DRAFT Tier 2 Framework for Adjusting Eco-Contact Soil Criteria

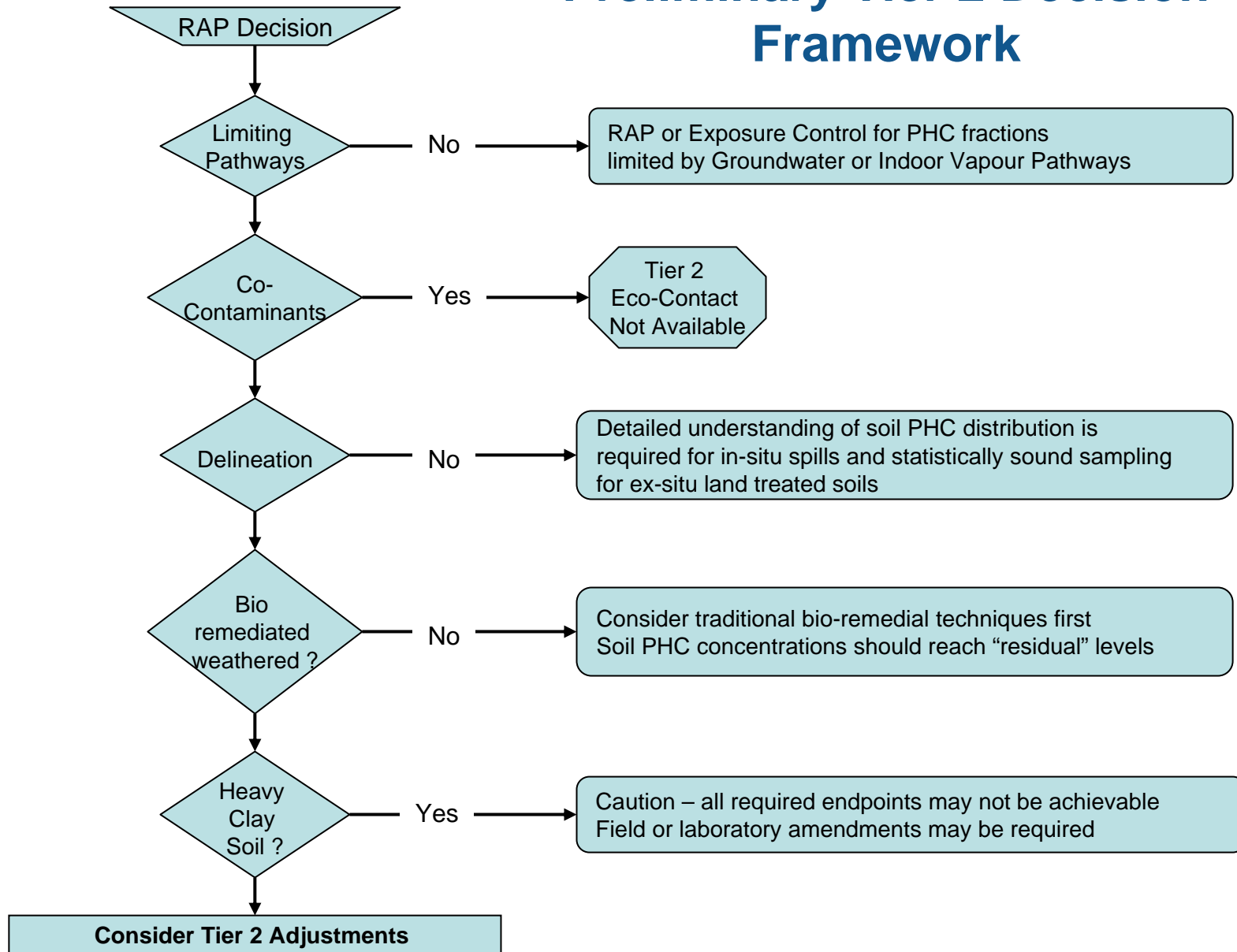## ESAA *Remediation Technologies Symposium*
October, 2007
Presented by: Craig Harris

