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After Showcasing Water Innovation: Updates on Beneficial Reuse of Sediment as a Growing Media

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City of Kitchener

Francine Kelly-Hooper, PhD
CH2M

TRIECA Conference 2016

Presentation Overview

- Showcasing Water Innovation Grant (MOECC)
- Sediment Disposal Options
- Lessons Learned
- Testing 21 SWMFs in Kitchener
- Plant Growth Experiment Results
- Next Steps

It all started with a lake

A study begins

- Undertook an EA to address water quality
- 50,000 tonnes of sediment

Sediment Quality

- Detailed design - tested 17 sediment samples
- Material did not meet Table 1 or Table 2 of O.Reg 153/04

Disposal Considerations

- Normally disposal = contractor
- Stantec & CH2M - proposed Excess Material Plan

The Stars Align

- Disposal site ahead of tender
- Showcasing Water Innovation Grant applications due
- Region of Waterloo – Waste Management Master Plan
- Future SWMF cleanouts

Showcasing Water Innovation

- Testing sediment over 2 years
- Feasibility Study for Soil Campus
  Look into alternative uses

Construction Begins

- 45,000 t sediment & 45,000 t subsoil

Meanwhile at the landfill

After drying more

Sediment Trials

3 Experiments

- 1) Large Windrows
- 2) smaller - +urea & tarped portions
- 3) + compost

- Parameters:
  - PHCs
  - Metals
  - Inorganics
  - PAHs,
  - TOC,
  - TKN, TP, K
  - pH
  - BOD, COD & NOD

Overall Results

- Noticed decreases in PAHs and PHCs but above Table 1 & 2
- Exceedances in boron and SAR & EC
- Nutrient test & compost test – enhanced biological activity
- No re-use found

Soil Campus

- Study was completed by Golder
- Projected est. quantity of material in Region
  - Quality was unknown
- Recommended a soil matching database

Lessons Learned

- Crop advisor input would have helped
- Market demand for soil product
- Risk Assessment
- Takes time

Next Steps for City

- Further Study:
  - Get better understanding of SWMF sediment quality in city
  - Explore beneficial reuse
  - 21 SWMFs – residential + full of sediment
- Retained CH2M
  - experience + previous progress on pilots

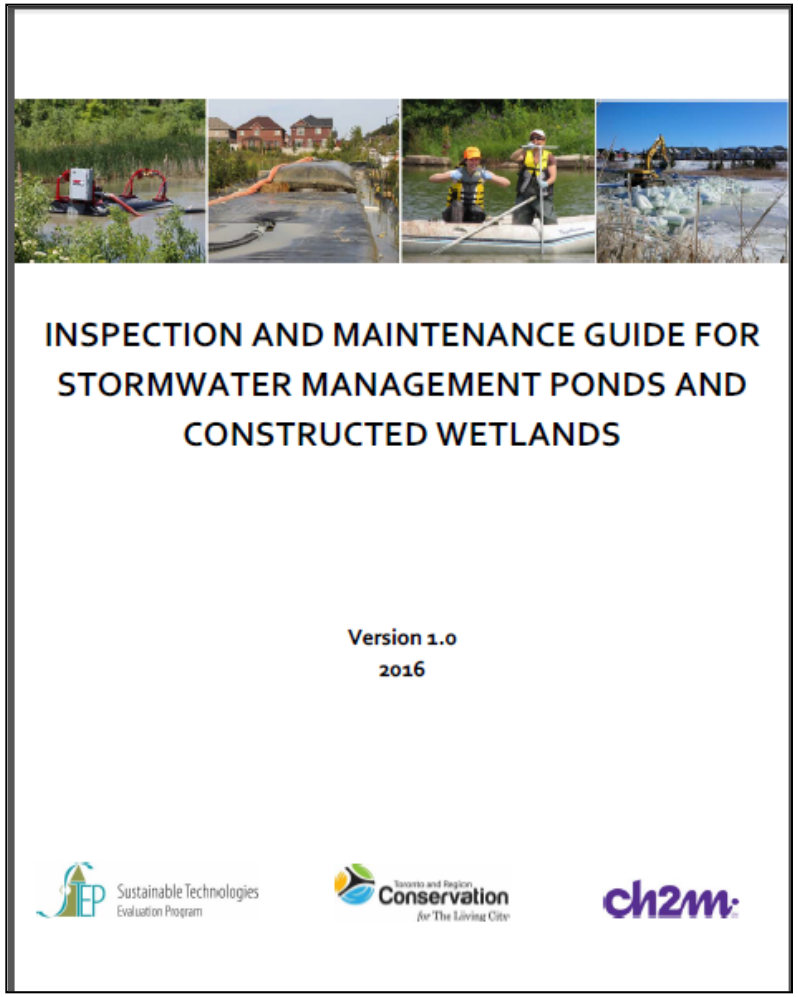
SWMF Sediment Plant Growth Greenhouse Experiments

Cities of Kitchener and Waterloo

Presented by: Francine Kelly-Hooper, PhD

Potential Beneficial Use as Roadside Topsoil Amendment Materials

Ontario SWMF Sediment Beneficial Use Regulatory Framework Discussion – Excess Soils BMP Approach



Excess Soil Risk Management Evaluation
Waste Disposal versus Beneficial Use

Question #1: Does the sediment pass O. Reg. 153/04 Table 1 (background) soil standards?

