Modern Sediment Quality Criteria for Metals and Applications to Superfund Sites

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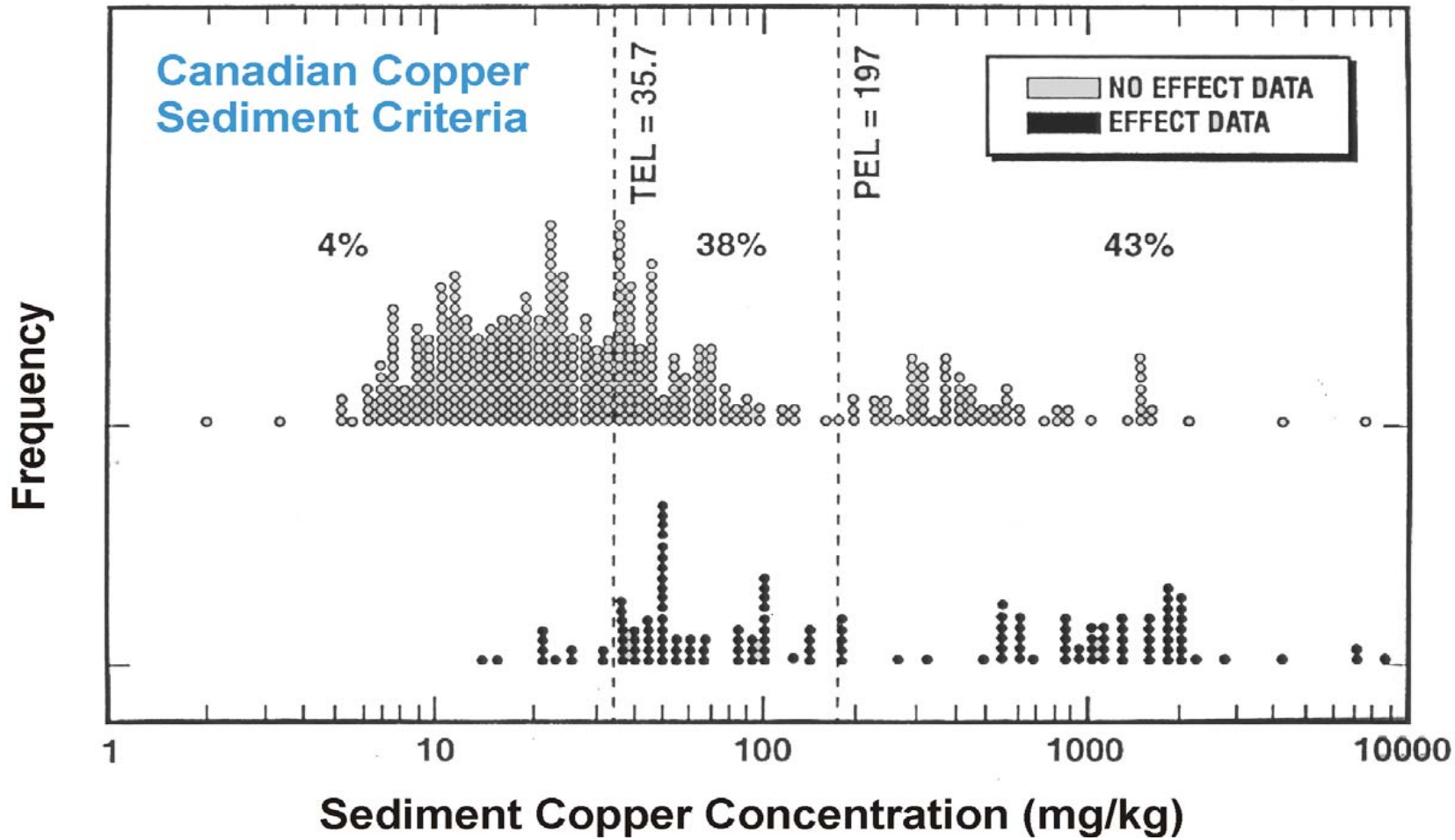
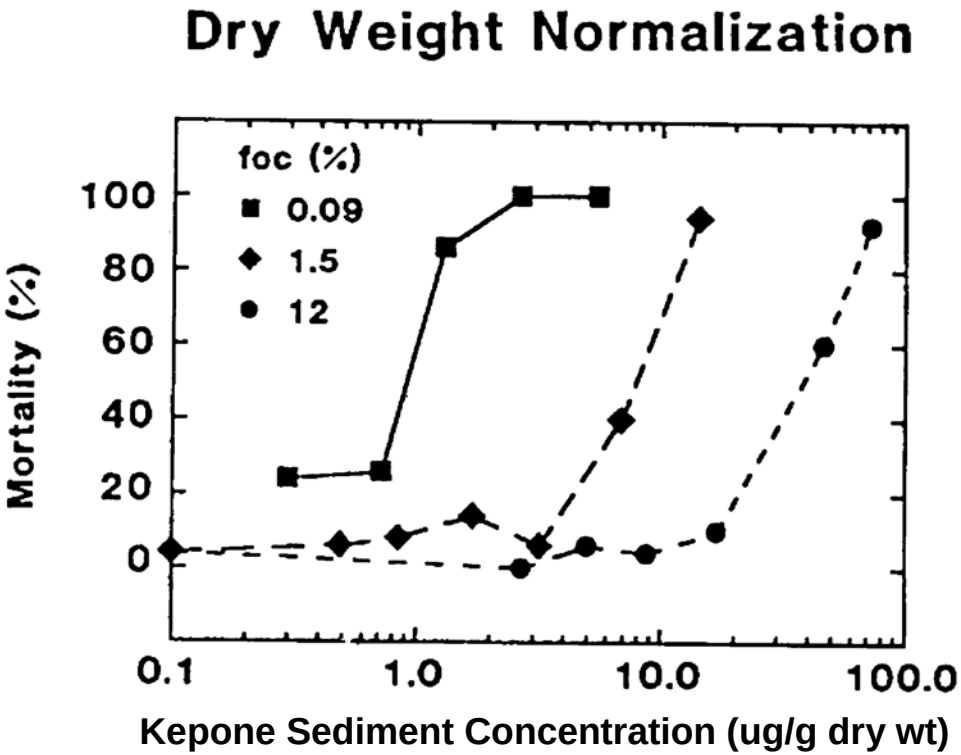
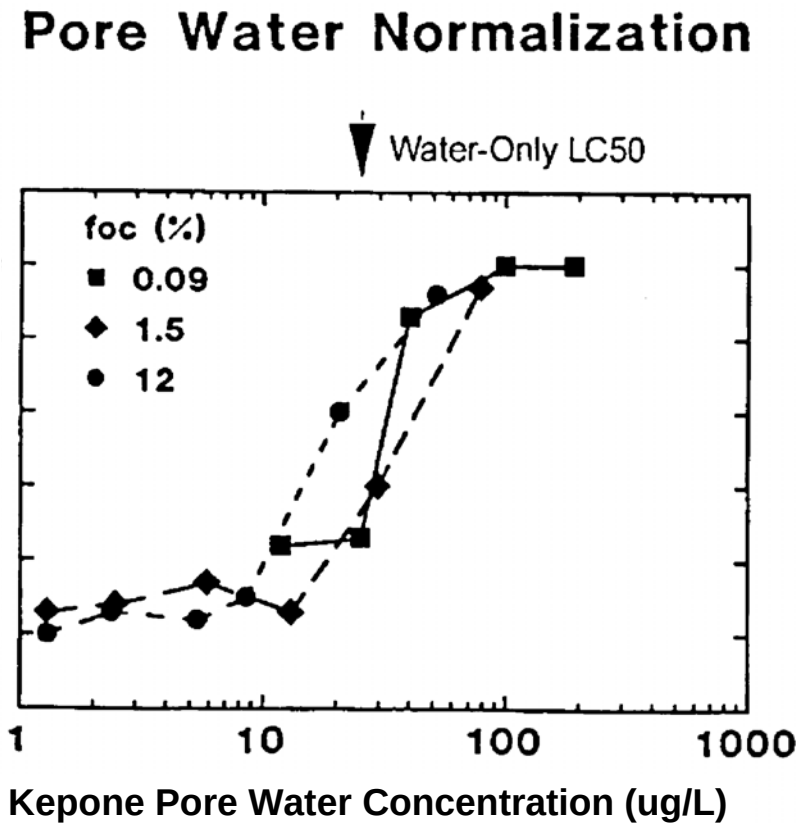
Bioavailability - Sediment