Tier 2 Eco-Contact Adjustments: Outline of Presentation

- – Tier 2 Eco-Contact Decision Flow Chart
  - How much delineation?
  - Dealing with heavy clay soil/ sub-soil
- – Tier 2 Eco-Contact Absolute Pass/ Fail Flow Chart
  - Define Full Testing Battery
  - Analytical Requirements
  - Define Tier 2 Pass
- – Tier 2 Provisional SSRO Flow Chart
  - SSRO Development Protocols
 - Examples of Quantitative Analysis of Toxicity Data

Preliminary Tier 2 Decision Framework

RAP Decision

Limiting Pathways — No → RAP or Exposure Control for PHC fractions limited by Groundwater or Indoor Vapour Pathways

Co-Contaminants — Yes → Tier 2 Eco-Contact Not Available

Delineation — No → Detailed understanding of soil PHC distribution is required for in-situ spills and statistically sound sampling for ex-situ land treated soils

Bio remediated weathered ? — No → Consider traditional bio-remedial techniques first. Soil PHC concentrations should reach "residual" levels

Heavy Clay Soil ? — Yes → Caution – all required endpoints may not be achievable. Field or laboratory amendments may be required

Consider Tier 2 Adjustments

How Much Delineation is Required?

< Land Treatment Soil

Define the upper limit PHC concentration.
Temporal trend – are treatments effective?
Have amendments influences soil chemistry?
(nutrients, conductivity, phenols etc..).
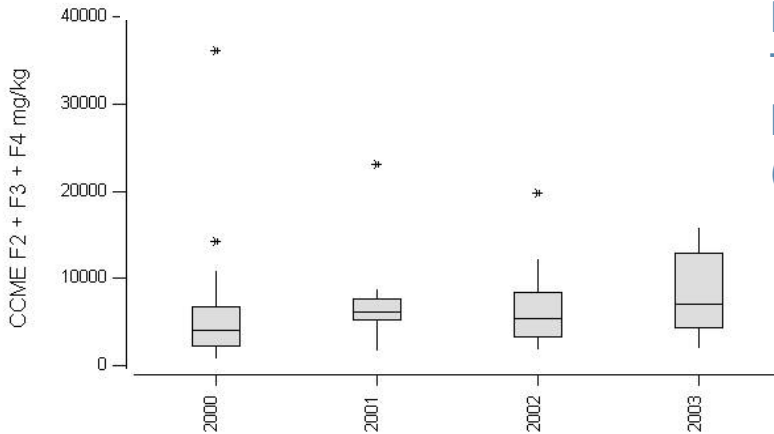
Complex Surface Soil **>**

Spatial PHC distribution (grid pattern).
Full concentration range including outliers.
Other contaminants (metals, major ions) and basic
soil characteristics (texture, nutrients, organic
carbon).
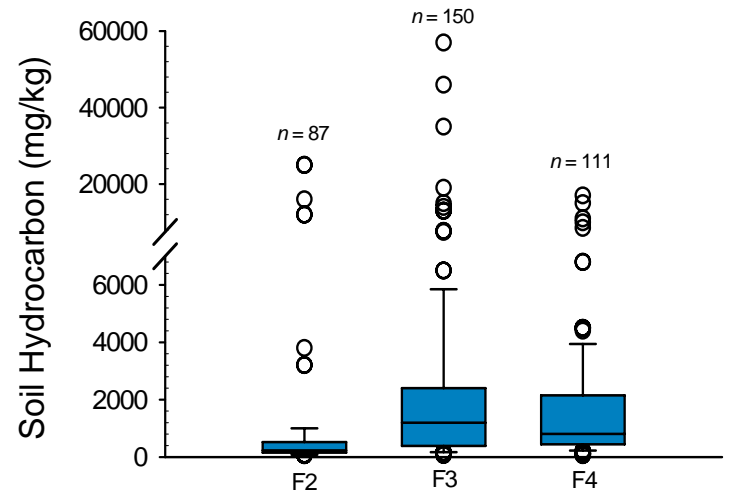
Dealing with Clay Till: Laboratory Soil Amendments

Objective is to improve soil textural and nutrient quality to support earthworm and plant survival.

- High degree of manipulation of original clay soil.
- Are field soil conditions adequately represented?
- Are there reductions in PHC concentrations or bioavailability?

