Iron King / Humboldt Smelter Superfund Site

Findings for Arsenic and Lead in Residential Yards

April 2015

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U.S. EPA Region IX

EPA Fact Sheet

EPA

Iron King Mine / Humboldt Smelter Superfund Site

U.S. Environmental Protection Agency • Region 9 • San Francisco, CA • April 2015

EPA Sampling Results for Arsenic and Lead in Soils in Residential Yards

This fact sheet discusses the results of the U.S. Environmental Protection Agency's (EPA) sampling of soils for arsenic and lead in residential yards in Dewey-Humboldt. EPA's sampling of yards is part of a larger environmental investigation related to the historical mine and smelter operations 75 to 110 years ago.

EPA is currently evaluating the possible health risks posed by contamination in residential yards, at the former mine and smelter properties, and in contaminated gulches and storm water pathways in Dewey-Humboldt. EPA is also exploring potential cleanup options for this contamination. EPA will continue to update and seek input from community members before a cleanup action is selected for the Iron King Mine / Humboldt Smelter Site.

EPA has now screened or sampled soils in XX residential yards and analyzed more than YY samples during its investigation. Residents whose yards were fully evaluated with 10 samples during our 2014 field work have been sent individual letters with their soil results.

Where the Contamination Came From and Why EPA Sampled Residential Yards

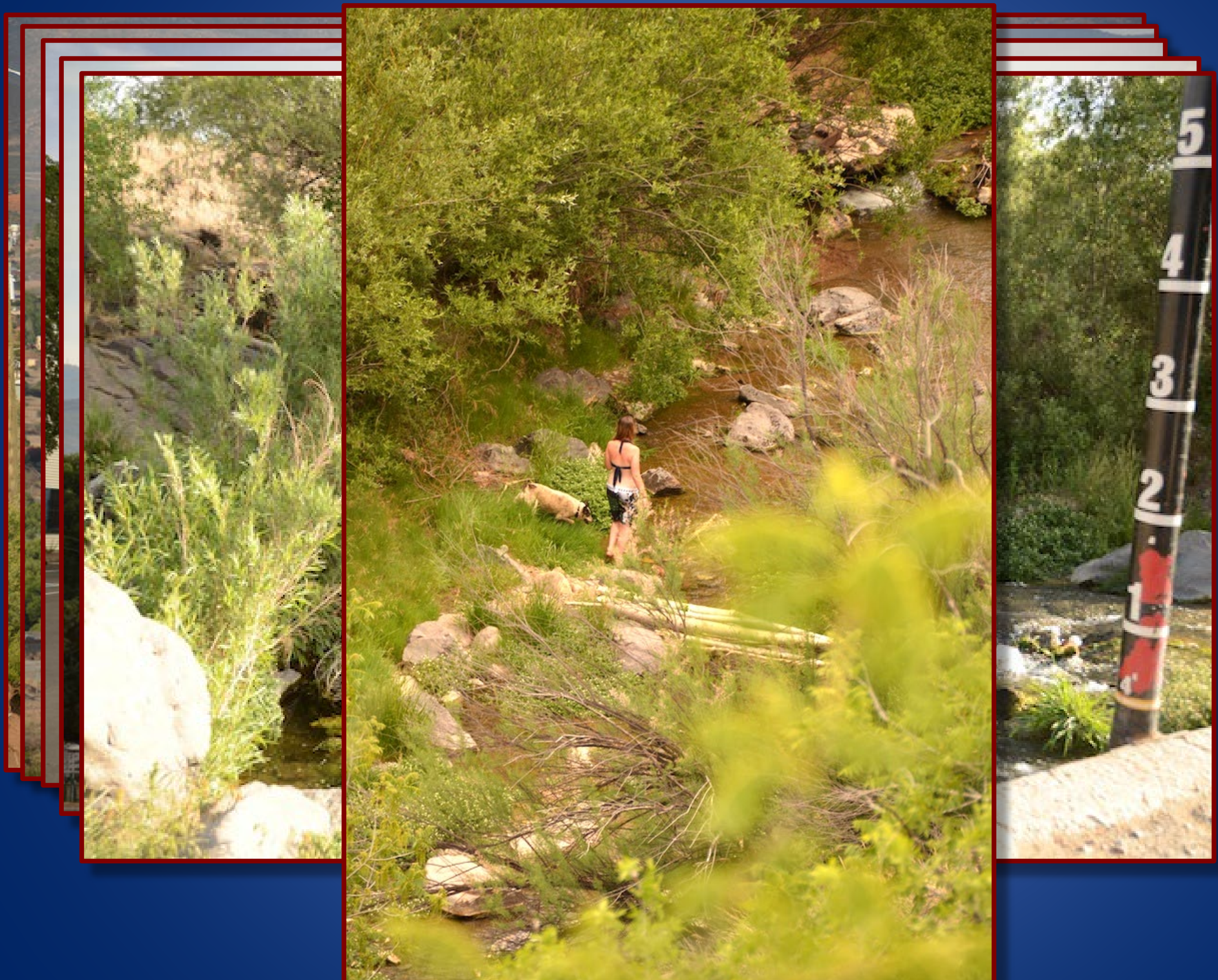
The old mining and smelting operations in Dewey-Humboldt produced waste called *tailings* that have high levels of arsenic and lead. The companies who ran the mine and smelter dumped fine-grained tailings in piles — such as the 4-million cubic-yard tailings pile on Highway 69 — and in ponds held back by dikes or dams. Over time, piles collapsed and dikes failed. This allowed tailings to move into storm drainages and gulches where they are found today, mixed in with other soils. While in operation, the smelter also released contaminated particles into the air through its smoke stack.

Over decades, some of the mine and smelter tailings also reached residential yards. Tailings or particles may have blown in the wind, been used as fill material, or been left in areas that later became yards. If levels of arsenic and lead in residential soils are high enough, they can pose health risks to persons exposed to the soils. For this reason, EPA has investigated where residential soils have high levels of arsenic or lead because of the mine and smelter, and whether these elevated levels may pose a health risk to residents. EPA's investigation has found that some residential yards have soil that has been impacted by the mine or smelter, though most yards have not been affected.

Information at a Glance

- EPA has finished sampling and studies in both residential and non-residential areas of the Iron King Mine/Humboldt Smelter Superfund Site.
- EPA has sampled arsenic and lead levels in soils for over XX residential yards in Dewey-Humboldt.
- The majority of yards sampled do not have arsenic and lead levels that would pose an elevated health risk, even to someone exposed over years or decades.
- EPA has not yet decided which yards will need cleanup.
- Next, EPA will finish the investigation reports and risk assessment and begin evaluating cleanup options.

In the Midst of Humboldt …



In the Midst of Humboldt – Also, A Mining Legacy

…from 45 to as much as 120 years ago

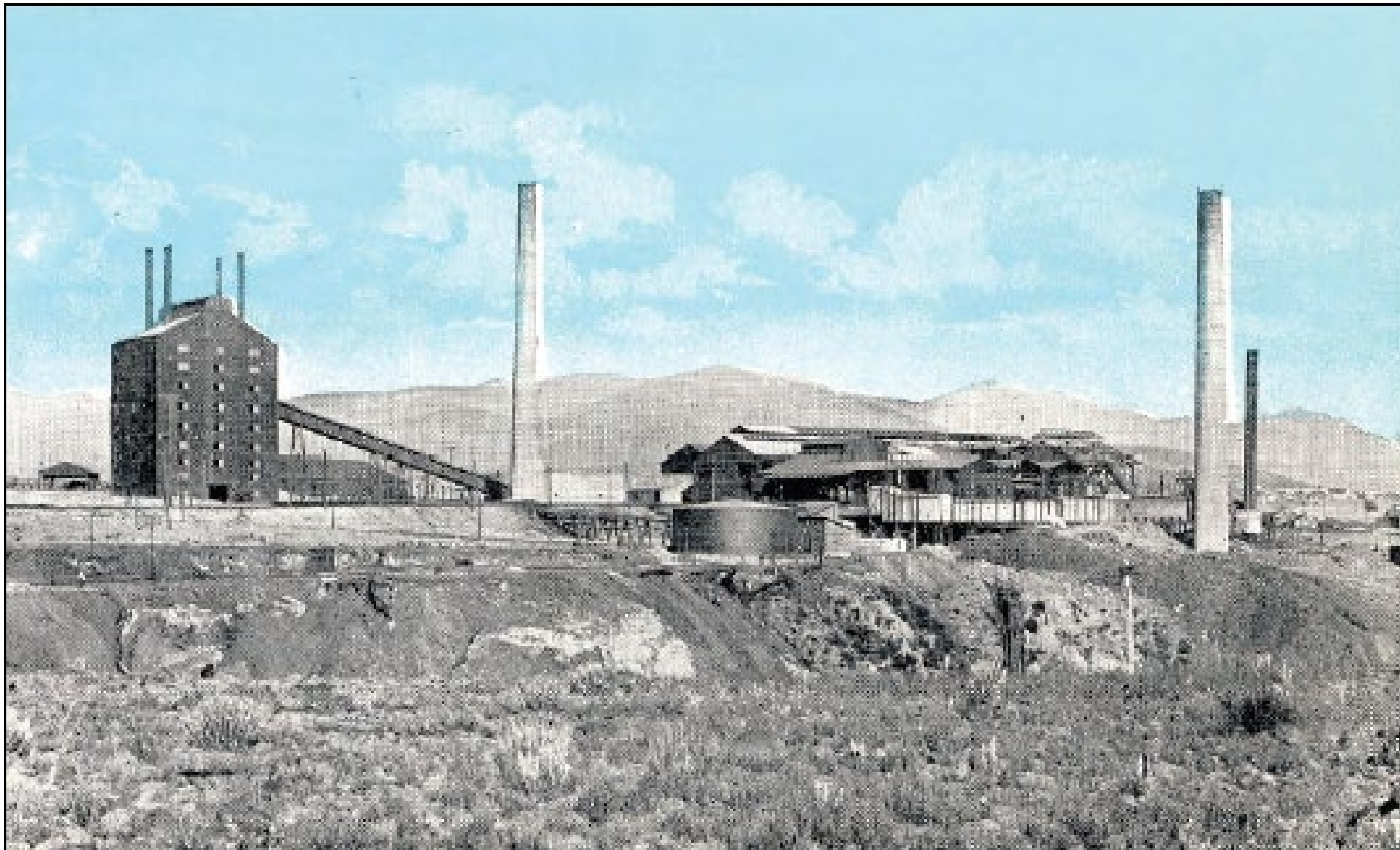
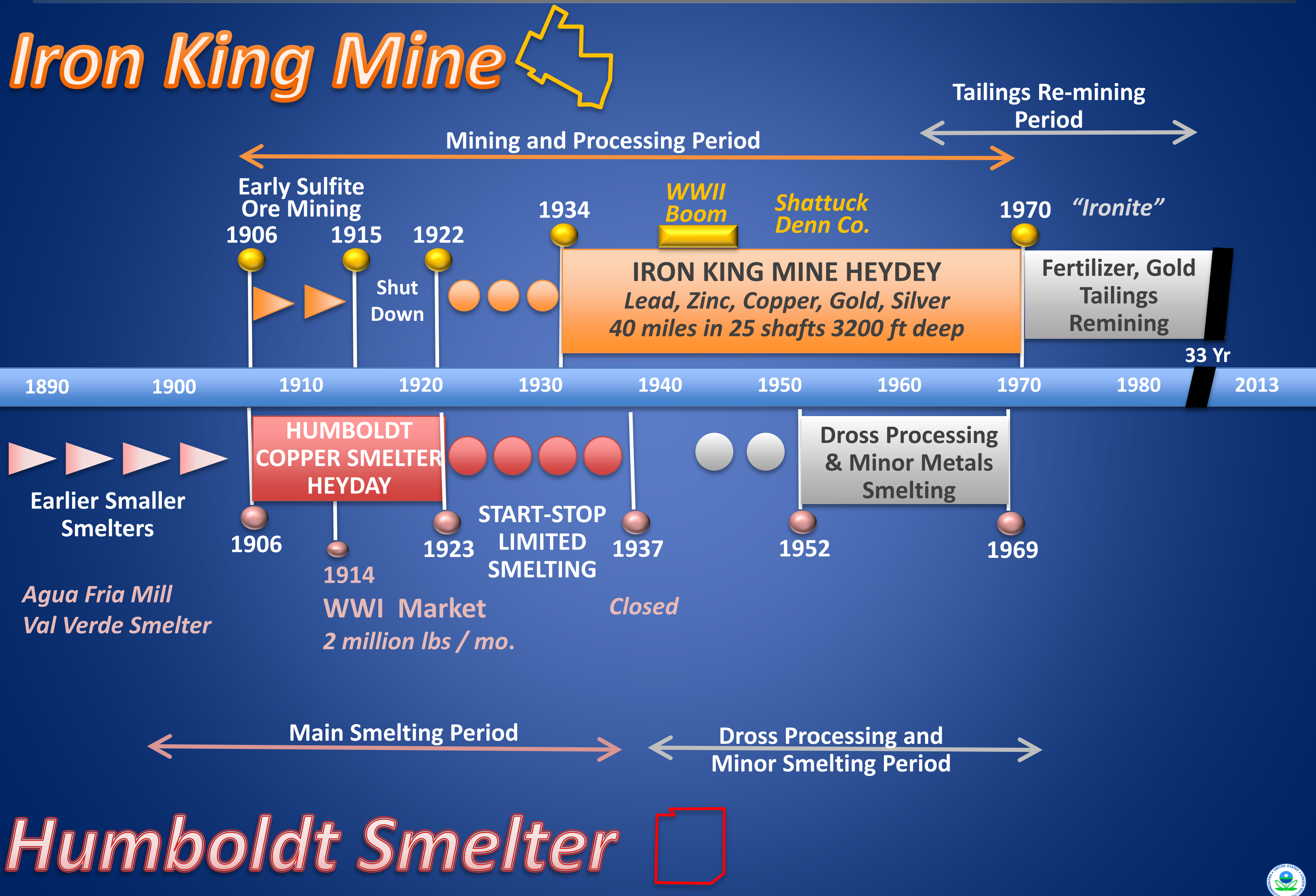


Figure 21. Ca. 1918 Tinted Postcard of Smelter and Sample Mill, Humboldt (image courtesy of Sharlot Hall Museum).

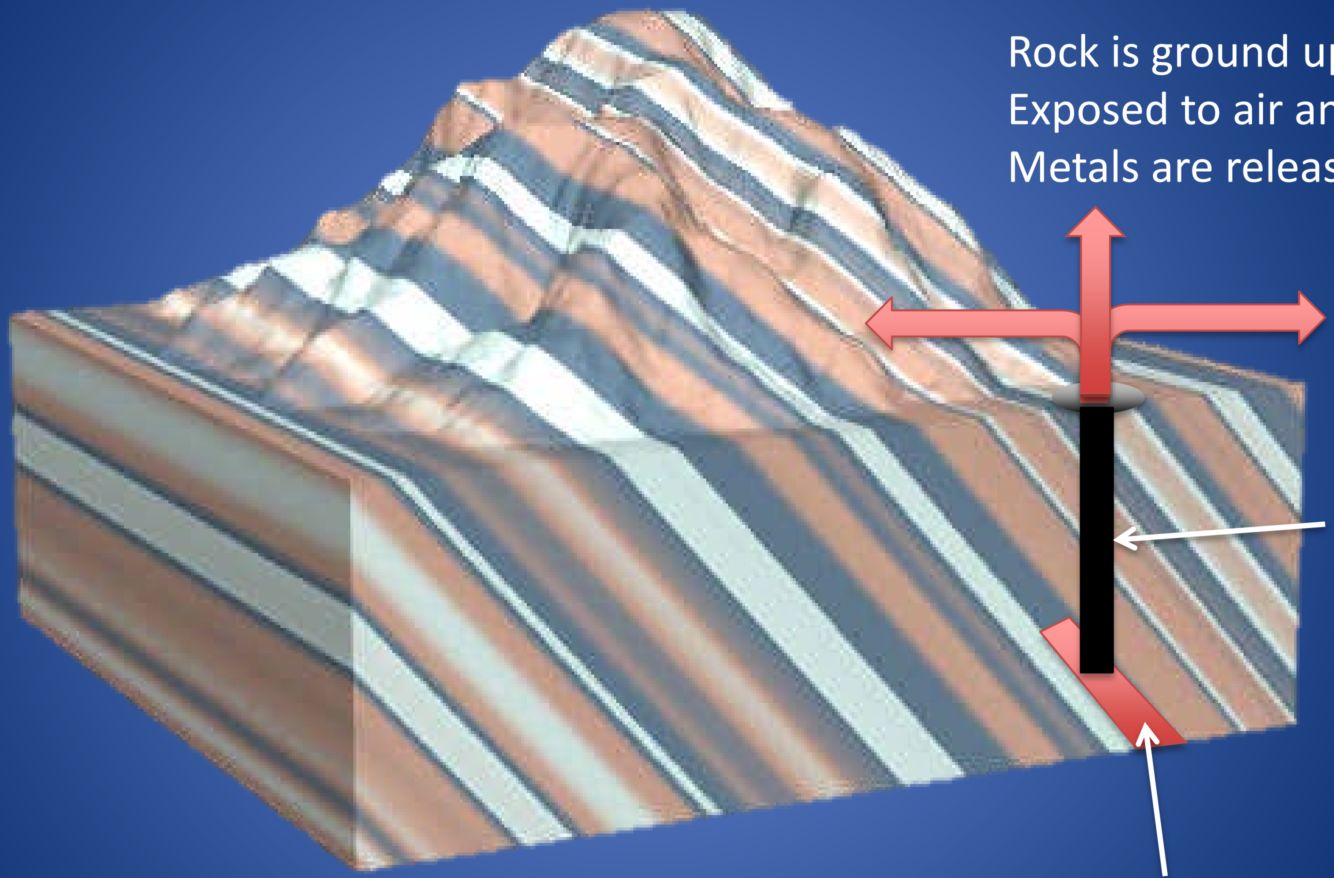
Figure 17. Ca. 1905–1907 Image of Arizona Smelting Company Smelter at Humboldt.

The History of the Mine and the Smelter



Why are Tailings a Problem?

They can have toxic levels of metals such as arsenic and lead.



Why are Tailings and Smelter Emissions a Problem?

They can have toxic levels of metals such as arsenic and lead.
…and they can move, mix, and react in the environment.

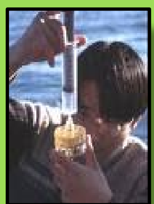
AIR

WATER

SOIL

The Superfund Process – Protect Human Health & Environment

Understand It



- What is it?
- Where is it?
- How much?
- How much from the site?

What Health Risk Does It Pose?

- How toxic is it?
- How much exposure for people?
- What chance to cause health effects?

What are the Options to Address it?

- What would work?
- How well?
- What does community think?

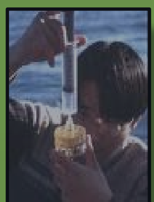
Pick an Option and Take Action

- Public Input
- Decide on Cleanup
- Design Cleanup
- Do Cleanup

The Superfund Process – Protect Human Health & Environment

Remedial Investigation

Understand It



- What is it?
- Where is it?
- How much?
- How much from the site?

Risk Assessment

What Extra Health Risk Does It Pose?

- How toxic is it?
- How much exposure for people?
- What chance to cause health effects?

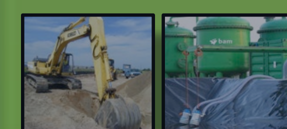
Feasibility Study

What are the Options to Address it?

- What would work?
- How well?
- What does community think?