Pore water Concentration Predicts Sediment Toxicity

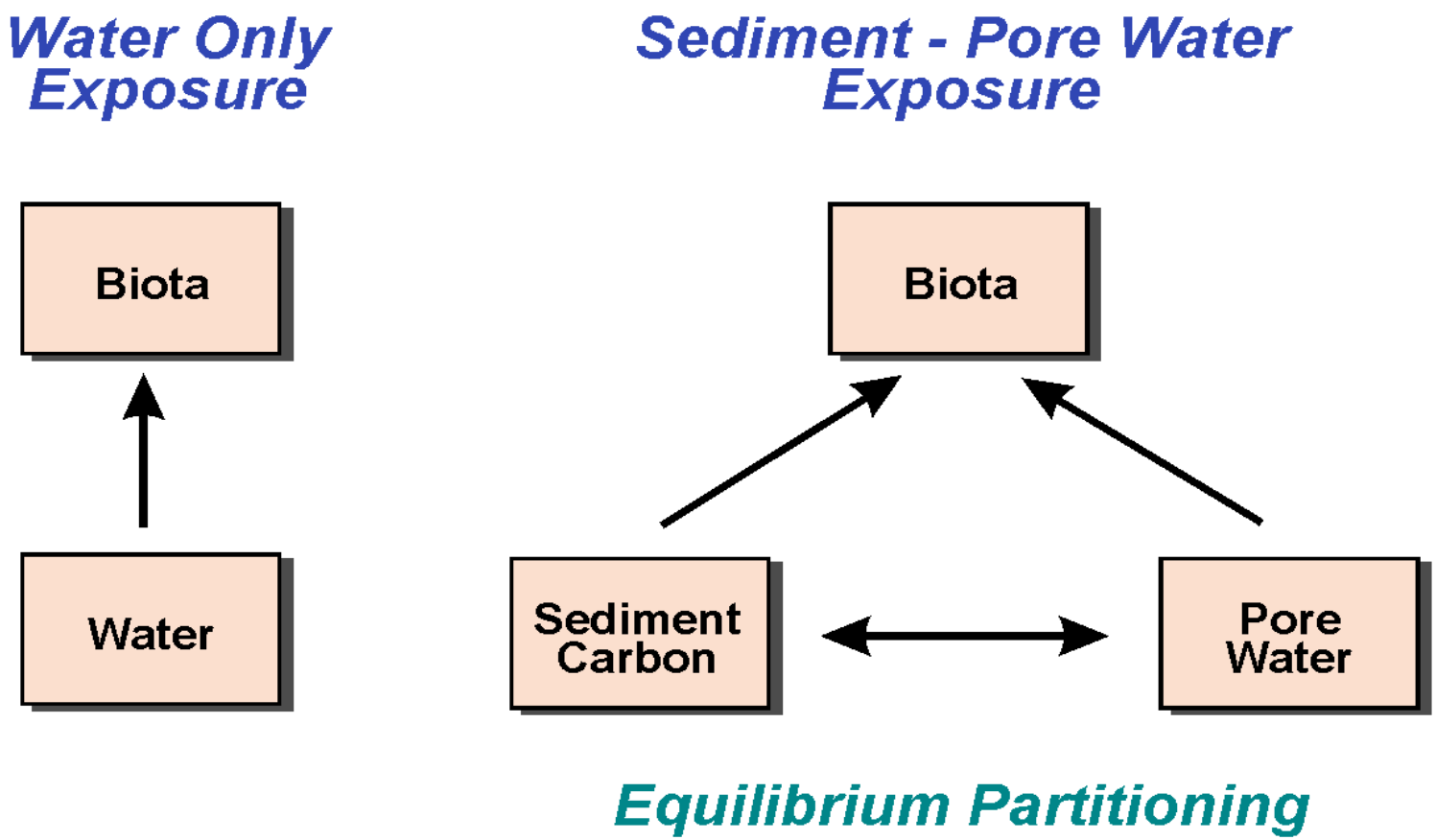




Adams, W. J., Kimerle, R. A., & Mosher, R. G. (1985). In R. D. Cardwell, R. Purdy, & R. C. Bahner (Eds.), Aquatic Toxicology and Hazard Assessment: Seventh Symposium. STP 854 (pp. 429-453). Am. Soc. for Testing and Materials.

Di Toro, D. M., C. S. Zarba, D J. Hansen, W J Berry, R C. Swartz, C E. Cowan, S P. Pavlou H E. Allen, N A Thomas, P R Paquin. (1991). Environ. Toxicol. Chem. 11(12): 1541-1583.

