

# AZ Magma Mine Site Waste Evaluation

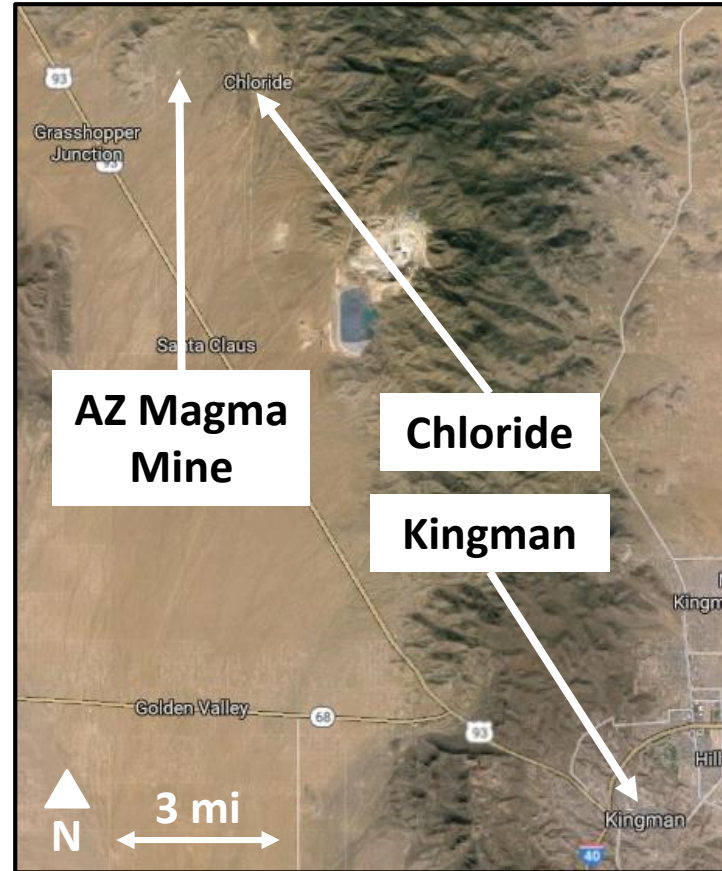


April 28, 2017

Northern Arizona University  
CENE 486 – Spring 2017

# Project Purpose

- Analyze soil from AZ Magma Mine for contaminants of concern (COCs)
- Preliminary assessment and site inspection document (PA/SI)



**Figure 1.** AZ Magma Mine in reference to Chloride and Kingman [1]

# Project Understanding

- Closed in 1945
- Stakeholders
  - Bureau of Land Management (BLM)
  - Chloride residents
  - General public

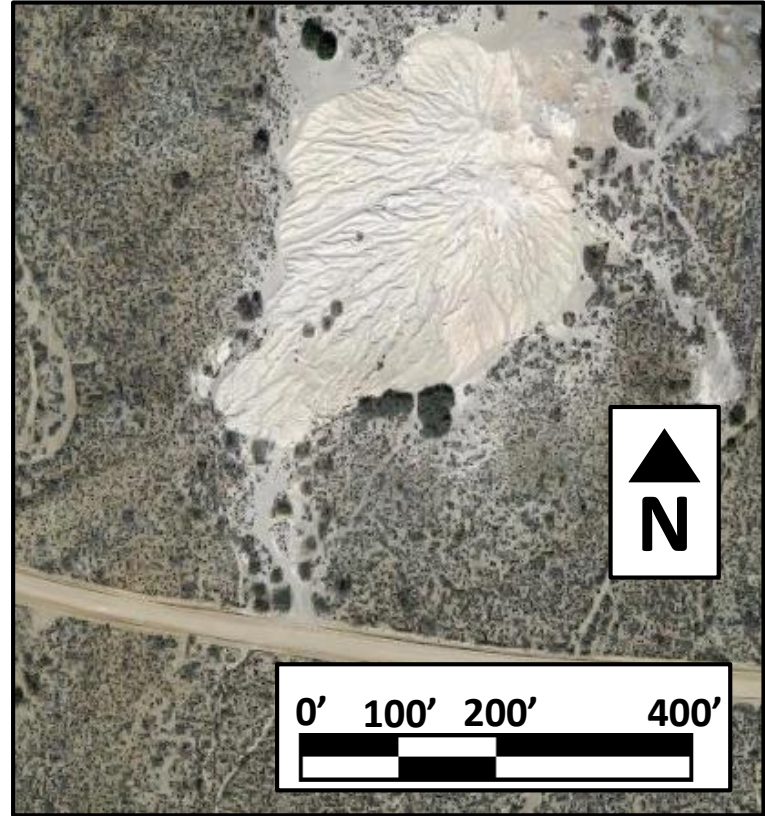


Figure 2. AZ Magma Mine tailings pile [1]

# Work Plan

- Sampling & Analysis Plan
  - field methods
  - sampling grid
  - lab analyses
- Health & Safety Plan
  - required training
  - PPE, hazard analysis
  - emergency response

