Field Report and Preliminary Results
X-Ray Fluorescence (XRF) Soil Sampling April 17-19, 2012
Iron King – Humboldt Smelter Superfund Site, Humboldt, Arizona

By Jeff Dhont, Remedial Project Manager
April 25, 2012

On April 17, 18, and 19, Jeff Dhont and Greg Nagle of EPA Region 9 conducted a sampling of soils over a wide area in association with the Iron King Mine – Humboldt Smelter Superfund Site (IKHS), using a portable X-Ray Fluorescence spectrometer (XRF). This effort supplemented and extended a previous similar effort conducted in January, 2012, by Monika O'Sullivan, Jeff Dhont, John Hillenbrand, and Peter Husby, of EPA Region 9. The results of that effort, as well as laboratory samples collected by EPA's contractor EA in the intervening time, were used to inform sample locations during this field effort.

Jeff Dhont is a remedial project manager assigned to the IKHS site. The lead RPM, Monika O'Sullivan, was unable to attend this event. Mr. Dhont directed the effort based on planning conducted in advance by the project management team. This included deciding on sampling locations in the field and navigation to sampling locations. Greg Nagle is on staff of the Field Services Team at the U.S. EPA Region 9 Laboratory. Mr. Nagle operated the XRF device, obtained all Global Positioning System (GPS) readings for sample points, conducted calibration and quality control procedures for the instrument, and provided interim results in the field to Mr. Dhont, who logged all samples by hand on paper in the field. He also transported equipment and samples back to the laboratory and coordinated any follow-up laboratory analysis at the lab. The XRF and GPS devices maintained electronic records of all samples and GPS locations for direct processing back at the laboratory. *Greg Nagle is issuing a separate report on this field effort to complement this field report.*

All sample locations and results shown in this report should be considered preliminary pending the more formal results posted by the EPA Region IX laboratory. Sample locations shown in this report are posted on aerial photos based on field logs and direct knowledge of the effort, not GPS. Results posted were based on oral transmission from XRF operator to field logger, and may be subject to limited transcription errors. However, the results should have few errors. This report also does not contain the results of laboratory correlative samples analyzed by the laboratory, if any. This will be reported by Mr. Nagle.

Background and Objectives of Sampling

The IKHS site contains two major sources – the former Iron King Mine (IKM) which contains a tailings pile with as much as 4 million cubic yards of material; and the former Humboldt Smelter. The operations at both facilities ceased at least 40 years ago and the smelter was operational as early as 1880. The IKM main tailings pile is located on the edge of the town of Humboldt. The smelter is somewhat of a centerpiece near the center of town. Primary metals being mined include zinc and copper, and possibly limited lead and gold. The primary contaminants of concern from a risk standpoint are arsenic and lead. Even when not a health concern, with proper scientific scrutiny zinc and copper levels have been found to be a useful consideration when evaluating influences from the sites on surrounding soils.

A major drainage known as the Chaparral Gulch traverses the mountains to the west and runs by the north edge of the IKM main tailings pile. It then crosses Highway 69 into the Humboldt town and then passes by the former smelter, which sits above the Gulch. Tailings from the IKM main tailings pile have entered this drainage. There are also tailings located on the smelter property, which have mixed into the same drainage farther downstream. The Gulch ultimately drains into the Agua Fria River. The smelter property also contains may piles of ash (likely wood burning or coal ash used to stoke the furnaces) and black slag.

The Agua Fria River flows from the north through the center of town, passing on the east side of the smelter property. The town is nestled in unconsolidated sediments in the river valley, between mountain ranges on the east and west. The rock geology in these ranges varies significantly, including quaternary, tertiary, and pre-tertiary deposits of sedimentary and igneous rock layers interspersed with subsequent lava upflows, raised at a significant dip angle. The geology in the east and west ranges appears to differ. The geology south of town also appears to differ from that in the town and north of the town. An agricultural region sits north of the town and just west of the River, extending northward to Arizona Highway 169.

During the last few years, significant numbers of samples have been collected in residential areas close to the main tailings pile and the smelter, primarily to the north of both the smelter and the IKM main tailings pile as well as in-between these two locations. However, prior to 2012 sampling efforts, insufficient data had been collected at locations farther out to evaluate the physical area which contains the influence of historical aerial dispersion from either source, nor what should be considered a “background” level for various metals, or whether more than one “background” level may be necessary.

The distribution of metals in soils in areas surrounding the IKM mine and Humboldt smelter are influenced by a number of factors. The first is geology, which is highly variable and does result in varying levels of metals in rock and soils; arsenic especially. This influence itself does, however, display some spatial patterns. For example, the average arsenic levels, and their variability, both appear greater in the eastern mountains and downstream unconsolidated sediments, than do average and variability of arsenic in the western mountains. The ranges southeast of the smelter also appear to have different metals characteristics than either the east or west ranges. These are generalizations.

In addition, traces of the former operations that may remain have been altered by up to 100 years of human activity in the area, including industry, construction, soil cut-and-fill, landscaping, etc. There is some evidence that foreign material, possibly from quarries some distance from the sites (a few have been sampled), as well as tailings themselves, may have been brought into yards by landowners or developers as fill or landscaping material. Arseniccontaining (tailings-based) fertilizers were also used residentially in the valley at times in the past. It is important to be able to distinguish such occurrences from aerial dispersion of dusts or tailings, although complete scientific control of such factors is likely impossible.

The degree of confounding due to multiple sources of influence and variability applies most strongly to arsenic. When one observes only arsenic levels (perhaps because it is a metal with the most significance from a risk standpoint) discerning trends and correlations can be difficult at many locations due to overlapping modes of influence. Evaluating a background level and spatial area of influence for the sources therefore suggests the use of a multiple-line of evidence approach. In particular, the distributions of other metals in soils, whether or not their levels may pose health risks, can be indicative of influences. The ratios of metals concentrations may also provide additional lines of evidence.

And, agreement or lack of agreement between surface and deeper soils can provide an indicator of whether the soil levels are natural or influenced by a more recent source (which the smelter and pile are in terms of geologic time). Confounding results can stray into even this analysis, however. In some locations, the mixing depth of surface soils may extend below the depth sampled; metals carried by rain infiltration may impact deeper soils, or human activity influences may be present where none is observed or expected. Again, multiple lines of evidence must be considered.

Dispersive/depositional influences from the sites could include either historical emissions from the smelter stack (which can no longer be sampled as they long-ago ceased) or tailings pile during mine operations; or more recent emissions from the residual piles due to wind. The chemical content of each of these may be different. It is noted also that the distance to which smelter stack emissions may have traveled, as well as their metals content, could have been influenced by particle size, and due to the significant period of time since the operation, such information is not readily obtainable.