Equilibrium Partitioning Model of Sediment Toxicity



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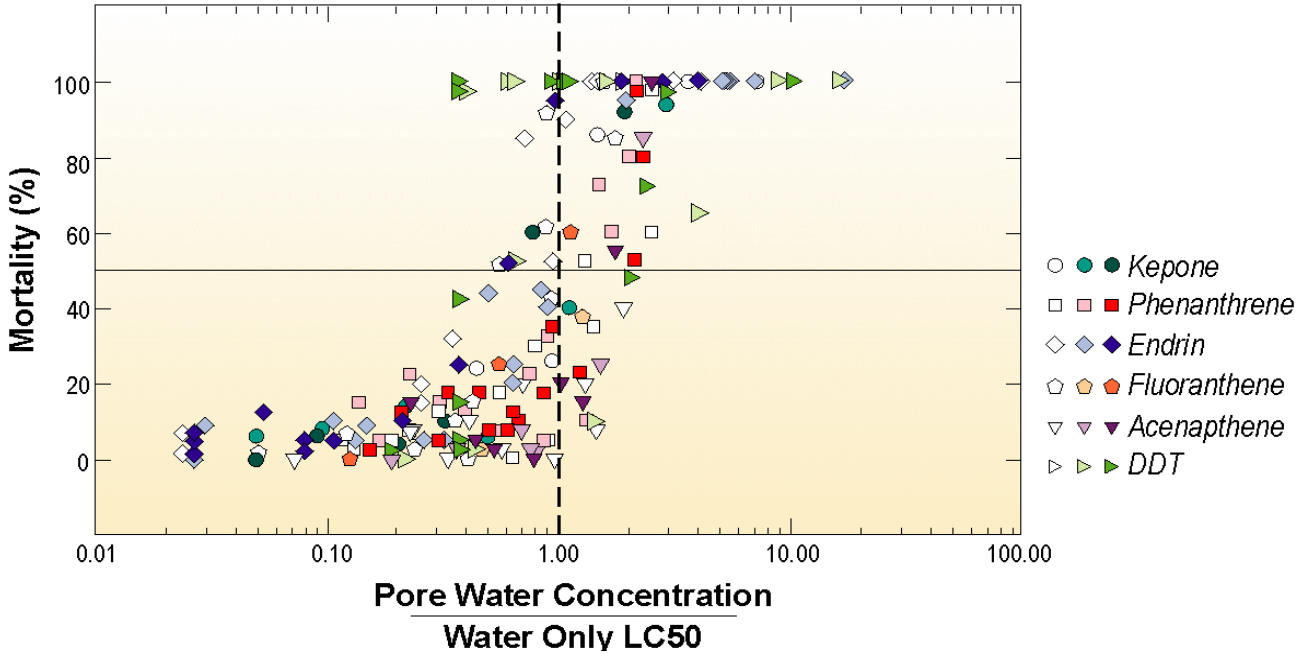
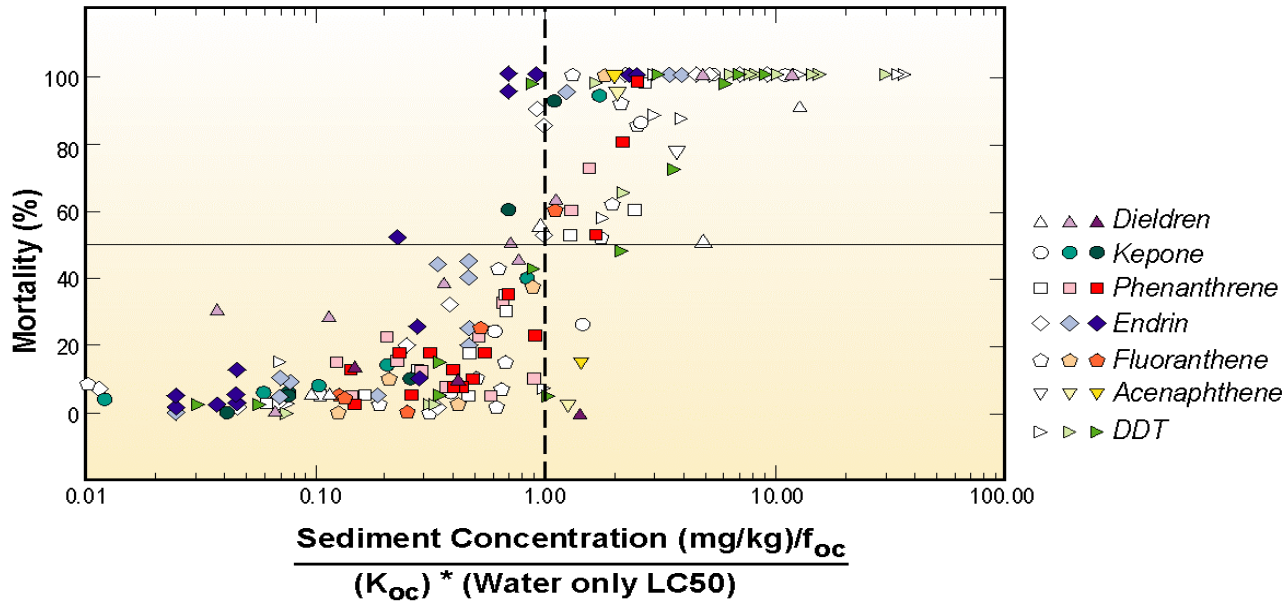
Sediment Toxicity Prediction

Pore Water

Organic Carbon Normalized





USEPA (2000). Draft Technical Basis for the derivation of Equilibrium Partitioning sediment guidelines (ESG) for the protect of benthic organisms: Nonionic organics No. EPA-822-R-00-001)

