Making Do With Scant Data

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A HYDROGEOLOGIST'S CREDO

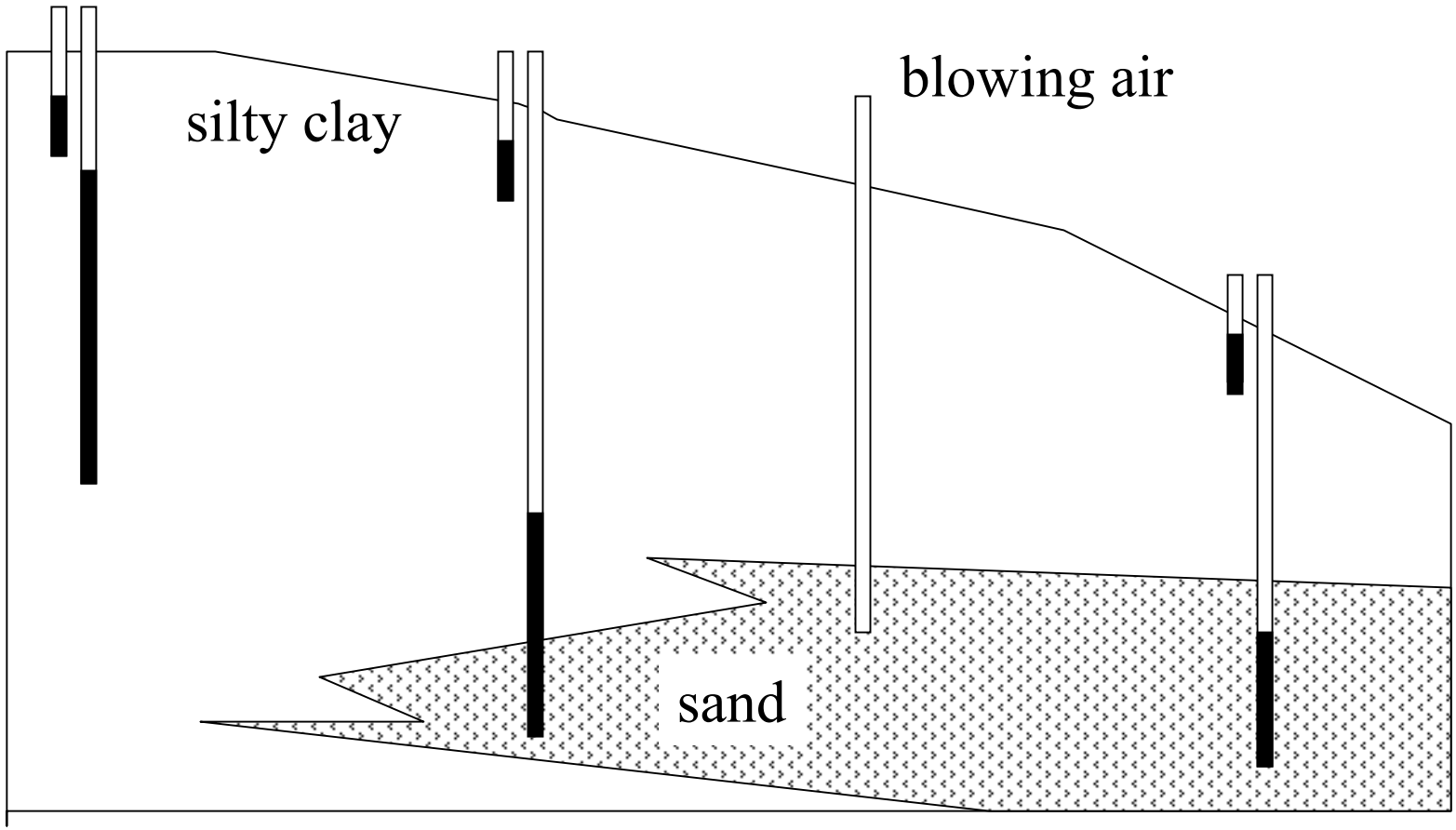
It is the mark of an instructed mind to rest satisfied with the degree of precision which the subject permits ….and not to seek an exactness where only an approximation of the truth is possible.

Aristotle

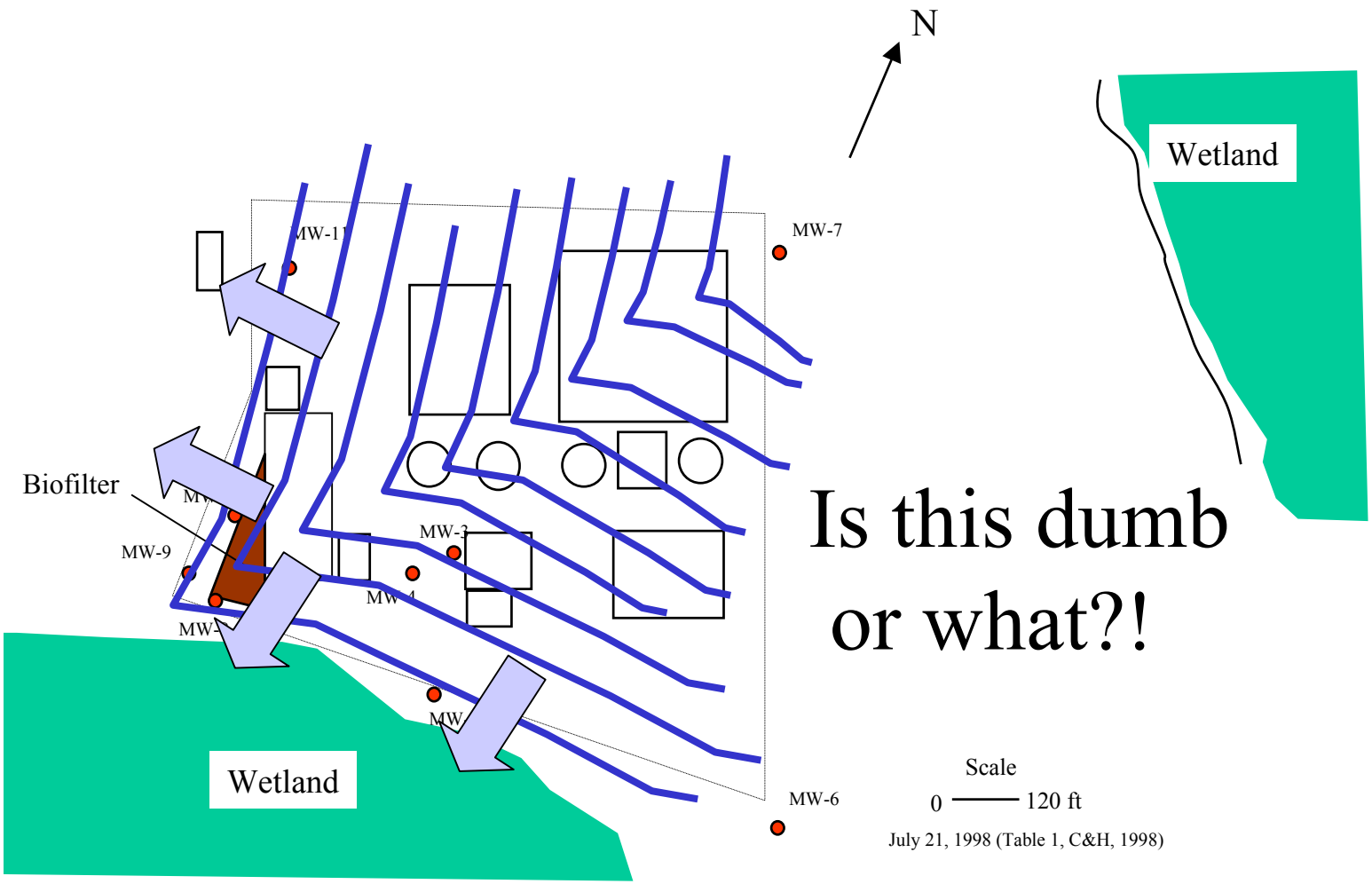
Your Students Won't Be Using This Kind of Instrumentation

In the summer, the piezometers will be knee high on the 4th of July!

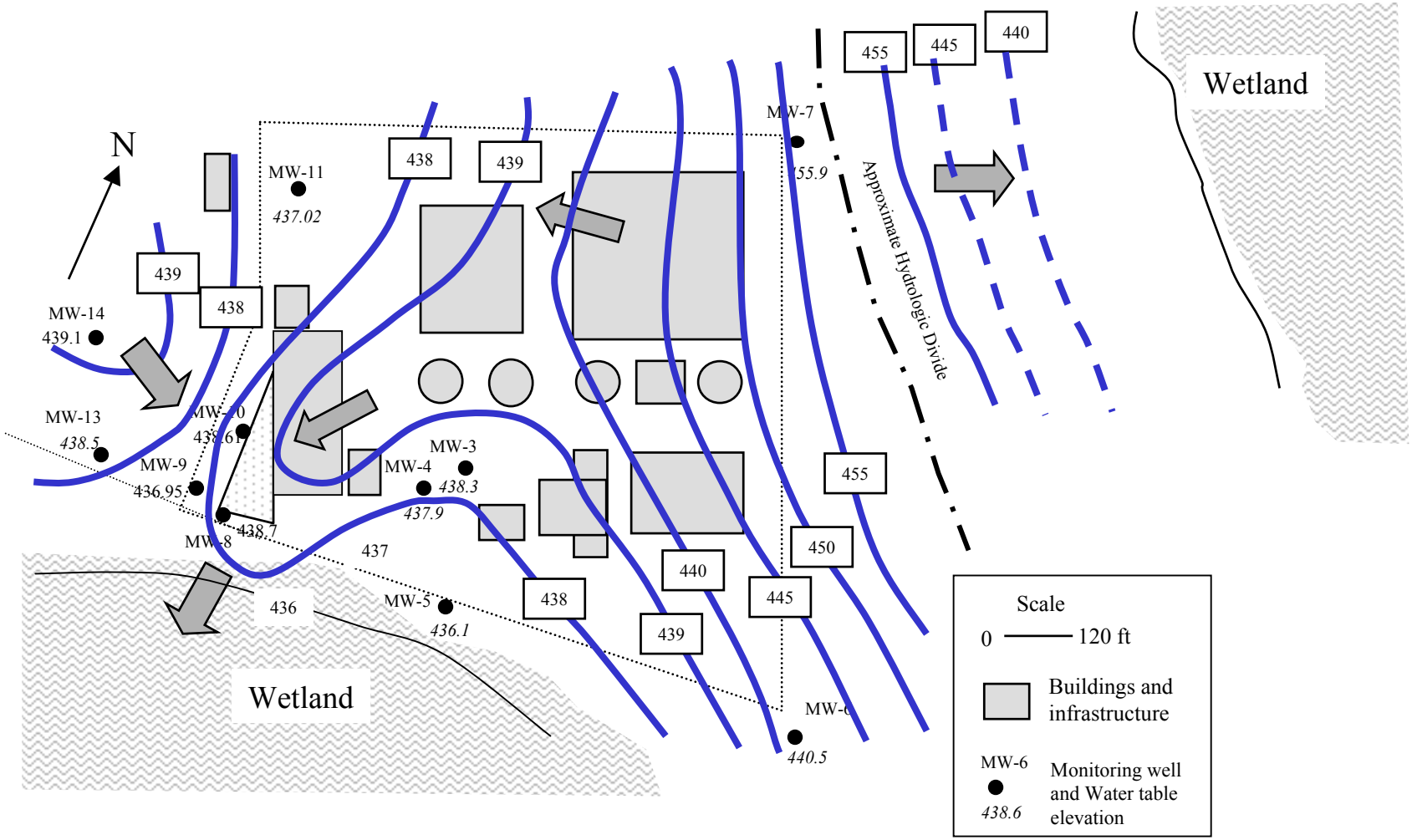
1. Where is the water table?