Objectives of this effort included 1) obtaining a spatially well-spread sampling distribution of surface soils at distances up to 2 miles from the sources; 2) obtaining a spatially-well spread and surface-correlated distribution of deeper soils (on the order of 1 foot) for comparison to surface soil data); 3) collecting data sufficient to analyze spatial trends in metals concentrations and correlate these with geology and distance from the sources; 4) collect sufficient data to obtain statistical calculations of such parameters as background threshold values for subpopulations that may be smaller than the entire data set, and may have many points removed due to various influences; 5) gain additional information about the sources, including if possible, source profiling information for comparison to background areas.

Once again, this field effort was conducted as a supplement to the XRF field effort conducted in January, which had largely the same objectives. Samples collected here therefore “filled in” gaps in the data that was collected in January and laboratory-analyzed soil sampling efforts conducted by EPA’s contractors in March.

Field Procedures and Approach

The portable X-ray fluorescence spectrometer was calibrated at the beginning of each working day by Mr. Nagle, using approximately 10 standards provided by the manufacturer of the instrument for such purposes (see report by Mr. Nagle on this effort).

Sample locations were based on previous planning considering all previous data, as well as observations once in the field. Large maps of every quadrant proximate to the sources were utilized by Mr. Dhont to locate the sampling team and choose sampling locations. Both U.S.G.S. geologic maps and photobase maps with overlaid roads and parcel boundaries were utilized. All sampling locations were penned onto the photo-base maps, with corresponding sample IDs.

In choosing sample locations, pointed consideration was given to finding locations that had undisturbed soils. In particular, any material that could be road bedding or have been subject to road grading was carefully avoided, as was soil that might have been subject to off-road vehicle traffic. Field notation was taken as to the terrain and depositional environment at each sampling location. Samples taken from active drainage channels were differentiated from soils on hillsides or open flat areas. Drainage channels can serve to "average" the metals levels from points upstream of the sample, making them of special advantage for background considerations. Effort was made to collect a balance of channel and other terrain (bluff, hillside/sloped, flat, ridge) samples and the pertinent conditions were logged in the field.

Most samples were collected to the side of public roadways, as long as a location could be found that was clearly not influenced by road construction and appeared undisturbed. The team ventured farther from the road where EPA had direct access agreements for properties (such as state lands or BLM lands). Sampling locations were kept outside property fence lines. The team did not conduct sampling in areas past private gates, fencelines, or into driveways or yards.

At virtually all locations, a photograph was taken of the sample number(s) written on a white board followed by a photograph of the area the sample was taken from. Samples were collected into plastic zip lock bags for analysis by XRF, generally conducted at the back of a 4WD vehicle. Prior to sample collection to the bag, the sample ID was written on the bag in indelible ink.

Surface soils were collected using a white plastic scoop designed and sold specifically for sampling applications which arrived at the site clean in sealed plastic bags. Scoops were reused in areas with similar characteristics and soil levels. If high levels were observed, scoops were changed out. Otherwise, soil and dust, if any, was wiped from the scoop between samples. It was not desired to use water for cleaning between samples as moisture content can affect XRF readings and, given the very large sample size compared to any residual low-level dust on the scoop, the effect of reuse was considered negligible.

Deeper samples, where collected, were obtained in one of two ways. Most commonly, a long-handle spade shovel was used to advance a hole to as close to 1 foot depth as possible. In several cases, this depth could not be achieved due to either 1) caliche or cobbles at a shallower depth, or 2) bedrock at a shallower depth. In such cases, soil was collected from the greatest depth that could be reached and the depth noted in field charts. In only a few situations, depths of 15 inches (more than 1 foot) were achieved.

The second manner that deep samples were collected was the "road cut" method. In some locations, when the road was constructed it was cut into the side of a hill such that a nearly vertical face remained at the roadside, with a native flat bluff or hillside immediately above. In these cases, the surface sample was collected from on top of the bluff (above the cut) and the deep sample from one foot below in the cut face. In general, the outer layer of soil in the vertical face, 1 foot down, was brushed away, and then the sample was collected from a few inches horizontally into the face.

When deeper samples were collected using a spade shovel, soil was dug out of the hole and pulled up along the side of the hole as much as possible in only one direction. When the hole had reached target depth, in-falling surface soil was removed as much as possible by pulling up and out of the hole along the same side. The spade was then used to cut a clean, vertical face a few inches in length on the ***opposite*** side of the hole, and near the hole bottom. The shaved off material was placed *behind and under* the shovel, with the shovel wedged at an angle just below the clean, deep face but slightly above the bottom of the hole. This was done to segregate the deeper soils from any soil that may have fallen into the hole from nearer the surface. With care not to push more surface soils into the hole, a scoop was used to pull soil out of the clean face at the bottom of the hole. Soil that fell out of the face fell on the metal blade of the shovel and could be retrieved off the shovel. Any holes were backfilled with the original soil material. Zip lock bags were sealed and brought back to the sampling vehicle.

Prior to analysis with XRF, each bag was massaged with the fingers to break up any colloids as much as possible. The bag was inverted several times to mix the contents well. With clay and moist soils, extra time was spent squeezing the clay flakes to spread them out, push them together again, and then spread them out in repetition. The bag was then inverted and mixed several times. The objective in each case was to provide as much mixing and as uniform a particle size distribution as possible.

XRF runs were made through the face of each ziplock bag, with the device's X-ray port window pressed firmly into the bag material, and the bag's face perpendicular to the axis of the spectrometer.

Every sample was analyzed by XRF twice, with further mixing of the bag between duplicate samples. These were designated as **[Sample No.] A** and **[Sample No.] B**. Values for both duplicates were recorded in memory electronically *and* logged into field charts manually.

All samples were retained, sealed, and shipped back to the EPA Region 9 laboratory in Richmond, California by next-day freight.

Interpretations for the following charts and figures

In the sample numbering scheme, **odd-numbered samples were always surface samples; even-numbered samples were always deep (usually 1 ft) samples.** In cases where no deep sample was taken at a location, the even numbered sample number was skipped and numbering resumed with the next odd number.

Data that show up in yellow, orange, or red are pre-flagged as appearing to be either higher than usual for the area, or to have a significant difference between the surface and the deeper sample, or both. Such markings were not used on the Humboldt Smelter property itself. Such markings have no relation to exposure or risk values; also, further interpretation of the results is likely after this report.

On the photo-based figures showing sample locations and results, the metals results are shown in the following order: **Arsenic, Lead, Zinc, Copper.**

When metals were not detected, the applicable detection limit is shown after a “less than” sign, e.g. “<8” means not detected with a detection limit of 8.

The term “Cut” on the field log table means that the sample was collected as described above from 1 foot below the top of a face left by cutting into a slope for a road, in lieu of digging down to 1 foot with a shovel from the top.

Red lines across roadways on the photo-base figures indicates that sampling could not occur past that point because the road was gated and marked private, or the road became impassable.

All units are in milligrams per kilogram of soil.

