



GUIDING THE REMEDIATION PROCESS: USING ECOTOXICITY FOR DERIVATION OF SITE SPECIFIC SOIL AND GROUNDWATER TARGETS LEVELS

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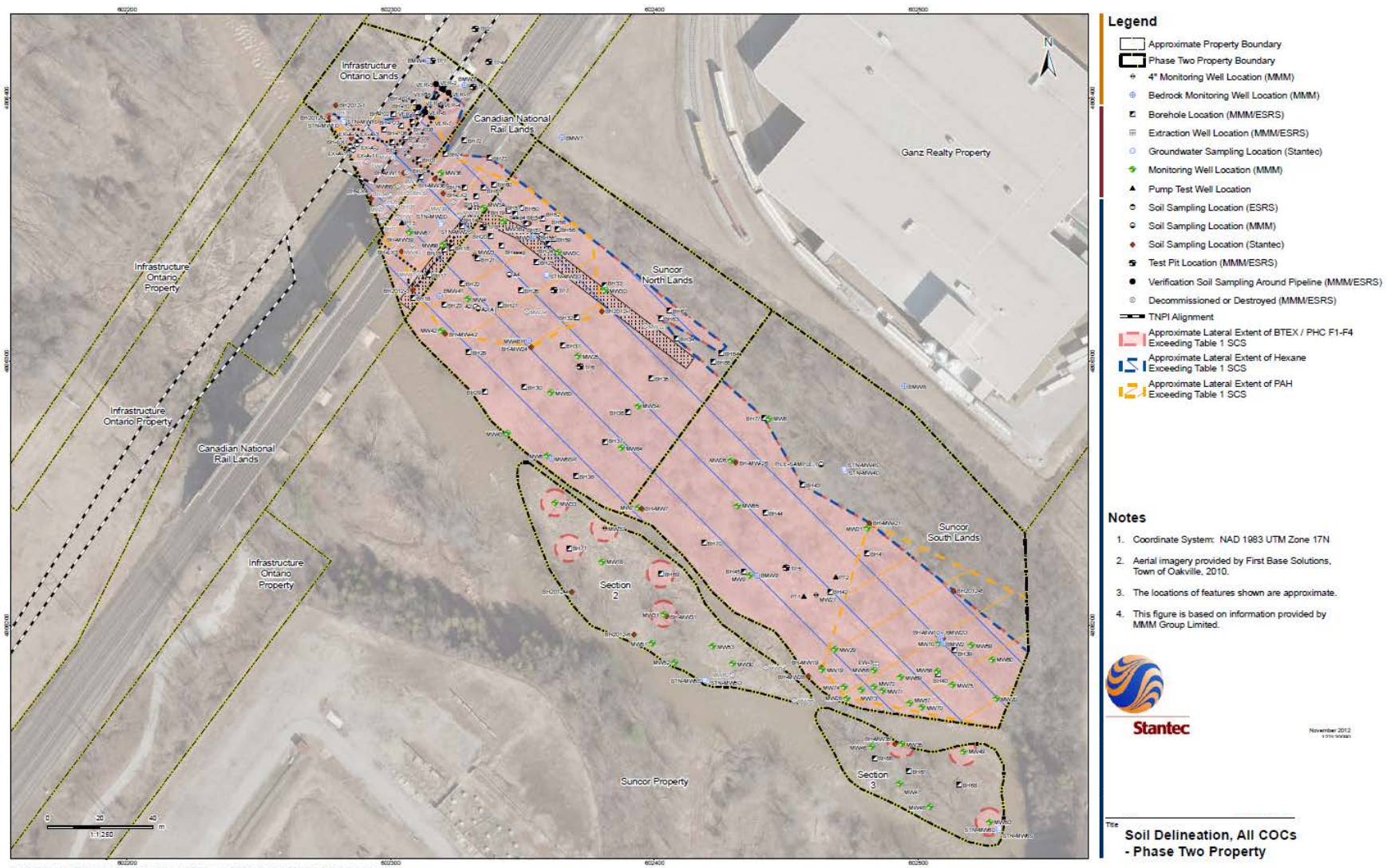
Guiding the Remediation Process

- Background
- Aquatic Toxicity Testing
- Terrestrial Toxicity Testing
- Conclusions