Proposed Plan Record of Decision & Remedial Action

Pick an Option and Take Action



- Public Input
- Decide on Cleanup
- Design Cleanup
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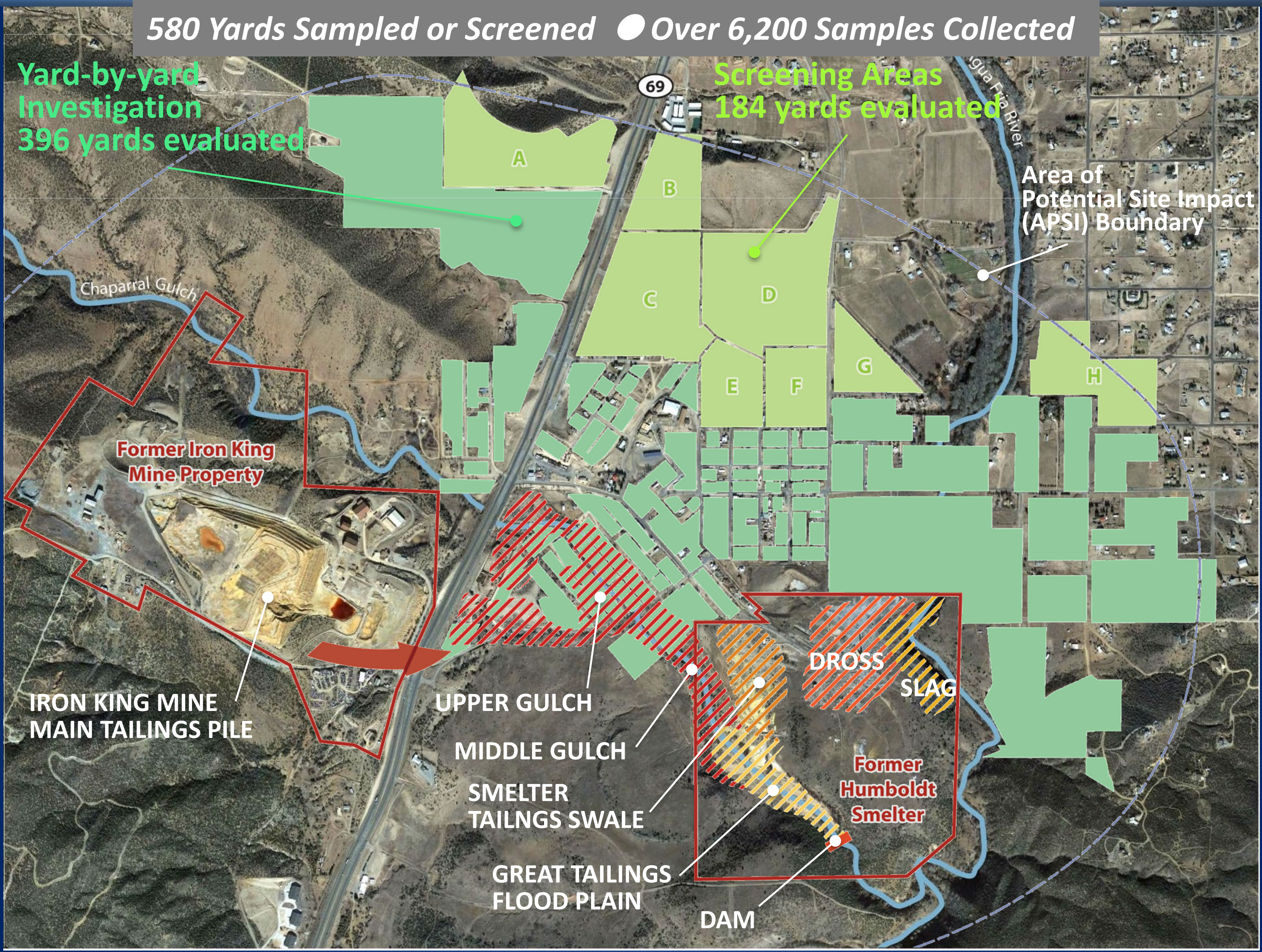
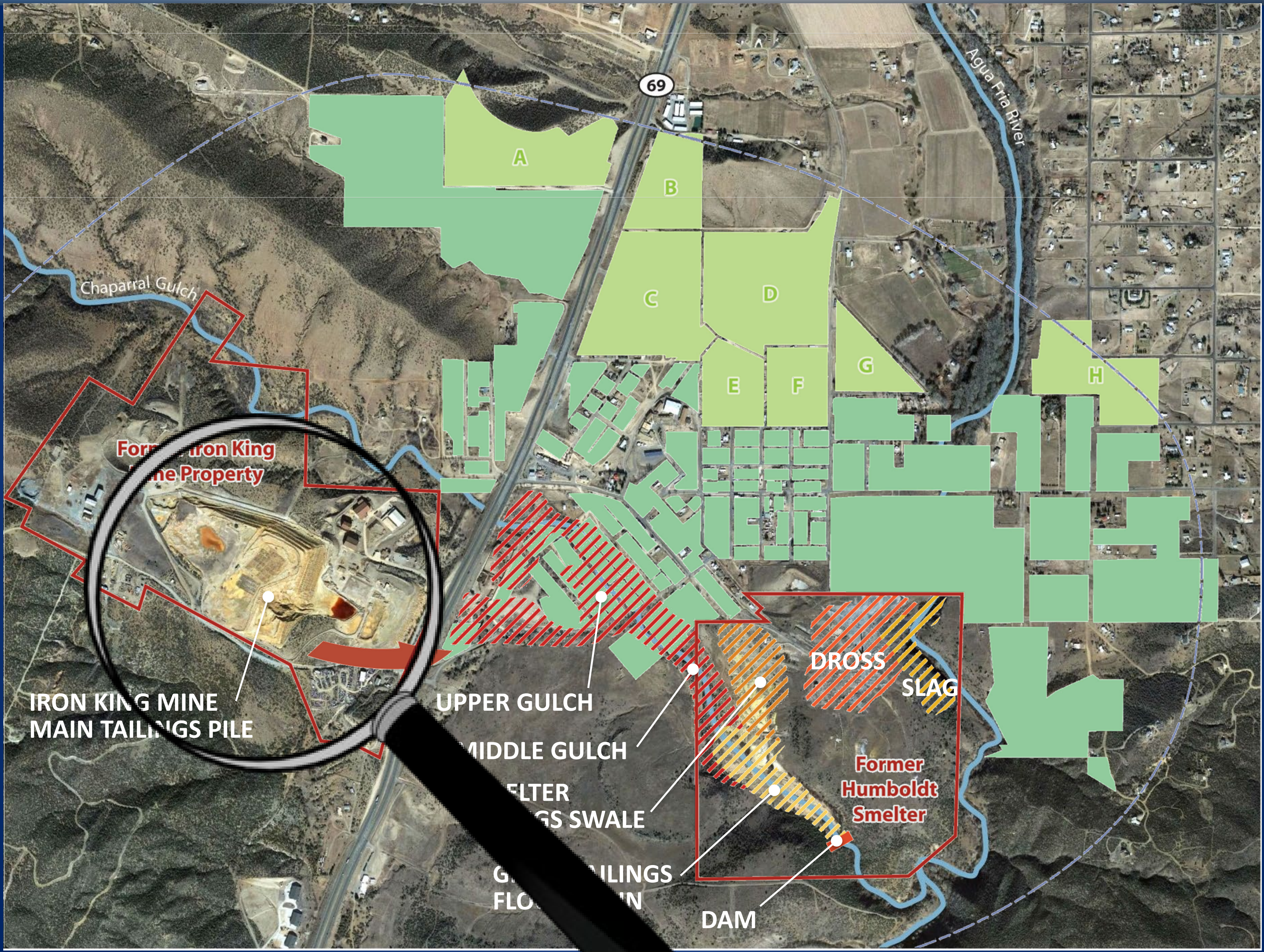
The Sources of Contamination and Areas of Focus for the Site



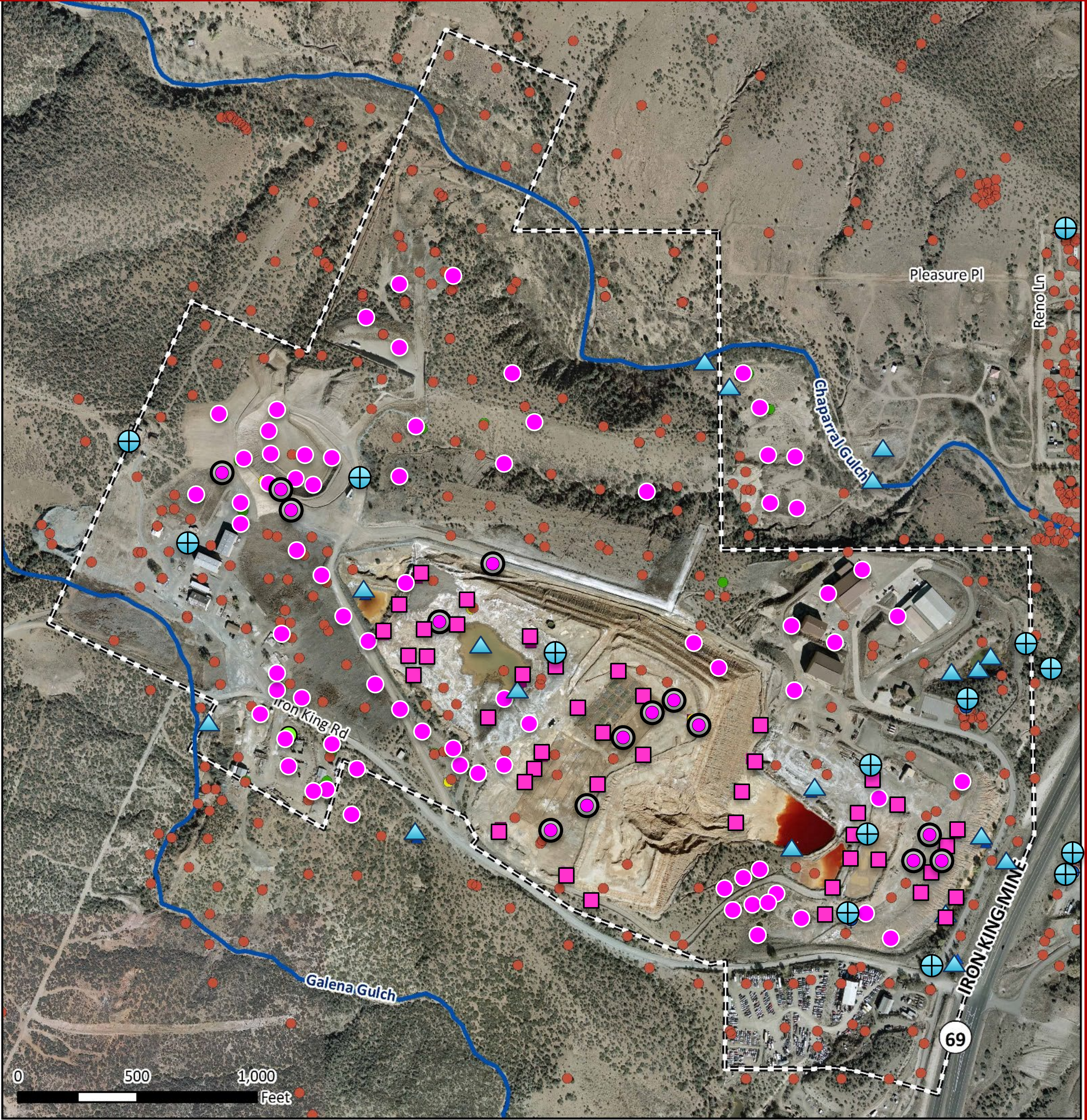
Exploring the Main Tailings Pile



Exploring the Main Tailings Pile

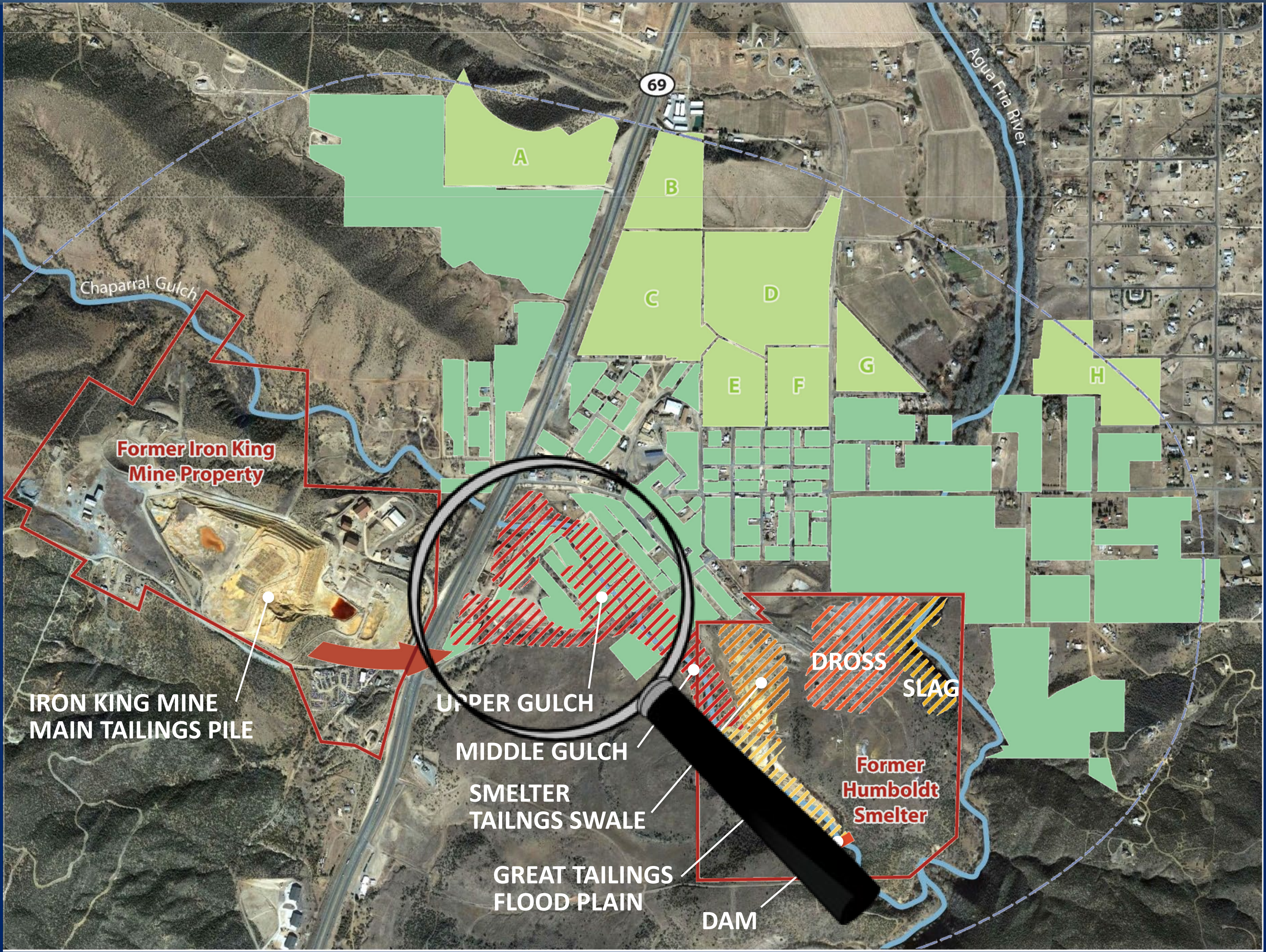
Figure 11. 1955 Aerial View of Iron King Mine, Looking East (photograph courtesy of Sharlot Hall
Museum).

Main Tailings Pile Investigation



- Surface Sample
- Boring 15 ft or less
- Boring up to 108 ft
- CPT boring up to 125 ft
- Groundwater Well to tailings bottom or bedrock
- Surface water sampling

