

# **Rolling Knolls Landfill Superfund Site**

CAG Meeting

March 11, 2019



# Ecological Risk Assessment

- **Ecological Risk Assessment (ERA)** refers to a qualitative and/or quantitative evaluation of the actual or potential impacts of contaminants from a hazardous waste site on plants and animals (other than humans and domesticated species).

# Ecological Risk Assessment

- **EPA's 8-Step ERA Procedure:**
  - **Screening Level Ecological Risk Assessment (SLERA)**
    - **Step 1** – Screening-Level Problem Formulation and Ecological Effects Evaluation
    - **Step 2** – Screening-Level Preliminary Exposure Estimate and Risk Calculation
  - **Baseline Ecological Risk Assessment (BERA)**
    - **Step 3** – BERA Problem Formulation
    - **Step 4** – Study Design and DQO Process (LOE, ME, WP, SAP)
    - **Step 5** – Verification of Field Sampling Design
    - **Step 6** – Site Investigation and Analysis of Exposure and Effects
    - **Step 7** – Risk Characterization
    - **Step 8** – Risk Management

# SLERA

- Comparison of site chemical concentrations in soil, sediment, and surface water to conservative screening criteria (e.g., NJDEP's ESC)
  - If no chemicals exceed screening criteria, there is no ecological risk.
  - If chemicals exceed screening criteria, it doesn't necessarily mean ecological risk, simply that additional evaluation is warranted.
  - Chemicals that exceed screening criteria are then evaluated as contaminants of potential ecological concern (COPECs) in the BERA.
- Rolling Knolls Landfill SLERA was finalized February 2012 (Arcadis)

# BERA

- COPECs are carried through the BERA process, which may also include:
  - Additional sampling (soil, sediment, surface water, biota tissue)
  - Toxicity/Bioaccumulation testing
  - Surveys (benthic macroinvertebrates, wildlife, plants)
  - Food chain exposure modeling using **surrogate receptors**
- Assessment and Measurement Endpoints
  - Assessment Endpoints (AEs): Are soil COPEC concentrations sufficient to impact survival, growth, or reproduction of vermivorous birds (robin)?
  - Measurement Endpoints (MEs): Food chain exposure modeling using site-specific soil, water, and tissue concentrations to evaluate the COPEC **dose**
- Rolling Knolls Landfill BERA was finalized December 2016 (Integral Consulting, Inc.)
  - BERA Site-Wide Risk Recalculation technical memo was submitted May 2018

# Rolling Knolls BERA

- COPECs carried from the SLERA included:
  - PAHs, phthalates, pesticides, PCBs, dioxins/furans, metals, and cyanide
- Additional samples analyzed:
  - Soil – upland and wetland soils
  - Surface water – site ponds, Loantaka Brook, Black Brook
  - Sediment – Loantaka Brook, Black Brook, site ponds, and offsite reference pond
  - Tissue – small mammals, earthworms, arthropods, tadpoles, forage fish, and aquatic plants
  - Sediment Toxicity Tests – amphipods and midges
- Food chain exposure modeling – surrogate birds and mammals
- Habitat Assessments – upland terrestrial and wetlands



# BERA Samples

- Samples analyzed:
  - **Surface Water** – 10 samples: 3 West Pond #1, 1 North Pond #1, 1 North Pond #2, 4 Landfill Perimeter, and 1 Offsite Reference Pond;
  - **Sediment** – 19 samples: 6 Loantaka Brook, 6 Black Brook, 3 West Pond #1, 1 North Pond #1, 1 North Pond #2, and 2 Offsite Reference Pond;
  - **10-Day Acute Toxicity Tests** (*Hyaella* and *Chironomus*) – 10 samples: 1 Black Brook, 3 West Pond #1, 1 North Pond #1, 1 North Pond #2, 2 Landfill Perimeter, and 2 Offsite Reference Pond.

