

AQUATIC ECOLOGICAL RISK CASE STUDY: MERCURY AT A FORMERLY USED DEFENSE SITE



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Site History

- ▣ 1907 fireworks manufacturing
- ▣ WWI military munitions
- ▣ 1930s through WWII, operated 24 hours/day with 5,000 employees
- ▣ Operated until 1970 producing fireworks and munitions and conducting munitions research and development

Current Use

- ▣ 240 acres owned by more than 20 entities
- ▣ 130 acres of town conservation land
- ▣ Remaining acreage developed as commercial/ industrial park
- ▣ 30 businesses operate on the northern portion of the site



Aquatic Resources

- ▣ Consists of a river with two channels and ponds caused by impounding the river
- ▣ Flow at the two dams is set manually with flashboards



Aquatic Resources

- ▣ Ponds and river are largely undeveloped
- ▣ Sediment mercury is highest at pond perimeters
- ▣ Depth in the ponds ranges from one to eight feet.



NATURE AND EXTENT OF CONTAMINATION

Sediment Analytical Data

- ▣ Total and methyl mercury not strongly correlated with grain size or TOC
- ▣ Highest total mercury was 7,420 mg/kg and >10 mg/kg in most samples in the Eastern Channel. (TEC = 0.18 mg/kg)
- ▣ Ponds were lower but still had a number of samples between 10-100 mg/kg

Surface Water and Pore Water

Media	Maximum Total Mercury (ug/L)	Maximum Methyl Mercury (ug/L)	Total Mercury Criterion (ug/L)
River Pore Water	1,500	1.8	0.77
Pond Pore Water	7.7	0.47	0.77
Pond Surface Water	0.0029	0.0027	0.77
River Surface Water	0.048	0.016	0.77

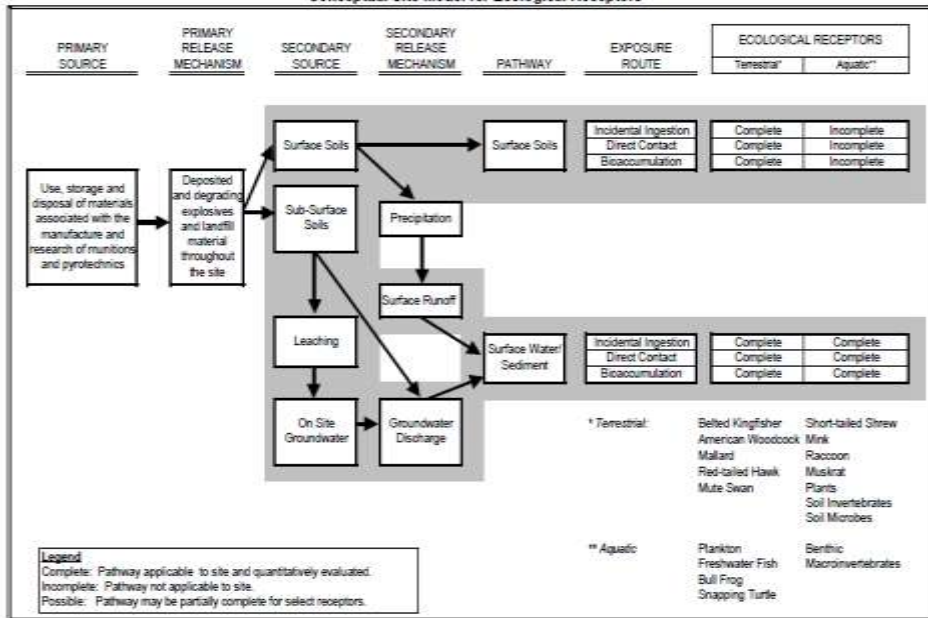
Bass analytical data

Analyte	River (mg/kg)		Pond (mg/kg)	
	Reference Area	Site	Reference Area	Site
Total Mercury	0.46	2.94	0.42	2.87
Methyl mercury	0.66	2.83	0.60	2.54



CONCEPTUAL SITE MODEL

Conceptual Site Model for Ecological Receptors



ASSESSMENT ENDPOINTS AND MEASURES OF EFFECT

Measures of Effect

Receptor/Community	Measures of Effect
Benthic Macroinvertebrates	<ol style="list-style-type: none"> 1. Sediment Benchmarks 2. Acid Volatile Sulfides-Simultaneously Extracted Metals 3. Sediment Pore Water Benchmarks 4. Bioaccumulation in <i>Lumbriculus variegatus</i> 5. Benthic Community Structure and Function 6. Whole Sediment Toxicity Tests

Invertebrate Weight of Evidence

Measure	Results
Sediment Benchmarks	Exceeded in all habitats
Acid Volatile Sulfides-Simultaneously Extracted Metals	Not available for incorporation into tissues. Not predicted to be toxic
Pore Water Benchmarks	Exceeded in all habitats
Bioaccumulation in <i>Lumbriculus</i>	1-2 order of magnitude increase compared to reference. Max tissue = 3.2 mg/kg total mercury
Benthic Community	Shift from worms to insects in all habitats
Sediment Toxicity Tests	10-day tests, low toxicity

Measures of Effect

Receptor/Community	Measures of Effect
Warm Water Freshwater Fish	<ol style="list-style-type: none"> 1. Surface Water Benchmarks 2. Community Structure and Function 3. Gross External Examination 4. Tissue-Based NOAELs and LOAELs 5. Fathead Minnow Survival and Growth Test

Fish Weight of Evidence

Measure	Results
Surface Water Benchmarks	Not exceeded
Community Structure and Function	Similar to references
Gross External Examination	Minor increases in cloudy eyes, ulcers/lesions, and parasites
Tissue-Based NOAELs and LOAELs	Exceeded behavioral and reproductive benchmarks in all habitats
Fathead Minnow Test	7-day test showed low toxicity

Measures of Effect

Receptor/Community	Measures of Effect
Piscivorous Birds – Belted Kingfisher	<ol style="list-style-type: none"> 1. Belter kingfisher exposure modeling 2. Comparison to prey tissue residue guidelines 3. Avian species surveys

Kingfisher Weight of Evidence

Measure	Results
Belter Kingfisher Exposure Modeling	LOAEL benchmark exceeded in in all habitats, including reference areas
Comparison to Prey Tissue Residue Guidelines	Forage and predatory fish exceeded guidelines in all habitats and in reference areas
Avian species surveys	Kingfishers were observed in low numbers

Conclusions

- ▣ Evaluate all relevant ecological receptor groups at your site
- ▣ Collect enough data to make lines of evidence sufficiently strong
- ▣ Background samples are often neglected or insufficient
- ▣ Benthic organisms are more than fish food
- ▣ Perform 28-day sediment toxicity tests