Iron King Humboldt Smelter Site: 2nd Phase X-Ray Fluorescence Sampling, April 16 – 19, 2012 *Jeff Dhont Field Recording*								
Sample	**A/B**	**Depth**	**As**	**Pb**	**Zn**	**Cu**	**Terrain/Deposition**	**Location and Observations**
SECTION: 201-212: SOUTH / SOUTHWEST OF IK MAIN TAILINGS PILE; SECTION: 213+ SOUTH/SOUTHWEST OF SMELTER								
201	A	Top	32	28	142	82	Flat, low point	Iron King Road near Iron King Mine. Road comes west from Hwy 69 to back of main tailings pile. Sample point is shortly after road turns sharply to the right. ***Sample is taken in a low point --likely drainage.*** Refusal to shovel was encountered at 9 inches. Hard clay layer. Levels of lead observed are higher than most at the site.
201	B	Top	32	19	119	82		
202	A	9 inches	27	17	124	80	Flat	
202	B	9 inches	29	<8	141	78		
203	A	Top	26	18	130	70	Small slope	Further south on Iron King Road. Refusal of shovel encountered at 8 inches due to caliche and/or rock.
203	B	Top	62	43	179	105		
204	A	8 inches	25	<9	121	79	Small slope	
204	B	8 inches	22	12	118	89		
205	A	Top	74	34	154	103	Hillside channel	Well off road, east side of Iron King Road, farther south. Placed in meandering channel through sloped hill with evidence of water flow.
205	B	Top	52	41	124	102		
206	A	8 inches	27	19	90	74	Hillside channel	
206	B	8 inches	37	11	96	76		
207	A	Top	15	10	100	68	Active Channel	In the gas right of way, north of intersection with Iron King Road, in active channel. Natural gulley bottom.
207	B	Top	22	<8	120	68		
208	A	8 inches	20	<8	109	88	Active Channel	
208	B	8 inches	22	<9	106	62		
209	A	Top	16	17	92	54	Hillside	Natural gas right of way, well up on hillside, below tall peak. Near the point that ROW enters private property and road is fenced off. Sample point was bout 40 feet off road on west side. On deep sample, met refusal due to cobbles at 10 inches.
209	B	Top	15	17	78	50		
210	A	10 inches	12	13	69	40	Hillside	
210	B	10 inches	13	<8	65	46		
211	A	Top	87	21	113	118	Gentle slope	Natural gas right of way, well on hillside, 30 feet off road on open ground. Cobbles and caliche resulted in refusal at 8 inches for the deep sample.
211	B	Top	87	22	117	94		
212	A	8 inches	75	14	110	120	Gentle slope	
212	B	8 inches	71	10	106	140		
213	A	Top	22	33	118	86	Flat, open	Agua Fria Road, southeast of smelter. Deeper sample has a darker, loamy and loose character that is deeper than soils on the west side of the highway nearer to the mine. Some moisture in deep sample.
213	B	Top	25	26	116	73		
214	A	1 ft	<8	21	136	59	Flat, open	
214	B	1 ft	15	20	79	59		
215	A	Top	11	26	87	63	Top of anticline	Agua Fria Road, farther east than last sample. 30 feet off road, south of road. Deep sample was same as last location – loamy and fairly dark. Loose, little resistance to 1 ft. Some moisture.
215	B	Top	10	22	100	53		
216	A	1 ft	10	15	75	70	Top of anticline	
216	B	1 ft	<9	29	85	72		

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Sample	**A/B**	**Depth**	**As**	**Pb**	**Zn**	**Cu**	**Terrain/Deposition**	**Location and Observations**
SECTION: SOUTH/SOUTHEAST OF SMELTER								
217	A	Top	<11	38	98	73	Active Channel	Active Channel sediments off Agua Fria Road south of smelter – drainage.
217	B	Top	12	31	96	70		
218	-	-	-	-	-	-	*-No Sample -*	
218	-	-	-	-	-	-		
219	A	Top	20	37	124	121	Bluff	Agua Fria Road near but *not* at the bottom of hill, near southwest corner of smelter property, before road splits. There is a steep eroded crescent here, perhaps 15 feet high, on side of road. Deep sample used roadside cut to obtain 16 inch depth. Scooped an inch into side of road cut to get sample. Shallow sample was collected from top of crescent after climbing up the side.
219	B	Top	22	32	114	80		
220	A	Cut 16''	11	23	88	65	Eroded Crescent	
220	B	Cut 16''	<8	21	73	96		
221	A	Top	<10	41	111	80	Hillside steep upslope	After split from Agua Fria Road onto uphill road unnamed that goes along south end of smelter, but at higher elevation. Deeper sample was collected from side of cut for road. Reddish horizon visible in lower soils in cut.
221	B	Top	11	35	108	92		
222	A	Cut 1 ft	15	22	90	86	Road cut	
222	B	Cut 1 ft	<8	24	99	77		
223	A	Top	51	107	289	468	Gentle Slope	At the top of the rise of the north road extending off of Agua Fria Road. Just before the descent on east side of hill. More directly south of the smelter property with the Chaparral Gulch in-between. This location is much higher elevation than the smelter property.
223	B	Top	65	125	334	500		
224	A	1 ft	33	52	175	215	Gentle Slope	
224	B	1 ft	35	38	143	153		
225	A	Top	100	158	396	704	Slope	North road off of Agua Fria Road, on downslope to bottom a little ways from end of road. About 1 foot down in road cut there was firm clay. Sample was taken in clay.
225	B	Top	111	179	451	752		
226	A	Cut 1 ft	<8	19	78	94	Slope	
226	B	Cut 1 ft	<8	13	63	92		
227	A	Top	72	180	482	745	Slope	North road off Agua Fria Road, same road near the bottom near end of road. Hard clay at 1 ft – sample taken from there. Possible change of geology.
227	B	Top	68	179	457	702		
228	A	Cut 1 ft	100	10	52	81	Slope	
228	B	Cut 1 ft	107	16	61	74		
229	A	Top	88	211	273	355	Bluff	Sample taken from loop at bottom of the road. This location sits perhaps 30 feet off the floor of Chaparral Gulch as it empties into the Agua Fria. Tailings are visible far below in Gulch. Cobbly/rocky soil and possible bedrock with refusal at 6 inches. *It is questionable whether this is truly a "deep sample" - it was fairly shallow and underlain by rock.
229	B	Top	97	180	263	342		
230*	A	6 inches	187	361	329	616	Bluff	
230*	B	6 inches	210	341	406	654		
231	A	Top	30	20	85	59	Bluff	Location is collected on bluff off dirt road leading out of the loop to the SOUTH and eventually into private property. Sits above Agua Fria Canyon, around corner from Smelter. Possible geology change. Soil is very loose, fine, and deep. Few cobbles compared to last samples. White, shiny quartz chunks and outcrops observed near road.
231	B	Top	47	21	101	59		
232	A	15 inches	16	19	64	42	Bluff	
232	B	15 inches	20	17	61	42		

