

US EPA ARCHIVE DOCUMENT

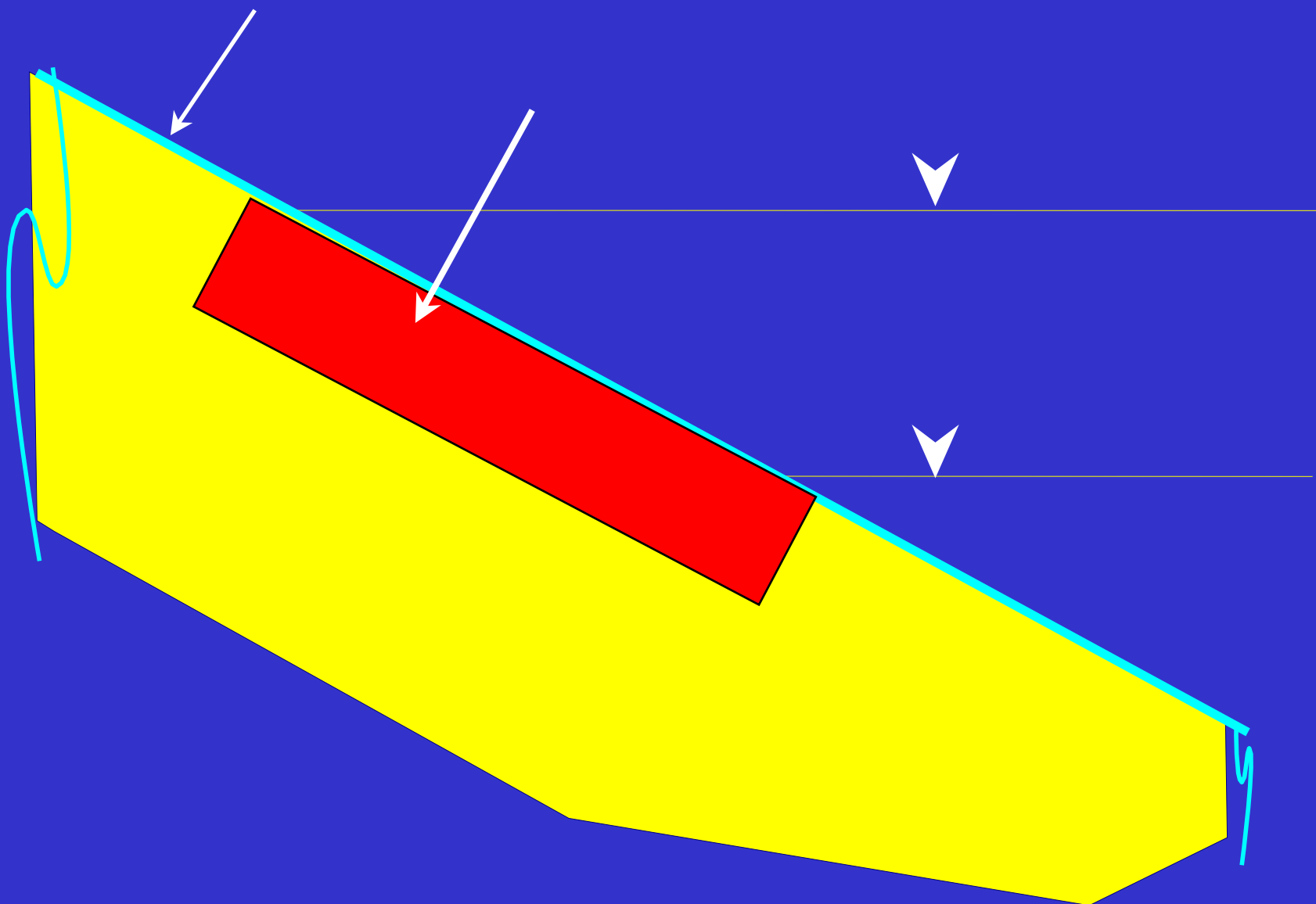
Prediction of Nutrients Movement in the Banks of Tidally Influenced Estuaries and Beaches

