



# **Mobility of Relict **As** and **Pb** in a Wyoming Orchard Soil**

**Philip Lavallee Jr**

**EPSCoR 2013 Undergraduate Research Day**

**Brandon Reynolds · Scott Schell · Prof. K.J. Reddy  
Dept. of Ecosystem Science and Management  
College of Agriculture and Natural Resources  
University of Wyoming**

# OUTLINE

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- » **Discussion with Landowner**
- » **Background Research**
- » **Permission and Support for Project**
- » **Location/Sampling**
- » **Methods and Materials**
- » **Results**
- » **Discussion**
- » **Acknowledgments**

# DISCUSSION AND CONTACT

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- » **Scott Schell - UW Extension Service**
- » **Contacted by landowner about orchard in western Fremont County, Wyoming**
  - › **Looking into history of 100+ year old apple orchard**
  - › **Period applications of arsenical pesticides**
  - › **Landowner interested in fate of relict As and Pb from pesticide application**

# BACKGROUND RESEARCH

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- » **Arsenic contamination an issue with increasing research**
- » **Lead contamination**
- » **EPA Values**
- » **Lead arsenate pesticide application**
  - › **Banning of pesticides and lag effect applications**
  - › **Residual traces of lead arsenate pesticides and their fate (leaching, mobility)**



# **LANDOWNER PERMISSION EPSCoR/FACULTY SUPPORT**

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- » **Landowner gave permission for study**
  - › **Results of study shared with landowner**
- » **Proposal written**
  - › **Support/funding for study by Prof. K.J. Reddy, has conducted extensive arsenic research**
- » **EPSCoR approval and support**
  - › **Within proposal: background, written sampling methods, processing methods, hypothesis, intent to report results**

# GOALS OF THE PROJECT

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- » **Gain experience in:**
  - › **Sample collection**
  - › **Lab analysis**
  - › **Interpreting and presenting results**
  
- » **Work with landowner**
  - › **Share results of study**
  - › **Work with landowner on possible remediation/treatment/course of action if mobility of As or Pb observed**

# OBJECTIVES

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- » **Determine presence/absence of relict As and Pb in water soluble fraction from soil solution**
- » **Determine soil pH, due to influence of pH on mobility of As and Pb**
- » **Determine mobility if As and Pb are found to be present**
  - › **Vertical mobility through soil profile**
  - › **Movement across the soil surface down slope**

# **HYPOTHESIS**

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- » **Hypothesis: If present, relict As and Pb will be bound within 30cm of soil profile and show minimal to no movement across slope**



