



MILLENNIUM
EMS Solutions Ltd.

DATABASE OF BACKGROUND CONCENTRATIONS OF METALS IN ALBERTA SOIL

PTAC Soil and Groundwater Forum 2016

Objective

- Determine distributions of natural metal concentrations in shallow Alberta soils

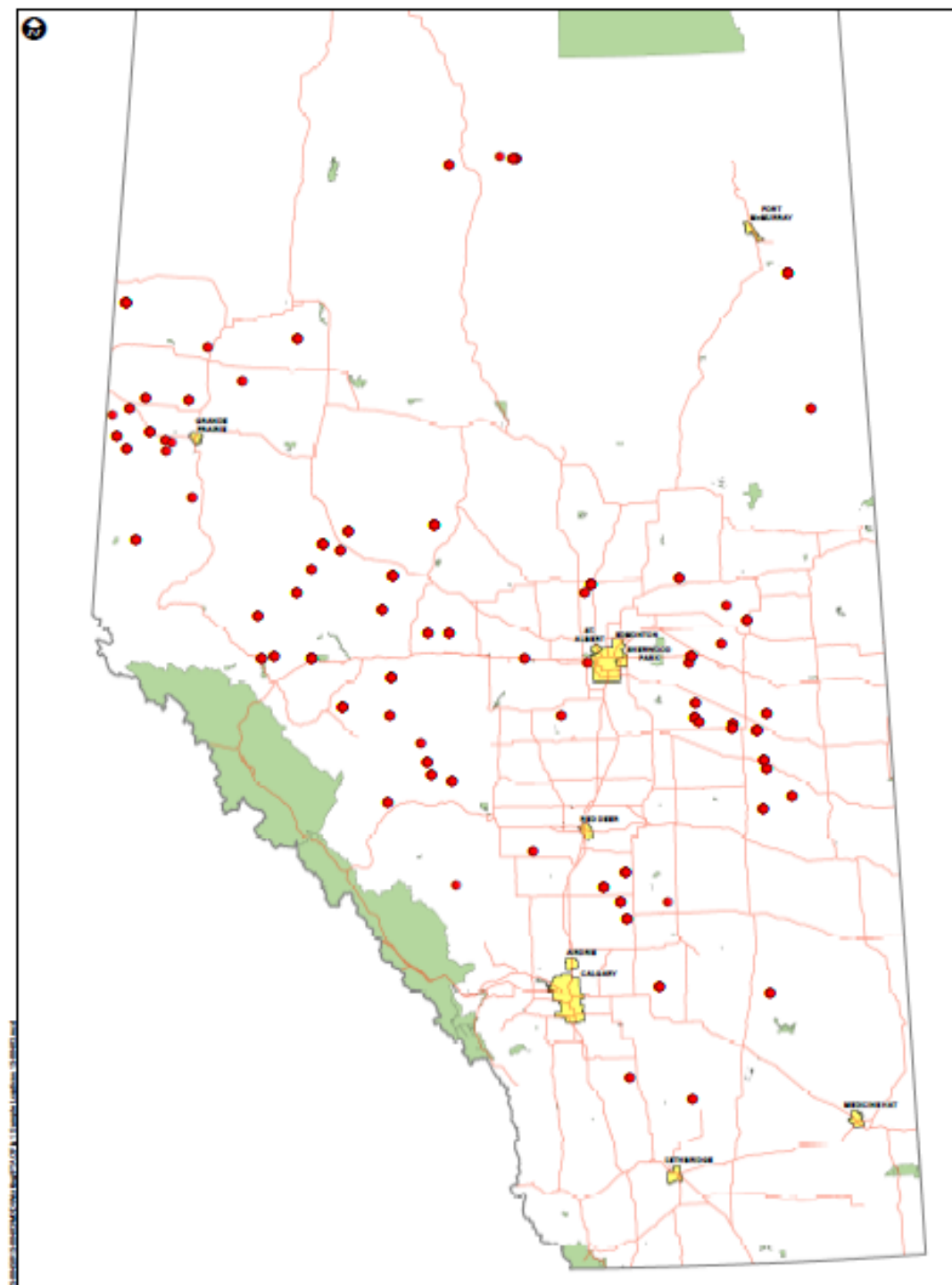
Overview

- Identify a population of soil samples with available metals concentrations.
- Develop a screening methodology to distinguish true background from anthropogenic impact
- Generate distributions and statistics for background metals concentrations