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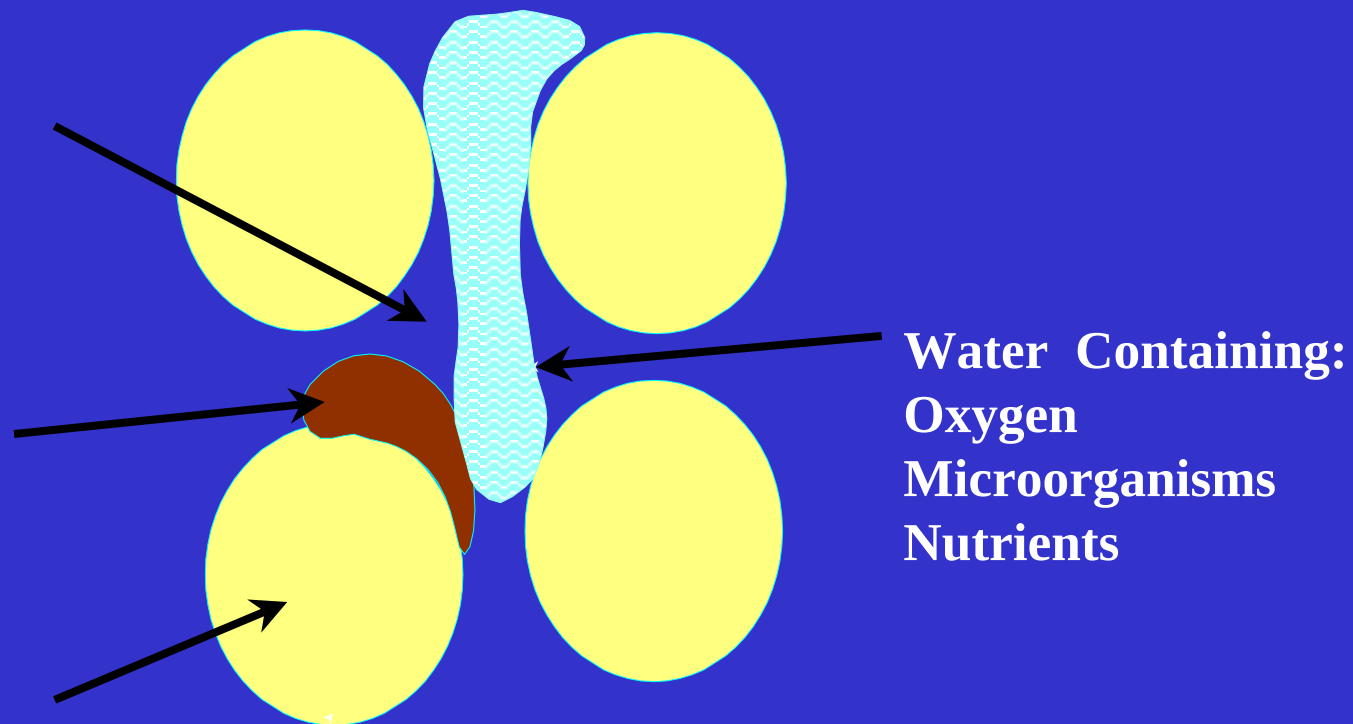
and