Preliminary Approach (Tier 2 Pass/Fail)
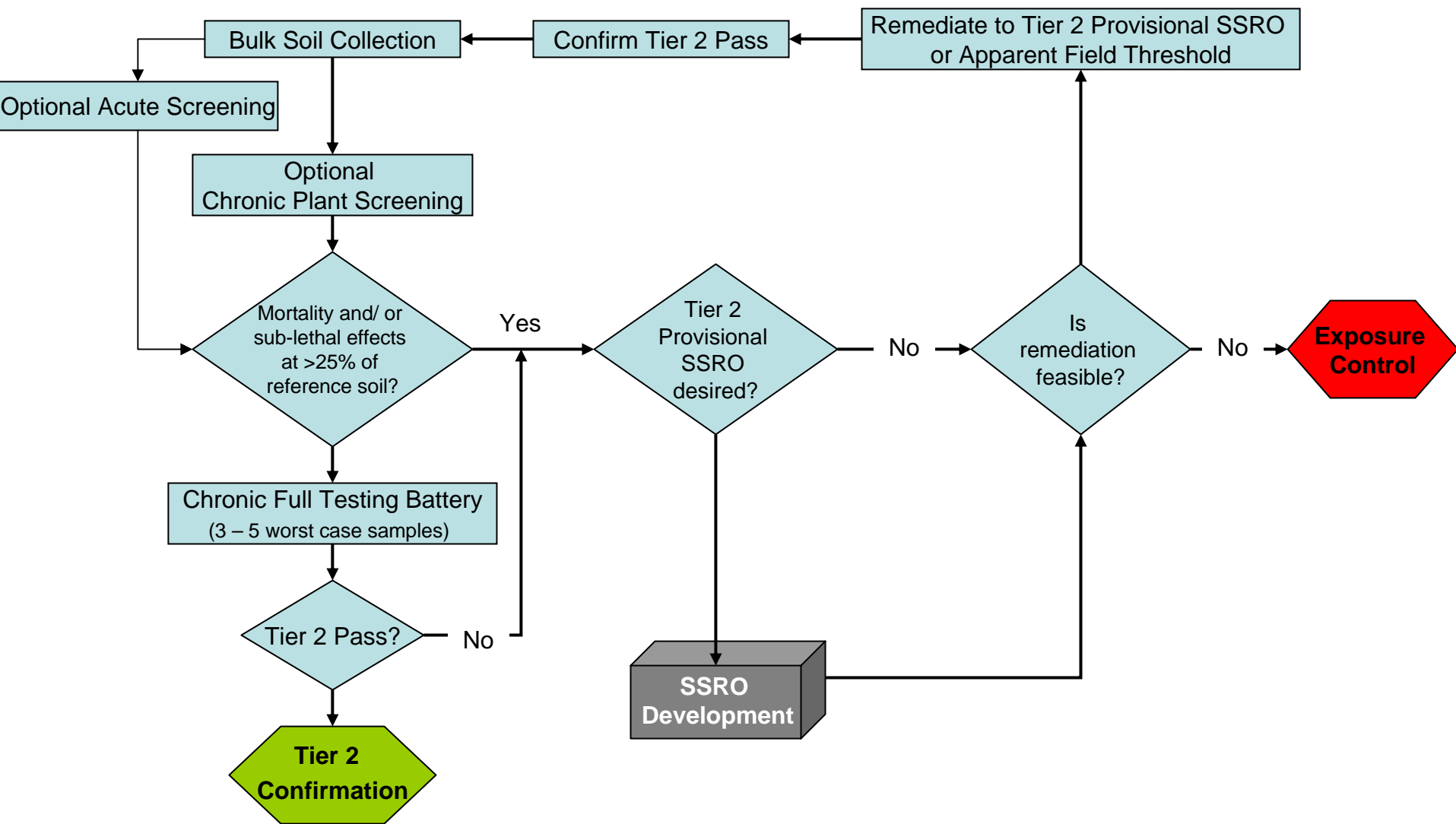
Designing Bulk Soil Collection Program

Sampling Program Rationale
- Target soil that fails Tier 1
  - Worst case soils from land treatment stockpiles.
  - Capture range of field PHC gradient for complex sites.
- Avoid lighter PHC fractions, or mono aromatics, subject to alternate limiting pathways (e.g. groundwater mediated).