2. How do you draw a water table map?

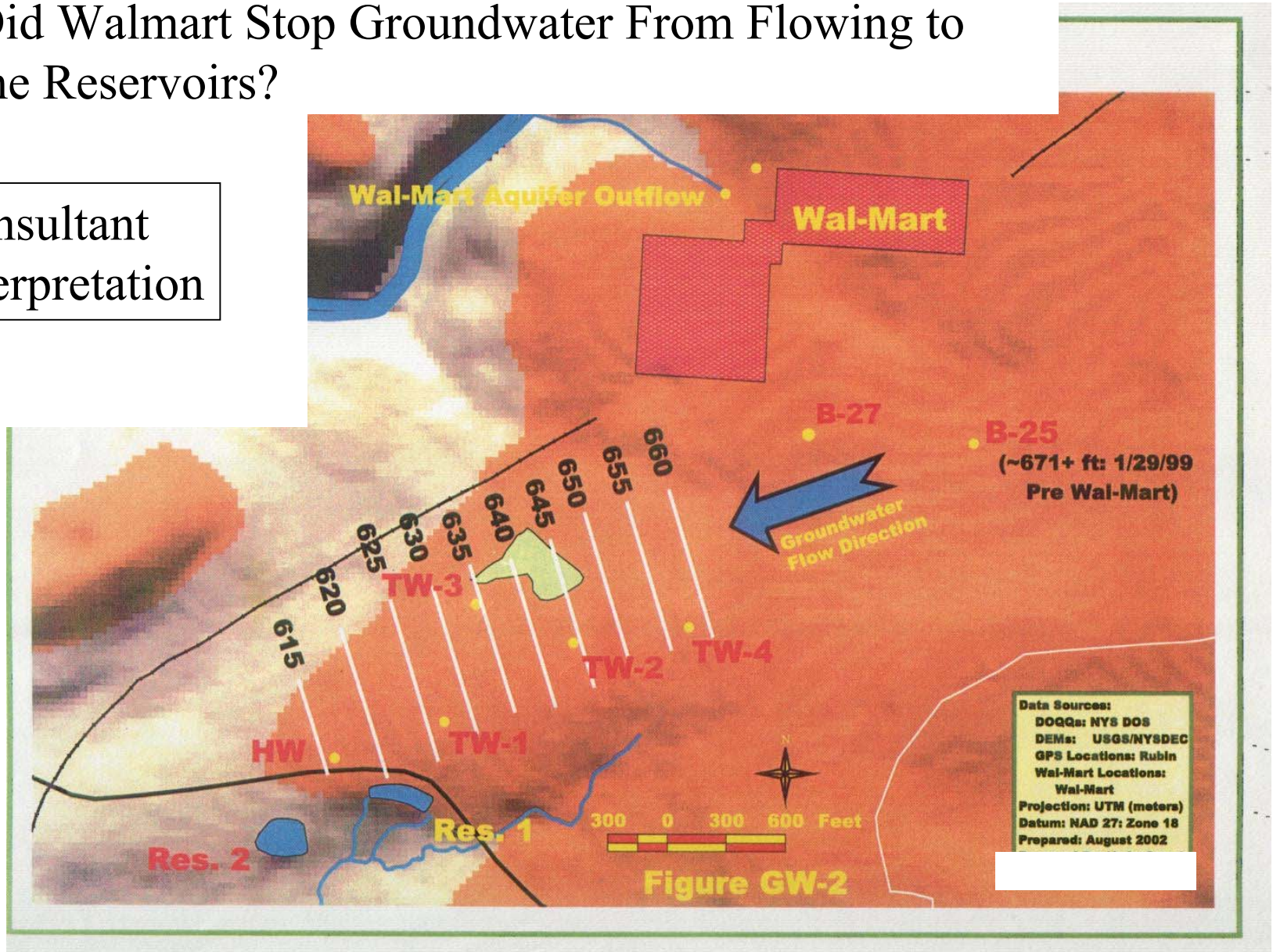


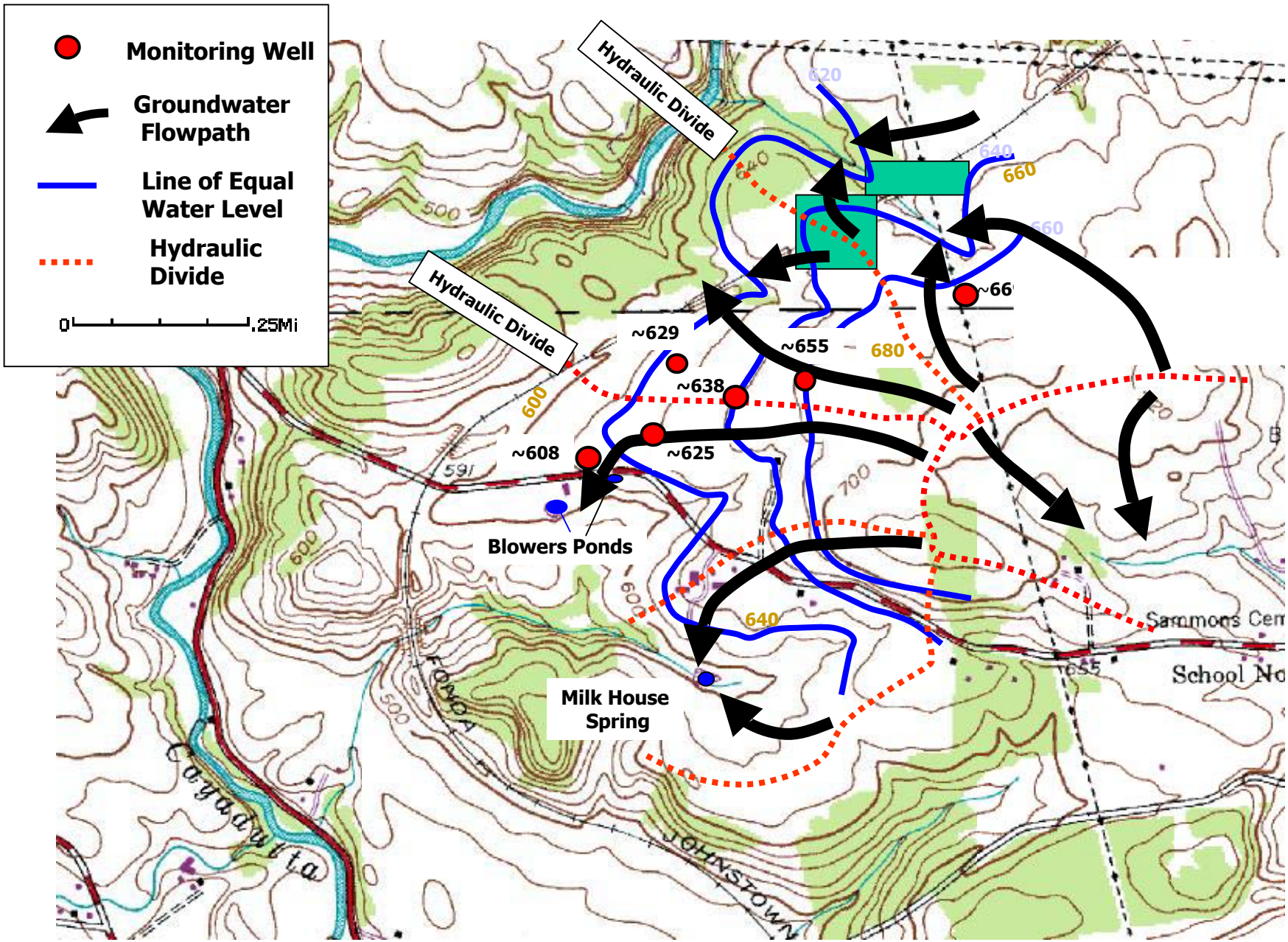
Is this dumb or what?!

