Prediction of total soil Pb from Mehlich3 Pb in a commercial soil testing laboratory

A lower cost alternative for soil lead screening (?)

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Promising correlations in the literature for Mehlich3, Morgan, modified Morgan and 1N HNO_3 extracts

Nicklow CW, Norvell WA, Spittler T. 1981. Predicting total soil lead from an acetic acid-sodium acetate buffered solution. Commun. Soil Sci. Plant Anal. 12:239–45.

Hamel SC, Heckman JR, Shilke-Gartley KL, Hoskins B. 2003. Lead extraction using three soil fertility tests and Environmental Protection Agency method 3050. Commun. Soil Sci. Plant Anal. 34:2853–73

McBride M, Rao Mathur R, Baker L. 2011. Chemical extractability of lead in field-contaminated soils: implications for estimating total lead. Commun. Soil Sci. Plant Anal. 13:1581–93.

Minca, K.K. and N.T. Basta. 2013. Comparison of plant nutrient and environmental soil tests to predict Pb in urban soils. Sci. Tot. Env. 445–446:57–63.

Commercial lab (cost) limitations

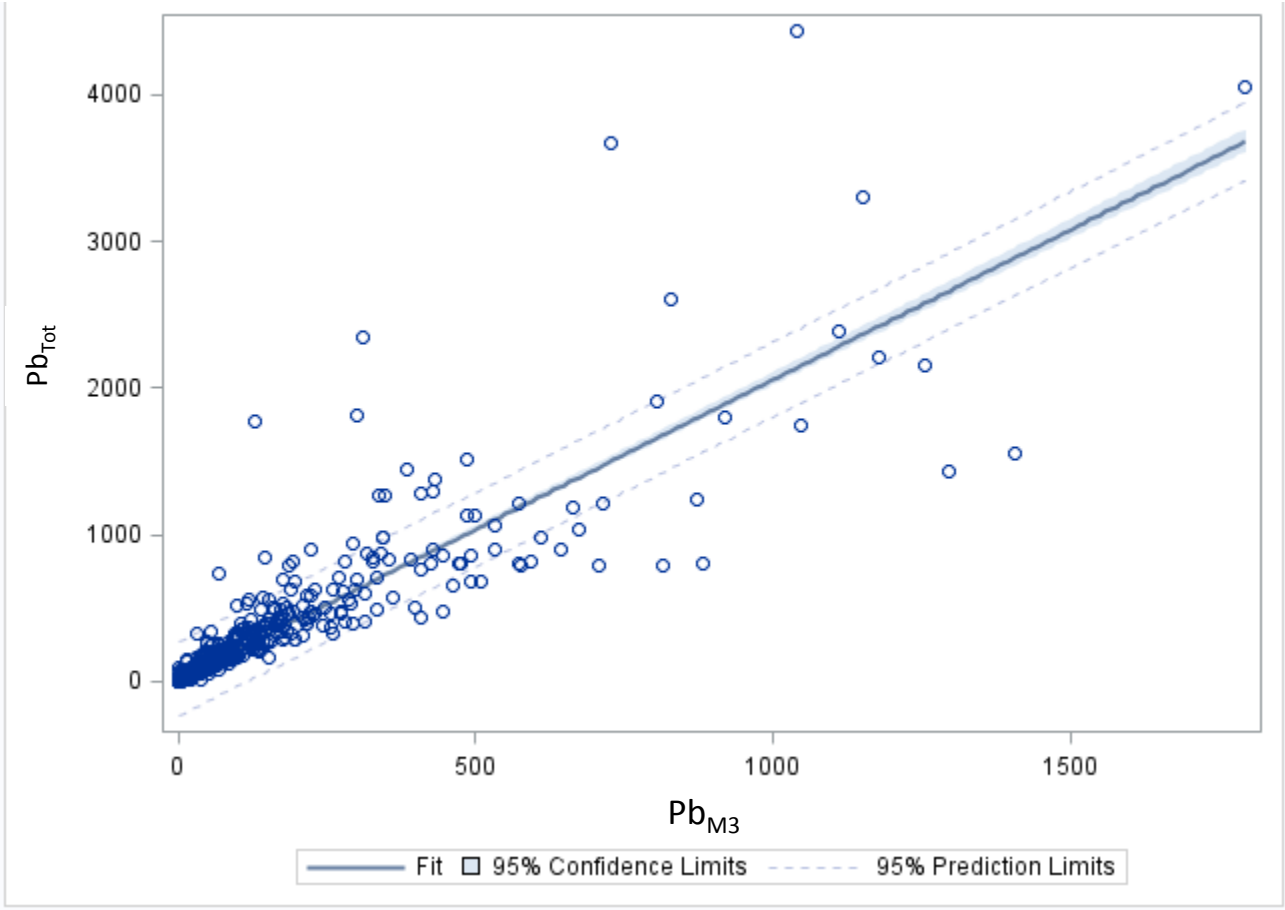
- Use standard soil scoop, weighing adds time and cost
- Grinding to <0.250 mm is too costly
- Must fit into current operations