Exploring the Upper Gulch



Exploring the Upper Gulch

Upper Gulch Investigation

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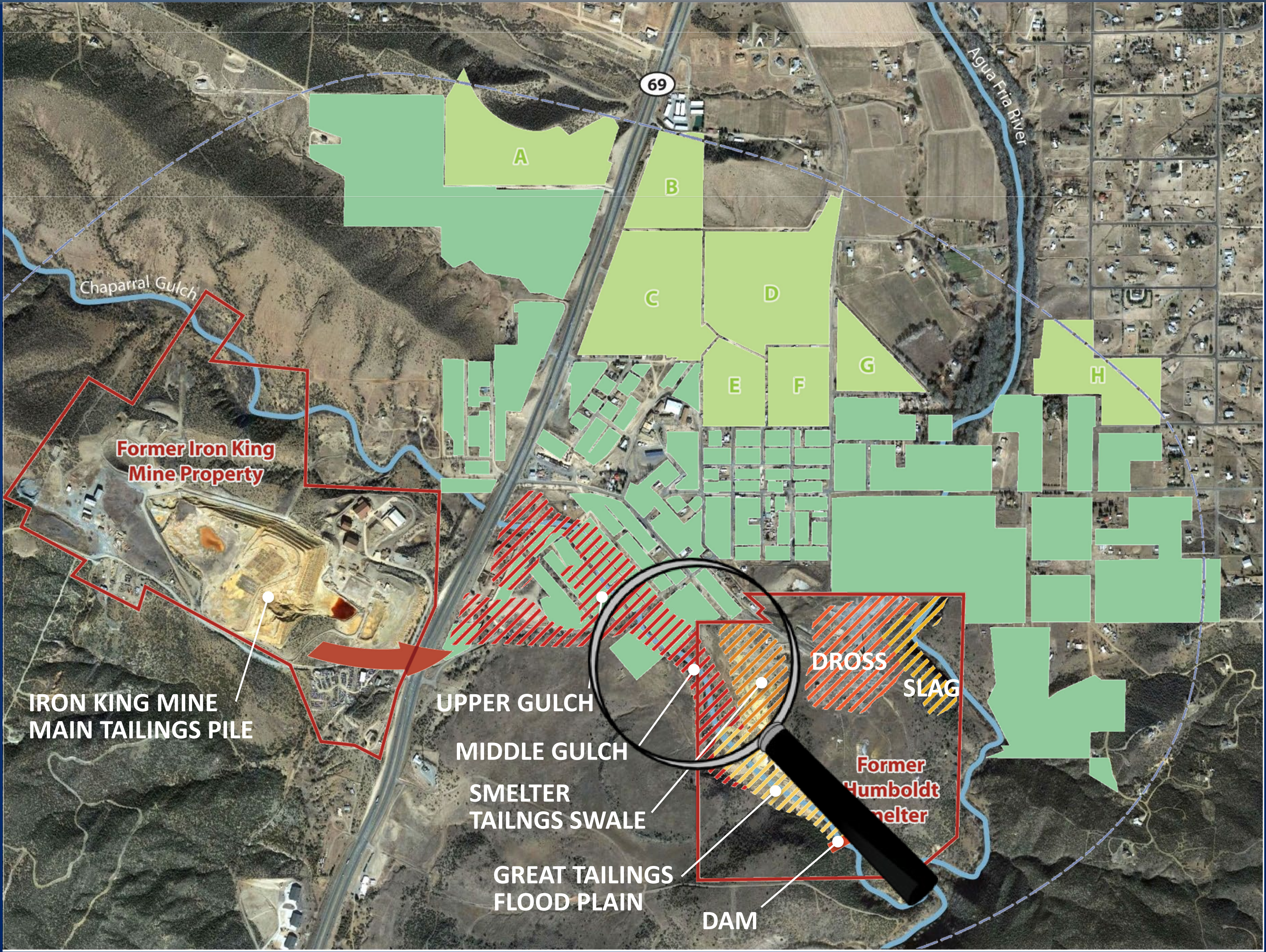
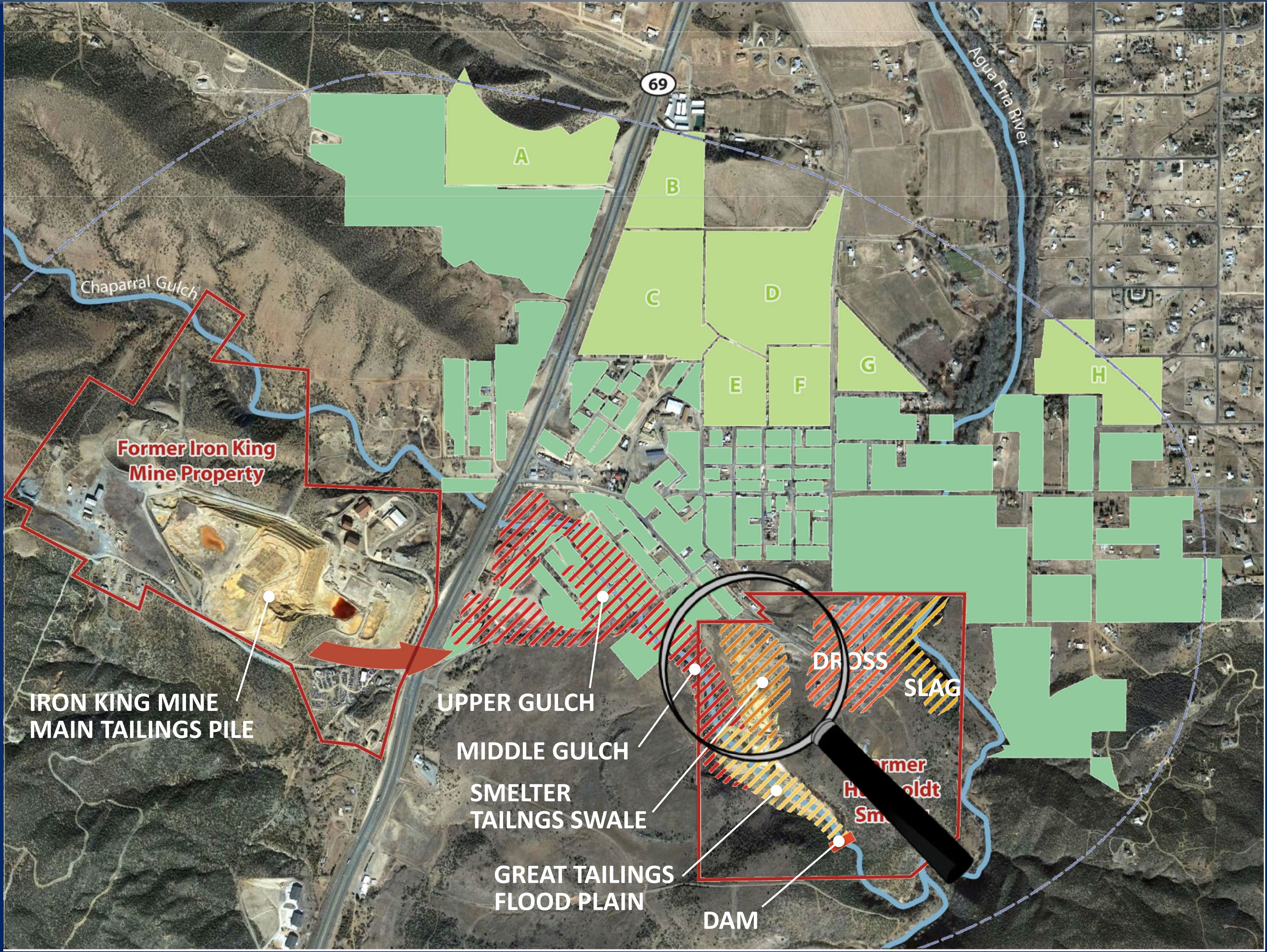
Exploring the Middle Gulch

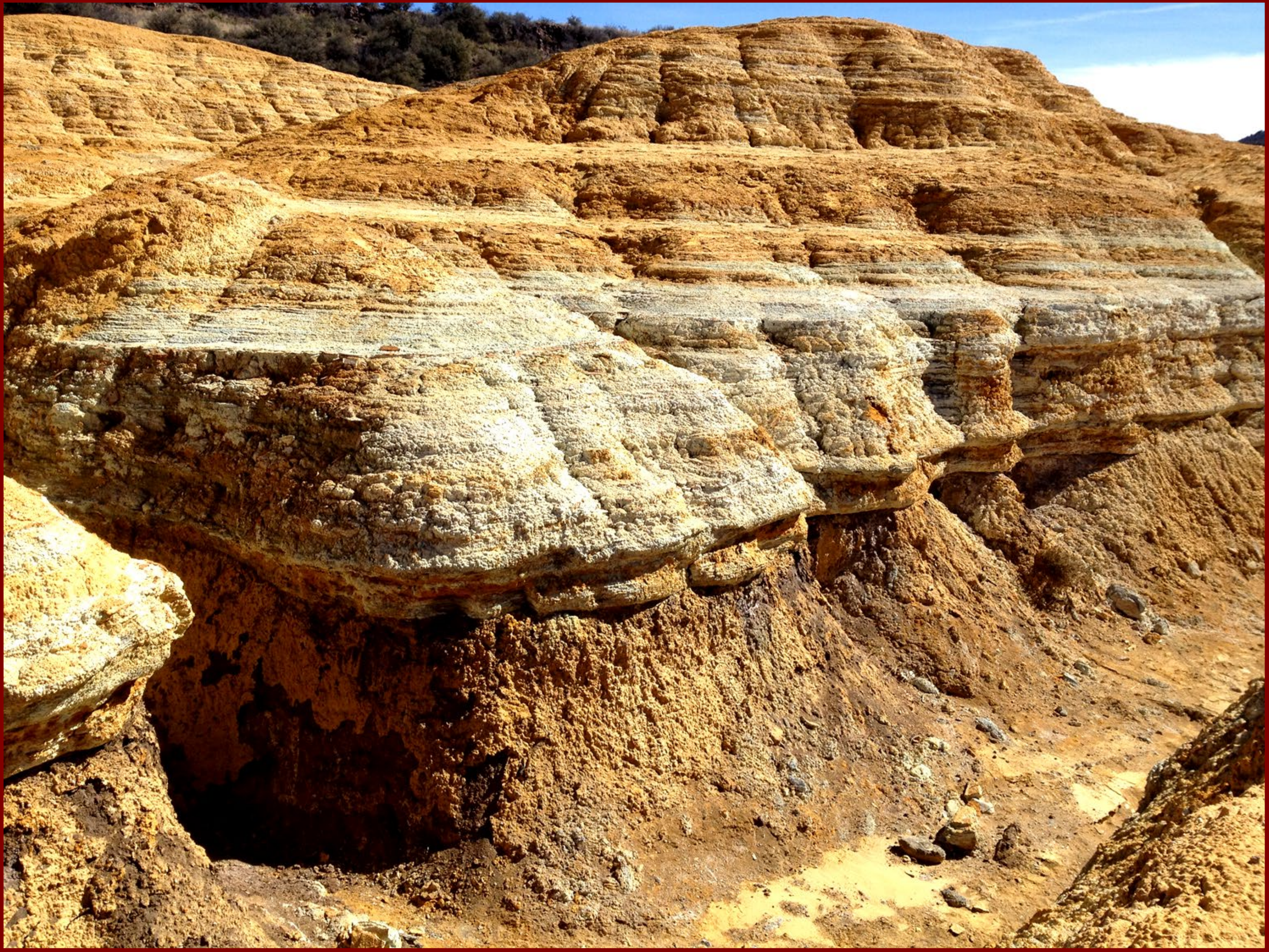


Middle Gulch Investigation

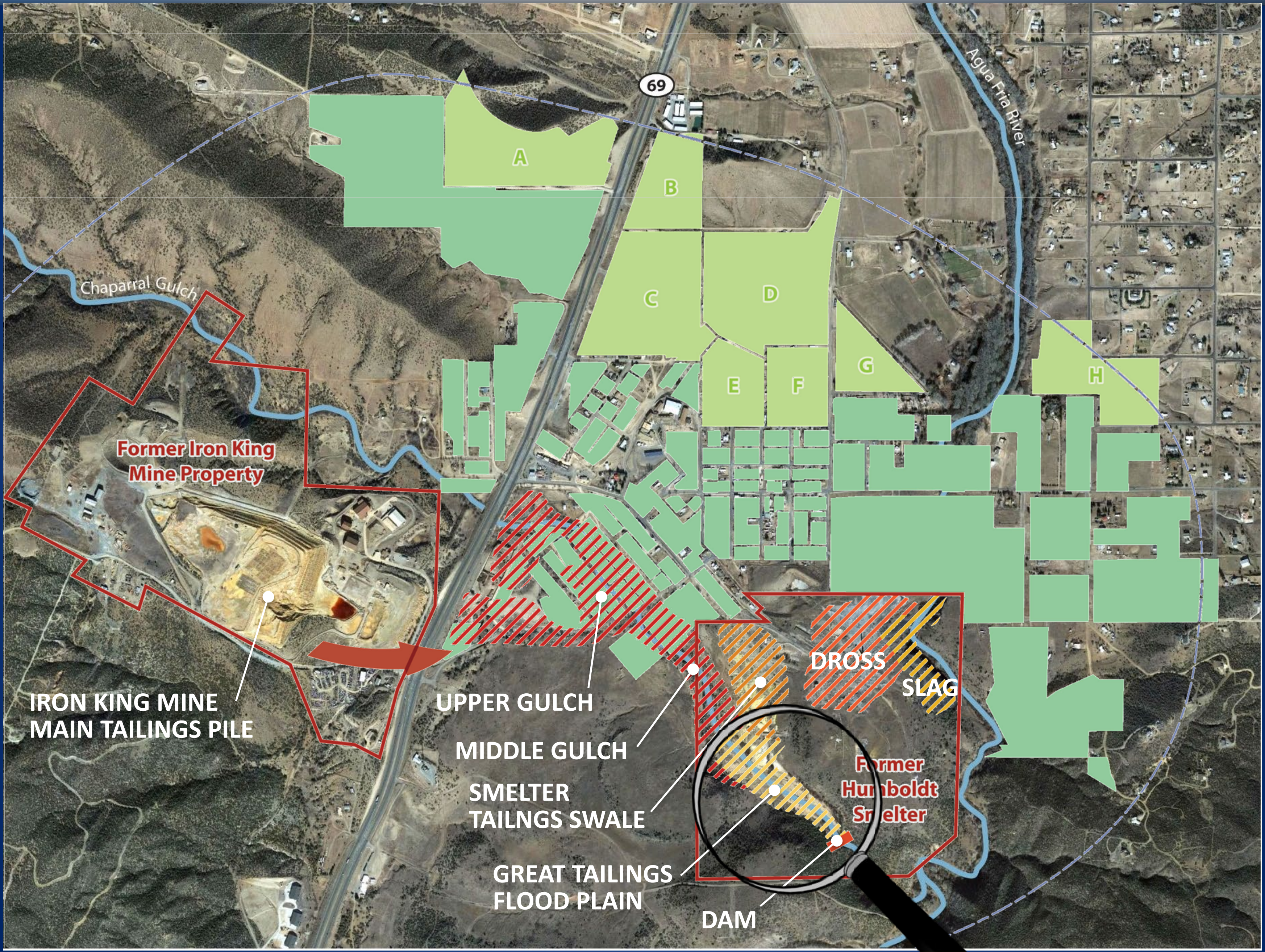
Exploring the Smelter Tailings Swale



Exploring the Smelter Tailings Swale

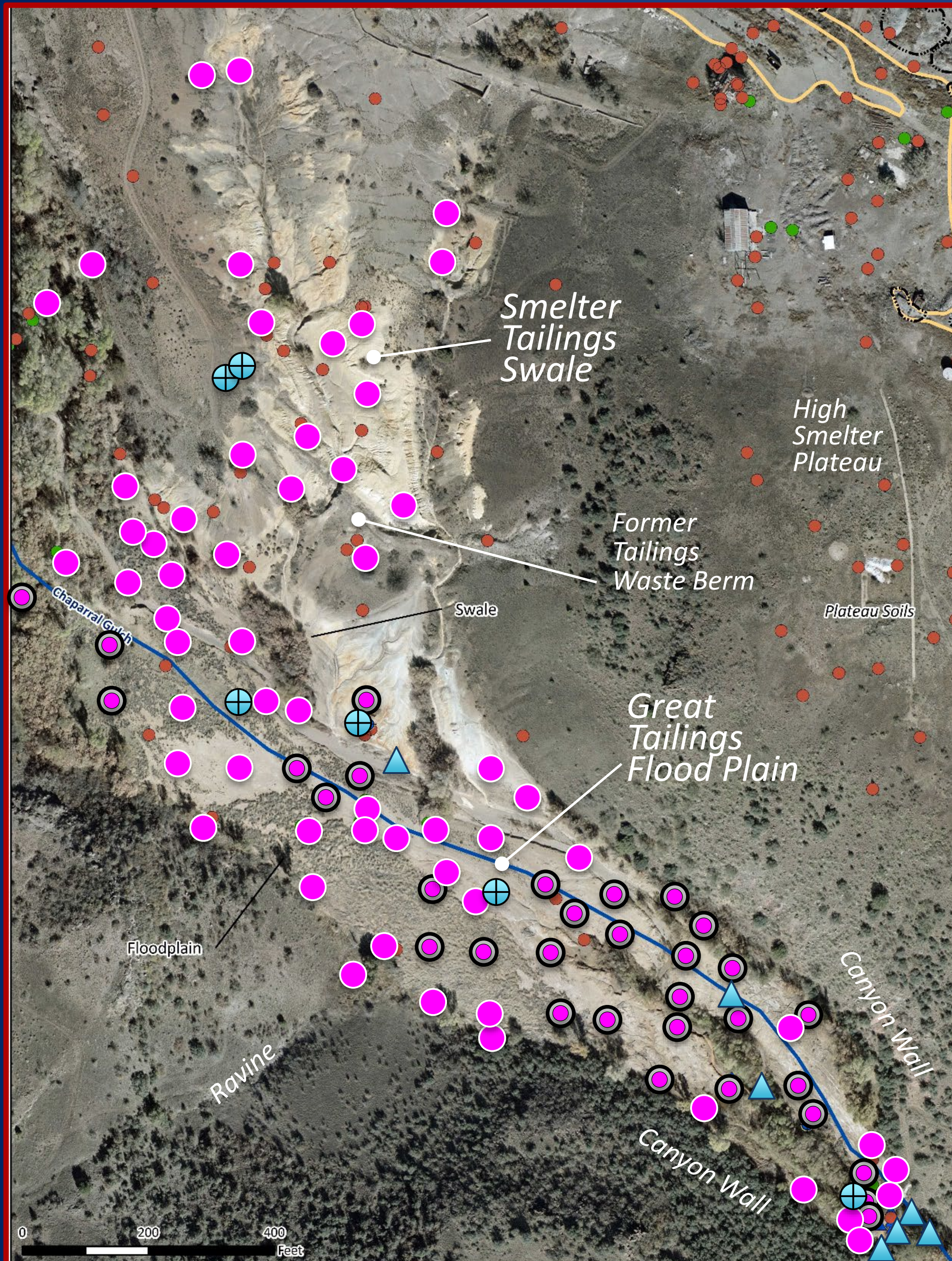


Exploring the Great Tailings Flood Plain



Exploring the Great Tailings Flood Plain

Great Tailings Flood Plain & Smelter Tailings Swale Investigation



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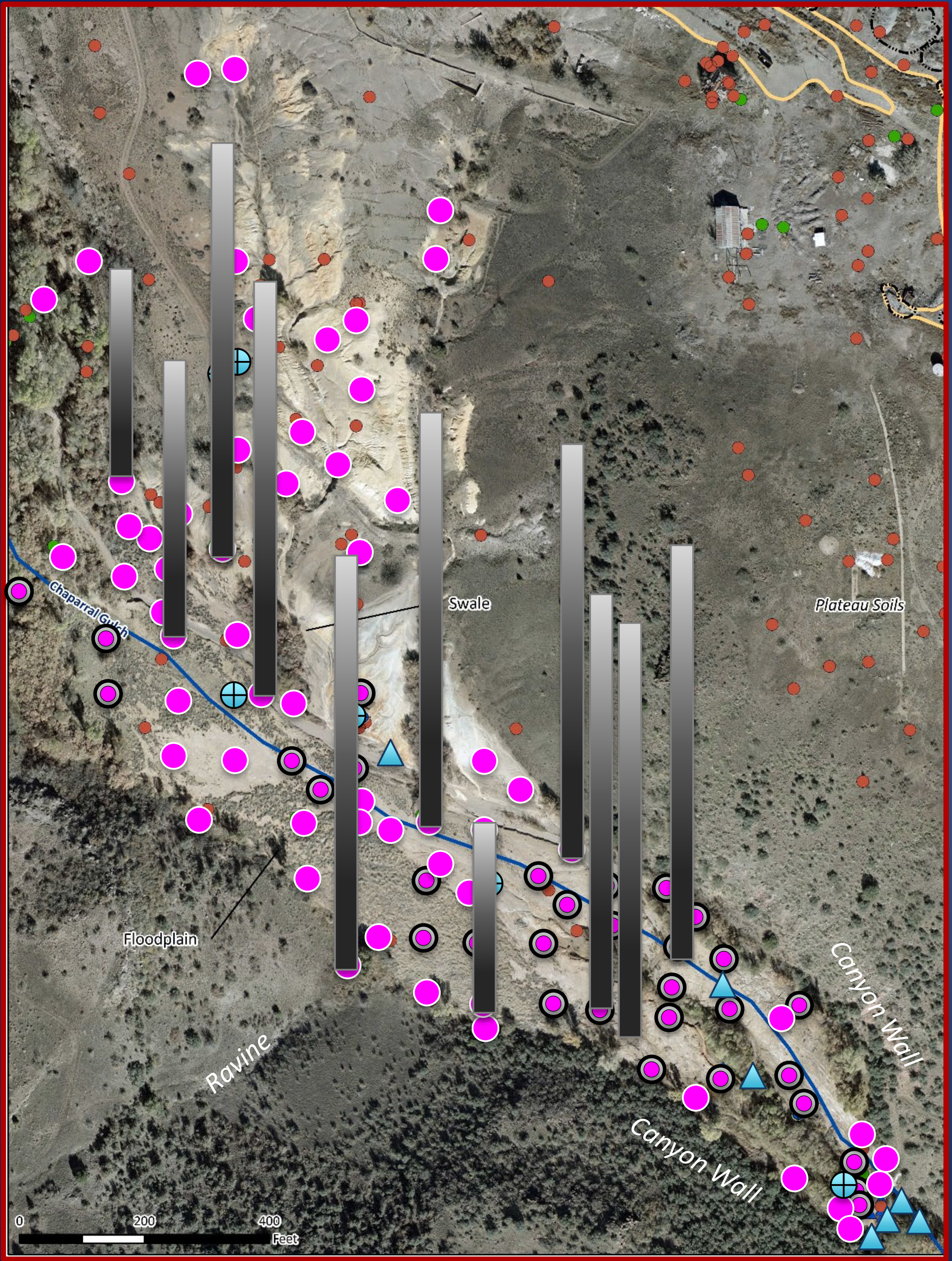