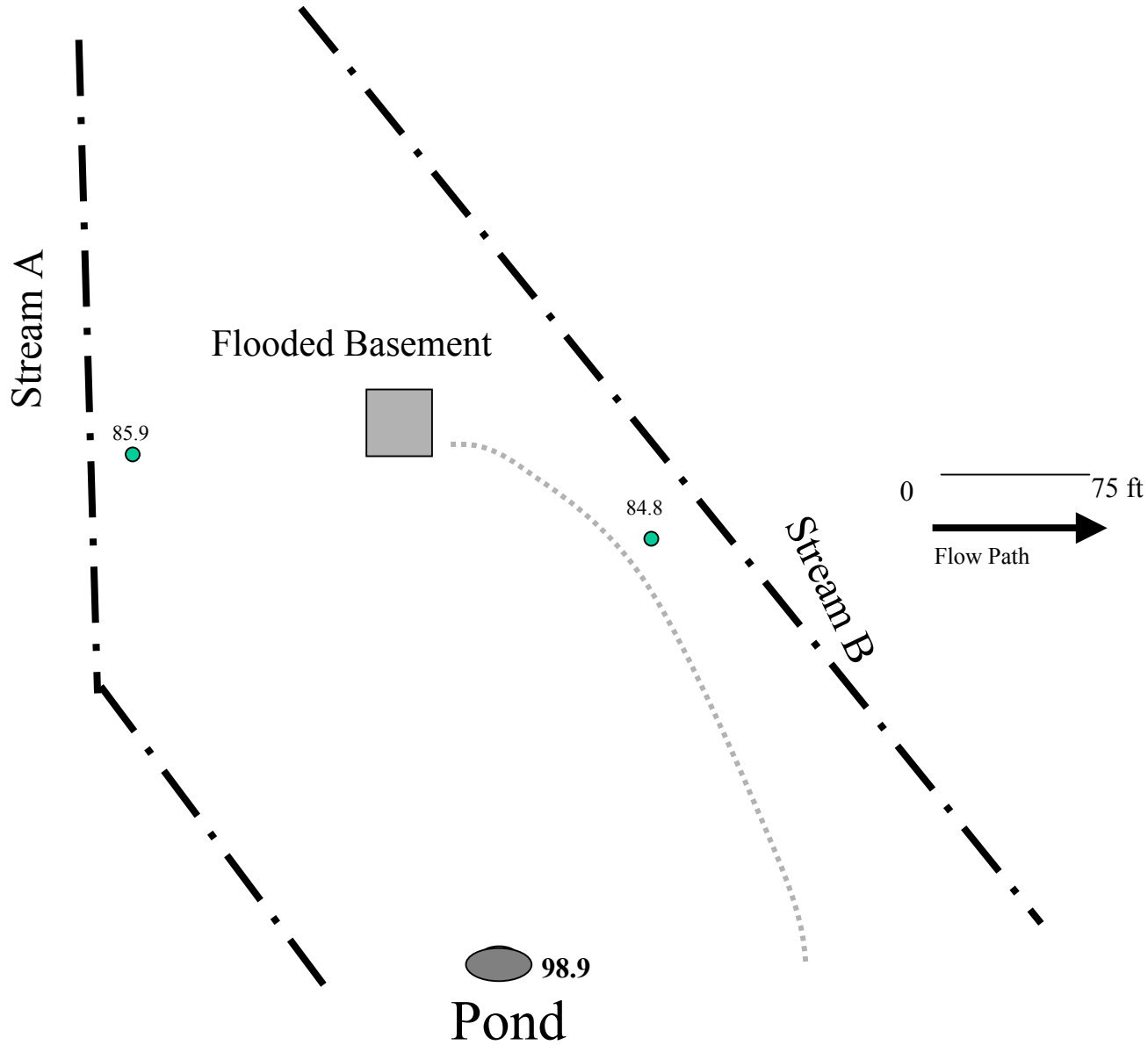

N
MW-11
437.02
438
439
439
438
MW-14
439.1
MW-13
438.5
MW-10
438.61
MW-9
436.95
MW-8
438.7
MW-3
MW-4
438.3
437.9
437
436
MW-5
436.1
438
439
440
445
450
455
MW-7
455.9
455
445
440
Approximate Hydrologic Divide
Wetland
Wetland
MW-6
440.5
Scale
0 120 ft
Buildings and infrastructure
MW-6
438.6
Monitoring well and Water table elevation

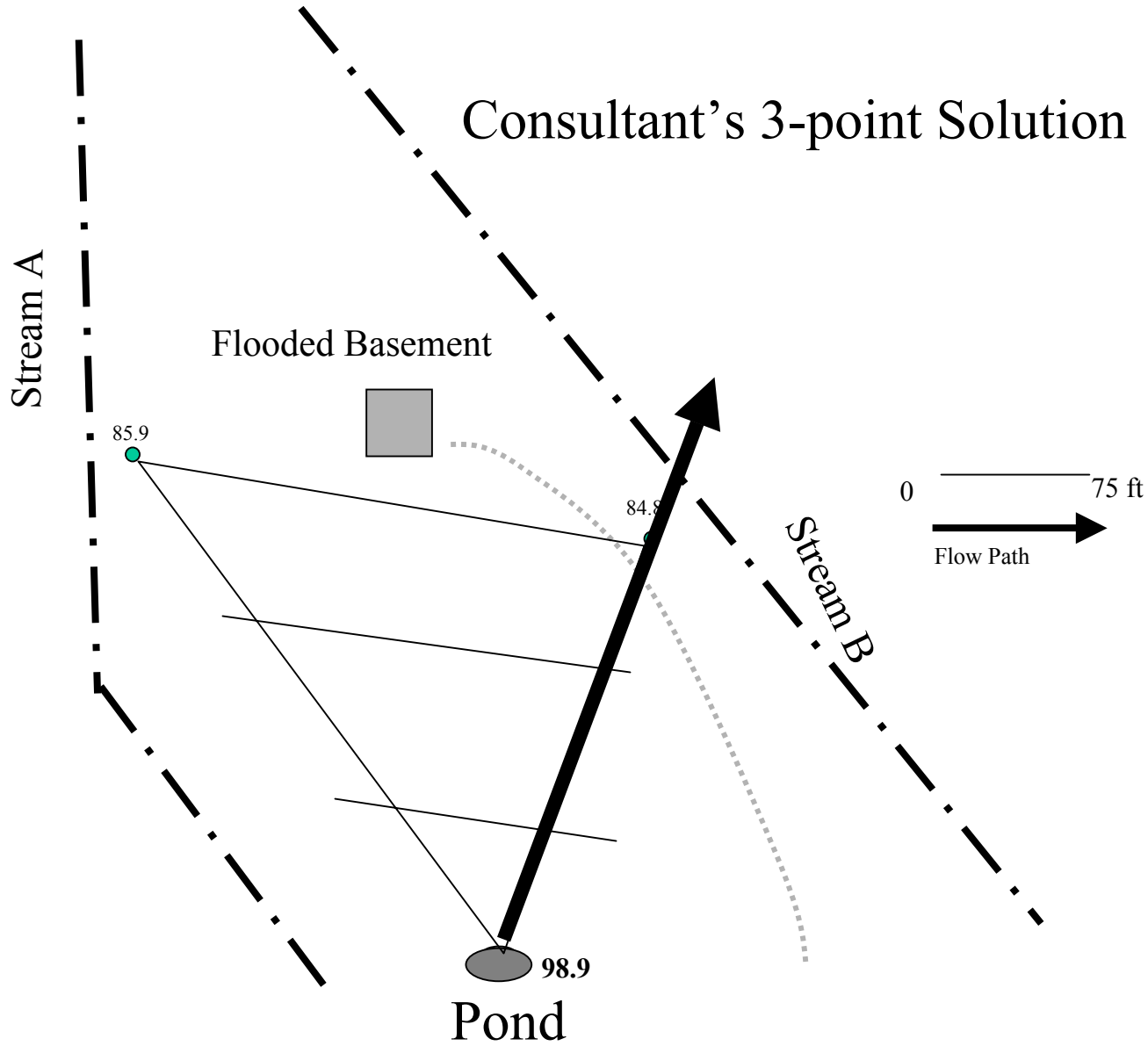
Did Walmart Stop Groundwater From Flowing to the Reservoirs?