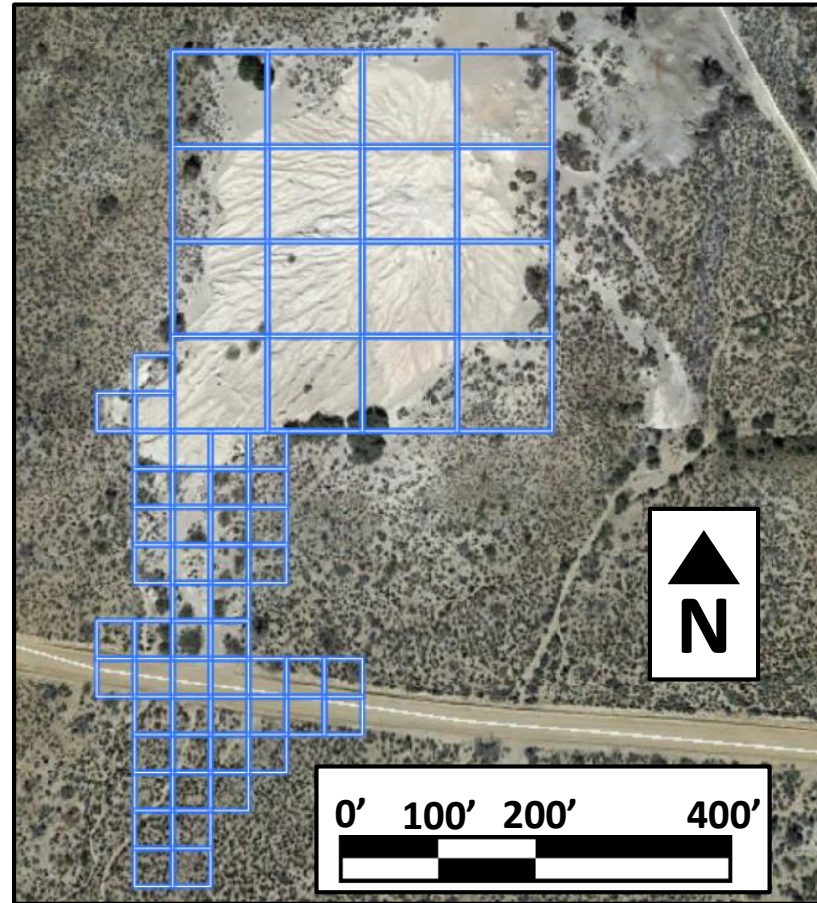


Figure 3. Grid map for site [1]

# Sampling

- Adverse weather
- Deviations
  - reduced PPE
  - fewer samples collected



**Figure 4.** Josue collecting a tailings pile sample [3]

# Sampling

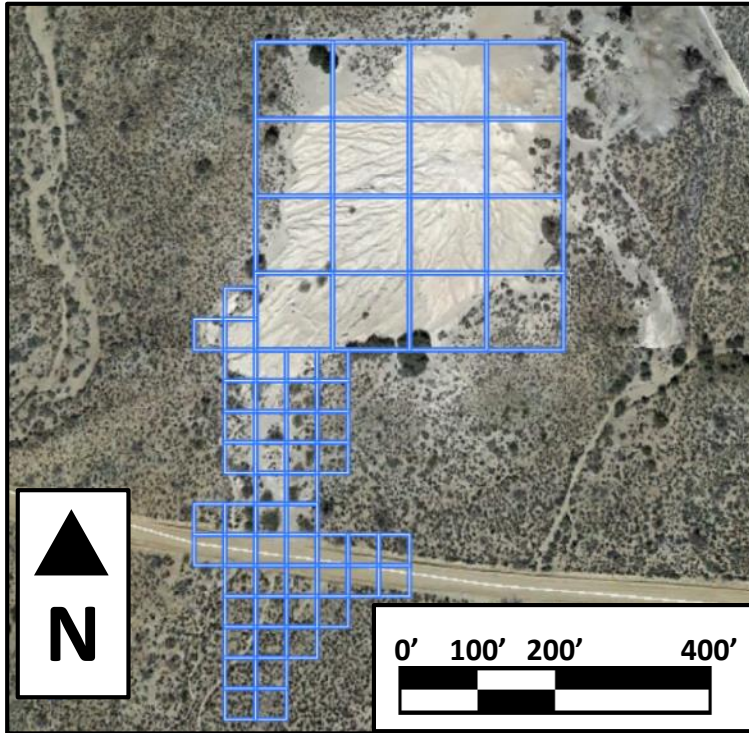


Figure 5. Original grid map [1]

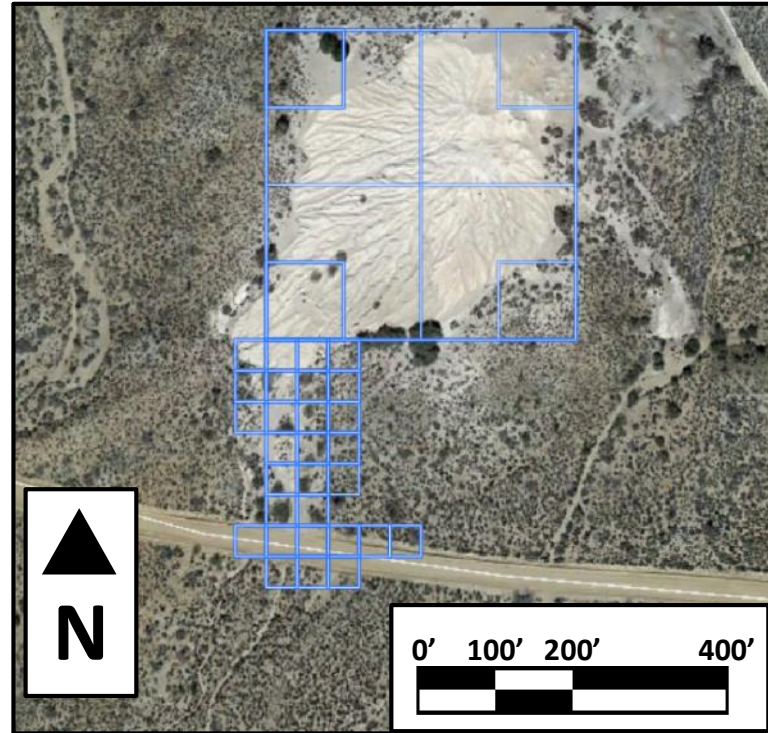


Figure 6. Adjusted grid map [1]

# X-ray Fluorescence (XRF) Analysis

- Quantifies chemical concentrations
- Screening-level data



Figure 7. XRF analyzer [2]

# Contaminants Found

- Arsenic
  - carcinogen (skin, bladder, lung)
  - neurotoxin
  - cardiac disease
  - birth defects

