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

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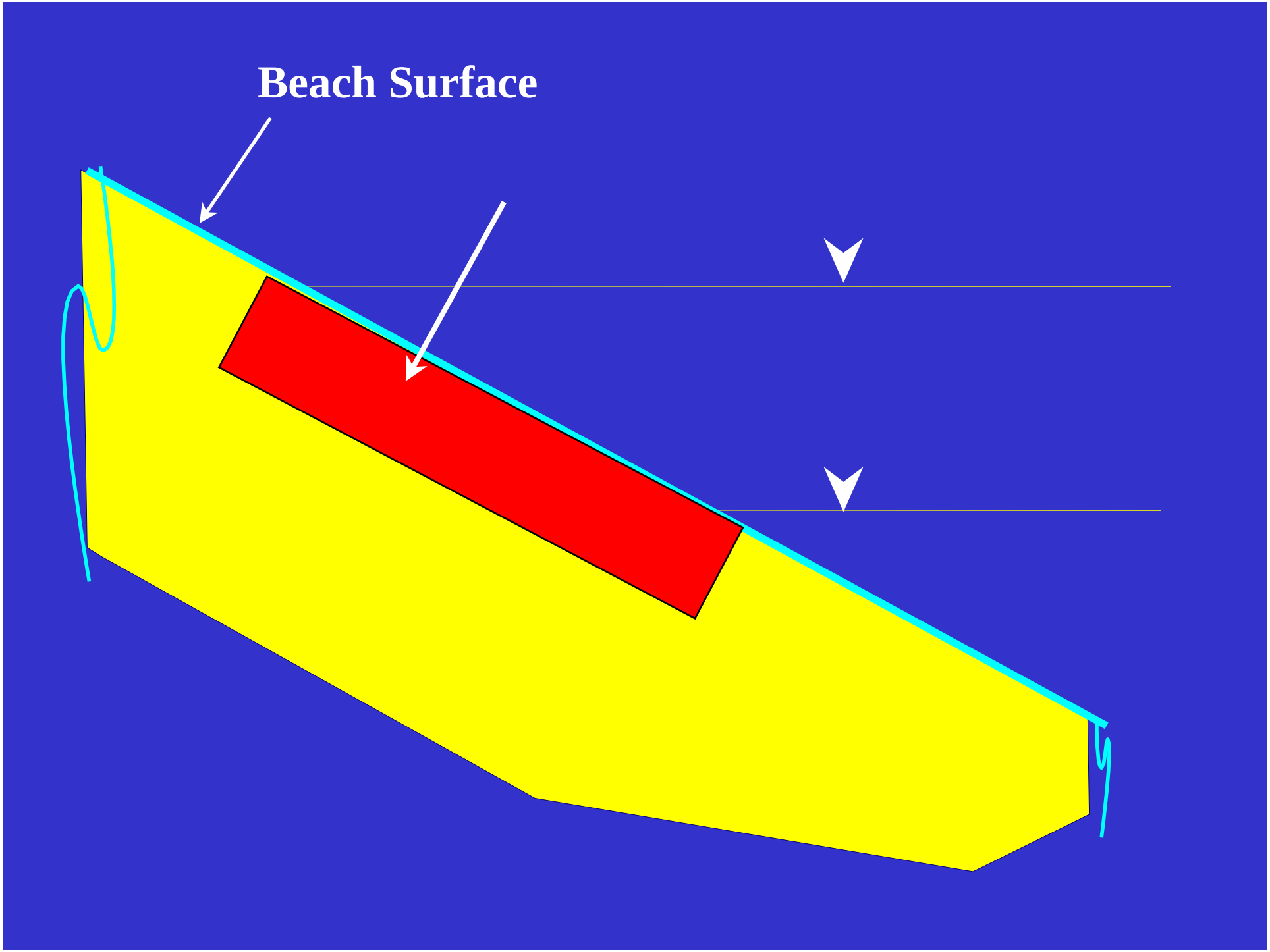
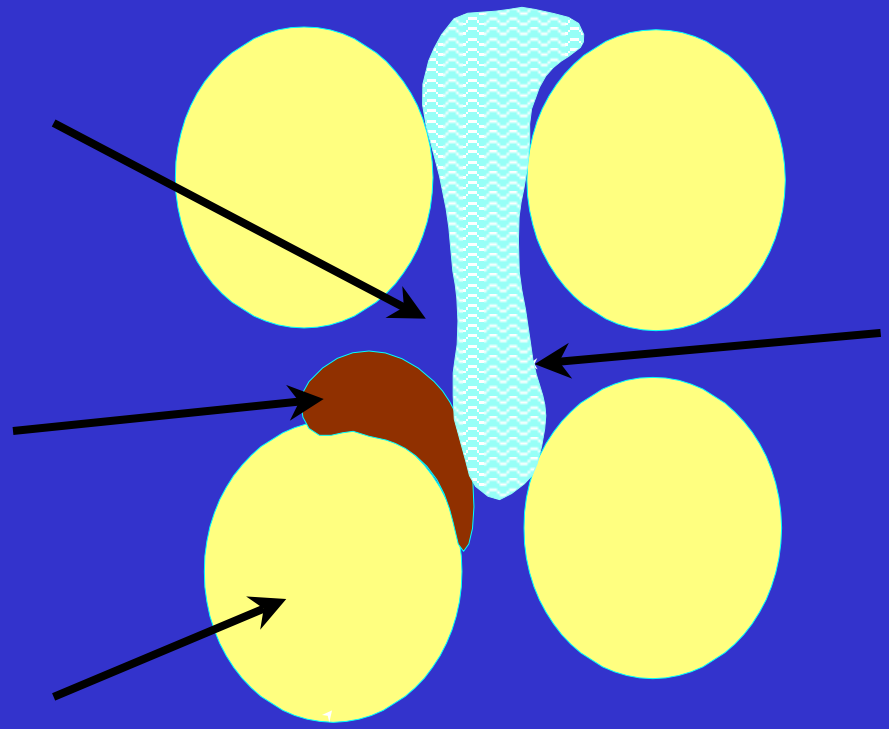