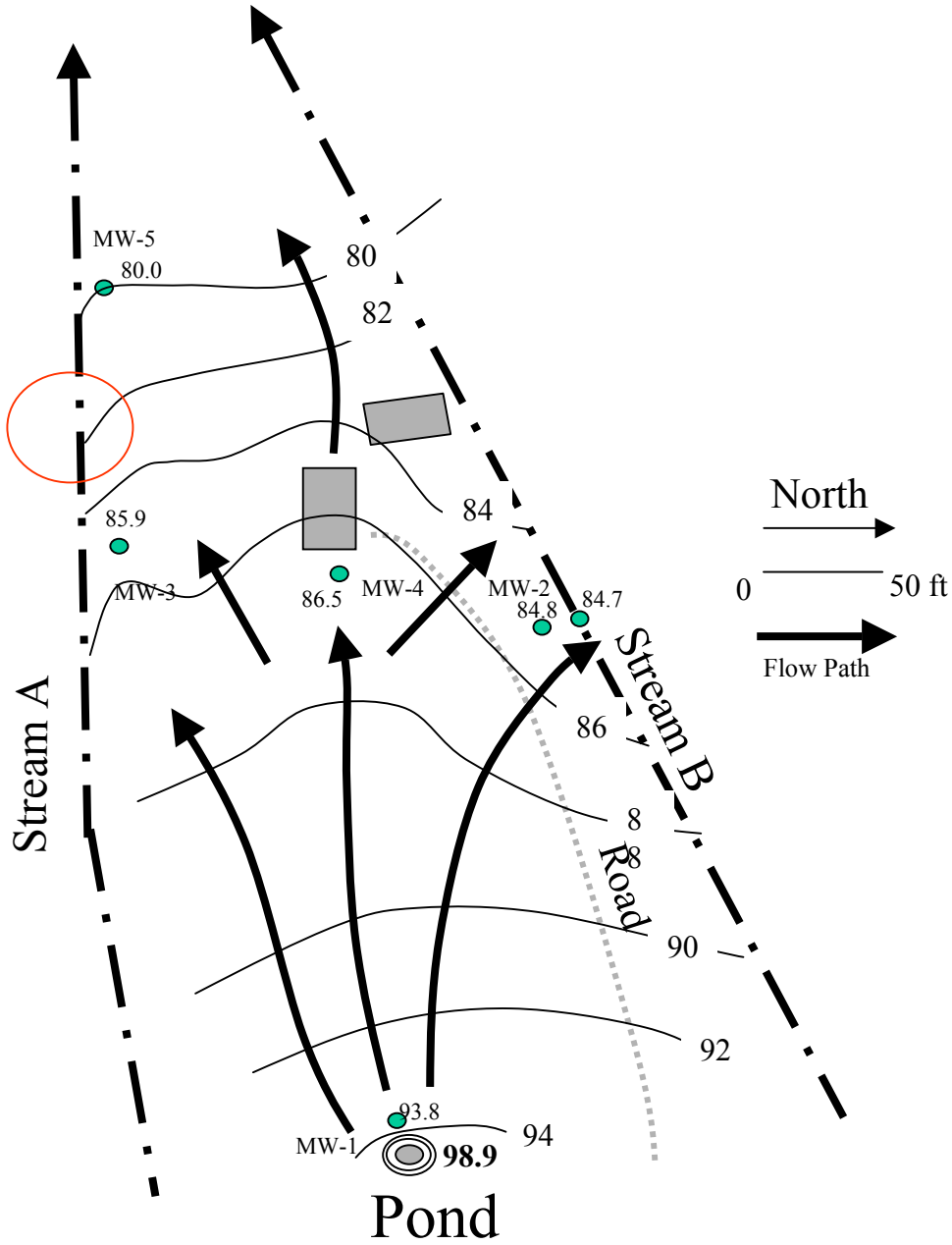
Consultant Interpretation




Monitoring Well
Groundwater Flowpath
Line of Equal Water Level
Hydraulic Divide
0
.25Mi
Hydraulic Divide
Hydraulic Divide
~629
~655
~638
~608
~625
~66
Blowers Ponds
Milk House Spring
620
640
660
680
600
700
500
591
655
Sammons Cem
School No
FONDA
JOHNSTOWN
Cayadutta


Stream A
Flooded Basement
85.9
84.8
Stream B
0
75 ft
Flow Path
98.9
Pond


Consultant's 3-point Solution
Stream A
Flooded Basement
85.9
84.8
Stream B
0
75 ft
Flow Path
98.9
Pond


MW-5
80.0
80
82
84
85.9
MW-3
86.5
MW-4
MW-2
84.8
84.7
North
0
50 ft
Flow Path
Stream A
Stream B
86
88
Road
90
92
93.8
MW-1
94
98.9
Pond

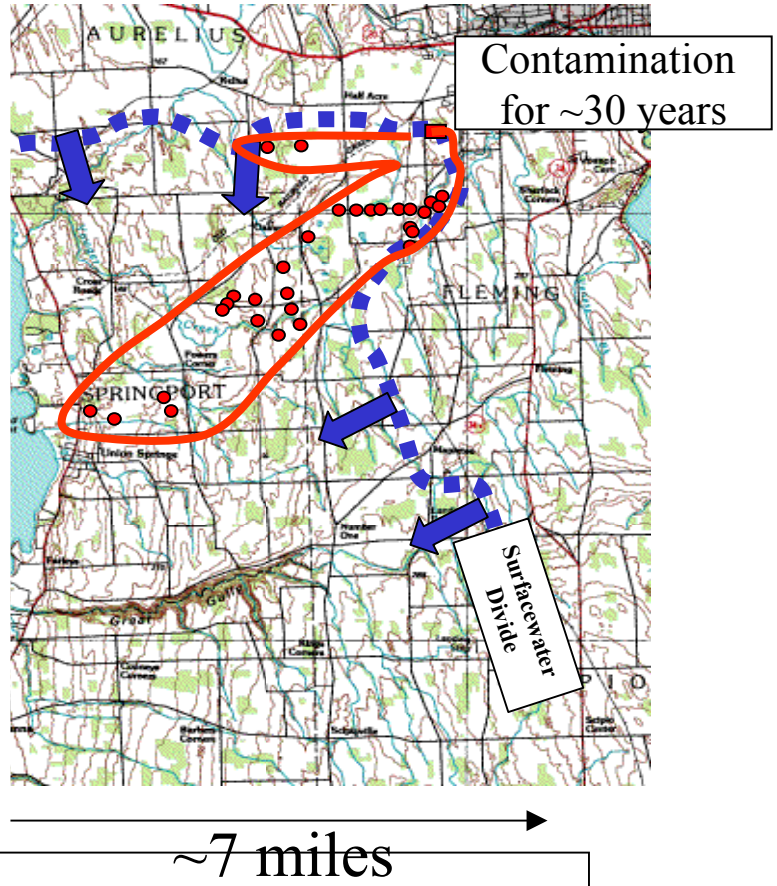
3. Fluidly do calculations with Darcy's Law.

Seepage Velocity

v = distance/time
v = 37000ft/30 years
v ~ 3 ft/d

Algebraic Manipulation

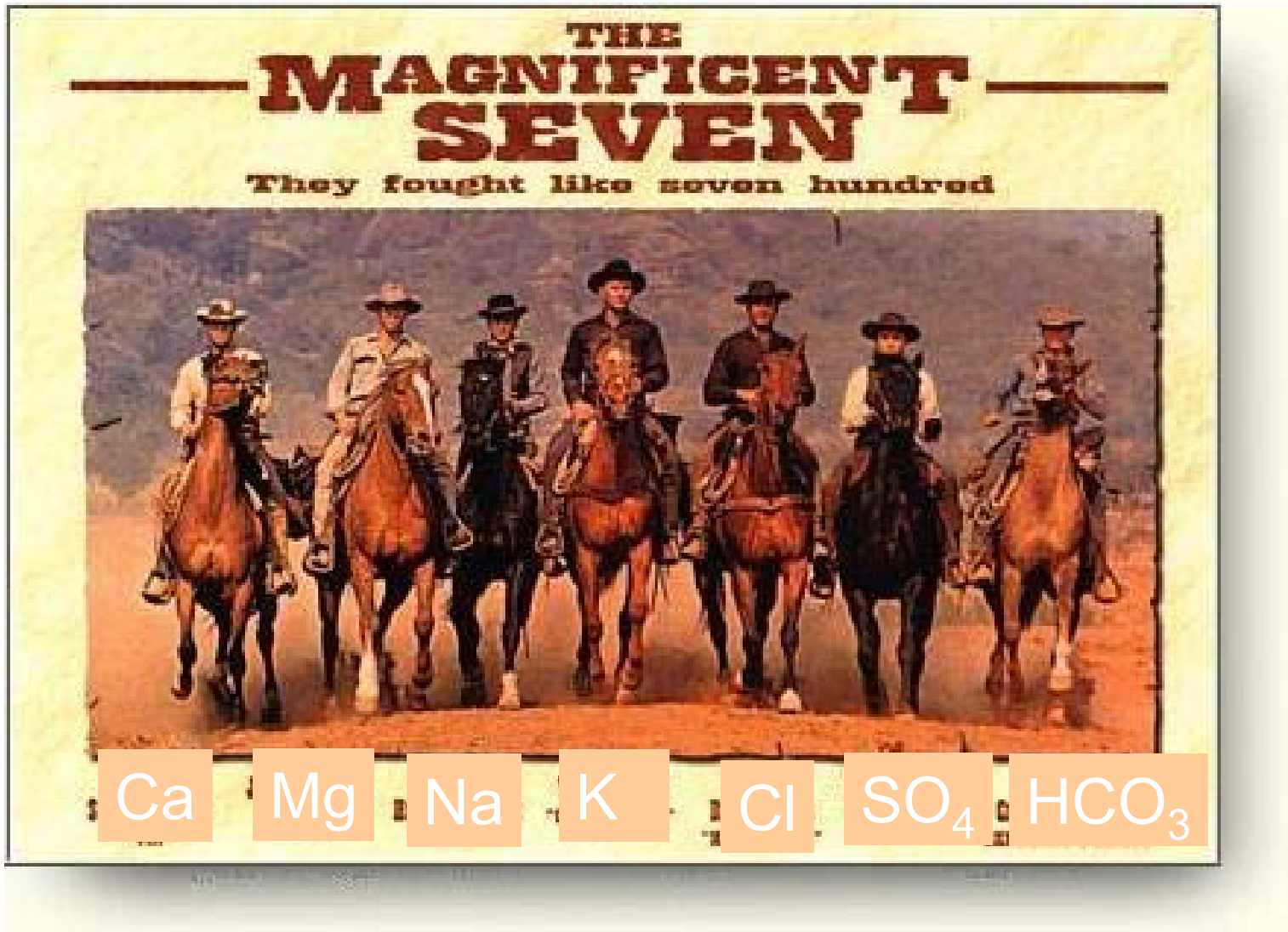
$v = KI/n_e$
$K = v\, n_e/I$
K = 3ft/d*0.1/[(733-380)/37000)]
K = 3ft/d*0.1/0.01 = 30 ft/d



Q calculations

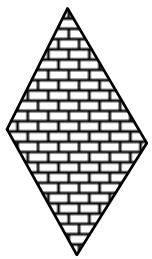
mass = Q* concentration
KIA (in L/d)*concentration (in mg/L) = mg/d loading etc..