# ORCHARD LOCATION



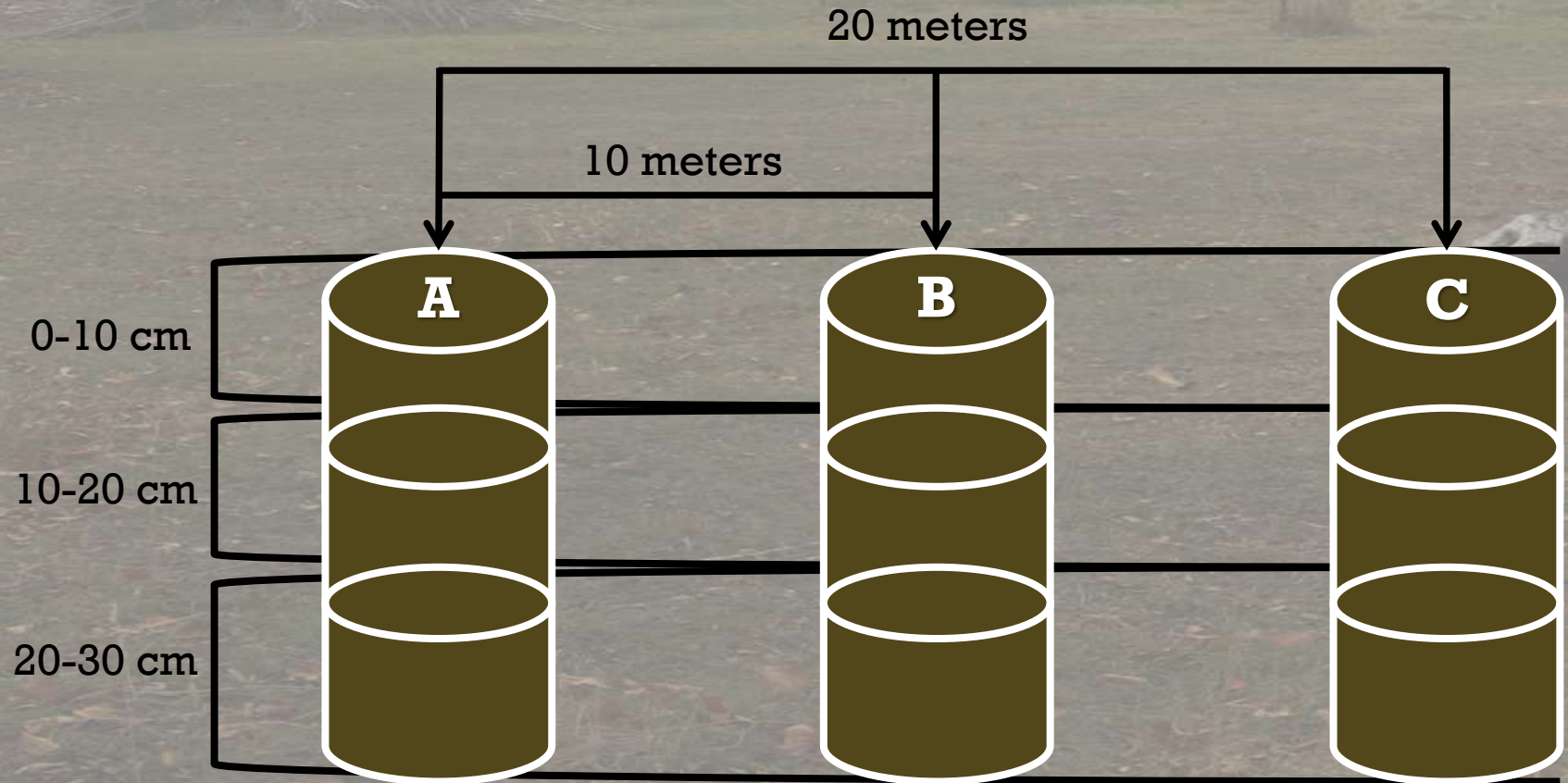
# SOIL SAMPLING

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- » **2 transects (20m long)**
- » **3 sampling points/transect (A,B,C)**
- » **3 sampling depths/point (0-10cm, 10-20cm, 20-30cm)**
- » **2 control samples (1 above, 1 below orchard)**
- » **20 samples**

