Source Control Early Action Focused Feasibility Study

Empirical Mass Balance Model Results for the Lower Passaic River

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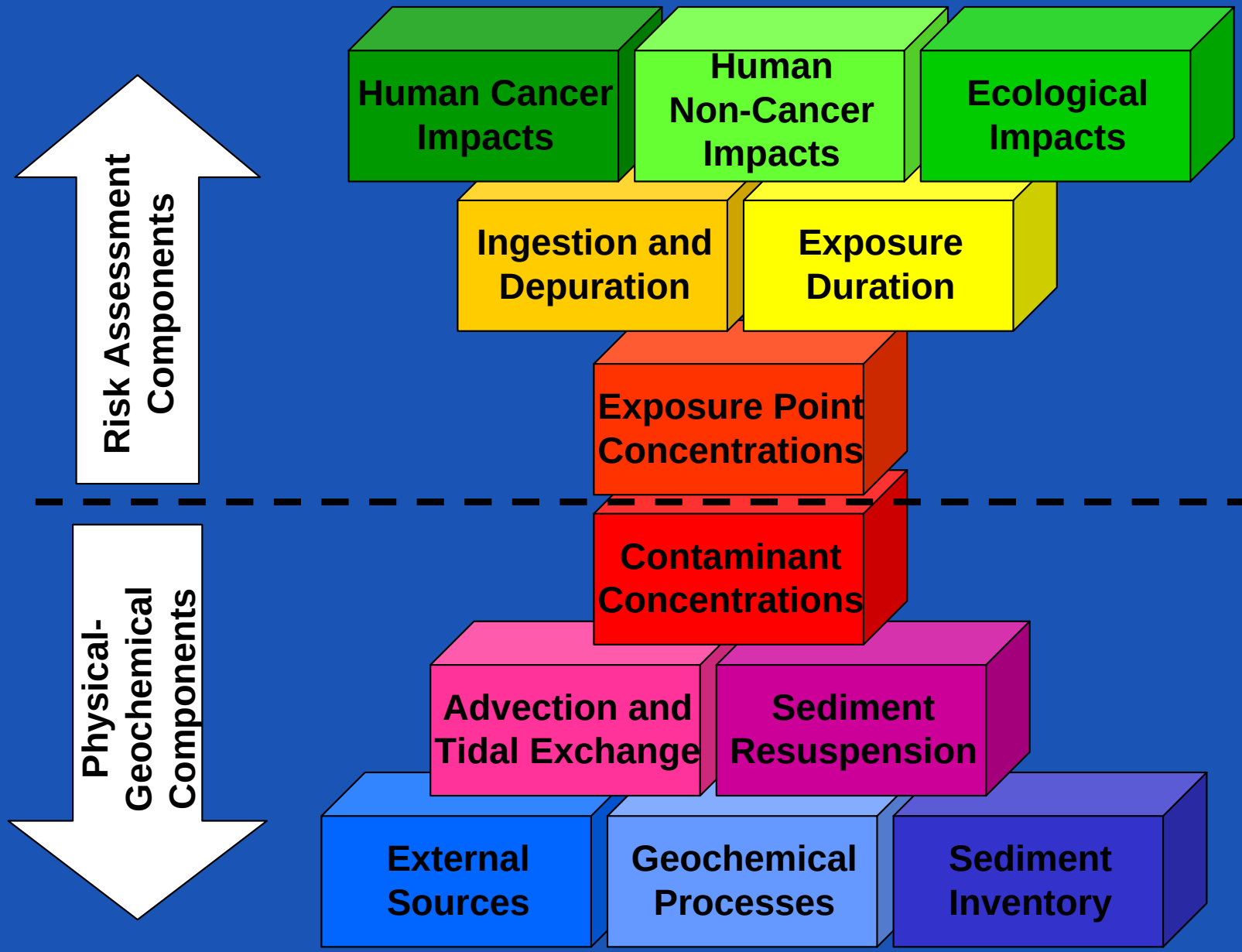
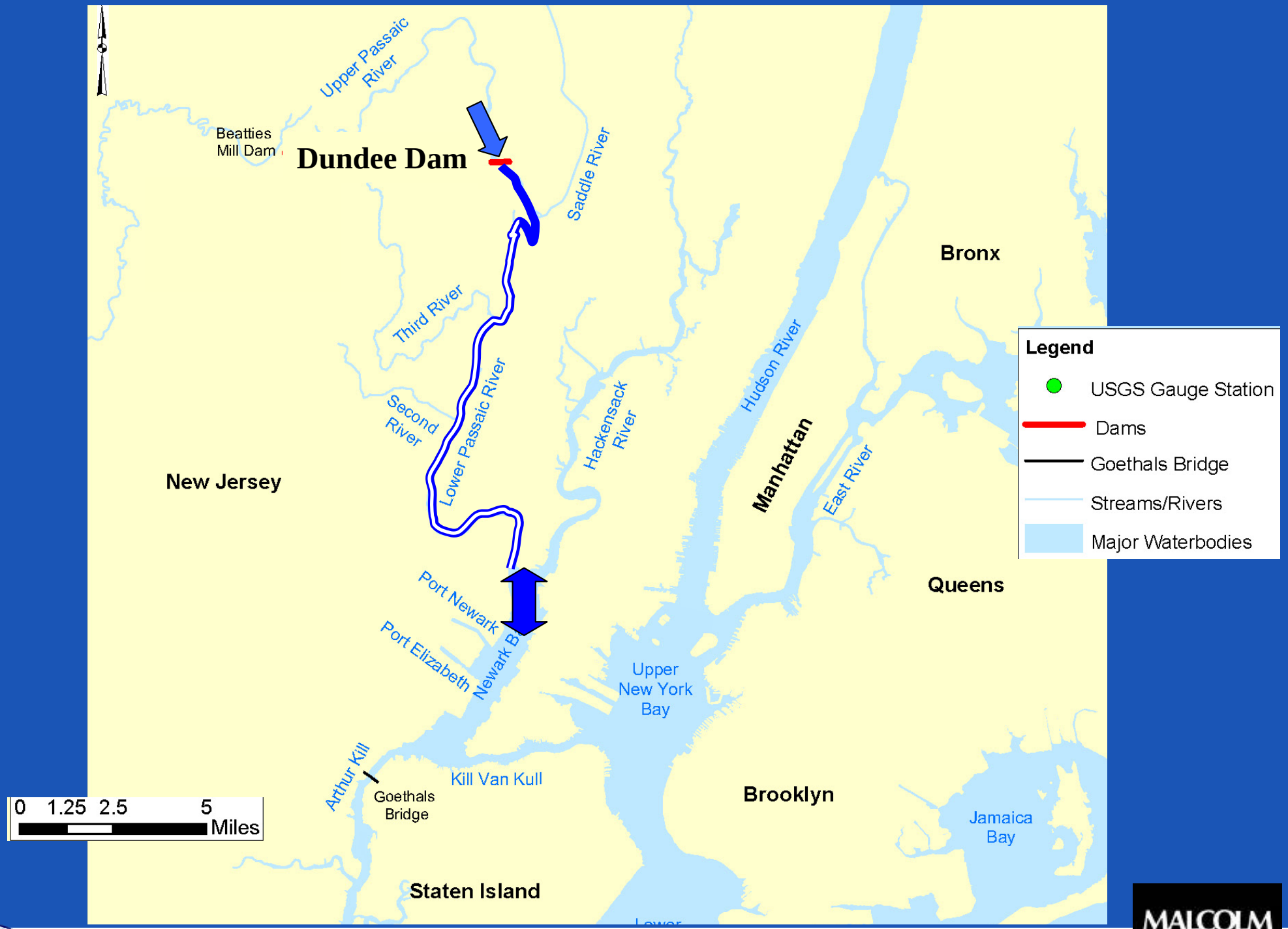
Remedial Options Workgroup Meeting
June 2007

Outline

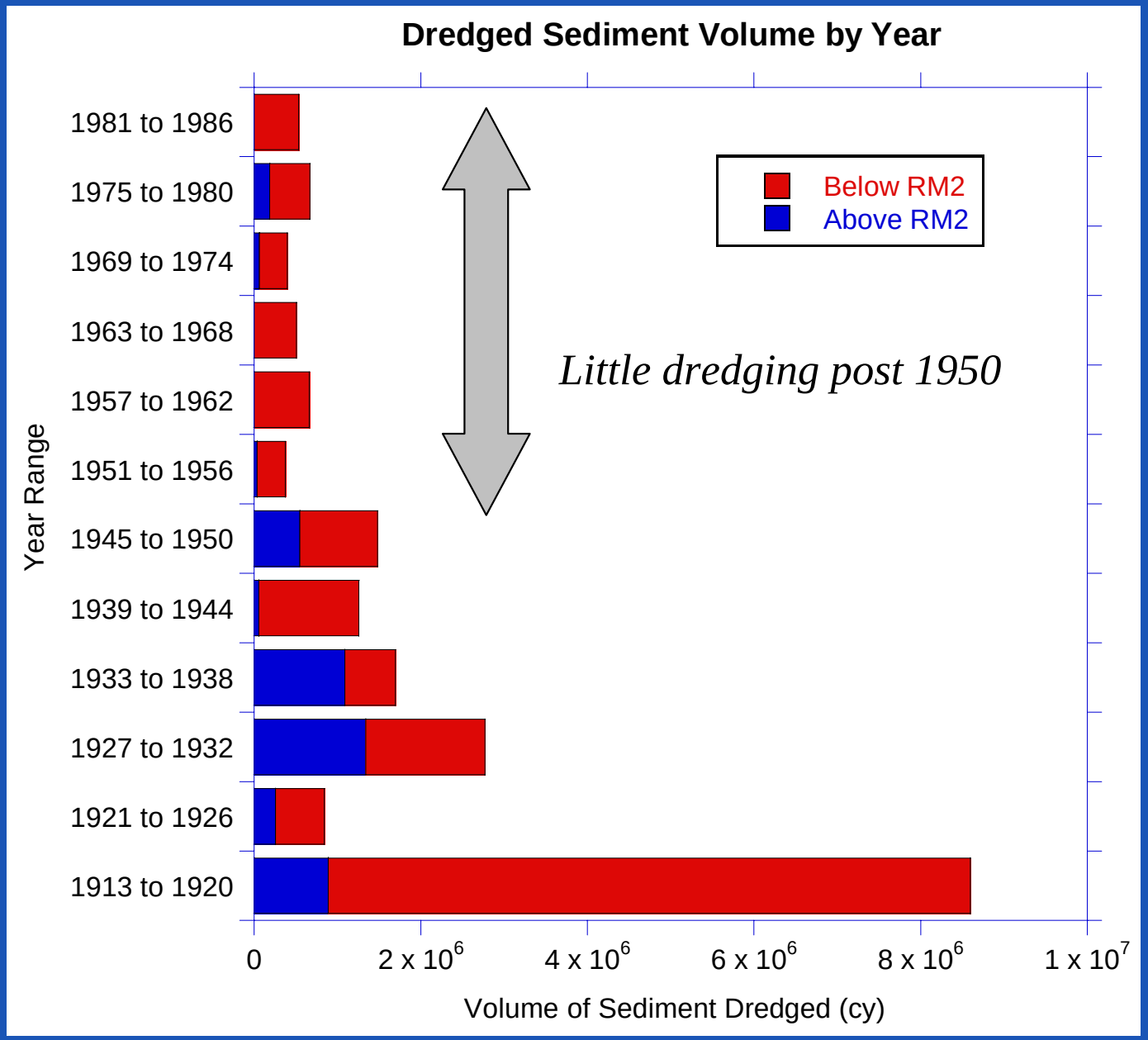
- Components of the Conceptual Site Model (CSM)
  - Physical-Geochemical Setting
  - Human and Ecological Setting
- Framework for the Empirical Mass Balance Model
- Mass Balance Results
- Historical Record and Remedial Scenario Forecasts
- Conclusions