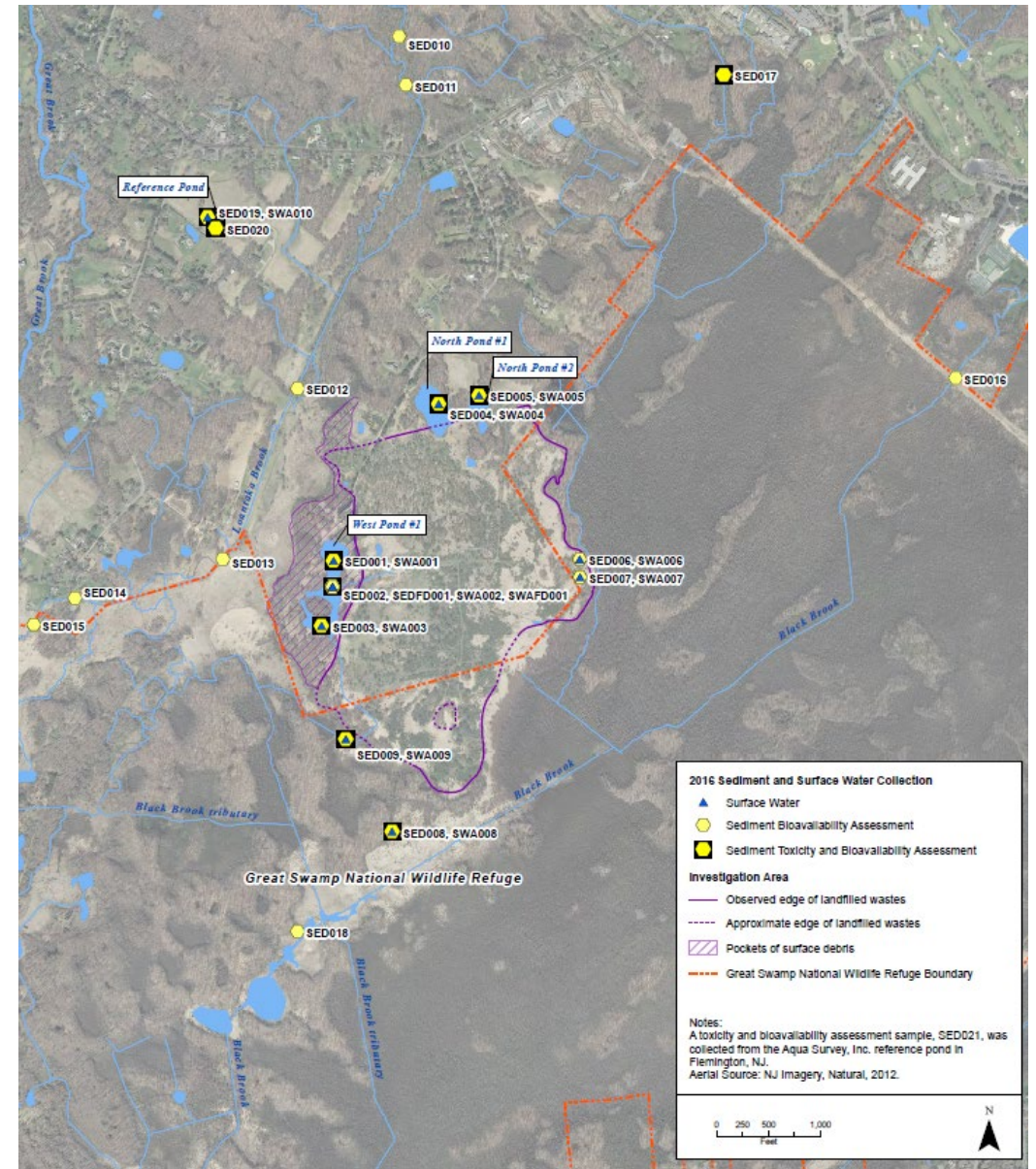
