# Developing Hydrocarbon PRGs Using Passive Sampling, Porewater, and Bulk Sediment

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POSTER GROUP 2

## Newtown Creek Superfund Site

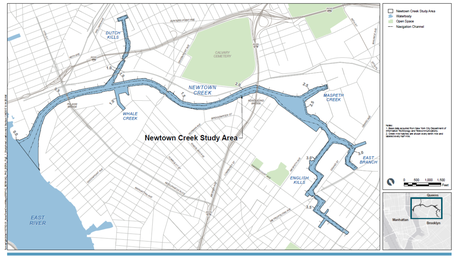



Figure 2-1
Study Area Location Map
Baseline Ecological Risk Assessment
Newtown Creek RI/FS

- 3.8-mile dead-end creek in a mixed residential/ industrial area between Brooklyn and Queens in New York City
- Tidal inlet to the East River
- Five dead-end tributaries
  - Dutch Kills, Whale Creek, Maspeth Creek, East Branch, English Kills
- Sediments heavily contaminated with hydrocarbon compounds and other contaminants
- Study discusses deriving ecological risk-based pre-liminary remediation goals (PRGs) for hydrocarbons

### EPA Porewater PAH RG Method

- EPAs 2017 guidance used to derive PRGs
  **Developing Sediment Remediation Goals at Superfund Sites Based on Pore Water for the Protection of Benthic Organisms from Direct Toxicity to Non-ionic Organic Contaminants**
- Guidance uses freely dissolved concentrations ($C_{free}$) of 34 different polycyclic aromatic hydrocarbons [PAH (34)] in porewater (PW)
- Used toxicological data and chemical data from bulk sediment and PW analyses from 35 study area locations

## Sediment Toxicity

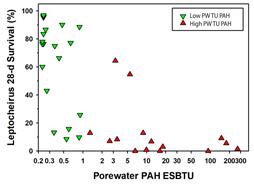
- Performed 10-day and 28-day amphipod studies with *Leptocheirus plumulosus* on all 35 study area samples
- There were no correlations with PAH (34) Cfree and observed toxicity
- Although sublethal endpoints tend to be more sensitive
  - 28-day growth and reproduction were significantly reduced in all but a few locations
  - Thus, correlations were not possible
- Survival in the 10-day toxicity test was poor (only one location had survival above 75%)
- Used 28-day survival to derive hydrocarbon PRGs
  - Thus, PRGs are likely to underestimate risk

## Porewater PAH RG Results

- EPA Region 2 followed EPA's 2017 guidance
- After consultation with EPA ORD guidance authors, results indicated that PW data from the 35 sample locations did not lend itself to the PW RG method
  - Most PW concentrations were below detection limits, regardless of sediment concentrations.
  - Using ½ the reporting limit for most of the PW $C_{free}$ results yielded PW values not related to sediment concentrations
  - Potential explanations for results:
    - **Elevated anthropogenic organic carbon (OC)** – a significant part of the sediment OC in Newtown Creek is actually hydrocarbons
    - **Interference during sampling** – PW PAH(34) concentrations yielded extremely low sediment PRGs (e.g., <4 mg/kg)
- Collaboration with EPA ORD led to re-assessing bulk sediment, and evaluating many additional classes of petroleum hydrocarbon compounds

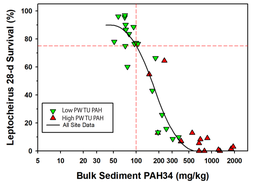
## Data

### Porewater PAH(34) $C_{free}$ vs. Survival



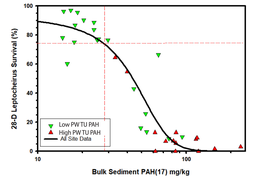

- ▽ = PW Toxic Units (TU)<1
- △ = PW TU>1
- PW $C_{free}$ of PAH (34) did not correlate with 28-D survival
- Most samples with PW TU <0.5 were non-detect; could have lower PW TUs
- All samples with PW TU >1 were toxic, as expected
- Many samples without bioavailable PAHs yielded low survival, indicating PAHs not the only cause of toxicity
- **PW TU not an adequate marker for toxicity**