Components of the CSM

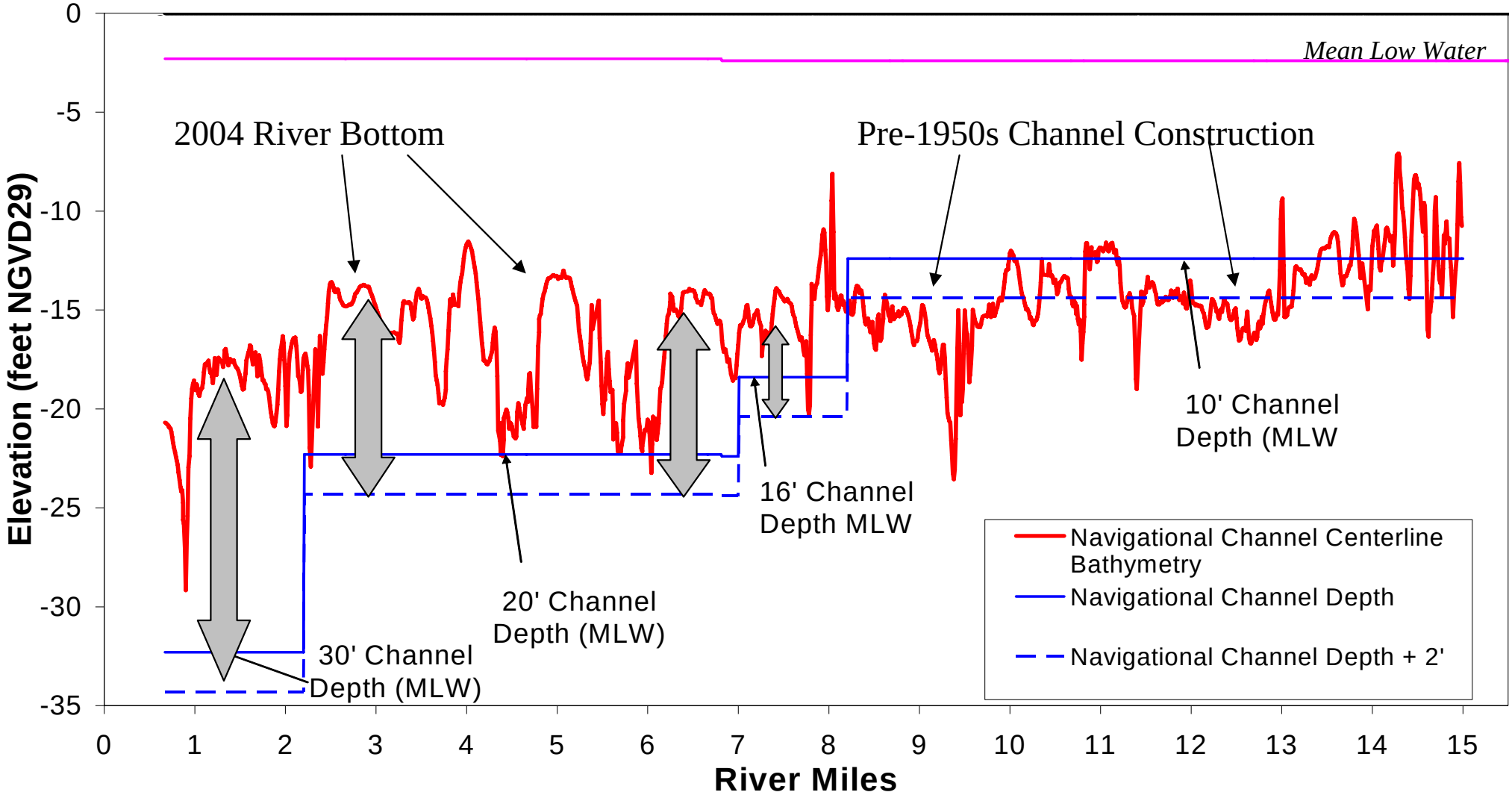



Upper Passaic River
Beatties Mill Dam
Dundee Dam
Saddle River
Third River
Second River
Lower Passaic River
Hackensack River
Hudson River
Bronx
Manhattan
East River
New Jersey
Queens
Port Newark
Port Elizabeth
Newark Bay
Upper New York Bay
Arthur Kill
Goethals Bridge
Kill Van Kull
Brooklyn
Jamaica Bay
Staten Island
Legend
USGS Gauge Station
Dams
Goethals Bridge
Streams/Rivers
Major Waterbodies
0 1.25 2.5 5
Miles

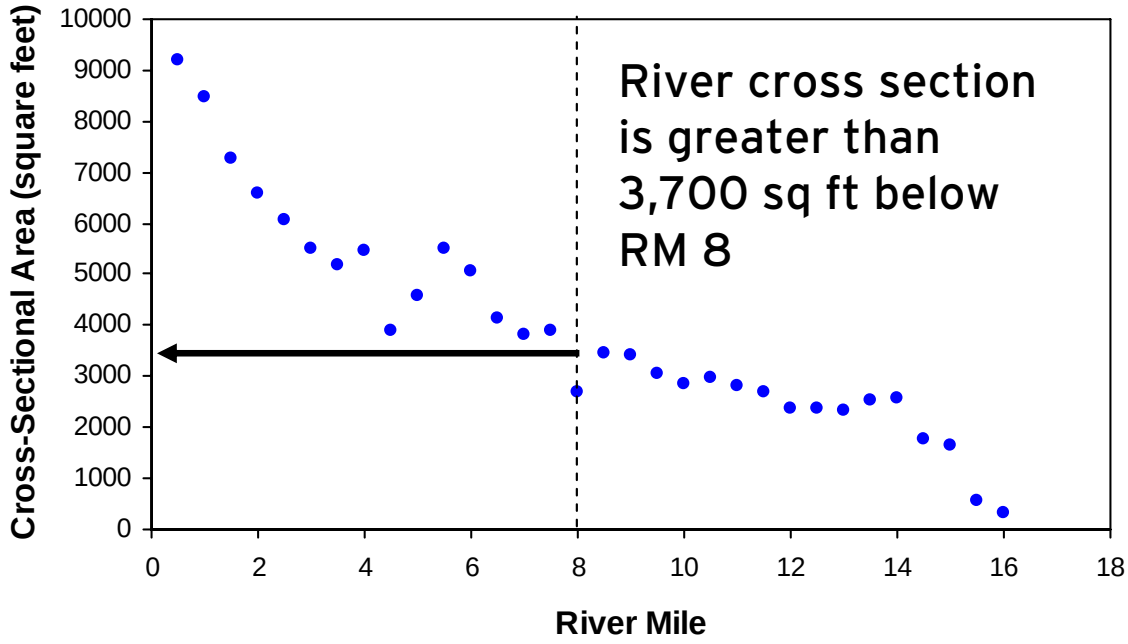
History of Dredging in the Lower Passaic

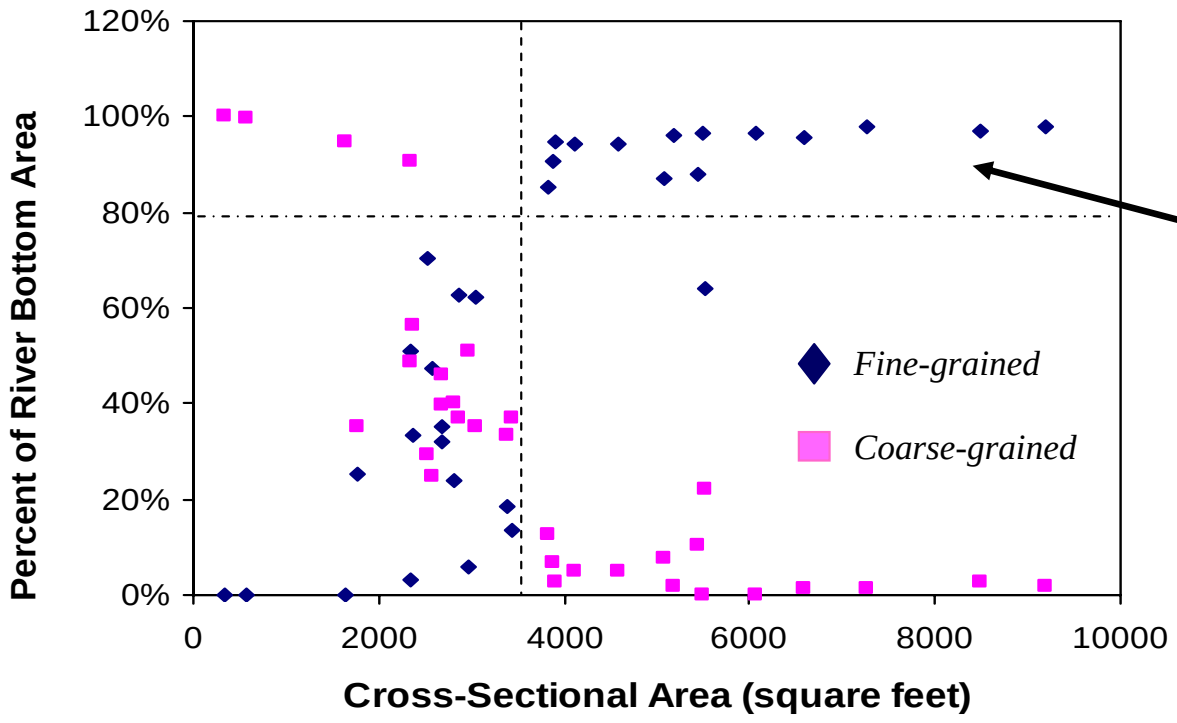


River Channel Elevation and the Constructed Depths of the Lower Passaic River Channel



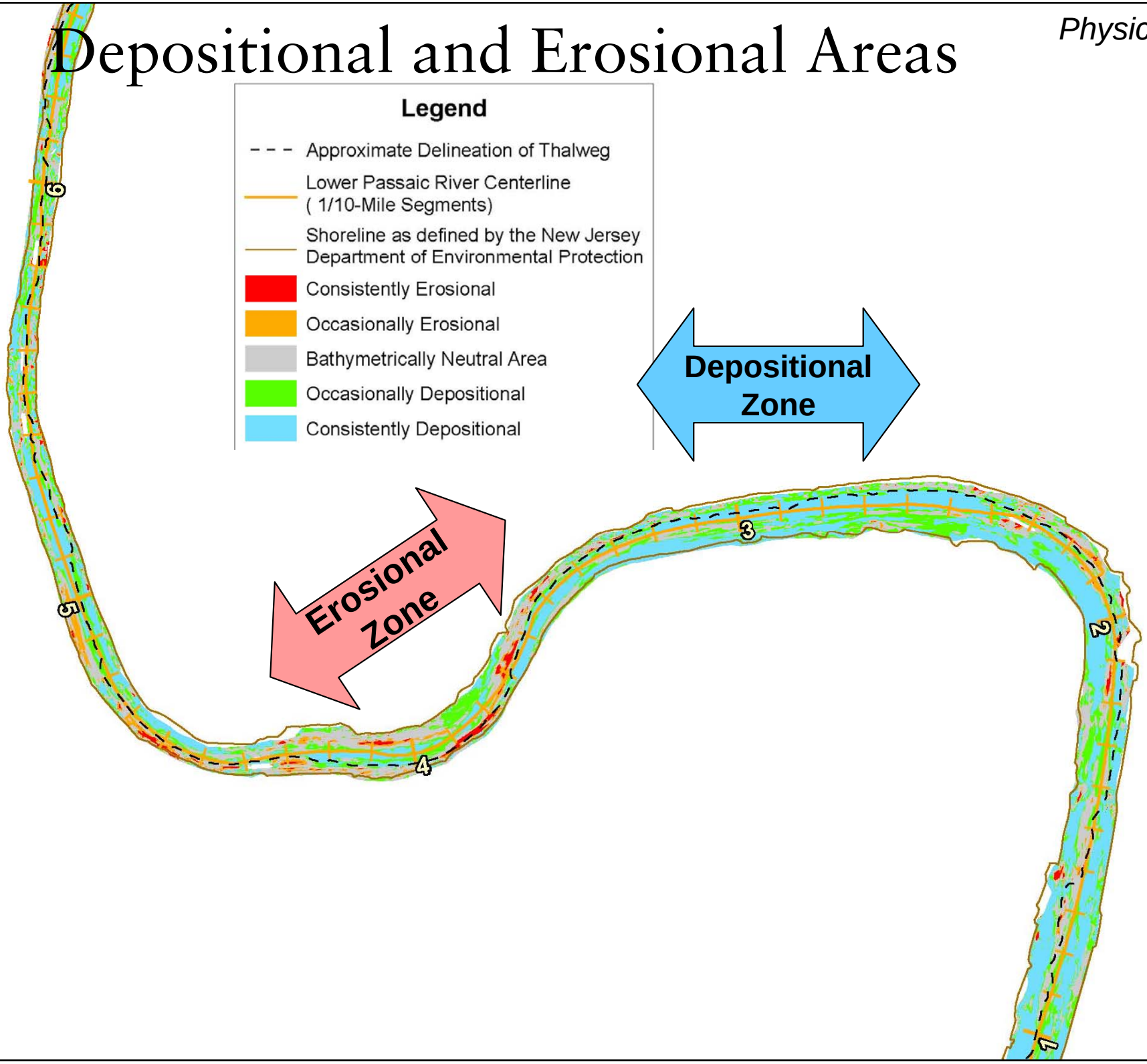
Passaic River Cross Section and Sediment Type