Beach Surface

The Porous Medium



Water Containing:
Oxygen
Microorganisms
Nutrients

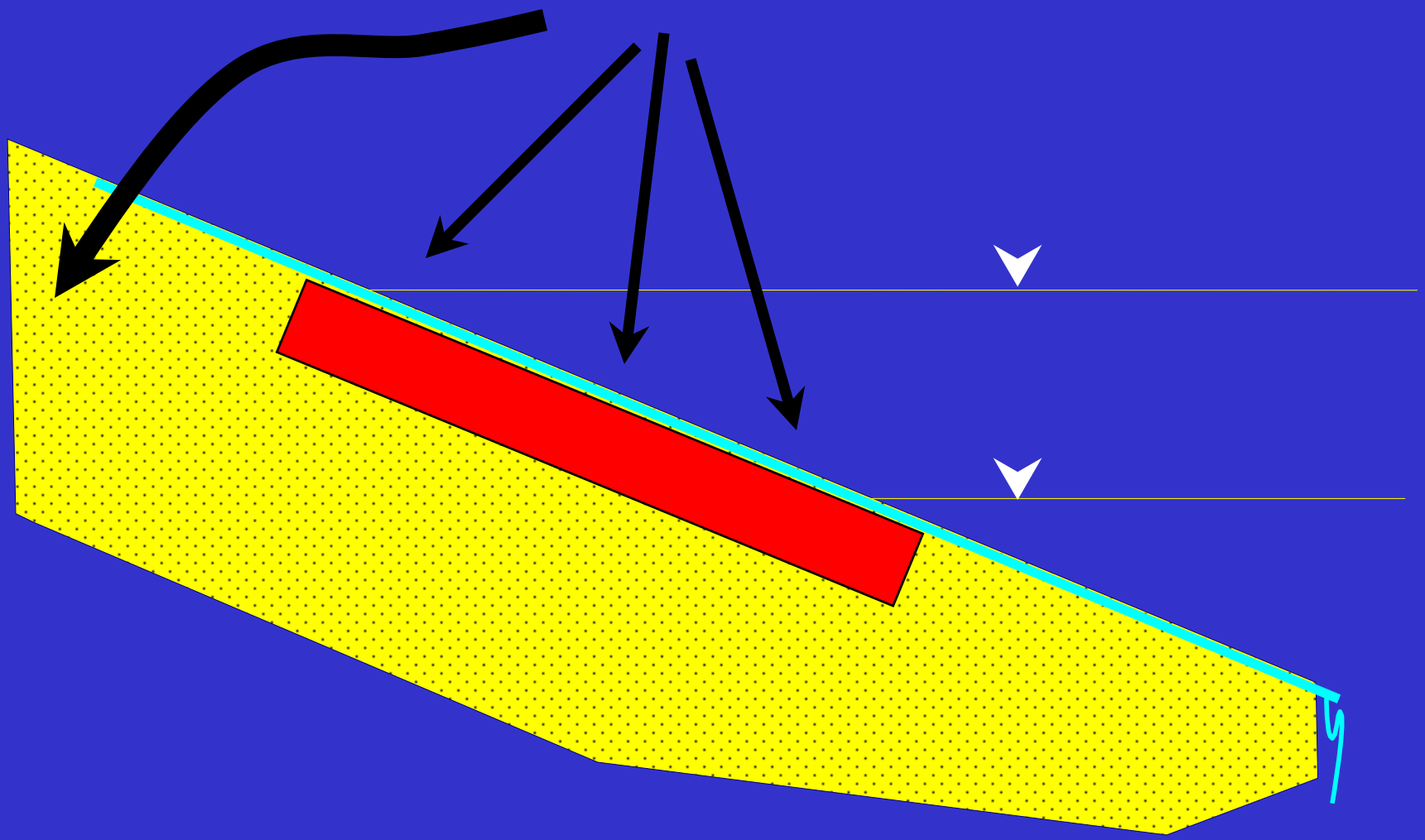
PROBLEM STATEMENT

- The Required Nutrient Concentration is Small. About 5-10 mg/L of Nitrate-N *.