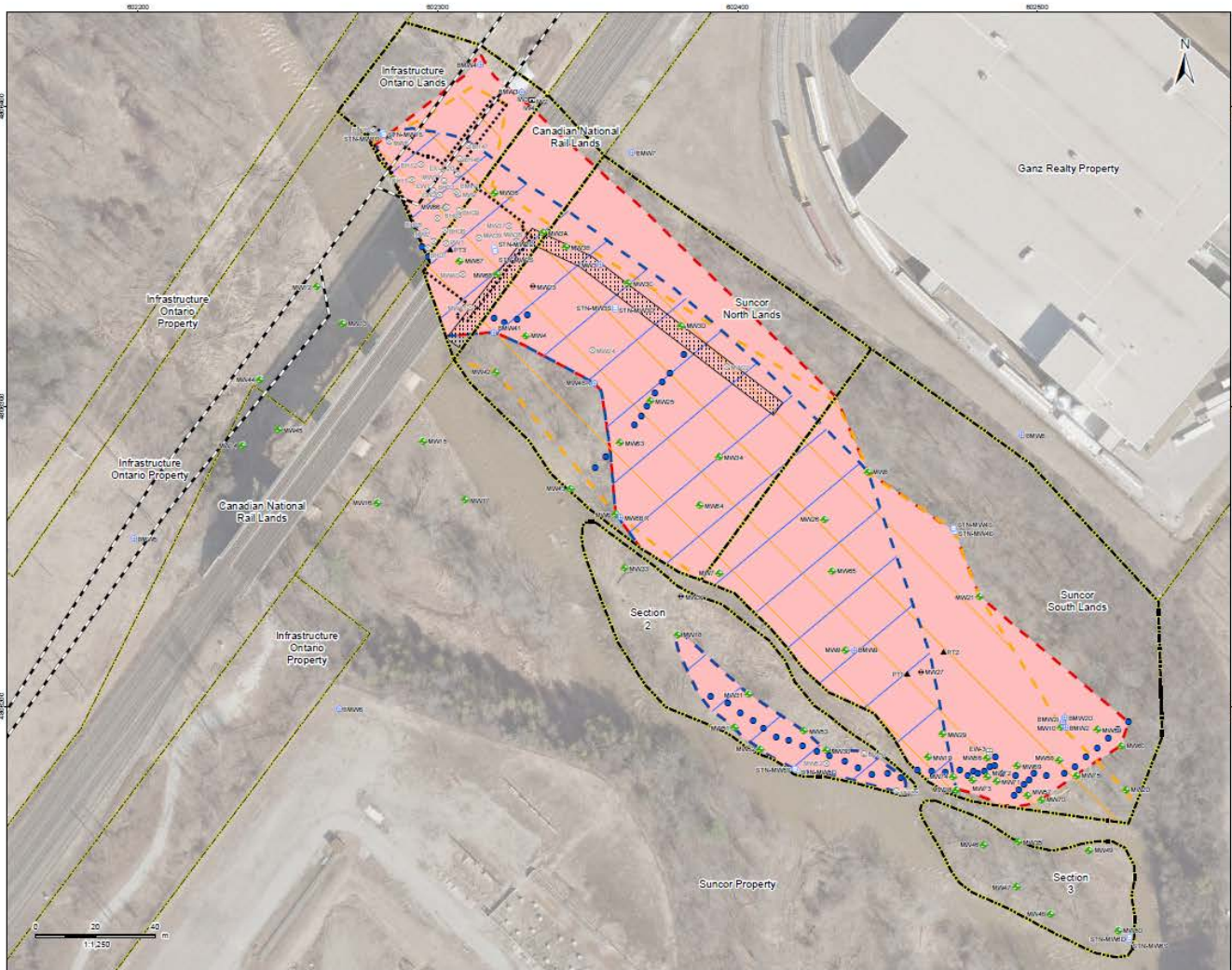
Background

- March 2010 – Notification of PHC release and emergency response; initial drilling investigation
- May 2010 – Operation of groundwater treatment system
- October 2010 – February 2011 Completion of initial excavation
- June 2011 – Commencement of Adaptive Containment Monitoring Plan (ACMP)
- July 2011 – Installation of interceptor drain