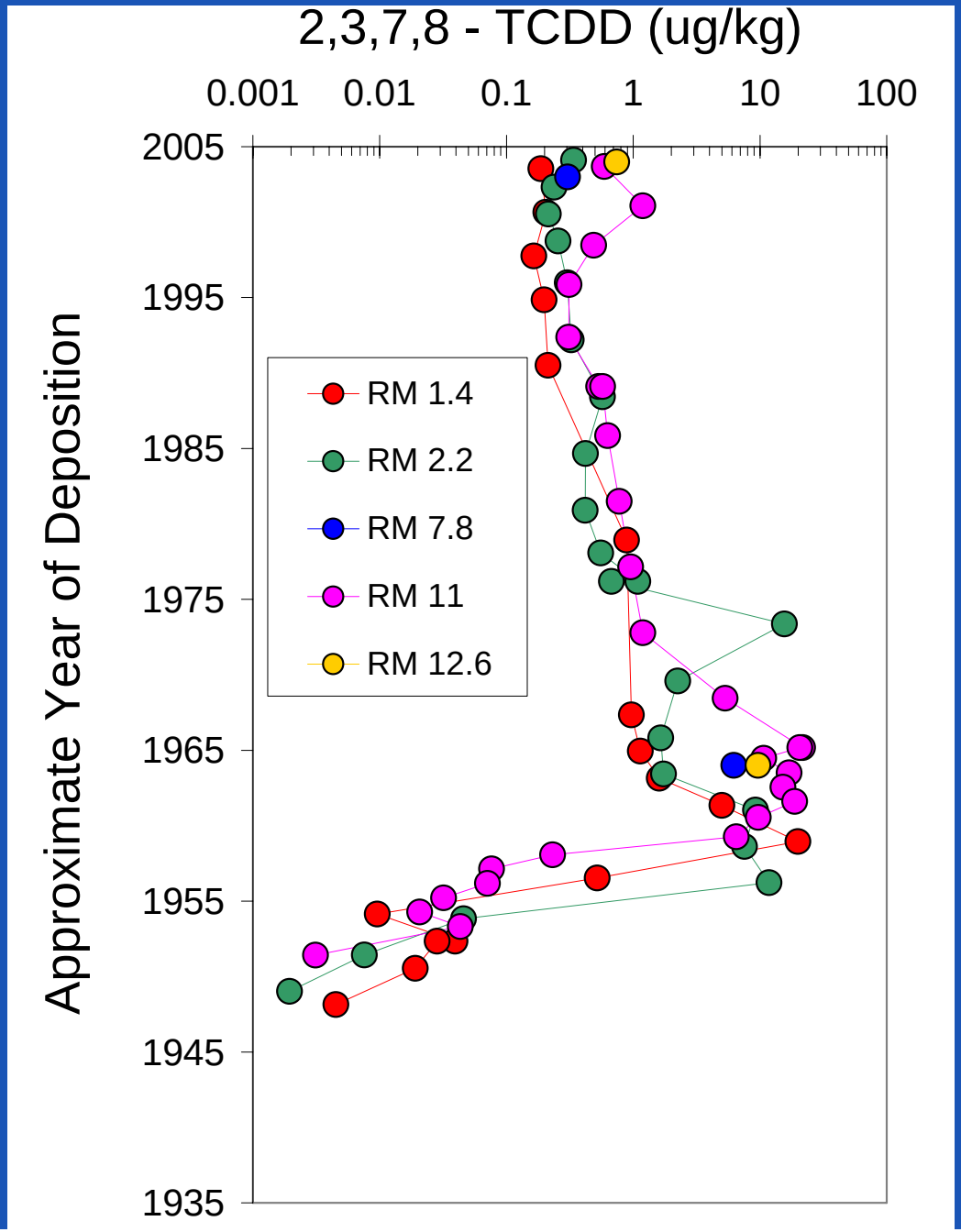


Fine-grained sediment covers 80% or more of the river bottom when the cross-sectional area is >3,700 sq ft

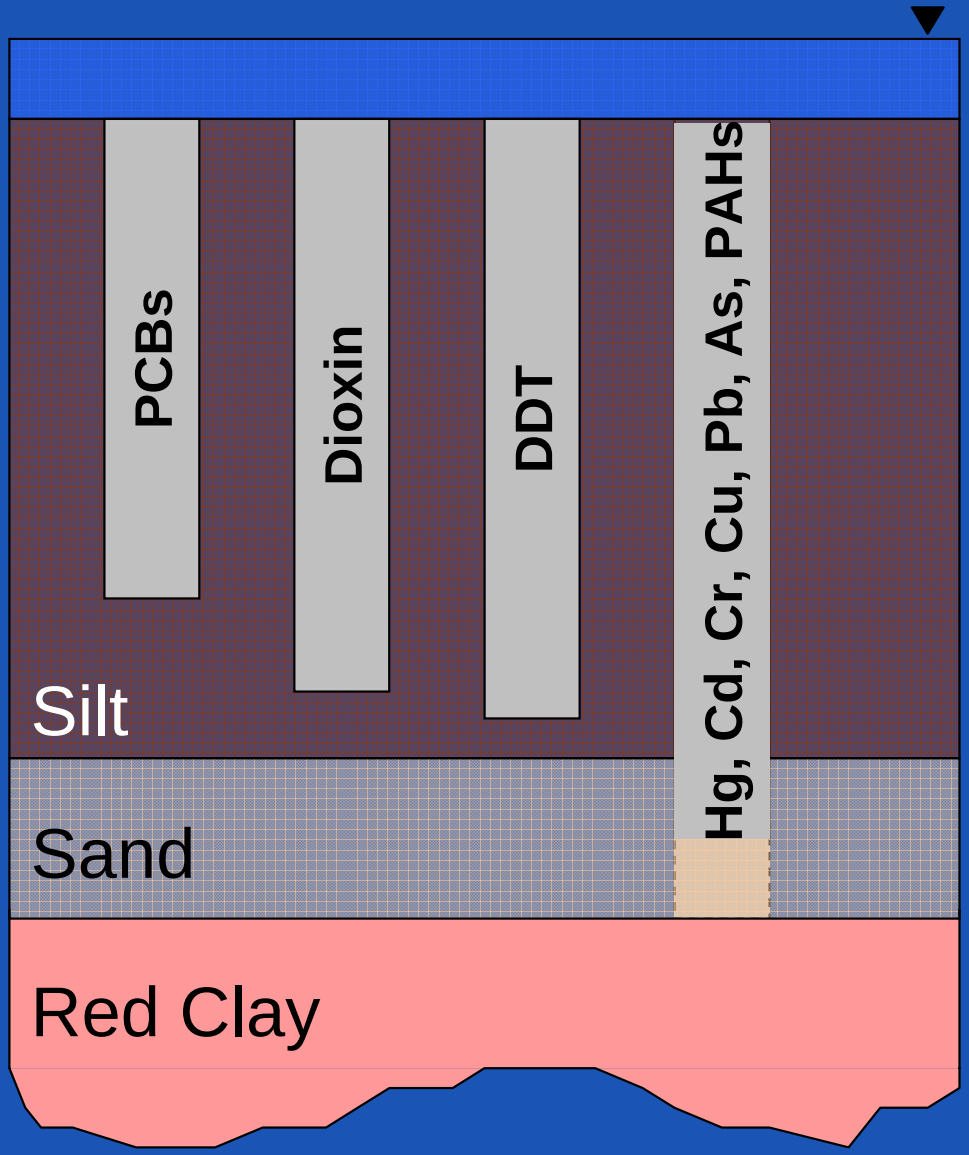
Depositional and Erosional Areas



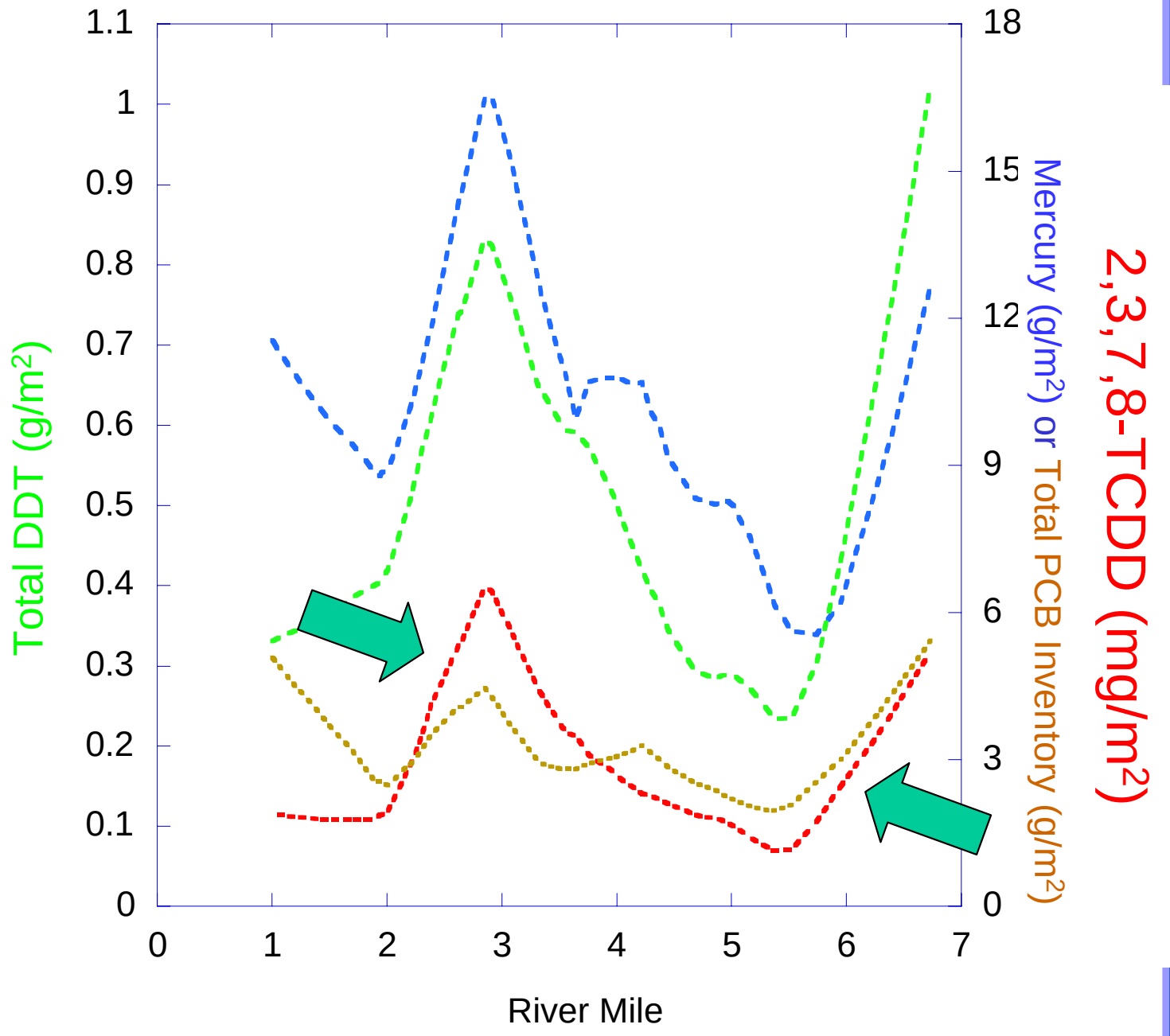
The History of Contamination is Recorded in the Sediments