**Table 1.** Arizona Soil Remediation Standards [4]

<b>Chemical</b>	<b>Residential (mg/kg)</b>	<b>Non-residential (mg/kg)</b>
<b>Arsenic</b>	10	10



# Contaminants Found

- Manganese
  - neurotoxin
  - glucose intolerance
  - birth defects
- Vanadium
  - neurotoxin
  - skin rash
  - behavior change
  - kidney and liver bleeding

**Table 2.** Arizona Soil Remediation Standards [4]

Chemical	Residential (mg/kg)	Non-residential (mg/kg)
Manganese	3,300	32,000
Vanadium	78	1,000

# Arsenic Sample Distribution

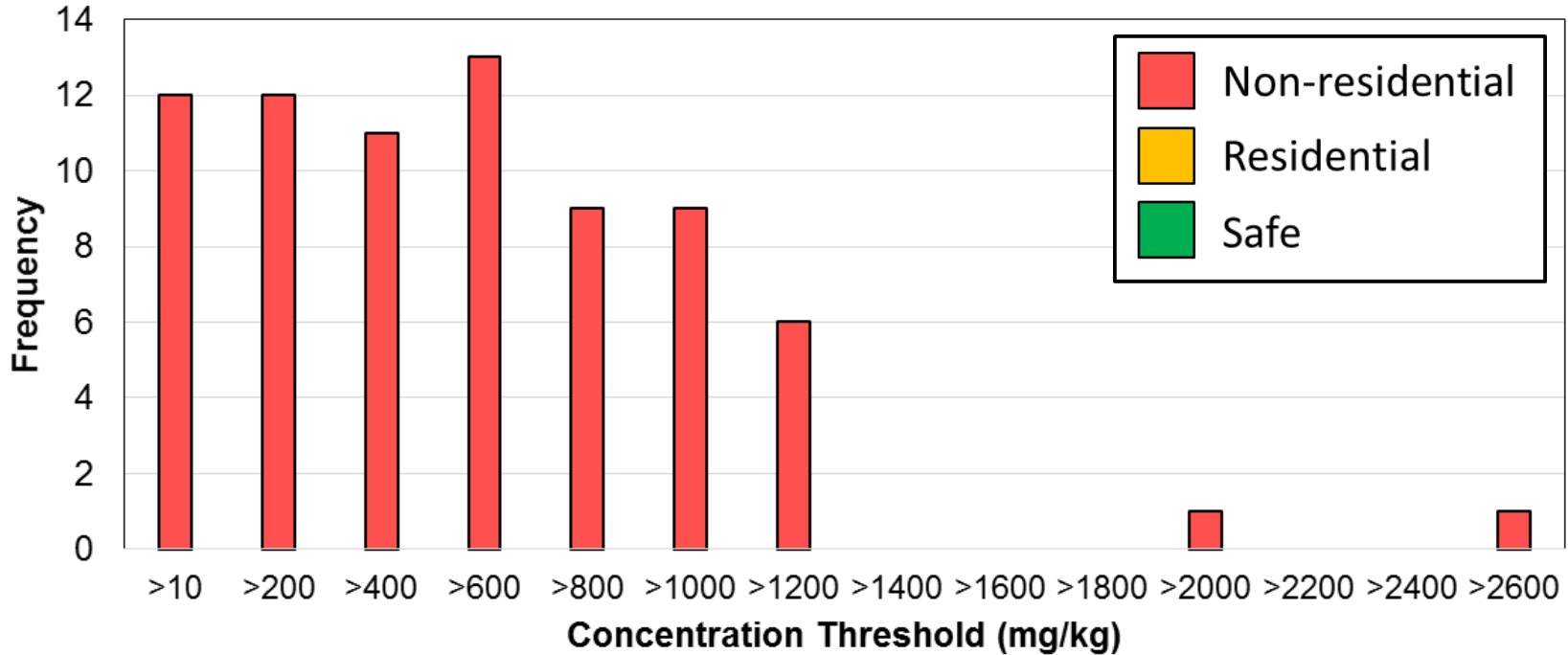


Figure 8. Frequency of Arsenic concentrations

# Manganese Sample Distribution

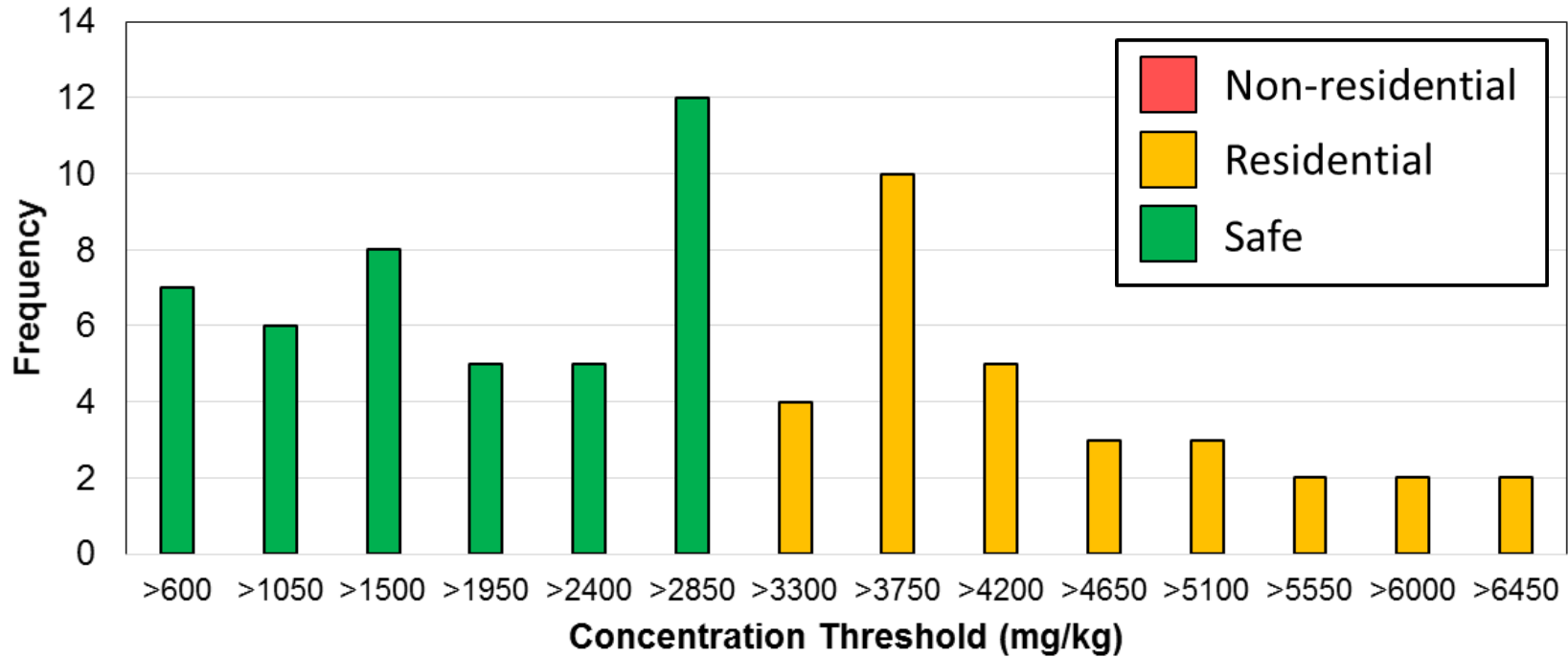