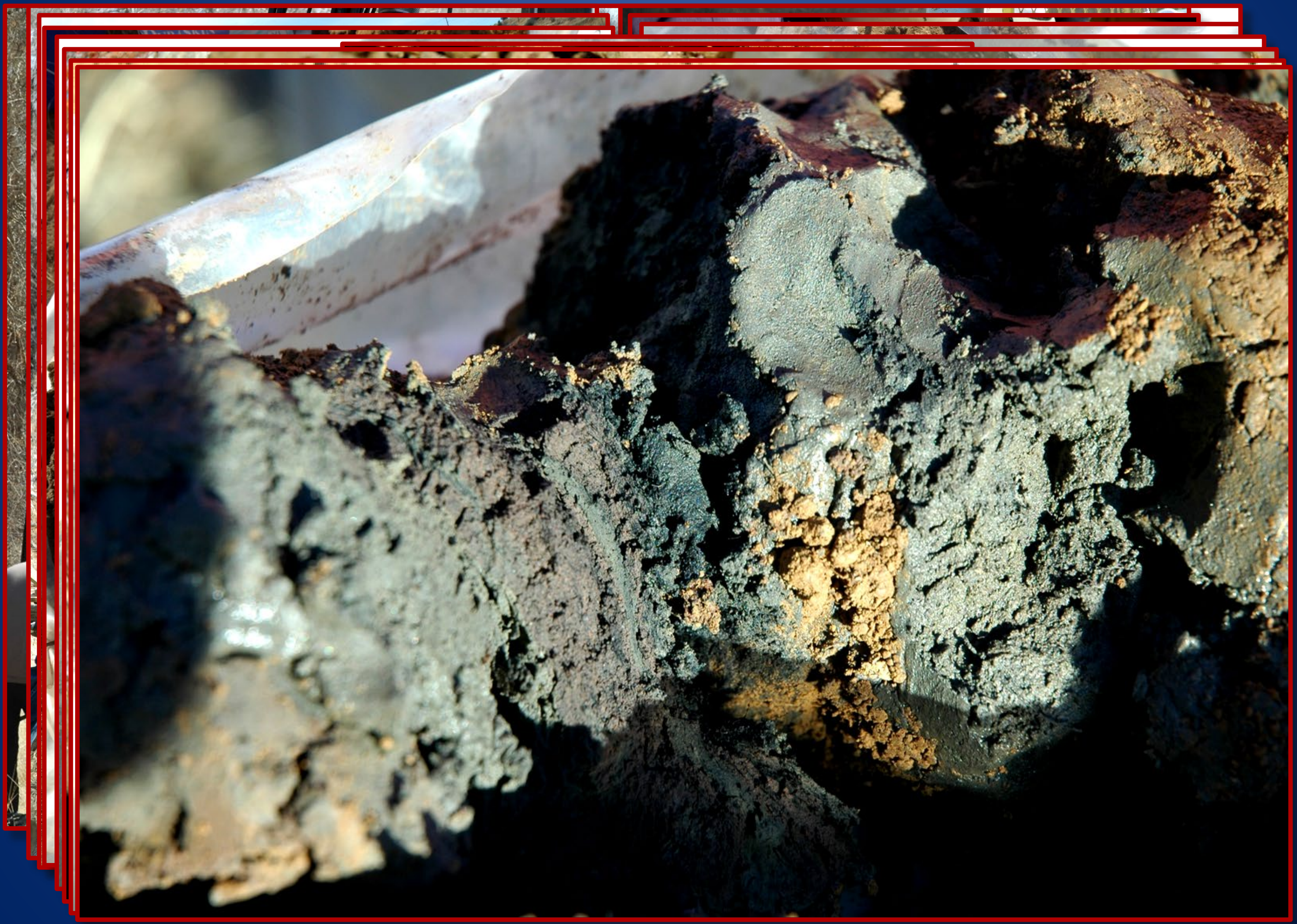
Boring Investigation

A drilling machine takes a core of material from the ground.

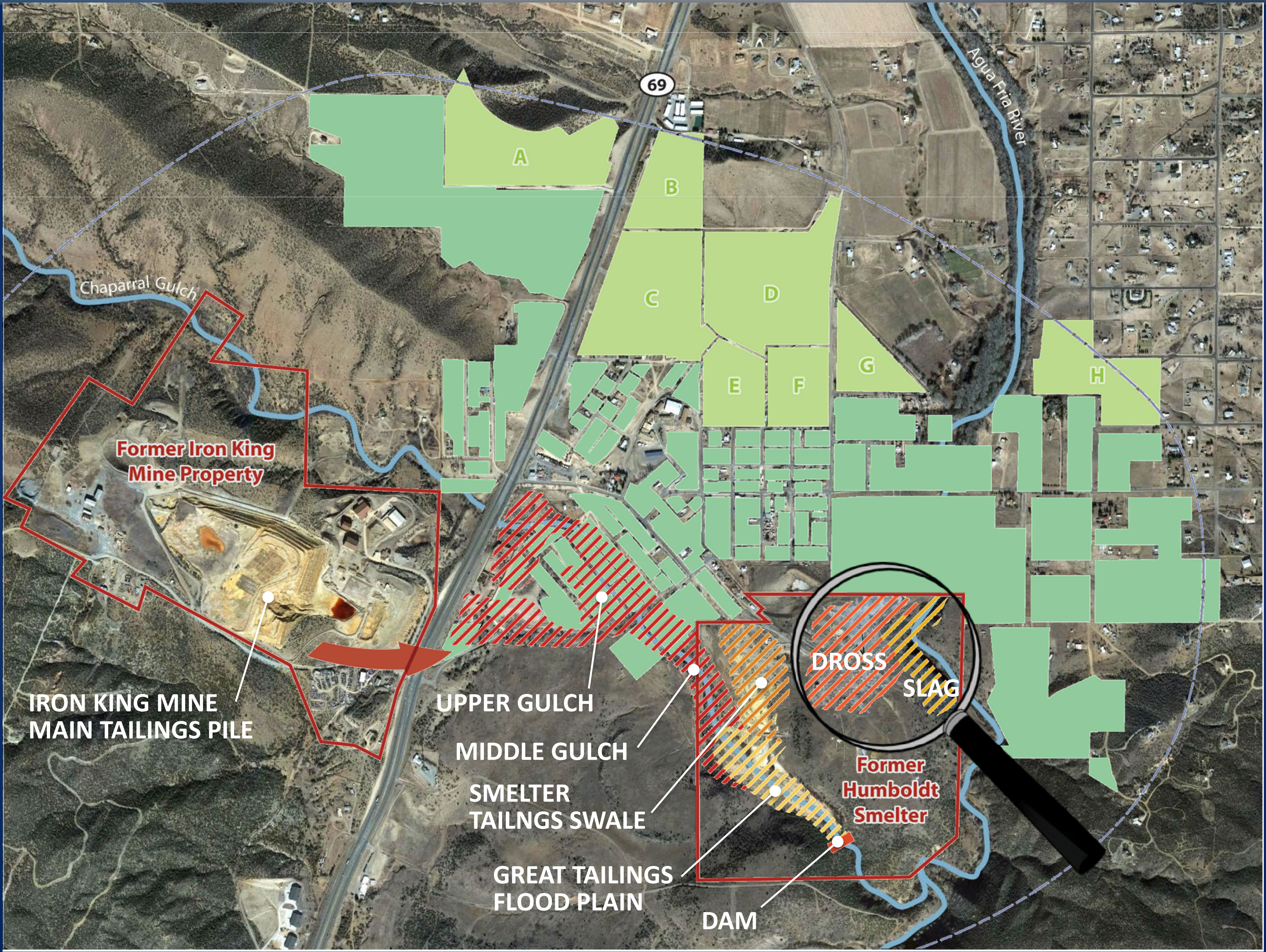
At the tailings flood plain, boring cores were between 8 and 32 feet in length

The cores can be sampled at any depth desired.

Boring Investigation: Mapping What's Under the Ground

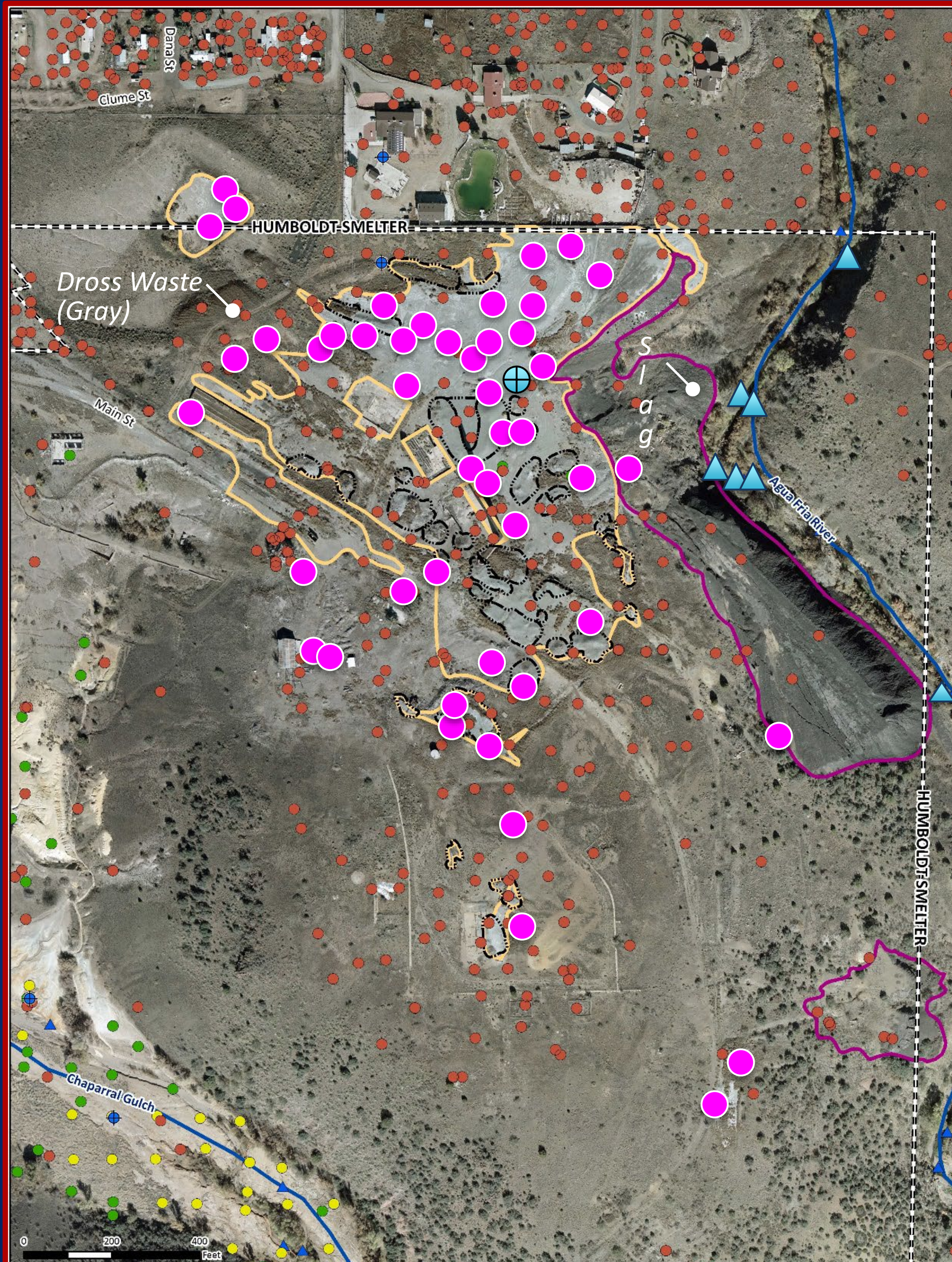


Exploring the Smelter, the Dross, the Slag



Exploring the Smelter, the Dross, the Slag

Smelter Dross and Slag Investigation



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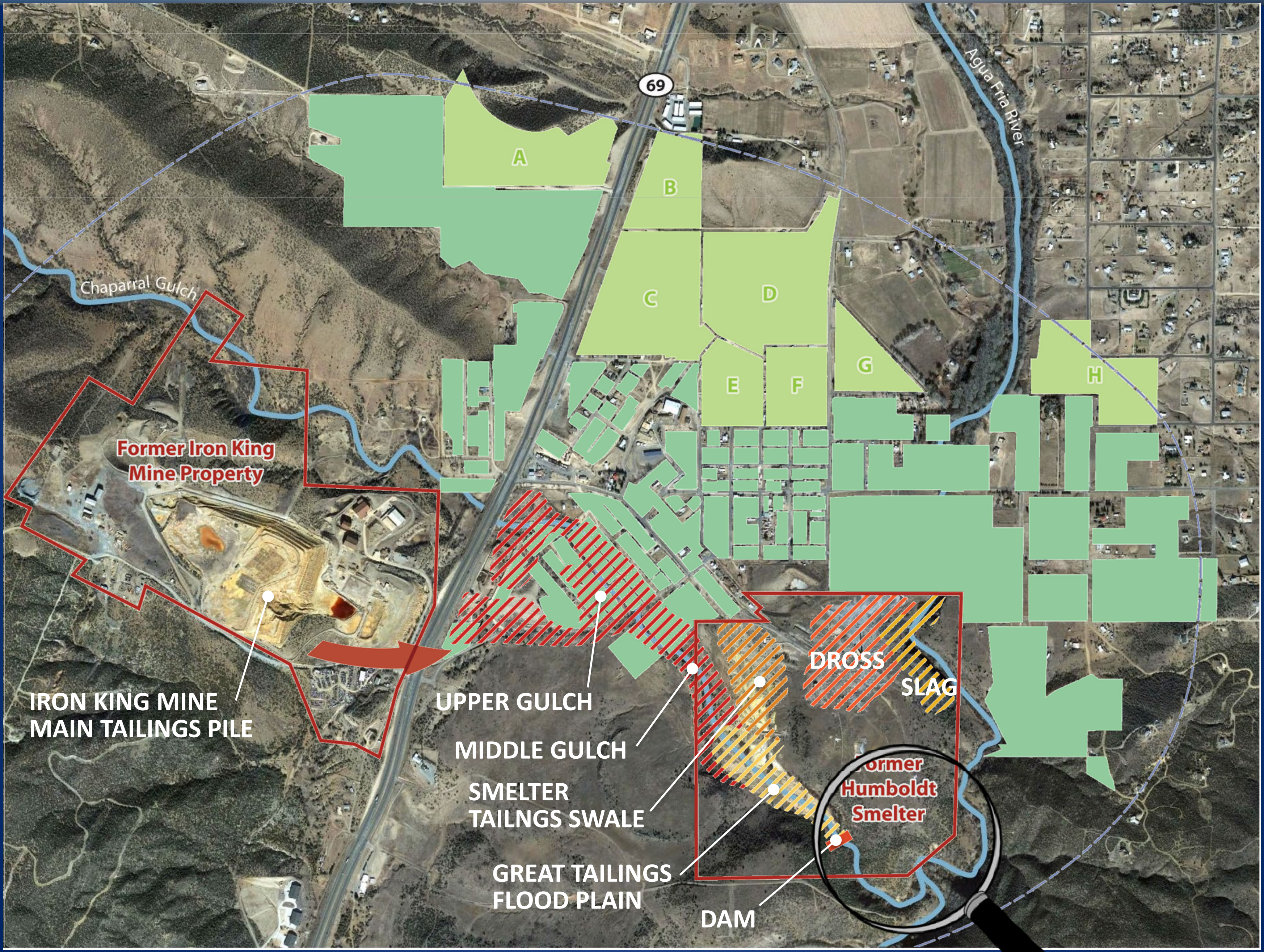
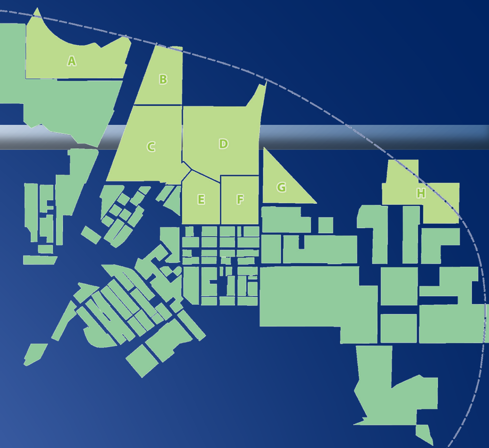
Exploring the Dam and Lower Gulch



Exploring the Dam and the Lower Gulch

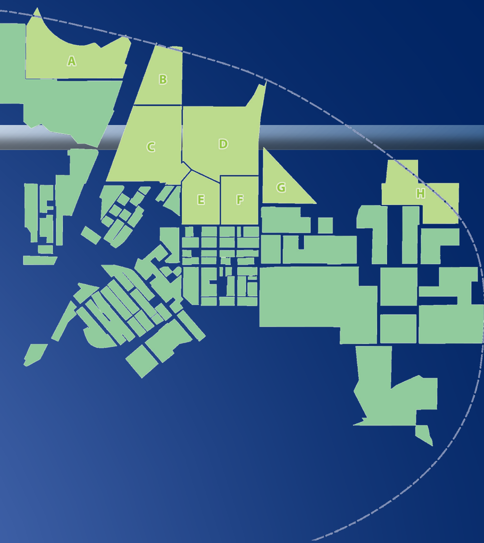
The Investigation of Residential Soils



- How can arsenic and lead get into residential yard soil?
- Why is background arsenic and lead so important in this case?
- How did EPA figure out background and decide where to investigate residential yards?
- How does EPA evaluate possible health risks?
- How did we do the yards investigation and what does the EPC number for each yard mean?
- What are the results across the community?

