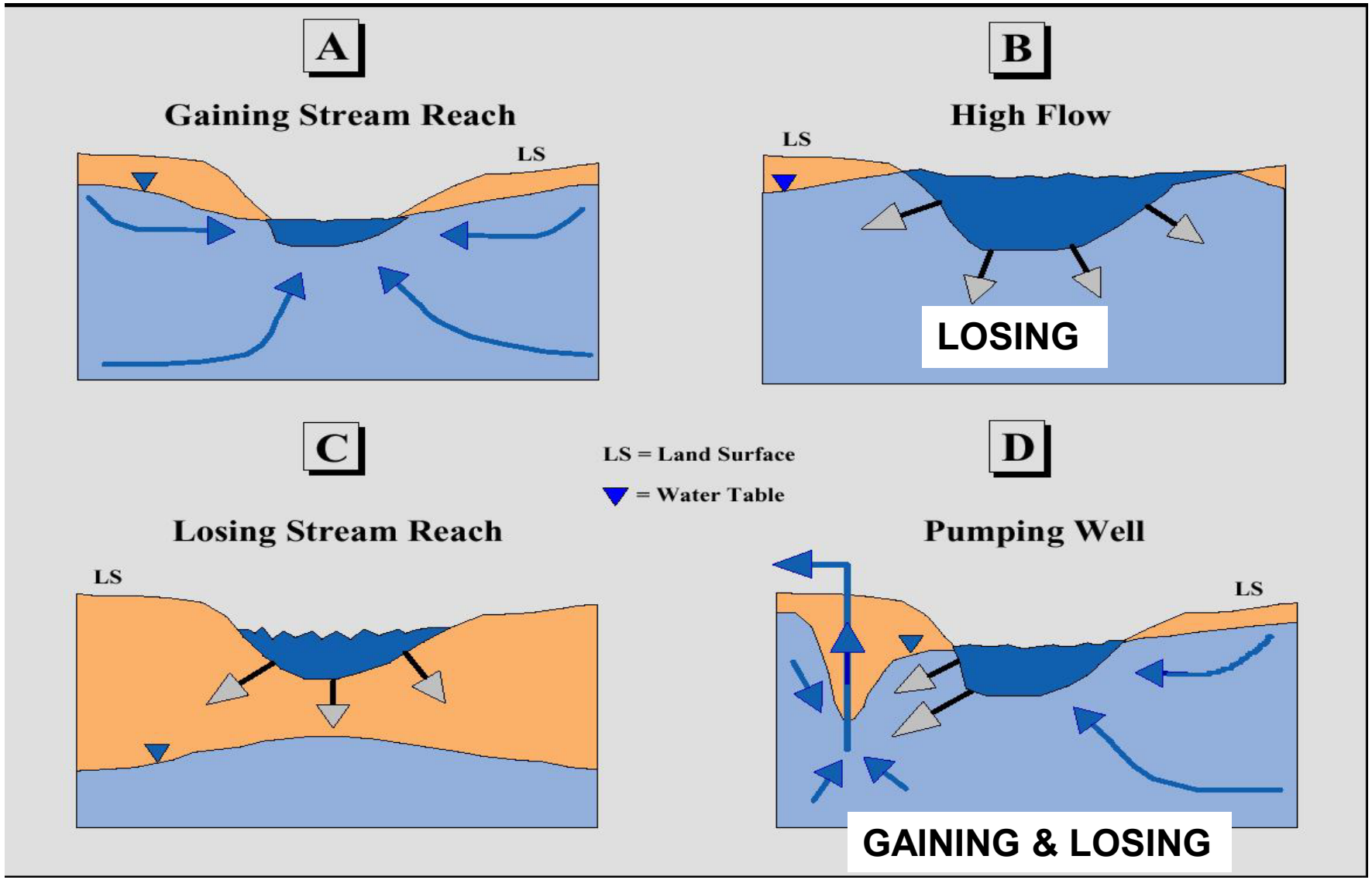


Note that distance between drainfields is from downgradient edge to upgradient edge