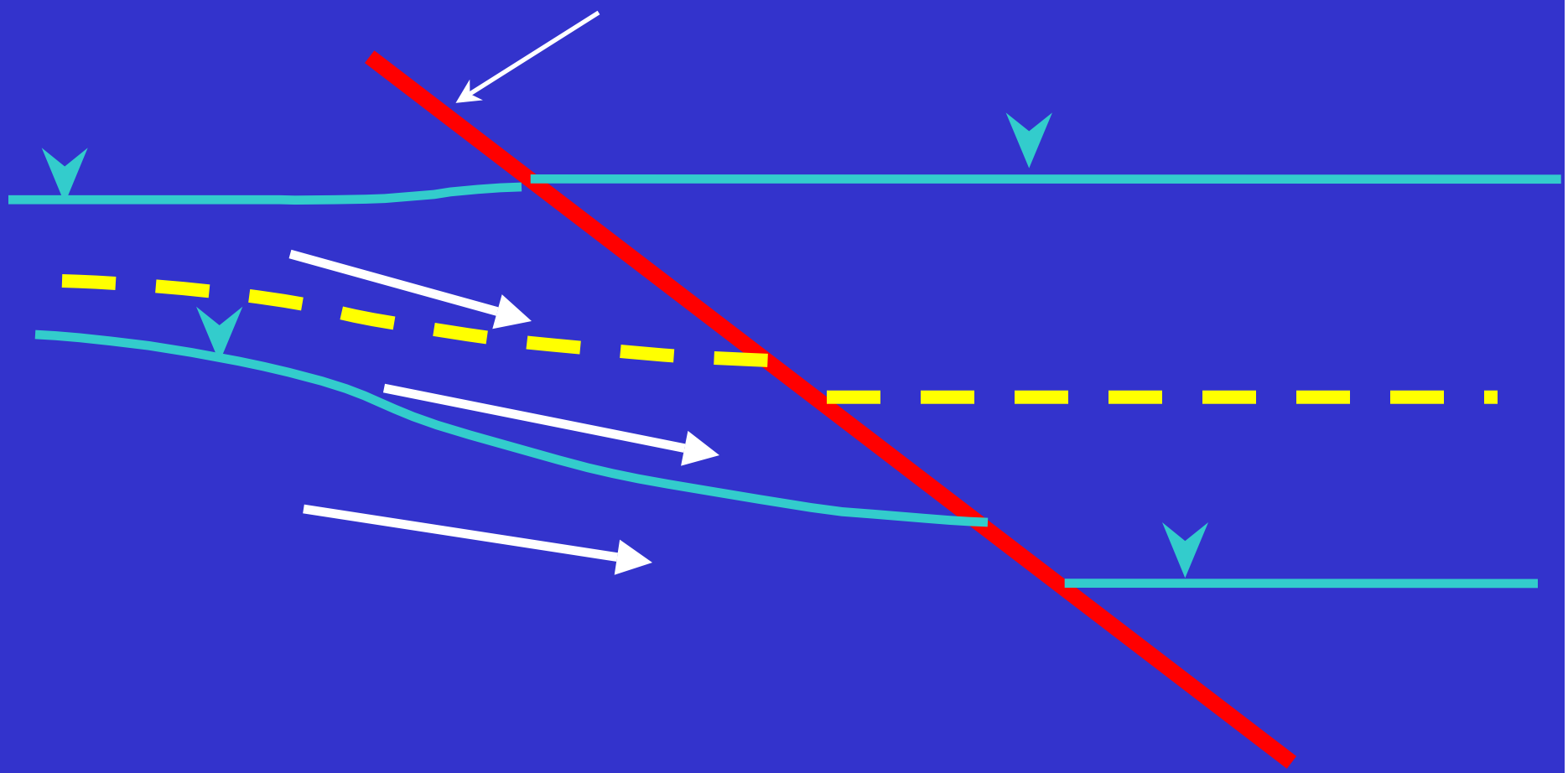
- The Goal is to Maximize the Contact Time of Nutrients with the Oil.