How Arsenic and Lead Can Be In Residential Yard Soil…

The Investigation of Residential Soils



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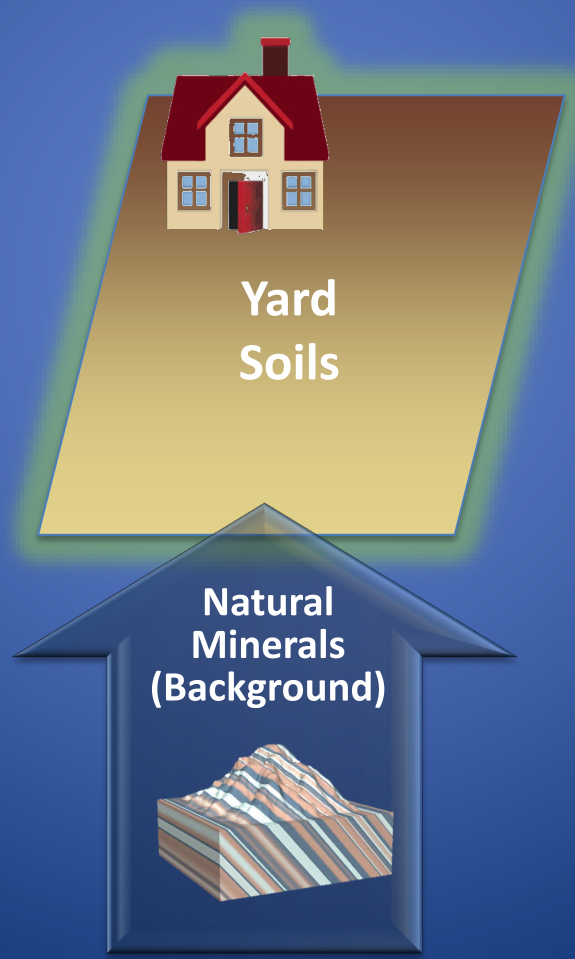
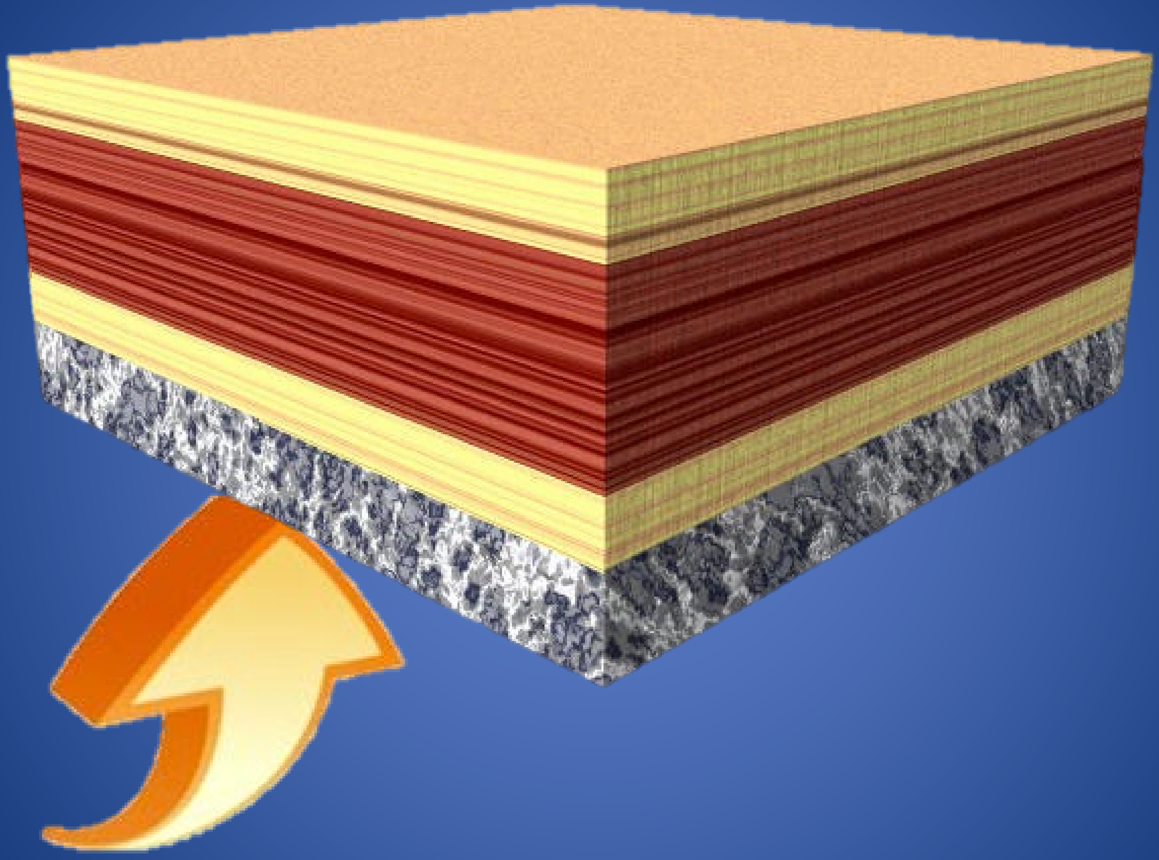
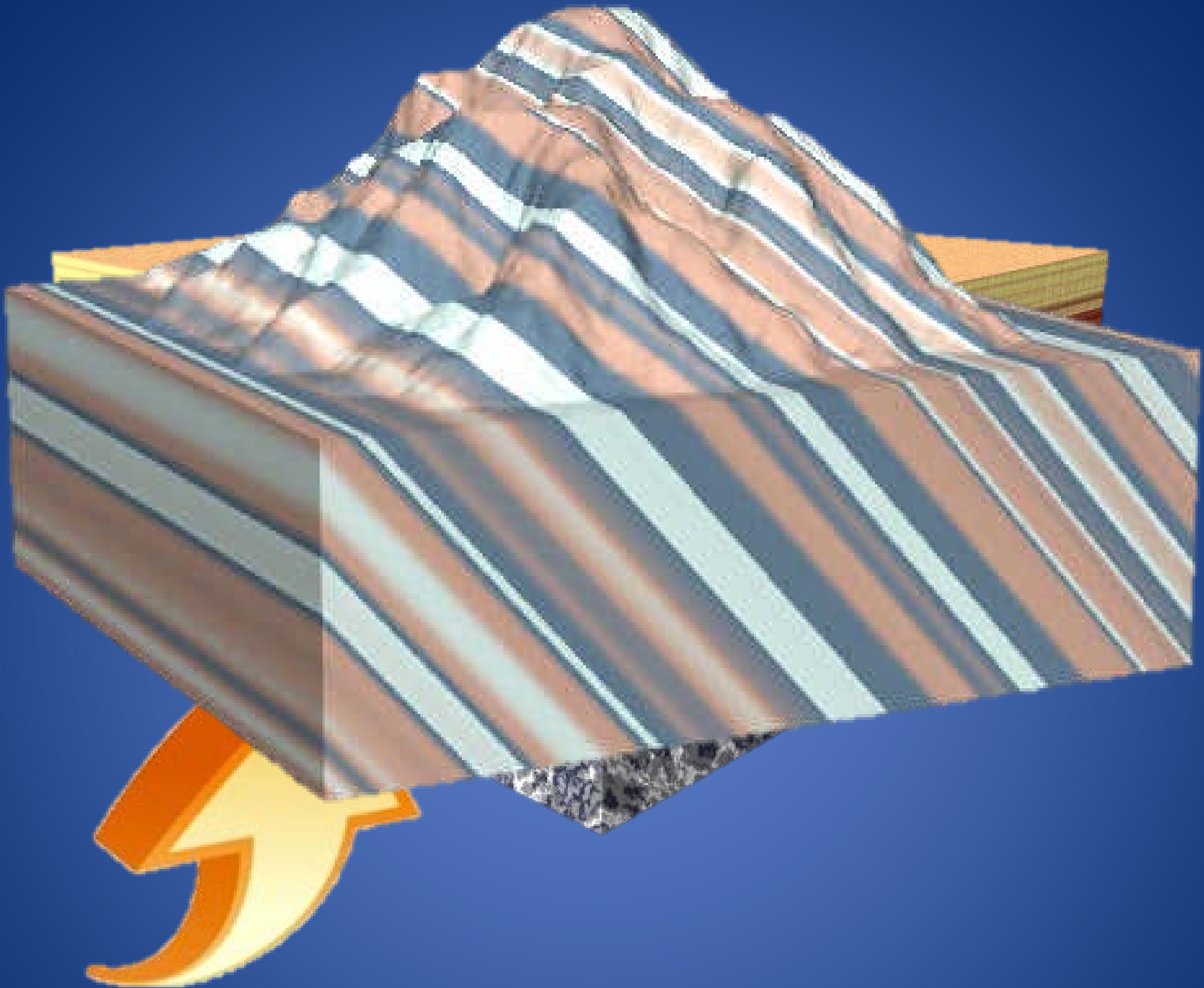
Understanding Background Arsenic and Lead:
How can arsenic and lead be in soils naturally?

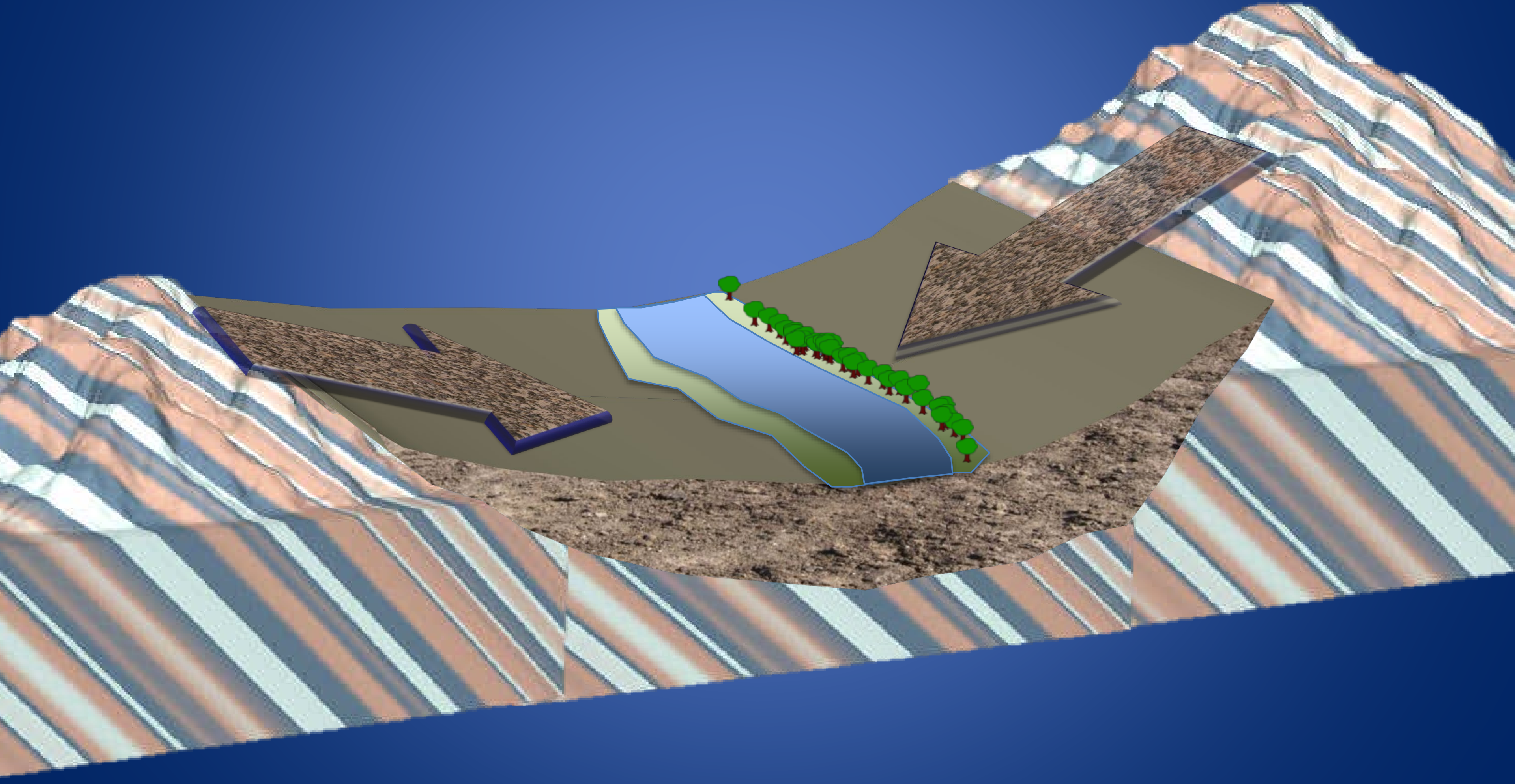
The "background"…

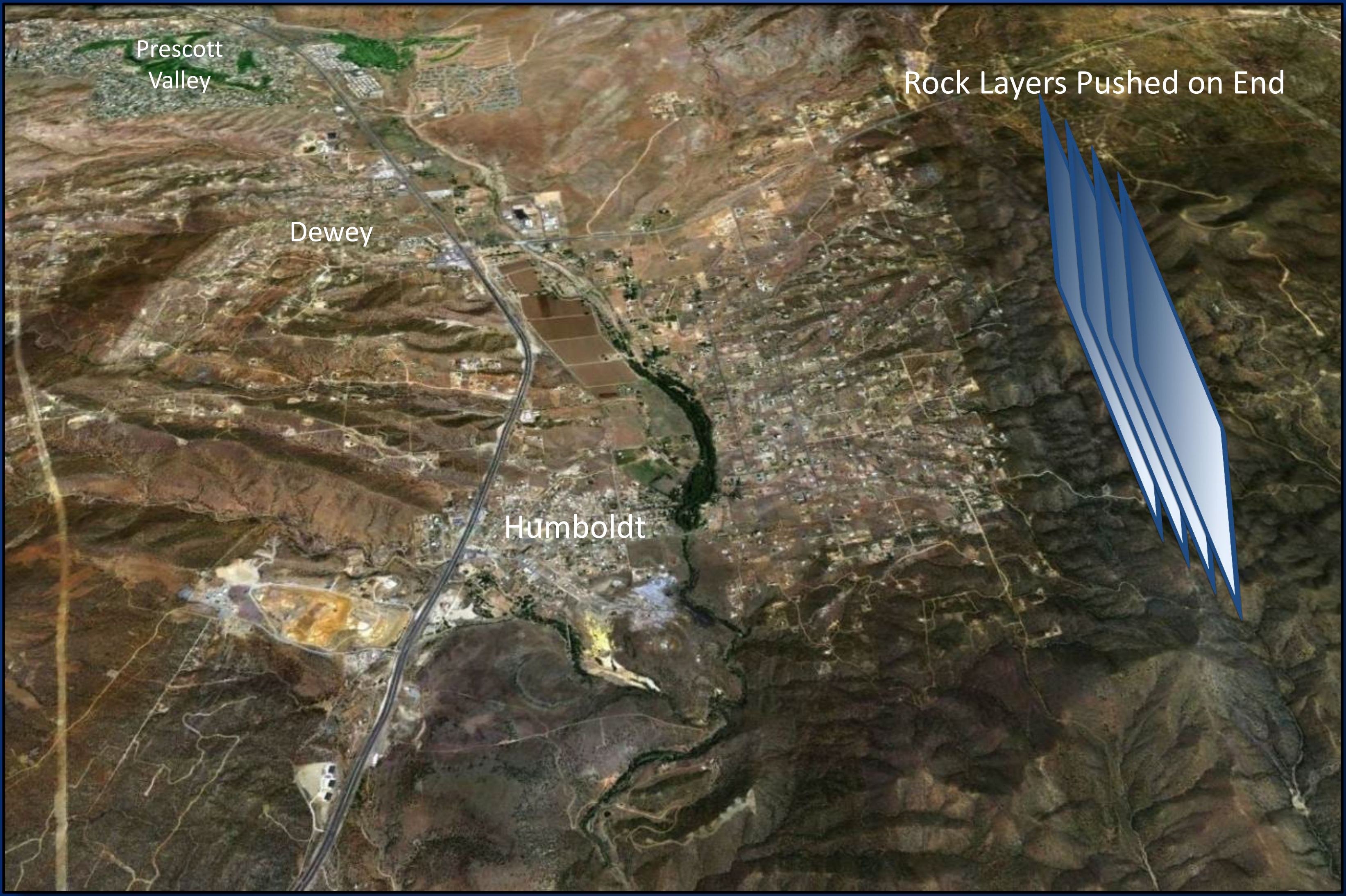
…would be there even without the Superfund Site







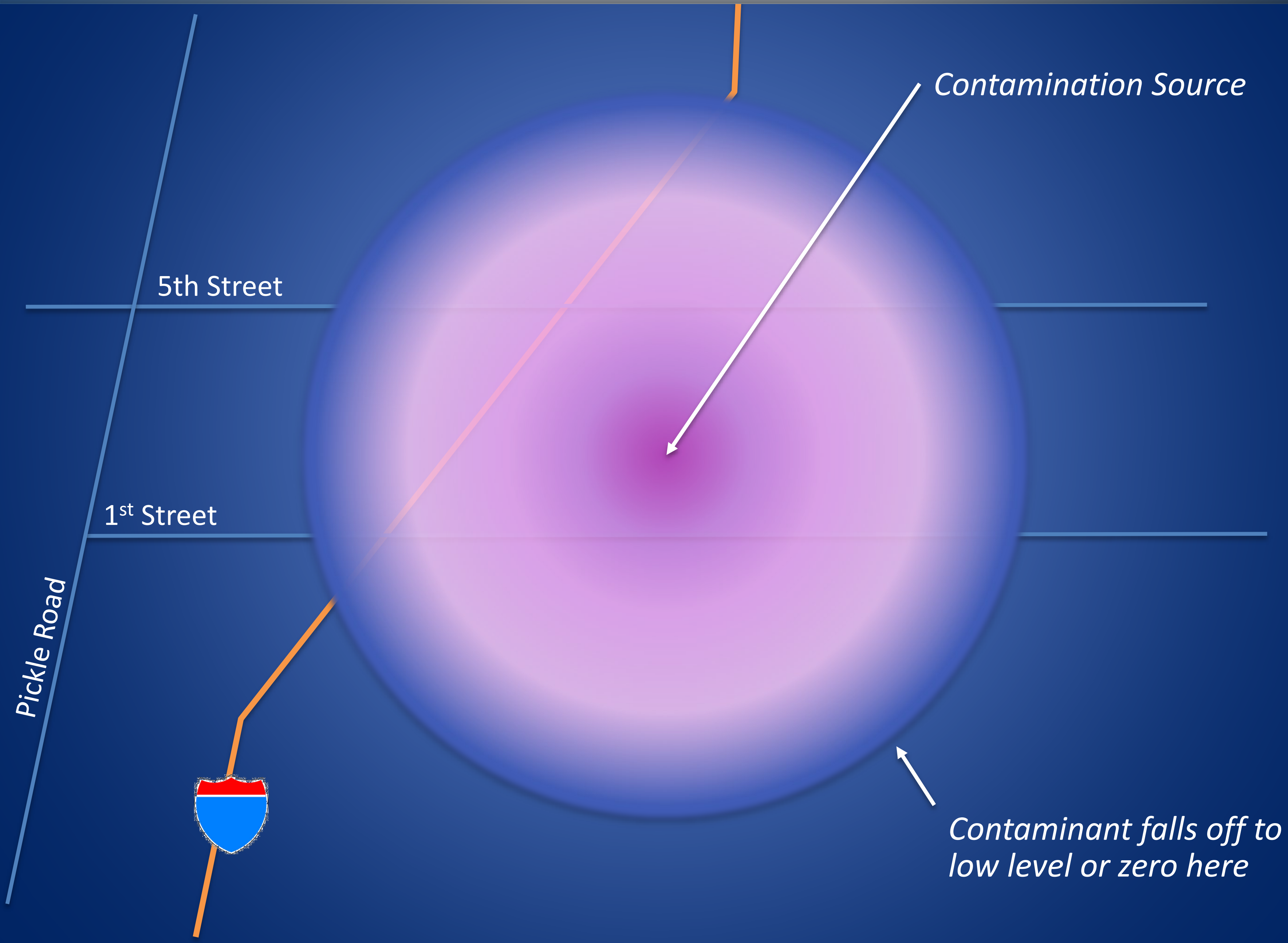



Prescott Valley
Dewey
Humboldt
Rock Layers Pushed on End

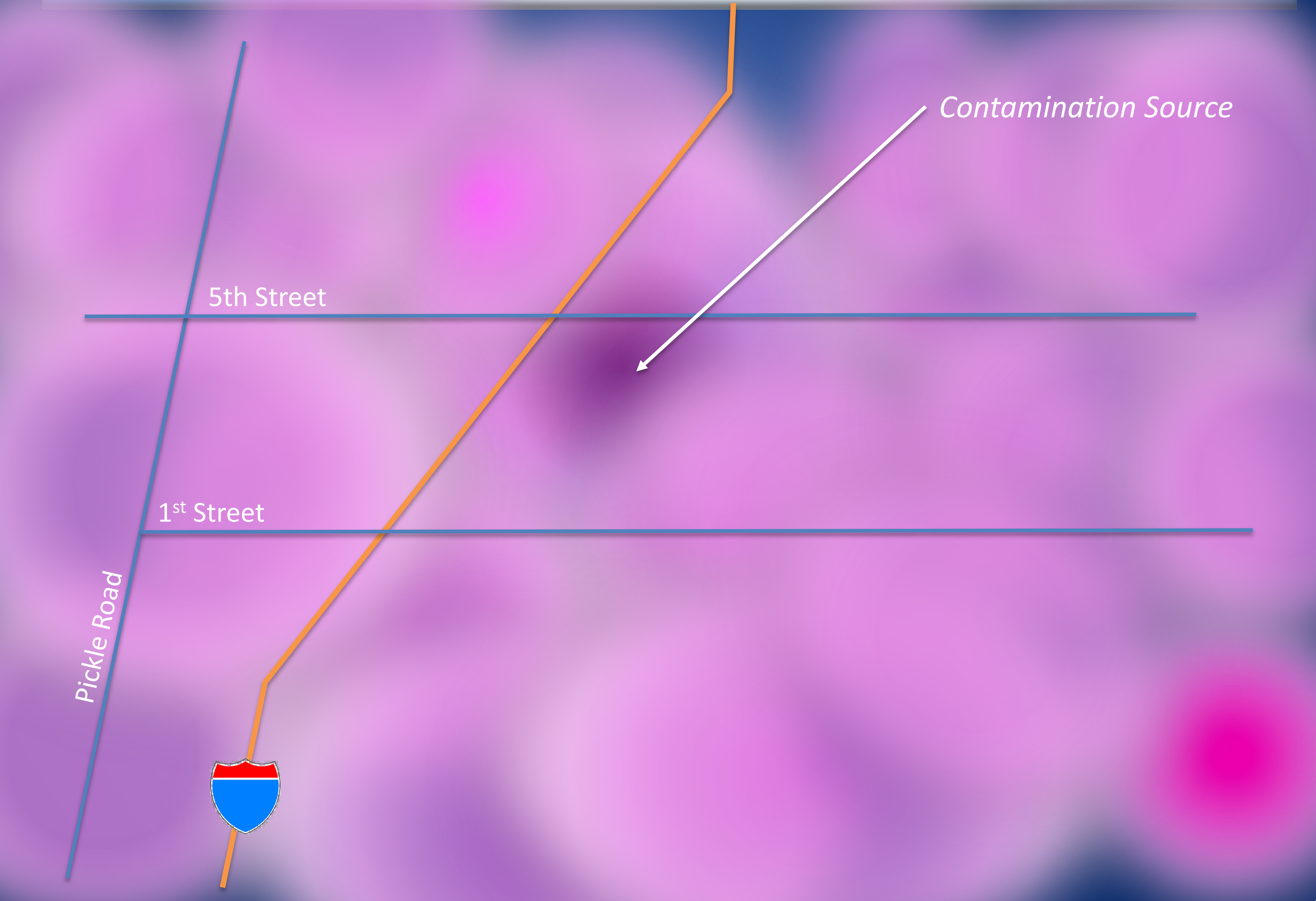
Why naturally -occurring (background) arsenic matters here…