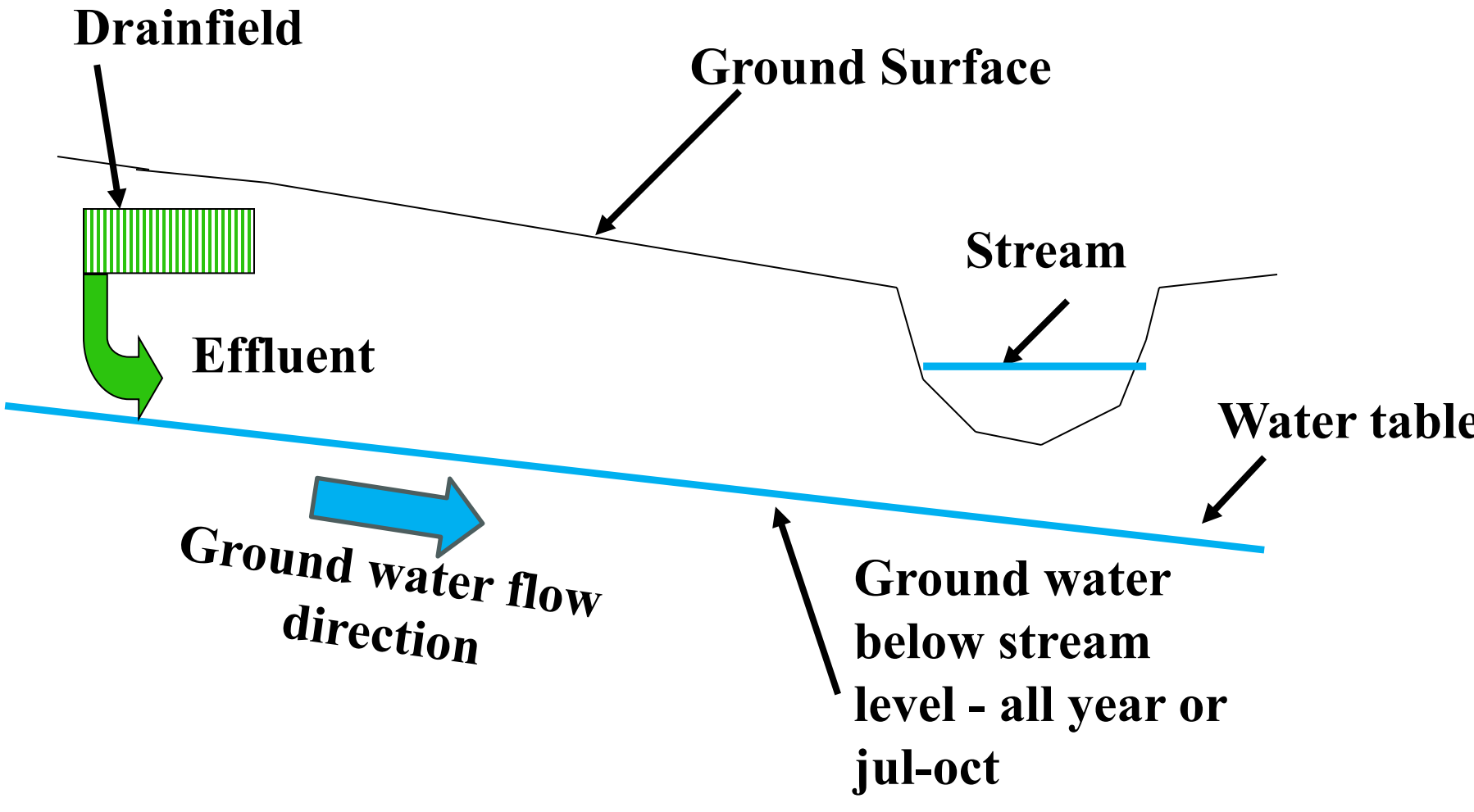
Gaining or Losing Surface Water

- Impacts to surface waters only applies to surface waters that receive groundwater/effluent ("gain") for any length of time during the applicable period….
  - 7Q10 – applicable period is all year (but usually can just look during spring runoff to determine if it gains)
  - 14Q5 – applicable period is July, August, September, October.
- Most canals/ditches are losing, but some gain (some are even designed to gain excess irrigation).
- Elevation of surface water must be below the bottom of absorption trench to be gaining (assume water does not flow up).
- Shallow confining layer – follow topography or top of confining unit slope (if known)