Penn State Agricultural Analytical Services Laboratory Data Set

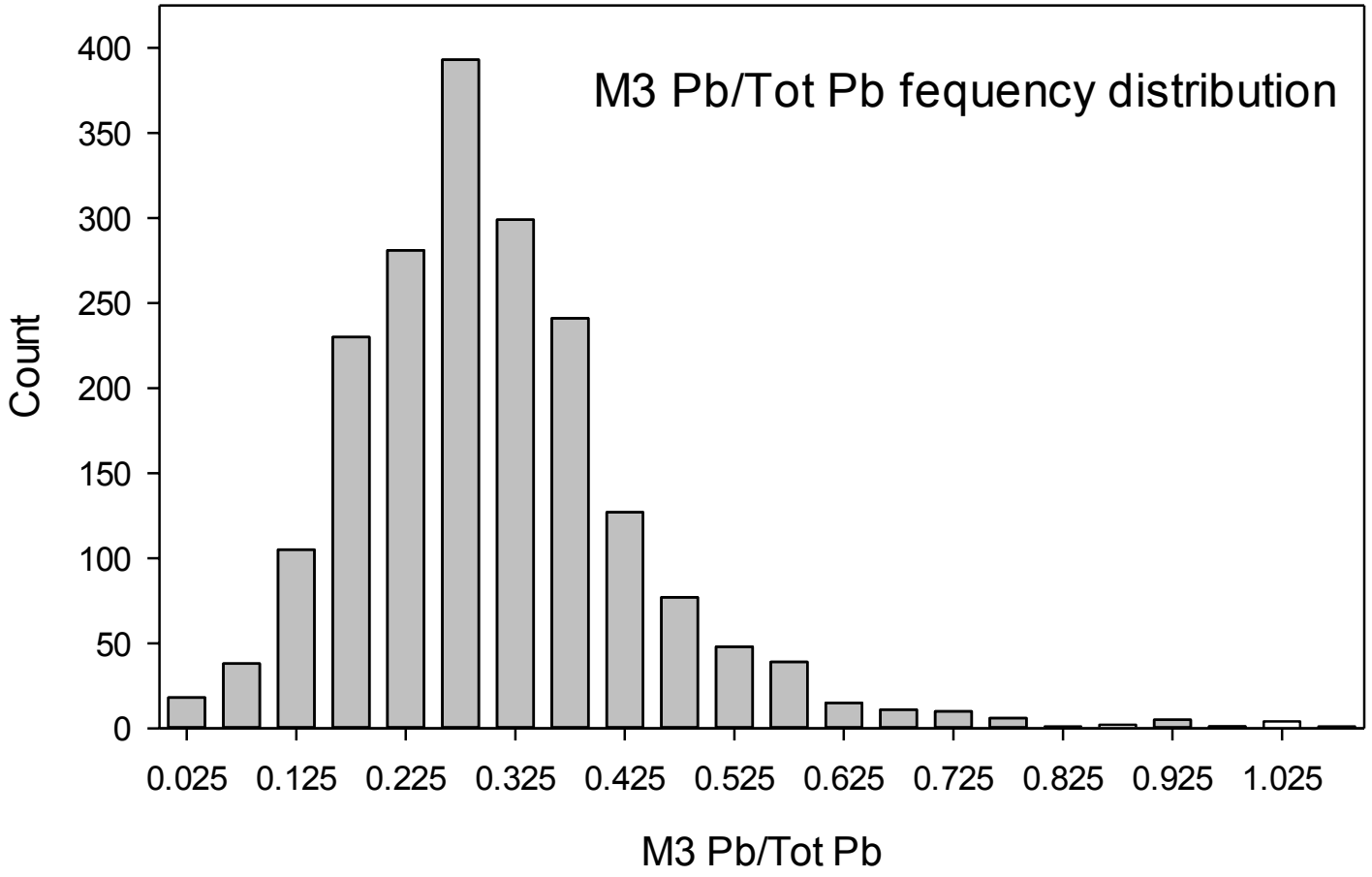
- 1952 samples
- Mehlich3 analysis
  - 1:10 soil to extract ratio
  - use 2.12 cm^3 scoop to measure soil and 25 mL M3 solution
- Total sorbed Pb
  - EPA 3050B
  - 1:50 soil to extract ratio
  - Weigh 1 g soil and 50 mL solution