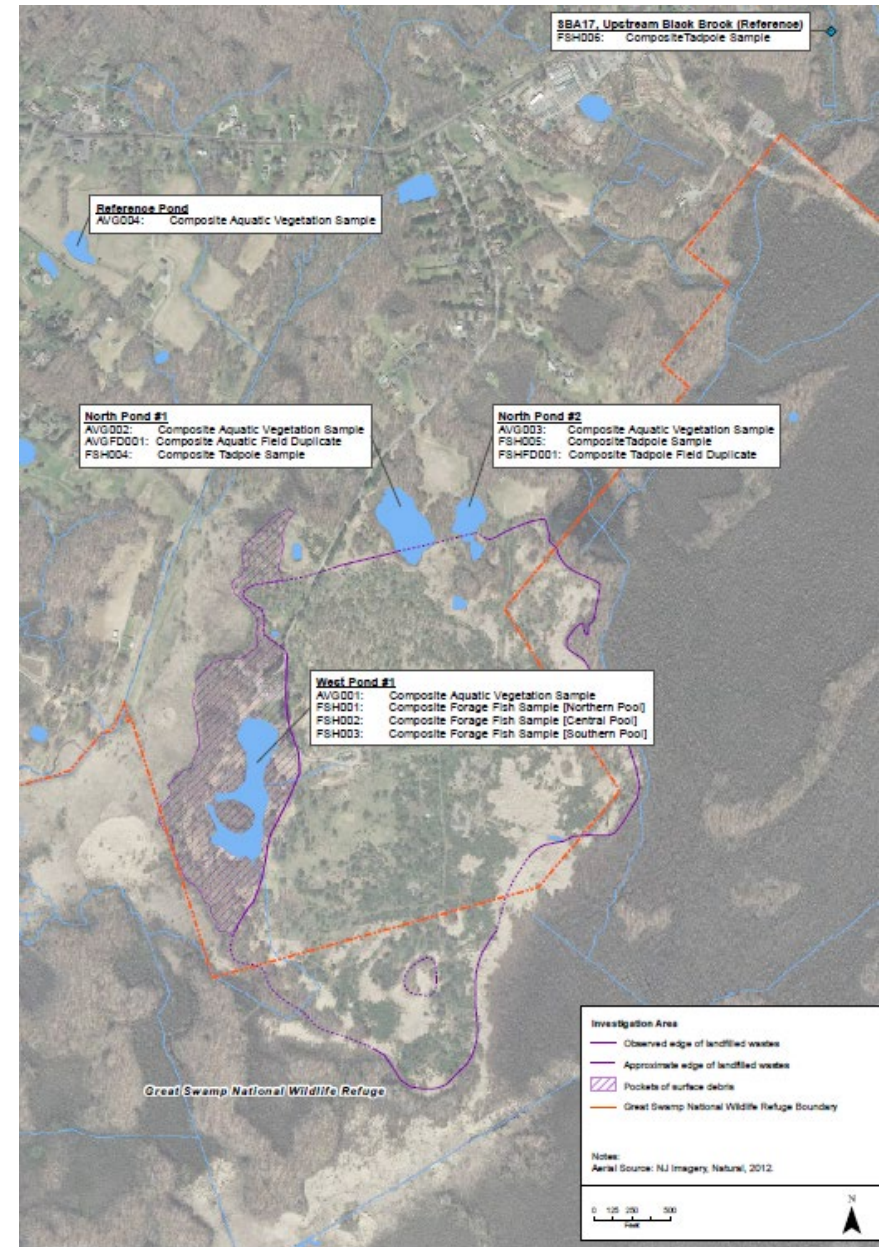