Figure 9. Frequency of Manganese concentrations

# Vanadium Sample Distribution

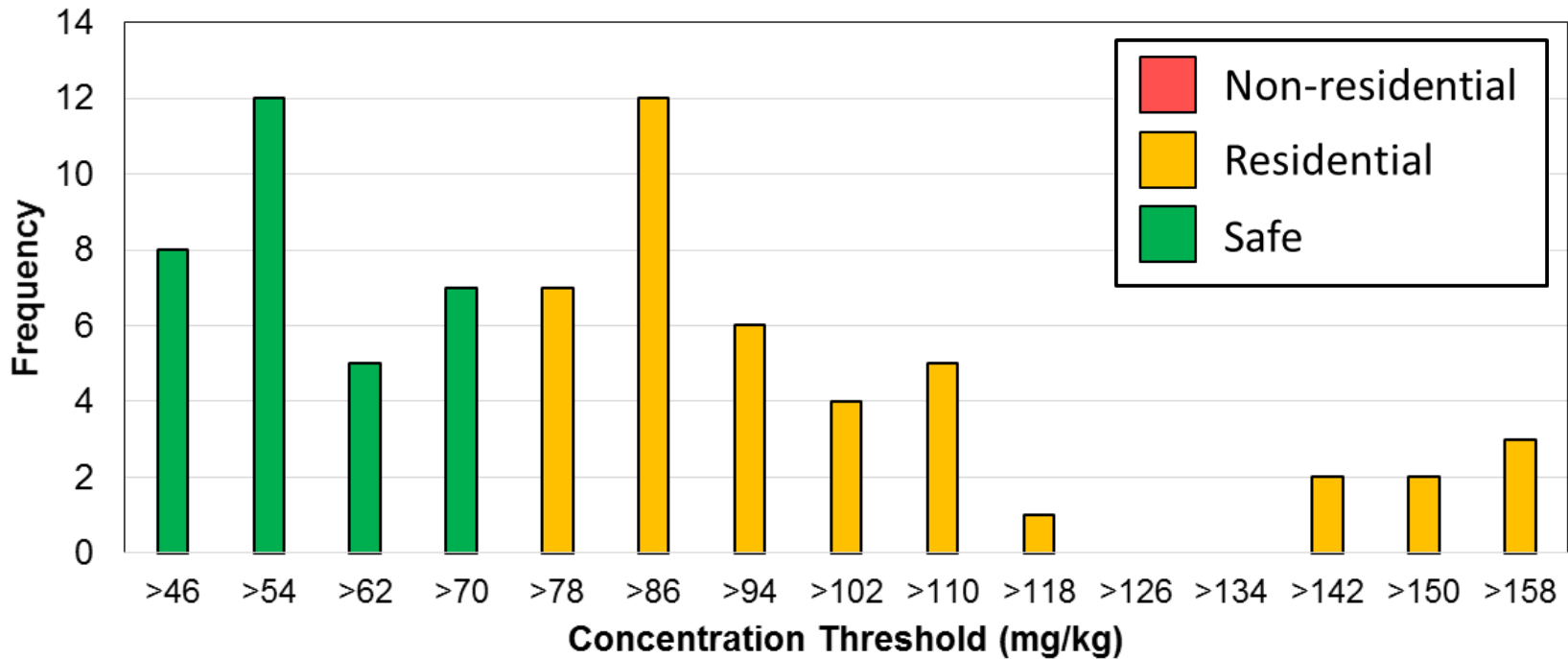


Figure 10. Frequency of Vanadium concentrations

# XRF vs. Atomic Absorption (AA)

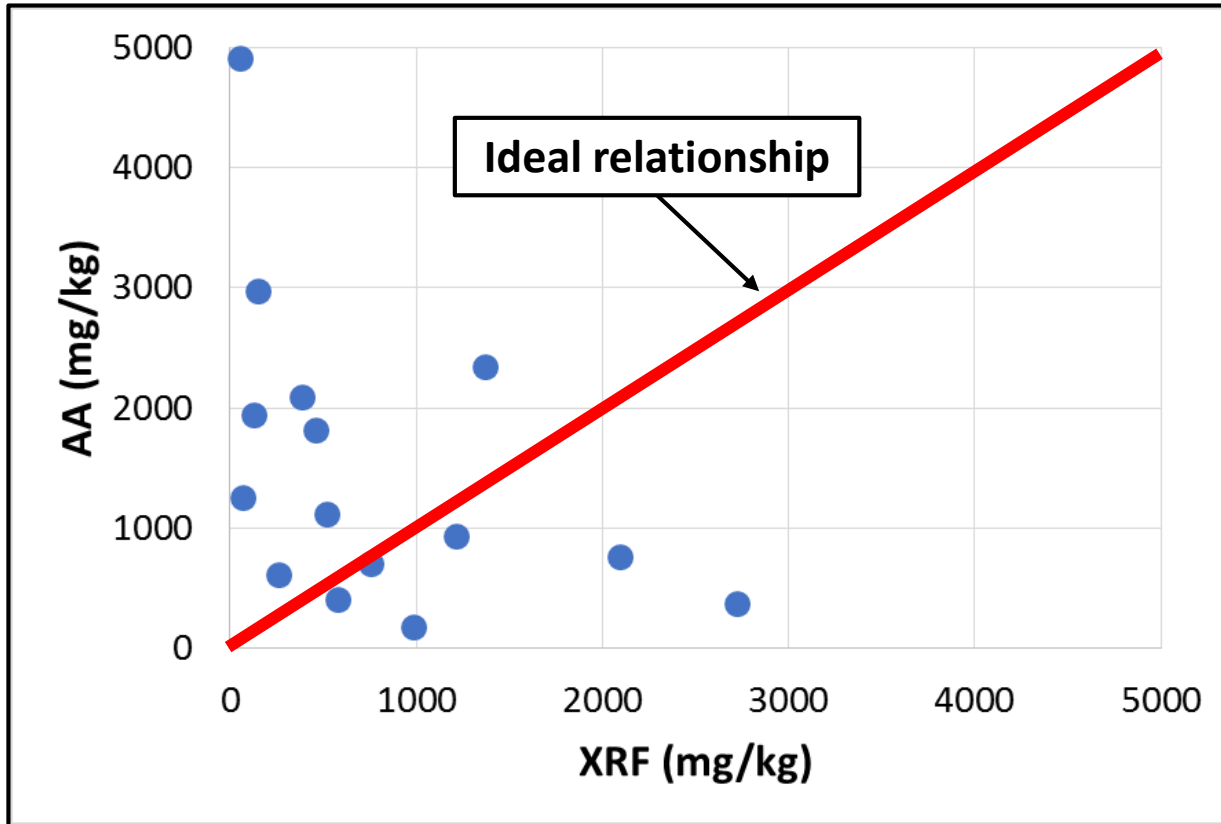


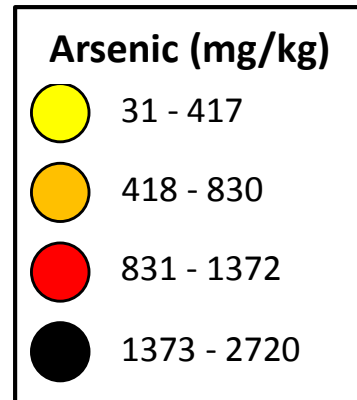
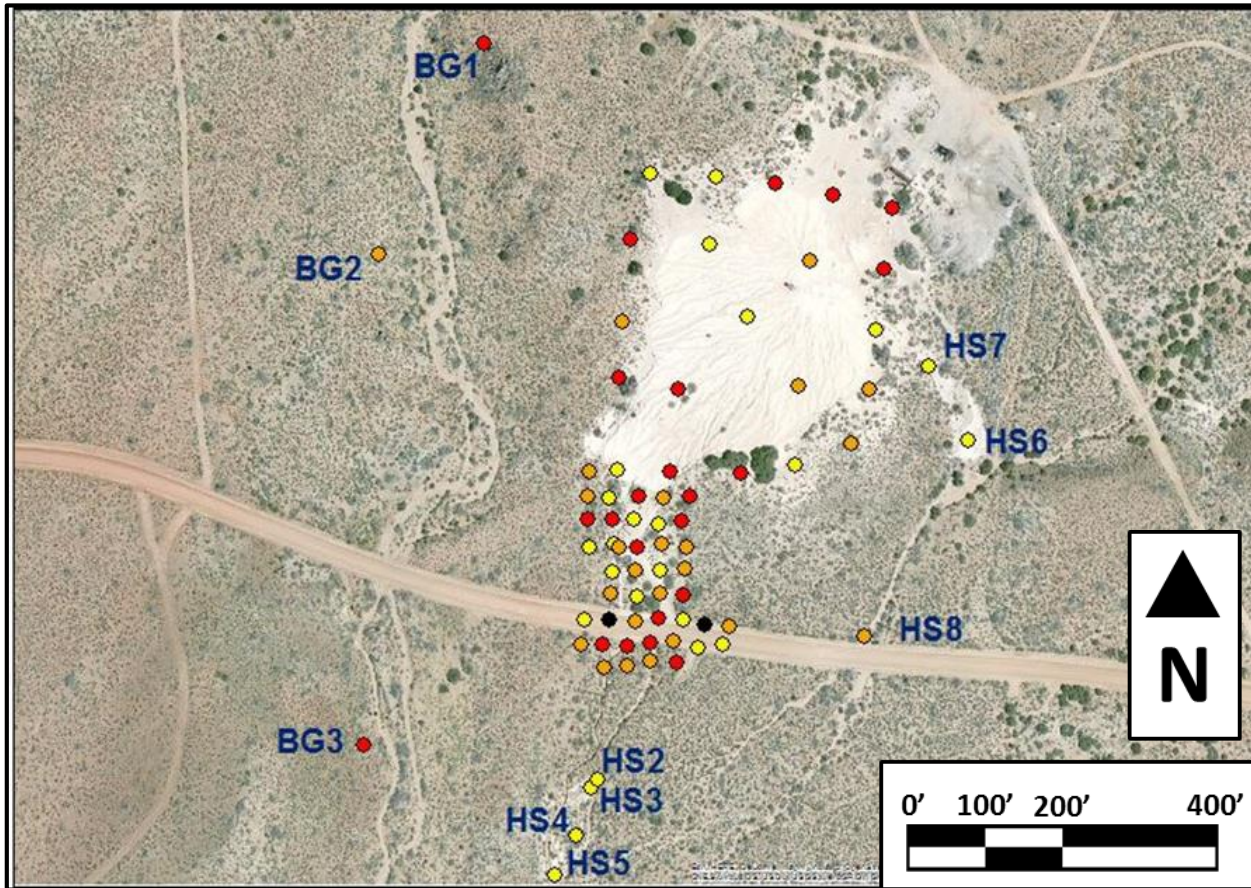
Figure 11. XRF and AA correlation