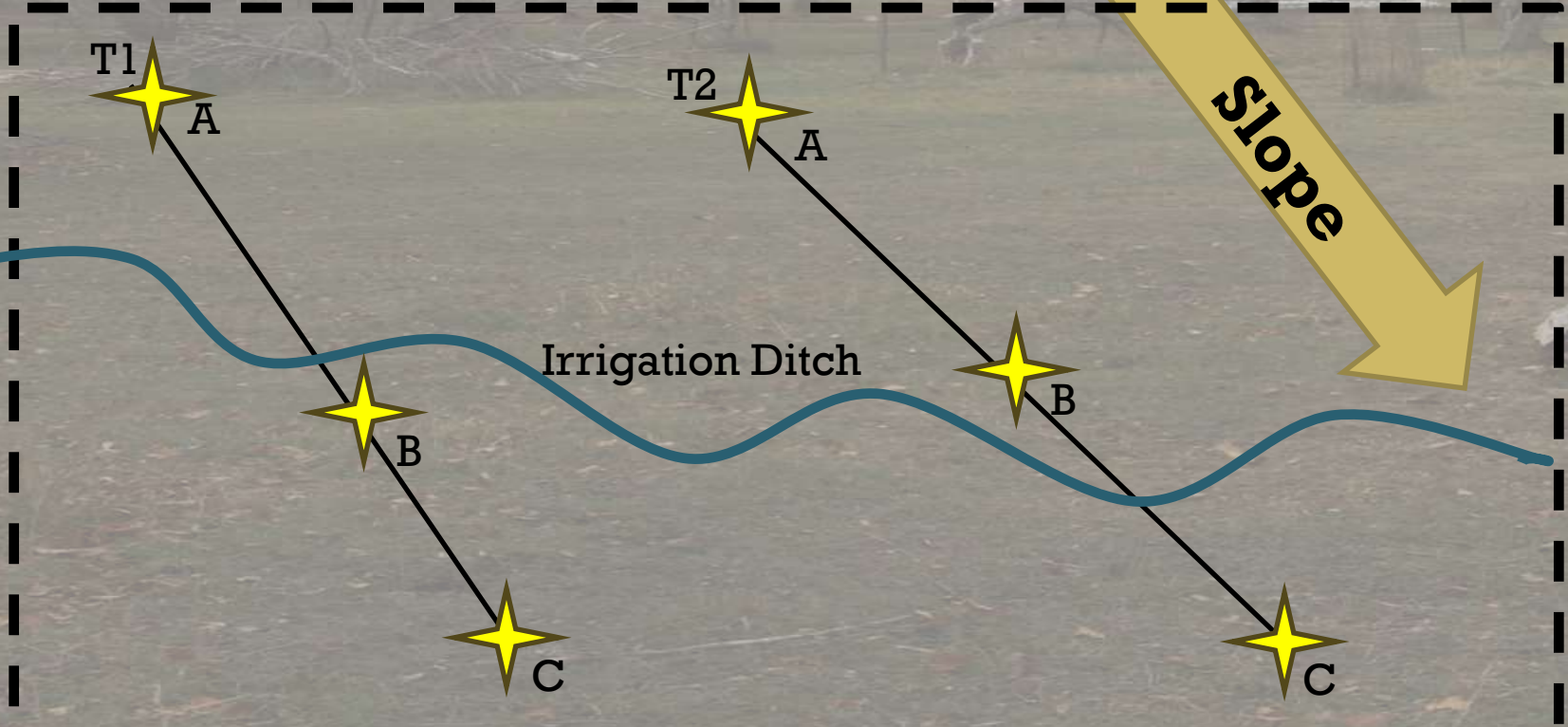


# SOIL SAMPLING cont.



# ORCHARD LAYOUT

Control A  
(Upper)



**Slope**

T1  
A

T2  
A

Irrigation Ditch

B

B

C

C

-Rough dimensions  
-Not to scale

Control B  
(Lower)



Stream

# **SAMPLE PROCESSING**

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- » **Samples brought back to Water Quality Lab at UW**
- » **Ground and sieved the soil samples to 2mm**
- » **Mixed 100g soil, 100ml DI water; extracted after 30min**
- » **Samples filtered, acidified and refrigerated, measured for pH**
- » **ICP-MS analysis for As and Pb performed by ALS Environmental Labs, Ft. Collins, CO**

# RESULTS

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- » **Results showed presence of relict As and Pb in water soluble form of soil solution**
  - › **Vertical mobility in the soil profile?**
  - › **Movement over surface down slope to stream?**
  
- » **Observed minimal vertical and horizontal mobility of As and Pb**
  
- » **Soil pH was similar throughout sampling site (neutral 6.3-7.7)**

# pH-Conclusions

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- » **Mostly uniform and neutral**
  - › **Increasing with depth due to OM at surface**
- » **At  $\text{pH} < 8.2$ , calcium carbonate negatively charged, adsorb  $+\text{As}$**