Figure 4-1.  
BERA 2016 Field Program - Sediment and Surface  
Water Sample Locations

# BERA Samples

- Samples analyzed:
  - **Aquatic Vegetation Tissue** – 4 samples:  
1 West Pond #1, 1 North Pond #1, 1 North Pond #2, and 1 Reference Pond;
  - **Tadpole Tissue** – 1 North Pond #1, 1 North Pond #2, 1 Black Brook Reference sample;
  - **Forage Fish Tissue** – 3 West Pond #1 samples





# BERA Samples

- Samples analyzed:
  - **Upland Soil** – 7 samples: 6 Upland and 1 Upland Reference;
  - **Soil Invertebrate Tissue** – 6 Upland earthworm, 4 Wetland earthworm, 2 wetland arthropod;
  - **Wetland Soil** – 9 samples: 8 Wetland and 1 Wetland Reference.

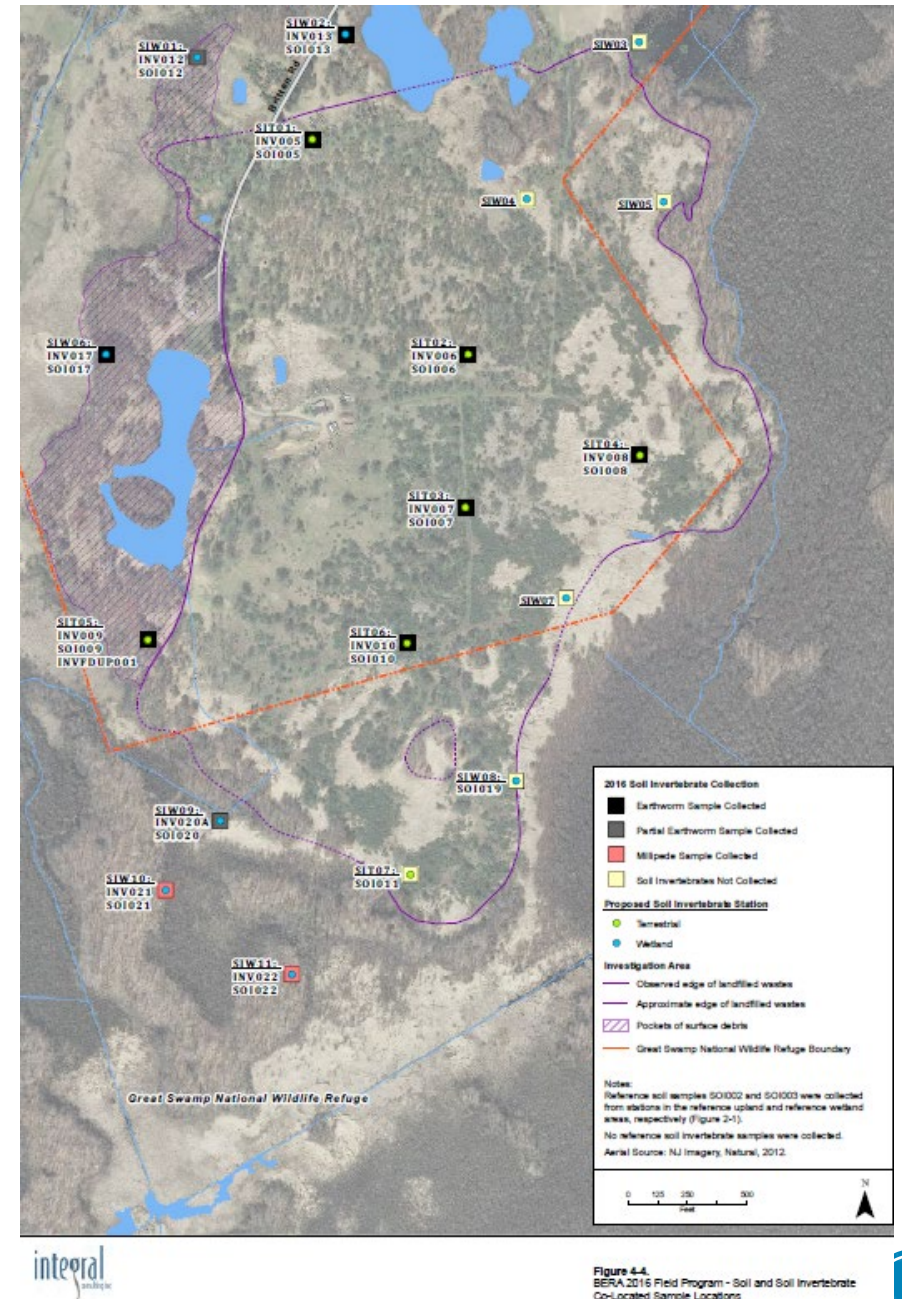
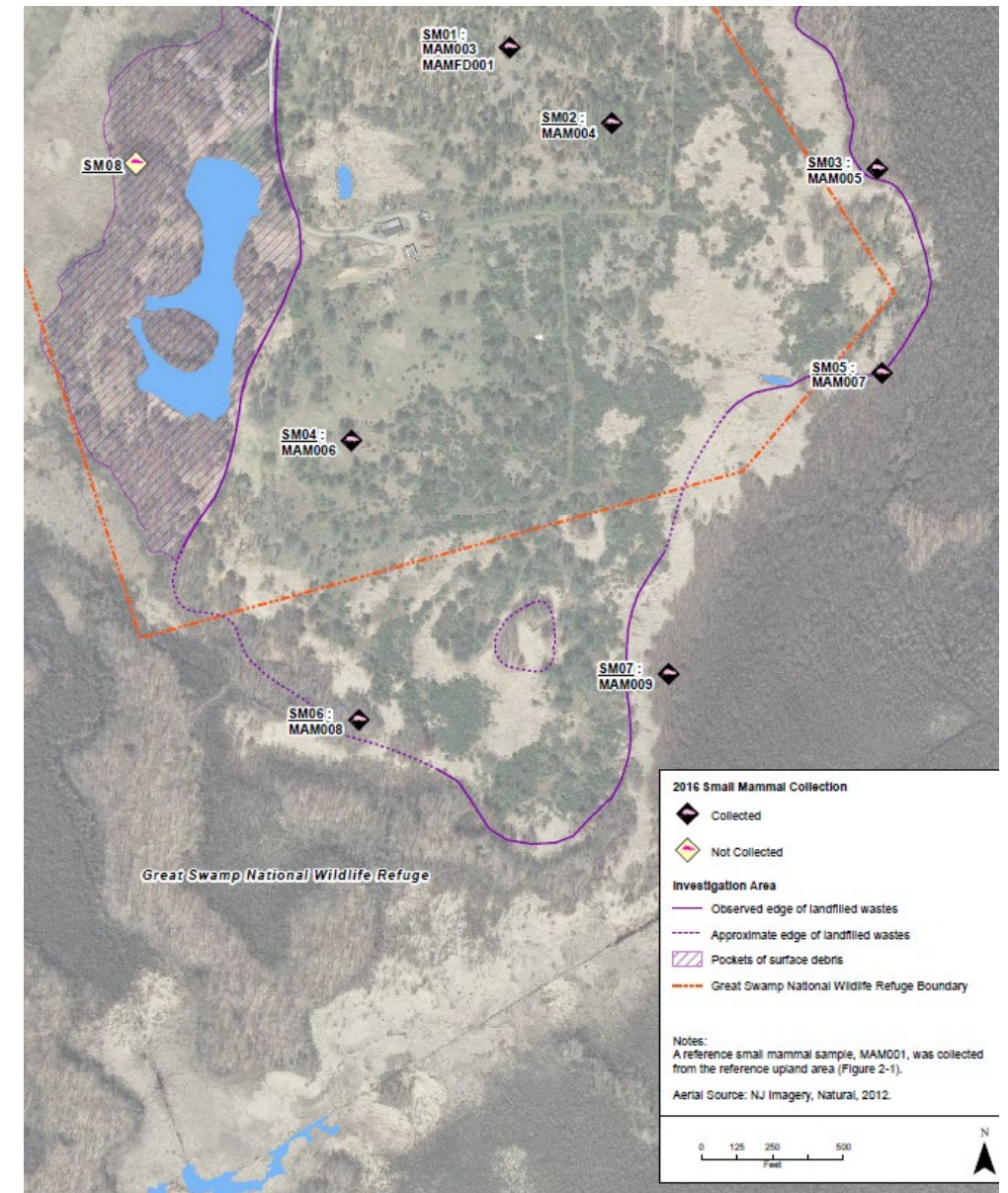