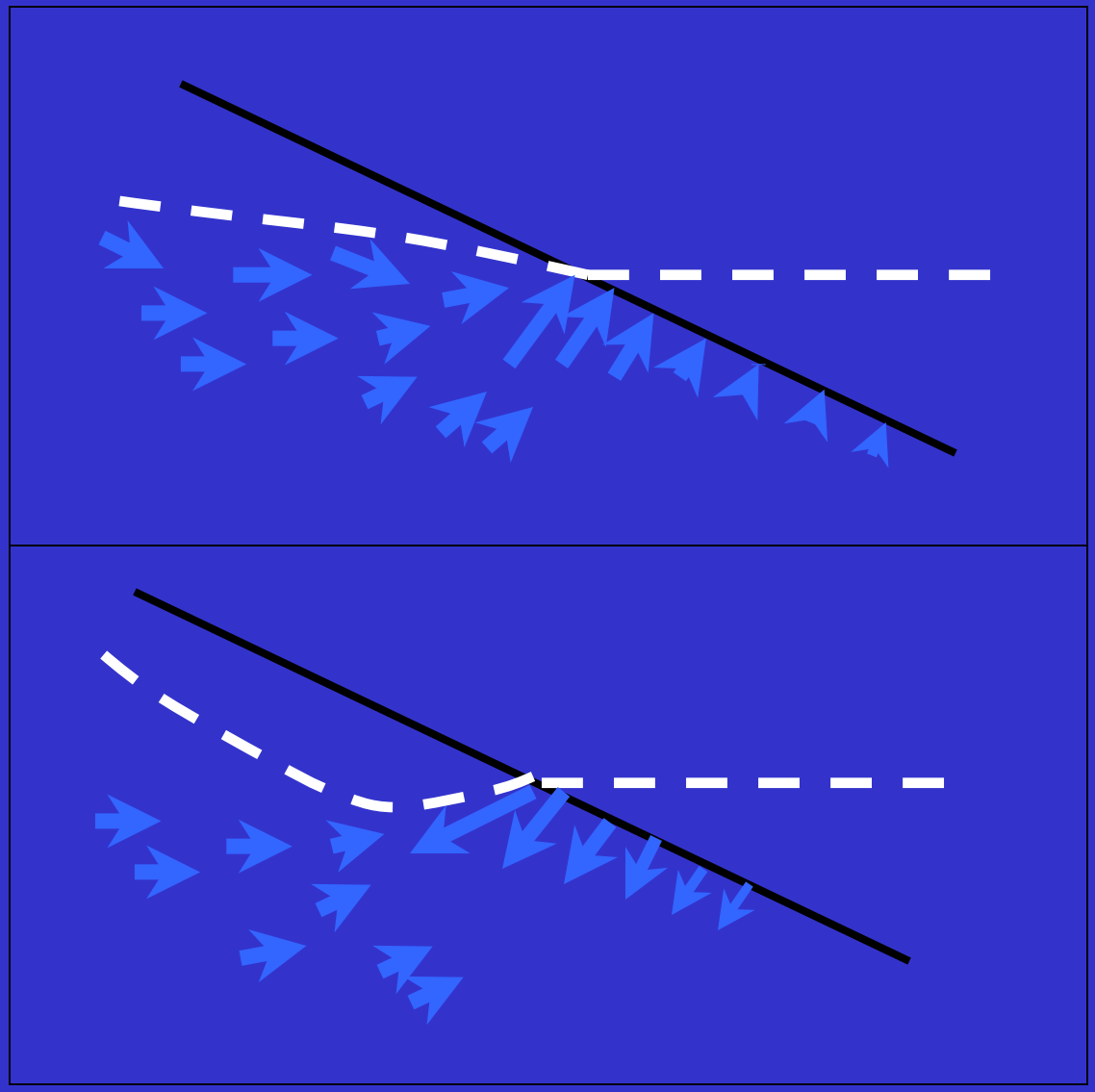
*Venosa *et al.* (1996), Env. Sc. Tech., 30, p 1764-1775.
*Boufadel *et al.* (1999), Env. Tech., 20, p 191-199.