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Sample	**A/B**	**Depth**	**As**	**Pb**	**Zn**	**Cu**	**Terrain/Deposition**	**Location and Observations**
SECTION: EAST OF SMELTER / EAST OF AGUA FRIA								
233	A	Top	35	64	206	216	Gentle Slope	Agua Fria Ranch Road, heading south. Deeper sample taken from side of road cut. Cutting into the cut, hit caliche almost immediately, so cut sample is outermost soils from 1 ft down from top of cut.
233	B	Top	45	60	255	196		
234	A	Cut 1 ft	<9	21	105	175	Gentle Slope	
234	B	Cut 1 ft	<8	21	97	77		
235	A	Top	119	77	217	257	Steep slope	At the hairpin turn, well south on Agua Fria Ranch Road, headed toward Agua Fria Ranch Estates. Took from top of hill flat above the road.
235	B	Top	112	83	208	306		
236	-	-	-	-	-	-	Sample not Possible	
236	-	-	-	-	-	-		
237	A	Top	19	28	125	130	Flat	Back at "Y" where Agua Fria Ranch Road splits from Road that goes Taken north of the "Y" in flat cattle field. (outside fence) 50 feet north of roadway. Deeper sample is dark brown and loamy. This is near the southeast corner of the smelter property, but across the Chaparral Gulch and at somewhat higher elevation.
237	A	Top	16	35	142	115		
238	B	15 inches	9	19	79	81	Flat	
238	B	15 inches	<7	20	77	80		
239	A	Top	44	19	88	52	Flat	Start of Day 2 – Mingus Road south of Lazy River Drive
239	B	Top	46	11	75	61		
240	A	1 ft	42	14	74	58	Flat	
240	B	1 ft	46	10	91	57		
241	A	Top	53	20	109	99	Slope	Mingus Road farther south, just past visible driveway, on upslope as move south toward Agua Fria Lane.
241	B	Top	48	34	99	91		
242	A	10 inches	52	13	88	90	Slope	
242	B	10 inches	54	18	86	68		
243	A	Top	73	9	110	69	Active Channel	Just around 145 degree turn in Rattlesnake Trail, which comes off Rancho Road. Down slope in active channel. Drainage comes down from higher elevations. Culvert under road.
243	B	Top	51	13	83	80		
244	A	1 ft	44	16	80	68	Active Channel	
244	B	1 ft	58	12	83	61		
245	A	Top	25	15	105	173	Gentle slope into channel	Rattlesnake trail, to side of small drainage channel coming down from hills behind toward Agua Fria. Deep sample refusal – cobbles and rock at 8 inches.
245	B	Top	21	<8	107	158		
246	A	8 inches	18	9	69	152		
246	B	8 inches	27	<7	69	158		
247	A	Top	54	<8	110	71	Active Channel	Ending hairpin, to south, on Rattlesnake Trail, in active channel from high above.
247	B	Top	49	12	105	107		
248	A	1 ft	44	<8	97	122	Active Channel	
248	B	1 ft	37	10	98	63		

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Sample	**A/B**	**Depth**	**As**	**Pb**	**Zn**	**Cu**	**Terrain/Deposition**	**Location and Observations**
SECTION: EAST OF SMELTER / EAST OF AGUA FRIA, continued								
249	A	Top	29	14	53	63	Flat and Open	On Agua Fria Lane east of Sleepy Acre
249	B	Top	40	<8	72	61		
250	A	6 inches	38	15	83	79	Flat and Open	
250	B	6 inches	38	14	83	83		
251	A	Top	55	18	76	80	Slight slope	Between Agua Fria Lane and Lazy River Drive on Sleepy Acre. There is a clear westward view of the smelter stack from this location.
251	B	Top	45	14	72	57		
252	A	1 ft	74	11	84	56	Slight slope	Deeper sample has *higher* levels As – may indicate a background location here.
252	B	1 ft	85	14	83	61		
253	A	Top	73	30	114	134	Slight slope	Green Valley Road south of Lazy River Drive, ½ of the way to where Agua Fria Lane would be if extended. Side of road samples. Native material. Deep sample was moist
253	B	Top	53	29	112	117		
254	A	1 ft	44	10	74	80	Slight slope	
254	B	1 ft	59	<7	87	64		
255	A	Top	46	68	142	168	Flat	Open field near corner of Agua Fria Lane and Holiday Drive – across river from smelter.
255	B	Top	37	56	140	170		
256	A	10 inches	32	31	99	99	Flat	
256	B	10 inches	25	18	83	96		
257	A	Top	83	36	134	99	Gentle Slope	Green Valley Road, south of where Beverly Hills Drive splits off to the east. Taken on top of flat by side of the road.
257	B	Top	65	36	135	104		
258	A	1 ft	63	26	111	98	Gentle Slope	
258	B	1 ft	60	24	109	71		
259	A	Top	44	52	115	97	Active Channel Bottom	Very active channel bottom sediment; Green Valley Road south of previous location.
259	B	Top	75	35	127	87		
260	-	-	-	-	-	-	No Sample	
260	-	-	-	-	-	-		
261	A	Top	85	64	203	137	Slope	Green Valley Road farther south, at last point before road turns private.
261	B	Top	67	46	180	141		
262	A	10 inches	58	18	133	140	Slope	
262	B	10 inches	66	15	133	140		

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Sample	**A/B**	**Depth**	**As**	**Pb**	**Zn**	**Cu**	**Terrain/Deposition**	**Location and Observations**
SECTION: HUMBOLDT SMELTER PROPERTY								
263	A	Top	54	187	764	1153	Flat	On smelter near brick building just off entrance road from Main Street, about 100 yards from the stack.
263	B	Top	98	260	911	1259		
264	A	8 inches	72	294	651	848	Flat	
264	B	8 inches	59	210	701	959		
265	A	Top	25	280	5550	10200	ASH SAMPLE	**ASH Sample –** near stack, and about due west of it. Quite low in arsenic.
265	B	Top	33	344	6332	9957		
266	-	-	-	-	-	-	No Deep Sample	
266	-	-	-	-	-	-		
267	A	Top	69	425	4545	4185		Soil sample taken just adjacent to smelter and stack. Could not dig to depth – rock.
267	B	Top	107	487	4451	4734		
268	-	-	-	-	-	-	No Deep Sample	
268	-	-	-	-	-	-		
269	A	Top	54	480	3950	5290	Flat – Soil near ash	West side of smelter stack, 50 years from Agua Fria and slag at edge of canyon.
269	B	Top	36	377	3286	4276		
270	A	8 inches	18	20	169	239	Flat – Soil near ash	
270	B	8 inches	9	23	167	221		
271	A	Top	<19	302	2518	6314	Ash Sample	Ash pile east of smelter. Pure ash. Surprisingly low in arsenic.
271	B	Top	<19	307	2797	6483		
272	-	-	-	-	-	-	No Deep Sample	
272	-	-	-	-	-	-		
273	A	Top	139	109	288	416	Soil -Flat	Southern portion of property. Thick, deep and loose soils. Darker than near smelter stack. Soft loam, deeper sample is damp and has some clay. Possible that deeper sample has been affected by historical activity, even though this is not evident. 100 years of history at this location. Piles of debris sporadically around.
273	B	Top	156	139	428	443		
274	A	1 ft	51	75	213	282	Soil-Flat	
274	B	1 ft	66	67	225	276		
275	A	Top	127	56	196	313	Soil – Flat	Same note.
275	B	Top	128	66	215	306		
276	A	1 ft	70	32	124	131	Soil – Flat	
276	B	1 ft	90	39	138	143		
277	A	Top	109	212	558	930	Soil – Flat	Same note.
277	B	Top	123	192	629	923		
278	A	1 ft	90	82	177	254	Soil – Flat	
278	B	1 ft	68	57	189	275		