Figure 4-4.  
BERA 2016 Field Program - Soil and Soil Invertebrate  
Co-located Sample Locations

# BERA Samples

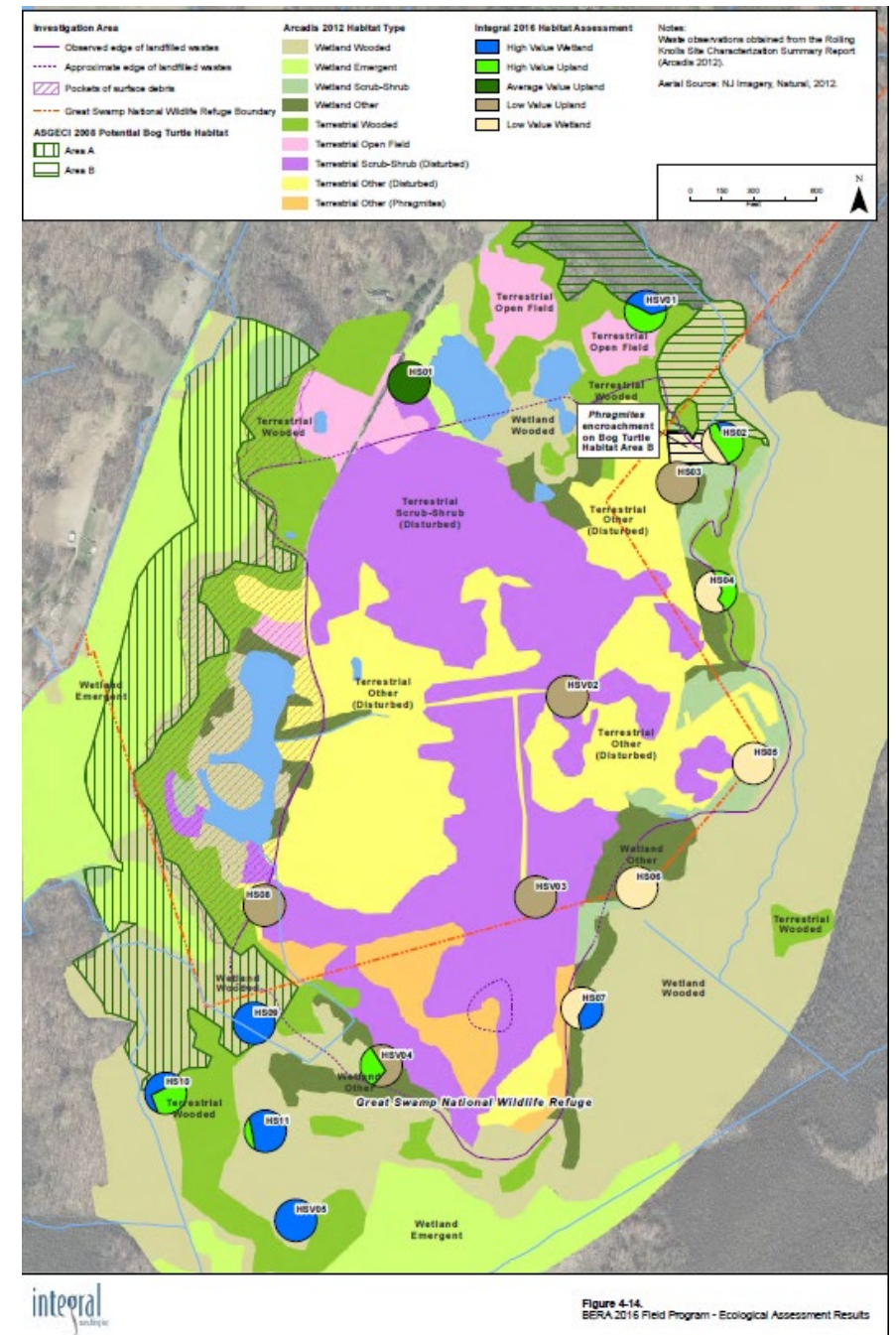
- Samples analyzed:
  - **Small Mammal Tissue** – 8 samples: 3 Upland, 4 Wetland, and 1 Upland Reference.





# BERA Results

- **AE 1 Vegetation:**
  - **ME 1-1** Ecological habitat survey – rated habitat areas by type of vegetation (grasses, shrubs, trees) and the species present, and ability to provide food base:
    - Terrestrial habitats rated “High Value” (mature and old growth), “Average Value” (disturbed/undisturbed), and “Low Value” (disturbed/patchy);
    - Wetland habitat rated “High Value” or “Low Value”;
    - Based on professional judgment.
- Results indicate that other than in areas with thin soil or visible solid waste, vegetation is not impacted, and there is valuable habitat all around the site.