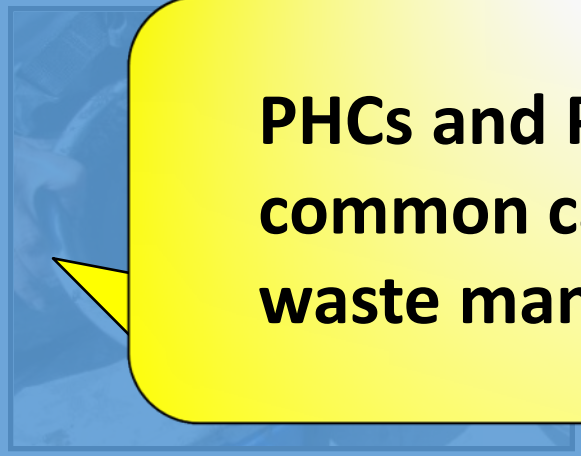
2005-2015 Residential Sediment Quality Survey Findings

Most Common Exceedences of O.Reg.153/04 Soil Standards

Almost all SWMF sediments triggered regulated waste management requirements

icipal
153/04

- 98% of F3 PHCs exceeded Table 1



PHCs and PAHs were the most common causes of regulated waste management requirements

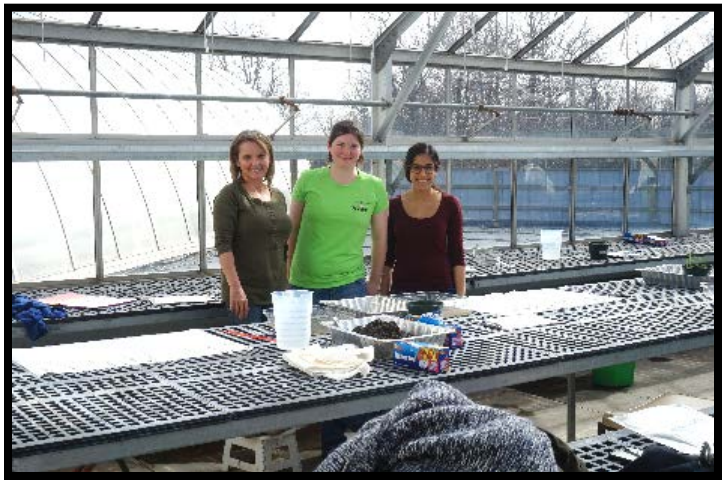
2 & 3

exceeded Tables 2 & 3

SWMF Sediment Plant Growth Experiments

21-Day Growth Periods

- #1 – Victoria Park Lake
- #2 – SWMF Wetland 46



- #3 – Silver Lake
- #4 – SWMF Wetland 53

Plant Growth Experiment Objective

To determine if turf grass species would successfully grow in SWMF sediments with contaminant levels that exceeded one or more of the following O.Reg. 153/04 Table 1, 2, 3 soil standards:

- Polyaromatic Hydrocarbons (PAHs) – **naturally biodegradable**
- Petroleum Hydrocarbons (PHCs) – **naturally biodegradable**
- Sodium Adsorption Ratio (SAR) road salt – **can be reduced by gypsum rinses**

*Samples with elevated trace metals concentrations were excluded due to land application bioaccumulation risks.

Sediment + Compost

= Topsoil Cost Savings

SWMF Sediment Plant Growth Experiments

- SWMF Selection Criteria -

All four SWMFs met the following sediment quality selection criteria for typical exceedences of O.Reg. 153/04 Tables 1, 2 and 3 soil standards:

1) No exceedences of Table 1 trace metal soil standards;

2) All SWMFs exceeded Table 1 F3 PHC soil standards;

3) All SWMFs exceeded Table 2&3 PAH soil standards; and

4) SAR – Only Silver Lake and Wetland 53 exceeded all SAR standards, but levels were sufficiently reduced by gypsum treatments