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Cincinnati, OH

Beach Surface



The Porous Medium



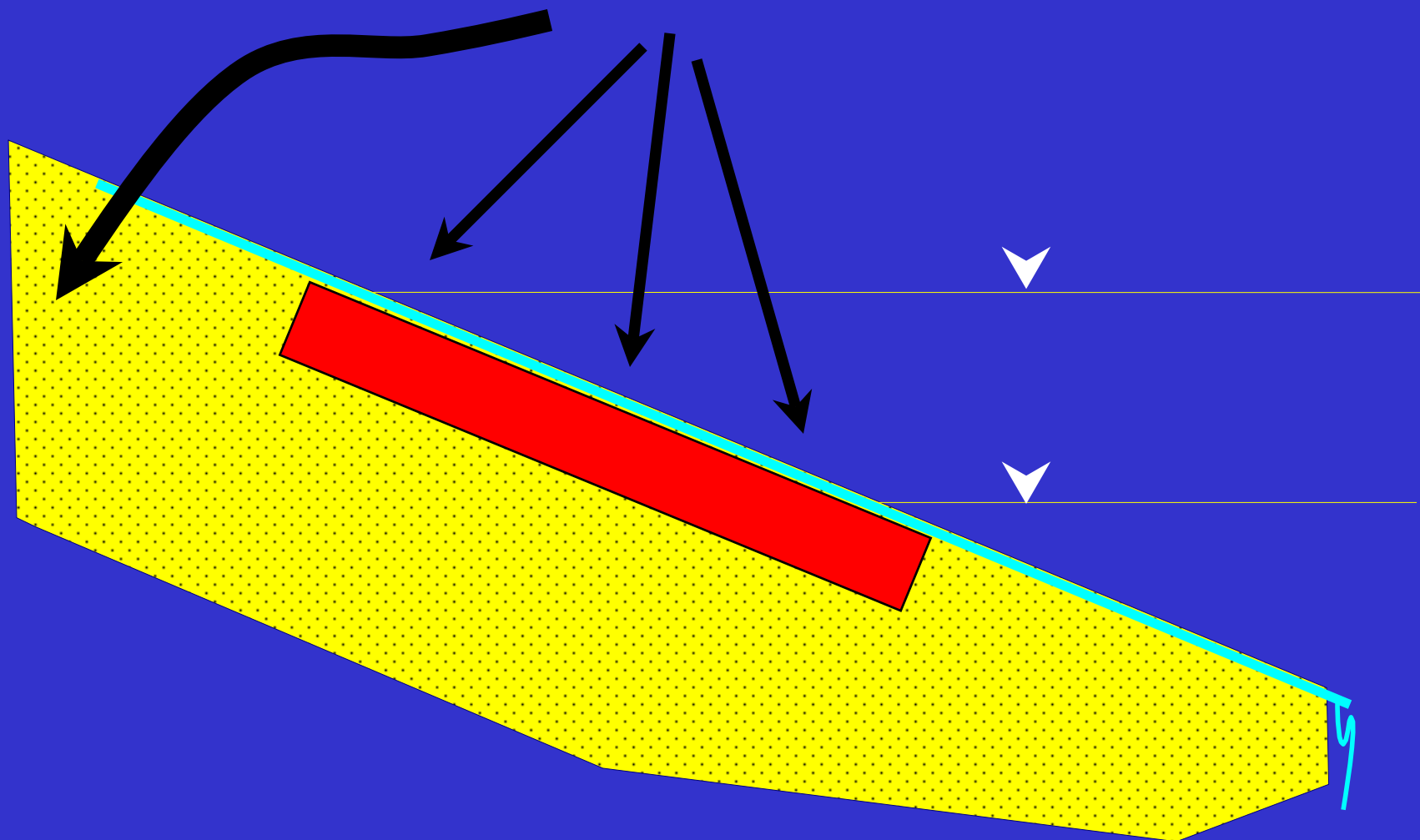
PROBLEM STATEMENT

- The Required Nutrient Concentration is Small.
About 5-10 mg/L of Nitrate-N *.
- The Goal is to Maximize the Contact Time of
Nutrients with the Oil.

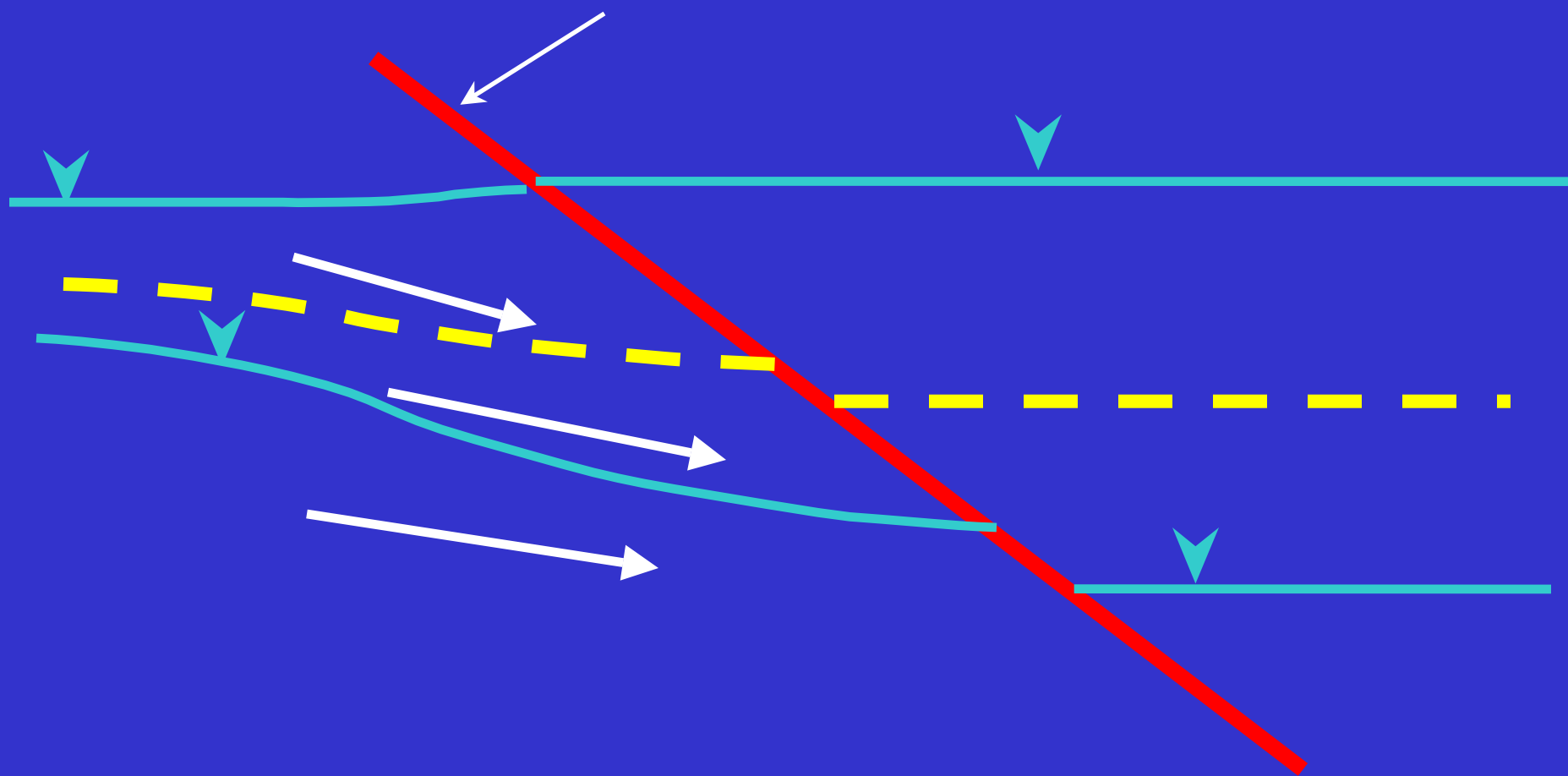
*Venosa *et al.* (1996), Env. Sc. Tech., 30, p 1764-1775.