SEM – AVS Model of Metal Bioavailability

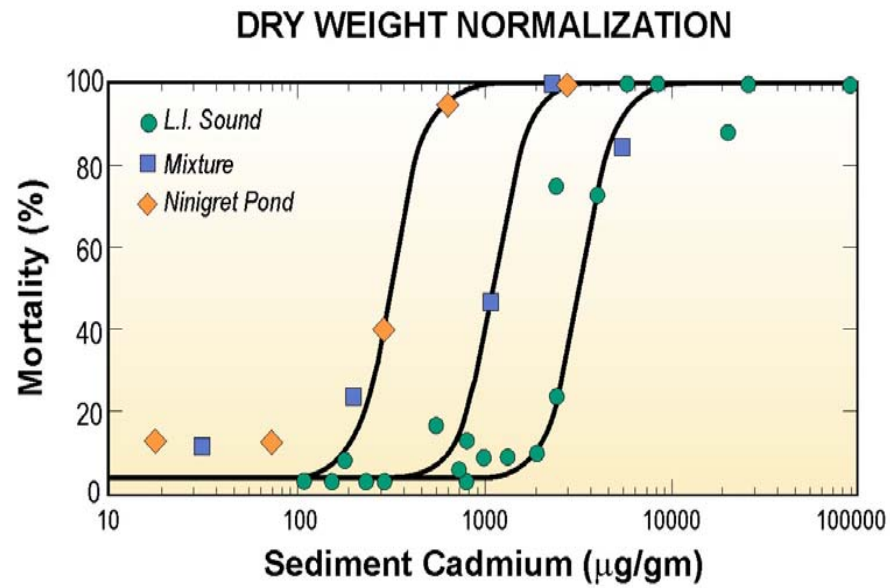
Metals are precipitated by reacting with iron monosulfide (AVS)

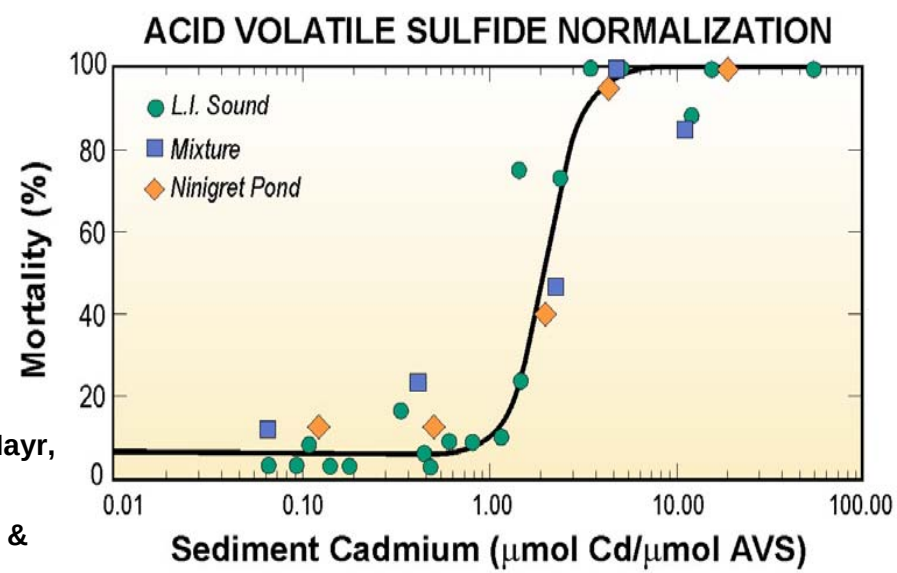
$$M^{2+} + FeS \longrightarrow Fe^{2+} + MS$$

Sediment metal (SEM) is quantified using same extraction as for AVS (1N HCl)

AVS > SEM No toxicity possible

AVS < SEM Toxicity possible





Di Toro, D. M., Mahony, J. D., Hansen, D. J., Scott, K. J., Hicks, M. B., Mayr, S. M., & Redmond, M. S. (1990). Environ. Toxicol. Chem., 9, 1487-1502.

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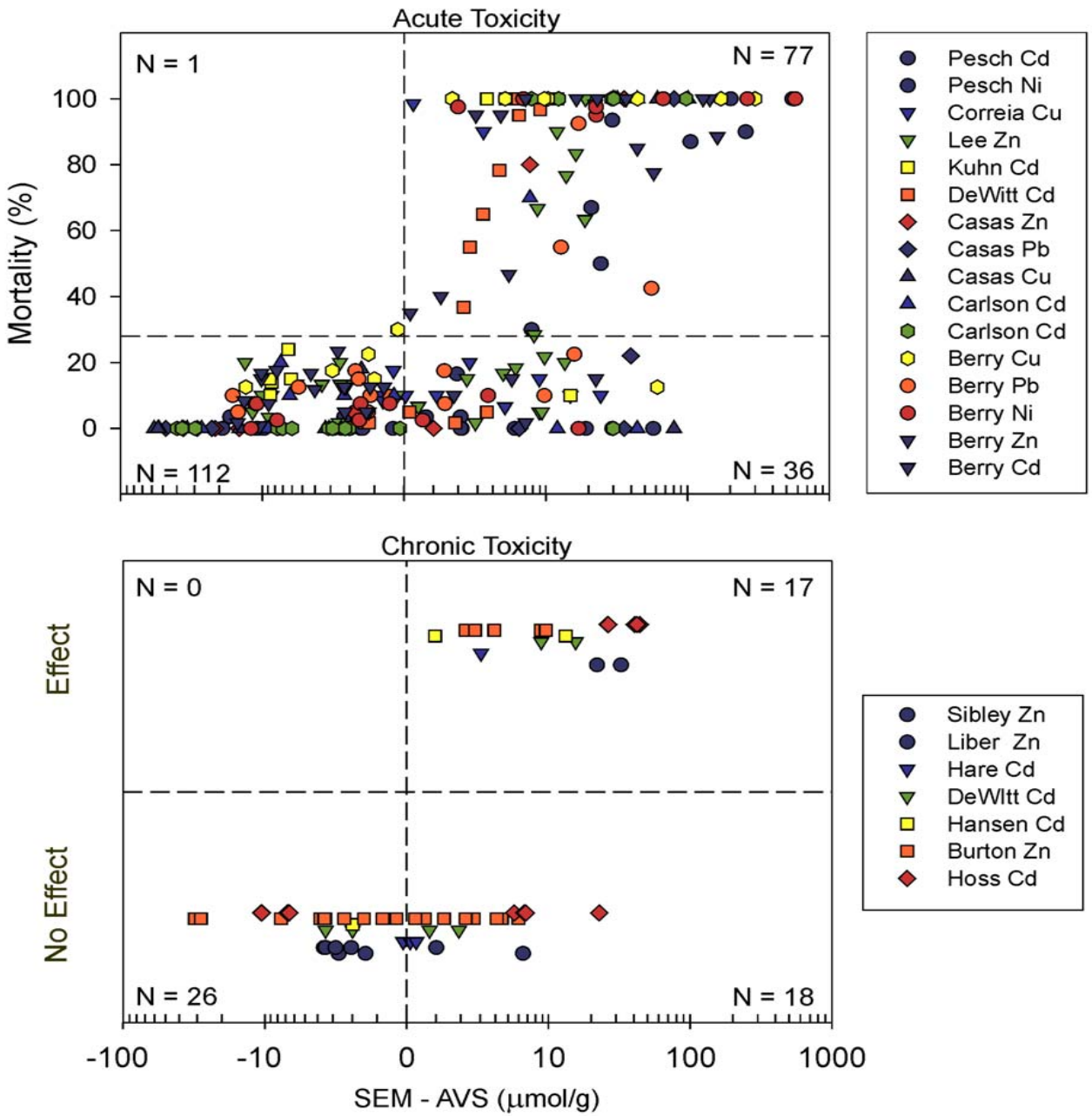
SEM – AVS

