

EnviroScience, Inc.

The Biomonitoring Specialists


Outline

- Basics of Bioassay Testing
- TRE vs. TIE
- Components of TREs
- TIE Effluent Characterization
- Factors which make TREs a Pain
- Recommendations should a TRE appear on the horizon (or in your next NPDES renewal permit)

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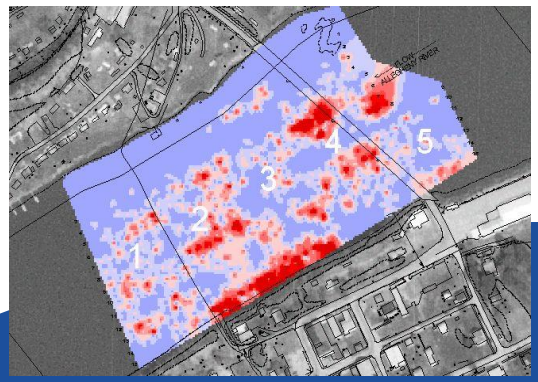
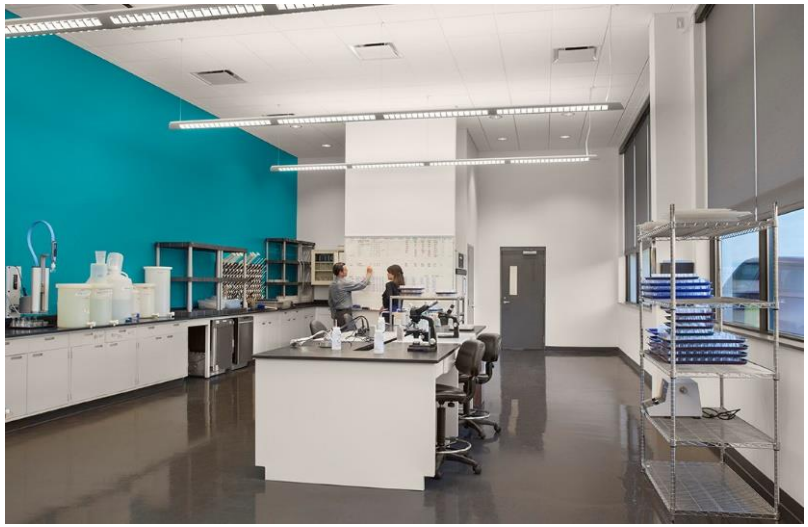
EnviroScience, Inc.

- Ecological services firm based in northern Ohio
- >100 biologists, environmental scientists and engineers specializing in aquatic biomonitoring, aquatic toxicity testing, wetland/stream restoration, invasive species, restoration and regulatory compliance
- Existing clients include State, federal and local governmental agencies (WV DOT, OH, FL, PennDOT, U.S.EPA, US Army Corp of Engineers), major industries and corporations across the U.S. (CSX, AEP, Reliant Energy, Mittal Steel) and many of the Nation's largest engineering firms (Leidos, TetraTech, Arcadis and others)



Bioassay Testing Overview



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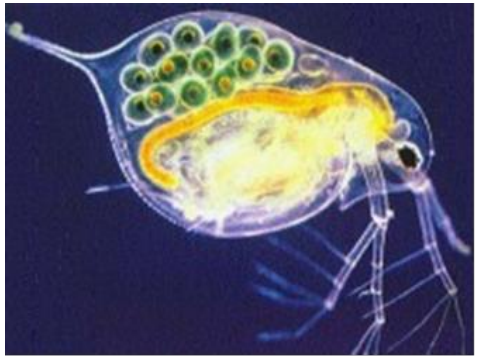
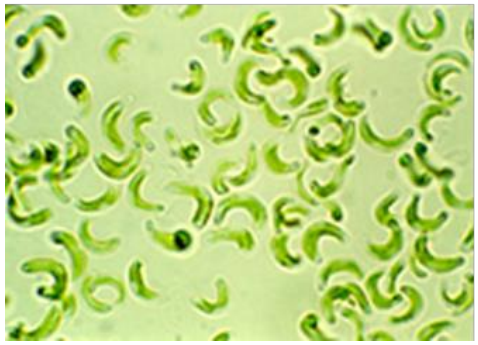
Where did this requirement come from?