# BERA Results

- **AE 2 Benthic Invertebrates:**
  - **ME 2-1** Sed/SW COPEC Concentrations – West Pond #1 exceeded benchmarks for DDx (HQ=4 in 1 of 3 WP1 samples) and metals, but overall no unacceptable risk was identified
  - **ME 2-2** Sediment COPEC Bioavailability (AVS/SEM) – indicated that metals were not bioavailable.
  - **ME 2-3** Sediment Toxicity Test Results – 10-day acute toxicity tests
    - *Hyalella azteca* (amphipod) – no reduction in survival, slight reduction in growth (<20%) in West Pond #1, North Pond #1, and North Pond #2.
    - *Chironomus dilutus* (midge) – no reduction in survival, slight reduction in growth (<20%) in one West Pond sample.
    - There was no correlation between observed toxicity and sediment COPEC concentrations.
- Results indicated slight risk to benthic invertebrates in the ponds, but no Site-wide unacceptable risk.



# BERA Results

- **AE 3 Amphibians and Reptiles:**
  - **ME 3-1** Sediment and Surface Water Concentrations – indicated no risk
    - Adult frogs and tadpoles were abundant in the ponds
- **AE 4 Herbivorous Birds (Mallard Duck):**
  - **ME 4-1** Food Chain Exposure Modeling – indicated no risk
- **AE 5 Piscivorous Birds (Great Blue Heron):**
  - **ME 5-1** Food Chain Exposure Modeling – indicated no risk

# BERA Results

- **AE 6 Herbivorous Mammals (Meadow Vole):**
  - **ME 6-1** Food Chain Exposure Modeling – indicated Site-wide terrestrial and wetland risk:
    - **NOAEL-based:**
      - Cadmium (HQ=1.2), chromium (HQ=3.8), methylmercury (HQ=29), selenium (HQ=4.2), zinc (HQ=1.4), PCDD/F-TEQ (HQ=14)
    - **LOAEL-based:**
      - Methylmercury (HQ=5.7), selenium (HQ=1.9), PCDD/F-TEQ (HQ=2.2)
- Results indicate slight risk to herbivorous mammals

# BERA Results

- **AE 7 Vermivorous Mammals (Short-tailed Shrew):**
  - **ME 7-1** Food Chain Exposure Modeling – indicated Site-wide terrestrial and wetland risk:
    - **NOAEL-based:**
      - PCBs - Aroclor 1254 (HQ=2.3), PCB-TEQ (HQ=28), Total PCBs (HQ=3.3)
      - Dioxins/Furans - PCDD/F-TEQ (HQ=8.6)
      - SVOCs – Total PAHs (HQ=2.2)
      - Metals – arsenic (HQ=1.8), barium (HQ=3.5), cadmium (HQ=19), chromium (HQ=77), copper (HQ=3.4), lead (HQ=16), manganese (HQ=6.7), methylmercury (HQ=24), nickel (HQ=6.1), selenium (HQ=15), vanadium (HQ=19)
    - **LOAEL-based:**
      - PCBs - Aroclor 1254 (HQ=1.2), PCB-TEQ (HQ=4.6), Total PCBs (HQ=1.7)
      - Dioxins/Furans - PCDD/F-TEQ (HQ=1.4)
      - Metals – barium (HQ=1.3), cadmium (HQ=2.8), chromium (HQ=13), copper (HQ=1.6), lead (HQ=4.4), manganese (HQ=3.8), methylmercury (HQ=4.8), nickel (HQ=2), selenium (HQ=6.9), vanadium (HQ=9.5)
- Results indicate risk to vermivorous mammals