Regression of total sorbed Pb on Mehlich3 Pb

$Pb_{Tot} = 17.4 + 2.04\ Pb_{M3}$ $R^2 = 0.80$ n=1952



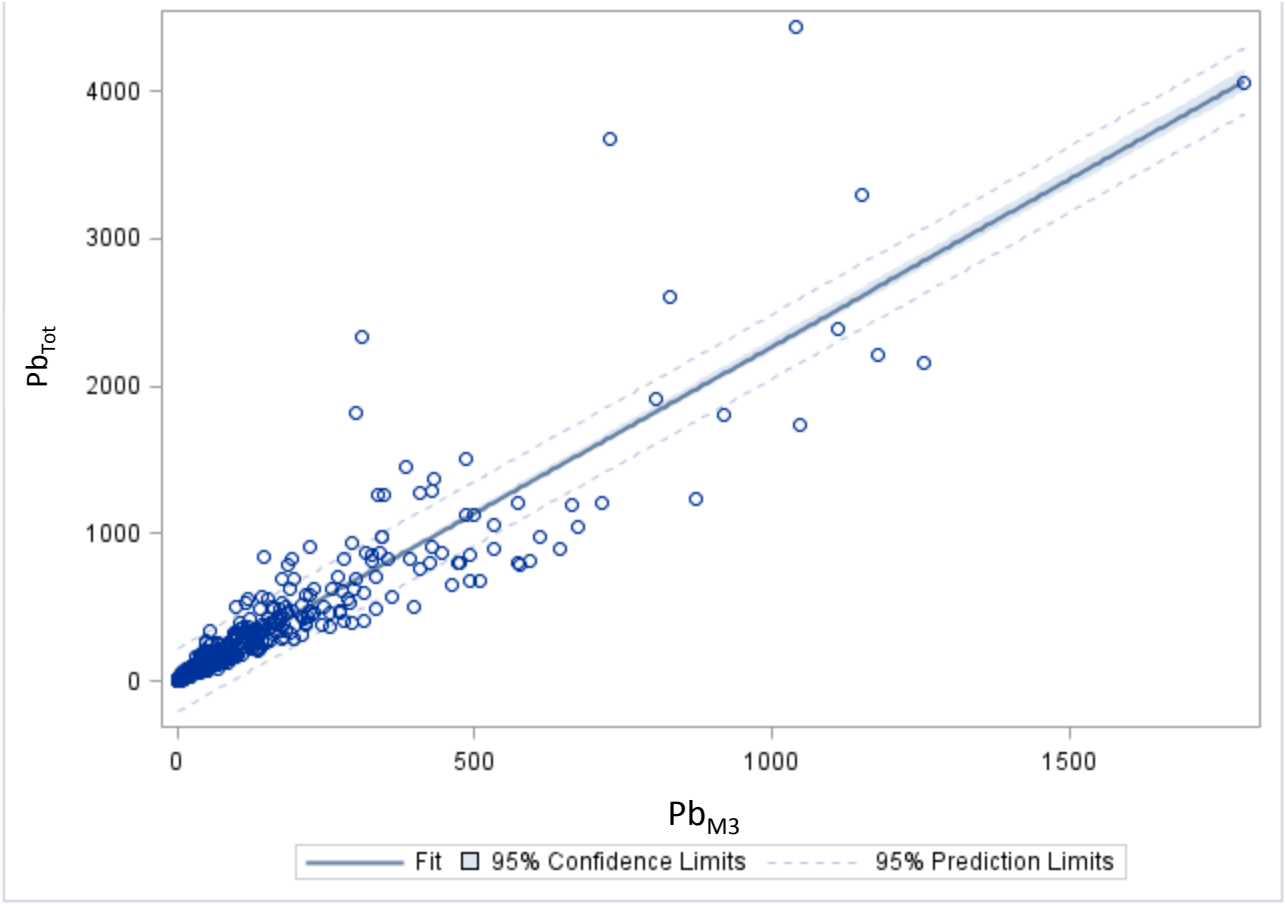
Ratio of Mehlich3 Pb to total sorbed Pb



Regression of total sorbed Pb on Mehlich3 Pb

data trimmed of extreme Pb_{M3}/Pb_{Tot} ratios

$Pb_{Tot} = 11.1 + 2.25\ Pb_{M3}$ $R^2 = 0.86$ n=1882

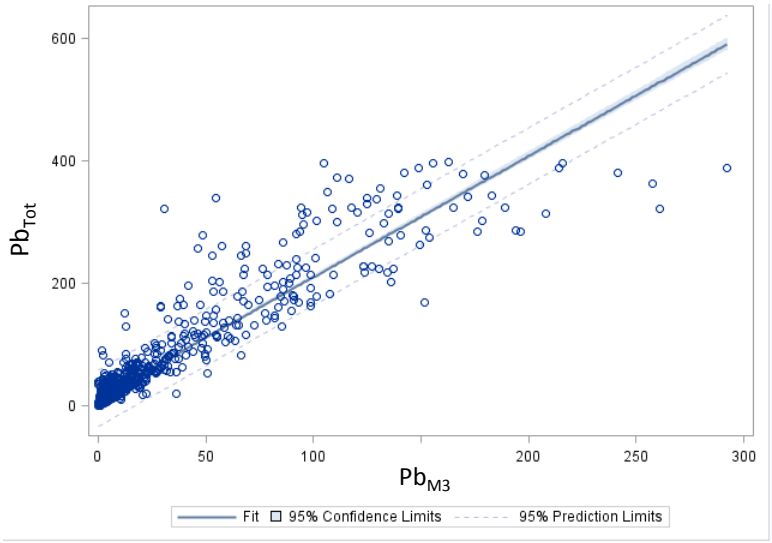


Regression of total sorbed Pb <u>*<400 mg kg^{-1}*</u> on Mehlich3 Pb

All data, n=1833

$Pb_{Tot} = 12.9 + 1.98\ Pb_{M3}$