Volumes Required
- 8 L plastic pail *minimum* - enabling optimized replicates for a full testing battery on undiluted site samples.

Field Reference Soil
- Match physicochemical characteristics of the contaminated site soil, but be free of contamination
- For *ex-situ* land treated soil:
  - a relatively uncontaminated (within Tier 1) soil which has undergone the same degree of *ex-situ* manipulation; and
  - the natural parent soil, undisturbed and devoid of any contamination.

Suggested Soil Analytical Program

Step 1 – Delineation Samples

- CCME PHC fractions
- Confirm PAH concentrations
- Grain size/ texture
- Organic carbon (especially for peat soil)
- Nutrients
- Other contaminants are confirmed to be absent – metal, salinity

Step 2 – Bulk Toxicity Samples

- CCME PHC fractions (required for all)
- OC, nutrients (optional)
- pH, Conductivity, Moisture Content and Water Holding Capacity (Lab completes on "conditioned" test soil)

Step 3 – Toxicity Samples post-amendment (if required)

- CCME PHC fractions (selection)

Preliminary Chronic Full Testing Battery

Northern wheatgrass and at least one additional plant species tested for:

- emergence success
- root growth endpoints (length and dry biomass)
- shoot growth endpoints (length and dry biomass)

Two chronic soil invertebrates tested for:

- earthworm survival (adult survival)
- earthworm reproduction (mean # juveniles per treatment)
- juvenile growth (mean dry weight of individual live juveniles)

- collembolan survival (adult survival)
- collembolan reproduction (mean # progeny per treatment)

Testing battery can yield a _maximum_ of 11 data points.

DRAFT Definition of Tier 2 Pass

Test results must meet the following criteria -

- Test designs must be capable of detecting a 25% difference;

- Statistical differences between treatment and reference must be < 25% for at least 75 % of endpoints, and

  - No more than one endpoint per test species may exceed the 25 % difference.

- Test organism mortality in treatment soils must be no greater than mortality in reference soils; and

- Invertebrate reproduction in treatment soils must not be less than 50 % of that observed in reference soils.

A **commercial/ industrial Tier 2 pass**
Criteria similar except the permissible difference between reference and treatment endpoint responses is < 50 % (EC50)

Pass or Fail: Individual Sample Failure vs. Overall Concentration – Response Relationship