Contaminant Inventory in the Lower Passaic River



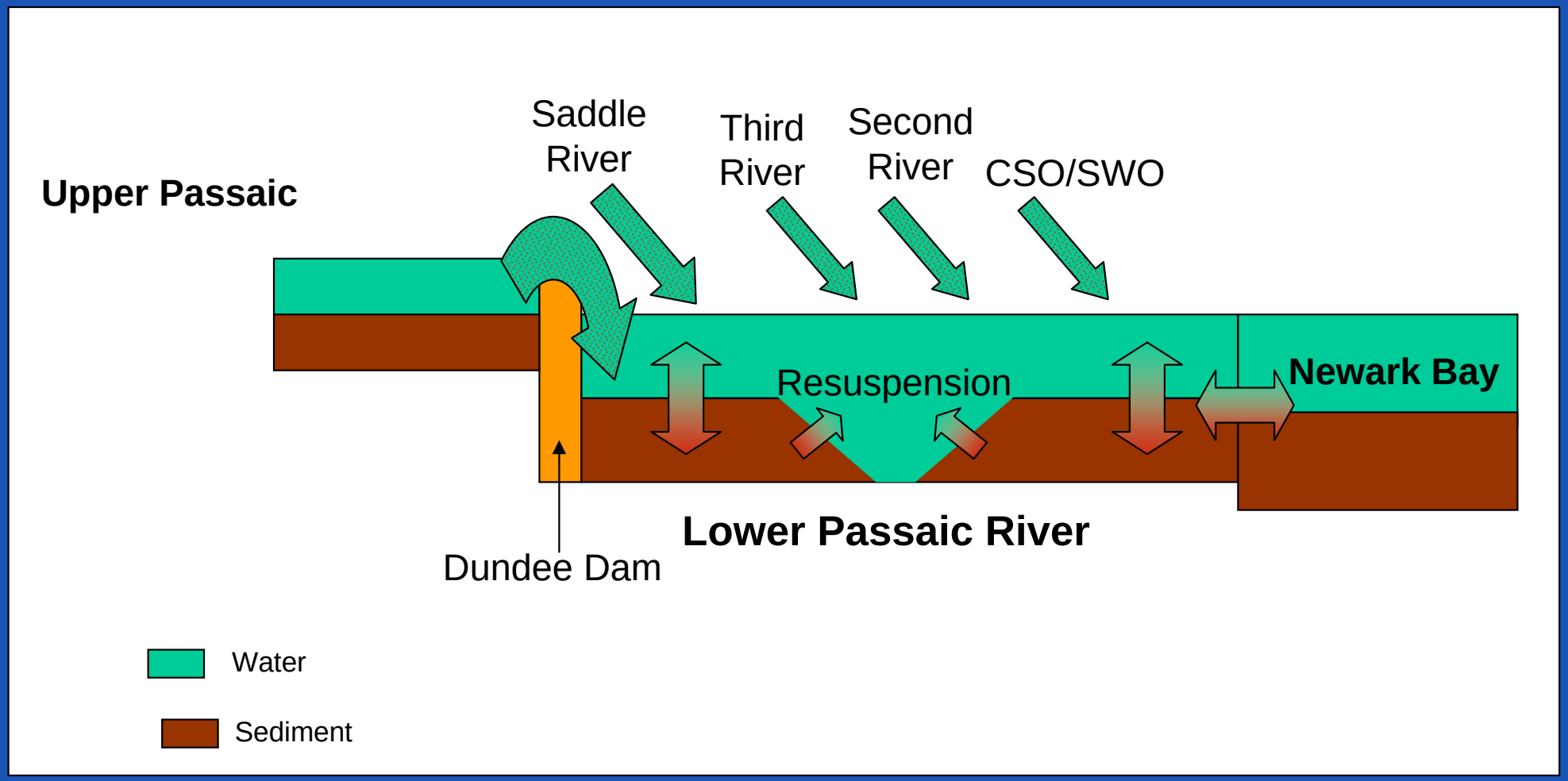
Inventory Results



Sediment inventories coincide with areas of deposition, not proximity to source

Framework of the Empirical Mass Balance Model

Schematic of Box Model for the Lower Passaic River Empirical Mass Balance



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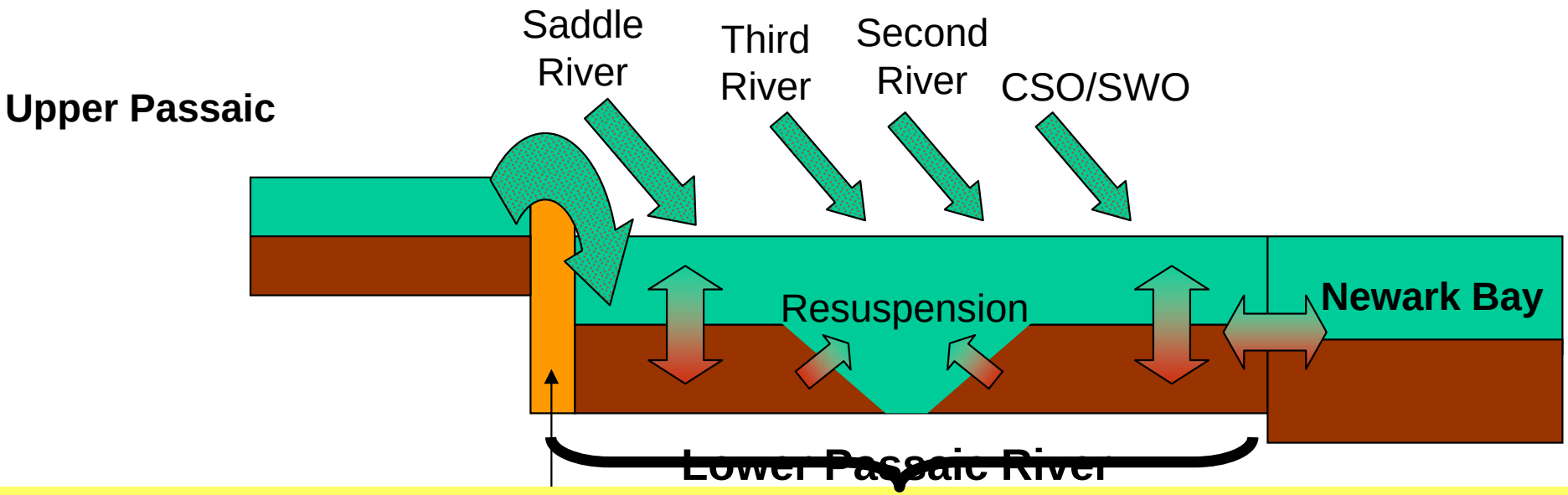
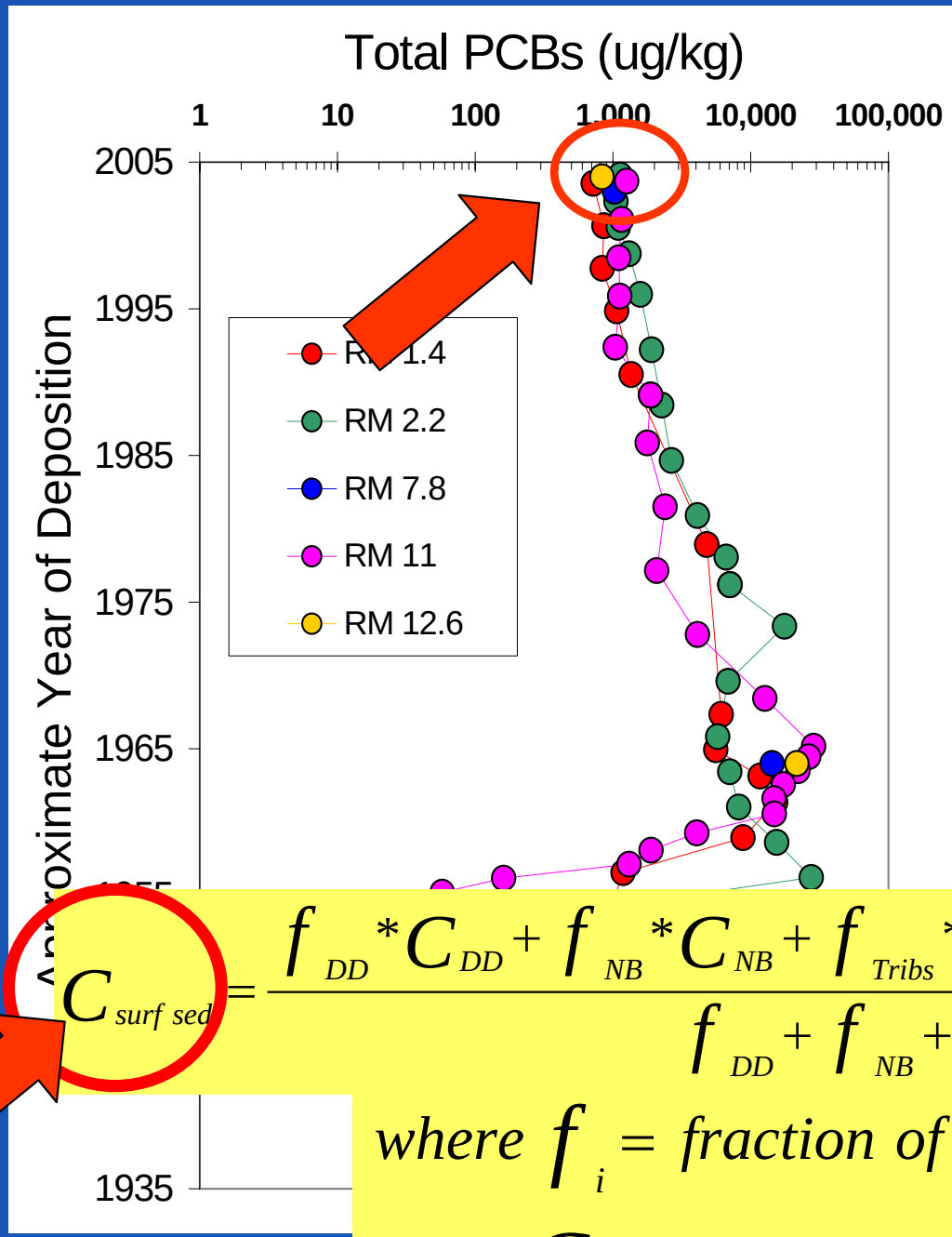


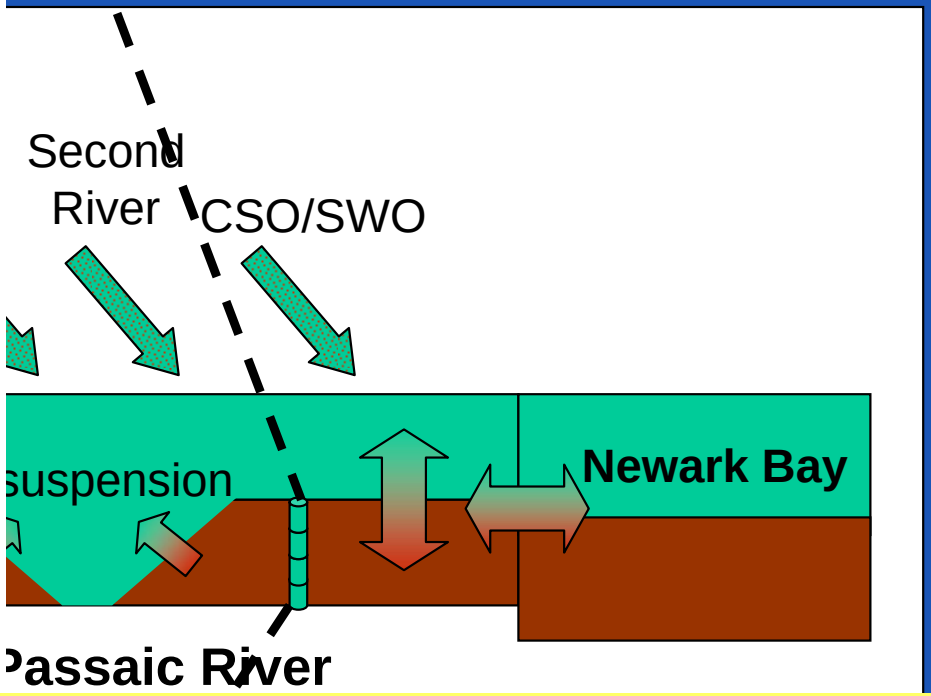
$$C_{surf\ sed} = \frac{f_{DD} * C_{DD} + f_{NB} * C_{NB} + f_{Tribs} * C_{Tribs} + f_{CSO/SWO} * C_{CSO/SWO} + f_{resusp} * C_{resusp}}{f_{DD} + f_{NB} + f_{Tribs} + f_{CSO/SWO} + f_{resusp}}$$

where f_i = fraction of solids from source i

C_i = contaminant concentration in source i

del for the Lower al Mass Balance





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Contaminants Used in the EMBM

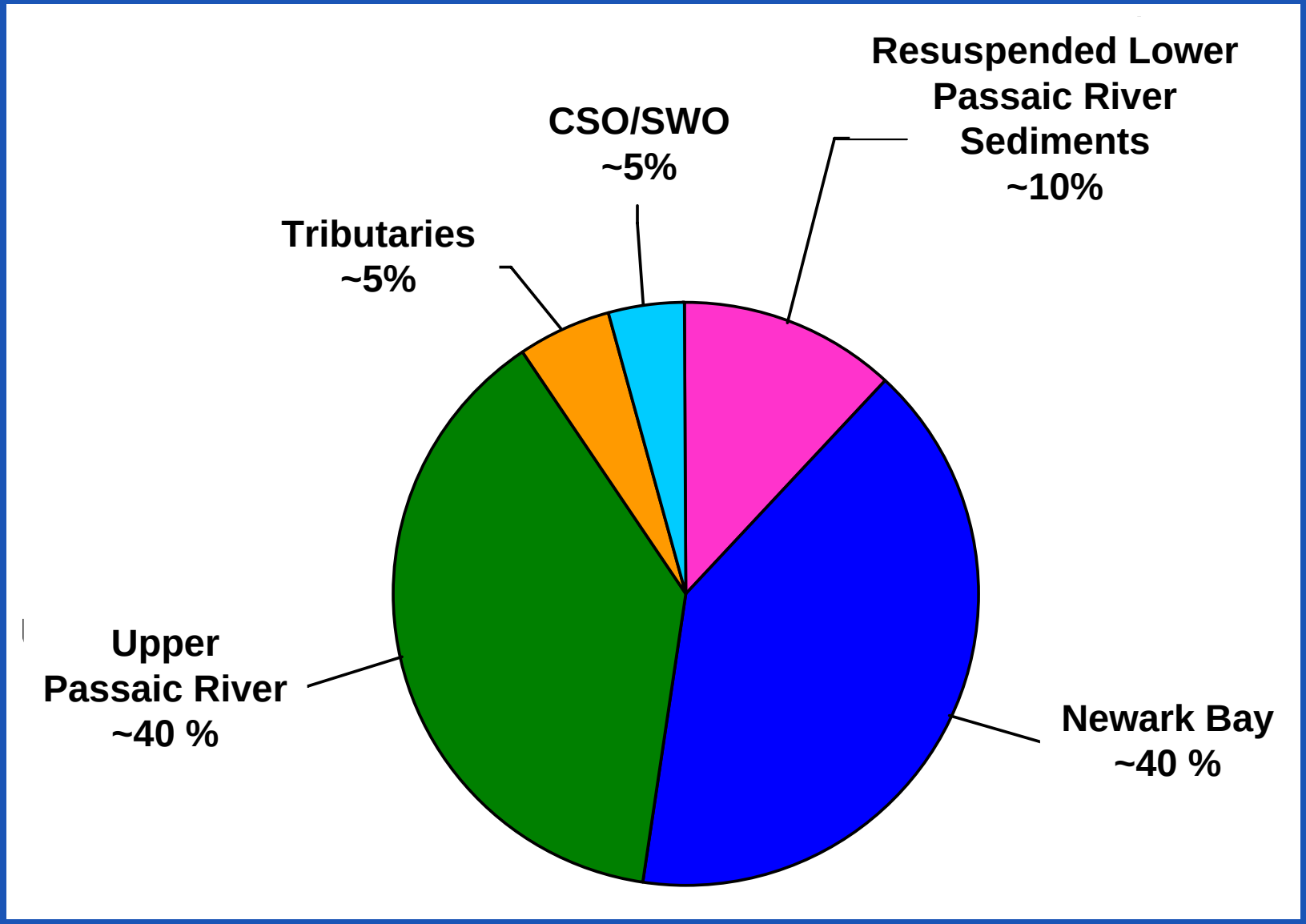
- Metals
  - Lead
  - Mercury
- PCDD/F
  - 2,3,7,8-TCDD
  - Total TCDD
- Pesticides
  - DDE
- PAHs
  - Benzo[a]pyrene
  - Fluoranthene
- PCB Congeners
  - BZ 52
  - BZ 180+193