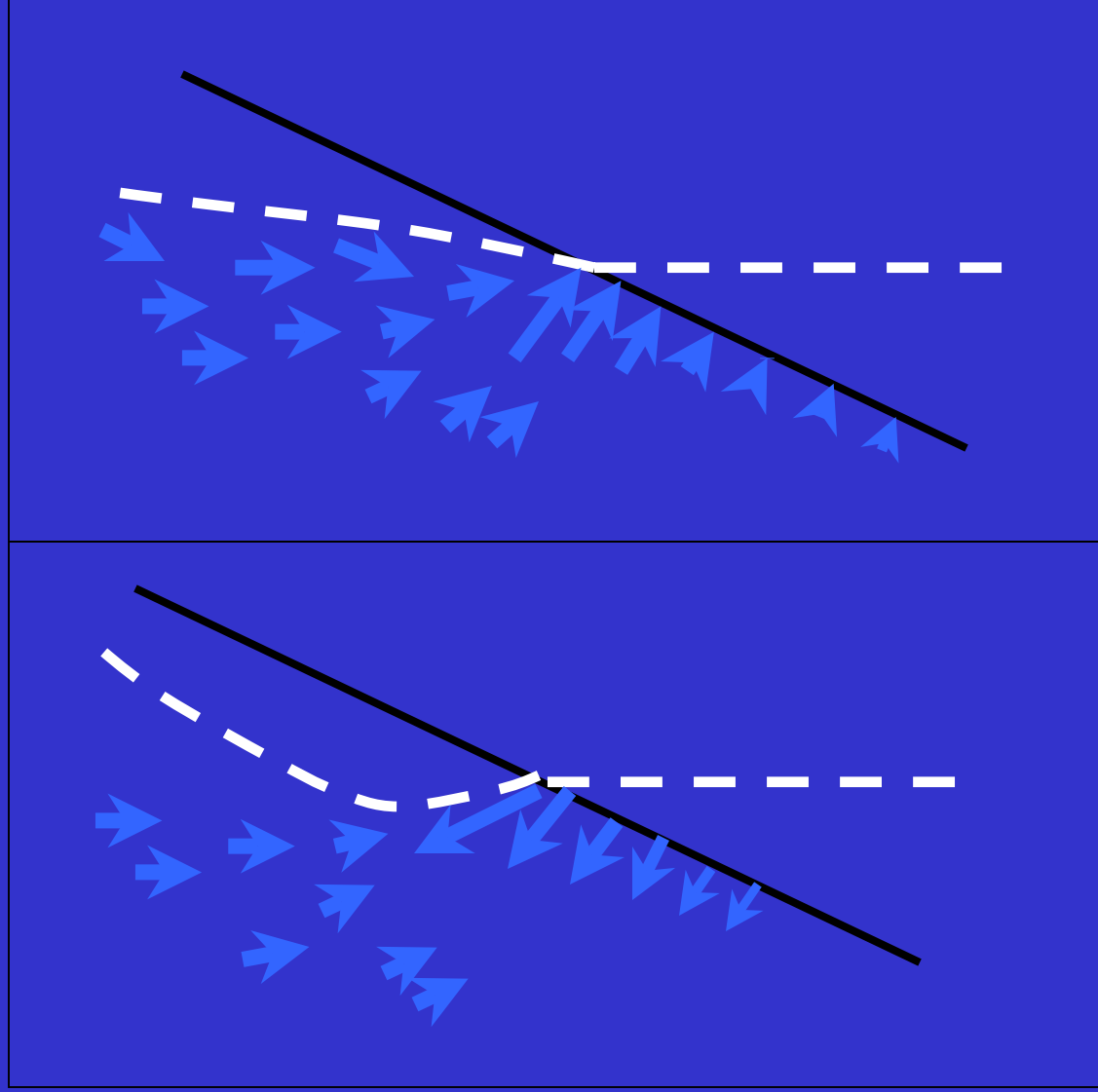
*Boufadel *et al.* (1999), Env. Tech., 20, p 191-199.