Data Selection

- Dataset of soil samples from:
 - 2008 – 2015
 - EIA, ESA, remediation and reclamation work
 - Alberta
 - Data with metals analysis
 - “Background” and “site” samples
 - 5 Alberta laboratories

Distribution of Sample Locations



Analytical Considerations

- Most metals:
 - $\text{HNO}_3 + \text{H}_2\text{O}_2 \Rightarrow \text{ICP-MS}$, or
 - $\text{HNO}_3 + \text{HCl} \Rightarrow \text{ICP-MS}$
- Mercury
 - Analysis by ICP-MS or CVAAS
- Hexavalent Chromium
 - Alkaline digestion – colourimetric detection
- Boron
 - HWS vs. saturated paste

Screening Methodology

- “Global” Screening
- Site-Specific Verification

Global Screening Steps

- The following were screened out globally:
- Depths >10 m
- Anomalous data
- Data with chloride > 100 mg/kg
- Data with total barium > 500 mg/kg
- Data with detectable B, E, X, F1, or F2
- Data with detectable process chemicals

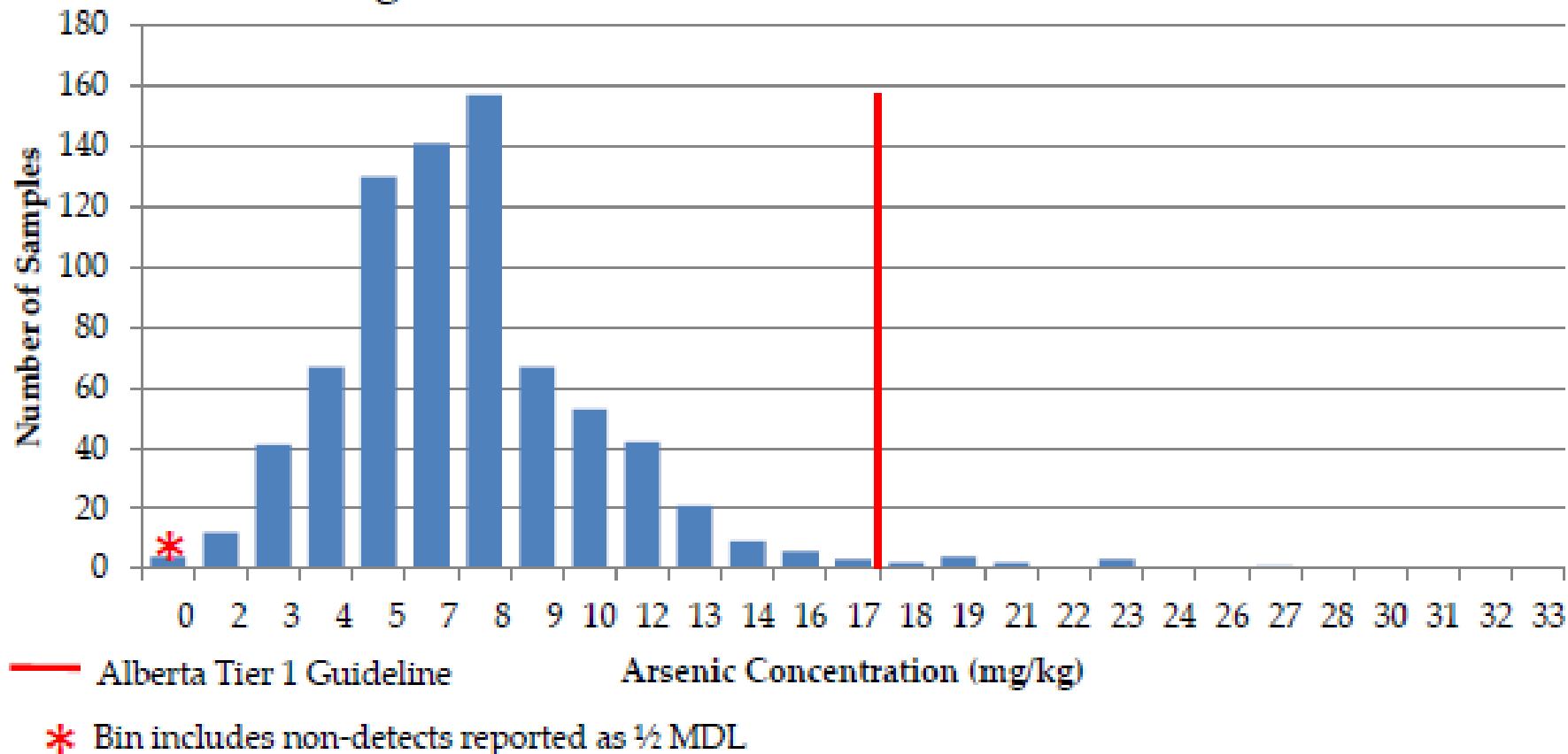
Site-Specific Verification Steps

The following were examined on highest remaining data:

- Site setting
- Borehole logs
- Location and type of site contamination
- Distance from site contamination
- Concentrations in overlying samples

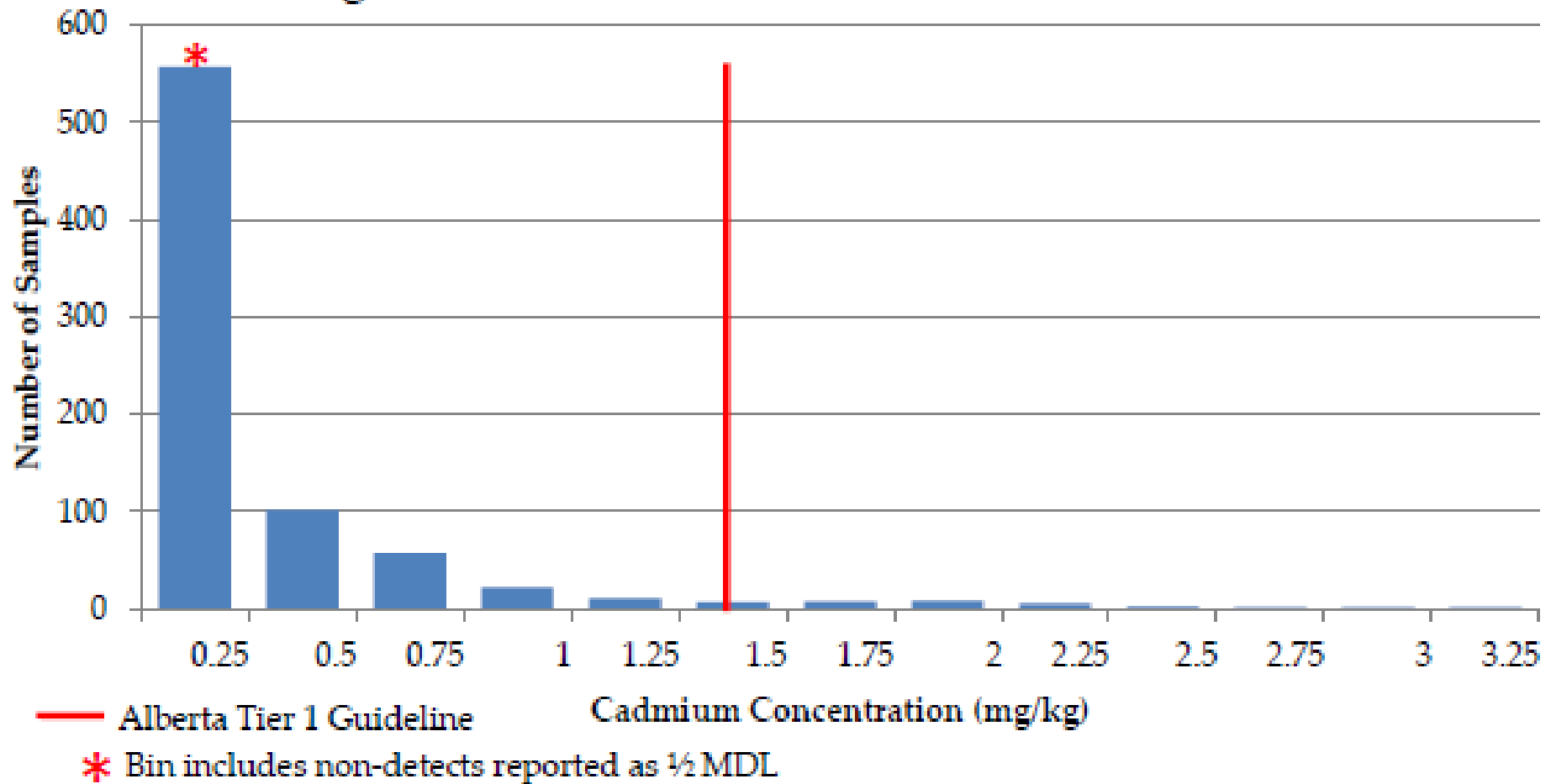
Until maximum background value established with high confidence.