### Bulk Sediment PAH(34) vs. Survival



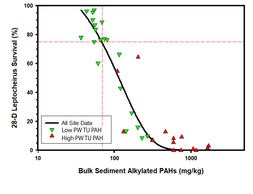

- Bulk sediment PAH(34) correlates well with toxicity
- But, eight samples did not have bioavailable PAHs; PAH(34) may be correlated with other sources of toxicity
- Below 75% of survival samples are toxic
- Toxic to *Leptocheirus* at:
  **100 milligram/kilogram (mg/kg) dry weight (dw) PAH(34)**

### Bulk Sediment PAH(17) vs. Survival



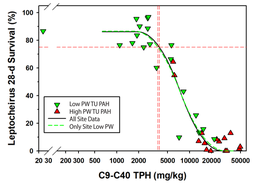

- Bulk sediment PAH(17) correlates well with toxicity
- Shows many samples that did not have bioavailable PAHs; PAH(17) may be correlated with other sources of toxicity
- Toxic to *Leptocheirus* at:
  **30 mg/kg dw PAH(17)**

### Bulk Sediment Alkylated PAHs vs. Survival



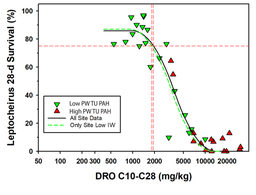

- Bulk sediment Alkylated PAHs = **subtract the PAH(17) list from the PAH(34) list, yielding the more toxicologically potent hydrocarbons**
- Alkylated PAHs correlate well with toxicity
- Show some samples that did not have bioavailable PAHs; PAHs may be correlated with other sources of toxicity
- Toxic to *Leptocheirus* at:
  **70 mg/kg dw Alkylated PAHs**

### Bulk Sediment C9-C40 TPH vs. Survival



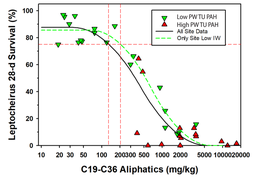

- Bulk sediment total petroleum hydrocarbon (TPH) correlates well with toxicity
- Toxic to *Leptocheirus* at:
  **3,820 mg/kg dw TPH**

### Bulk Sediment DRO vs. Survival




- Bulk sediment Diesel-Range Organics (DRO) correlates well with toxicity
- Toxic to *Leptocheirus* at:
  **1,920 mg/kg dw DRO**

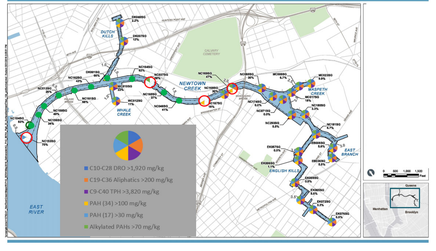
### Bulk Sediment C19-C36 vs. Survival




- Bulk sediment C19-C36 aliphatic hydrocarbons correlate well with toxicity
- Several samples with PAH(34) TU >1 and low survival are at the center bottom
  - Pull response curve down
  - Indicates toxicity in those samples is related to PAHs rather than C19-C36 aliphatics
- If remove site samples with the high PW PAH TUs (fitting the line to only the green samples)
  - Response curve moves to the right
  - Model has a better fit in the area of the 75% survival
- 75% survival line perfectly segregates toxic samples from nontoxic samples
- Toxic to *Leptocheirus* at:
  **200 mg/kg dw C19-C36**

## EPA's Risk-Based PRG Spatial Distribution

- EPA's calculated spatial distribution of hydrocarbon risk-based PRG exceedances




- Initial interpretation: all six PRGs have similar footprints except four locations (open red circles)

## Conclusion

- There were no correlations between observed toxicity and PW hydrocarbon concentrations, so bulk sediment was evaluated
- The 28-day survival and bulk sediment concentrations of C9-C40 TPH, C10-C28 DRO, C19-C36, PAH(34), PAH(17), and Alkylated PAHs all showed good correlation, and all were similar
- EPA concluded that the following hydrocarbon concentrations should be used, together, until final PRGs can be developed:

**Bulk Sediment PAH(34) at 100 mg/kg dw**
**Bulk Sediment C19-C36 at 200 mg/kg dw**

### Reference

EPA (United States Environmental Protection Agency). 2017. Developing Sediment Remediation Goals at Superfund Sites Based on Pore Water for the Protection of Benthic Organisms from Direct Toxicity to Non-ionic Organic Contaminants. EPA/600/R-15/289. Office of Research and Development, National Health and Environmental Effects Research Laboratories, Duluth, MN and Narragansett, RI.