# T1/Control - pH





# T2/Control - pH

5.00 5.50 6.00 6.50 7.00 7.50 8.00



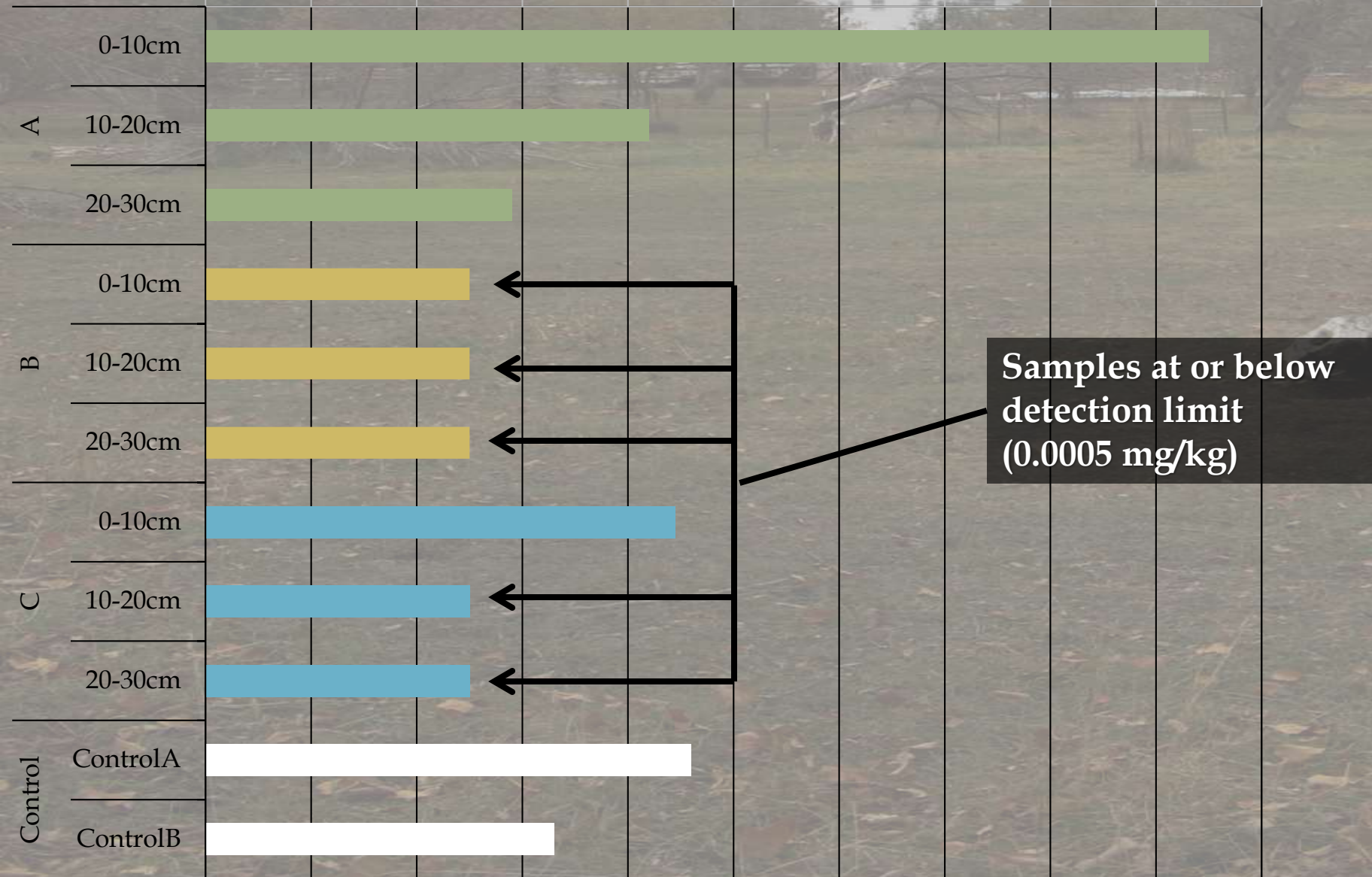
# **Pb and As-Conclusions**

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- » **Lead within background levels**
  - › **Most samples at or below detection limit**
  - › **No apparent trends in data**
  
- » **Arsenic within background levels**
  - › **At or near detection with decreasing amounts in lower profile**
  - › **No noticeable increase down slope in the orchard, indicating no surface movement**