21-Day Plant Growth Experiment Designs

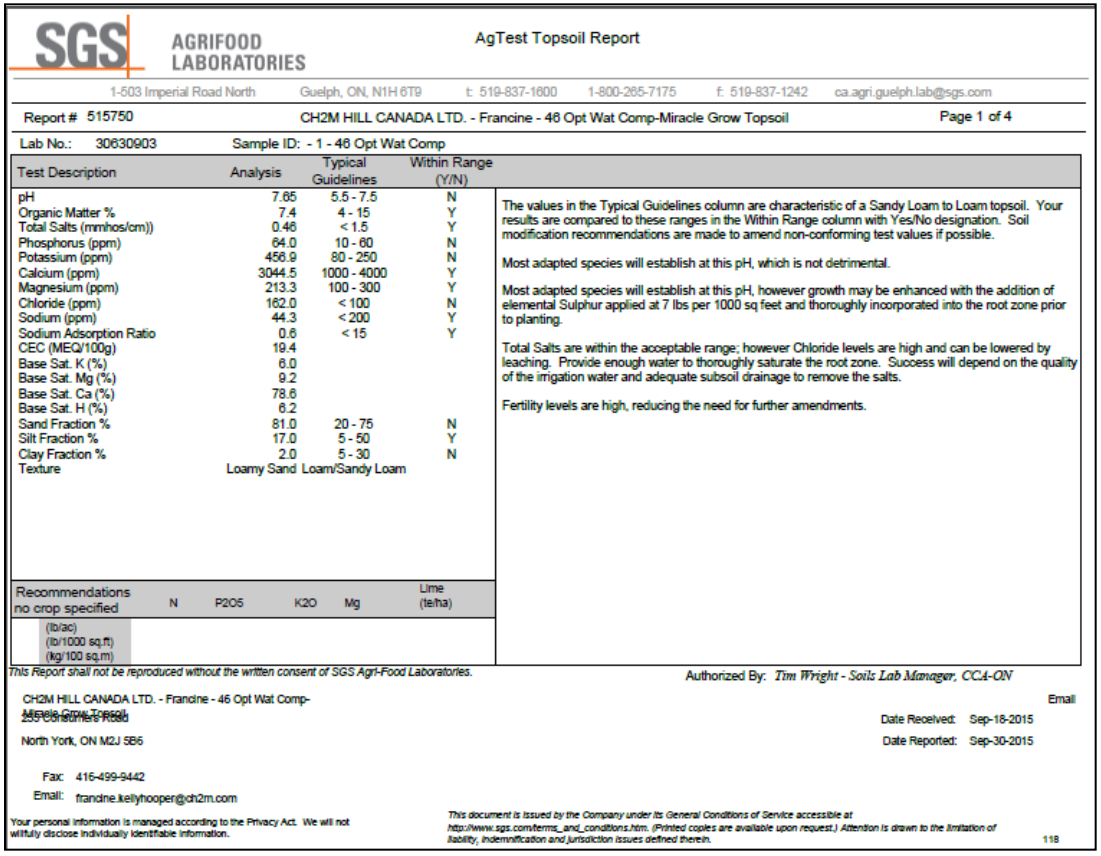
Kitchener Treatments	• 20 fescue + ryegrass seeds/pot • 5 replicates/treatment
(1) Control – Miracle Grow Soil	
(2) VP Lake Sediment + Wood Chips	
(3) Wetland 46 Sediment + Compost	
(4) Wetland 46 Sediment (No Compost)	

Waterloo Treatments	• 10 fescue seeds/pot • 3 replicates/ treatment	• 10 ryegrass seeds/pot • 3 replicates/ treatment
(1) Control – Miracle Grow Soil		
(2) Silver Lake Sediment + Compost		
(3) Wetland 53 Sediment + Compost		

Laboratory Topsoil Report

Jack Legg, Certified Crop Advisor provided compost mixing ratio recommendations

This topsoil amendment beneficial use approach was developed through several years of discussions between Jack Legg (SGS AgriFood), Dale McComb (OMAFRA) and Francine Kelly-Hooper (CH2M)



SGS AGRIFOOD LABORATORIES

AgTest Topsoil Report

1-503 Imperial Road North Guelph, ON, N1H 6T9 t: 519-837-1600 1-800-265-7175 f: 519-837-1242 ca.agri.guelph.lab@sgs.com

Report # 515750 CH2M HILL CANADA LTD. - Francine - 46 Opt Wat Comp-Miracle Grow Topsoil Page 1 of 4