# BERA Results

- **AE 8 Vermivorous Birds (American Robin):**
  - **ME 8-1** Food Chain Exposure Modeling – indicated Site-wide terrestrial and wetland risk:
    - **NOAEL-based:**
      - PCBs - Total PCBs (HQ=4.1), PCB-TEQ (HQ=37), Aroclor 1254 (HQ=3.3), Aroclor 1260 (HQ=1.1)
      - Dioxins/Furans - PCDD/F-TEQ (HQ=30)
      - SVOCs – Total PAHs (HQ=14), benzo(a)anthracene (HQ=6.9), benzo(a)pyrene (HQ=5.9), bis(2-ethylhexyl)phthalate (HQ=1.5), chrysene (HQ=41)
      - Metals – arsenic (HQ=2.4), barium (HQ=18), cadmium (HQ=25), chromium (HQ=3.1), cobalt (HQ=1.8), copper (HQ=26), lead (HQ=99), manganese (HQ=2.6), methylmercury (HQ=26), nickel (HQ=4.9), selenium (HQ=23), vanadium (HQ=28), zinc (HQ=25)
      - bis(2-ethylhexyl)phthalate (HQ=1.5), cyanide (HQ=110).
    - **LOAEL-based:**
      - PCBs - PCB-TEQ (HQ=3.7)
      - Dioxins/Furans - PCDD/F-TEQ (HQ=3)
      - SVOCs – Total PAHs (HQ=1.4)
      - Metals – arsenic (HQ=2), barium (HQ=9), cadmium (HQ=8.5), chromium (HQ=1.5), copper (HQ=15), lead (HQ=19), manganese (HQ=1.7), methylmercury (HQ=20), nickel (HQ=3.3), selenium (HQ=10), vanadium (HQ=14), zinc (HQ=15)
      - Cyanide (HQ=11).
- Results indicate risk to vermivorous birds



# BERA Results

- **AE 9 Carnivorous Mammals (Red Fox):**
  - **ME 9-1** Food Chain Exposure Modeling – indicated Site-wide terrestrial and wetland risk:
    - **NOAEL-based:**
      - PCBs – PCB-TEQ (HQ=3.5)
      - Dioxins/Furans – PCDD/F-TEQ (HQ=1.2)
      - Metals – antimony (HQ=1.6), methylmercury (HQ=1.5), selenium (HQ=3.6), vanadium (HQ=1.3)
    - **LOAEL-based:**
      - Metals – selenium (HQ=1.8)
- Results indicate no unacceptable risk to carnivorous mammals

# BERA Results

- **AE 10 Insectivorous Mammals (Little Brown Bat):**
  - **ME 10-1** Food Chain Exposure Modeling – indicated Site-wide terrestrial and wetland risk
    - **NOAEL-based:**
      - Metals – arsenic (HQ=2), barium (HQ=1.9), copper (HQ=2.5), methylmercury (HQ=3.4), selenium (HQ=18), vanadium (HQ=1.4), zinc (HQ=5).
    - **LOAEL-based:**
      - Metals – copper (HQ=1.1), selenium (HQ=8)
- Results indicate slight risk to insectivorous mammals

# BERA Results

- AE 11 Insectivorous Birds (Tree Swallow):
  - ME 11-1 Food Chain Exposure Modeling – indicated no risk
- AE 12 Carnivorous Birds (Red-tailed Hawk):
  - ME 12-1 Food Chain Exposure Modeling – indicated no risk

# BERA Results

- **AE 13 Piscivorous Mammals (Mink):**
  - **ME 13-1** Food Chain Exposure Modeling – indicated Site-wide terrestrial and wetland risk:
    - **NOAEL-based:**
      - PCBs – Aroclor 1254 (HQ=1.1)
      - Metals – antimony (HQ=1.8), copper (HQ=5.4), selenium (HQ=2.2), vanadium (HQ=1.2)
    - **LOAEL-based:**
      - Metals – copper (HQ=2.8), selenium (HQ=1.1)
- Results indicate slight risk to piscivorous mammals



# BERA Conclusions

- Site COPECs do not pose ecological concern for most receptors
  - COPEC concentrations generally higher in the terrestrial portion than in the wetland
  - No significant differences in biota tissue COPEC concentrations between terrestrial and wetland
  - Some LOEs showed slight risk to benthic invertebrates, herbivorous mammals, insectivorous mammals, piscivorous mammals, but other LOEs indicated no risk
  - Loantaka Brook has not been impacted by the Site, and COPECs in Black Brook are higher upgradient of the Site than downgradient
- Low potential risk was noted for vermivorous receptors (shrew and robin) and benthic invertebrates
  - Risk drivers are PCBs and metals
  - Addressing risk to vermivorous birds/mammals should address any risk to other receptors.