Native Grass Seed Emergence
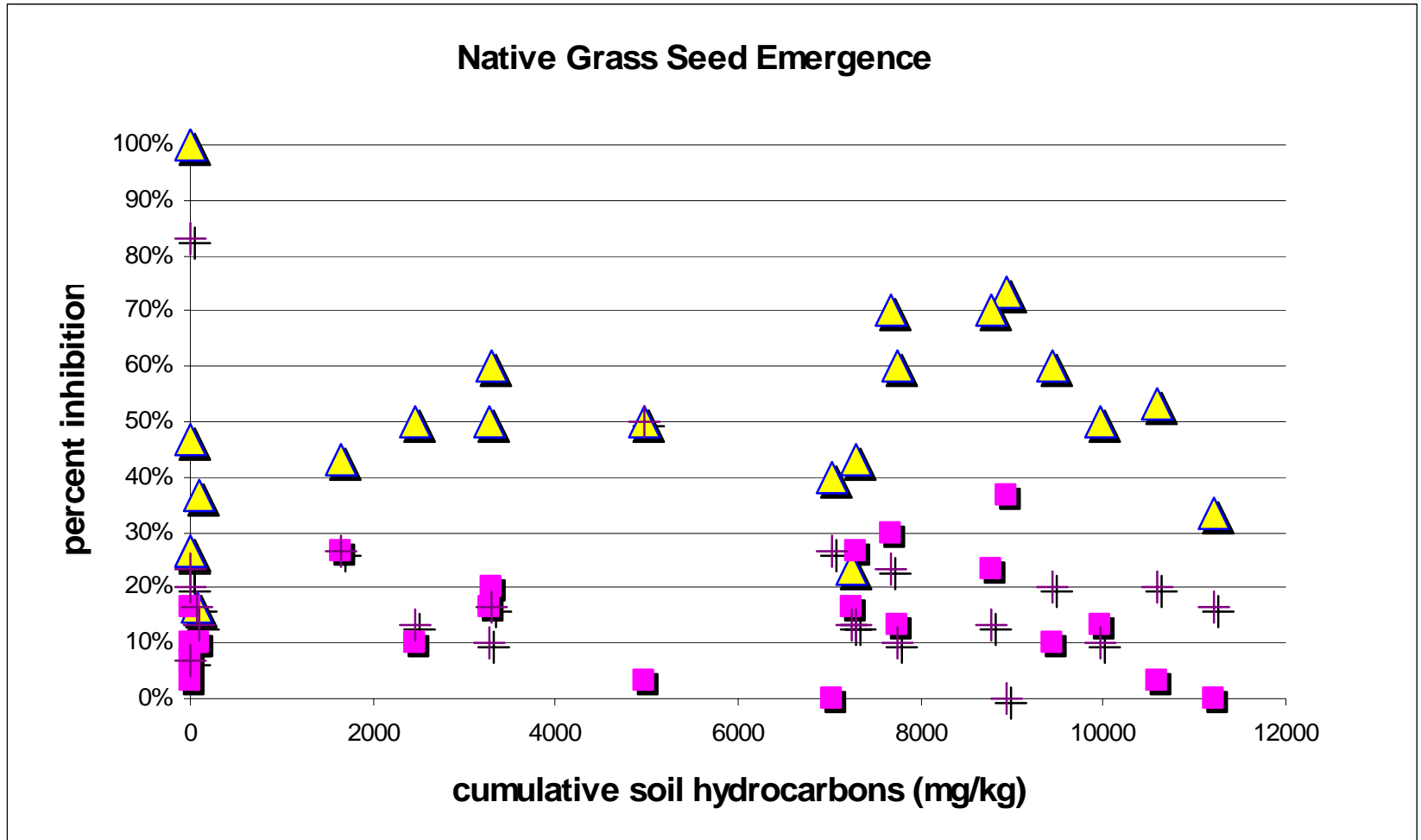
DRAFT Provisional Tier 2 SSRO
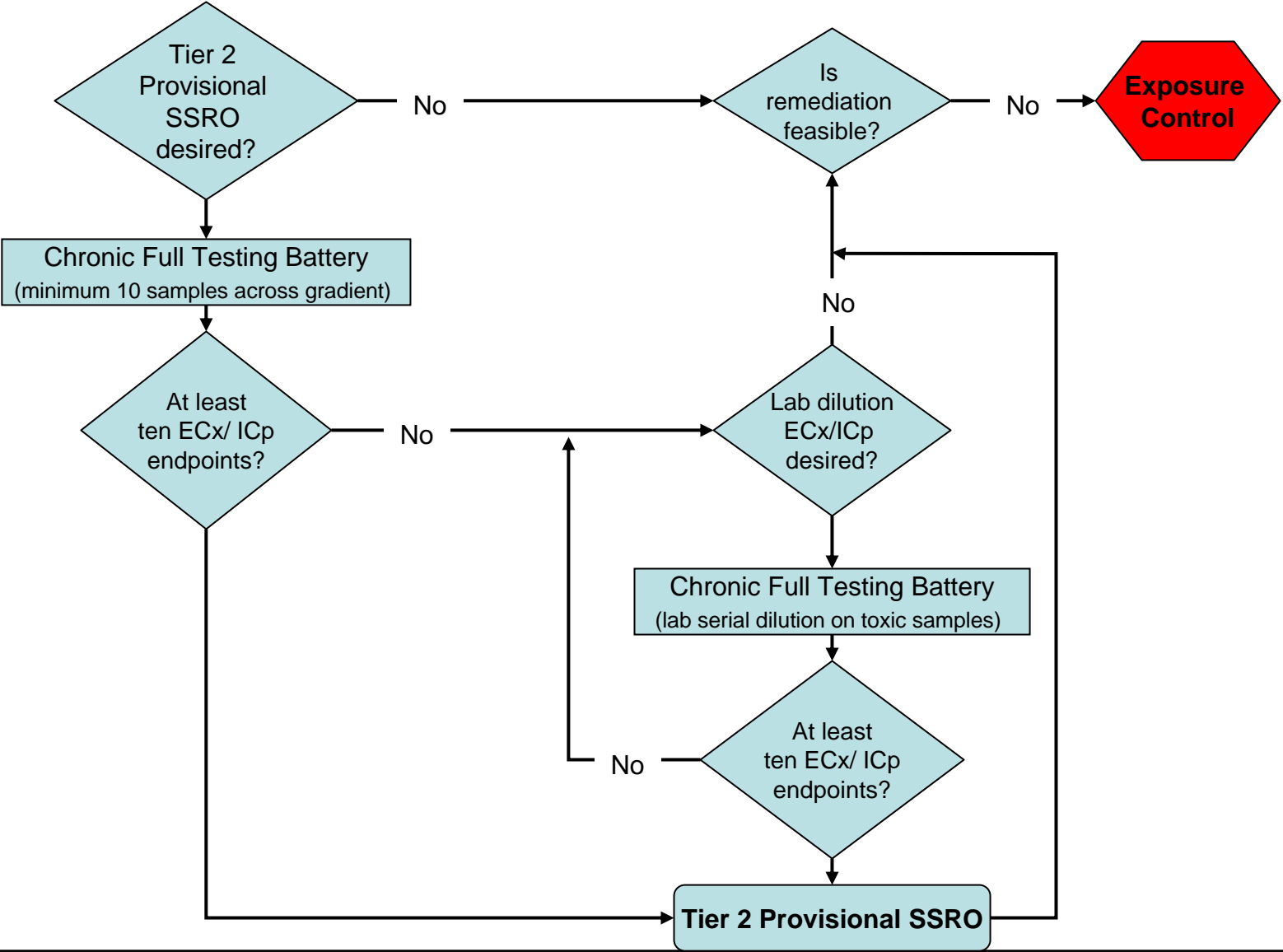
Provisional SSRO Development