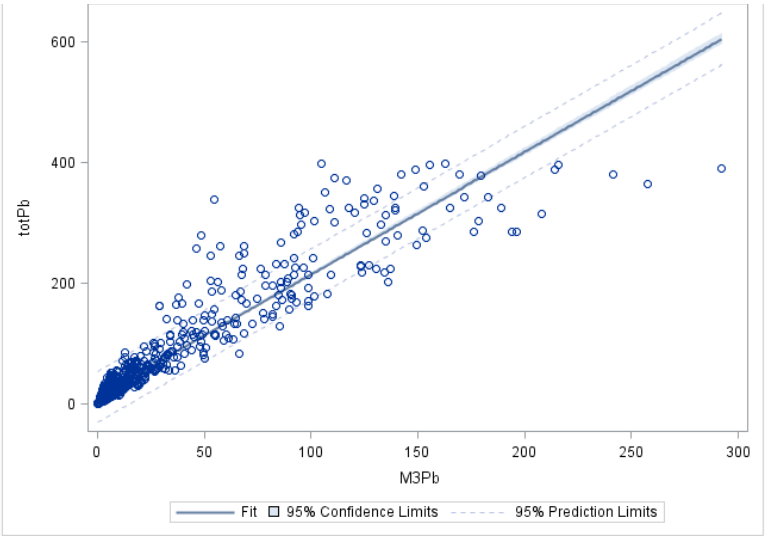
$R^2 = 0.88$



Trimmed data, n=1772

$Pb_{Tot} = 11.7 + 2.03\ Pb_{M3}$

$R^2 = 0.89$

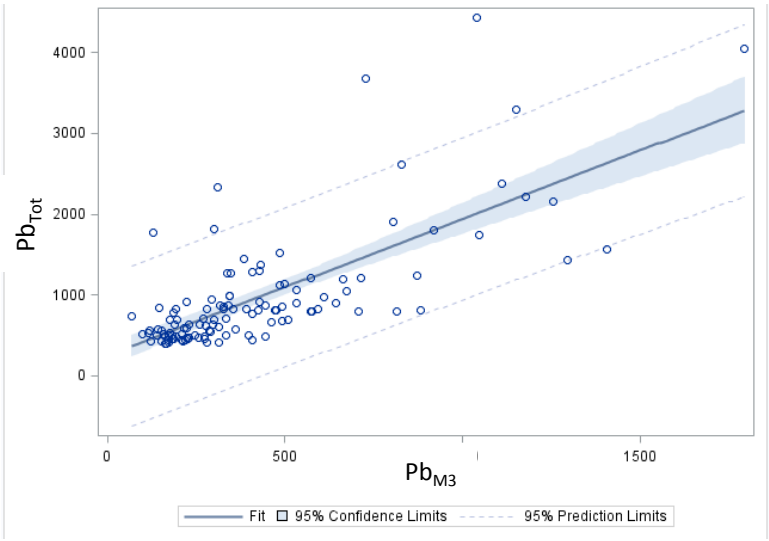


Regression of total sorbed Pb *>400 mg kg^{-1}* on Mehlich3 Pb

All data, n=119

$Pb_{Tot} = 248 + 1.69\ Pb_{M3}$

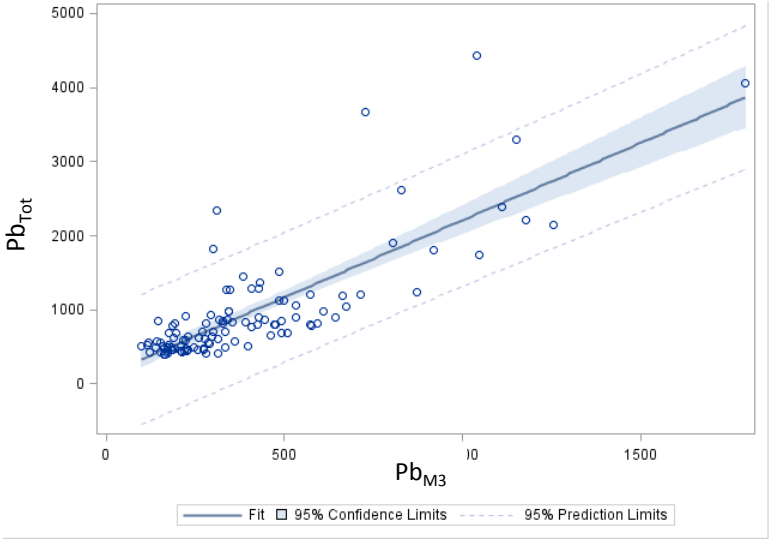
$R^2 = 0.53$



Trimmed data, n=110

$Pb_{Tot} = 127 + 2.08\ Pb_{M3}$

$R^2 = 0.89$

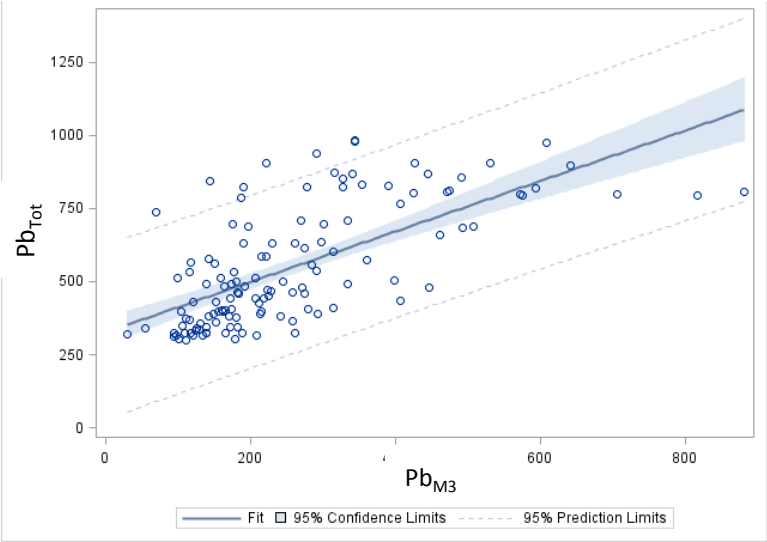


Regression of total sorbed Pb *300-1000 mg kg^{-1}* on Mehlich3 Pb