4. You Need to Know Major Dissolved Concentrations



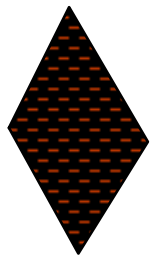
Water-type Associations

$Ca\text{-}Mg\text{-}HCO_3$



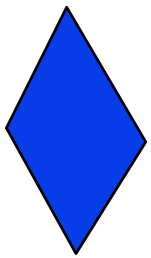
Glacial Till
Crystalline Rocks
Carbonate Rocks

$Na\text{-}HCO_3$



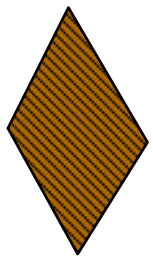
Ion-exchange
MSW Leachate

$Na\text{-}Cl$



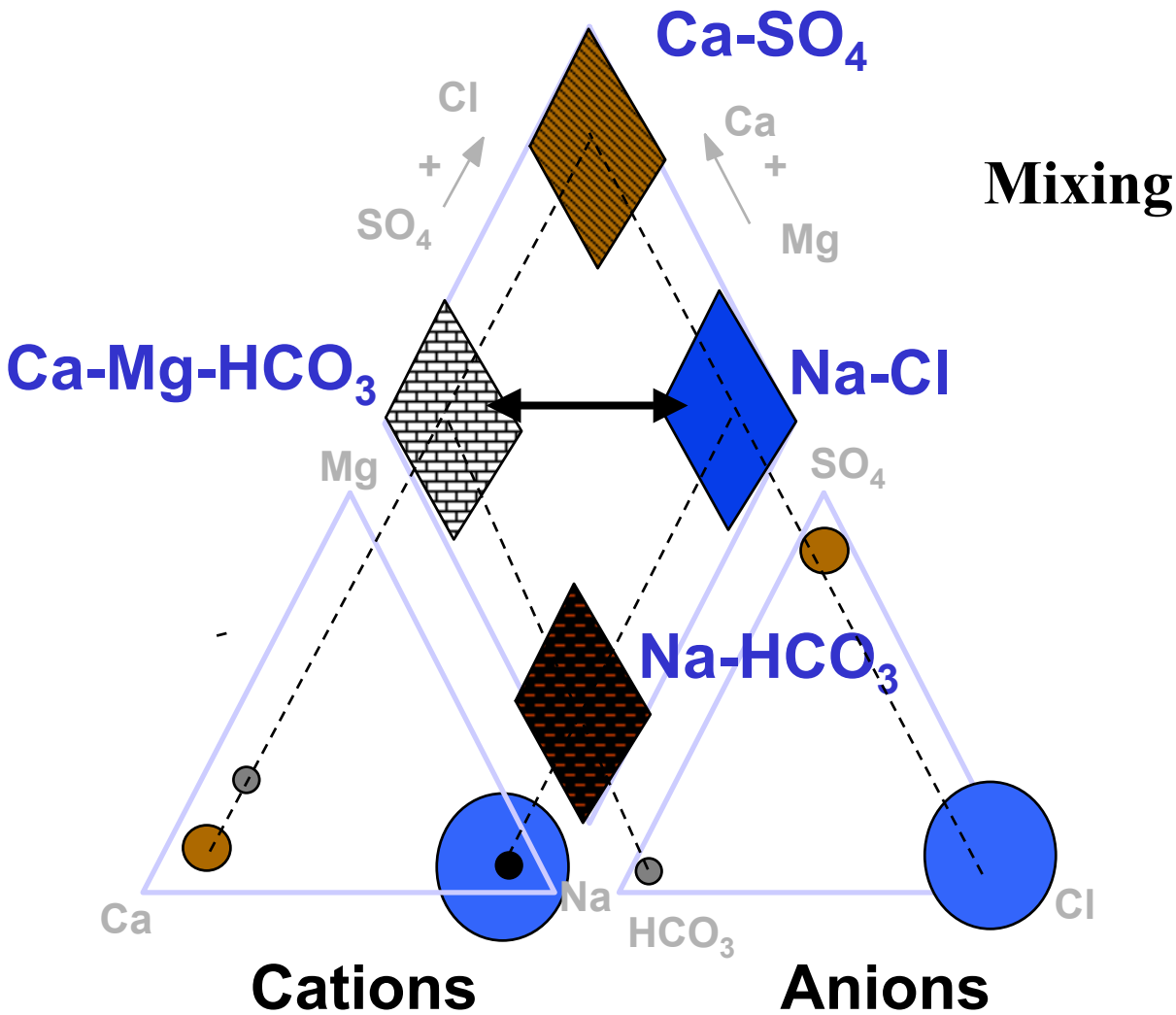
Ocean water
Sedimentary Brines
Salt Contamination

$Ca\text{-}SO_4$

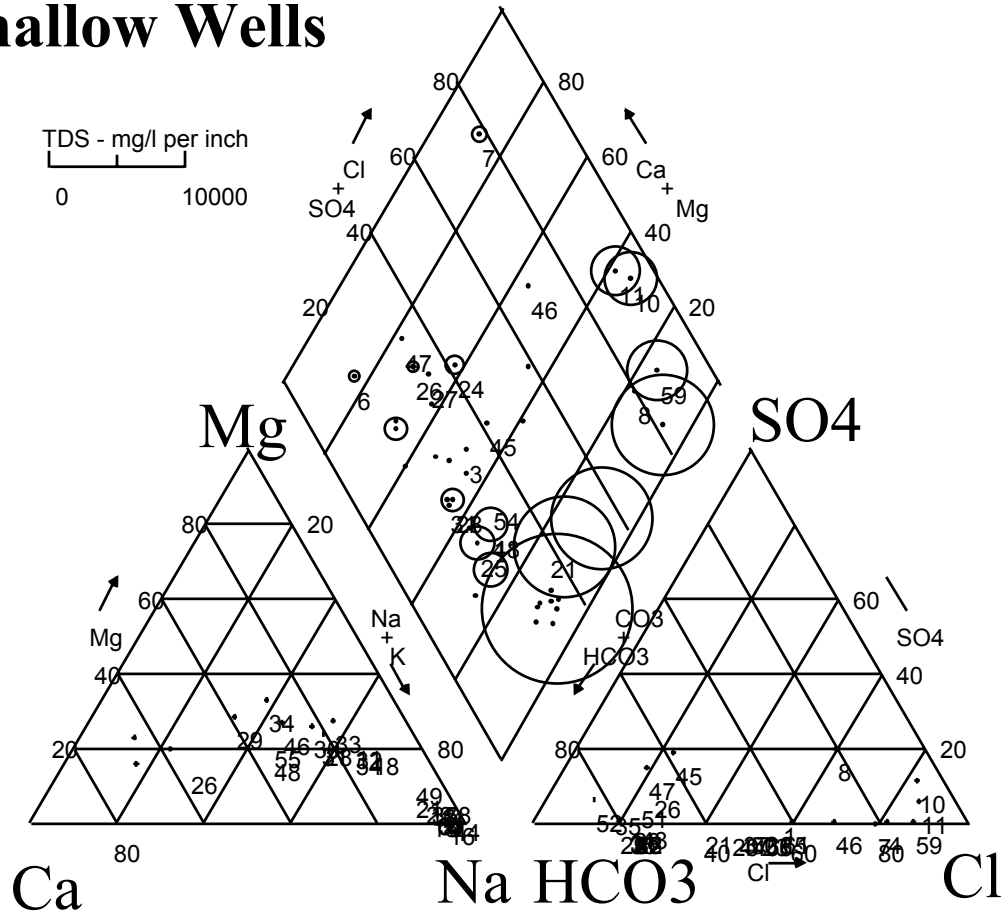


Gypsiferous Rx
Sulfide Oxidation
(Acid contamination)