- Stems from the Clean Water Act
- NPDES permit program
- State Agencies
- Individual NPDES permit holders

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What does it accomplish?

Bioassay testing can……

- address combinations of toxicants
- address unknown substances
- allows direct interaction with aquatic life
- provide a more comprehensive and realistic picture of effects- a ‘real world’ measure of the impacts a discharge may be having

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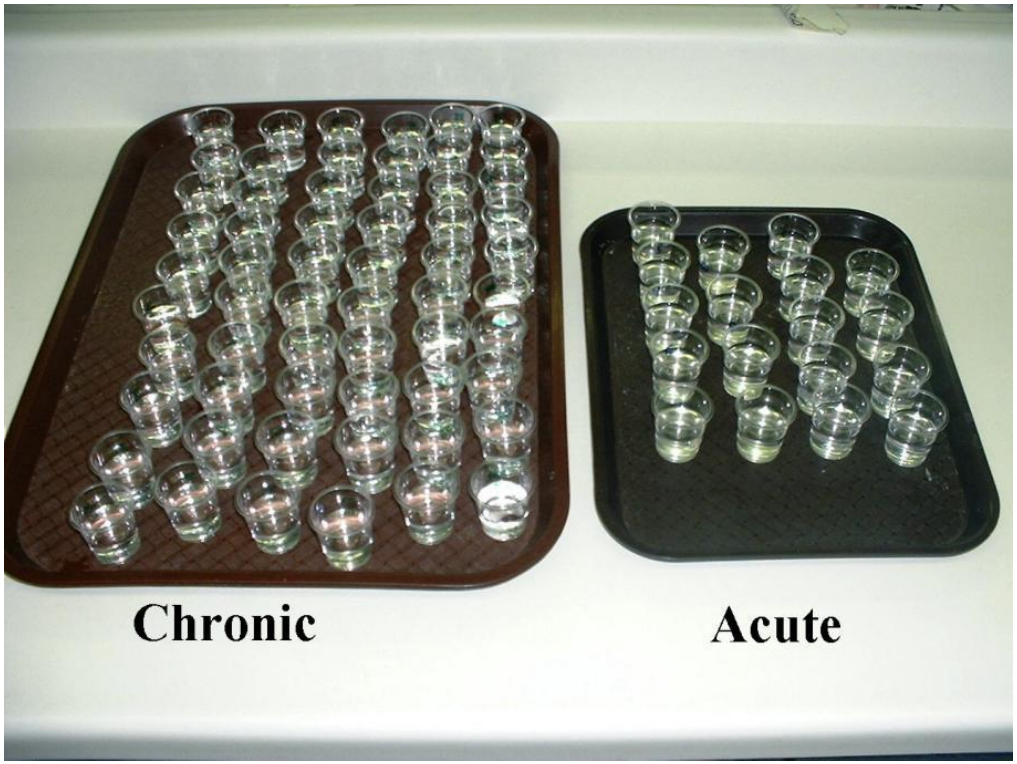
Common Toxicity Tests

- Chronic Toxicity
- Acute Toxicity
- Stormwater Screening
- Sediment Testing
- Elutriate Testing
- Product Testing



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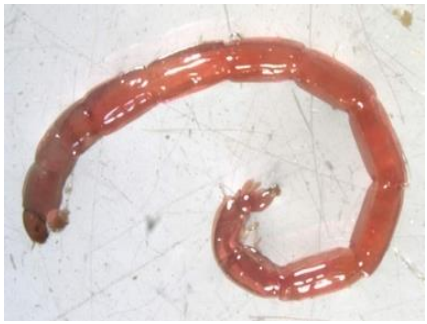
Common Test Organisms

- ***Pimiphales promelas***
- ***Ceriodaphnia dubia***
- *Daphnia magna*
- *Hyalella azteca*
- *Chironomous dilutus*
- *Selenastrum capricornutum*
- *Mysidopsis bahia*
- *Cyprinodon variegatus*
- *Menidia beryllina*