Plan view of Estimated Extents of Soil Impacts



Plan view of Estimated Extents of Groundwater Impacts



Legend

- Approximate Property Boundary
- Phase Two Property Boundary
- 4" Monitoring Well Location (MMM)
- Bedrock Monitoring Well Location (MMM)
- Extraction Well Location (MMM/ESRS)
- Groundwater Extraction Well Location (MMM/ESRS)
- Groundwater Sampling Location (Stantec)
- Injection Well
- Monitoring Well Location (MMM)
- Pump Test Well Location
- Decommissioned or Destroyed (MMM/ESRS)
- TNPI Alignment
- Approximate Lateral Extent of BTEX/PHC F1-F4 Exceeding Table 1 SCS
- Approximate Lateral Extent of Hexane Exceeding Table 1 SCS
- Approximate Lateral Extent of PAHs Exceeding Table 1 SCS

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Aerial imagery provided by First Base Solutions, Town of Oakville, 2010.
3. The locations of features shown are approximate.
4. This figure is based on information provided by MMM Group Limited.



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Title
**Groundwater Delineation
- Phase Two Property**

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Revised: 2012-10-28 By: mrs@stantec

Approach

- Community-Based Risk Assessment (CBRA) is currently being conducted
 - Develop Site Specific Target Levels (SSTL) protective of human and ecological receptors potentially exposed to chemicals of concern (CoC) associated with pipeline release
 - Recommend risk management measures (RMM), as necessary



Approach

- CBRA weight of evidence approach:
 - Literature review on Natural Ecosystem Recovery at Spill Sites
 - Aquatic Baseline Study
 - Natural Environment Study
 - **Aquatic Ecotoxicity Testing**
 - **Terrestrial Ecotoxicity Testing**



Aquatic Ecotoxicology Testing Overview

- 1 Objectives
- 2 Test Methods
- 3 Description of Testing and Results
- 4 Conclusions

1 Aquatic Toxicity Objectives

- Support the development of site-specific groundwater quality standards that are protective of the surface water and sediment
- The standard will be based on the cumulative effects of the chemical mixture (PHCs)

2 Aquatic Toxicity Methods

- Test medium was the contaminated on-site groundwater
- The potential toxicity was quantified using a suite of whole-effluent toxicity (WET) tests and a “sediment” toxicity test

2 Aquatic Toxicity Methods

WET Tests



- 96-hour rainbow trout LC50 (EPS 1/RM/13)
- 7-d survival and growth using fathead minnows (EPS 1/RM/22)
- 7-d survival and reproduction using *Ceriodaphnia dubia* (EPS 1/RM/21)

2 Aquatic Toxicity Methods

WET Tests

- 72-h growth inhibition using *Pseudokirchneriella subcapitata* (EPS 1/RM/25)
- Initial studies with single concentrations followed by dilution series