NUTRIENTS SOLUTION

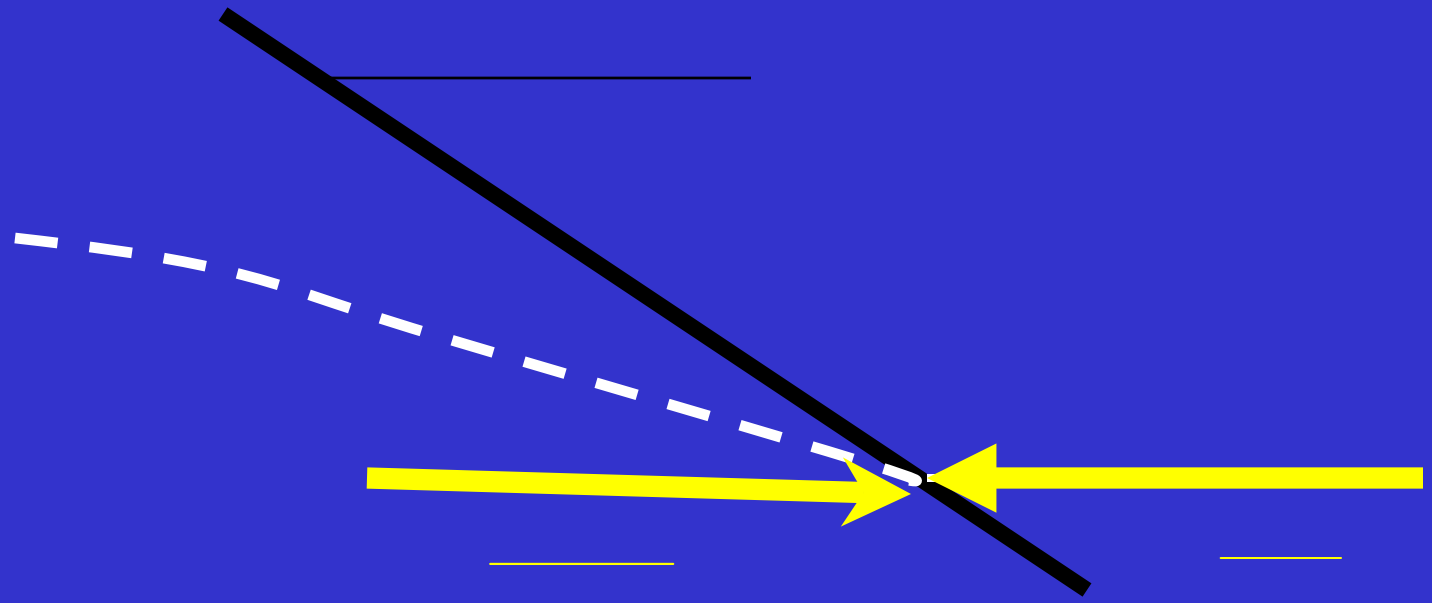


Tidal Action





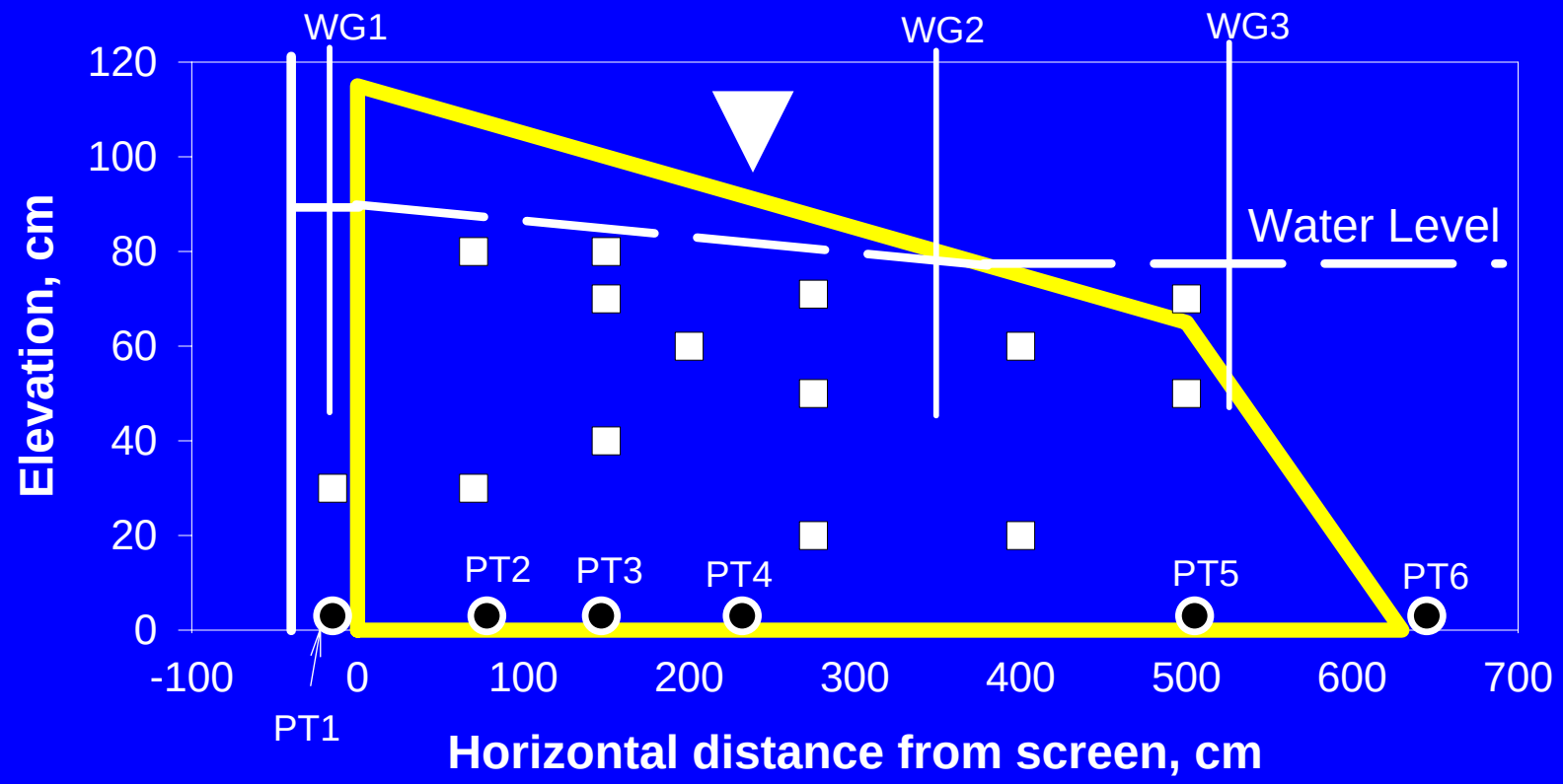
How Fast is Fast?