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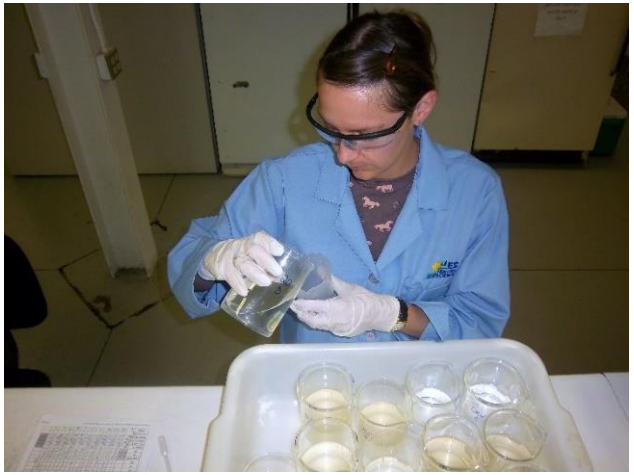
Toxicity Testing Steps

- Obtain Samples
- Dilute Samples
- Add Organisms (all are less than 24hrs. old)
- Monitor daily/ renew water/ monitor chemistry
- End Test
- Data Analysis
- Report Results



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Acute Toxicity Tests

- Test Procedures
  - 96 hours or less (species specific)
  - Mortality is the measured endpoint
- Advantages
  - Less expensive and time consuming
  - Endpoint is easy to quantify
- Disadvantages
  - Indicates only lethal concentrations
  - Only the effects of fast acting chemicals are exhibited

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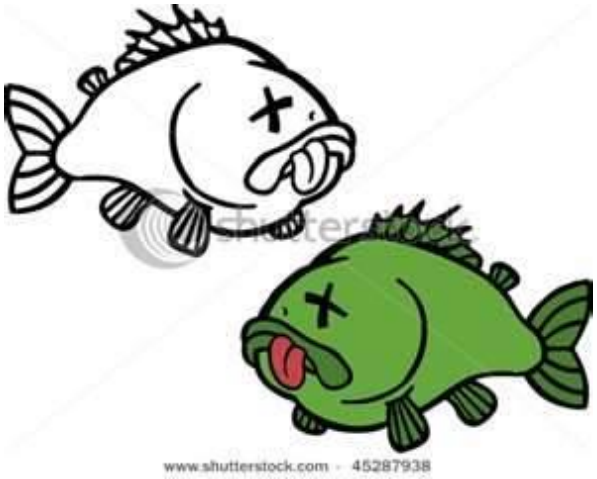
Acute Endpoints

LC_{50} (Lethal Concentration)

- Concentration of effluent that is lethal to 50 percent of the exposed organisms at a specific time of observation

Tu_a (Acute Toxic Unit)

- Defined as $100 \div LC_{50}$



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Chronic Toxicity Tests

Test Procedures

- Typically 4-21 days
- Measures mortality, growth, and reproduction

Advantages

- More sensitive than acute
- Assesses more parameters other than lethality

Limitations

- More costly and time intensive than acute

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Chronic Endpoints

IC_{25}

Inhibition Concentration- Concentration of effluent which has an inhibitory effect on 25% of the test organisms for the monitored effect, as compared to the control

NOEC

No Observable Effect Concentration- Highest concentration of effluent tested which shows no statistically significant effect on the organisms as compared to the control

LOEC

Lowest Observable Effect Concentration- Lowest concentration of effluent tested which shows statistically significant effect on the organisms as compared to the control

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Chronic Endpoints (Cont.)

- % affected
  - Typically used for ambient waters or one level screenings
- ChV
  - Chronic Value= square root of NOEC x LOEC
- Tu_c
  - Chronic Toxic Unit- Computed by
    - 100÷ChV
    - 100÷IC_{25}
    - 100÷NOEC

Toxicity Reduction Evaluations

- If you have suspected or confirmed toxicity, you can expect permit language requiring your facility to conduct (or at least plan for) a TRE to identify source(s) of toxicity and reduce/eliminate them
- The most common and problematic situation triggering TREs is low-level and intermittent chronic toxicity

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Toxicity Identification/Reduction (TIE/TRE) Evaluations

- Generally conducted in a phased iterative approach
- Does not necessarily involve extensive laboratory evaluation and testing (the TIE part of the TRE)
- Variability of waste stream often poses significant challenges, especially with low-level chronic toxicity