Iron King Humboldt Smelter Site: 2nd Phase X-Ray Fluorescence Sampling, April 16 – 19, 2012 *Jeff Dhont Field Recording*								
Sample	**A/B**	**Depth**	**As**	**Pb**	**Zn**	**Cu**	**Terrain/Deposition**	Location and Observations
SECTION: HUMBOLDT SMELTER PROPERTY, continued								
279	**A**	**Top**	**215**	**1251**	**995**	**2093**	**Flat**	Smelter property, near south end, but still on the flat, south of a tiny tailings or ash pile but far from it. No apparent reason for the high readings, particularly of lead. Loose, loamy soil with little resistance.
279	**B**	**Top**	**228**	**1118**	**912**	**1821**		
280	**A**	**1 ft**	**35**	**65**	**252**	**234**	**Flat**	
280	**B**	**1 ft**	**30**	**70**	**168**	**223**		
281	**A**	**Top**	**121**	**340**	**207**	**1355**	**Sloped**	South end of smelter, over the edge of the plateau and on the slope leading into the Chaparral Gulch. **<u>Refusal at 6 inches – more cobbles and rocks</u>**. Different entirely than deep, loose soils up on the plateau in southern edge of property. *Deep sample is quite shallow – may not be representative of old soil; cross-contamination from surface is likely, also.
281	**B**	**Top**	**102**	**235**	**542**	**1085**		
282*	**A**	**6 inches**	**123**	**370**	**749**	**1914**	**Sloped**	
282*	**B**	**6 inches**	**131**	**305**	**649**	**1629**		
283	**A**	**Top**	**79**	**206**	**365**	**763**	**Flat**	On flat open area, loamy, loose and dark like previous samples before last sample; south end of property, SW side, North of Chaparral Gulch, east of Smelter Tailings.
283	**B**	**Top**	**70**	**232**	**446**	**883**		
284	**A**	**1 ft**	**57**	**146**	**254**	**403**	**Flat**	
284	**B**	**1 ft**	**53**	**204**	**251**	**438**		
285	**A**	**Top**	**64**	**105**	**312**	**592**	**Flat**	SW side of property, western edge of higher plateau. Farther from tailings and ash piles.
285	**B**	**Top**	**54**	**99**	**307**	**582**		
286	**A**	**1 ft**	**47**	**102**	**276**	**582**	**Flat**	
286	**B**	**1 ft**	**45**	**74**	**240**	**415**		
287	**A**	**Top**	**93**	**221**	**913**	**1660**	**Gentle Slope**	On lower elevation, very close to but not in tailings that are at the smelter – on the western edge of the property in tailings area.
287	**B**	**Top**	**96**	**212**	**867**	**1530**		
288	**A**	**1 ft**	**24**	**40**	**175**	**191**	**Gentle Slope**	
288	**B**	**1 ft**	**22**	**36**	**159**	**241**		
289	**A**	**Top**	**100**	**182**	**1042**	**1045**	**Pure Deep Tailings**	Tailings- dark orange with crust (cut through to get sample).
289	**B**	**Top**	**103**	**200**	**1046**	**1021**		
290	**-**	**-**	**-**	**-**	**-**	**-**	**– No Deep Sample-**	
290	**-**	**-**	**-**	**-**	**-**	**-**		
291	**A**	**Top**	**153**	**216**	**506**	**901**	**Pure Deep Tailings**	Tailings – lighter yellow, finer, and no crust
291	**B**	**Top**	**173**	**215**	**641**	**1005**		
292	**-**	**-**	**-**	**-**	**-**	**-**	**– No Deep Sample-**	
292	**-**	**-**	**-**	**-**	**-**	**-**		
293	**A**	**Top**	**190**	**200**	**417**	**820**	**Pure Deep Tailings**	Tailings – lighter yellow, finer, and no crust
293	**B**	**Top**	**167**	**210**	**577**	**706**		
294	**-**	**-**	**-**	**-**	**-**	**-**	**– No Deep Sample-**	
294	**-**	**-**	**-**	**--**	**-**	**-**		

Iron King Humboldt Smelter Site: 2nd Phase X-Ray Fluorescence Sampling, April 16 – 19, 2012 *Jeff Dhont Field Recording*								
Sample	**A/B**	**Depth**	**As**	**Pb**	**Zn**	**Cu**	**Terrain/Deposition**	**Location and Observations**
SECTION: NORTH CENTRAL								
295	A	Top	24	38	140	117	Flat	**Start of Day 3**: North side of Green Gulch Road, farmland, not in crop zone but out of roadway base.
295	B	Top	20	43	143	144		
296	A	8 inches	19	38	124	102	Flat	
296	B	8 inches	23	30	134	92		
297	A	Top	29	46	135	79		Pale Moon Drive, north side of the gulch, open spot on south side of street, not far in (west) from the Old Black Canyon Hwy. Refusal encountered due to cobbles at 3 inches.
297	B	Top	20	38	119	66		
298	-	-	-	-	-	-	No Sample	
298	-	-	-	-	-	-		
299	A	Top	11	12	58	35	Flat	At the side of a slope off Old Black Canyon Highway, leading into irrigation ditch – but not in the ditch bottom. Not on crop land.
299	B	Top	14	13	62	35		
300	A	10 inches	13	16	74	38	Flat	
300	B	10 inches	19	14	72	49		
301	A	Top	15	30	87	60	Flat	From the north side of Highway 169, about 1 ½ blocks east of Hwy 69 intersection. Open field edge. Vegetation. Soft soil – good dig to 1 ft.
301	B	Top	17	26	94	66		
302	A	1 ft	17	30	84	41	Flat	
302	B	1 ft	17	39	77	40		
303	A	Top	20	46	135	67	Flat	Latilla Lane, off end of Coldwater drive. Light industry in area. Lot appears to have trash on it, but not be disturbed. Light vegetation.
303	B	Top	26	38	142	71		
304	A	1 ft	16	37	91	55	Flat	
304	B	1 ft	12	45	107	45		
305	A	Top	38	19	82	67	Flat	Far out on Outback Road, as far as the small housing block. Open field, east side of road. Cow manure observed.
305	B	Top	39	23	69	53		
306	A	1 ft	34	17	68	40	Flat	
306	B	1 ft	35	15	69	51		