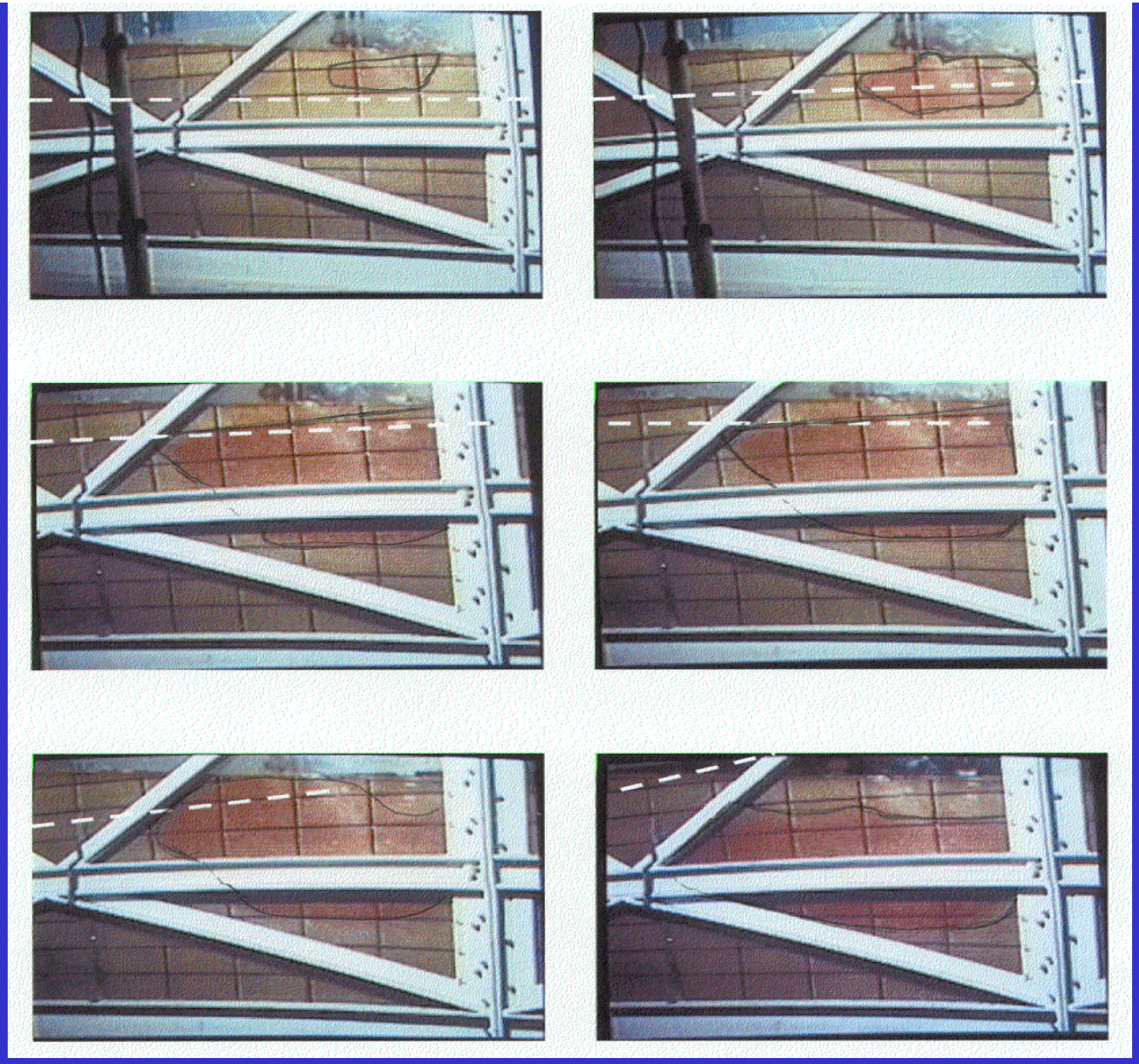


For $\sin(\theta)=0.1$, $n=0.3$
$K=0.1$ cm/s.
$V_s \approx 0.03$ cm/s

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

WG = Wave Gauge
PT = Pressure Transducer
Squares = Conductivity Meter





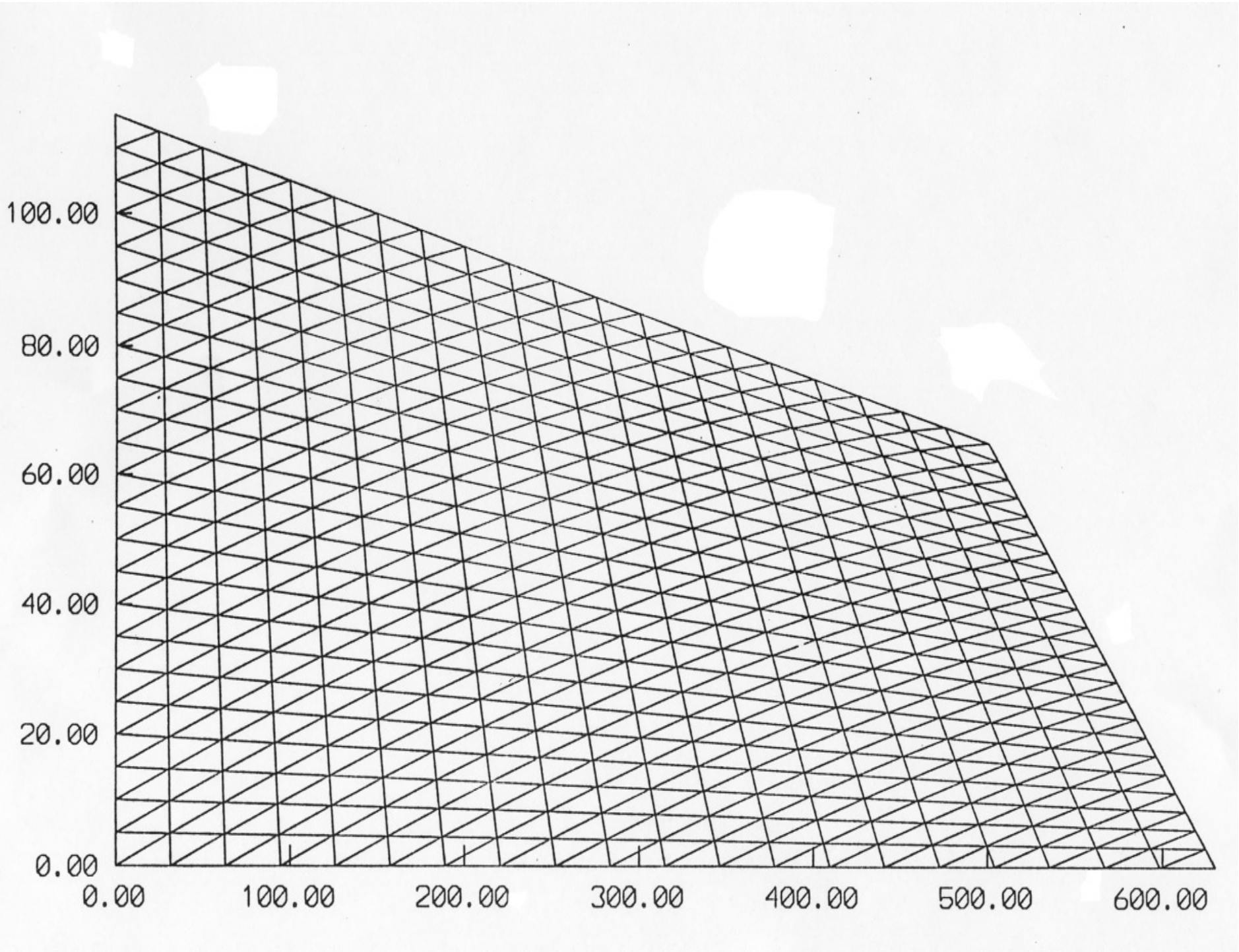
Boufadel, Suidan, Venosa, J. Env. Enggr., ASCE, 2006.