# T1/Control - Pb (mg/kg)

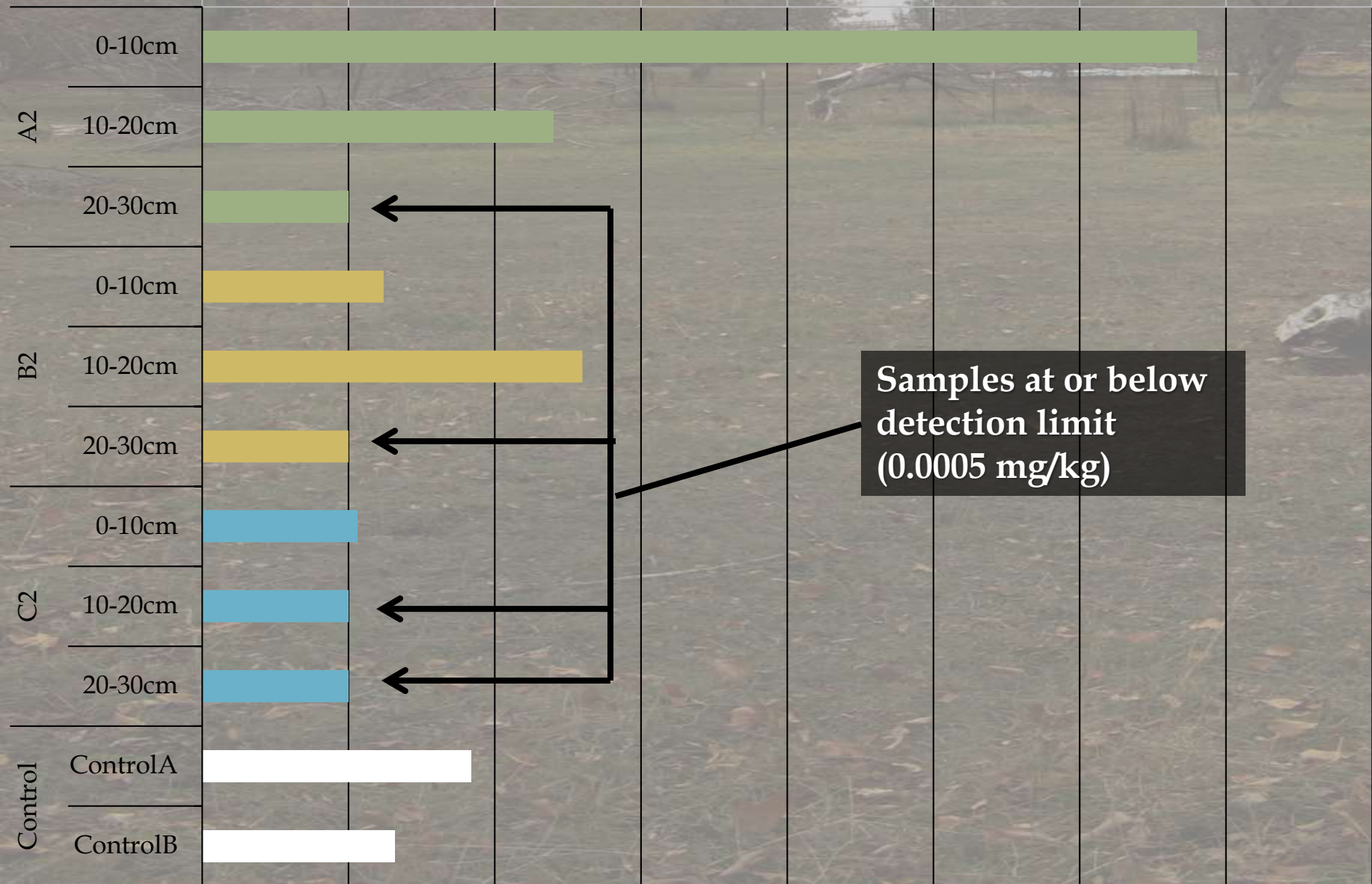
0.00000 0.00020 0.00040 0.00060 0.00080 0.00100 0.00120 0.00140 0.00160 0.00180 0.00200