2 “Sediment” Toxicity Method



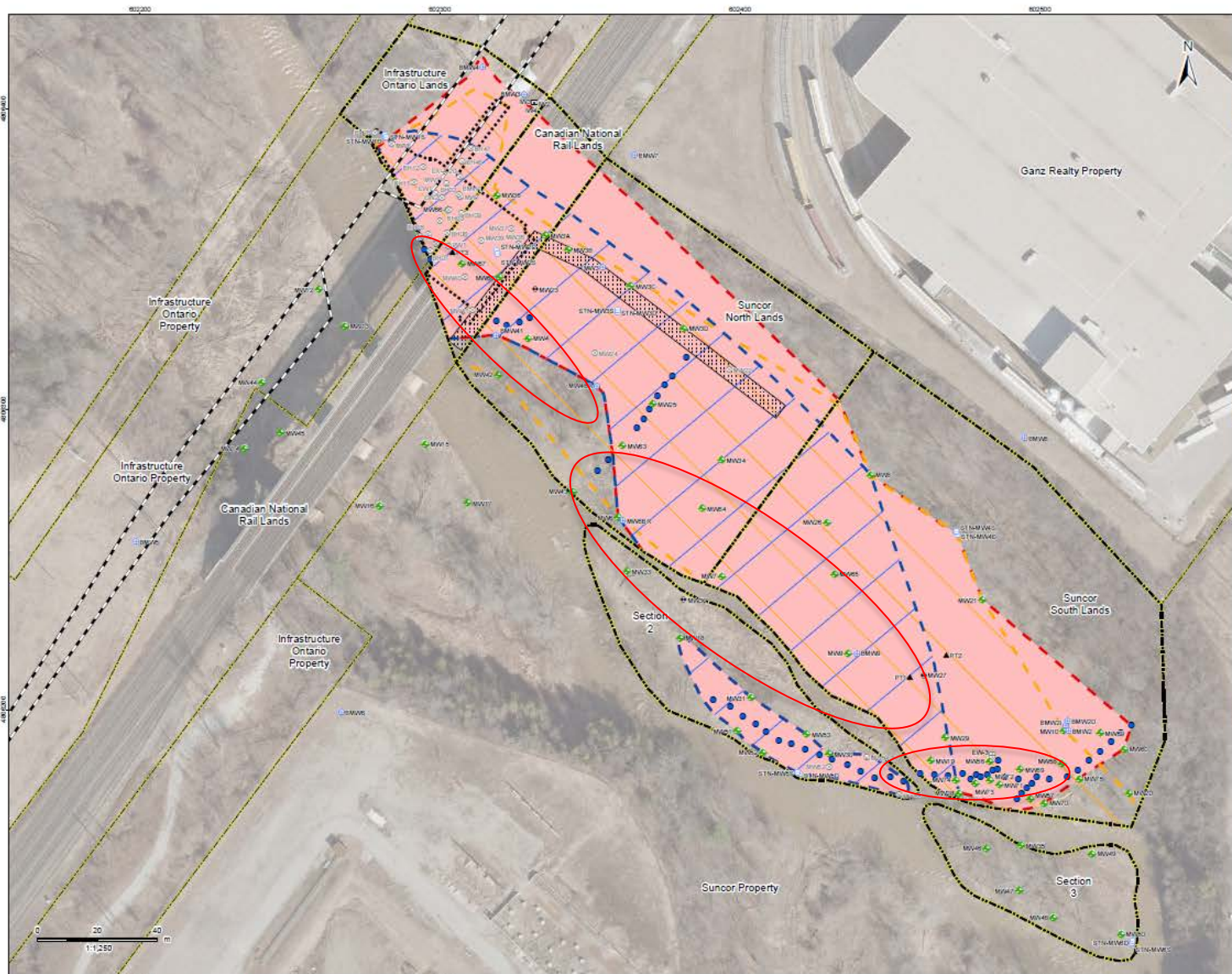
- LC50 water-only tests with *Hyalella azteca* (based on EPS 1/RM/33 with modifications)
- As with the WET studies, initial studies with single concentrations followed by dilution series

3 Aquatic Toxicity Method

Groundwater Exposure

- Representative of the groundwater quality that might enter nearby creek
 - Near-shore monitoring wells representative of a reasonable worse-case
 - Up-gradient of the treatment system