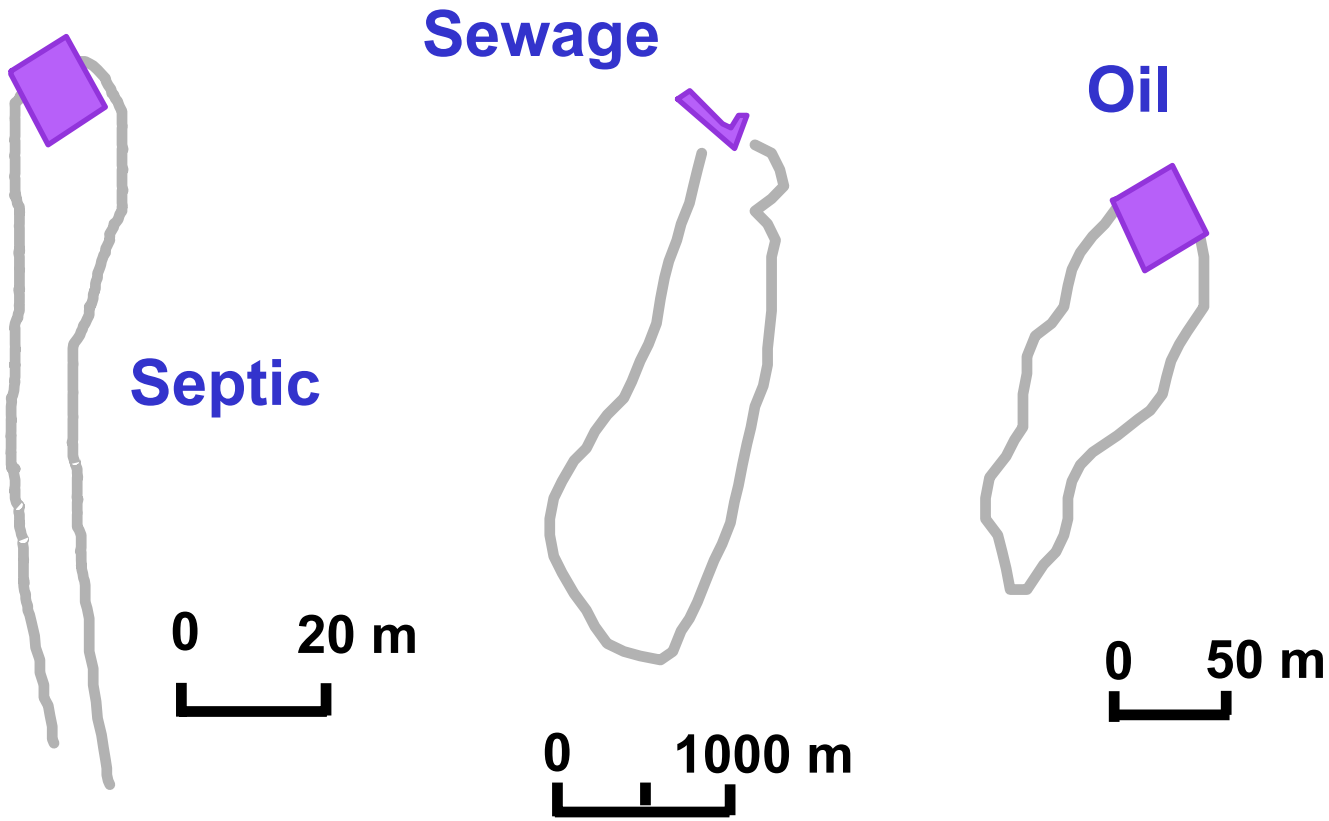
The Four Major Groundwater Types



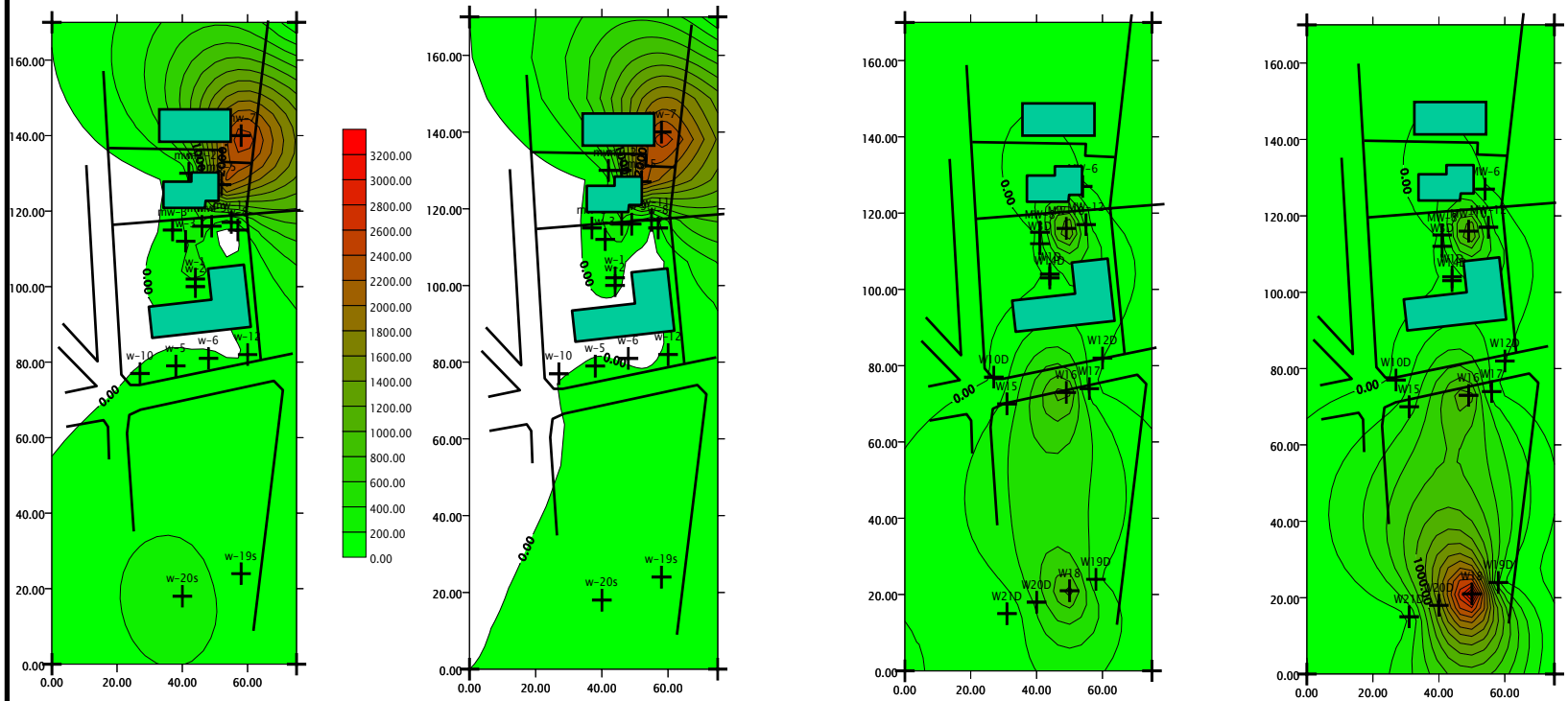
Shallow Wells



5. It is reasonable to assume that plumes will generally be narrow.



Anything Seem Odd?

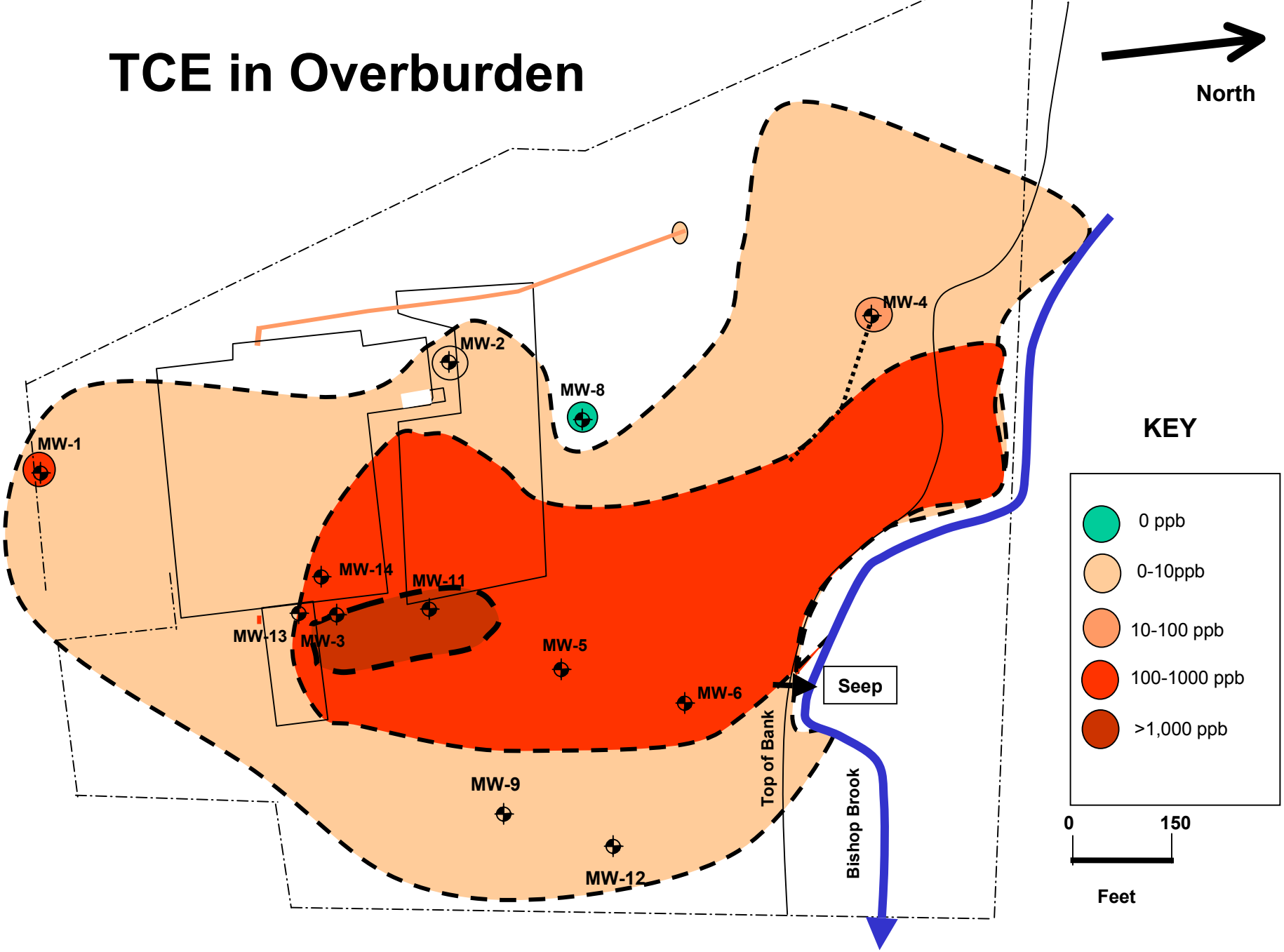


TOTAL VOCS SHALLOW | PCE SHALLOW | TOTAL VOCS DEEP | PCE DEEP

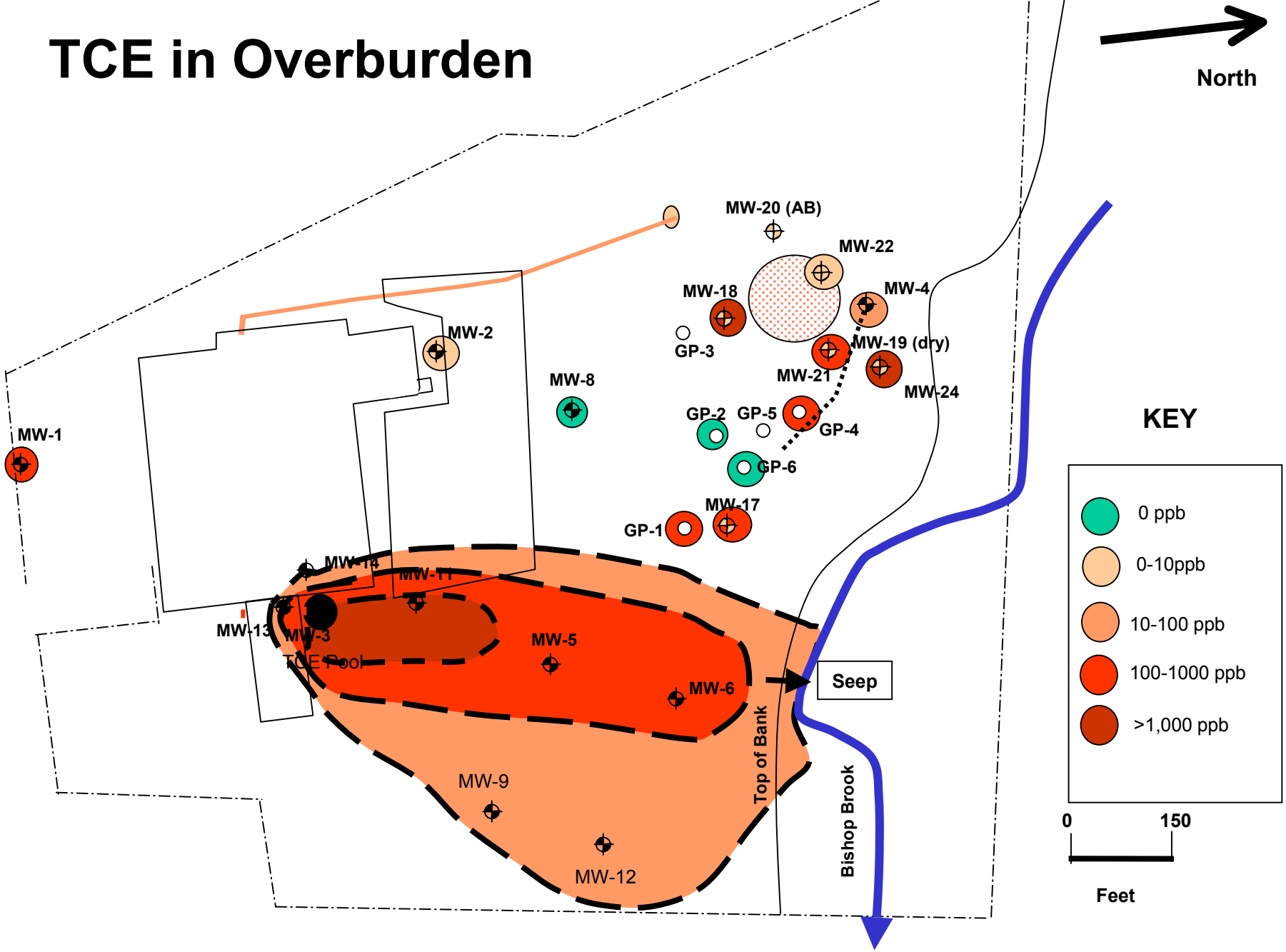
Shallow = 60 feet deep
Deep = 110 feet deep.