**Samples at or below  
detection limit  
(0.0005 mg/kg)**

# T2/Control - Pb (mg/kg)

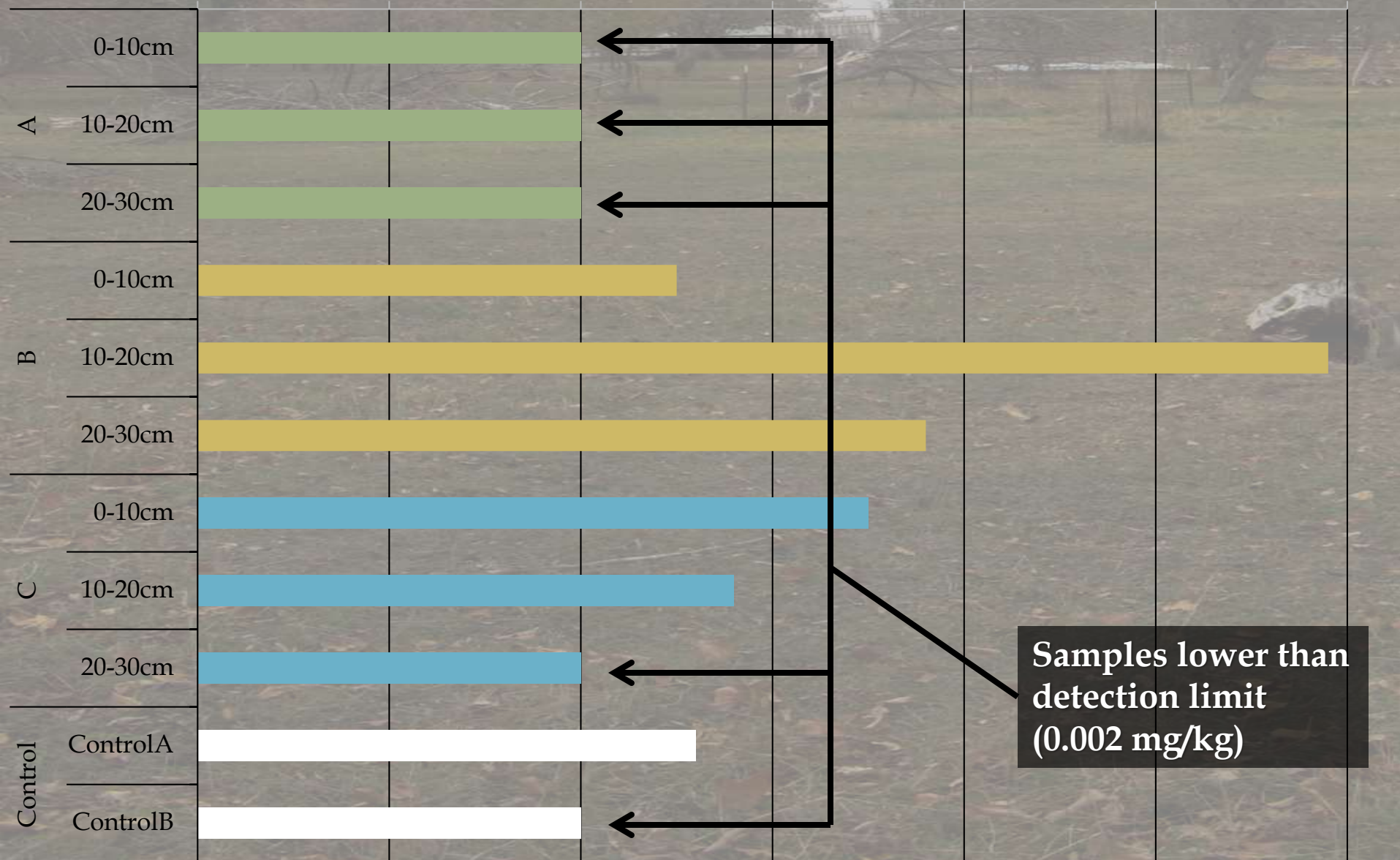
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**Samples at or below  
detection limit  
(0.0005 mg/kg)**