Model Validation



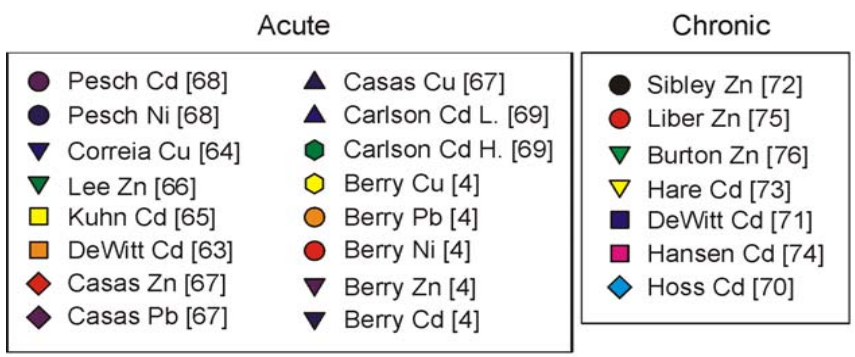
Predicting Sediment Metal Toxicity

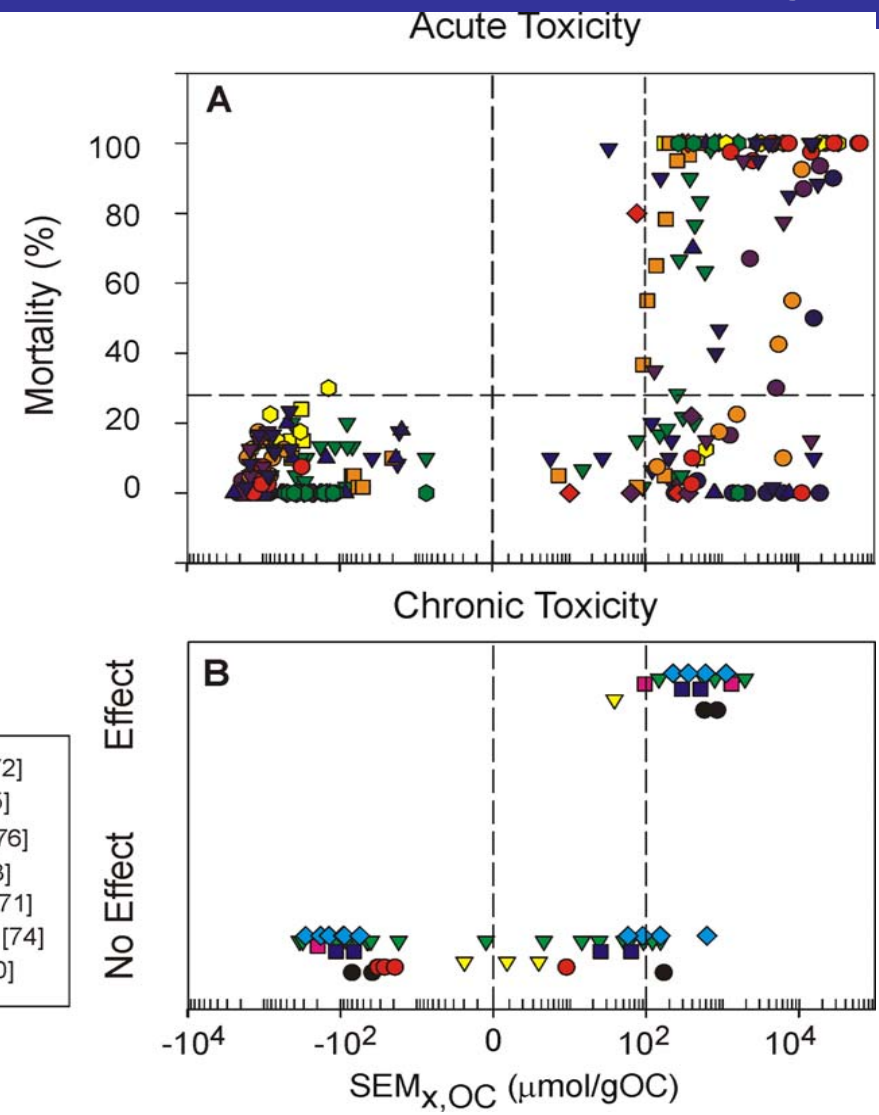
Organic Carbon Normalized Excess SEM

$SEM_{x,oc} = (SEM - AVS)/f_{oc}$

Observed Toxicity Boundary

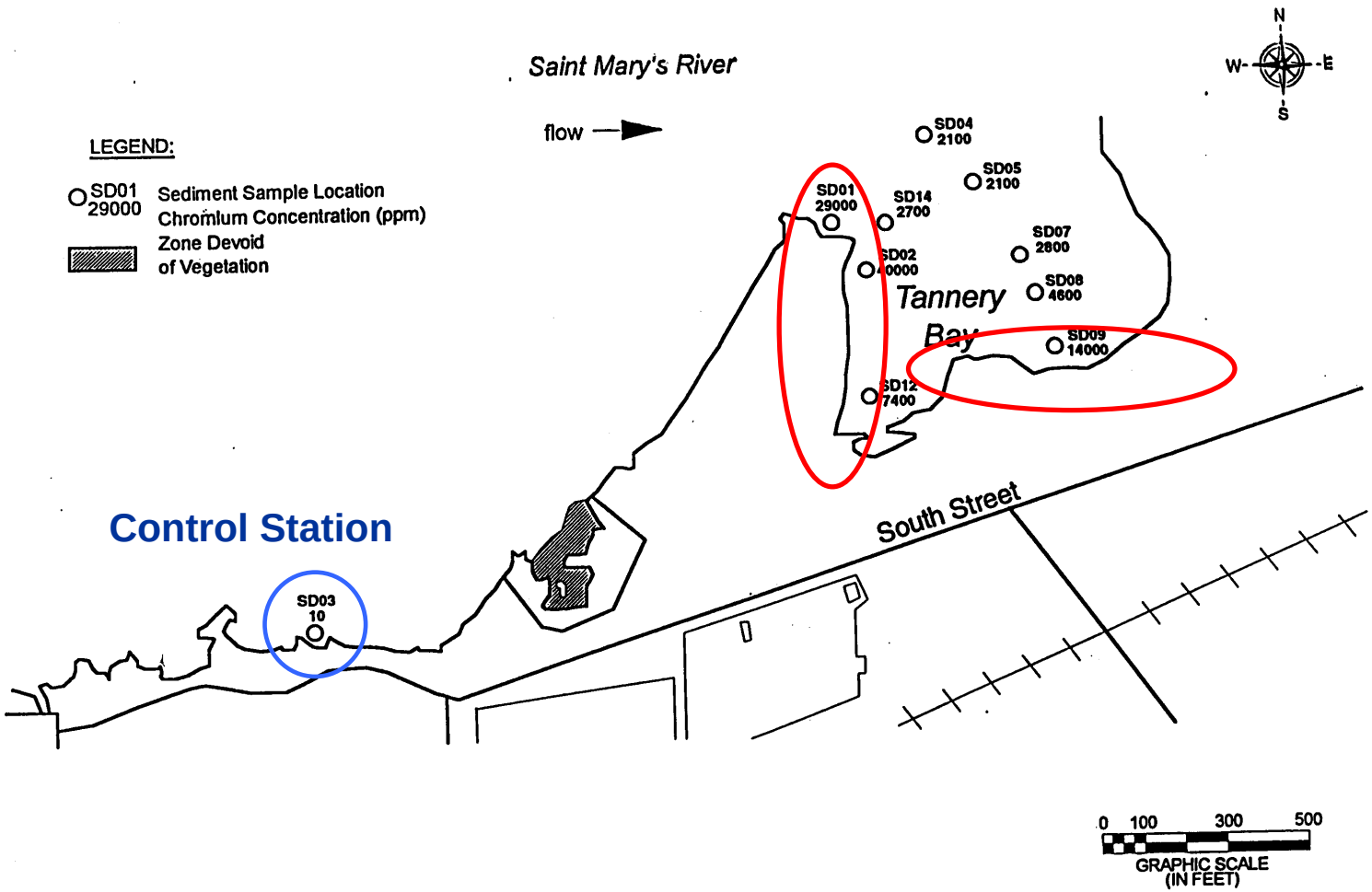
$SEM_{x,oc} = 100\ \mu mol/gOC$