Lab No.: 30630903 Sample ID: - 1 - 46 Opt Wat Comp

Test Description	Analysis	Typical Guidelines	Within Range (Y/N)
pH	7.65	5.5 - 7.5	N
Organic Matter %	7.4	4 - 15	Y
Total Salts (mmhos/cm))	0.46	< 1.5	Y
Phosphorus (ppm)	64.0	10 - 60	N
Potassium (ppm)	456.9	80 - 250	N
Calcium (ppm)	3044.5	1000 - 4000	Y
Magnesium (ppm)	213.3	100 - 300	Y
Chloride (ppm)	162.0	< 100	N
Sodium (ppm)	44.3	< 200	Y
Sodium Adsorption Ratio	0.6	< 15	Y
CEC (MEQ/100g)	19.4		
Base Sat. K (%)	6.0		
Base Sat. Mg (%)	9.2		
Base Sat. Ca (%)	78.6		
Base Sat. H (%)	6.2		
Sand Fraction %	81.0	20 - 75	N
Silt Fraction %	17.0	5 - 50	Y
Clay Fraction %	2.0	5 - 30	N
Texture	Loamy Sand	Loam/Sandy Loam	

The values in the Typical Guidelines column are characteristic of a Sandy Loam to Loam topsoil. Your results are compared to these ranges in the Within Range column with Yes/No designation. Soil modification recommendations are made to amend non-conforming test values if possible.

Most adapted species will establish at this pH, which is not detrimental.

Most adapted species will establish at this pH, however growth may be enhanced with the addition of elemental Sulphur applied at 7 lbs per 1000 sq feet and thoroughly incorporated into the root zone prior to planting.

Total Salts are within the acceptable range; however Chloride levels are high and can be lowered by leaching. Provide enough water to thoroughly saturate the root zone. Success will depend on the quality of the irrigation water and adequate subsoil drainage to remove the salts.

Fertility levels are high, reducing the need for further amendments.

Recommendations no crop specified	N	P2O5	K2O	Mg	Lime (te/ha)
(lb/ac) (lb/1000 sq.ft) (kg/100 sq.m)					

Authorized By: *Tim Wright - Soils Lab Manager, CCA-ON*

CH2M HILL CANADA LTD. - Francine - 46 Opt Wat Comp-
Miracle Grow Topsoil
225 Consumers Road
North York, ON M2J 5B6

Fax: 416-499-9442
Email: francine.kellyhooper@ch2m.com

Email

Date Received: Sep-18-2015
Date Reported: Sep-30-2015

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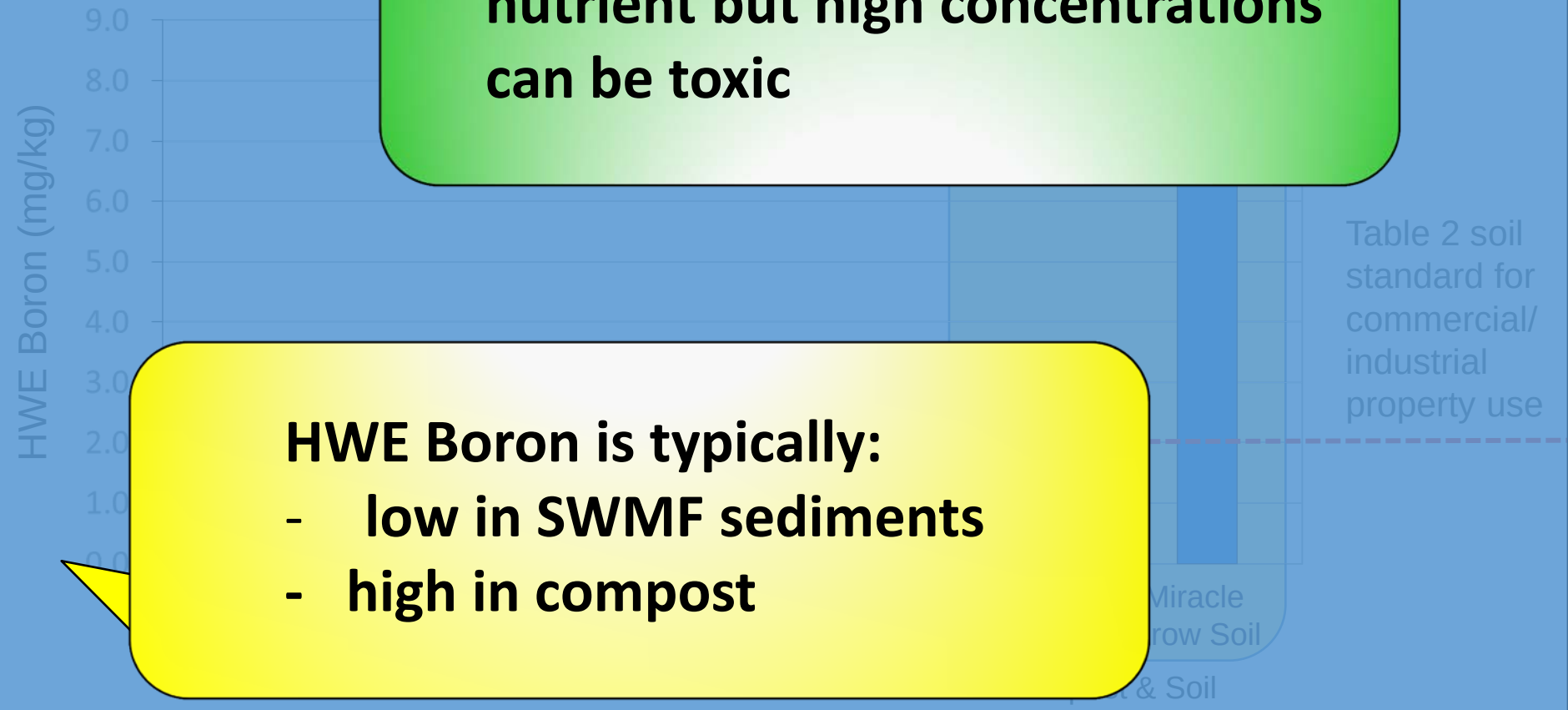
Boron (hot water extractable) Concentrations for Unmixed Sediment, Compost and Potting Soil