Background Arsenic Distribution in Alberta Soil



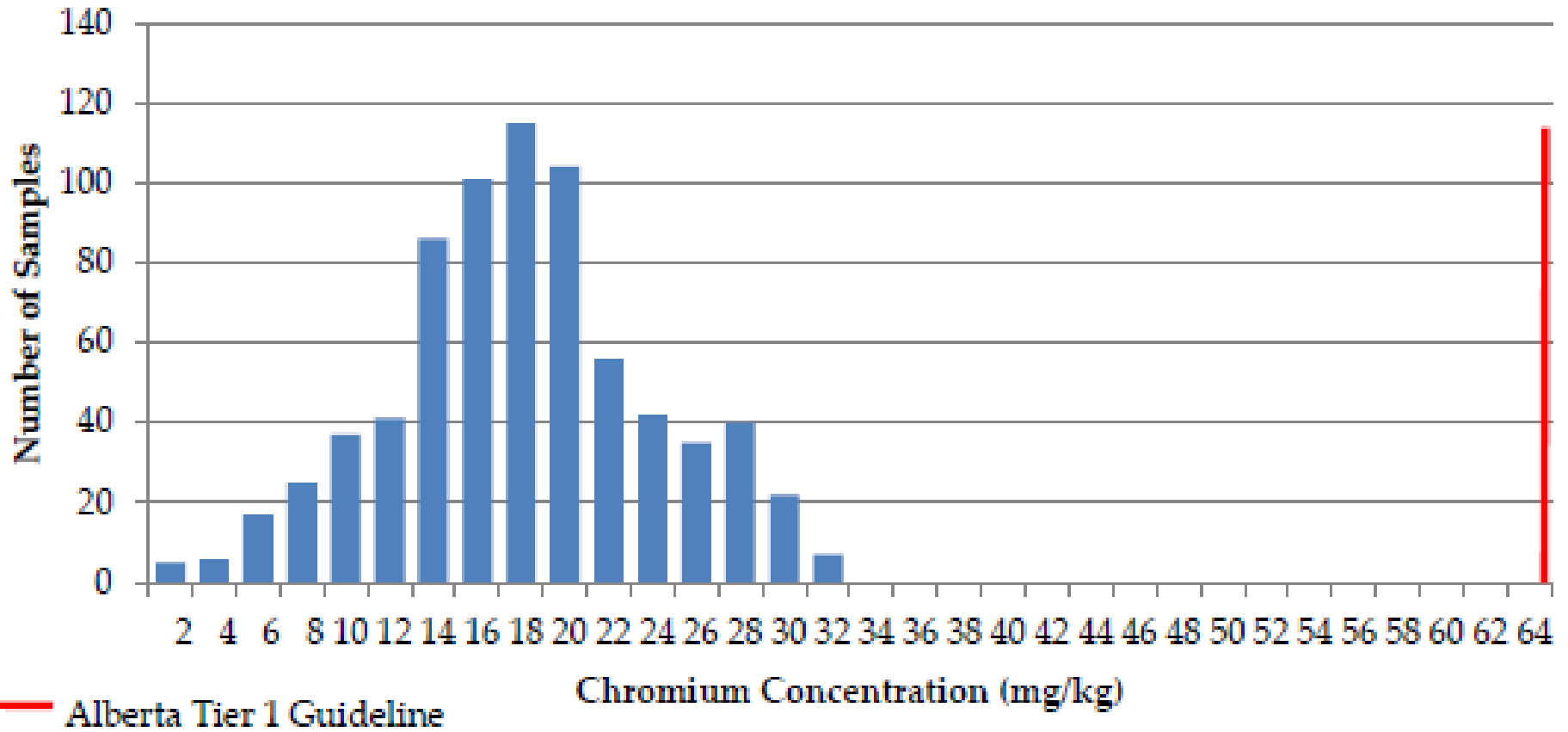
Maximum:	34.7 mg/kg
Tier 1 Guideline:	17 mg/kg
Number of Samples:	766