Iron King Humboldt Smelter Site: 2nd Phase X-Ray Fluorescence Sampling, April 16 – 19, 2012 *Jeff Dhont Field Recording*								
Sample	**A/B**	**Depth**	**As**	**Pb**	**Zn**	**Cu**	**Terrain/Deposition**	**Location and Observations**
SECTION: NORTHWEST OF IRON KING MINE MAIL TAILINGS PILE								
307	A	Top	21	18	86	42	Flat	Prescott Dells Ranch Road, just south of the end of Misty Dells Road which meets Prescott Dells about 3 blocks east of Hwy 69. Very, very hard to dig. Cobbles and rock.
307	B	Top	19	20	86	43		
308	A	10 inches	11	8	57	29	Flat	
308	B	10 inches	15	12	76	42		
309	A	Top	47	40	151	54	Gentle slope	Cody Ridge Road
309	B	Top	46	40	140	45		
310	A	8 inches	25	16	82	45	Gentle Slope	Caliche interfered with deep sample going deeper.
310	B	8 inches	19	20	91	50		
311	A	Top	85	60	252	89	Steep slope	Cody Ridge Road, near end on south
311	B	Top	96	69	247	60		
312	A	8 inches	22	14	68	43	Steep Slope	Hard clay prevented deeper sample.
312	B	8 inches	21	12	93	60		
313	A	Top	69	49	200	56	Steep Slope	Cody Ridge Road
313	B	Top	67	74	265	85		
314	A	Cut 1 ft	17	14	86	56	Steep Slope	Caliche and hard clay right there on deep sample
314	B	Cut 1 ft	18	<7	63	40		
315	A	Top	20	19	88	30	Flat	Cody Ridge Road. Top flat over cut to side of roadway.
315	B	Top	29	29	87	45		
316	A	10 inches	14	14	60	44	Flat	Clay prevented deeper sample.
316	B	10 inches	15	15	73	54		
317	A	Top	32	38	135	34	Flat	Cody Ridge Road near intersection with Prescott Dells Ranch Road.
317	B	Top	47	35	165	51		
318	A	10 inches	24	16	72	40	Flat	Caliche in deep sample at 10 inches.
318	B	10 inches	13	12	60	34		
319	A	Top	13	9	56	12	Gentle Slope	Prescott Dells Ranch Road where it makes a "leg" to the right and then back left again toward west if heading outward. Right side of road in native soils.
319	B	Top	17	13	66	68		
320	A	1 ft	17	14	52	41	Gentle Slope	
320	B	1 ft	14	15	80	36		
321	A	Top	7	<7	80	<21	Active Channel	Natural gas right of way, just south of intersection with Prescott Dells Ranch Road, below culvert with well cut-out banks to sides. Active Channel here. 1 foot sample also collected in this case.
321	B	Top	28	9	52	<21		
322	A	1 ft	9	14	47	24	Active Channel	
322	B	1 ft	12	13	61	41		

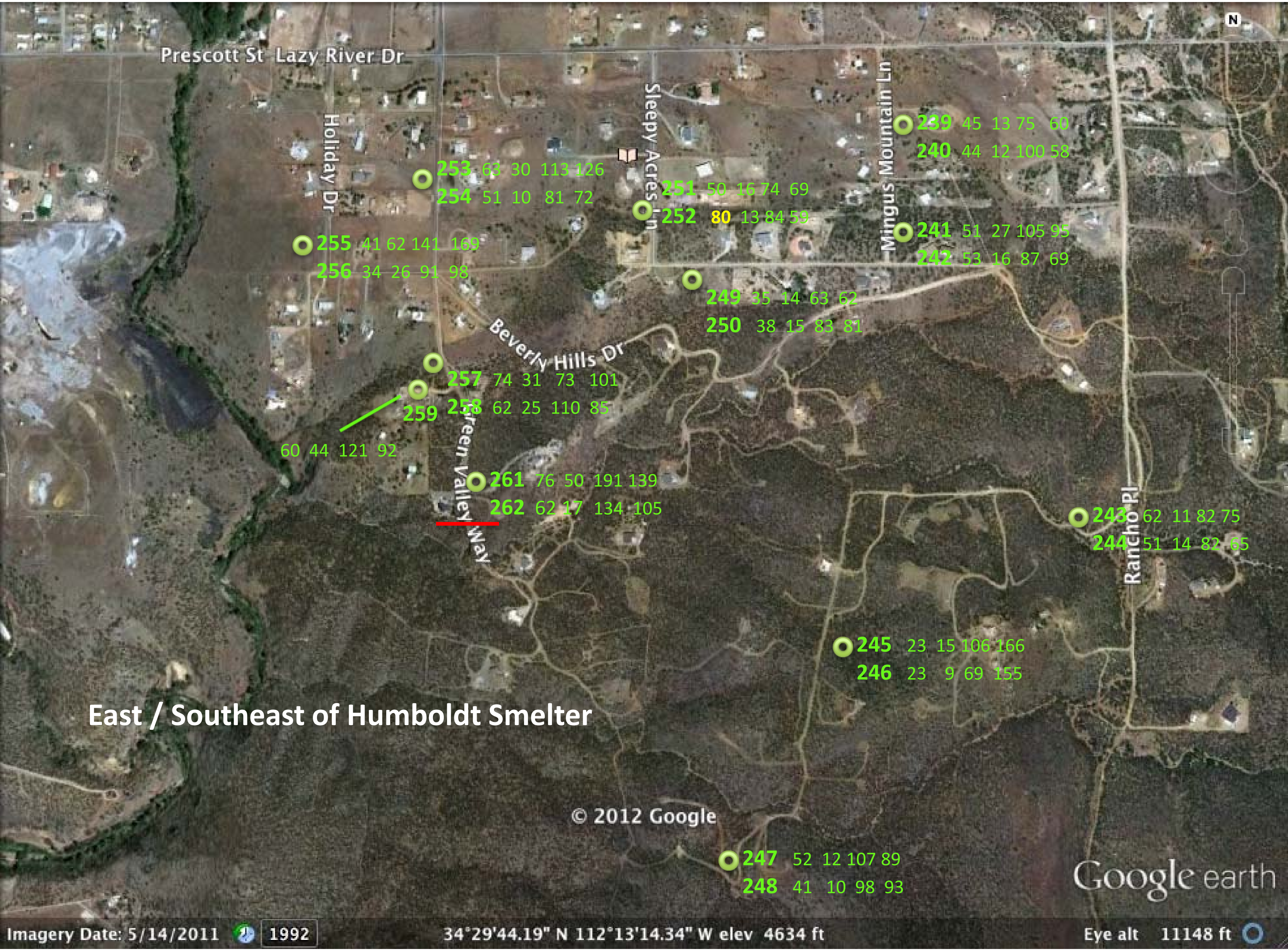
Iron King Humboldt Smelter Site: 2nd Phase X-Ray Fluorescence Sampling, April 16 – 19, 2012 *Jeff Dhont Field Recording*								
Sample	**A/B**	**Depth**	**As**	**Pb**	**Zn**	**Cu**	**Terrain/Deposition**	**Location and Observations**
SECTION: NORTHWEST OF IRON KING MINE MAIL TAILINGS PILE, continued								
323	**A**	**Top**	**51**	**10**	**91**	**45**	**Hilltop**	Natural gas right of way farther south. High terrain north of the gulch pass. The arsenic at this location appears isolated and at depth primarily, and given this location, natural.
323	**B**	**Top**	**71**	**13**	**94**	**31**		
324	**A**	**1 ft**	**107**	**<7**	**82**	**<21**	**Hilltop**	
324	**B**	**1 ft**	**121**	**<8**	**85**	**<22**		
325	**A**	**Top**	**25**	**15**	**91**	**36**	**Ridge Top**	High above Chaparral Gulch at the mountain pass where water can drain in from the back (west) watershed toward the mine.
325	**B**	**Top**	**30**	**27**	**102**	**57**		
326	**A**	**1 ft**	**22**	**10**	**58**	**32**	**Ridge Top**	
326	**B**	**1 ft**	**22**	**13**	**73**	**51**		
327	**A**	**Top**	**73**	**14**	**79**	**26**	**Active Channel**	BOTTOM OF CHAPARRAL GULCH BELOW MOUNTAIN PASS Active channel sediments, draining from back side of mountain as well as multiple gullies on mountainside to this location. High erosion/water velocities/scour. Dry at time of sample.
327	**B**	**Top**	**83**	**21**	**88**	**47**		
328	**-**	**-**	**-**	**-**	**-**	**-**	**No deep sample**	
328	**-**	**-**	**-**	**-**	**-**	**-**		
329	**A**	**Top**	**70**	**20**	**100**	**41**	**Active Channel**	BOTTOM OF CHAPARRAL GULCH BELOW MOUNTAIN PASS Active channel sediments, draining from back side of mountain as well as multiple gullies on mountainside to this location. High erosion/water velocities/scour. Dry at time of sample.
329	**B**	**Top**	**110**	**24**	**118**	**53**		
330	**-**	**-**	**-**	**-**	**-**	**-**	**No deep sample**	
330	**-**	**-**	**-**	**-**	**-**	**-**		
331	**A**	**Top**	**52**	**32**	**152**	**45**	**Soil Bar Raised in Active Channel**	BOTTOM OF CHAPARRAL GULCH BELOW MOUNTAIN PASS Active channel sediments, draining from back side of mountain as well as multiple gullies on mountainside to this location. Some trees growing here, indicating lower water velocities. Dry at time of sample.
331	**B**	**Top**	**65**	**34**	**158**	**41**		
332	**-**	**-**	**-**	**-**	**-**	**-**	**No deep sample**	
332	**-**	**-**	**-**	**-**	**-**	**-**		
333	**A**	**Top**	**196**	**12**	**117**	**122**	**Steep Slope**	BOTTOM OF CHAPARRAL GULCH BELOW MOUNTAIN PASS From side of hill above the Gulch and banks of Gulch.
333	**B**	**Top**	**165**	**11**	**94**	**111**		
334	**-**	**-**	**-**	**-**	**-**	**-**	**No deep sample**	
334	**-**	**-**	**-**	**-**	**-**	**-**		
335	**A**	**Top**	**63**	**22**	**110**	**68**	**Steep Slope**	BOTTOM OF CHAPARRAL GULCH BELOW MOUNTAIN PASS From side of hill above the Gulch and banks of Gulch.
335	**B**	**Top**	**63**	**31**	**101**	**81**		
336	**-**	**-**	**-**	**-**	**-**	**-**	**No deep sample**	
336	**-**	**-**	**-**	**-**	**-**	**-**		