Boron is an essential plant nutrient but high concentrations can be toxic

HWE Boron is typically:

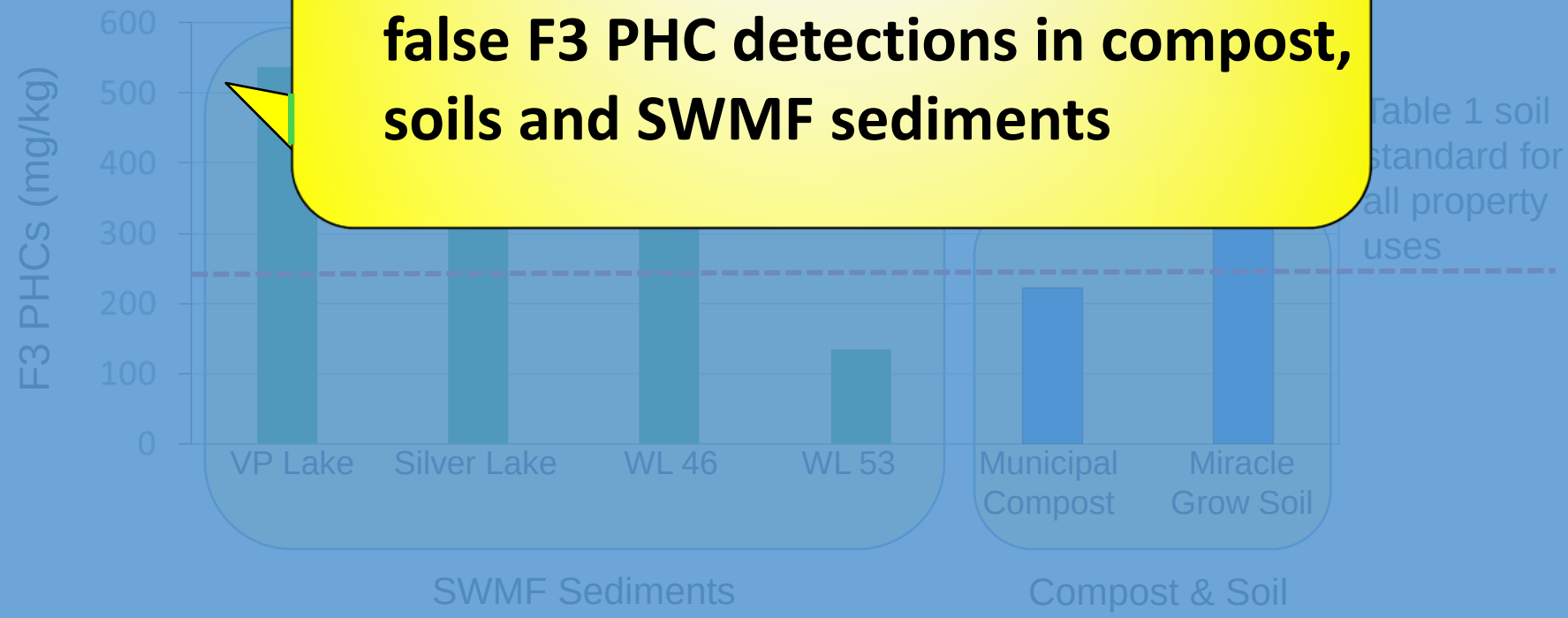
- **low in SWMF sediments**
- **high in compost**

F3 Petroleum Hydrocarbon Concentrations for Unmixed Sediment, Compost and Potting Soil

Asphalt & tar are main sources of F3 PHCs

FALSE PHC detections in clean compost and soil

Natural organic matter can cause false F3 PHC detections in compost, soils and SWMF sediments