Groundwater Wells Chosen for Aquatic Toxicity Testing



Legend

- Approximate Property Boundary
- Phase Two Property Boundary
- 4" Monitoring Well Location (MMM)
- Bedrock Monitoring Well Location (MMM)
- Extraction Well Location (MMM/ESRS)
- Groundwater Extraction Well Location (MMM/ESRS)
- Groundwater Sampling Location (Stantec)
- Injection Well
- Monitoring Well Location (MMM)
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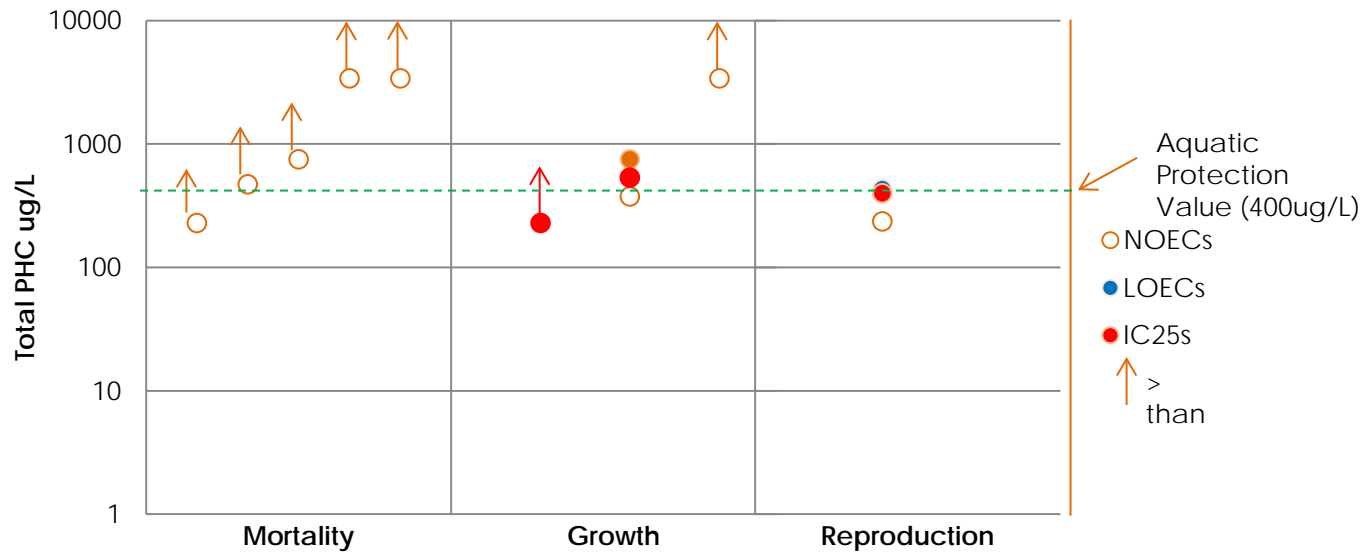


The Groundwater Delineation - Phase Two Property

4 Results

- Single concentration studies showed significant effects at the highest PHC concentrations to the invertebrates
- There was no effect on the rainbow trout
- Algae showed growth stimulation at all concentrations of PHC
- Dilution series studies were run with fathead minnows, *Ceriodaphnia* and *Hyalella* to identify the “safe” concentration or Aquatic Protection Value

Aquatic Protection Value Derivation



Terrestrial Ecotoxicology Testing Overview

- 1 Objectives
- 2 Test Methods
- 3 Description of Testing and Results
- 4 Conclusions

1 Objectives of Ecotoxicological Assessment

1. Target excavation efforts to “hotspots” with concentrations at which adverse effects have been observed under laboratory conditions
2. Identify areas where soil management measures can be recommended to reduce and mitigate any confirmed risks to receptors
3. Quantify the range of toxicological responses using a battery of tests with both soil invertebrate and plant species

2 Test Methods

Test Methods (chronic or definitive):

Environment Canada:

2004 – Report 1/RM/43 (worms)

2005 – Report 1/RM/45 (plants)

2007 – Report 1/RM/47 (springtails)



3 Soil Toxicity Testing

Round 1 Testing

Dilution test performed using 11 concentrations (0% to 100% PHC contaminated soil)

- 28-d springtail survival and reproduction test (*F. candida*)
- 14- and 21-d plant emergence and growth tests (Northern Wheatgrass, Red Clover, Perennial Ryegrass)