NUTRIENTS SOLUTION

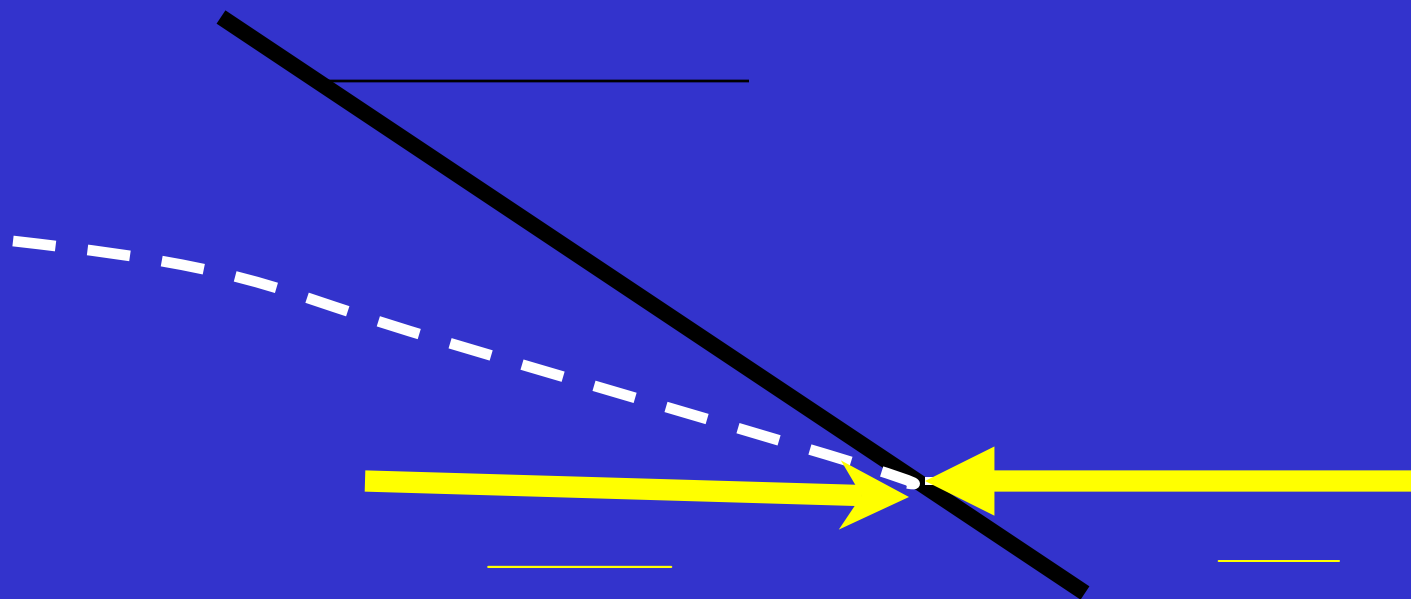


Tidal Action



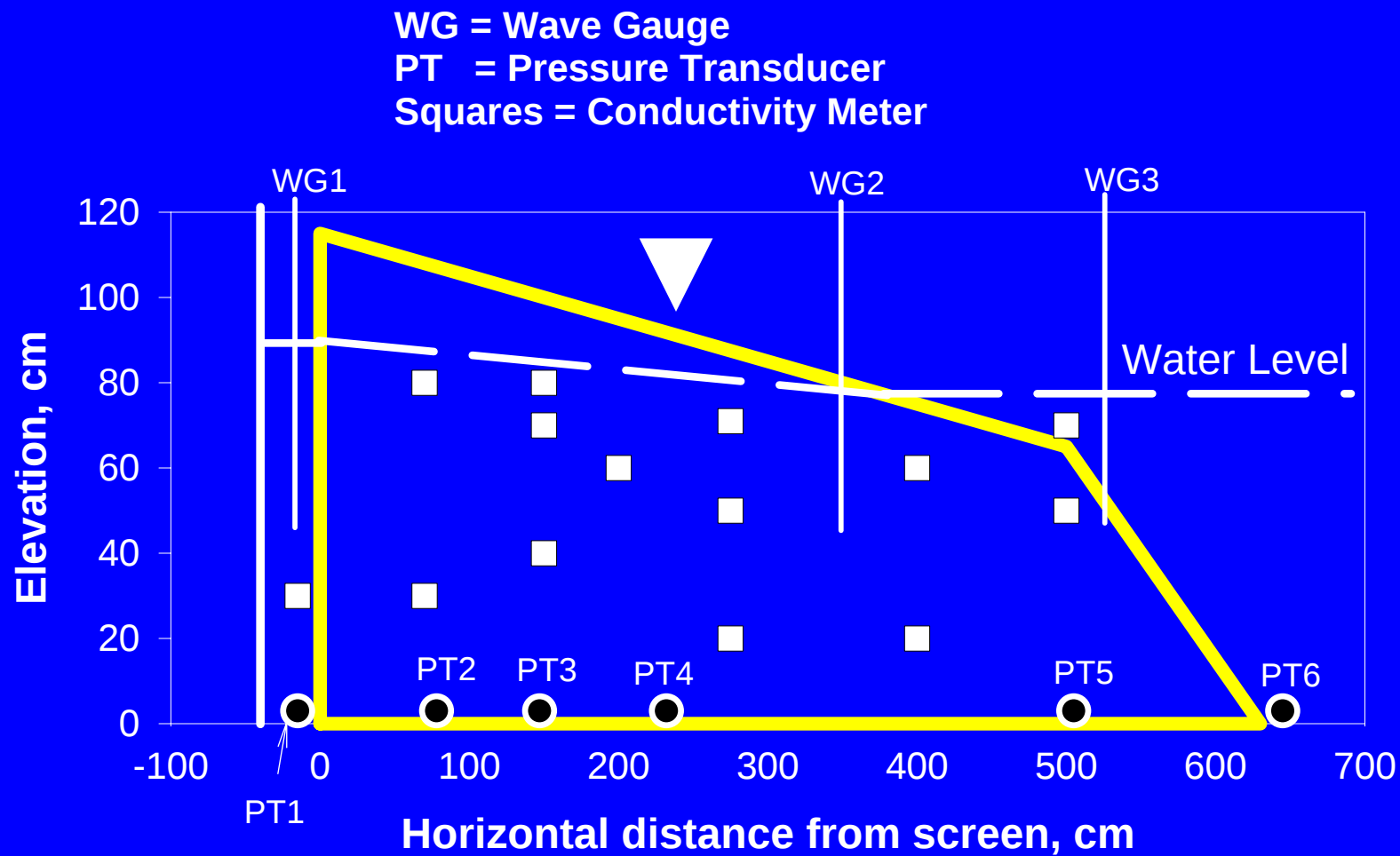