# XRF Inaccuracy

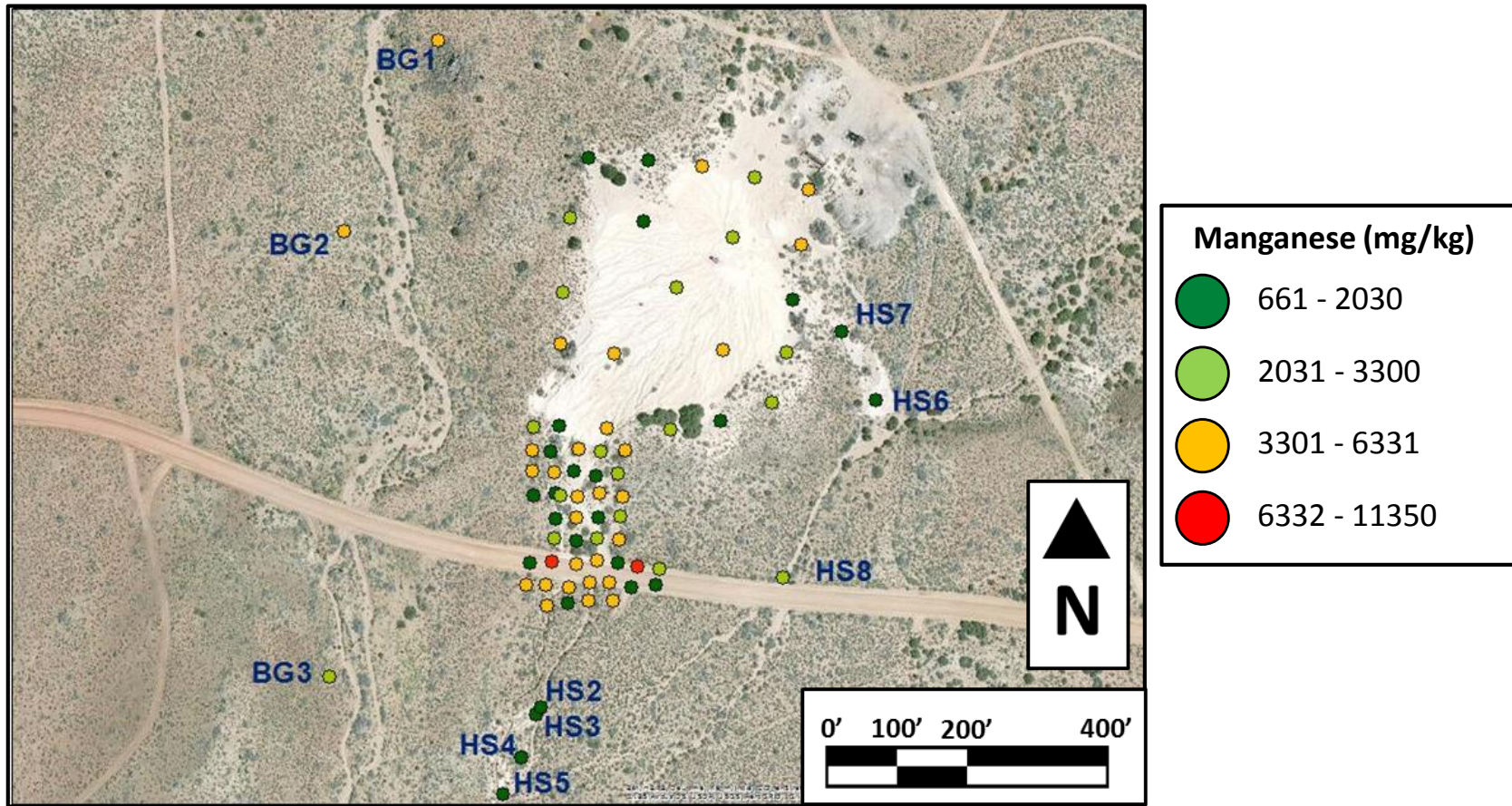
- Potential causes:
  - soil moisture  
(results run lower)
  - soil homogeneity
  - spectral interference