Background Cadmium Distribution in Alberta Soil



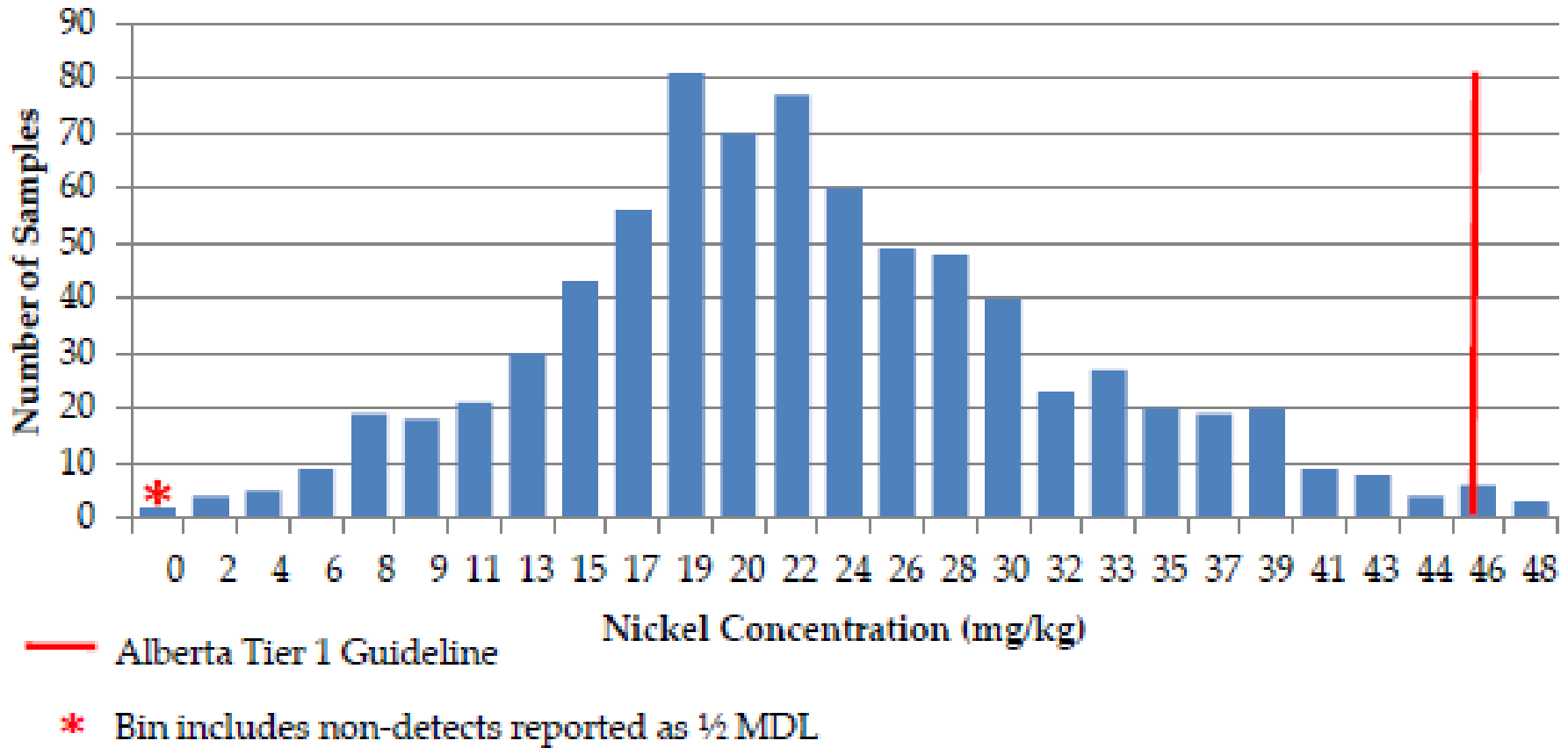
Maximum:	3.22 mg/kg
Tier 1 Guideline:	1.4 mg/kg
Number of Samples:	779