Formulation for the EMBM

- Five unknowns + 1
  - f_{DD} to f_{resusp}
  - C_{resusp} narrowly constrained by range of sediment conditions
- Nine equations
  - One for each of nine contaminants
- Solve by optimization
  - Minimize overall level of error for all five unknowns for given C_{resusp}

Empirical Mass Balance Model Results

Solids Balance for the Lower Passaic River: External Solids Dominant



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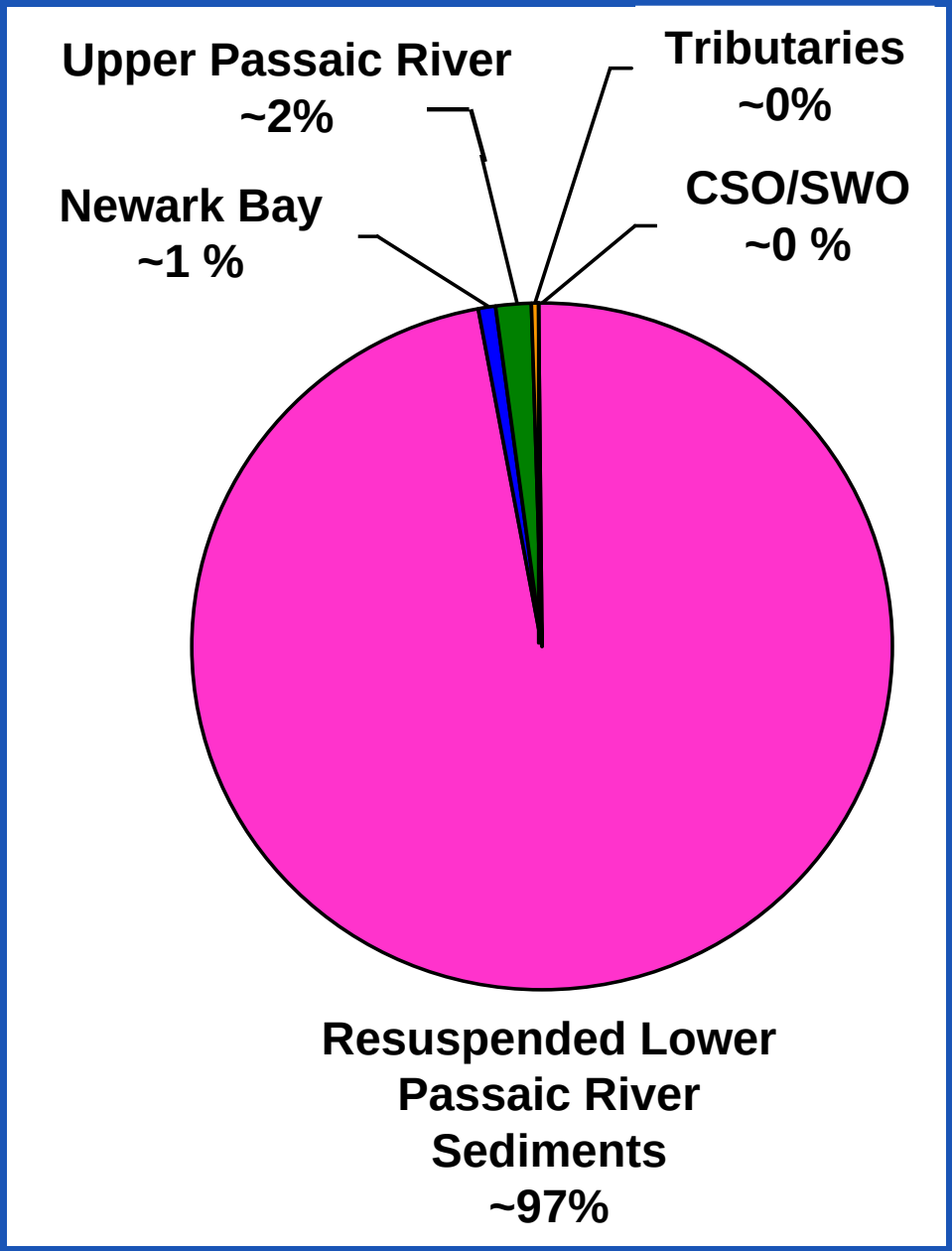
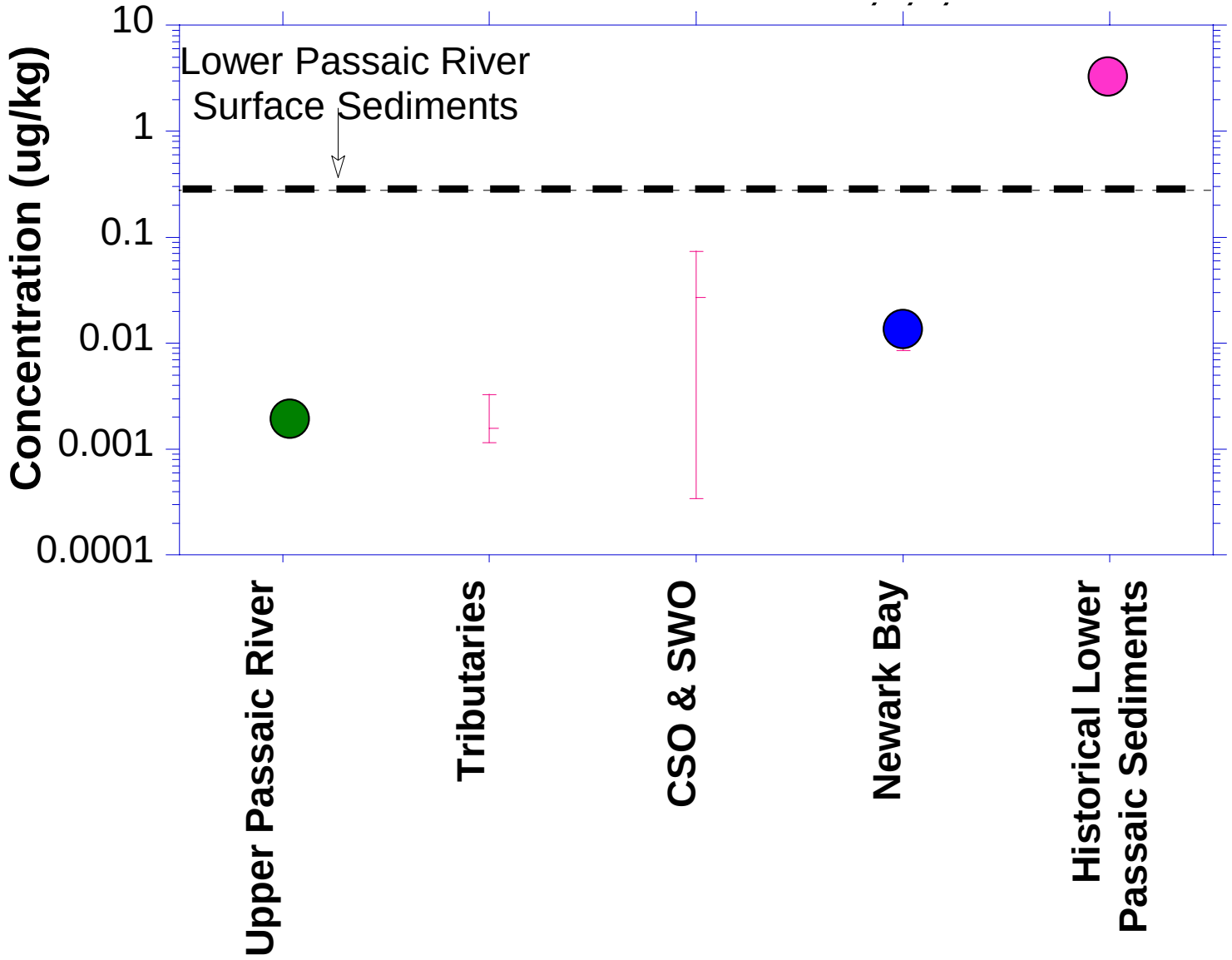
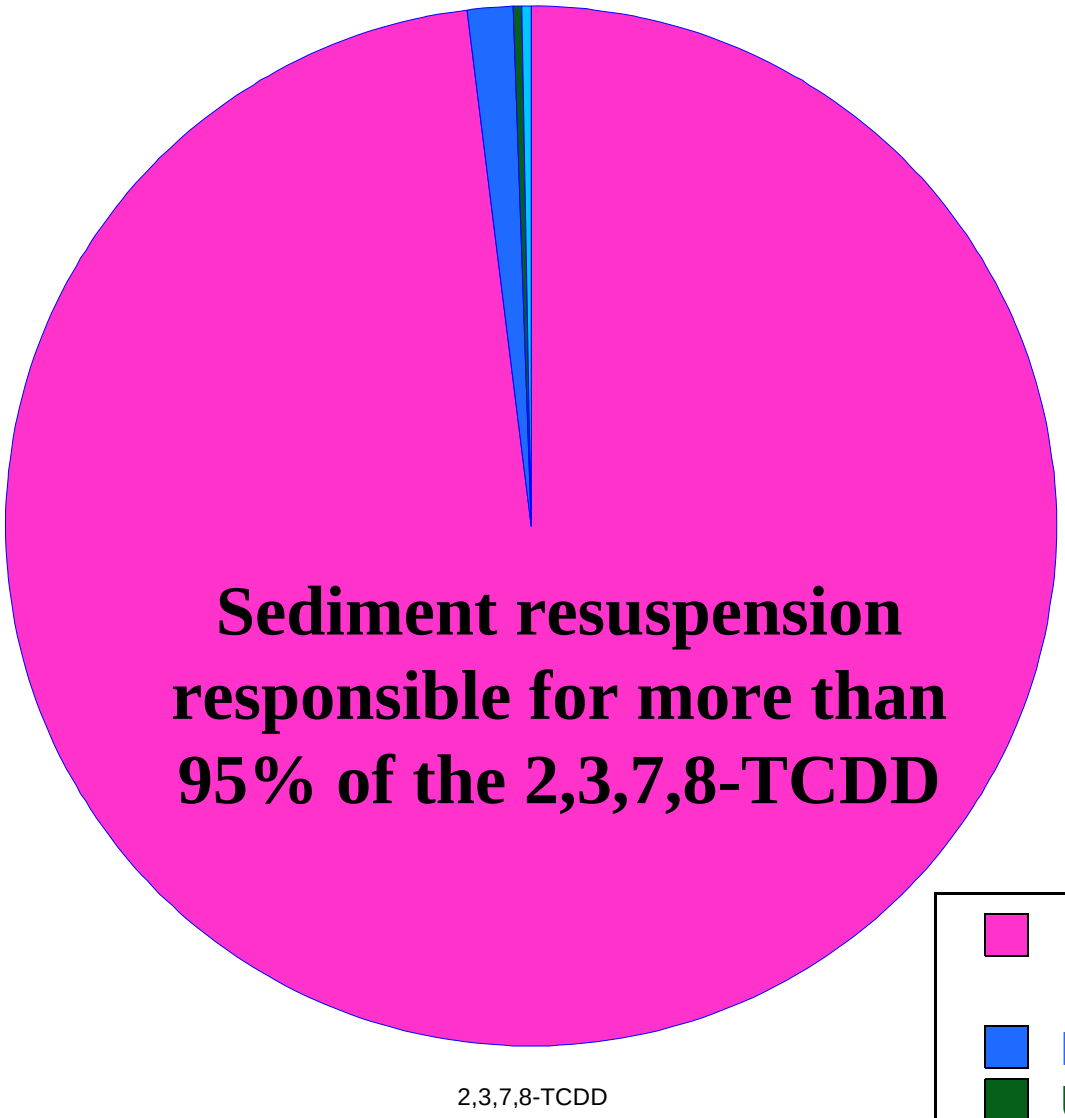