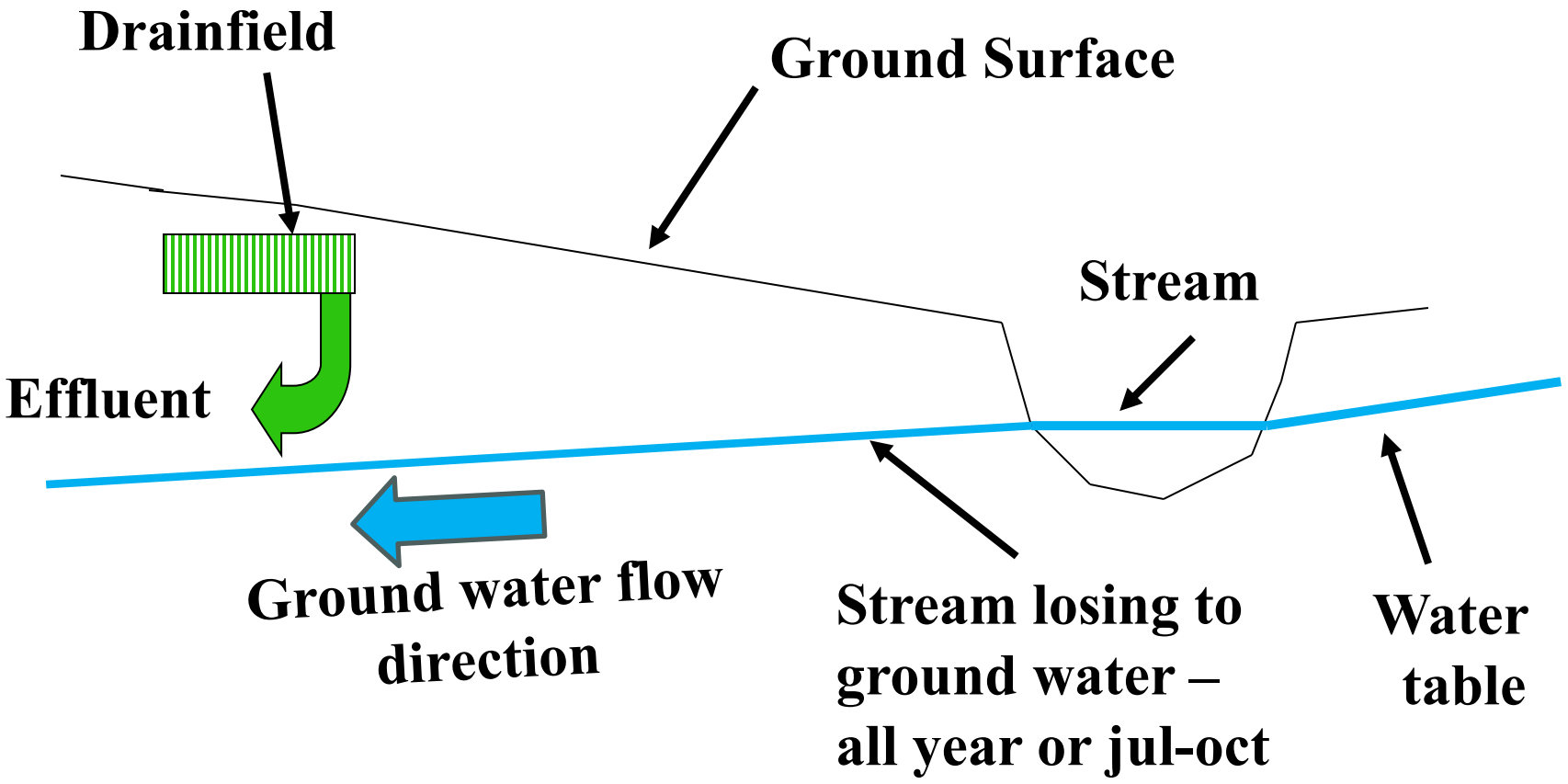
Surface Water - Ground Water Interaction Examples