CCME (2006) protocols for weight of evidence approach
– Minimum of 10 data points with at least two soil invertebrates and two crop or plant species represented

Estimate threshold effects (ECx/LCx/ICp)
– Establish concentration-response relationship with -
  • undiluted site soils (site gradient)
  • lab serial dilution (dilute toxic samples into multiple treatments)

Use the effects thresholds normalized around 25th percentile to construct an estimated species sensitivity distribution (ESSD)
– ESSD defined as a mathematical probability distribution function, either linear, or non-linear
  • 25th percentile of ESSD (sensitive land use)
  • 50th percentile of ESSD (commercial land use)

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Concentration – Response
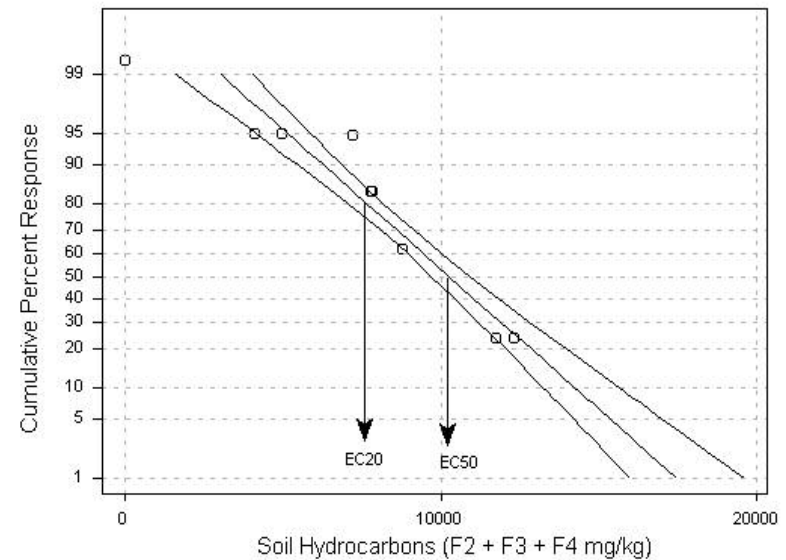# Strong Relationship
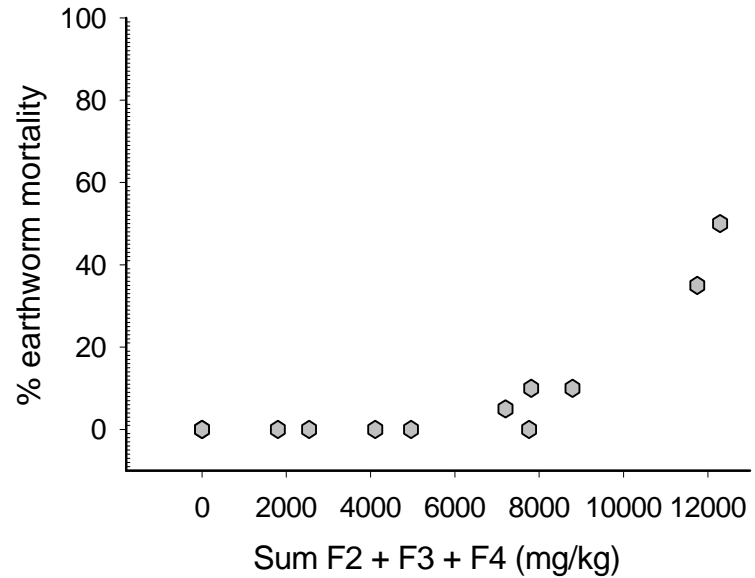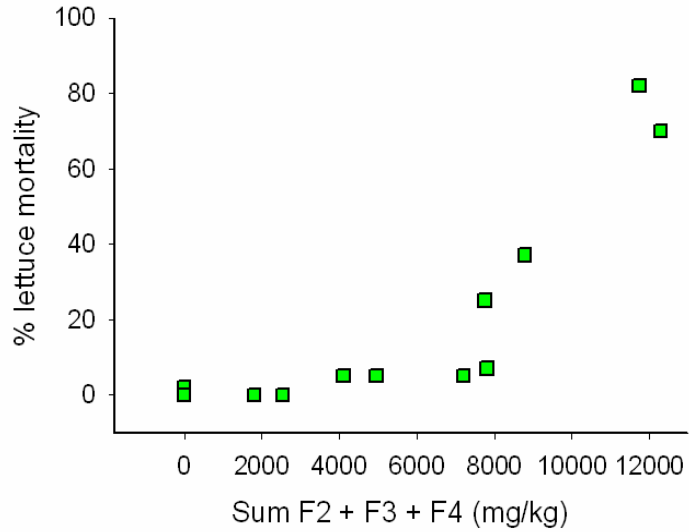
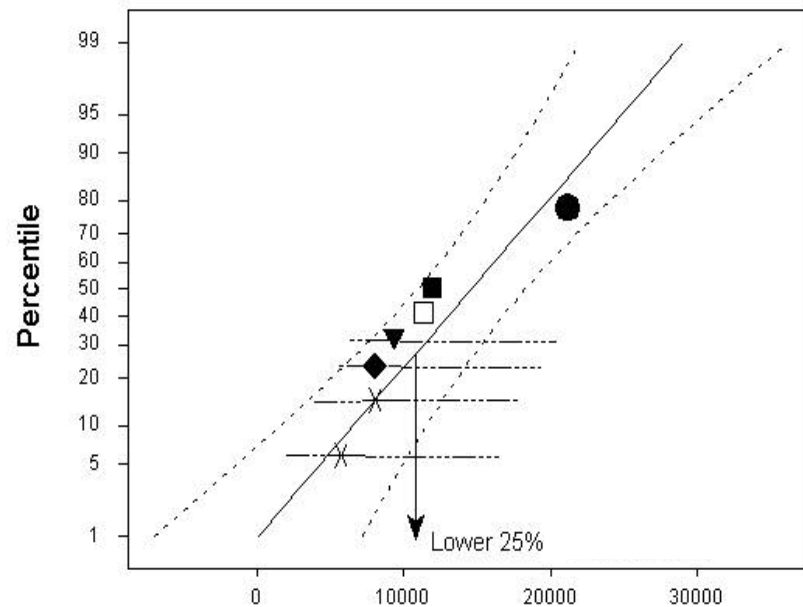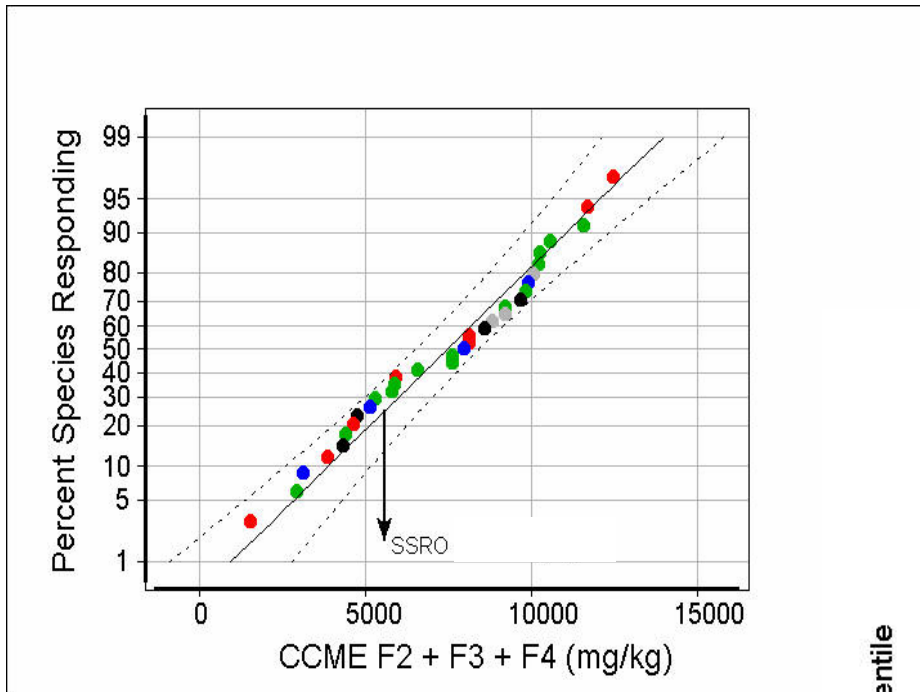# Probit Estimate of ECx/ LCx