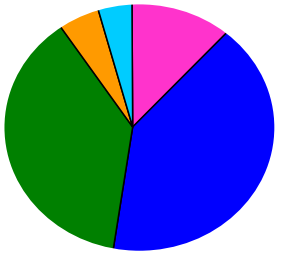
Source Concentrations for 2,3,7,8-TCDD



2,3,7,8-TCDD Mass Balance



Solids Balance

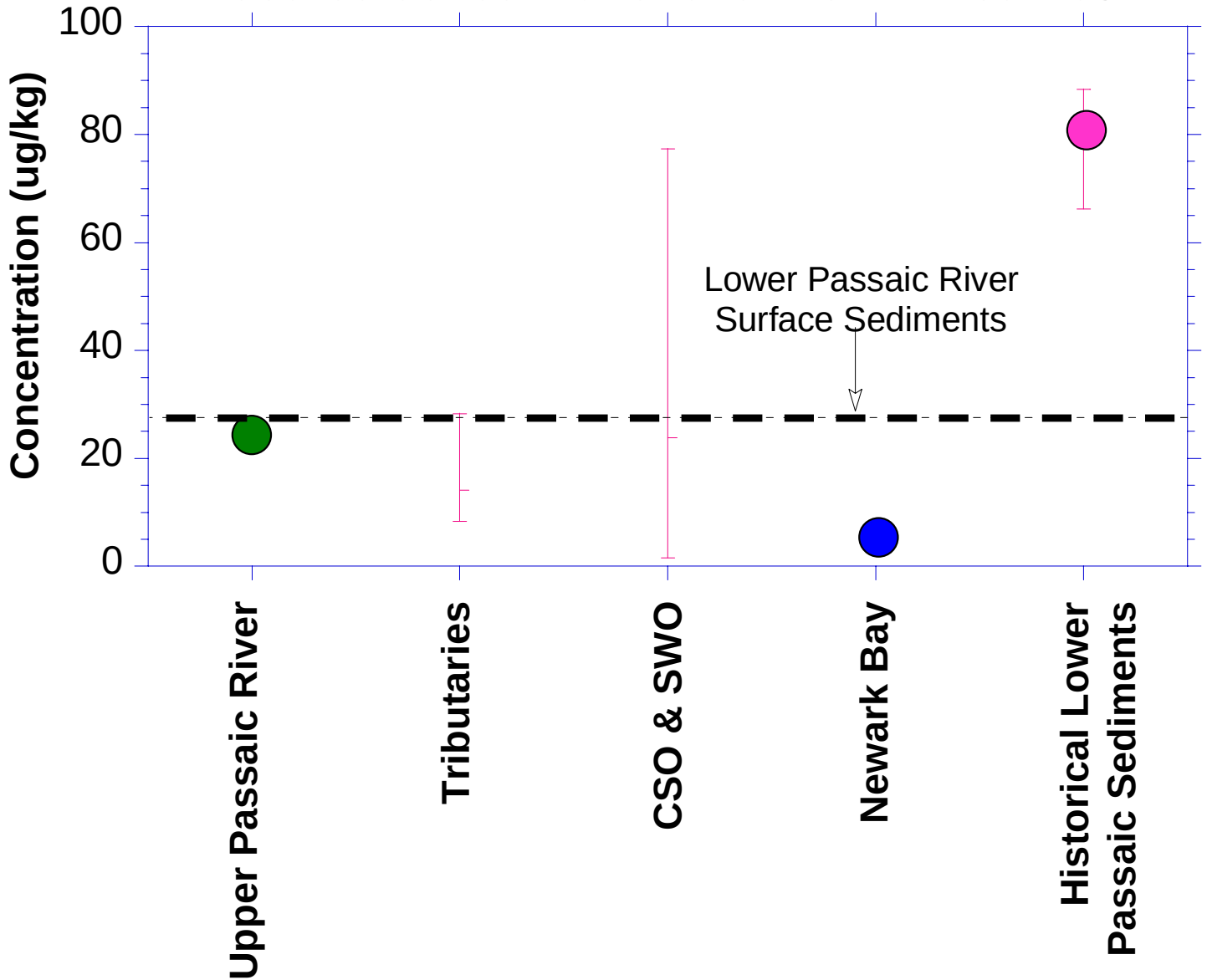


Similar Compounds

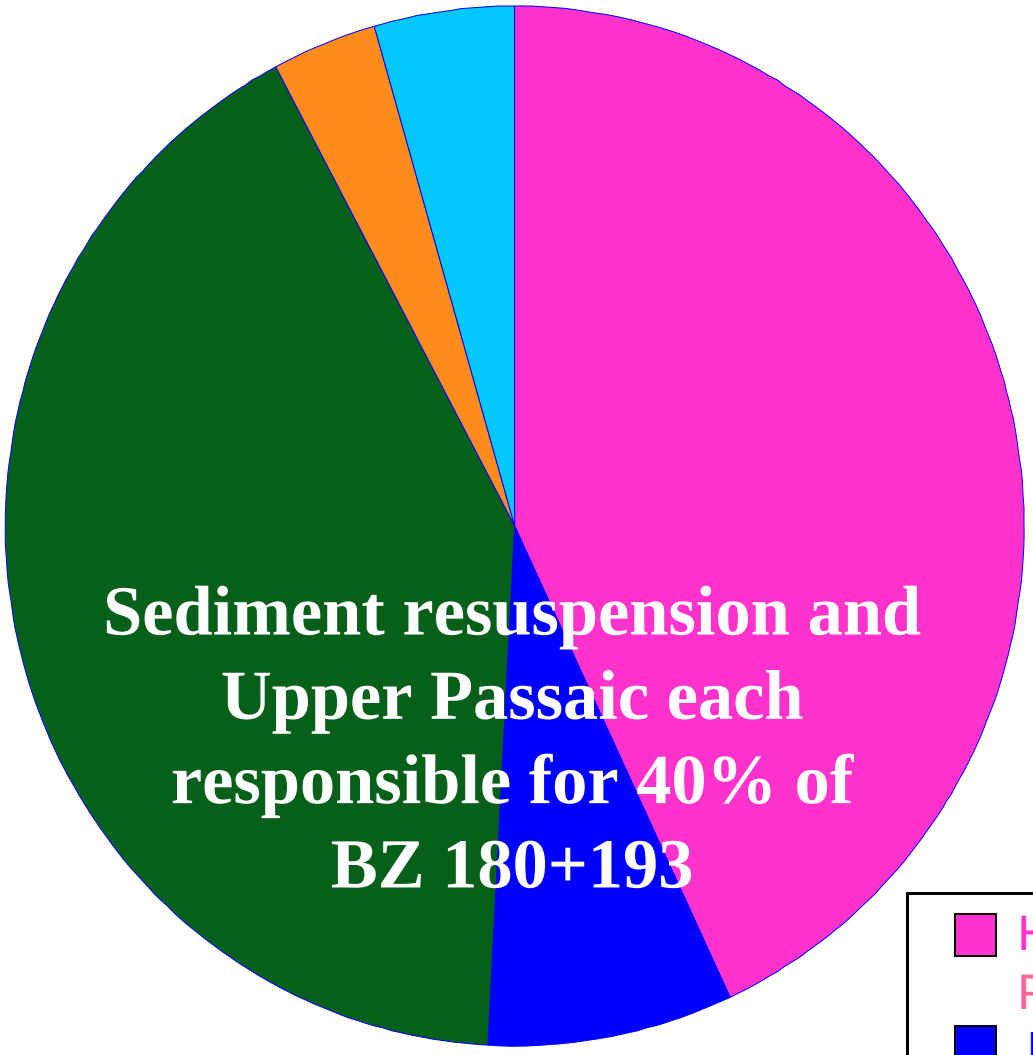
Total TCDD

Light PCBs

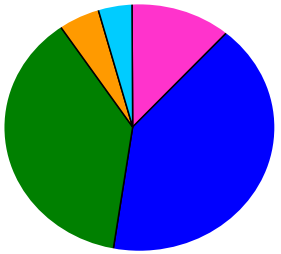
Source Concentrations for PCBs BZ180+193



PCB BZ180+193 Mass Balance



Solids Balance

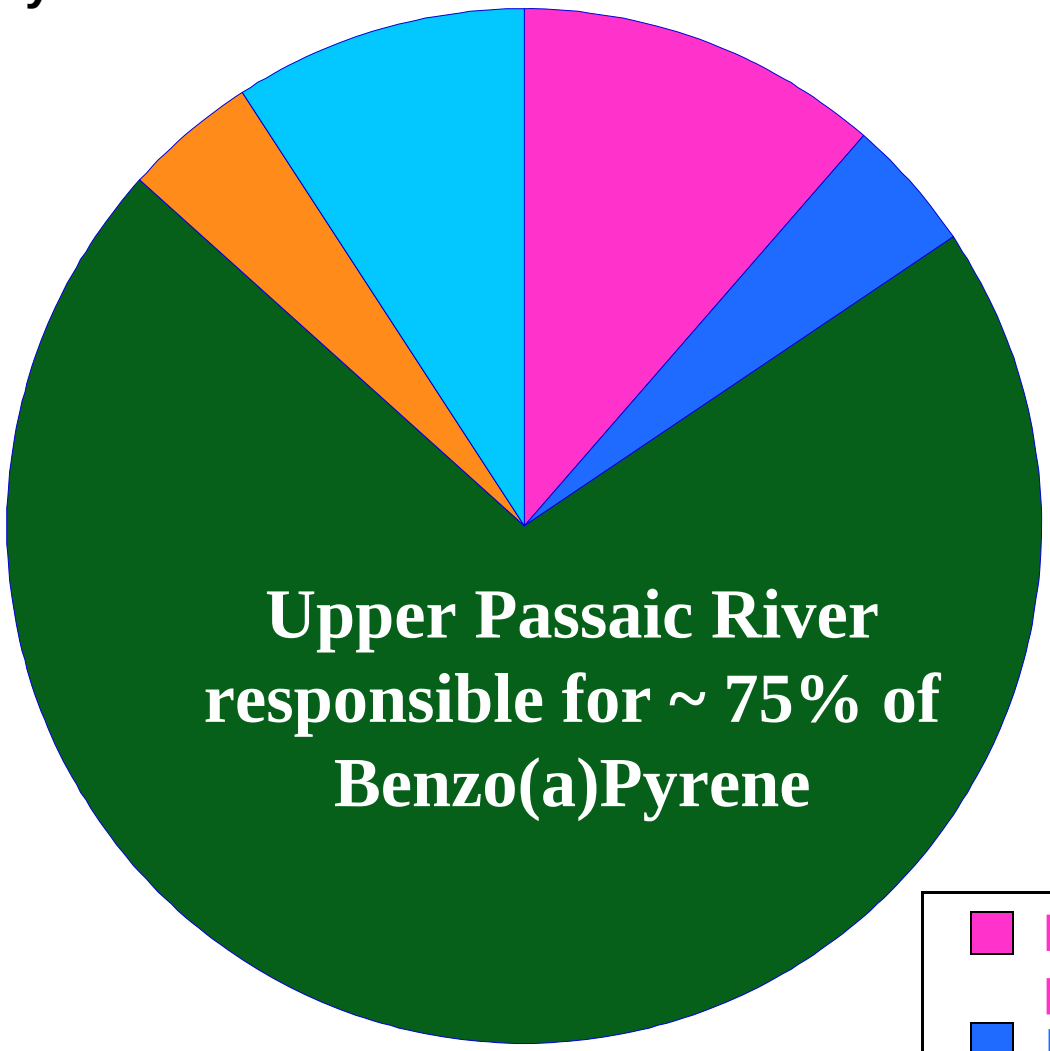


Similar Compounds

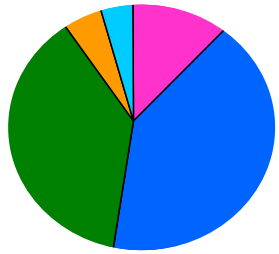
Heavy PCBs
DDTs
Mercury

- Historical Lower Passaic Sediments
- Newark Bay
- Upper Passaic
- Tributaries
- CSO&SWO