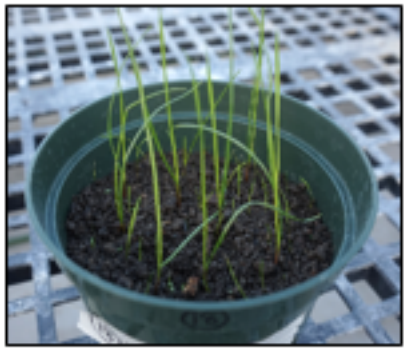


21-Day Plant Growth Results

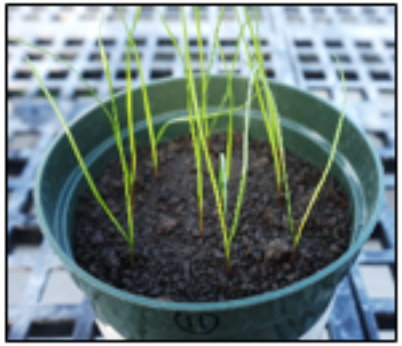
Control - Miracle Grow Soil

Victoria Park Lake Sediment + Compost

Silver Lake Sediment + Compost

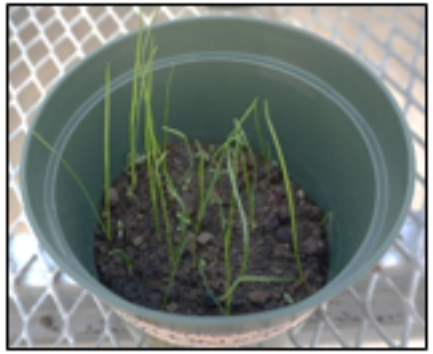


SWM Wetland 53 Sediment + Compost

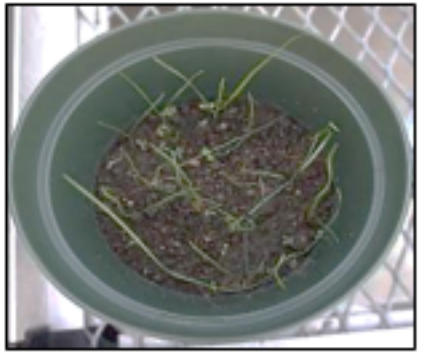