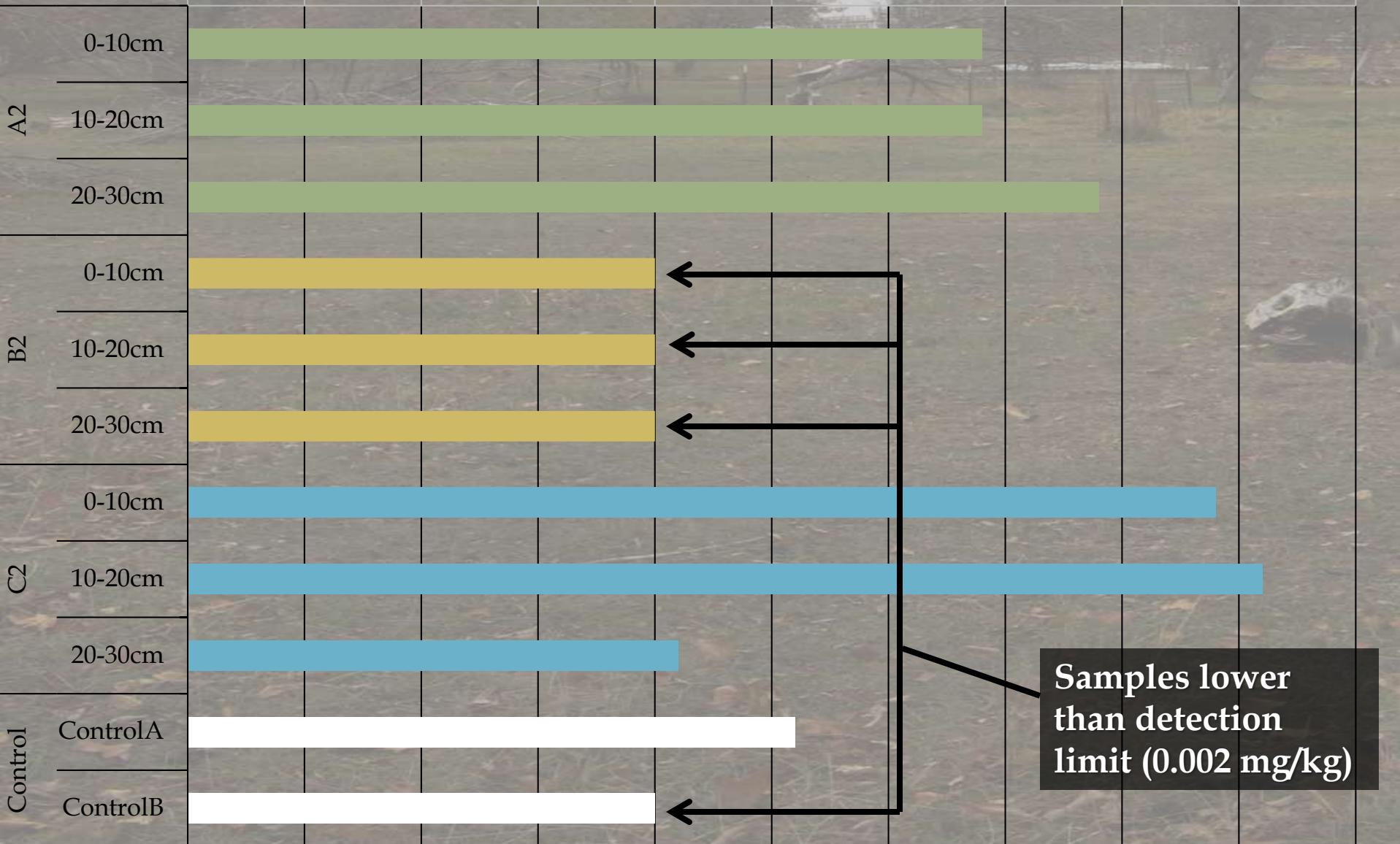
# T1/Control - As (mg/kg)