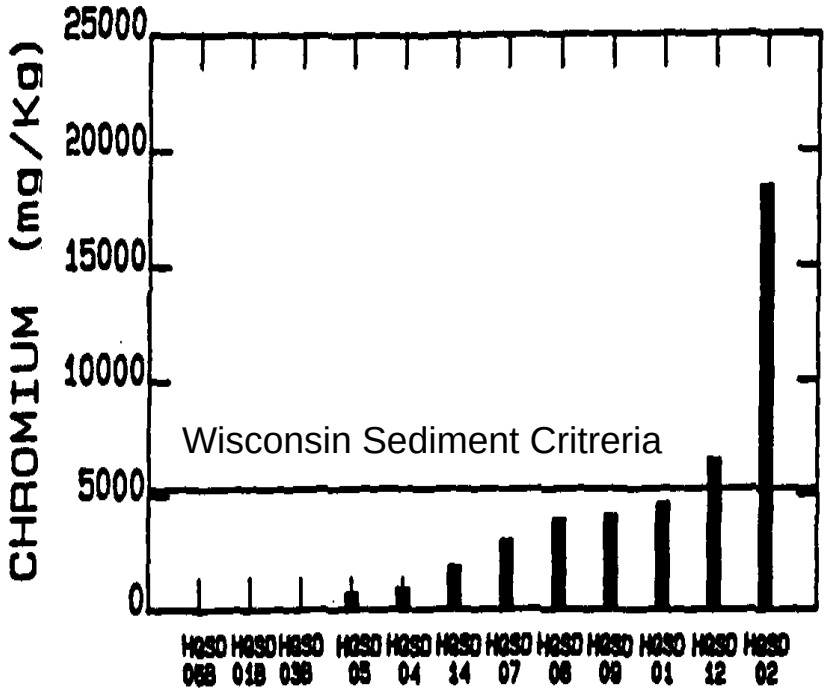
Di Toro, D. M., McGrath, J. M., Hansen, D. J., Berry, W. J., Paquin, P. R., Mathew, R., Wu, K. B., & Santore, R. C. Predicting Sediment Metal Toxicity Using a Sediment Biotic Ligand Model: Methodology and Initial Application. Environ Tox. Chem., (2005).