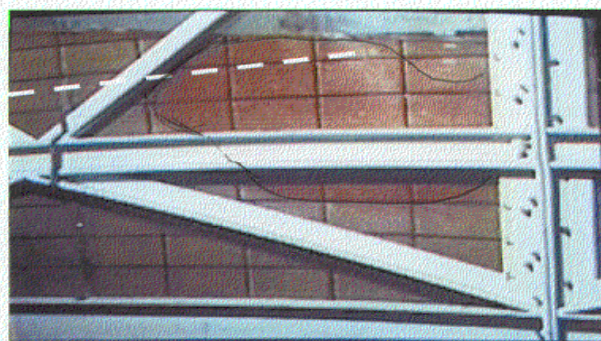
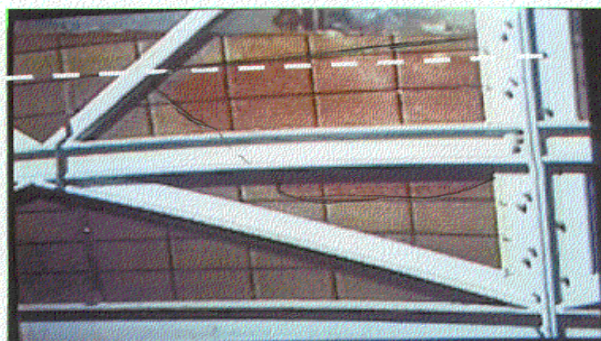
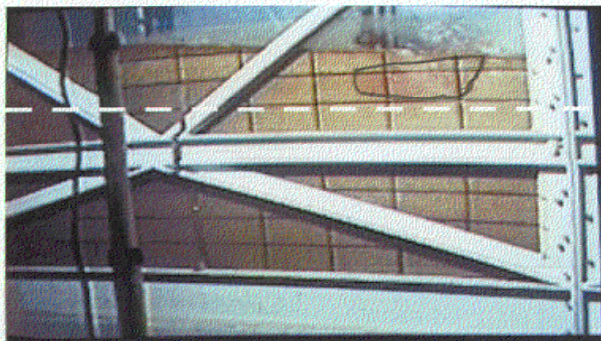
How Fast is Fast?