- We see arsenic most places we look, and levels of arsenic go up and down as we move away from the mine and smelter - they don't fall to low levels, so…
  - How do we know where arsenic that came from the mine and smelter drops off and the arsenic we see is only from background?
  - How do we know how far out we need investigate and where we can stop investigating?
- We can't use Superfund to clean up background arsenic – only arsenic that came from the mine and smelter.

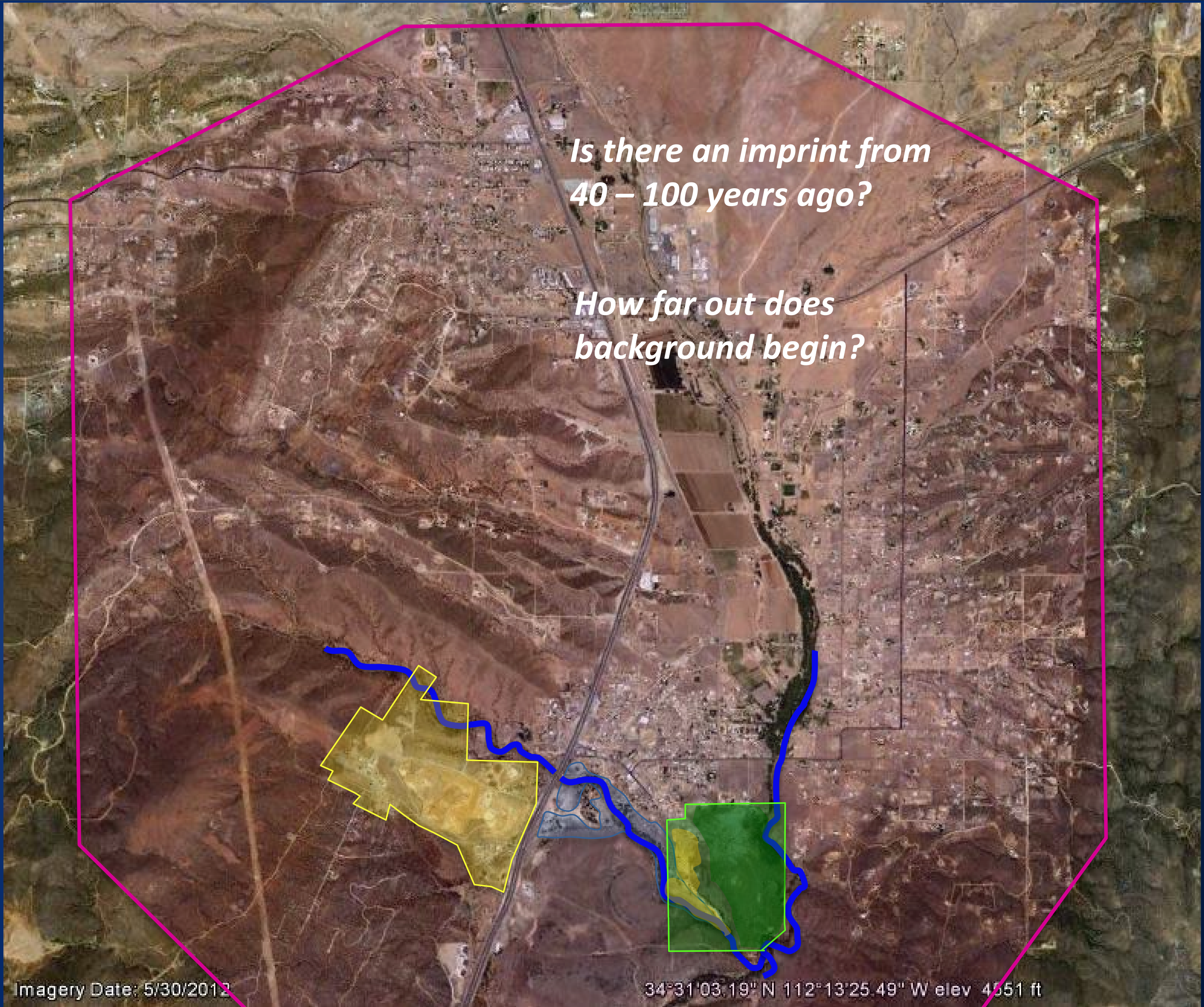
Example: At a Site Where Background Is Low…



At a Site Where Background Is High and Goes Up and Down…



The Valley Soils Background Question



The Investigation of Residential Soils

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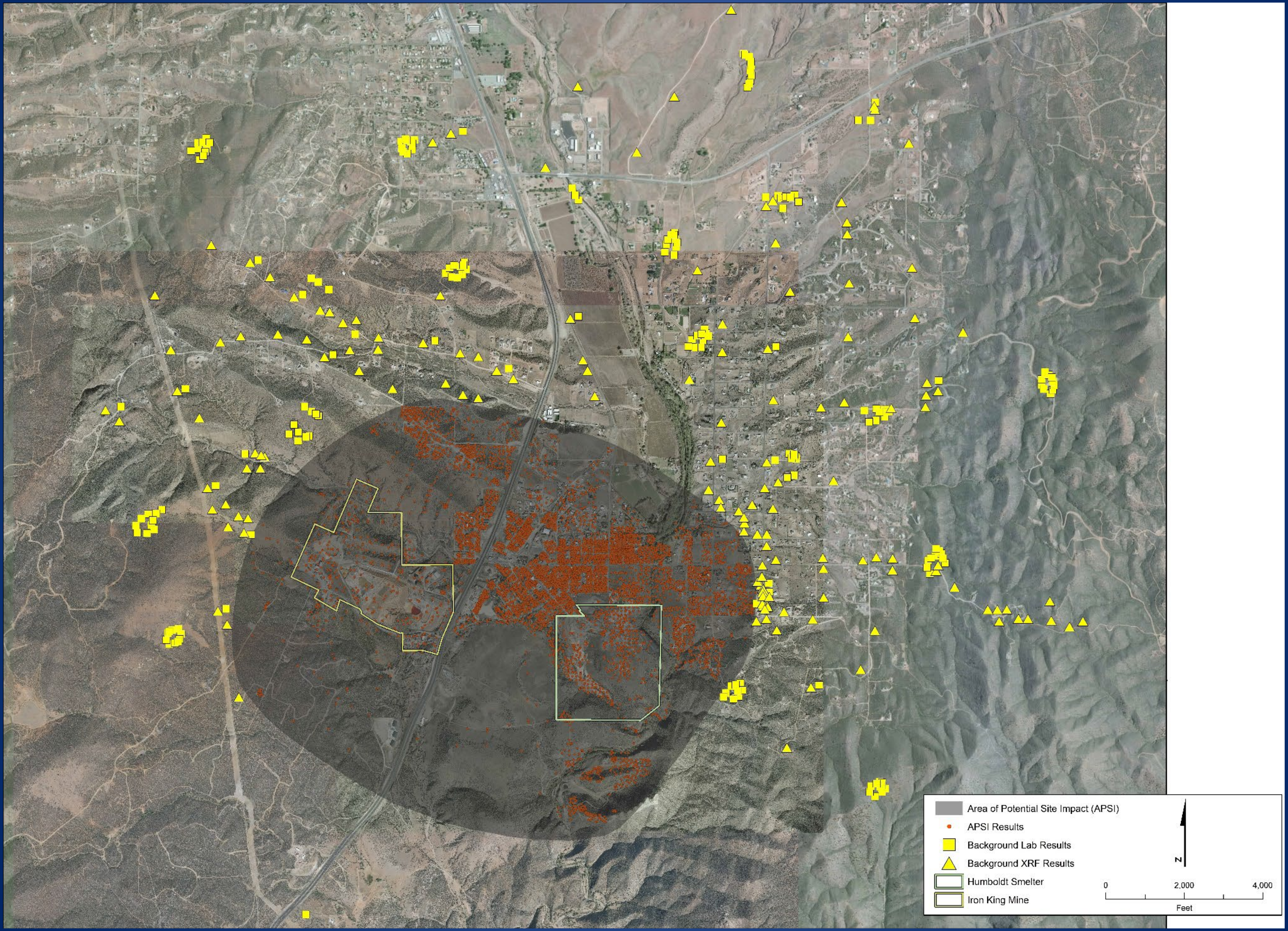
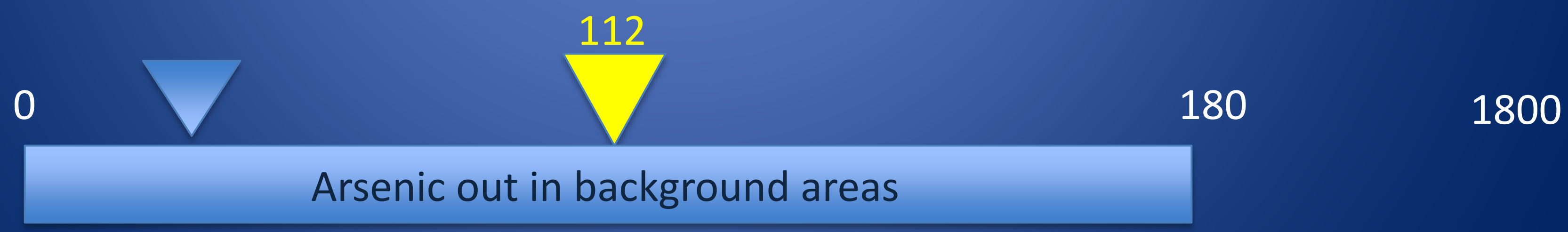
Where did we sample for background?



Statistical Background Values for Important Metals in Soils

- Arsenic: 112 milligrams per kilogram
- Lead: 35 milligrams per kilogram
- Zinc: 136 milligrams per kilogram
- Copper: 182 milligrams per kilogram



95% Certain That Value Is Not Background

How did we decide where to Investigate?

1 *Instead of arsenic, we used zinc and copper as indicators for where mine/smelter contamination may be.*

2 *We used statistics to find where <u>undisturbed</u> soils at the surface have significantly higher arsenic than soils one foot down.*

Where to Investigate: The Area of Potential Site Impact (APSI)

The Investigation of Residential Soils

- ✓ How can arsenic and lead get into residential yard soil?
- ✓ Why is background arsenic and lead so important in this case?
- ✓ How did EPA figure out background and decide where to investigate residential yards?
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How We Think About Health Risks: Ways of Possible Exposure

There must be exposure for there to be a health risk.

- Food
- Drinking Water
- Swallowing Soil or Dust
- Inhalation
- Skin Contact

Possible Types of Exposure

How Do We Calculate The Risk of Health Effects?

We want to ensure we calculate safe levels and cleanup values that will be health protective…

Simplified Risk Assessment Process…

Toxicity

How toxic is the chemical itself?

X

Levels in the Environment

How much chemical is in soil (or water or air)?

X

Exposure to Environment

How much soil, water or air can get into the body?

X

Bioavailabililty

How much of what gets in the body stays in the body?

X

Time

How long? Days? Years? Decades?

Risk

Chance of health effects from site

Use to guide cleanup decisions

Studies

Sampling

2 liters water or 2 tablespoons soil per day, etc.

We purposely overestimate to ensure we are protective of health.

100% ?
60% ?
20% ?

*We usually assume a very long time such as **<u>30 years</u>** to ensure we are protective of health.*

Bioavailabililty

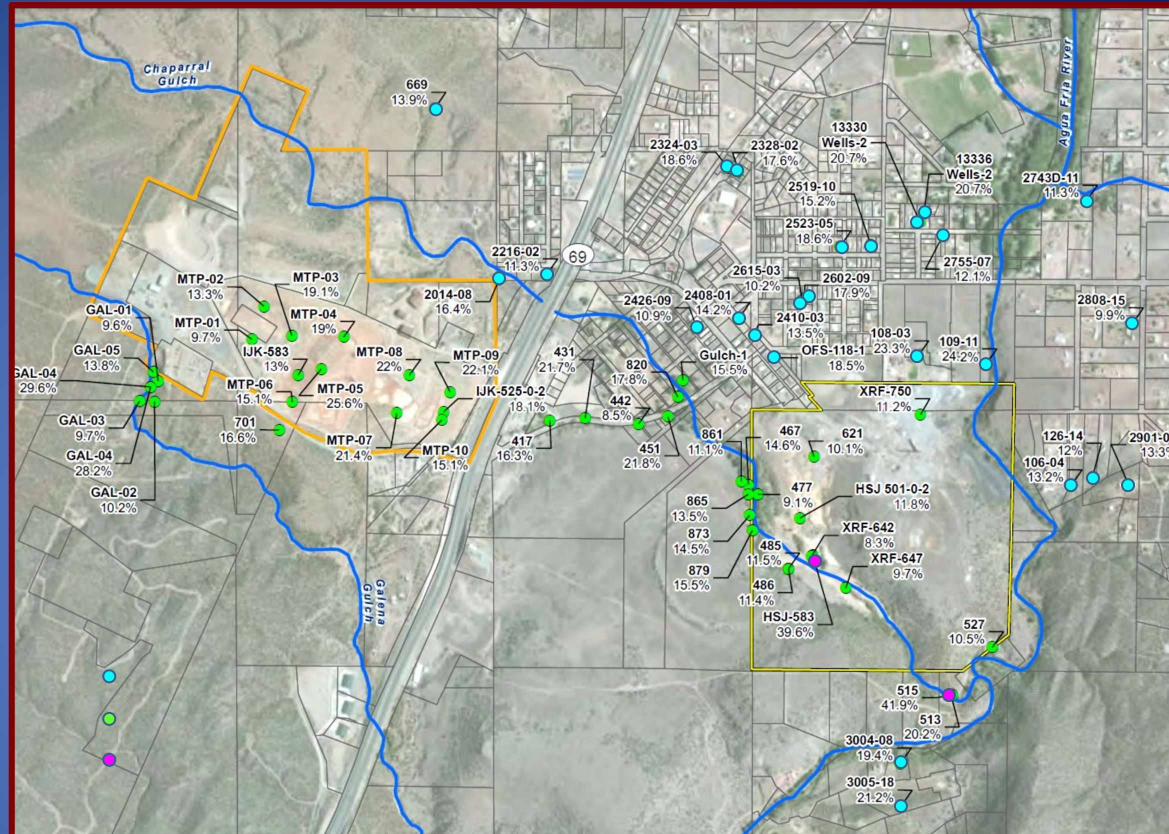
How much of what gets in the body stays in the body?

What is the bioavailability of arsenic in soils at this site?

When a contaminant enters the body,

The percentage that stays in the body is the bioavailability.

The rest of it is excreted.



Extensive Bioavailability Testing in Humboldt

BIOAVAILABILITY OF ARSENIC IN SOIL: 22%

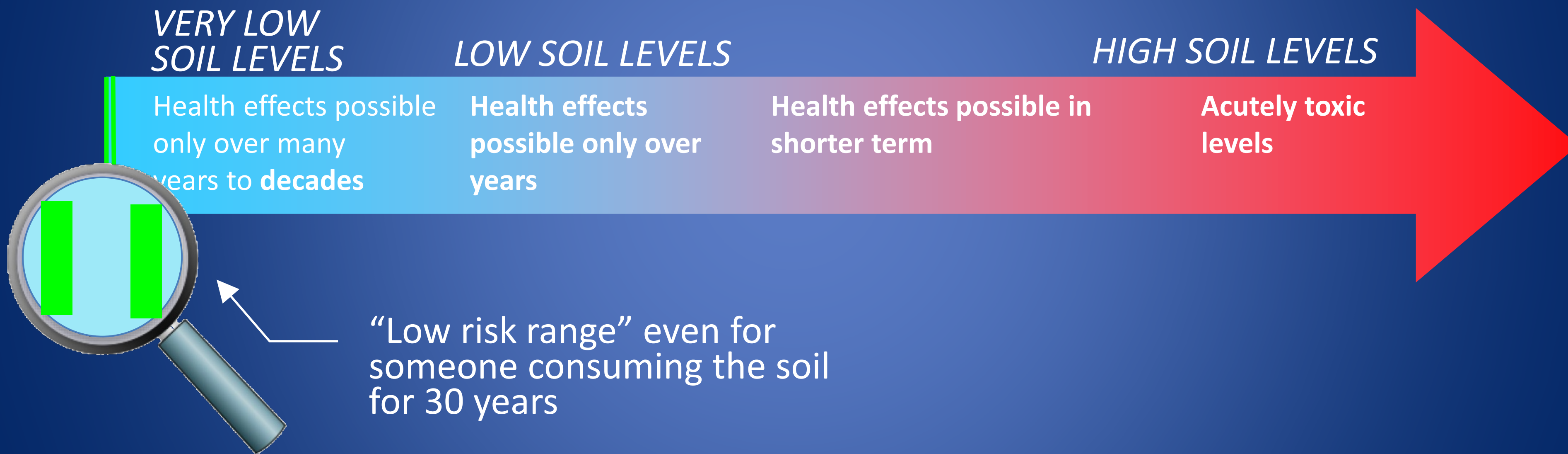
Available **Excreted**

Safe Levels – Do They Work Like This?