3 Soil Toxicity Testing

Round 2 Testing

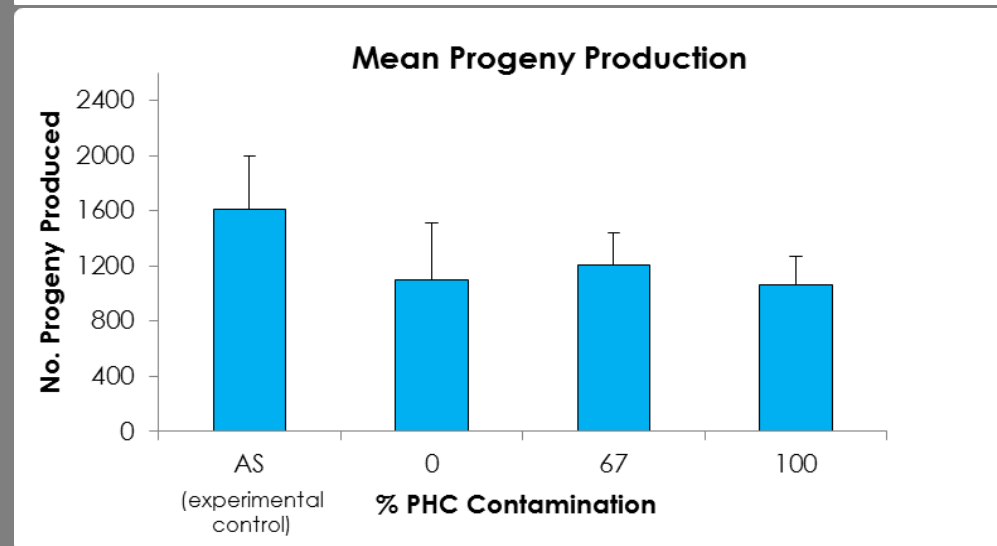
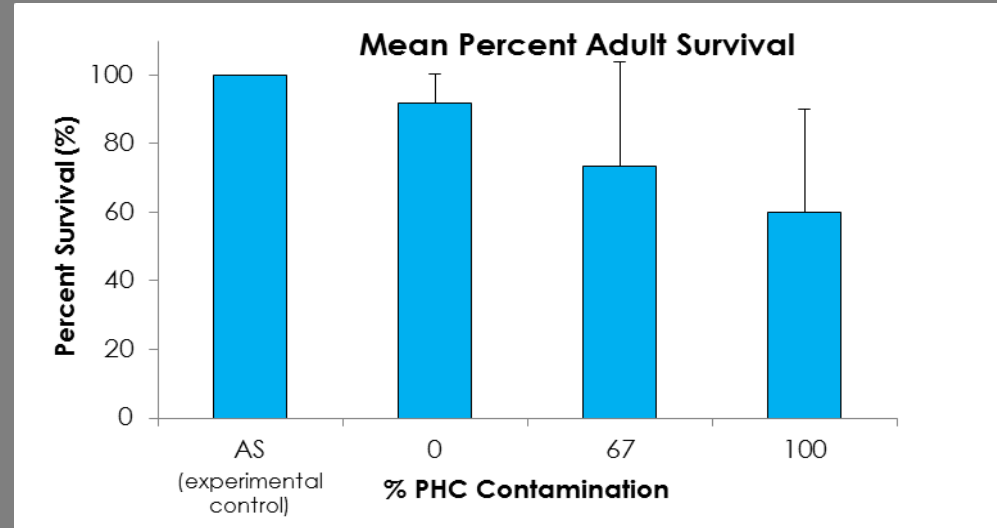
Single concentration test
(maximum PHC contaminated soil collected)

- 63-d earthworm survival and reproduction test (*E. andrei*)
- 28-d springtail survival and reproduction test (*F. candida*)
- 14- and 21-d plant emergence and growth tests
(Northern Wheatgrass, Red Clover, Perennial Ryegrass)