0.0000      0.0010      0.0020      0.0030      0.0040      0.0050      0.0060



# T2/Control - As (mg/kg)

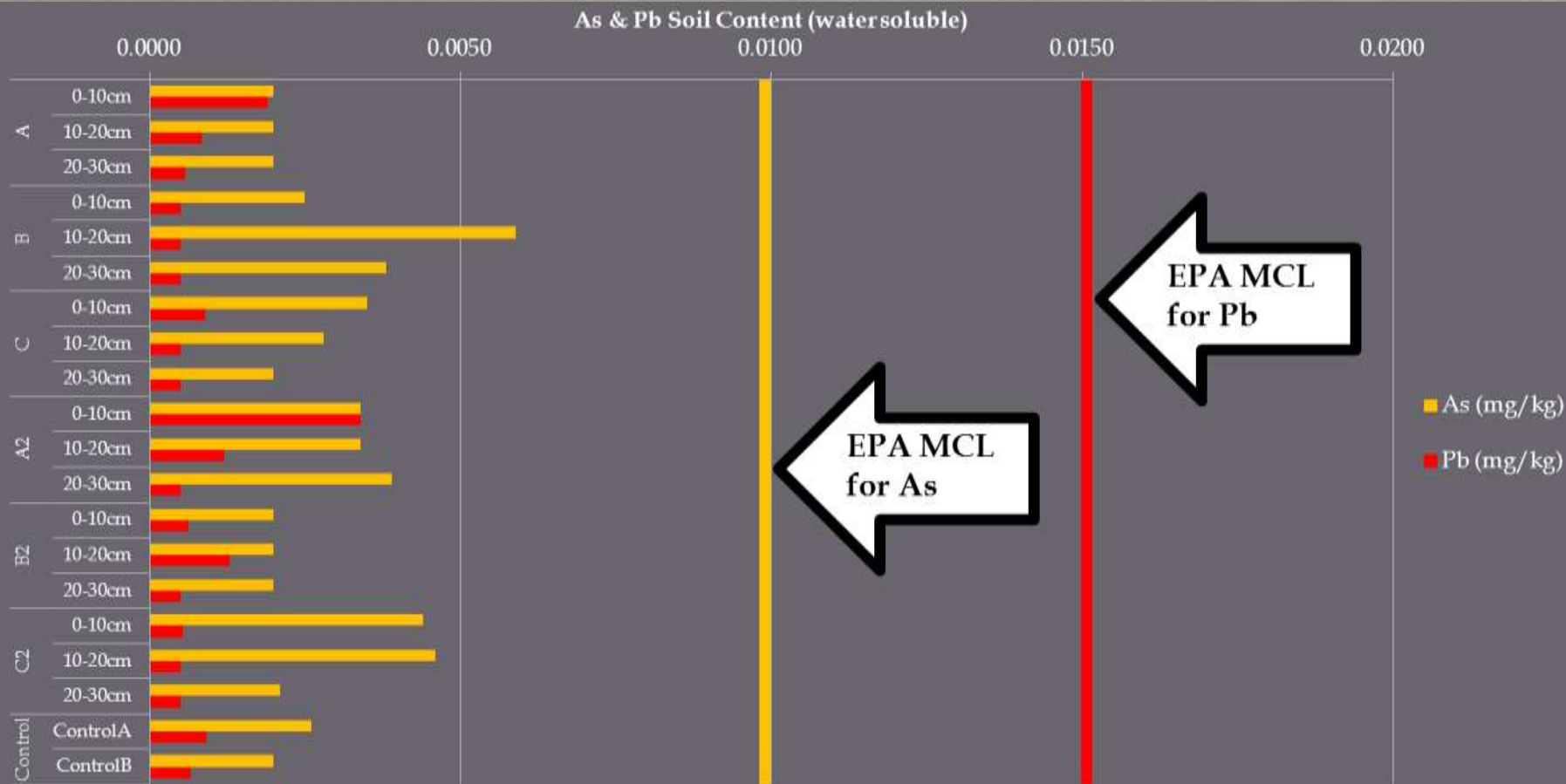
0.0000 0.0005 0.0010 0.0015 0.0020 0.0025 0.0030 0.0035 0.0040 0.0045 0.0050



# DISCUSSION

## » EPA Drinking Water Regulations

» **Pb=15 $\mu$ g/L, As=10 $\mu$ g/L (mg/L=ppb= $\mu$ g/kg)**



# **DISCUSSION cont.**

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- » **Orchard sample levels of As and Pb are not functionally higher than control samples**
- » **Levels of water soluble As and Pb are lower than EPA Drinking Water Regulation**
- » **Horizontal surface and vertical soil profile movement is not apparent**
- » **Likely most relict As and Pb tied into soil carbonates or already leached**
  - › **Possibly bound in soil in non-water soluble fraction, further investigation needed**



# ACKNOWLEDGMENTS

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- › **Landowner**
- › **Brandon Reynolds – UW ESM Dept.**
- › **Scott Schell – UW ESM/Ag Extension**
- › **Prof. K.J. Reddy – UW ESM Dept.**
- › **Wyoming EPSCoR Program**
- › **UW Undergraduate Research Day**



# REFERENCES

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"Arsenic in Drinking Water." Home. 25 Apr. 2013  
<<http://water.epa.gov/lawsregs/rulesregs/sdwa/arsenic/index.cfm>>.