MODELING APPROACH

- Account for Vadose Zone Hydraulics

- Simulate Tide as a Dynamic Process

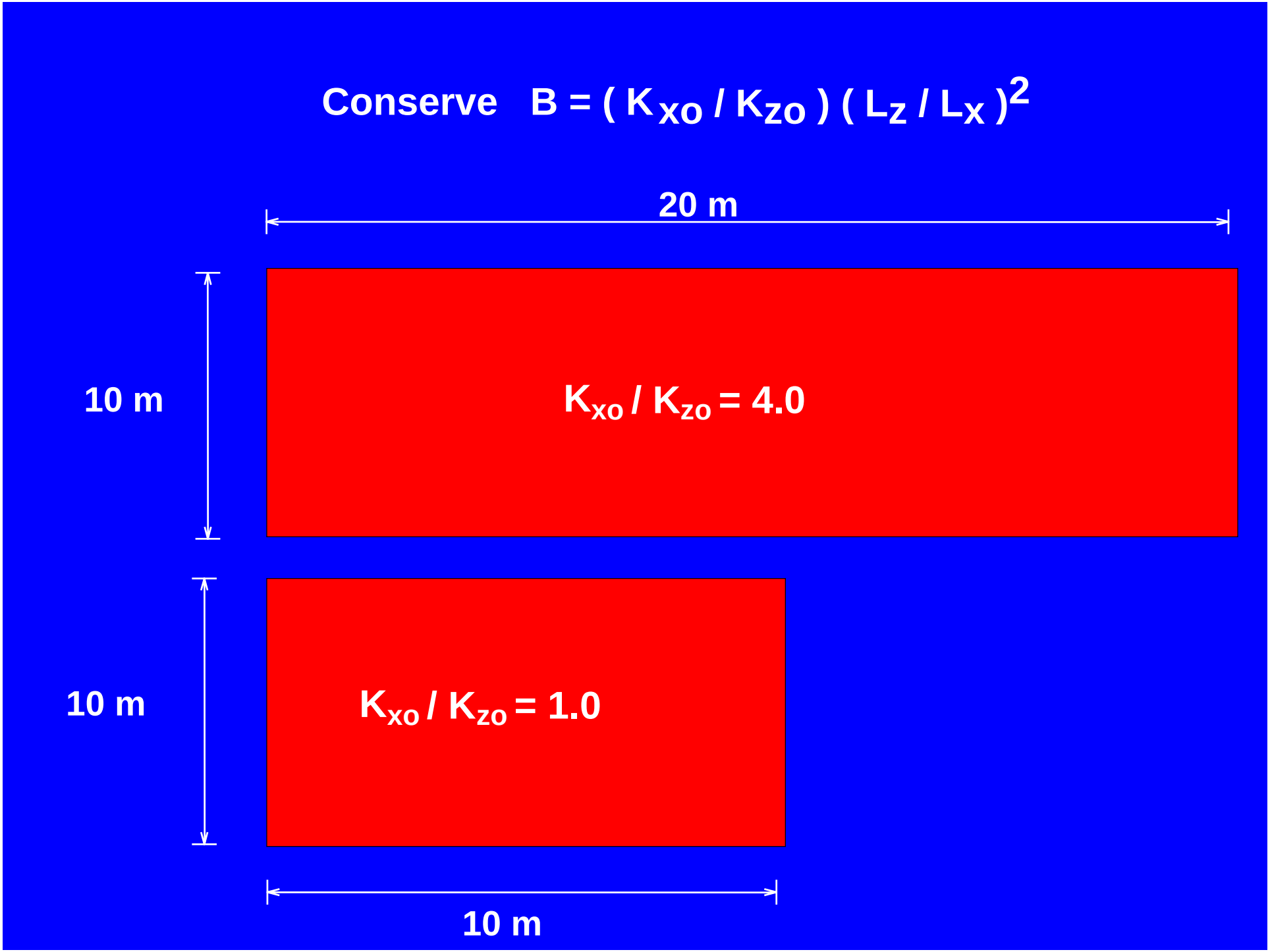
Boufadel, Suidan, and Venosa, J. of Contaminant Hydrology, 37, p1-20, 1999.