SWM Wetland 46

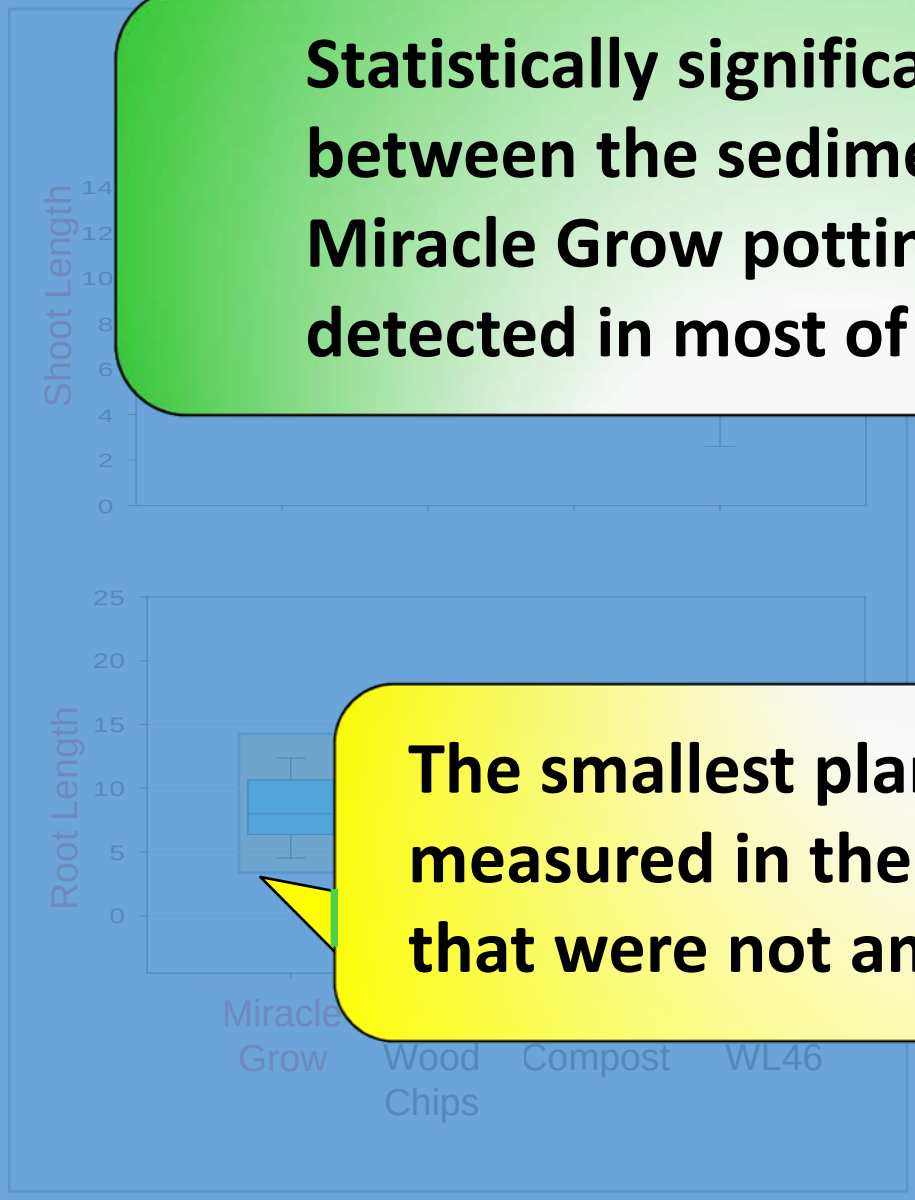
Sediment + Compost

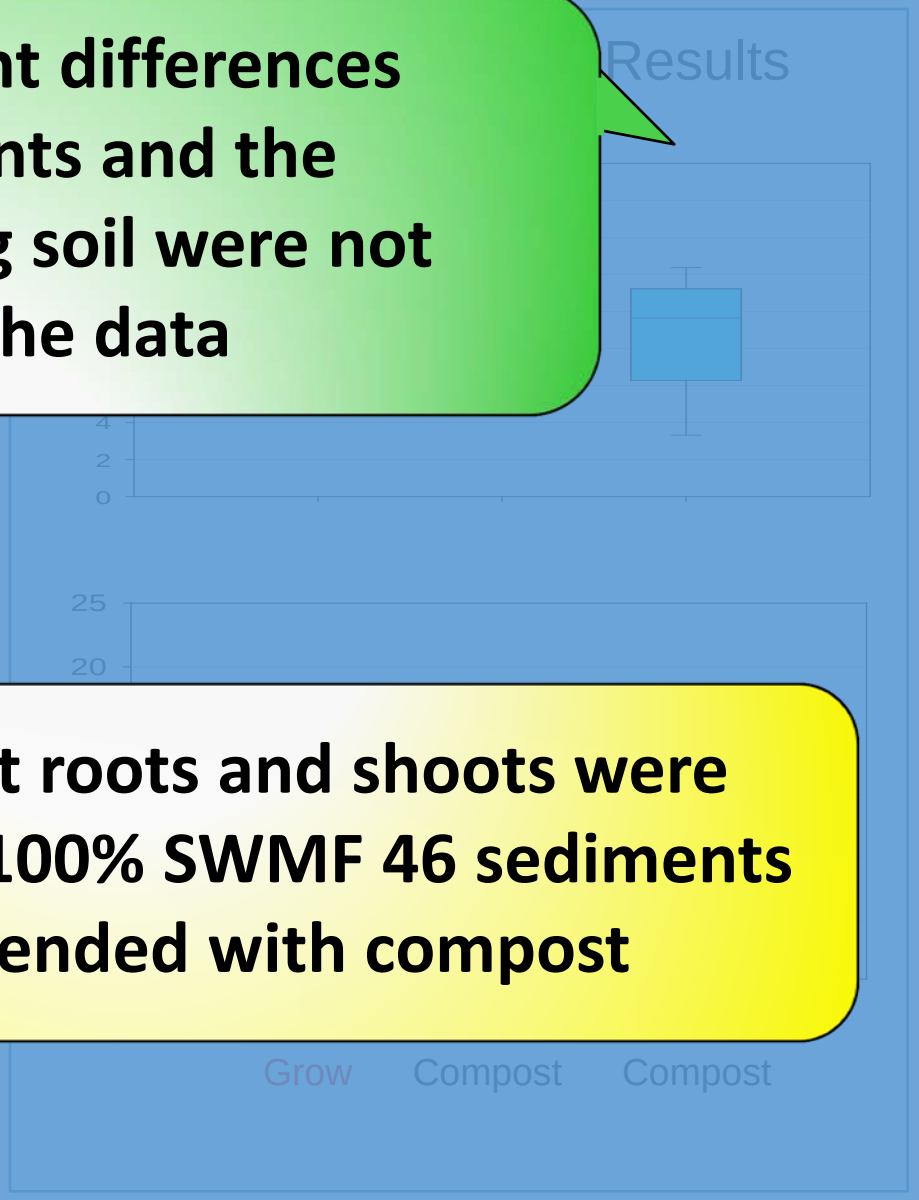


100% Sediment



Plant Shoot and Root Lengths



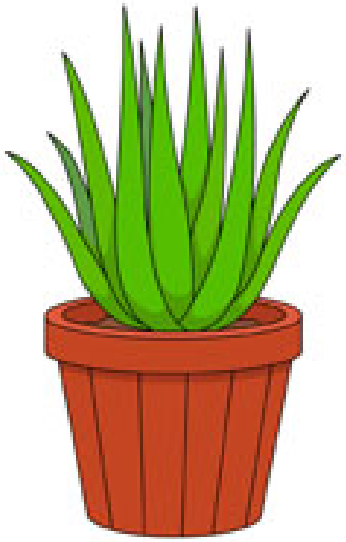


Statistically significant differences between the sediments and the Miracle Grow potting soil were not detected in most of the data