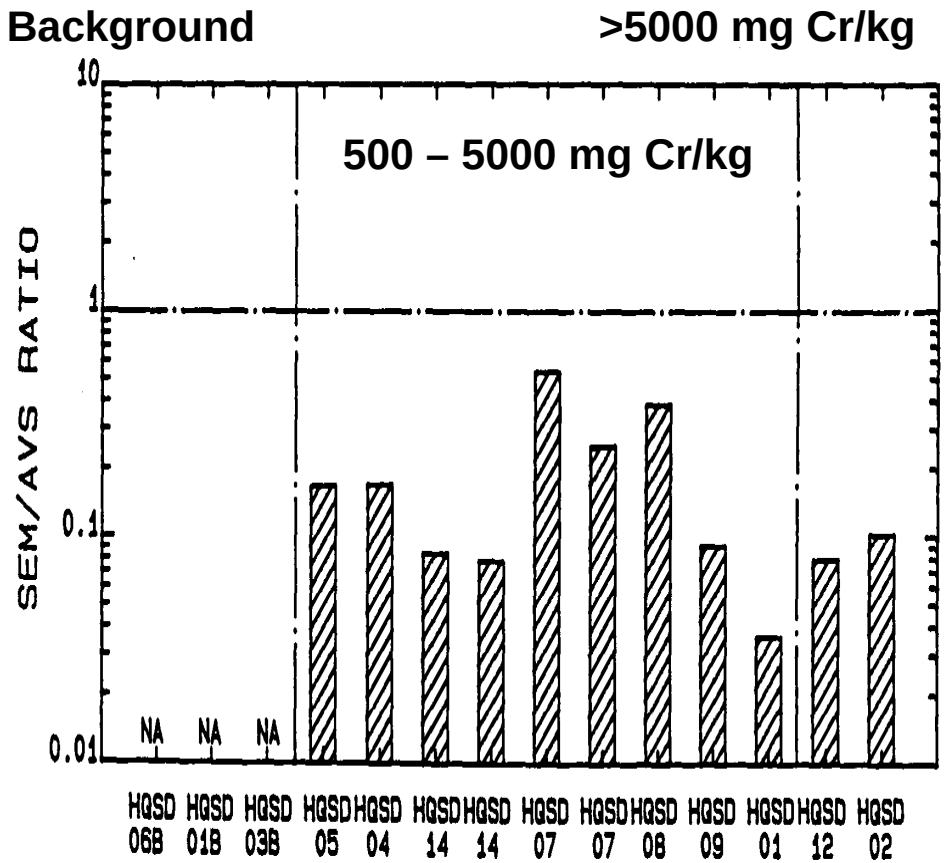
Tannery Bay – Chromium Contamination



Sediment Chromium Concentration

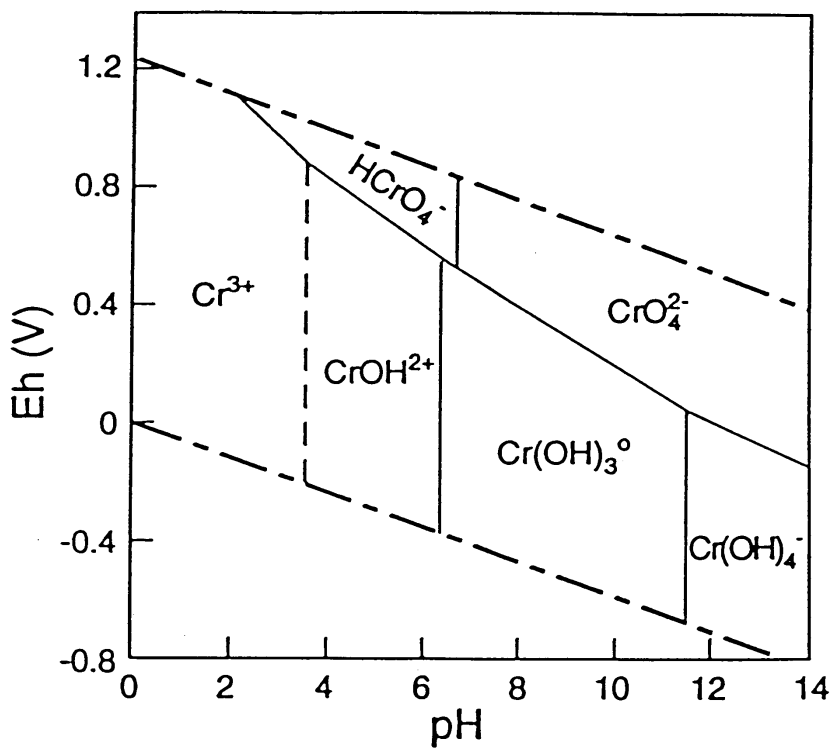
SEM – AVS Ratio



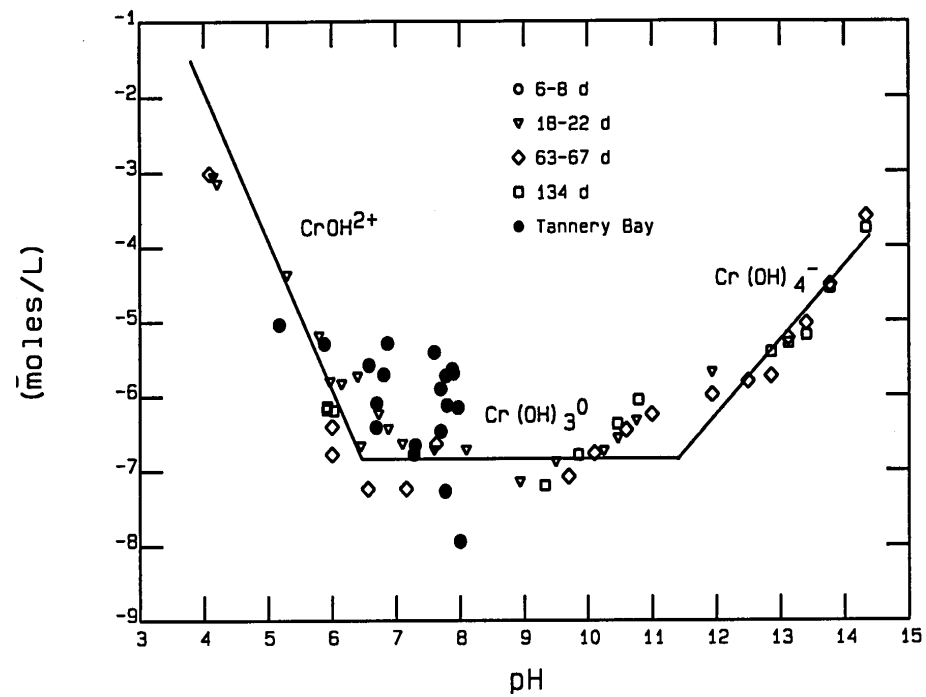