How EPA Looks at What Are Safe Levels for Soil

Reality: Risks fall on a continuum from extremely tiny to high

For someone consuming soil or breathing soil dust with…



When considering whether a cleanup action is needed, EPA uses very low, health-protective levels that would still pose a low health risk even if someone were exposed to the soil for decades.

The Investigation of Residential Soils

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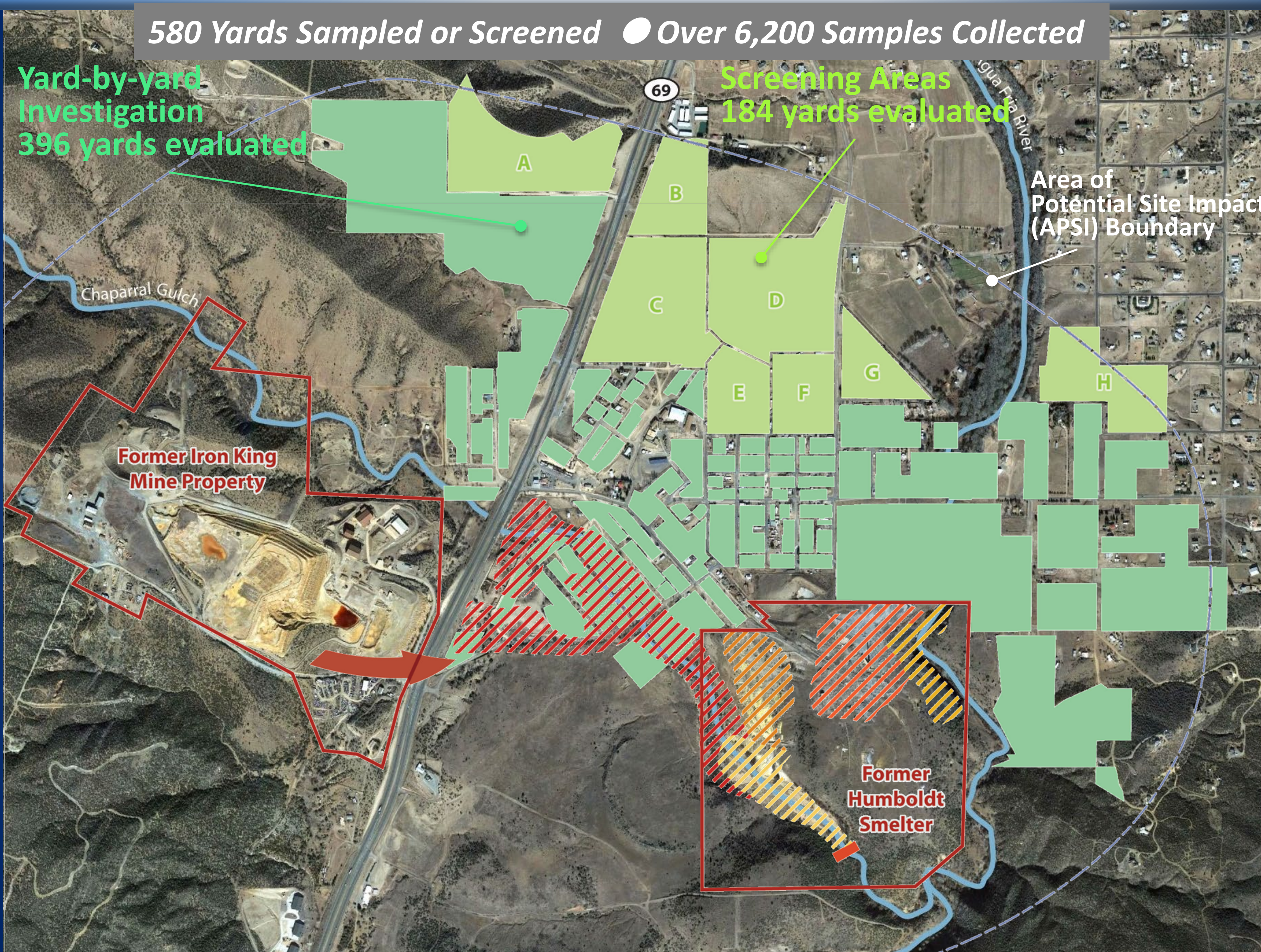
How the Investigation Was Done - Residential Investigation Areas



The EPC – A Health-Protective Average for a Yard

X-Ray Fluorescence Spectrometer

Results

Special average of the samples called "EPC"

Higher than a regular average

10-20 samples

The Mobile Laboratory

The Investigation of Residential Soils

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Putting Yard Soil Results into Perspective…

For someone consuming soil or breathing soil dust with…

VERY LOW SOIL LEVELS	*LOW SOIL LEVELS*		*HIGH SOIL LEVELS*
Health effects possible only over many years to **decades**	**Health effects possible only over years**	**Health effects possible in shorter term**	**Acutely toxic levels**

The colored ranges still pose a low risk even to someone exposed to the soils for many years to decades.

Exposure Point Concentrations (EPC Numbers) for Residential Yards

	0 – 104 *(112)*	104 – 206	206 – 400	Above 400
ARSENIC	509 yards in this range	*37 yards in this range*	*13 yards in this range*	*6 yards*
	GREEN: Level low enough that need for cleanup is unlikely	*YELLOW: Borderline range where EPA begins to consider cleanup to protect health over long term*	*ORANGE: Borderline range where long term risk is still low but need for cleanup is more likely*	*Above the range of low risks*
LEAD	475 yards in this range	*61 yards in this range*	*18 yards in this range*	*11 yards*
	0 *(35)* – 142	142 – 400	400 – 1200	Above 1200

Residential Results – Lead and Arsenic Concentrations

SWITCH TO PDF OF CONCENTRATION DOT PLOT

Residential Results – EPC Numbers for each Yard

SWITCH TO PDF OF EPC COLOR PLOT

Some Important Conclusions

- The great majority of residential yard soils do not pose a significant health risk due to the mine and smelter
- Historical blowing dust may have had less effect on health risks from residential soils than was expected.
- Historical placement of material has had a more prominent effect in those yards that are contaminated than was expected.
- Soils in a few yards do pose an unacceptable health risk and these are of higher priority.

Next Steps

- EPA takes steps to minimize exposure at the high priority yards.
- EPA completes the full risk assessment
- EPA completes the full remedial investigation report
- EPA begins the feasibility study of options for the tailings source areas as well as residential properties
- More public input leading to remedial decisions

EPA Contacts

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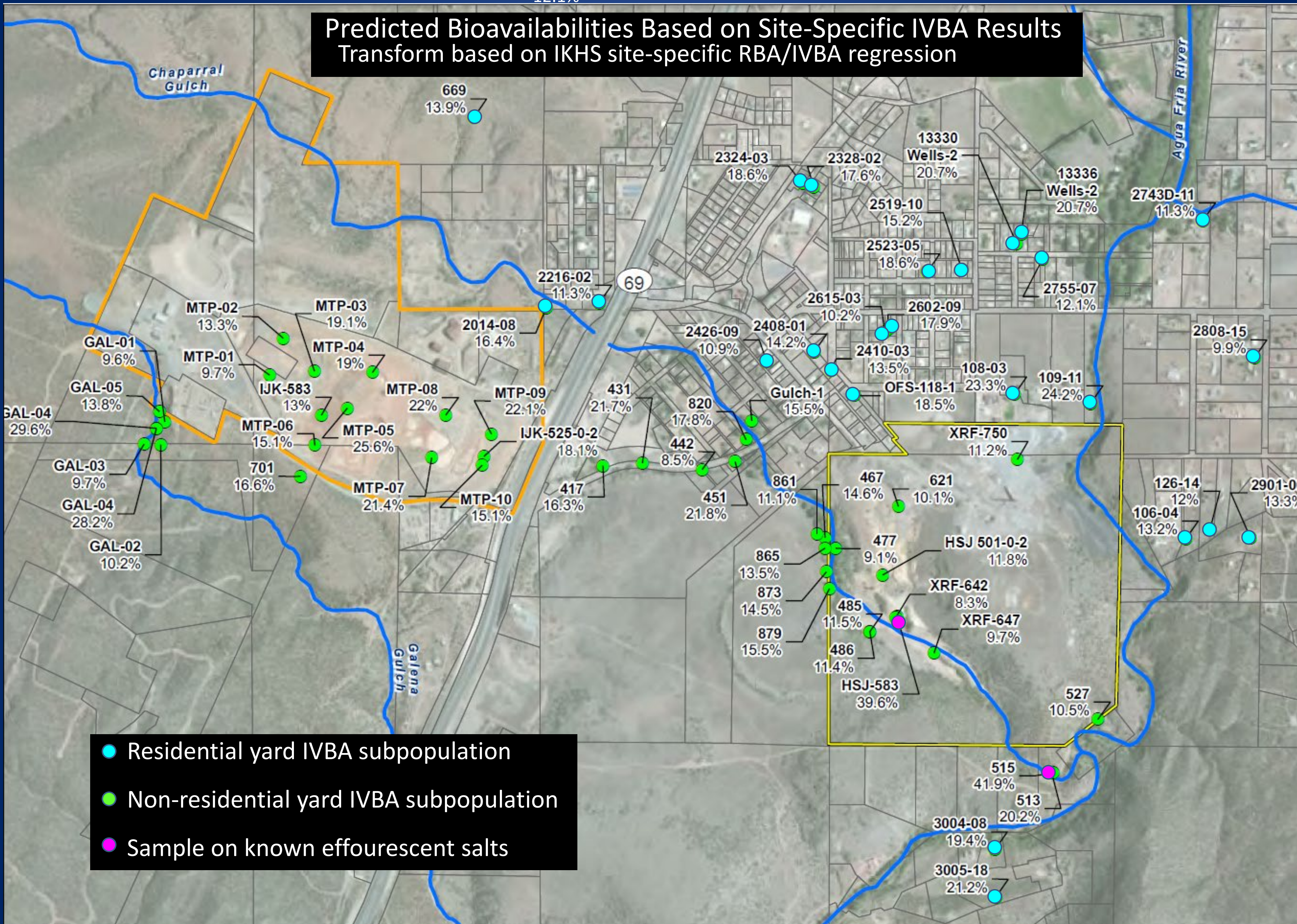
Estimates of Bioavailability of Arsenic in Soil
Iron King Mine

Sample	Date	Total Sieved As mg/kg	Extractable As mg/kg	As IVBA %	% Bioavailable As Bradham Regression	% Bioavailable As Griffin Regression	% Bioavailable As IKM Regression (N=5)
IJK-525-0-2	8/20/2008	6,899	NR	17.5	17.9	22.5	18.1
HSJ 501-0-2	9/4/2008	173	NR	6.80	10.2	16.1	11.8
OSF-118-1	9/18/2008	244	NR	18.1	18.3	22.9	18.5
HSJ-583	5/2/2009	280	NR	53.6	43.9	44.2	39.6
IJK-583	5/2/2009	4,495	NR	8.80	11.6	17.3	13.0
417	4/30/2013	2,550	369	14.5	15.7	20.7	16.3
431	4/30/2013	447	105	23.5	22.2	26.1	21.7
442	4/30/2013	2,990	37.9	1.27	6.17	12.8	8.5
451	4/30/2013	585	138	23.6	22.2	26.2	21.8
467	4/30/2013	1,480	170	11.5	13.5	18.9	14.6
477	4/30/2013	3,580	84.4	2.36	6.96	13.4	9.1
485	4/30/2013	4,180	267	6.39	9.86	15.8	11.5
486	4/30/2013	1,750	107	6.11	9.66	15.7	11.4
513	4/29/2013	888	186	20.9	20.3	24.6	20.2
515	4/29/2013	3,960	2,270	57.3	46.5	46.4	41.9
527	4/29/2013	6,730	312	4.64	8.60	14.8	10.5
621	4/30/2013	310	12.4	4.00	8.14	14.4	10.1
642	5/1/2013	240	ND	1.00	5.98	12.6	8.3
647	5/2/2013	190	6.40	3.37	7.69	14.0	9.7
648	5/3/2013	220	16.0	7.27	10.5	16.4	12.1
669	5/1/2013	305	31.4	10.3	12.7	18.2	13.9
701	5/2/2013	841	125	14.9	16.0	20.9	16.6
750	5/4/2013	29	1.70	5.86	9.48	15.5	11.2
753	5/5/2013	300	110	36.7	31.7	34.0	29.6
820	5/1/2013	660	112	17.0	17.5	22.2	17.8
861	5/1/2013	497	28.1	5.65	9.33	15.4	11.1
865	5/1/2013	649	62.7	9.66	12.2	17.8	13.5
873	5/1/2013	680	77.4	11.4	13.5	18.8	14.5
879	5/1/2013	892	116	13.0	14.6	19.8	15.5
978	5/6/2013	240	ND	1.00	5.98	12.6	8.3
979	4/29/2013	480	15.0	3.13	7.51	13.9	9.6
980	4/30/2013	3,700	510	13.8	15.2	20.3	15.9
13330WellsSt	7/11/2013	441	95.9	21.7	20.9	25.0	20.7
13336WellsSt	7/12/2013	387	84.2	21.8	20.9	25.1	20.7
GulchYard	7/13/2013	330	43.0	13.0	14.6	19.8	15.5
106-04	2/26/2014	250	23.0	9.20	11.9	17.5	13.2
108-03	2/24/2014	420	110	26.2	24.1	27.7	23.3
109-11	2/19/2014	170	47.0	27.6	25.2	28.6	24.2
126-14	2/27/2014	180	13.0	7.22	10.5	16.3	12.0
2014-08	1/31/2014	310	45.0	14.5	15.7	20.7	16.4
2216-02	3/5/2014	280	17.0	6.07	9.63	15.6	11.3
2324-03	2/5/2014	230	42.0	18.3	18.4	23.0	18.6
2328-02	2/5/2014	780	130	16.7	17.3	22.0	17.6
2408-01	3/10/2014	220	24.0	10.9	13.1	18.5	14.2
2410-03	3/10/2014	290	28.0	9.66	12.2	17.8	13.5
2426-09	2/5/2014	340	18.0	5.29	9.07	15.2	10.9
2519-10	3/10/2014	160	20.0	12.5	14.3	19.5	15.2
2523-05	2/19/2014	170	31.0	18.2	18.4	22.9	18.6
2602-09	2/13/2014	140	24.0	17.1	17.6	22.3	17.9
2615-03	2/20/2014	1,200	49.0	4.08	8.20	14.5	10.2
2743D-11	2/24/2014	650	39.0	6.00	9.58	15.6	11.3
2755-07	2/22/2014	150	11.0	7.33	10.5	16.4	12.1
2808-15	2/21/2014	410	15.0	3.66	7.89	14.2	9.9
2901-06	2/26/2014	160	15.0	9.38	12.0	17.6	13.3
3004-08	3/3/2014	260	51.0	19.6	19.4	23.8	19.4
3005-18	3/4/2014	230	52.0	22.6	21.5	25.6	21.2
GAL-01	2/28/2014	1,300	41.0	3.15	7.53	13.9	9.6
GAL-02	2/28/2014	170	7.10	4.18	8.27	14.5	10.2
GAL-03	2/28/2014	710	24.0	3.38	7.69	14.0	9.7
GAL-04	2/28/2014	2,700	930	34.4	30.1	32.7	28.2
GAL-04	2/28/2014	2,500	920	36.8	31.8	34.1	29.6
GAL-05	2/28/2014	650	66.0	10.2	12.6	18.1	13.8
MTP-01	2/27/2014	5,100	170	3.33	7.66	14.0	9.7
MTP-02	2/27/2014	4,300	400	9.30	12.0	17.6	13.3
MTP-03	2/27/2014	310	59.0	19.0	19.0	23.4	19.1
MTP-04	2/27/2014	1,800	340	18.9	18.9	23.3	19.0
MTP-05	2/27/2014	1,300	390	30.0	26.9	30.0	25.6
MTP-06	2/27/2014	2,100	260	12.4	14.2	19.4	15.1
MTP-07	2/27/2014	1,000	230	23.0	21.8	25.8	21.4
MTP-08	2/27/2014	1,500	360	24.0	22.5	26.4	22.0
MTP-09	2/27/2014	2,700	650	24.1	22.6	26.4	22.1
MTP-10	2/27/2014	890	110	12.4	14.2	19.4	15.1
			Number	72	72	72	72
			Minimum	1.00	5.98	12.6	8.32
			Maximum	57.3	46.5	46.4	41.9
			Average	14.3	15.6	20.6	16.3
			UCL (low)	16.77	17.17	21.82	17.50
			UCL (high)	20.09	17.26	22.07	17.62

- 71 IVBA Sample Points
- Transformed by 3 different regressions to predicted bioavailability
- Overall predicted results vary between 17 and 22%
- At bottom, results are based on UCL of values…subsequent slides show an alternate percentile approach