Background Chromium Distribution in Alberta Soil



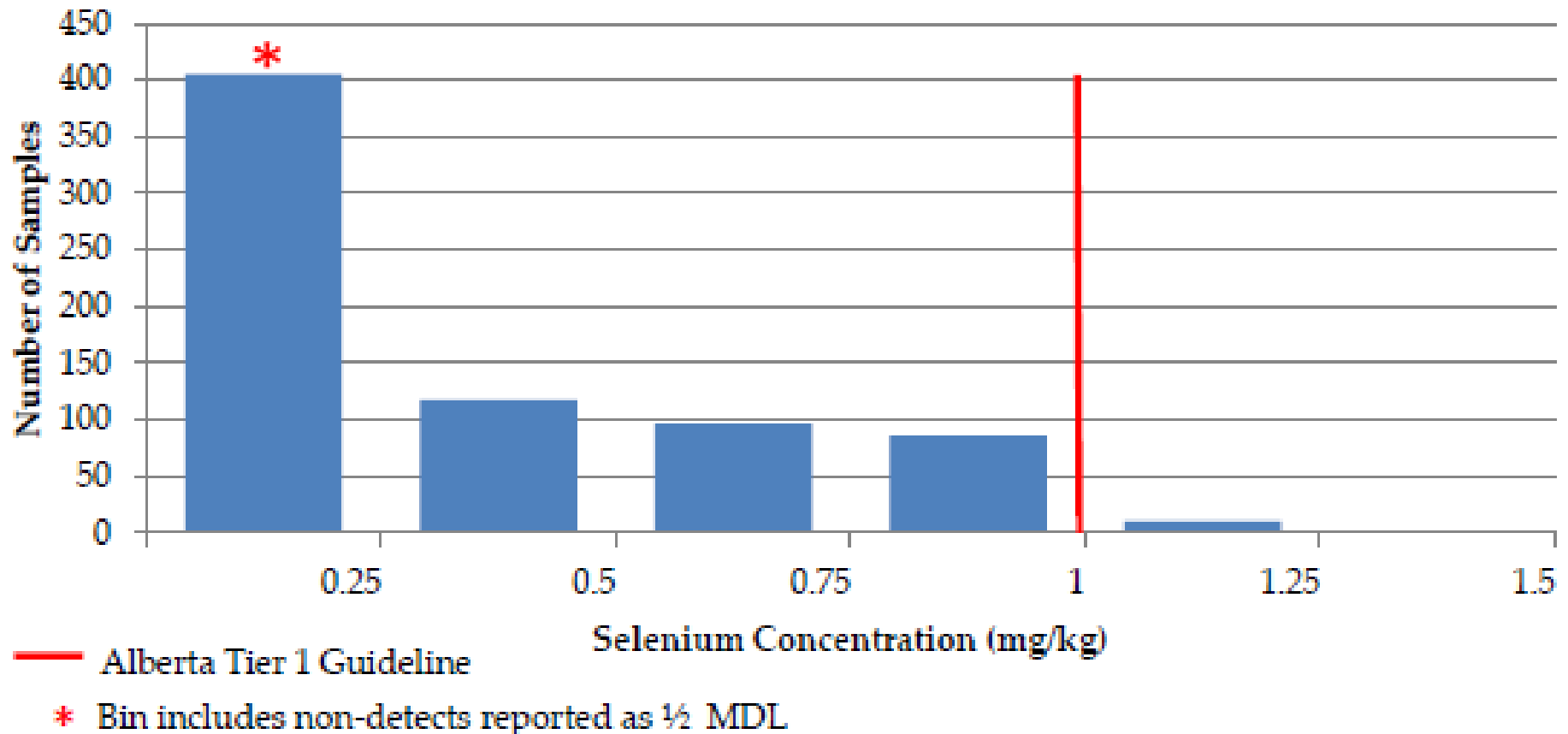
Maximum:	32 mg/kg
Tier 1 Guideline:	64 mg/kg
Number of Samples:	739