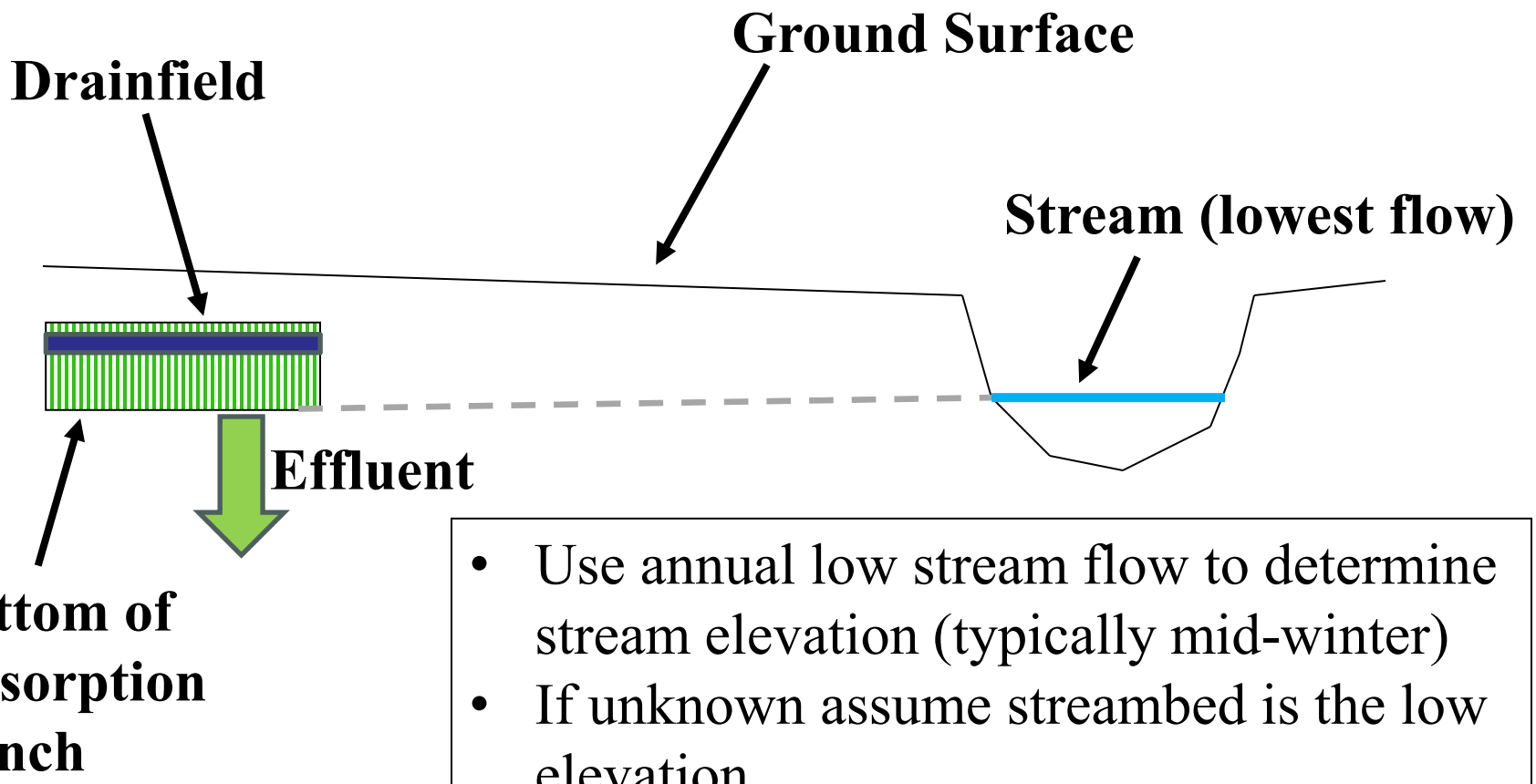
When Effluent Cannot Reach a State Water 1



When Effluent Cannot Reach a State Water 2



When Effluent Cannot Reach a State Water 3



- Use annual low stream flow to determine stream elevation (typically mid-winter)
- If unknown assume streambed is the low elevation

Measuring Gaining or Losing

- Most common way is to simultaneously measure water elevations in surface water and adjacent groundwater.
  - Groundwater measuring point approximately 10-30 feet from surface water (site condition dependent)
  - Weekly measurements during the applicable period
  - Two methods: one when groundwater flow direction at the site is measured and other when its just estimated.
  - Interimt method has been used, hope to publish final with the new Nondeg Circular (scheduled for July 2025).

Questions?

Why is a Surface Water Analysis Necessary?

- Complying with ground water N and P limits doesn't necessarily protect surface water
- Eutrophication – negative visual, human health, and biota impacts
  - Excess algae
  - Algal blooms (toxic)
  - Decreased dissolved oxygen
- What about "dead" pothole lakes?
  - High quality state water – nondeg still applies