Iron King Humboldt Smelter Site: 2nd Phase X-Ray Fluorescence Sampling, April 16 – 19, 2012 *Jeff Dhont Field Recording*								
Sample	**A/B**	**Depth**	**As**	**Pb**	**Zn**	**Cu**	**Terrain/Deposition**	**Location and Observations**
SECTION: NORTHWEST OF IRON KING MINE MAIL TAILINGS PILE, continued								
337	**A**	**Top**	**16**	**12**	**86**	**61**	**High and gentle slope**	On unnamed road extending north off of Prescott Dells Ranch Road, just after the natural gas r.o.w. Sample was taken from the point at the end before the road becomes impassable and a fence blocks off private property. Caliche and/or cobbles were encountered in the deep sample. The elevation of this point is relatively high.
337	**B**	**Top**	**14**	**15**	**69**	**50**		
338	**A**	**1 ft**	**12**	**<7**	**65**	**52**	**High and gentle slope**	
338	**B**	**1 ft**	**9**	**<7**	**43**	**53**		
339	**A**	**Top**	**9**	**9**	**39**	**<18**	**Active Channel**	Far out on Prescott Dells Ranch Road, behind the mountain. This sample was taken in an active channel draining out of the mountains the next ridge back.
339	**B**	**Top**	**10**	**14**	**35**	**<16**		
340	**-**	**-**	**-**	**-**	**-**	**-**	**No Sample**	
340	**-**	**-**	**-**	**-**	**-**	**-**		
341	**A**	**Top**	**19**	**65**	**72**	**29**	**Active Channel**	Far out on Prescott Dells Ranch Road, behind the mountain. This sample was taken in an active channel draining out of the mountains the next ridge back.
341	**B**	**Top**	**19**	**45**	**78**	**36**		
342	**-**	**-**	**-**	**-**	**-**	**-**	**No Sample**	
342	**-**	**-**	**-**	**-**	**-**	**-**		


Southwest of IK Mine Tailings Pile
201 32 23 130 82
202 28 17 132 79
Iron King Rd
209 16 17 92 54
210 12 13 69 40
203 49 30 155 92
204 23 12 120 96
205 74 34 154 103
206 27 19 90 74
207 15 10 100 68
208 22 <9 106 62
211 87 21 113 118
212 87 22 117 94
© 2012 Google
Google earth
Imagery Date: 5/14/2011
1992
34°29'57.22" N 112°16'03.30" W elev 5045 ft
Eye alt 13234 ft
N