Background Nickel Distribution in Alberta Soil



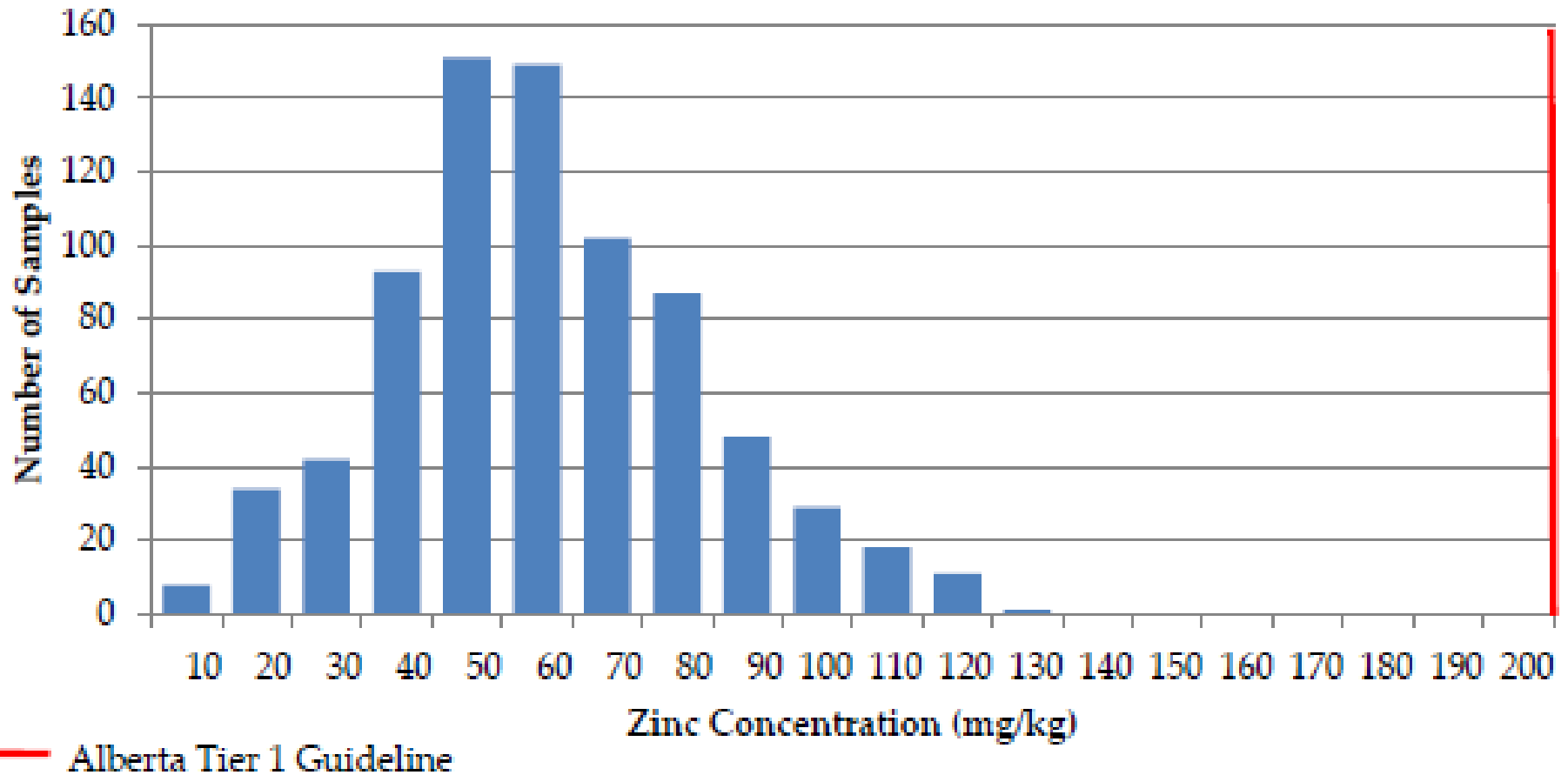
Maximum:	49.9 mg/kg
Tier 1 Guideline:	45 mg/kg
Number of Samples:	773