For $\sin(\theta)=0.1$, $n=0.3$
 $K=0.1$ cm/s.
 $V_s \approx 0.03$ cm/s

For $\sin(\theta)=0.1$;
 $V_r=2$ m/6 hours ≈ 0.01 cm/s
 $V_L \approx 0.1$ cm/s



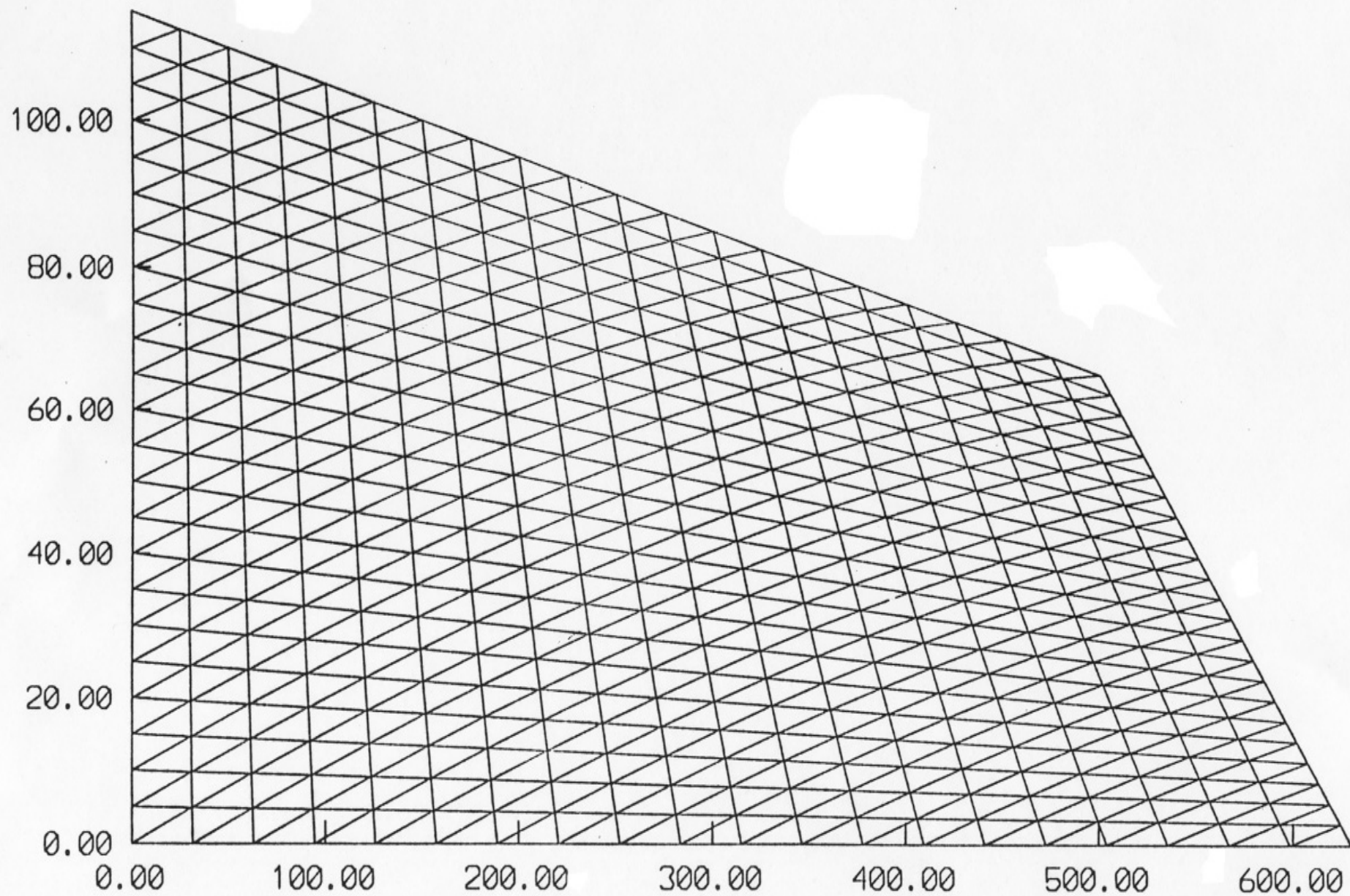


Boufadel, Suidan, Venosa, J. Env. Enggr., ASCE, 2006.

MODELING APPROACH

- Account for Vadose Zone Hydraulics
- Simulate Tide as a Dynamic Process

Boufadel, Suidan, and Venosa, J. of Contaminant Hydrology, 37, p1-20, 1999.



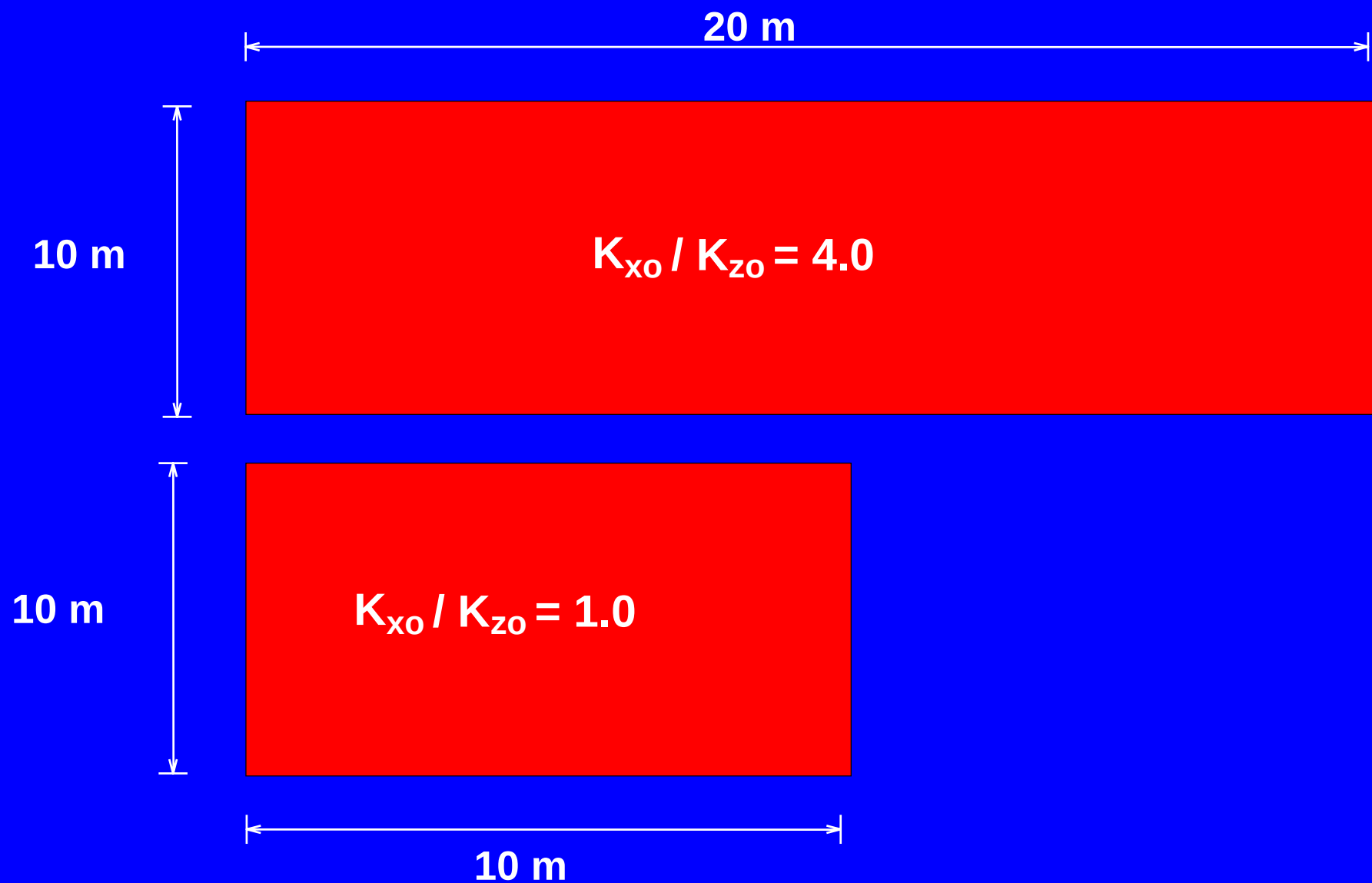


How to Scale Up ?