FIGURE
PCE AND TOTAL VOC IMPACTS

TCE in Overburden



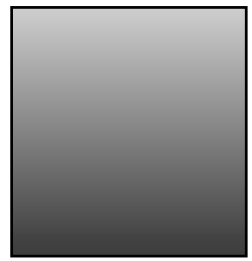
TCE in Overburden



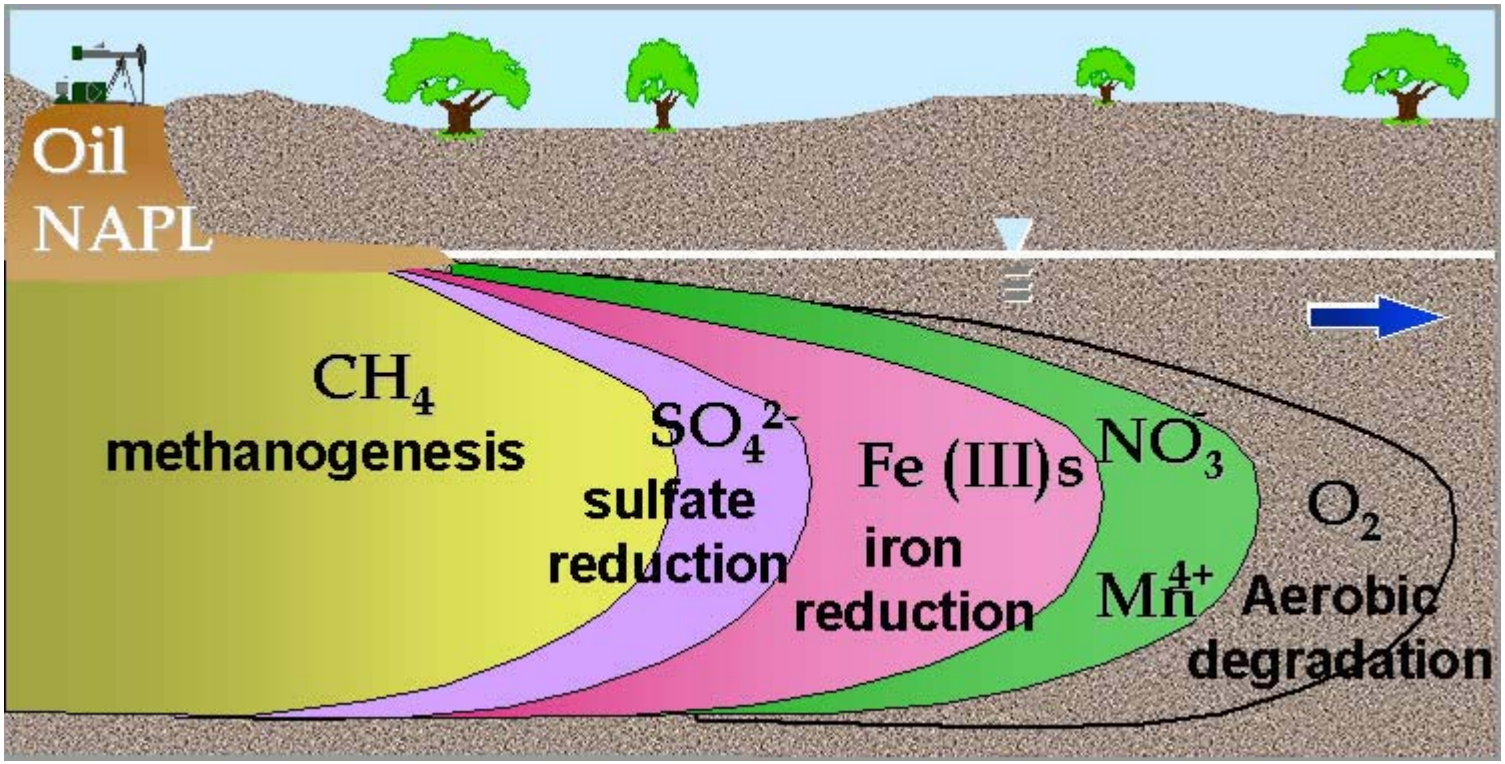
6. Organic Oxidation Controls Most EPA Contaminants of Interest