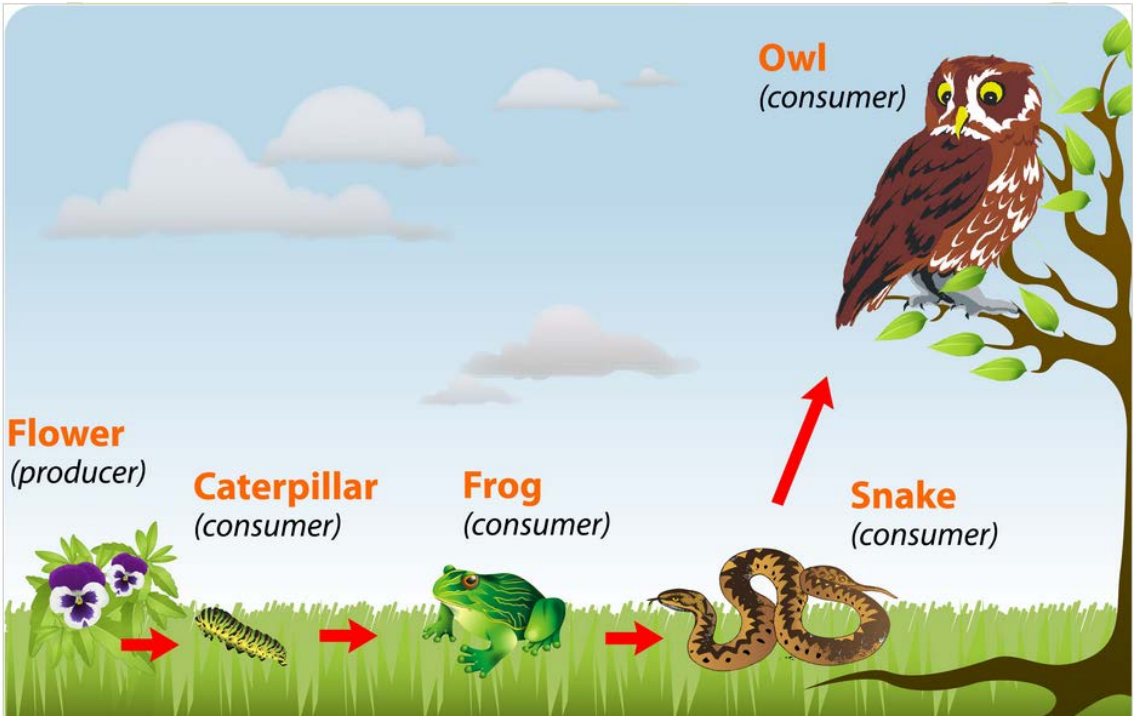
The smallest plant roots and shoots were measured in the 100% SWMF 46 sediments that were not amended with compost

Bottom Line?

Sediments were non-toxic to the test plants



But what about food chain transfer risks?

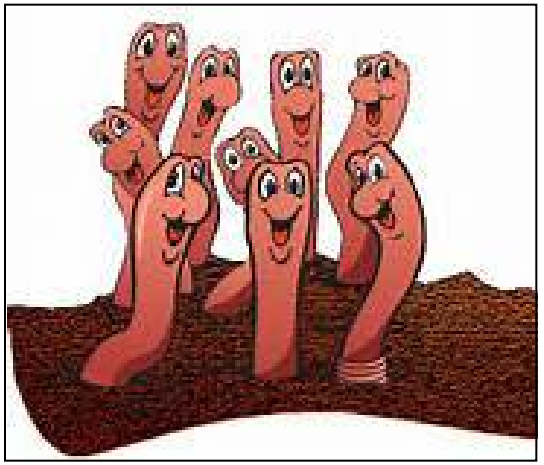


The Sediment PAHs & PHCs Have Very Low Water Solubility

Lower Uptake Risk for Plants

Plant roots absorb very little PAHs or PHCs

Higher Uptake Risk for Soil Organisms



Earthworms and other organisms consume soils along with adsorbed PAHs and PHCs

Next Steps?

- Update MOECC and OMAFRA on plant growth test results
- Expand benchscale plant growth tests to larger field trials
- Possible invertebrate benchscale studies

Thank You

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