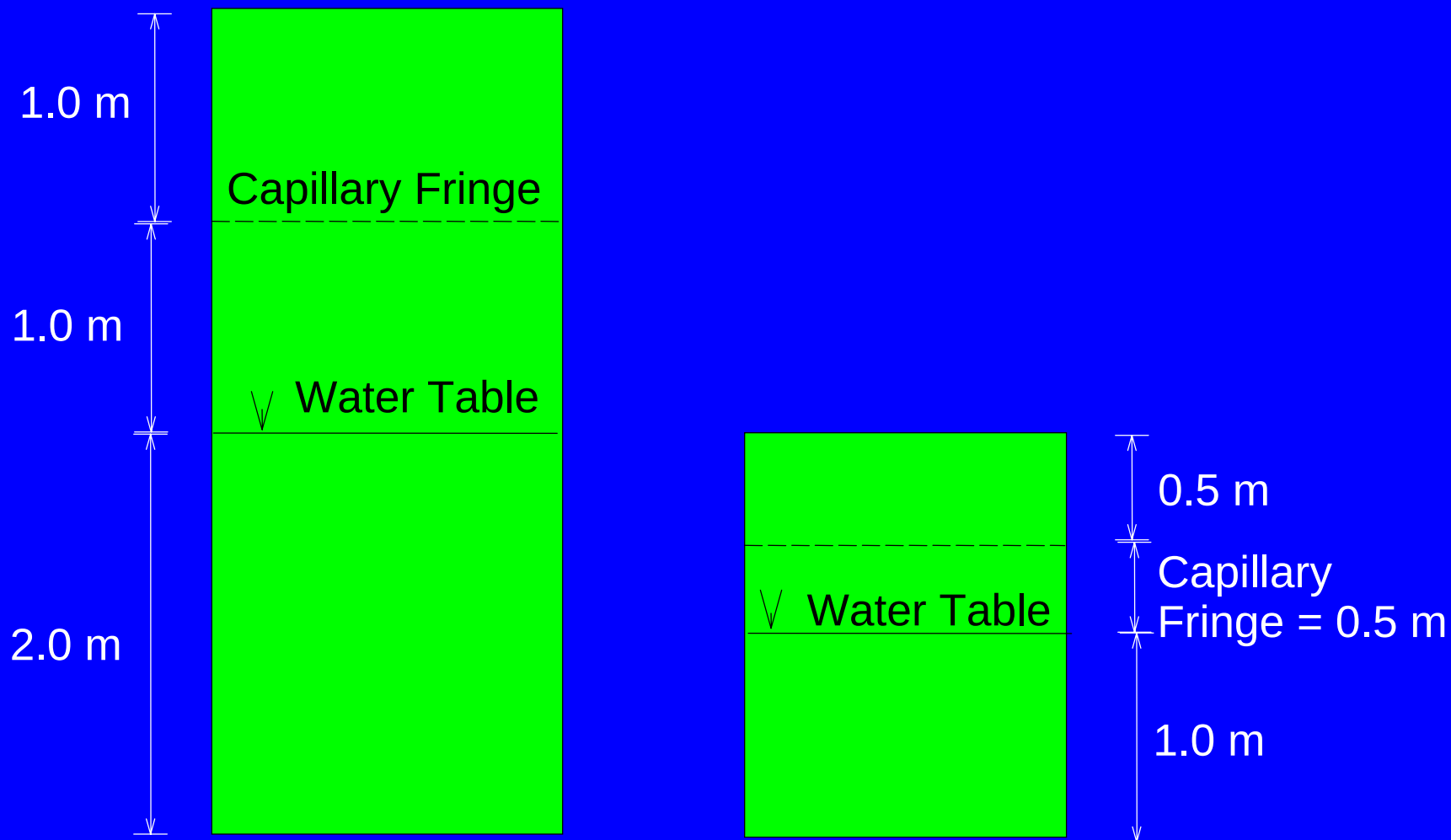
Conserve two dimensionless parameters

- **B**
- **CP**

Conserve $B = (K_{x0} / K_{z0}) (L_z / L_x)^2$



Conserve $C_p = \text{Capillary Fringe/Domain Height}$





CONCLUSIONS

The applied plume moves downward during rising tides and seaward during falling tides.

A formulation was developed to generalize the results to other systems.

ACKNOWLEDGEMENTS

Funding from the
EPA

National Risk Management Laboratory US
Cincinnati, Ohio

Disclaimer

Although this work was reviewed by EPA and approved for presentation, it may not necessarily reflect official Agency policy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Wave Action