**Figure 12.** Dried soil samples [2]

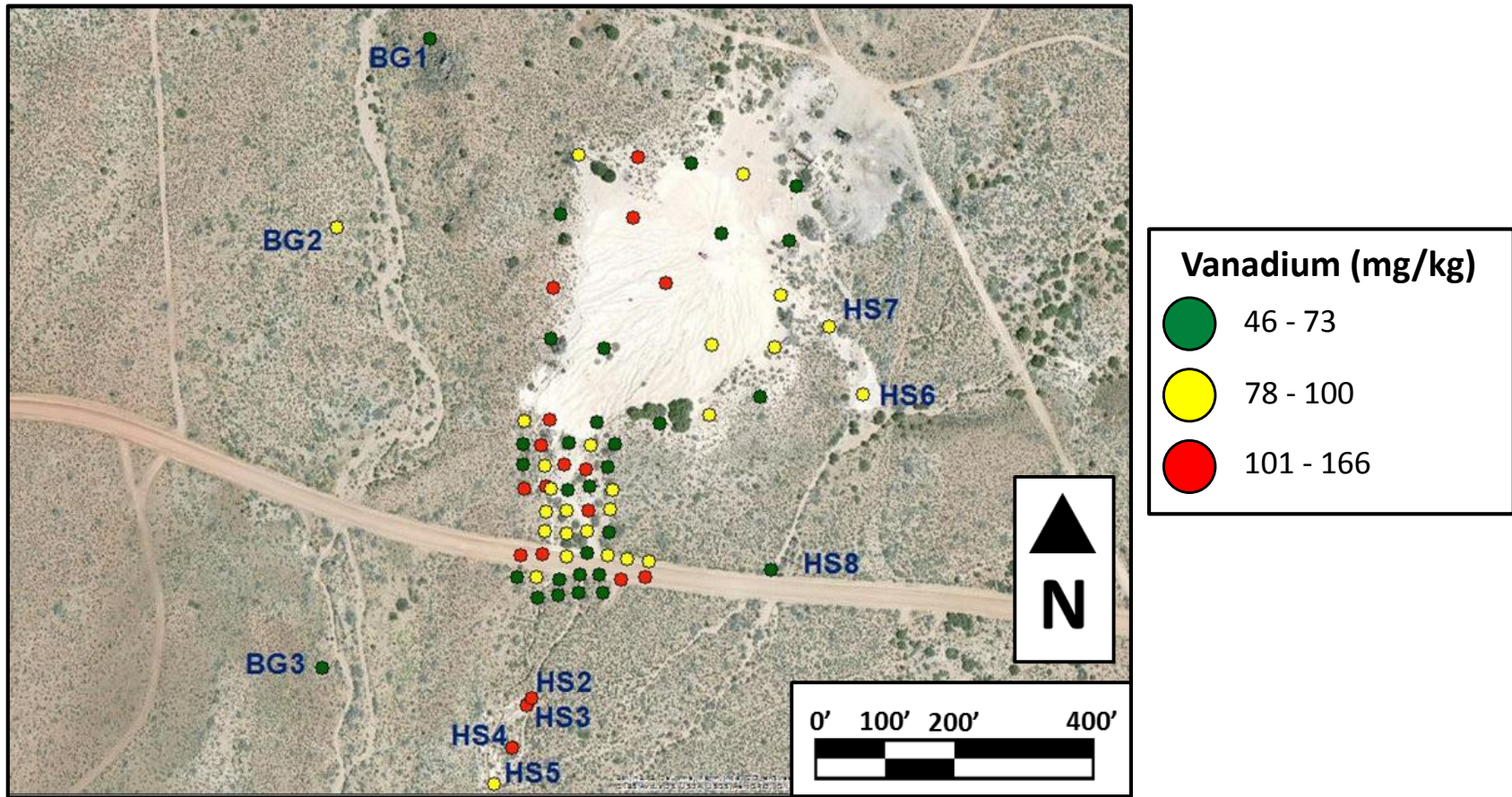


**Figure 13.** Arsenic GIS Map



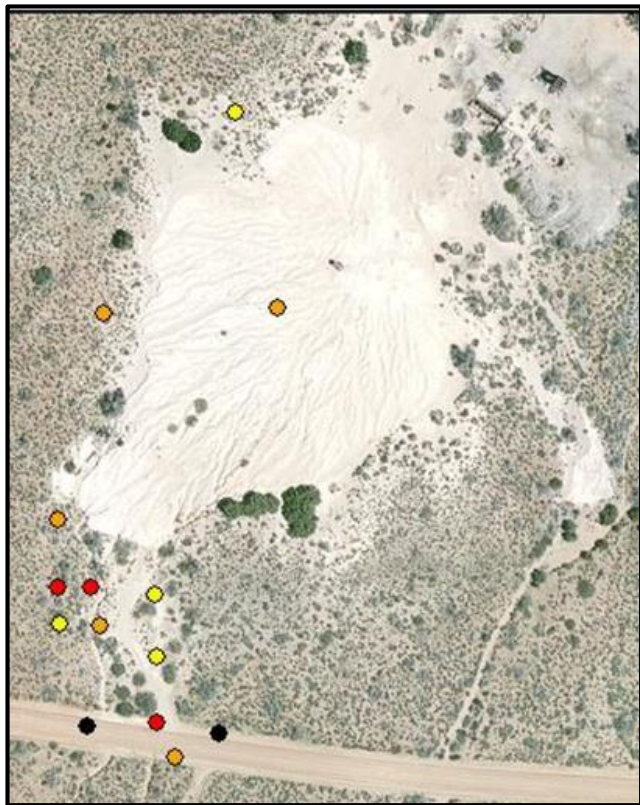
**Figure 14. Manganese GIS Map**



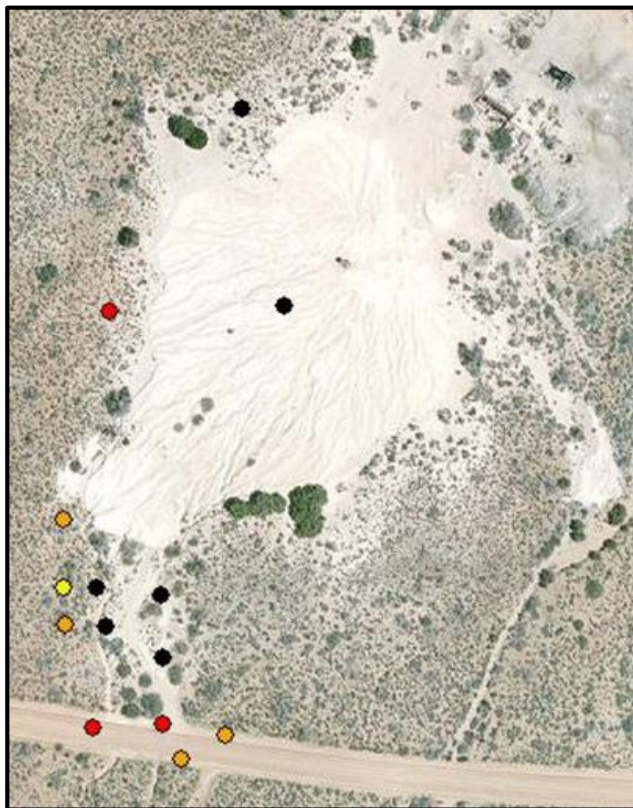


**Figure 15. Vanadium GIS Map**

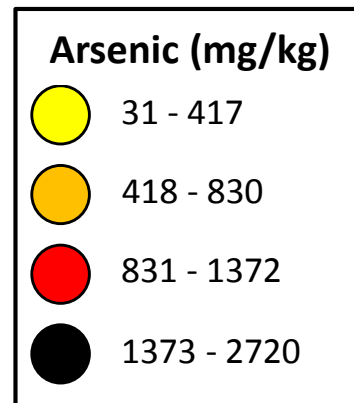
# XRF vs. AA



**Figure 16.** Arsenic by XRF analysis



**Figure 17.** Arsenic by AA analysis



# Risk Assessment

- Exposure scenarios:
  - residential
  - recreational
  - visiting
  - remediation worker
- Age groups:
  - adult
  - child age 6-12
  - child age 2-6
- Parameters:
  - body mass
  - soil ingestion
  - exposure duration
  - exposure concentration (50<sup>th</sup> percentile for all)

# Hazard Index: Adult

**Table 3.** Risk for adults (index > 1 represents risk)

Chemical	Residential	Recreational	Visiting	Worker
<b>As</b>	3.10	0.02	0.14	0.74
<b>Mn</b>	0.03	0.00	0.00	0.01
<b>V</b>	0.01	0.00	0.00	0.00

# Hazard Index: Child age 6-12

**Table 4.** Risk for children age 6-12 (index > 1 represents risk)

Chemical	Residential	Recreational	Visiting
<b>As</b>	7.50	0.04	0.34
<b>Mn</b>	0.08	0.00	0.00
<b>V</b>	0.03	0.00	0.00

# Hazard Index: Child age 2-6

**Table 5.** Risk for children age 2-6 (index > 1 represents risk)

Chemical	Residential	Recreational	Visiting
<b>As</b>	27.17	0.16	1.21
<b>Mn</b>	0.27	0.00	0.01
<b>V</b>	0.11	0.00	0.01

# Cancer Risk (in 10,000 people)

**Table 6.** People at risk for cancer in 10,000

Person	Residential	Recreational	Visiting	Worker
Adult	6.0	0.01	0.26	0.05
Child (6-12)	2.9	0.02	0.12	-
Child (2-6)	7.0	0.04	0.30	-

# Ecological Risk

- Fauna

- desert tortoise (endangered)
- rattlesnake
- desert horned lizard
- jackrabbit
- coyote
- raven



**Figure 18.** Desert tortoise [5]

- Flora

- creosote bush
- yucca