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TRE Objectives

- Determine whether toxicity is consistently present, and if so, determine a baseline and degree of variability.
- Evaluate in-plant practices, processes, and chemical usage in both process and wastewater treatment trains
- For municipalities, evaluate pretreatment information to identify significant industrial users and their potential to cause toxicity in the final effluent.
- Identify the general class of toxicant(s) present and then proceed to identify the specific toxicant(s) and source(s)
- Provide information, as needed, to support any necessary treatment or process changes

TRE ≠ TIE

Toxicity Reduction Evaluation- An investigation into possible source(s) of toxicity in an effluent discharge. May or may not involve conducting a

Toxicity Identification Evaluation- The laboratory phase of a TRE involving a series of effluent manipulation steps to characterize the effluent toxicity

Laboratory TIE work rarely makes sense before performing other parts of the TRE first

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TRE Components

- Establish baseline toxicity, variability and persistence of the effluent
- Chemical Optimization/ Operational Assessment
- Toxicity Identification Evaluation (TIE)
  - Phase I Characterization
  - Phase II Identification Analyses
  - Phase III Confirmation Analyses
  - Treatability Analyses

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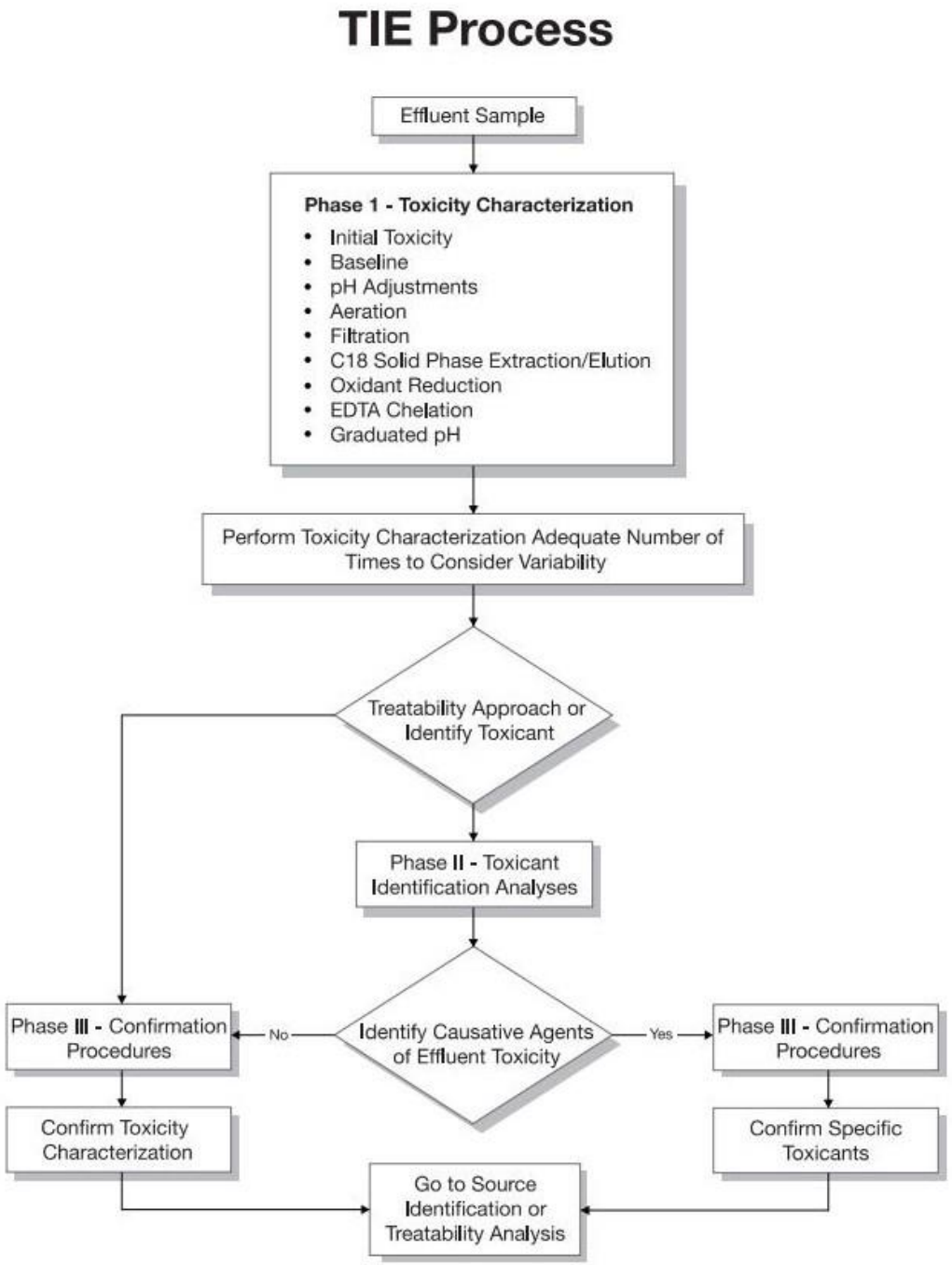
Operational Assessment