Chromium Chemistry

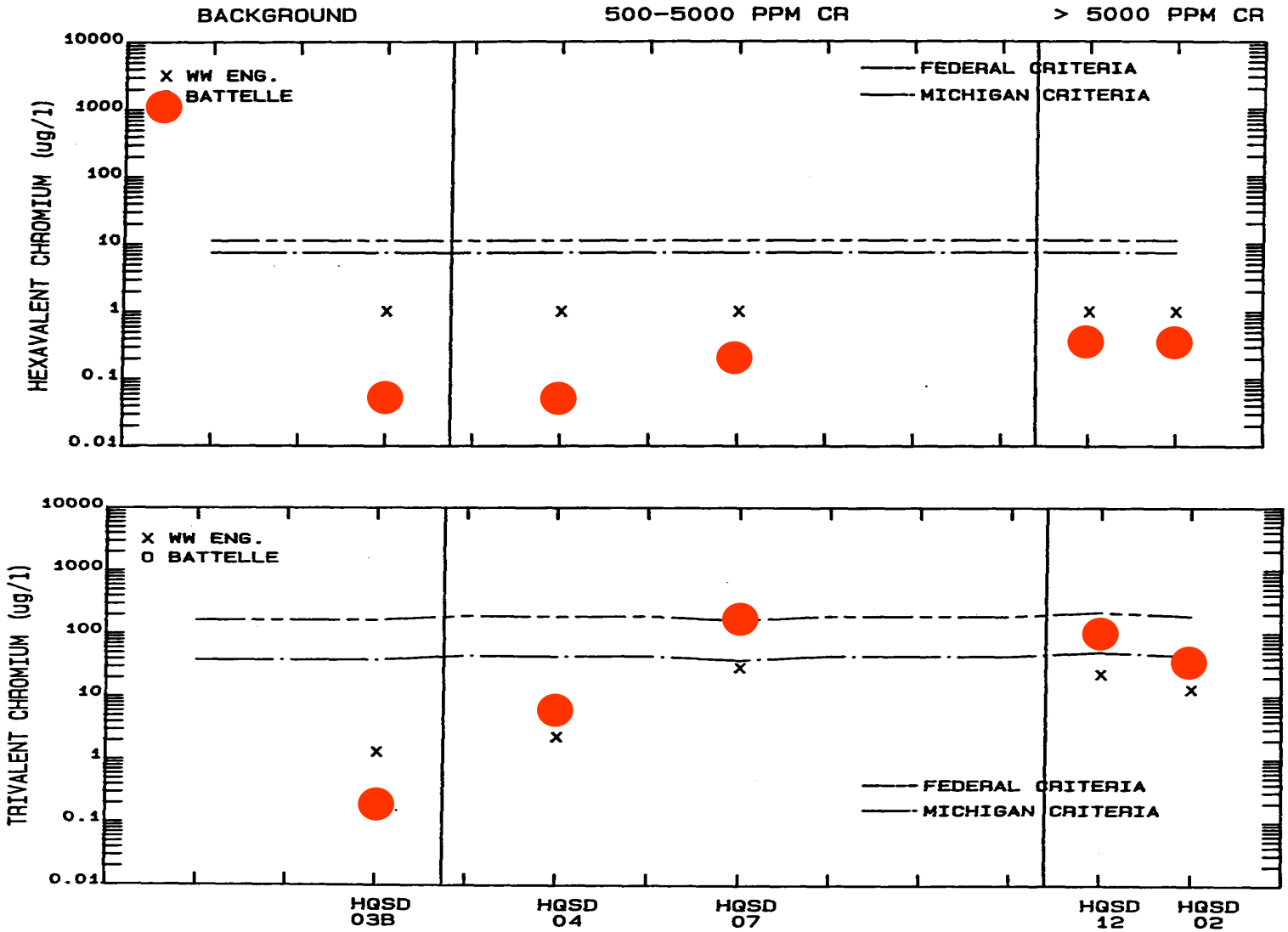
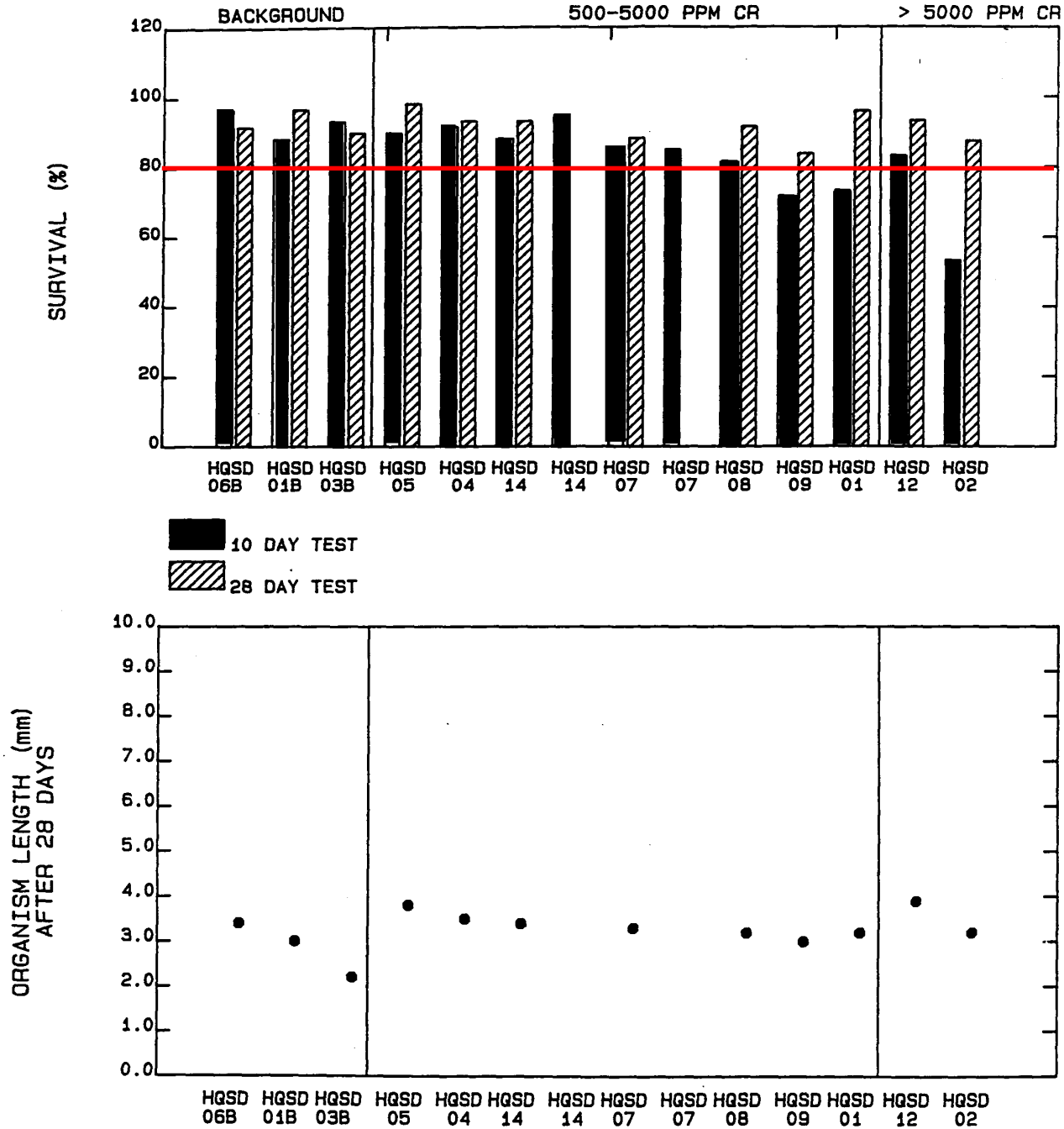
Cr(III) Redox Chemistry



Cr(III) Solubility



Pore Water Concentrations Cr(VI) & Cr(III)



Sediment Toxicity Tests