Background Selenium Distribution in Alberta Soil



Maximum:	1.3 mg/kg
Tier 1 Guideline:	1 mg/kg
Number of Samples:	715

Background Zinc Distribution in Alberta Soil



Maximum:	122 mg/kg
Tier 1 Guideline:	200 mg/kg
Number of Samples:	773

Maximum Background Concentrations

Metal	Alberta Tier 1 (mg/kg)	Maximum Background (mg/kg)	Number of Samples
Antimony	20	1.3	738
Arsenic	17	34.7	766
Beryllium	5	1.3	774
Boron (HWS)	*	2.08	342
Cadmium	1.4	3.22	779
Chromium	64	32	739
Chromium (VI)	0.4	<0.3	259
Cobalt	20	27	779
Copper	63	39.3	780
Lead	70	20.7	793

* Current Alberta Tier 1 boron guideline is based on saturated paste, not HWS)
 Red values exceed Tier 1 guidelines

Maximum Background Concentrations

Metal	Alberta Tier 1 (mg/kg)	Maximum Background (mg/kg)	Number of Samples
Mercury	6.6	0.10	302
Molybdenum	4	3.8	752
Nickel	45	49.9	773
Selenium	1	1.3	715
Silver	20	0.32	674
Thallium	1	0.6	760
Tin	5	2.6	757
Uranium	23	10.6	741
Vanadium	130	52	746
Zinc	200	122	773

Red values exceed Tier 1 guidelines

Discussion of Uncertainties

- Number of samples appears sufficient
- Spatial coverage is good but some gaps exist
- Confidence is high that maximum values quoted are genuine background
- Some background samples will have been conservatively screened out
- A small proportion of impacted samples may remain. Possible minor effect on distribution, not on maximum value.

Acknowledgements

- PTAC project #15-SGRC-02
- PTAC Project Champion:
 - Stephen Bromley, Husky Energy
- Technical Steering Committee:
 - Stephen Bromley, Husky Energy
 - Gordon Dinwoodie, AEP
 - Miles Tindal, Ian Mitchell, Millennium

Next Steps

- PTAC Review
- Technical Steering Committee Discussions
 - Identify any next steps
- Generate Final Report