Benzo(a)Pyrene Mass Balance



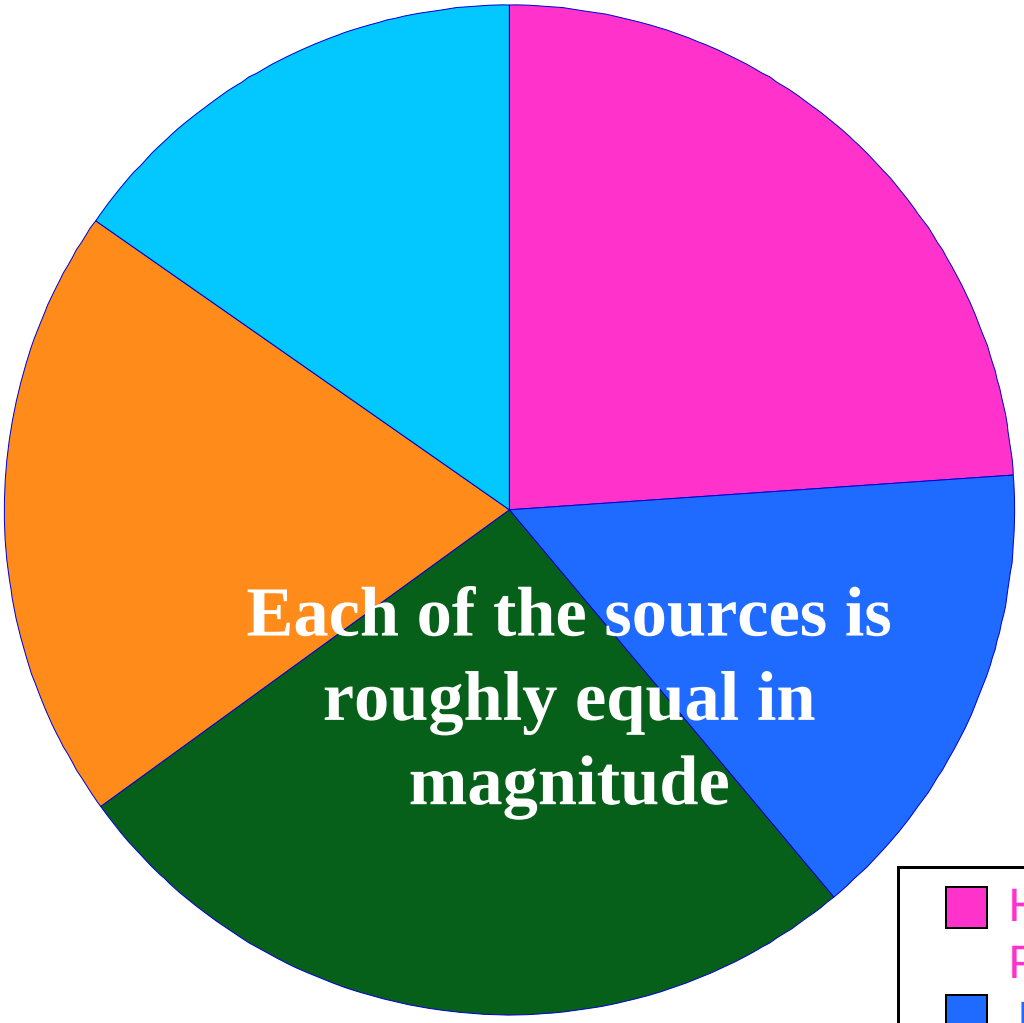
Solids Balance



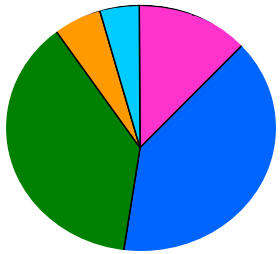
Similar Compounds

LMW PAHs
HMW PAHs

Lead Mass Balance



Solids Balance

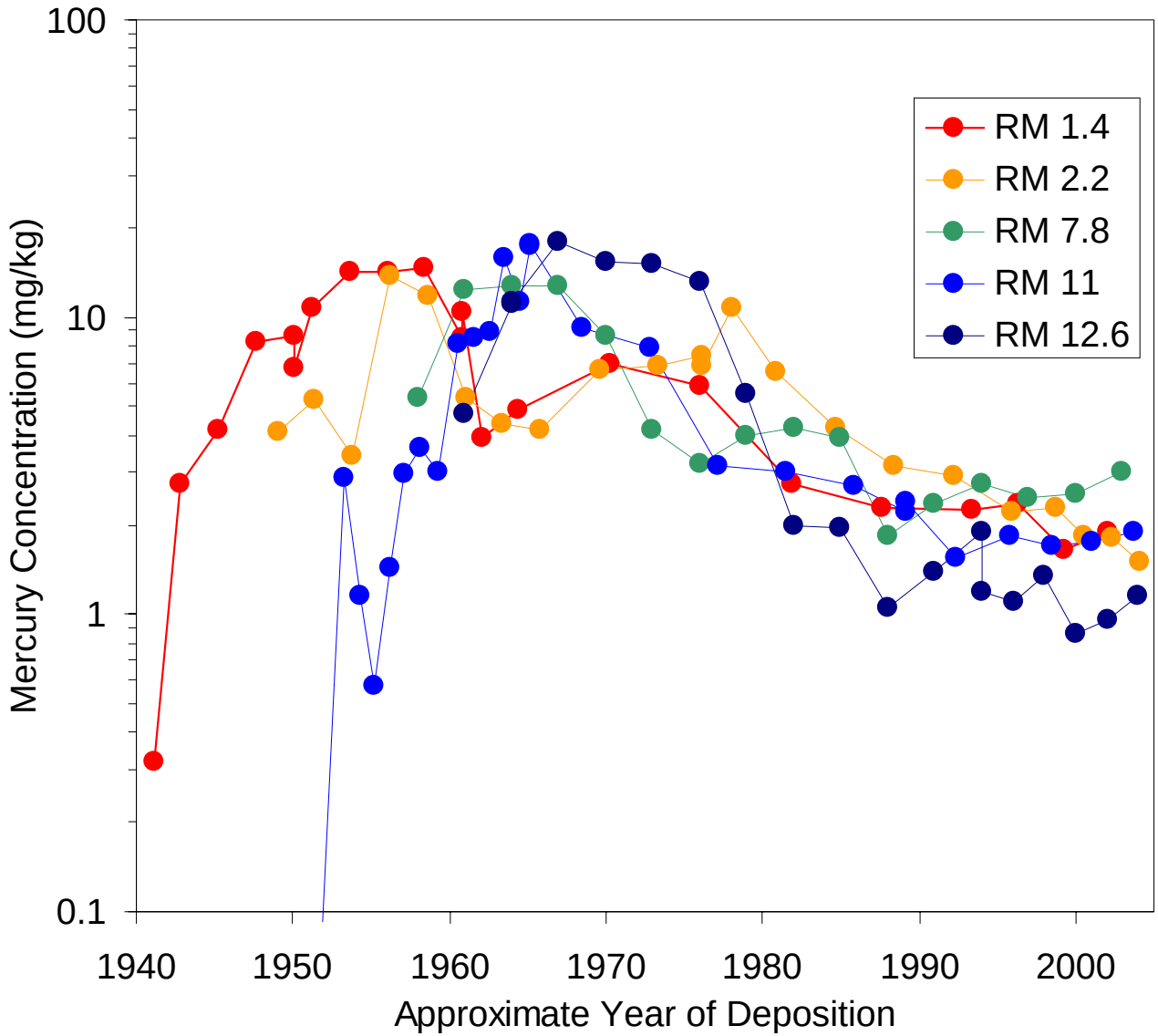


Similar Compounds

Copper
Chlordane
Dieldrin

The Historical Record
and
Remedial Scenario Forecasts

Basis for Forecasts: Dated Cores



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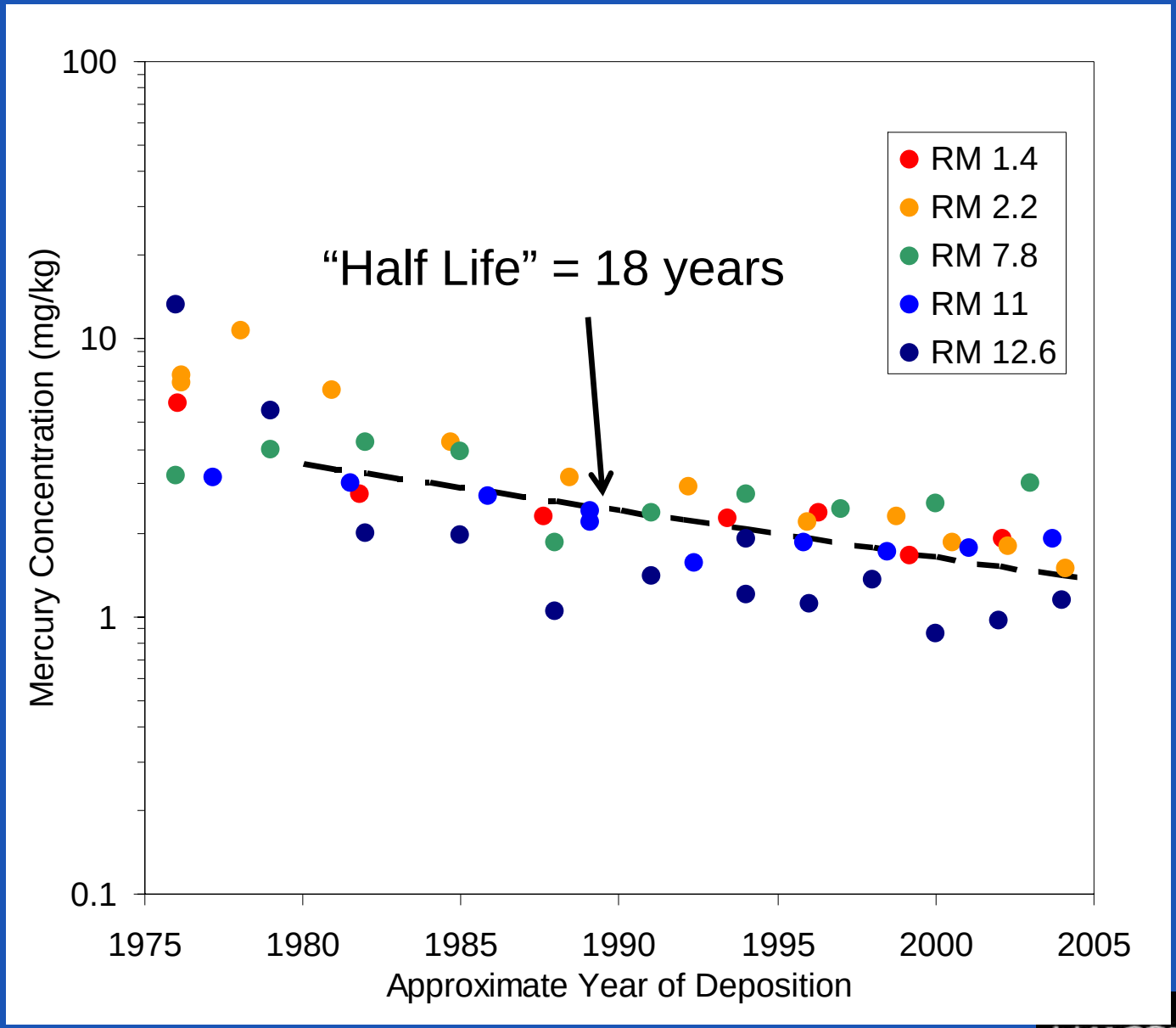
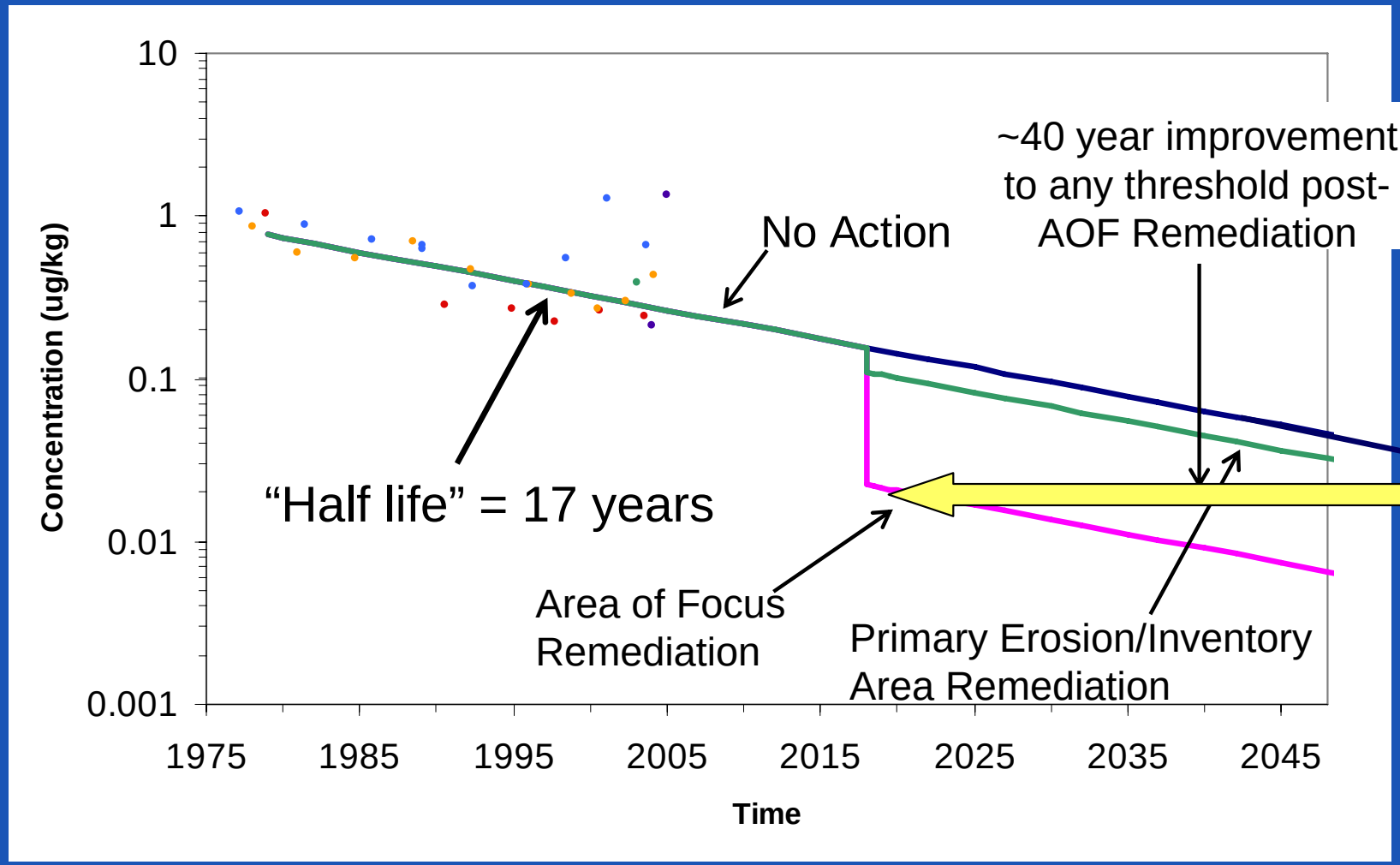