- Pre-laboratory phase of the TRE which investigates possible toxicity sources
- Focuses on:
  - Past analytical and bioassay data
  - In-house chemical usage and treatment processes
  - In-house practices and BMPs
- Combines in-plant knowledge of the facility and its waste stream with an outside perspective to identify possible sources of toxicity

Toxicity Identification Evaluation



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Common Effluent Manipulation Tests used in the TIE

- Baseline
- Aeration
  - volatiles
- pH Adjustment
  - Some metals
- Filtration
  - Particle size
  - Dissolved vs particulate bound
- C18 Solid Phase Extraction
  - Nonpolar organics, surfactants
- Oxidant Reduction
  - Chlorine, some metals
- Graduated pH
  - Ammonia, some metals
- EDTA Chelation
  - metals

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Complicating Factors Common to Many TREs

- Infrequent past biomonitoring (little data)
- Intermittent or low-level chronic toxicity
- Seasonal influences
- Highly variable influent wastewater
- High total dissolved solids (TDS) content effluents
- Some toxicants are not persistent over time
- Potential for pathogen interference from bacteria or fungi

Typical Steps in a TRE

1. Prepare a plan for submission to OEPA
2. Compilation and review of
   - 24 months of DMR & 5 years of bioassay data
   - Process flow diagrams
   - Raw material & chemical usage/storage in facility
   - Information on plant BMPs and housekeeping
   - For a municipality, review pretreatment records

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Typical Steps in a TRE (cont.)

3. Conduct a thorough walk-through of the facility
4. Conduct a series of at least six (6) weekly or biweekly screening tests to gauge variability and persistence of the effluent toxicity
5. Prioritize TIE manipulations and initiate TIE testing

Pre-TRE Recommendations

- Begin sampling for bioassay and periodic analytical requirements on the same days and from the same sample (just don't give us preserved samples!)
- To the extent possible, vary your sampling days
- Avoid targeted sampling
- Keep great records of things both large and small!

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When a TRE is looming…. It pays to be proactive

- Begin the process before you are forced to because:
  - there's never enough time
  - the process is easier when you control the schedule and the expenditures (as opposed to EPA)
- Always begin with an objective look at both the data and the facility
- Look for patterns in the data
- Talk to the operators!
- Use screening tests with fewer dilutions whenever possible (they are cheaper and don't need to be reported on MORs)

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Typical TRE Requirements

- Within 3 months, submit an initial investigation work plan
  - Include techniques that will be used to identify sources of toxicity and effluent variability
  - Describe in-house potential sources
  - Identify the person or contractor conducting the TRE
- Within 9 months, submit a detailed TRE work plan
  - Include further action and schedule
  - Consider implementing a TIE
- Within 12 months, implement the TRE work plan
- Within 30 months, submit a detailed plan for corrective action
- Within 47 months achieve compliance with final WET limits

When you are in a TRE Situation

- Try to avoid committing to a specific course of action in plans or discussions with the Agency
- Collect as much sample as possible whenever sampling for bioassay testing
- Look at simple things first (hint: check your sampler and tubing) & confirm your sampling locations!

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When you are in a TRE Situation (cont.)

- Note any recent changes and record everything!
- Focus on processes and chemical usage closest to the effluent discharge and chemicals used in the greatest quantities
- Evaluate treatment additive control rates and methods
- Talk to the operators!

When you are in a TRE Situation (cont.)

- Do as much baseline testing as possible to ensure you have adequately characterized the range and variability of the effluent before starting TIE work
- Use screening tests with fewer dilutions whenever possible (they are cheaper and don’t need to show up on MORs)
- Prioritize any TIE work using knowledge of the effluent and the plant

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Questions?

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