Probability Plot for Earthworm Survival
Normal Distribution-95.0% Confidence Intervals
Probit Data
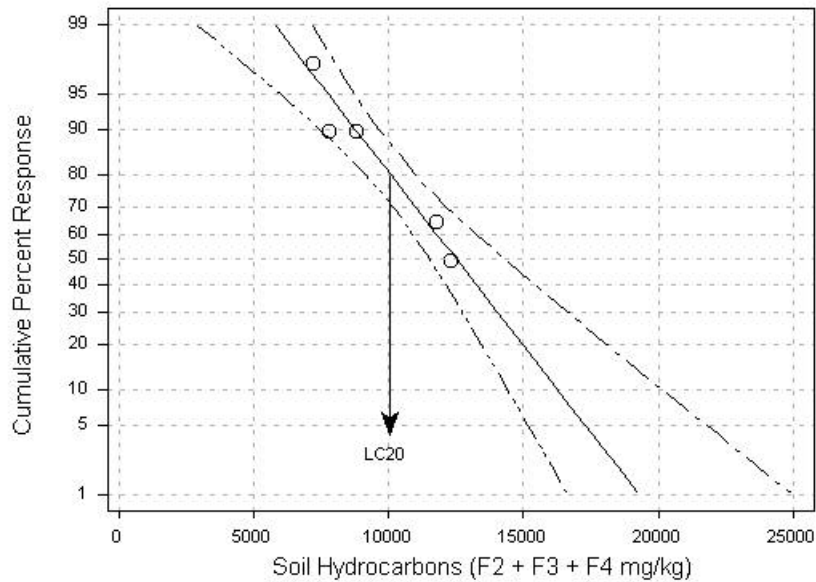
Probability Plot for Lettuce Emergence
Normal Distribution-95.0% Confidence Intervals
Probit Data

Estimated Species Sensitivity Distributions

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