Remedial Scenarios

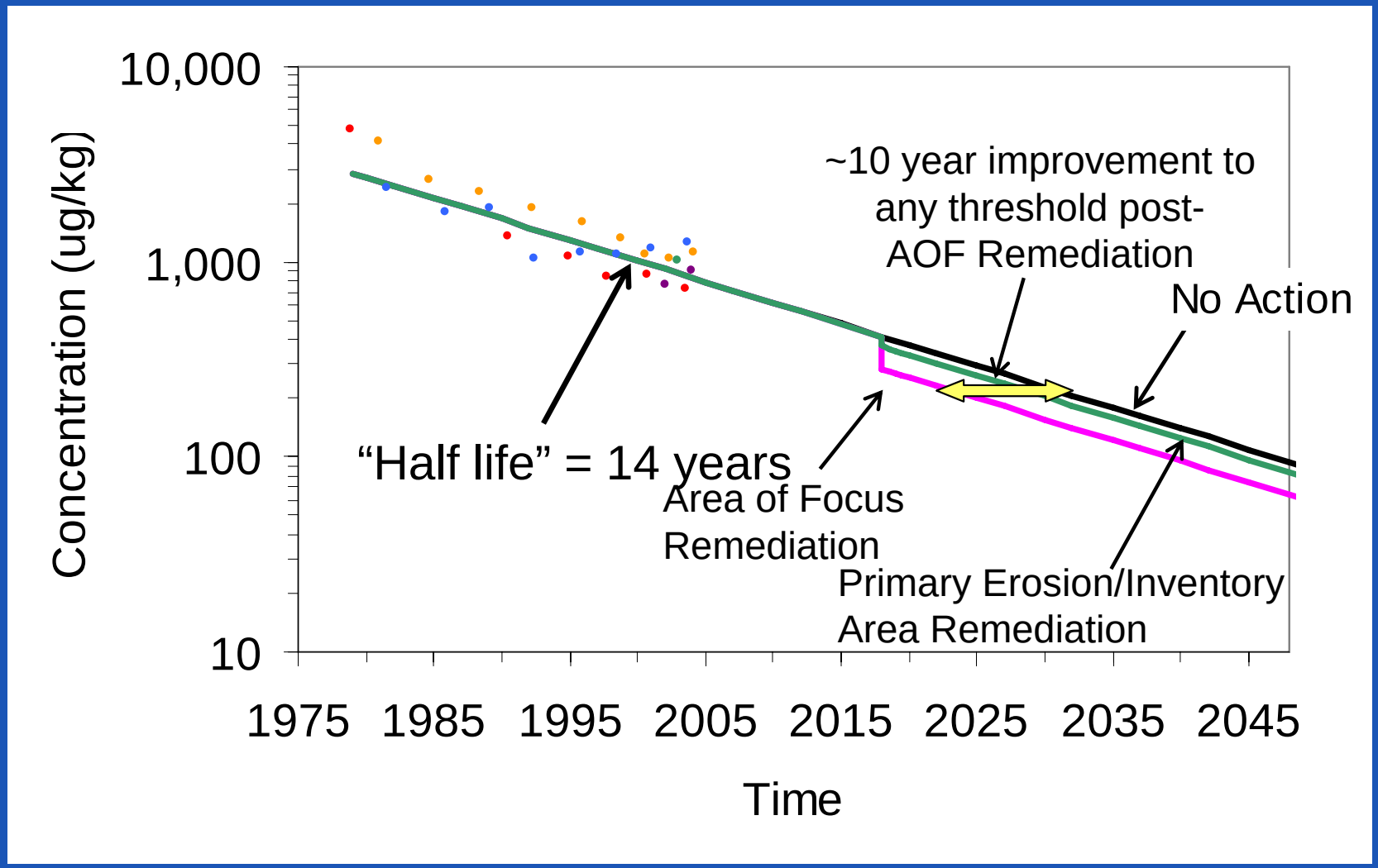
- No Action
- Primary Erosion/ Inventory Area Remediation
- Area of Focus Remediation

2,3,7,8-TCDD
Forecasted Surface Sediment Concentrations



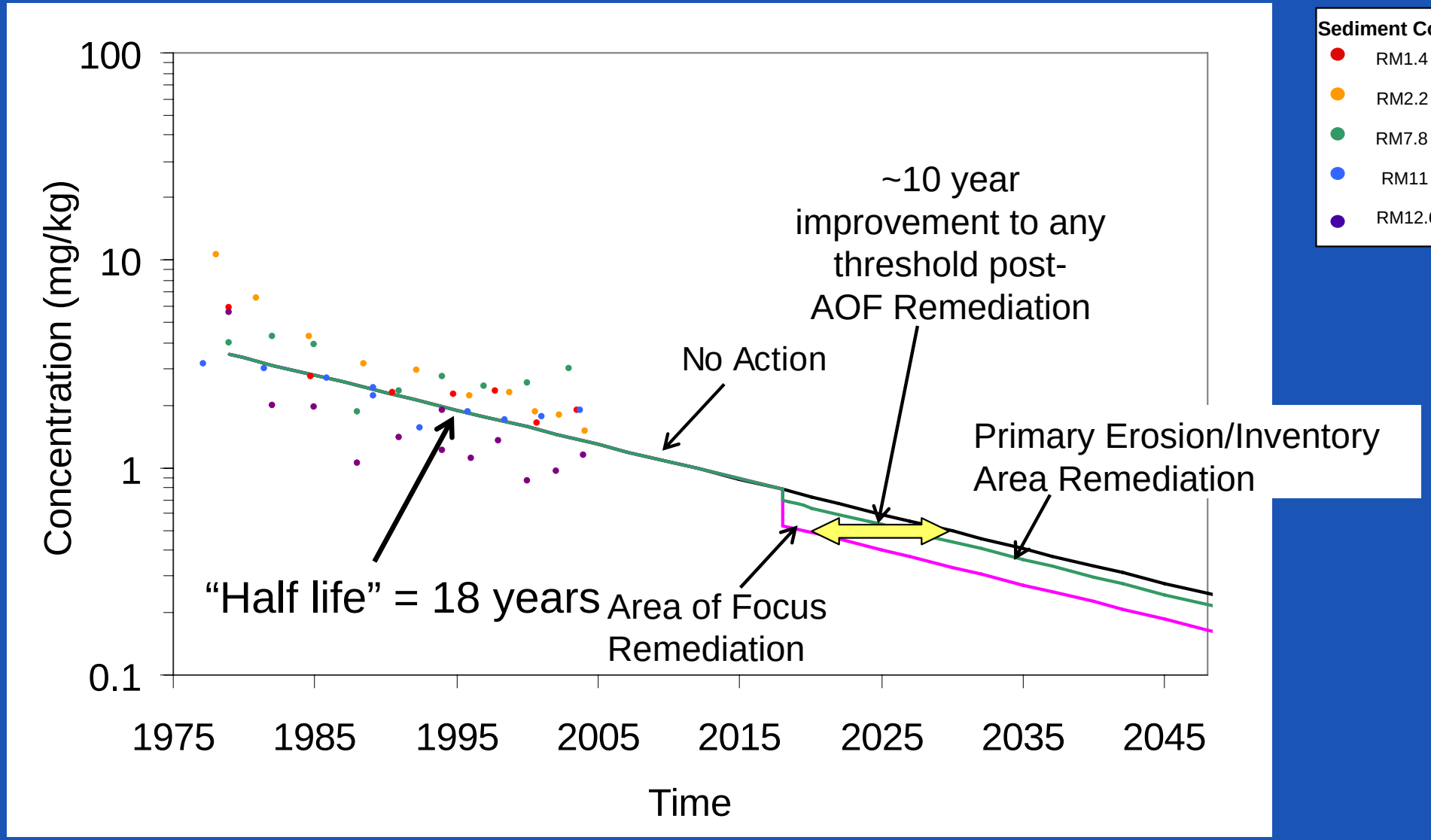
Total PCBs

Forecasted Surface Sediment Concentrations



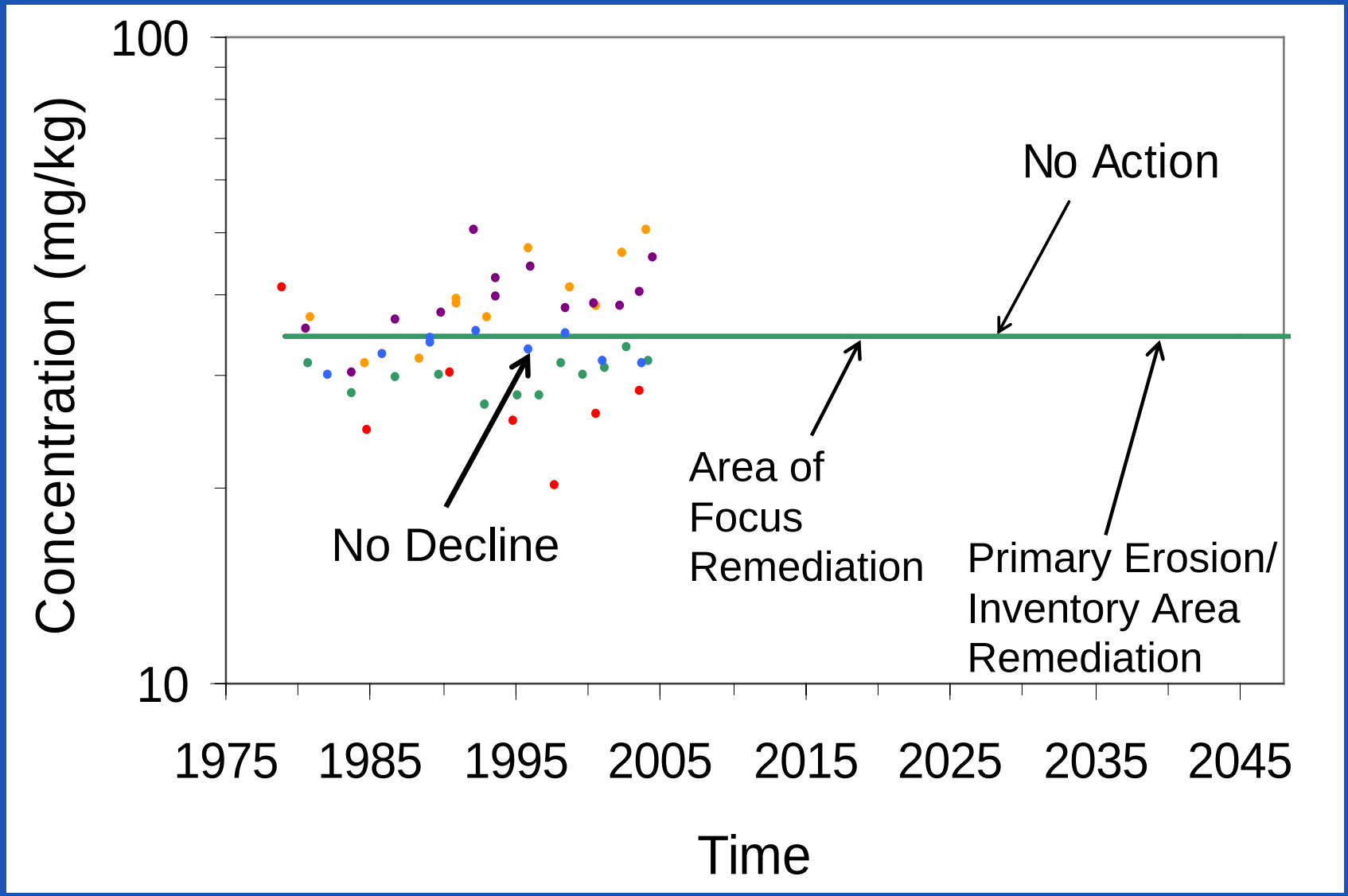
Mercury

Forecasted Surface Sediment Concentrations



High Molecular Weight PAHs

Forecasted Surface Sediment Concentrations



Conclusions of the EMBM

- External contaminant sources (by themselves) cannot account for the observed COPC concentrations.
- Sediment re-suspension is a major contributor to the contaminant burden of recently deposited sediments.
- Surface sediments originate from the Upper Passaic River and Newark Bay in roughly equal proportions.
  - Minor **solids** contributions from historical sediment re-suspension, tributaries, and CSO/SWOs.
- CSO/SWOs and the tributaries play lesser roles for most contaminants.[1]
  - More important for lead, dieldrin, chlordane and copper[1]

1. These bullets were modified from the original presentation to be more consistent with the oral presentation and the EMBM report.

Conclusions of the EMBM (cont.)

- Re-suspension of legacy sediments (*i.e.*, the historical inventory) =
  - ~10 percent of the total annual solids deposition
  - >95% of annual 2,3,7,8-TCDD load
  - Single largest source of :
    - PCBs
    - DDT+DDE+DDD
    - Mercury
- Upper Passaic River is the major source of PAHs and an important source of PCBs and mercury
- Newark Bay solids serve to dilute contamination in Lower Passaic River sediments.
  - Newark Bay represents about 25 % of mercury load

Conclusions of the EMBM (cont.)

- Surface sediment concentrations show very slow declines post 1980.
  - Total PCB has shortest half life, at 14 years.
- LMW PAHs, HMW PAHs, and dieldrin have not declined since 1980 and may be increasing slightly with time.
- Remediation of the Area of Focus of can significantly reduce future surface concentrations of dioxin, reducing the recovery time by ~40 years relative to No Action.
- Remediation of the Area of Focus can also improve surface concentrations of PCBs, DDT, and mercury, but to a lesser degree, improving recovery by ~10 to 15 years relative to No Action.
- Remediation of the Primary Erosion and Primary Inventory Zones results in only marginal improvements relative to No Action.