$$CH_2O + O_2 \longrightarrow CO_2 + H_2O$$

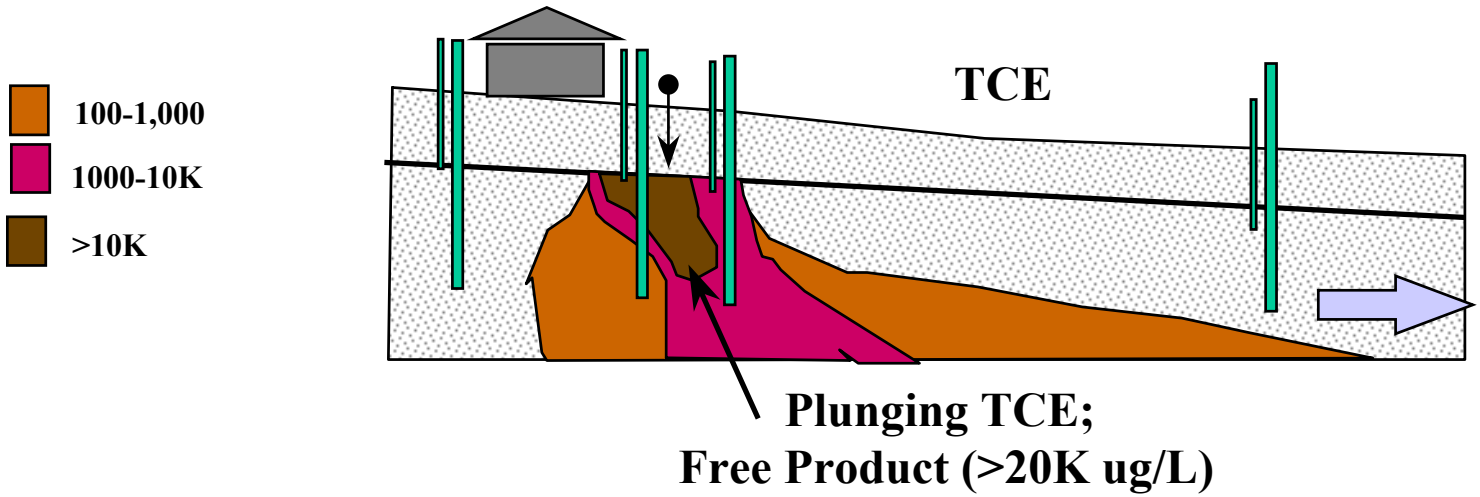
carbonic acid



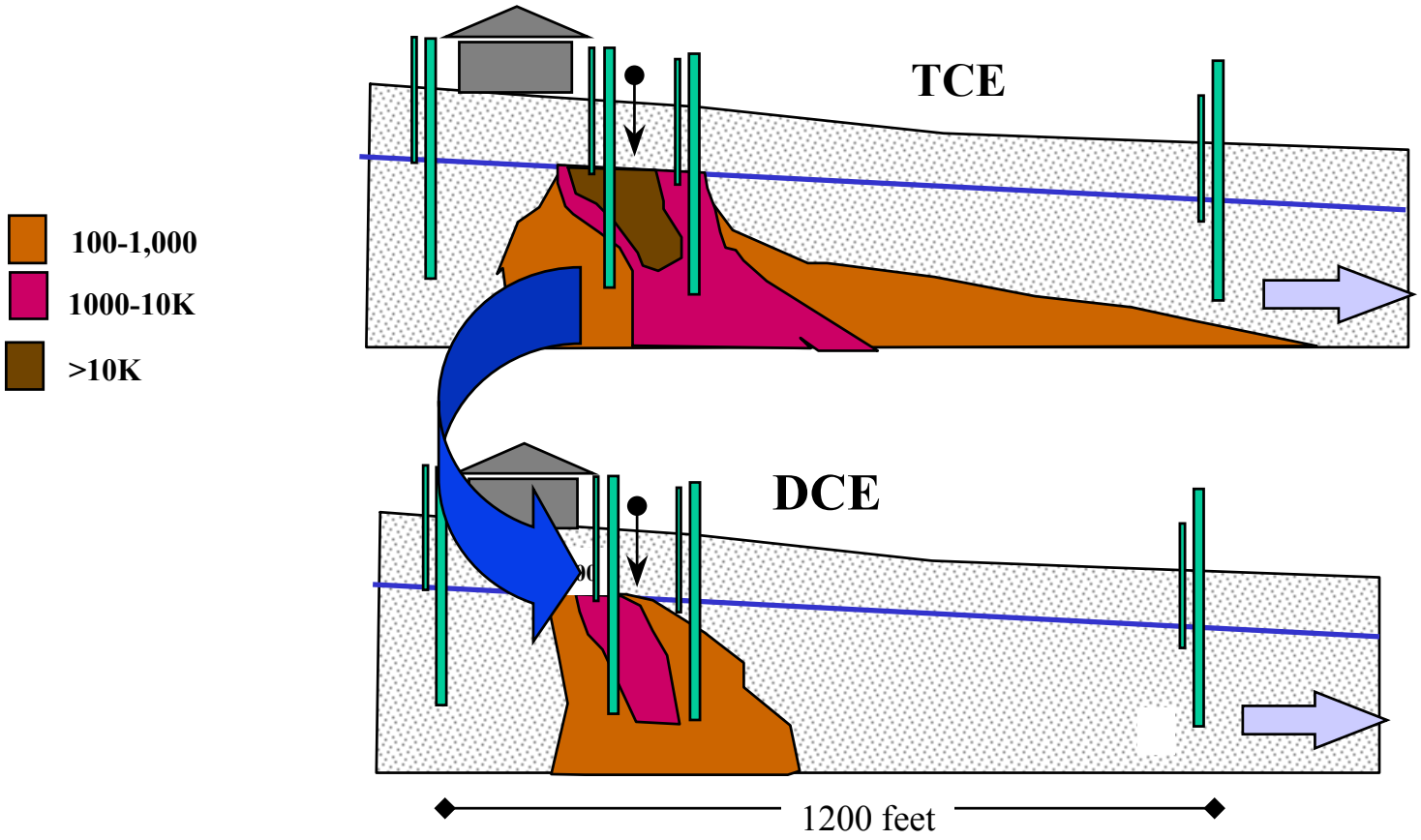
Zoned Changes in Redox



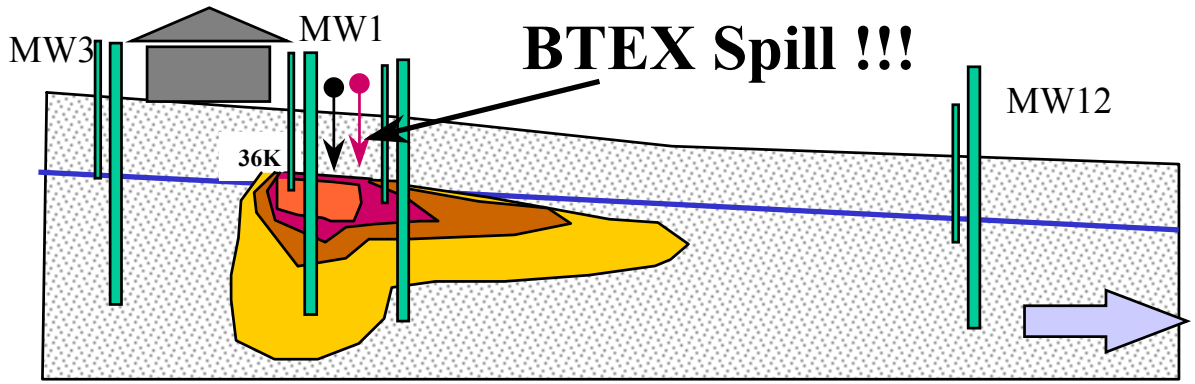
Example: TCE plume that plunges below spill site.



DCE degradation product found (only under anoxic conditions)

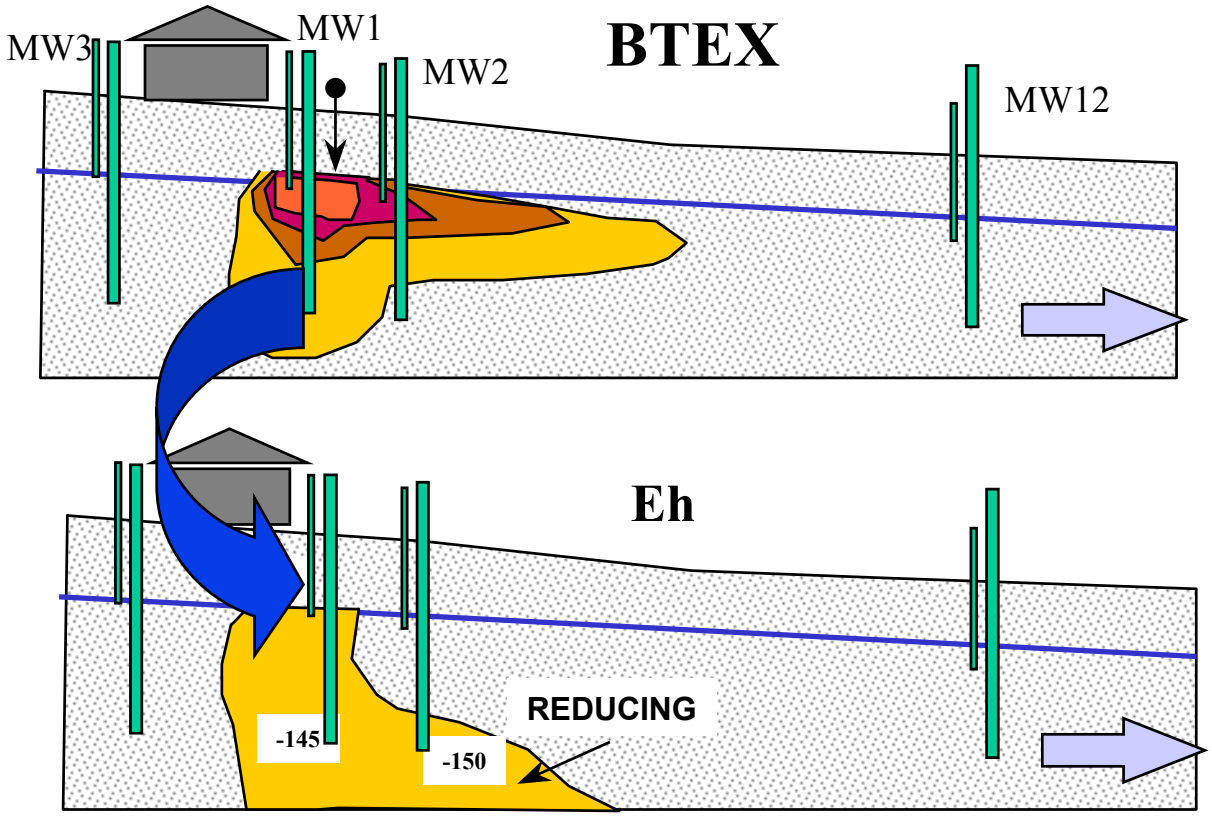


Unrecognized Oil Spill!

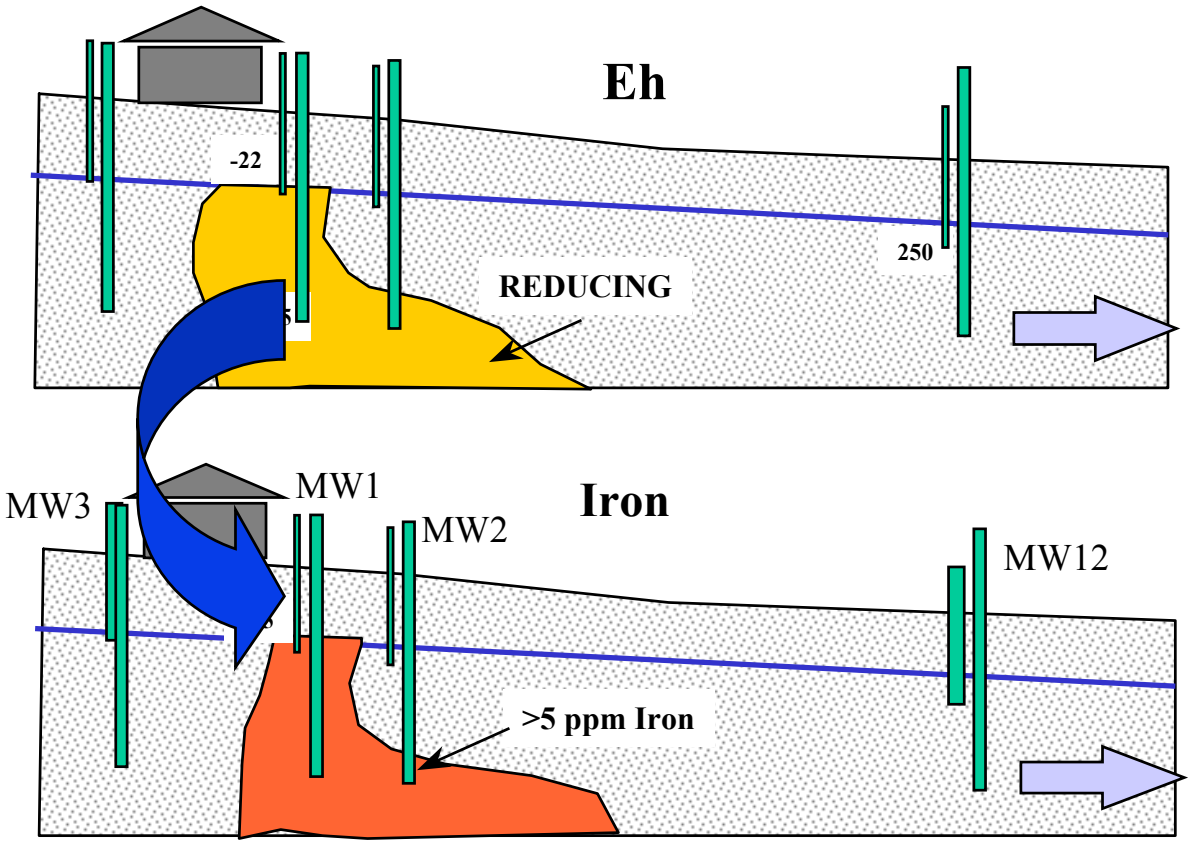


If BTEX is being oxidized, then Eh should drop….

Of course, there must be anoxia!



Which leads to iron reduction and so on....



The Five Flags of Hydrogeology

1. Aristotles maxim.
2. Know how to use Darcy's Law.
3. Know how to draw a reasonable water table.
4. Know how to interpret major solute chemistry with respect to sources.
5. Know how to draw plumes to fit more or less into flow tubes
6. Know how to interpret organic fate and transport generally in terms of presence of organics.