3 Results – Round 1 Testing

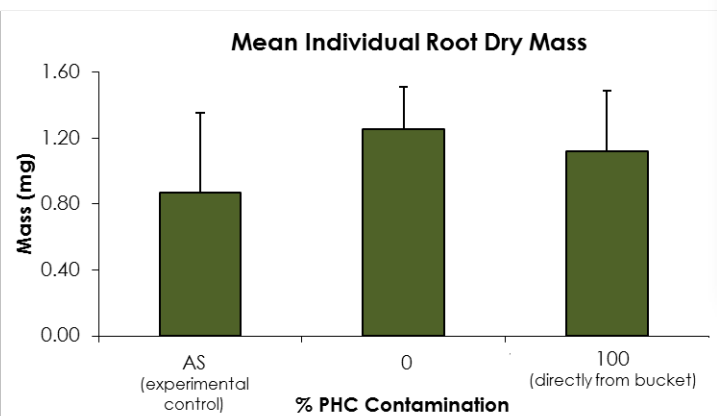
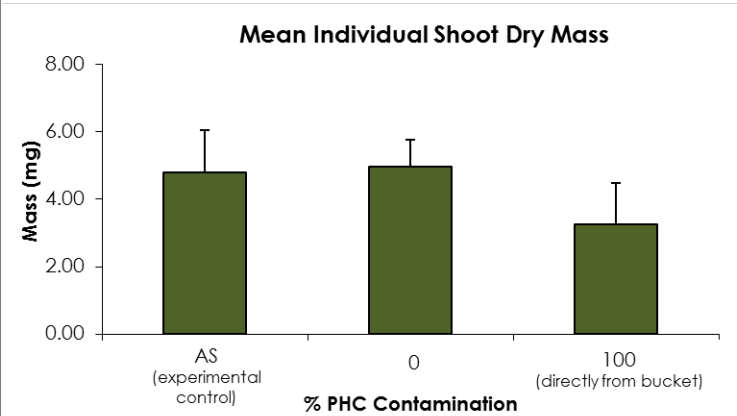
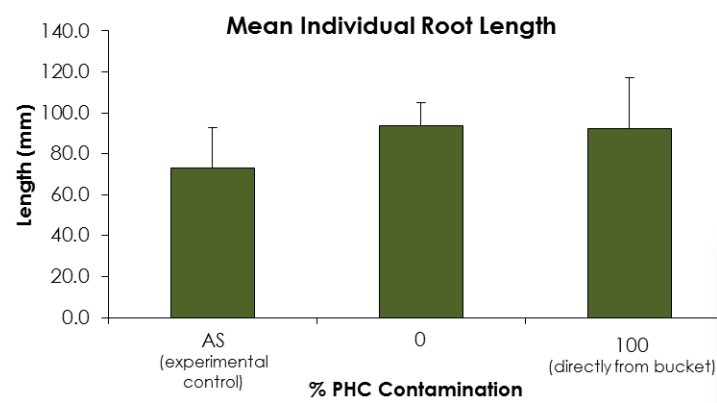
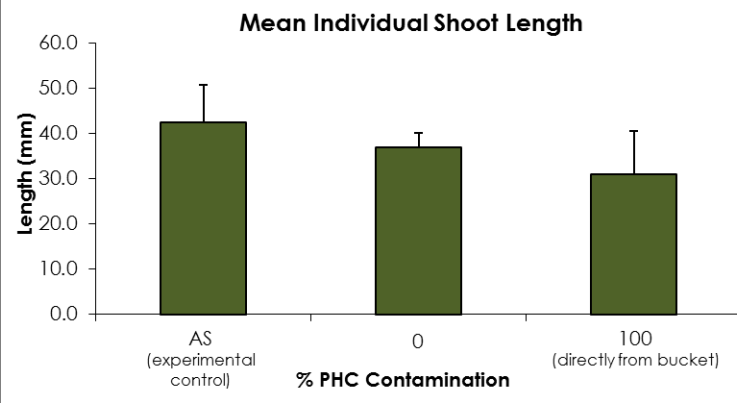
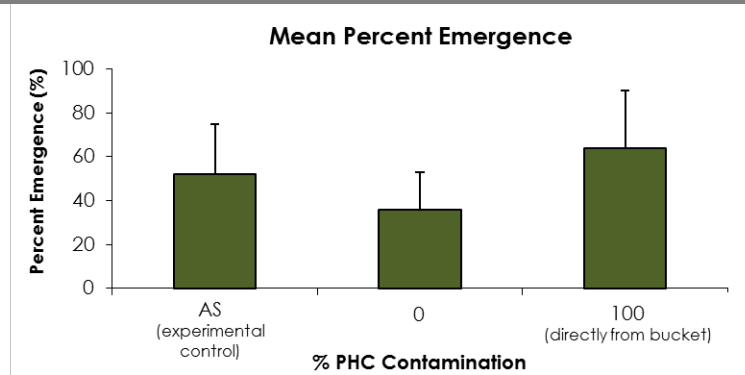
F. candida