Predicted Bioavailabilities Based on Site-Specific IVBA Results

Transform based on IKHS site-specific RBA/IVBA regression



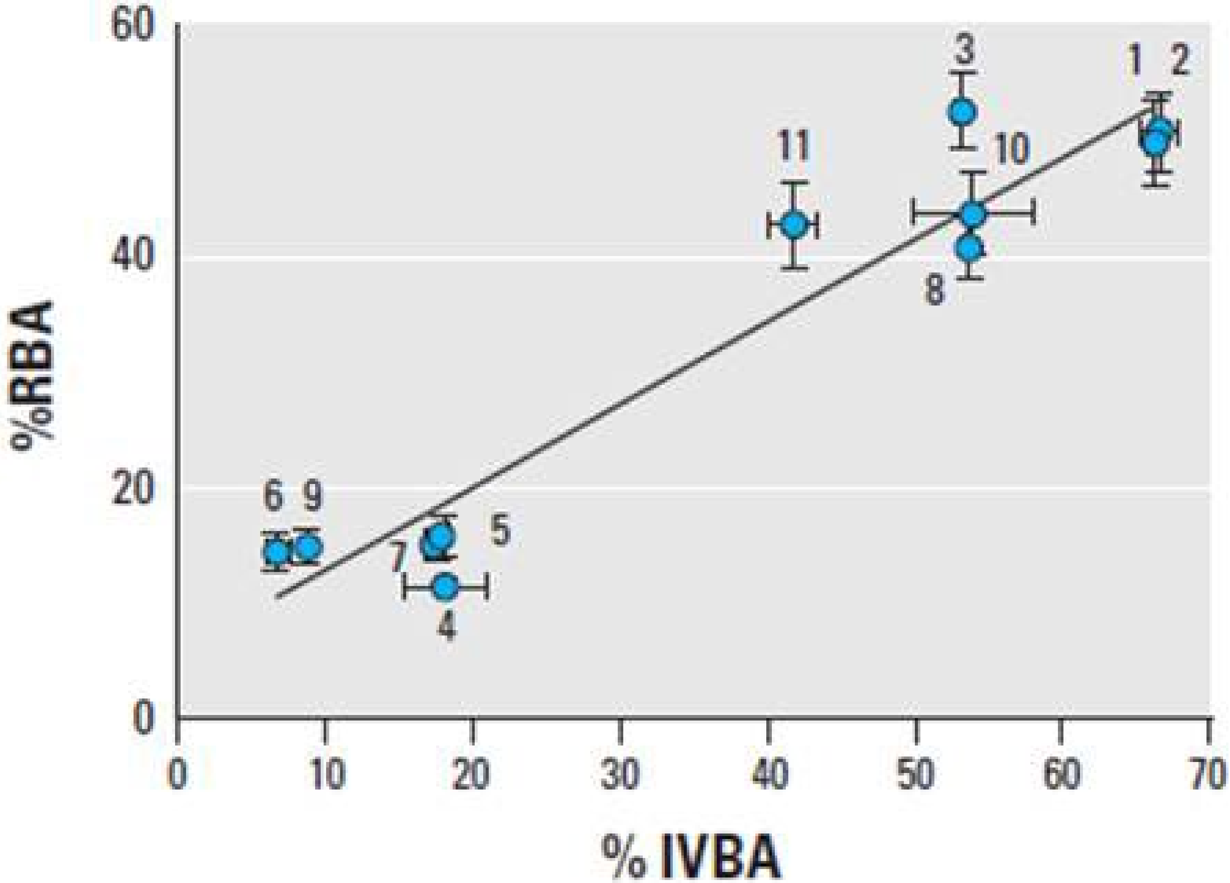
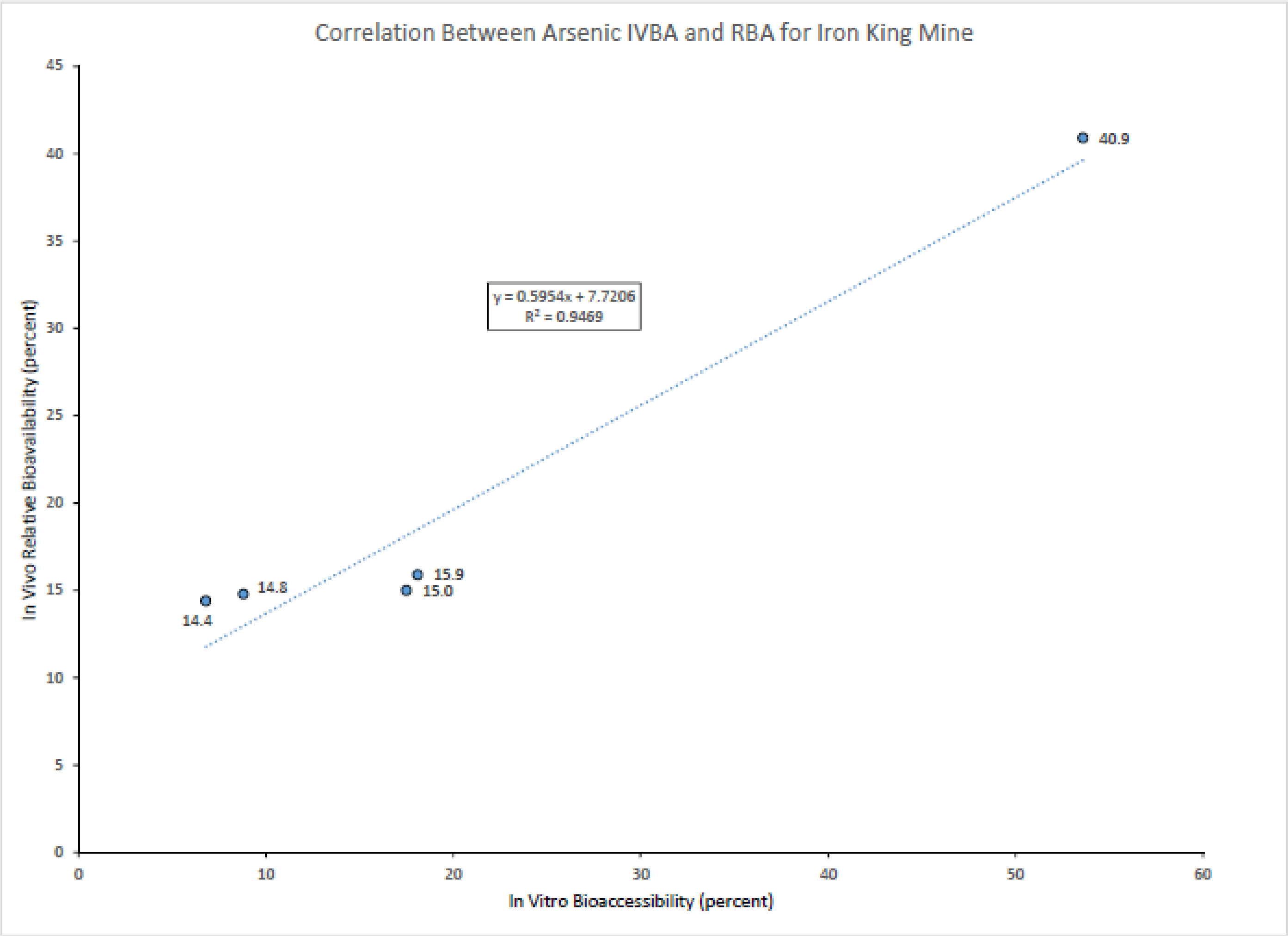
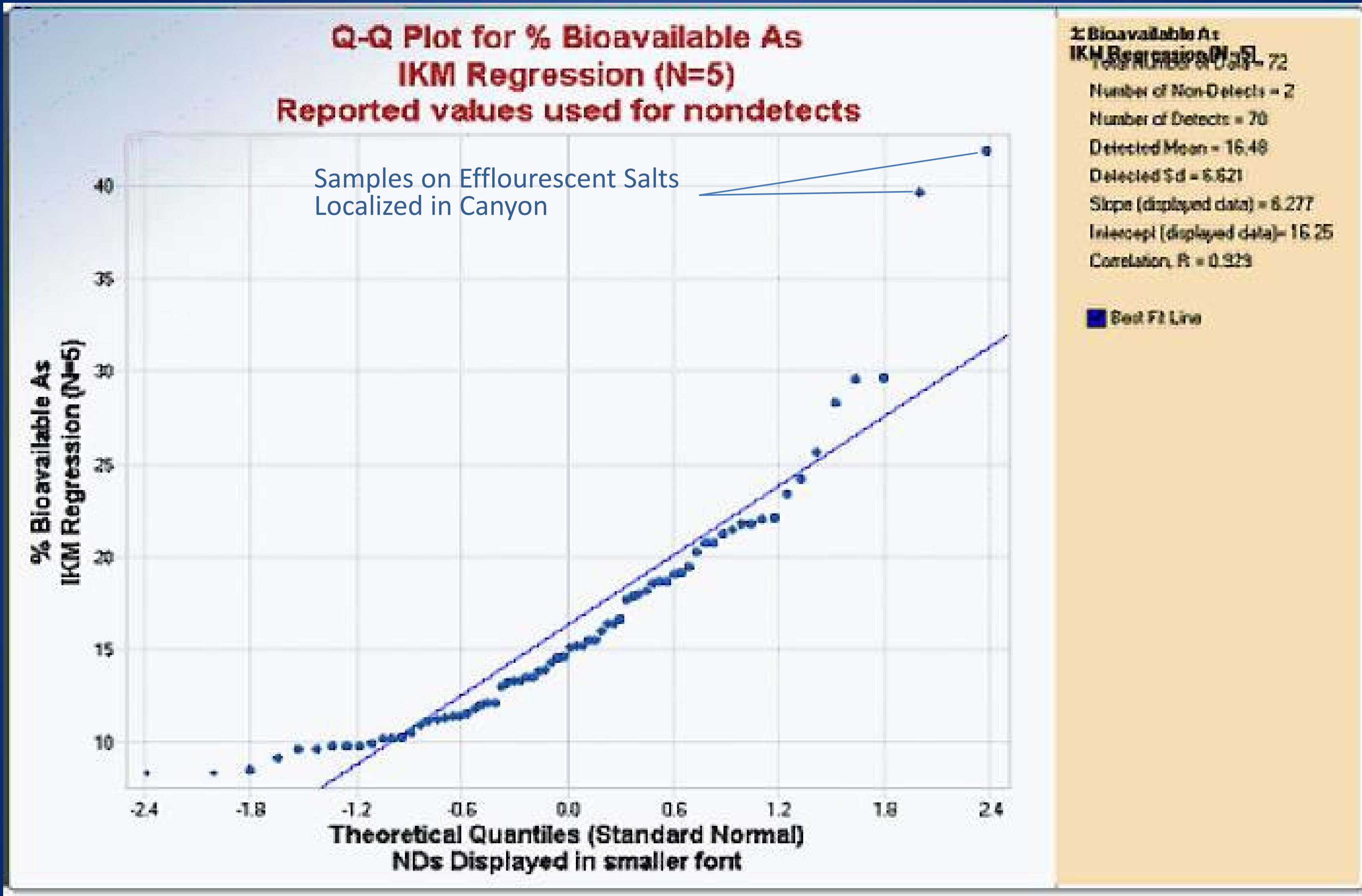


Figure 3. Correlation between estimates of As bioaccessibility and bioavailability (mean ± SD). %RBA = 0.72(%IVBA) + 5.64 (R^2 = 0.92).

IKHS Site-Specific Regression




Q-Q Plot for % Bioavailable As
IKM Regression (N=5)
Reported values used for nondetects
Samples on Efflourescent Salts
Localized in Canyon
% Bioavailable As
IKM Regression (N=5)
40
35
30
25
20
15
10
-2.4
-1.8
-1.2
-0.6
0.0
0.6
1.2
1.8
2.4
Theoretical Quantiles (Standard Normal)
NDs Displayed in smaller font
Number of Non-Detects = 2
Number of Detects = 70
Detected Mean = 16.48
Detected Sd = 6.621
Slope (displayed data) = 6.277
Intercept (displayed data)= 16.25
Correlation, R = 0.929
Best Fit Line

% Bioavailable As IKM Regression (N=5)

All Transformed IVBA

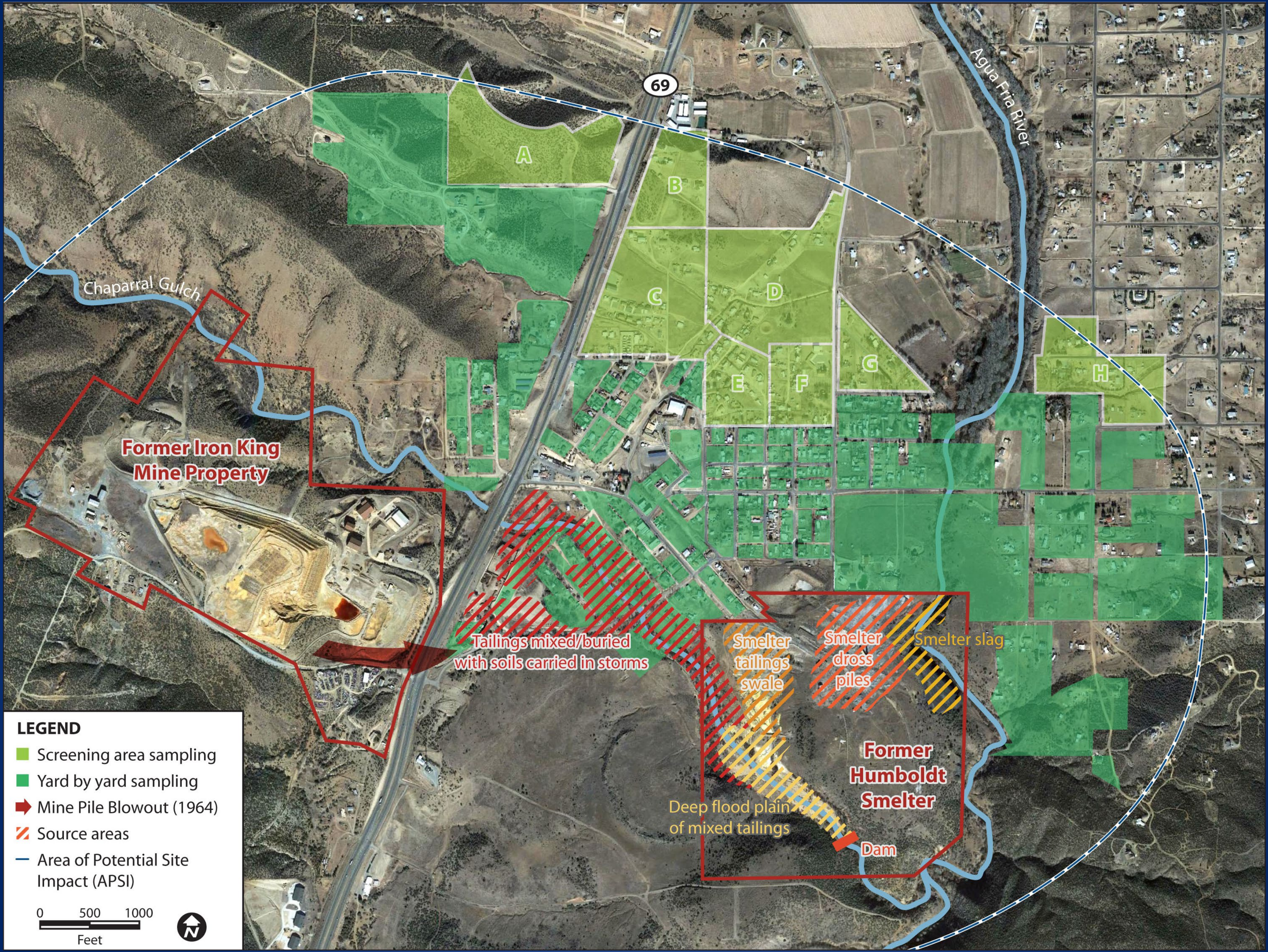
All IVBA Values (n=71)			
Risk Target	95%UCL 17.44	90th percentile 22.05	95th percentile 27.57
Arsenic RBC @ 10-6 risk (mg/kg)	1.74	1.48	1.26
Arsenic RBC @ 10-5 risk (mg/kg)	17.4	14.8	12.6
Arsenic RBC @ 10-4 risk (mg/kg)	174	148	126
Arsenic RBC @ HQ=1 (mg/kg)	287	245	209

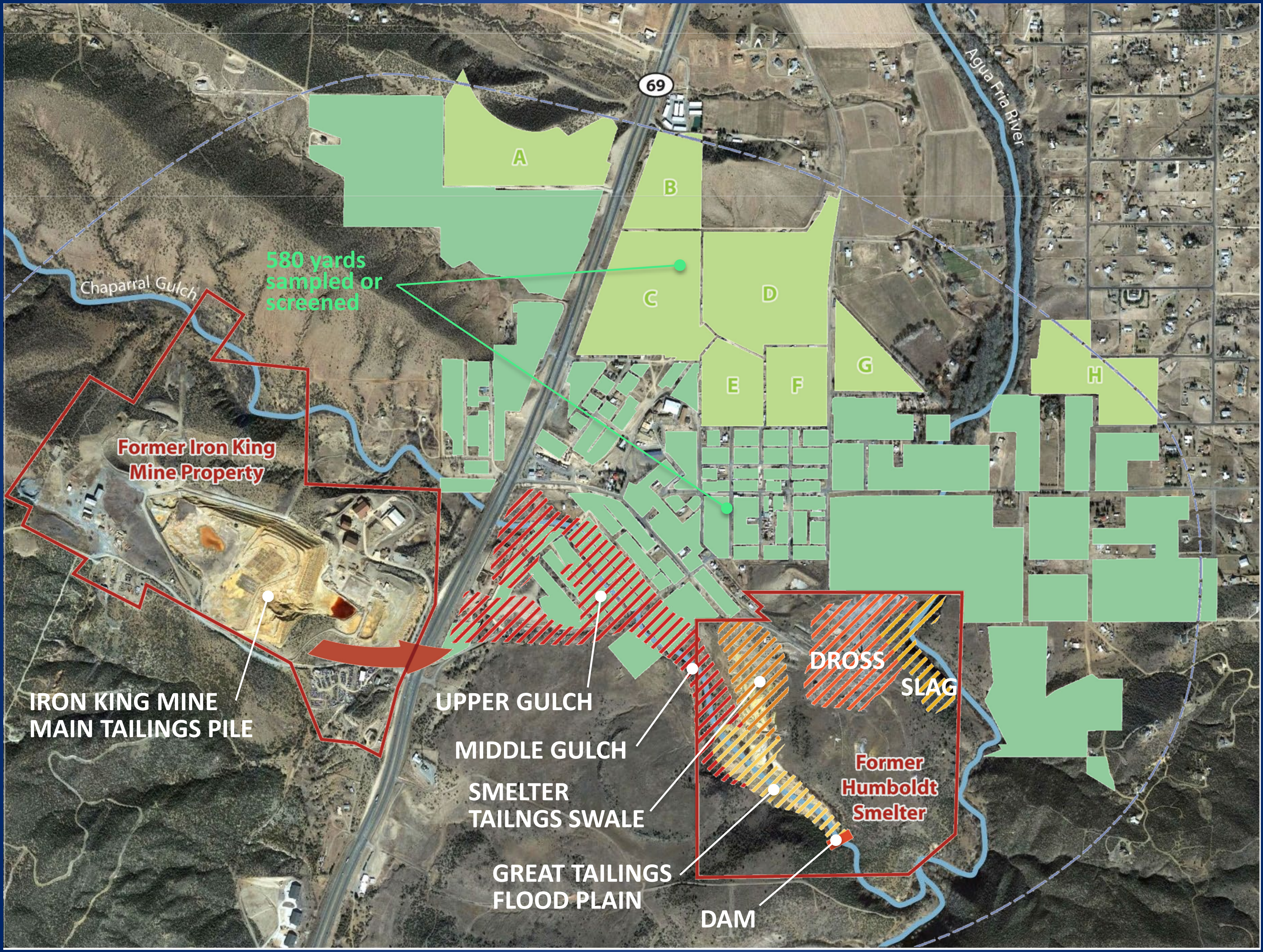
Transformed IVBA without 2 Samples on Efflourescent Salts

Excluding 2 Highest IVBA Values (n=69)			
Risk Target	95%UCL 16.39	90th percentile 21.81	95th percentile 23.83
Arsenic RBC @ 10-6 risk (mg/kg)	1.81	1.49	1.40
Arsenic RBC @ 10-5 risk (mg/kg)	18.1	14.9	14.0
Arsenic RBC @ 10-4 risk (mg/kg)	181	149	140
Arsenic RBC @ HQ=1 (mg/kg)	299	247	232

Residential Yard Transformed IVBA ONLY

Only Residential IVBA Values (n=26)			
Risk Target	95%UCL 17.18	90th percentile 20.93	95th percentile 22.78
Arsenic RBC @ 10-6 risk (mg/kg)	1.76	1.54	1.45
Arsenic RBC @ 10-5 risk (mg/kg)	17.6	15.4	14.5
Arsenic RBC @ 10-4 risk (mg/kg)	176	154	145
Arsenic RBC @ HQ=1 (mg/kg)	290	254	240


69
Agua Fria River
Chaparral Gulch
A
B
C
D
E
F
G
H
Former Iron King Mine Property
Tailings mixed/buried with soils carried in storms
Smelter tailings swale
Smelter dross piles
Smelter slag
Former Humboldt Smelter
Deep flood plain of mixed tailings
Dam
LEGEND
Screening area sampling
Yard by yard sampling
Mine Pile Blowout (1964)
Source areas
Area of Potential Site Impact (APSI)
0 500 1000
Feet
N


69
Agua Fria River
A
B
C
D
E
F
G
H
580 yards sampled or screened
Chaparral Gulch
Former Iron King Mine Property
IRON KING MINE MAIN TAILINGS PILE
UPPER GULCH
MIDDLE GULCH
SMELTER TAILNGS SWALE
GREAT TAILINGS FLOOD PLAIN
DAM
DROSS
SLAG
Former Humboldt Smelter