100.00
80.00
60.00
40.00
20.00
0.00
0.00
100.00
200.00
300.00
400.00
500.00
600.00

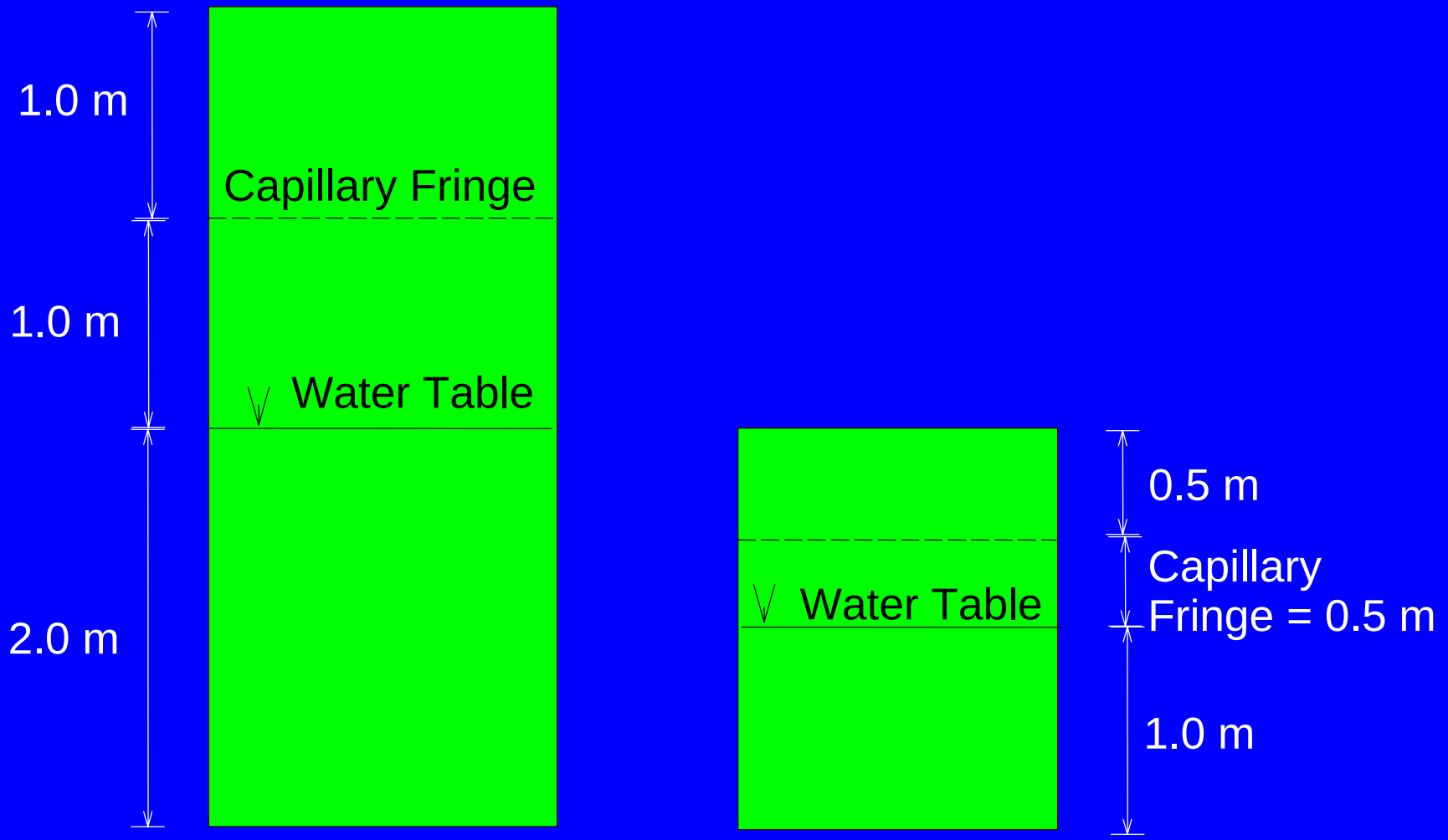
How to Scale Up ?

Conserve two dimensionless parameters

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


Conserve B = (K_{xo} / K_{zo}) (L_z / L_x)^2
20 m
10 m
K_{xo} / K_{zo} = 4.0
10 m
K_{xo} / K_{zo} = 1.0
10 m

Conserve Cp = 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

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Disclaimer

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Wave Action