All data, n=129

$Pb_{Tot} = 326 + 0.86\ Pb_{M3}$

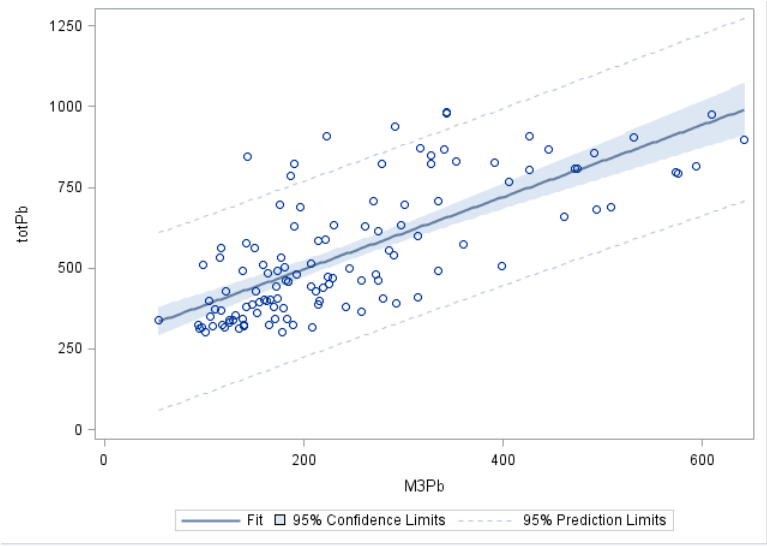
$R^2 = 0.45$



Trimmed data, n=120

$Pb_{Tot} = 273 + 1.12\ Pb_{M3}$

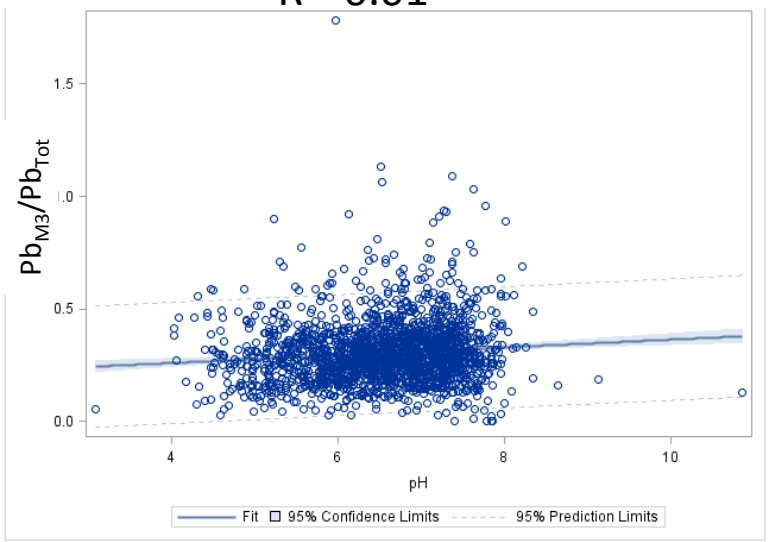
$R^2 = 0.53$



Correlations of other measured parameters with Pb_{M3}/Pb_{Tot} ratio

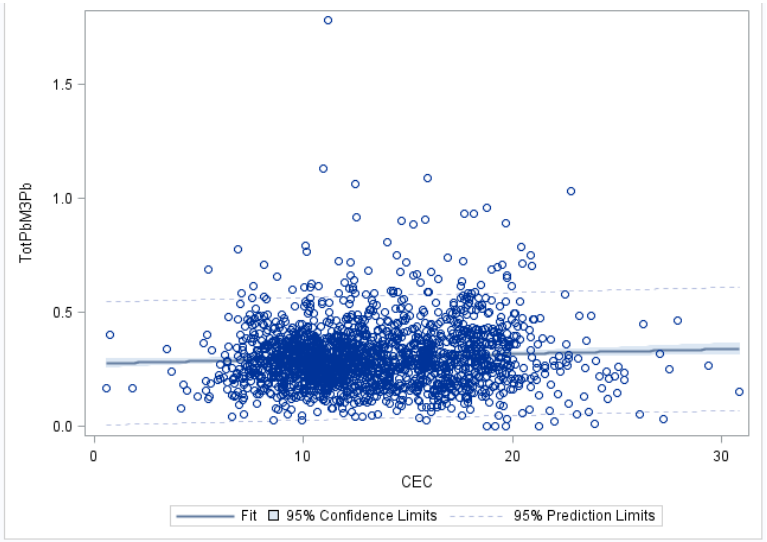
Soil pH

R^2=0.01



Soil CEC

R^2=0.004



Summary

Total soil Pb range	All data	Trimmed data
All samples (0 – 4,000 mg/kg)	$Pb_{Tot} = 17.4 + 2.04\ Pb_{M3}$ $R^2 = 0.80$ n=1952	$Pb_{Tot} = 11.1 + 2.25\ Pb_{M3}$ $R^2 = 0.86$ n=1882