- No effects observed for progeny production



3 Results – Round 2 Testing

Red Clover
results
after 14
days of
exposure
to the test
soils



3 Results – Round 1 Testing

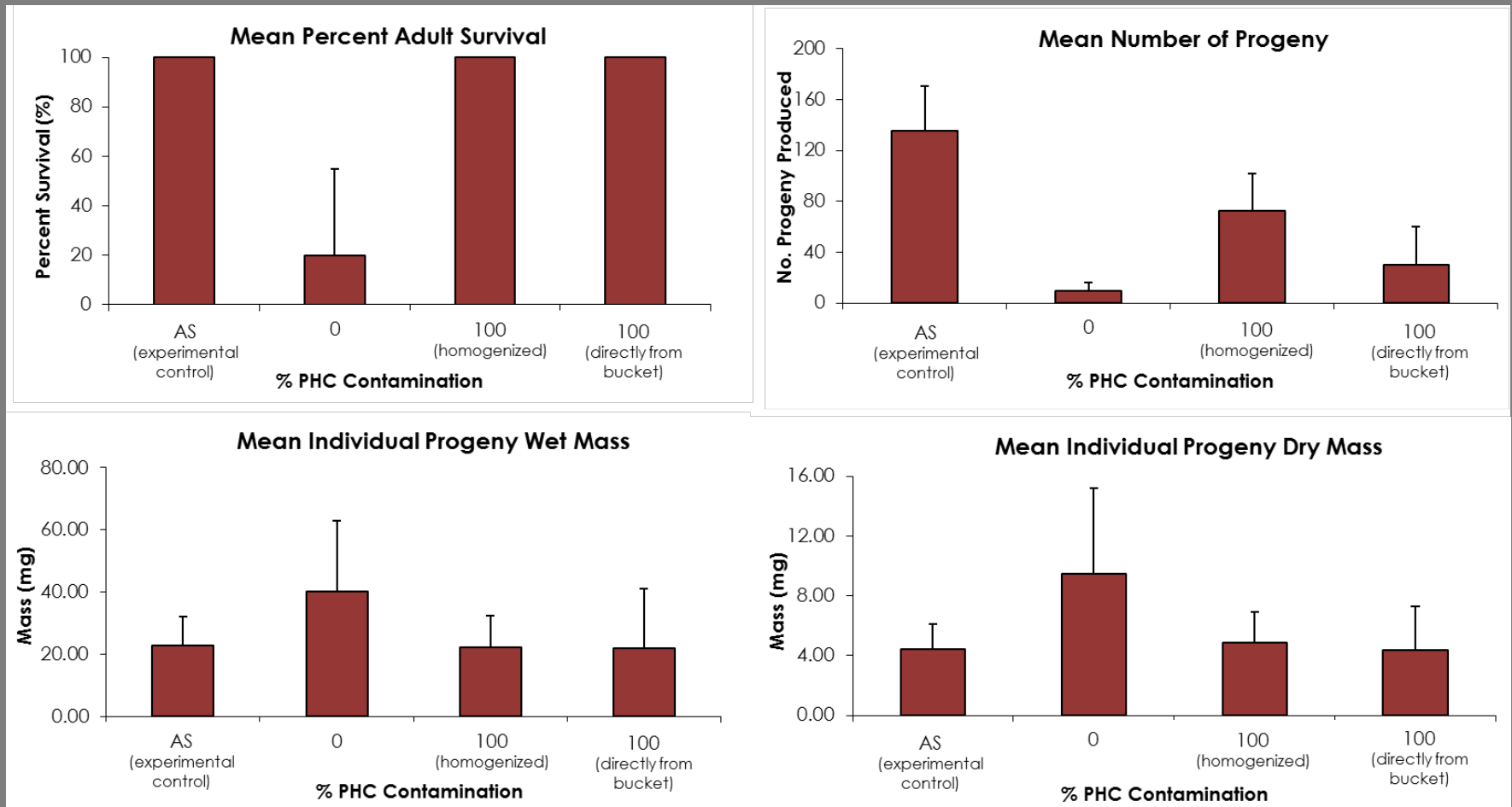
Red Clover

- No effects observed for emergence or root length
- Effects observed for shoot length, shoot and root mass



3 Results – Round 2 Testing

E. andrei



3 Results – Round 2 Testing

Red Clover

- Emergence was low in the control soil for this test
- No effects observed for root length or root mass
- Reduction of shoot length and mass



3 Results – Round 2 Testing

E. andrei

- Adult survival and progeny production was reduced in the control soil (possibly a result of soil texture)
- Wet mass and dry mass of individual progeny were affected



4 Conclusions

- PHC concentrations in test soils were lower than anticipated
- Risk management measures based on these data may be unduly conservative
- Results of terrestrial toxicity tests will be used to generate a species sensitivity distribution for total PHCs
- The species sensitivity distribution can be used to develop risk management measures for the site

Overall Conclusions

- The new aquatic protection value derived from GW exposure allowed the development of a remediation approach that is achievable and protective of the environment
- PHC concentrations in test soils were lower than anticipated, so a multiple endpoint distribution will be investigated
- Consideration for developing a soil management plan that would result in minimal disturbance of the natural environment