**Figure 19.** Yucca plant [2]



# Recommendations to BLM

- Further analysis of site
  - review soil sample data
  - confirm PA/SI results



**Figure 20.** Mine tailings [2]

# Schedule

**Table 7.** Projected vs. actual finish dates

Task		Projected	Actual
1.0 Work Plan		12/15/2016	12/15/2016
2.0 Training		1/19/2017	1/19/2017
3.0 Soil Sampling		1/21/2017	1/21/2017
4.0 Lab Analysis			
4.1	Drying and Sieving of Soil	2/22/2017	2/11/2017
4.2	XRF Analysis	2/26/2017	2/19/2017
4.3	Acid Digestion	3/5/2017	3/4/2017
4.4	Atomic Absorption	3/24/2017	4/6/2017
4.5	XRF & AA Correlation	4/2/2017	4/10/2017
4.6	GIS Mapping	4/2/2017	4/10/2017
5.0 Screening Risk Assessment		4/16/2017	4/19/2017
6.0 PA/SI		4/30/2017	5/9/2017
7.0 Project Management		5/9/2017	5/9/2017

Key
On-time
Late

# Staffing & Cost of Services

**Table 8.** Projected vs. actual hours and costs

	Projected Hours	Actual Hours	Projected Cost	Actual Cost
<b>1.0 Personnel</b>				
SENG	112	40	\$ 18,816	\$ 6,720
ENG	180	128	\$ 16,200	\$ 11,520
LAB	260	180	\$ 17,940	\$ 12,420
INT	190	136	\$ 5,130	\$ 3,672
ADMA	48	50	\$ 2,520	\$ 2,625
Total Hours	<b>790</b>	<b>534</b>	<b>\$ 60, 606</b>	<b>\$ 36,957</b>
<b>2.0 Subcontracted Analysis</b>			<b>\$ 194</b>	<b>\$ 233</b>
<b>3.0 Materials</b>			<b>\$ 315</b>	<b>\$ 392</b>
<b>4.0 Travel</b>			<b>\$ 985</b>	<b>\$ 985</b>
<b>5.0 Lab Rental</b>			<b>\$ 2,400</b>	<b>\$ 2,400</b>
<b>Total Project Cost</b>			<b>\$ 64,500</b>	<b>\$ 41,000</b>

# References

- [1] Google Earth, “AZ Magma Mill,” 35°25’00” N 114°13’27” W, Accessed: December 4, 2016.
- [2] Photo taken by Jessica Szaro
- [3] Photo taken by Dr. Bridget Bero
- [4] “Arizona Administrative Code Title 18, Ch.7.” Arizona Department of Environmental Quality. 2009.
- [5] “Desert Tortoise.” National Geographic Kids. Accessed: April 19, 2017.

# Thank you!



**Figure 21.** Team Magma (photo taken by Dr. Bero)