<400 mg/kg	$Pb_{Tot} = 12.9 + 1.98\ Pb_{M3}$ $R^2 = 0.88$ n=1833	$Pb_{Tot} = 11.7 + 2.03\ Pb_{M3}$ $R^2 = 0.89$ n=1772
>400 mg/kg	$Pb_{Tot} = 248 + 1.69\ Pb_{M3}$ $R^2 = 0.53$ n=119	$Pb_{Tot} = 127 + 2.08\ Pb_{M3}$ $R^2 = 0.89$ n=110
300 – 1,000 mg/kg	$Pb_{Tot} = 326 + 0.86\ Pb_{M3}$ $R^2 = 0.45$ n=129	$Pb_{Tot} = 273 + 1.12\ Pb_{M3}$ $R^2 = 0.53$ n=120

Results are promising, but…

- Correlation is good for
  - Full Pb range (up to 4,000 mg/kg)
  - Very strong for samples up to 400 mg/kg
- Correlation is weak in critical mid-range 300 – 1,000 mg/kg
- No evidence that soil pH or CEC correlate with Pb extraction
- Need to examine if multiple regression with other soil parameters measured in routine analysis can improve prediction, particularly in mid-range.
- We have an expanded data set now of over 5,000 samples
  - will provide more samples in mid- to high range Pb
  - Will provide for stronger assessment of correlation of Pb with other soil parameters