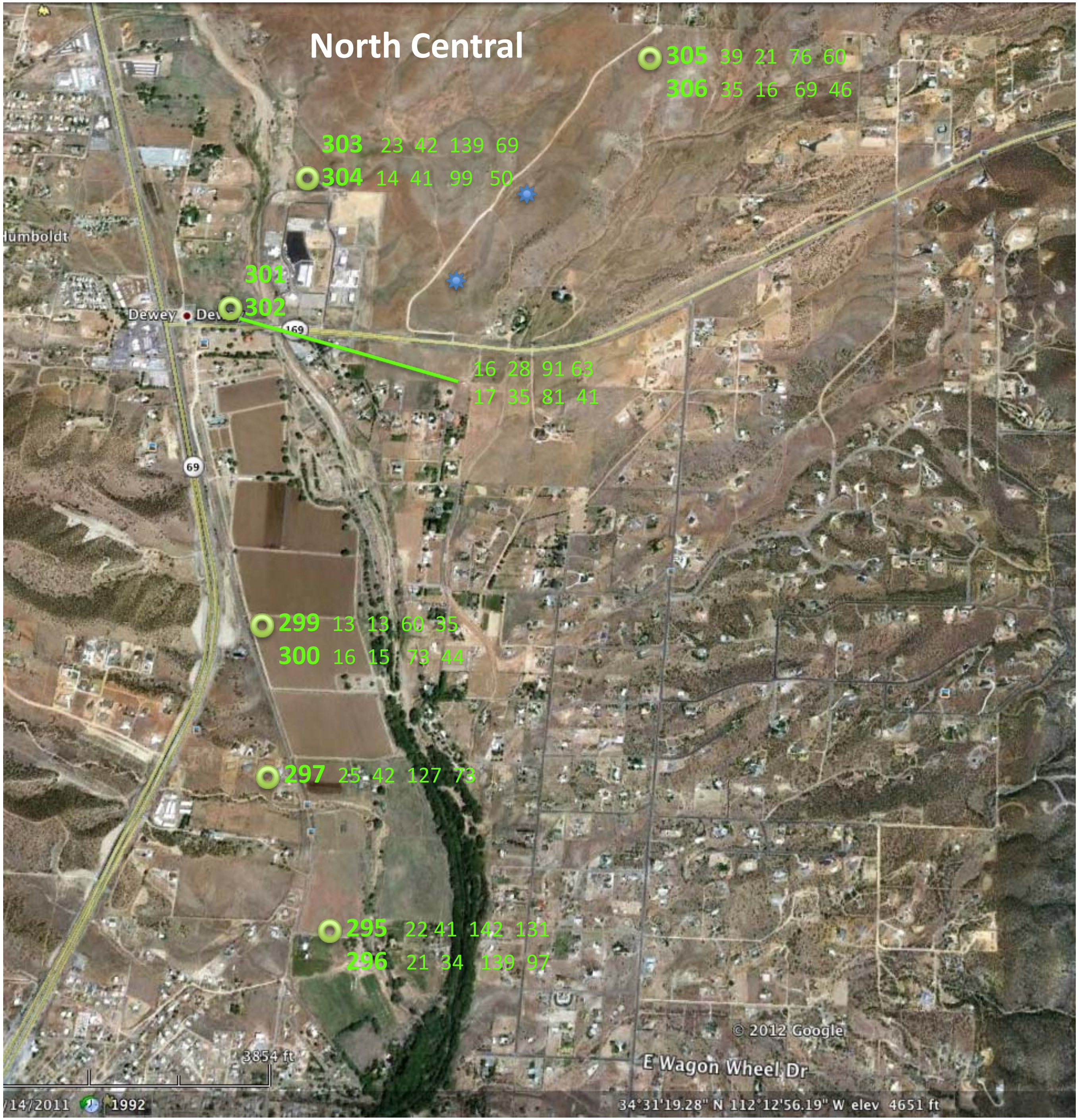
South of Humboldt Smelter
Hyslip's Ln
69
17 32 134 123
9 19 78 81
10 38 109 86
15 23 95 82
58 116 311 484
34 45 109 184
72 179 470 723
104 13 57 78
11 24 93 58
10 22 80 71
106 169 423 728
<8 16 71 93
Ridge
237
238
221
222
223
224
225
226
93 196 268 349
199 351 368 635
213
214
215
216
217
219
220
227
228
229
230
231
232
24 24 117 80
15 20 107 59
233
234
12 35 97 72
40 62 230 206
<8 21 101 76
21 35 101 50
11 22 81 81
39 20 93 59
18 18 63 42
235
115 80 213 281
No deep sample possible
© 2012 Google
Google earth
Imagery Date: 5/14/2011 1992 34°29'25.49" N 112°14'23.26" W elev 4594 ft Eye alt 10846 ft

ASH 58 312 5941 10078
76 224 837 1206
66 252 676 903
ASH <19 305 2657 6398
Main St
Ash Sample
265
Ash Sample
271
263
264
267
269 45 857 3618 4783
270 14 22 168 230
289
273 148 124 408 430
274 64 71 219 279
TAILS 102 191 1044 1083
287
288
291
88 456 4200 5012
90 429 3618 4783
293
285 69 102 310 587
286 46 88 261 499
275 128 61 206 619
276 80 36 131 137
TAILS 163 216 574 953
Pure Tailings
TAILS 179 205 497 763
277 116 593 927
278 79 70 265
283 75 219 406 823
284 55 175 253 421
279 222 1185 953 1957
280 33 68 210 457
281 122. 288 374 1220
282 127 338 699 1772
Humboldt Smelter Property
95 217 890 1595
23 38 167 216
© 2012 Google
Google earth
Imagery Date: 5/14/2011 1992 34°29'46.72" N 112°14'00.93" W elev 4594 ft Eye alt 7872 ft



East / Southeast of Humboldt Smelter
Prescott St
Lazy River Dr
Holiday Dr
Sleepy Acres Ln
Mingus Mountain Ln
Beverly Hills Dr
Green Valley Way
Rancho Pl
239 45 13 75 60
240 44 12 100 58
253 63 30 113 126
254 51 10 81 72
251 50 16 74 69
252 80 13 84 59
241 51 27 105 95
242 53 16 87 69
255 41 62 141 169
256 34 26 91 98
249 35 14 63 62
250 38 15 83 81
257 74 31 73 101
258 62 25 110 85
259
60 44 121 92
261 76 50 191 139
262 62 17 134 105
243 62 11 82 75
244 51 14 82 65
245 23 15 106 166
246 23 9 69 155
247 52 12 107 89
248 41 10 98 93
© 2012 Google
Google earth
Imagery Date: 5/14/2011
1992
34°29'44.19" N 112°13'14.34" W elev 4634 ft
Eye alt 11148 ft

North Central



North / West of IK Tailings Pile
15 14 78 56
11 <7 54 53
15 11 61 40
16 15 66 39
40 37 150 43
19 14 66 37
25 24 88 38
15 15 67 49
47 40 146 49
22 18 87 48
20 19 86 43
13 10 67 36
18 9 66 <21
11 14 54 33
337
338
319
320
321
322
317
318
315
316
309
310
307
308
10 12 37 <16
61 12 93 38
114 <7 84 <21
323
324
Ridge
Ridge
Ridge
339
341
28 21 97 64
22 12 66 42
325
326
59 33 155 43
78 18 83 37
311
312
313 68 62 233 71
314 18 14 75 52
19 55 75 33
90 21 94 44
63 27 106 75
331
329
327
333
335
180 12 106 117
91 65 250 75
22 13 81 52
Back Side
Very steep
Pass – major drainage point through elevation divide
© 2012 Google
69
To Mt. Bradshaw Pk
Imagery Date: 5/14/2011
1992
34°30'46.51" N 112°15'31.59" W elev 4791 ft
Eye alt 14807 ft
Google earth