HRS DOCUMENTATION RECORD COVER SHEET

Name of Site: Cherokee Zinc - Weir Smelter

EPA ID No. **KSN000706550**

Contact Persons

Site Investigation:

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Documentation Record:

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Pathways, Components, or Threats Not Scored

The ground water, and air migration pathways, and the subsurface intrusion component of the soil exposure and subsurface intrusion pathway were not scored in this Hazard Ranking System (HRS) documentation record because the surface water migration and soil exposure component of the soil exposure and subsurface intrusion pathway is sufficient to qualify the site for the National Priorities List (NPL). The ground water, and air migration pathways, and the subsurface intrusion component of the soil exposure and subsurface intrusion pathway are of concern to the U.S. Environmental Protection Agency (EPA) and may be considered during a future evaluation. At the time of the listing, the site score is sufficient without the pathways and component mentioned above.

Ground Water Migration Pathway: Groundwater use within 4 miles of the site is limited and nearby wells draw from a depth of over 800 feet (Ref. 32, p. 9). This migration pathway is not anticipated to contribute significantly to the overall site score.

Subsurface Intrusion Component, Soil Exposure and Subsurface Intrusion Pathway: Metals were detected in soil samples collected from residential yards. No subsurface intrusion sampling has been conducted within residential home or businesses to evaluate the component.

Air Migration Pathway: No air samples are known to have been collected to characterize the air migration pathway. The smelters in Weir is believed to have last operated around 1909 (Ref. 32, p. 4). No tailings piles or uncovered waste piles currently exist.

HRS DOCUMENTATION RECORD

Name of Site: Cherokee Zinc - Weir Smelter Date Prepared: September 2020

EPA Region: 7

Street Address of Site*: 413 N Washington St.

City, County, State, Zip Code: Weir, Cherokee, Kansas, 66781

General Location in the State: Southeast portion of the state

Topographic Map: Cherokee and Kirkwood, Kansas 2018

Latitude: 37° 18' 49.5" North

Longitude: 94° 46' 18.5" West

The coordinates above for Cherokee Zinc - Weir Smelter site was determined from the approximate center of the processing area of the former smelter as shown on Figure 2 of this HRS documentation record and Reference 5. This area is at the north end of North Washington Street, on the north side of a former railroad right of way.

* The street address, coordinates, and contaminant locations presented in this HRS documentation record identify the general area the site is located. They represent one or more locations EPA considers to be part of the site based on the screening information EPA used to evaluate the site for NPL listing. EPA lists national priorities among the known "releases or threatened releases" of hazardous substances; thus, the focus is on the release, and not precisely delineated boundaries. A site is defined as where a hazardous substance has been "deposited, stored, disposed or placed, or has otherwise come to be located." Generally, HRS scoring and the subsequent listing of a release merely represent the initial determination that a certain area may need to be addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Accordingly, EPA contemplates that the preliminary description of facility boundaries at the time of scoring will be refined as more information is developed as to where the contamination has come to be located.

Pathway	**Pathway Score**
Ground Water Migration[1]	Not Scored
Surface Water Migration	100.00
Soil Exposure and Subsurface Intrusion	26.96
Air Migration	Not Scored
HRS SITE SCORE	**51.78**

[1] "Ground water" and "groundwater" are synonymous; the spelling is different due to "ground water" being codified as part of the HRS, while "groundwater" is the modern spelling.

WORKSHEET FOR COMPUTING HRS SITE SCORE

	S Pathway	S^2 Pathway
1. Ground Water Migration Pathway Score (S_{gw}) (from Table 3-1, line 13)	NS	NS
2a. Surface Water Overland/Flood Migration Component (from Table 4-1, line 30)	100	10,000
2b. Ground Water to Surface Water Migration Component (from Table 4-25, line 28)	NS	NS
2c. Surface Water Migration Pathway Score (S_{sw}) Enter the larger of lines 2a and 2b as the pathway score.	100	10,000
3a. Soil Exposure Component Score (S_{se}) (from Table 5-1, line 22)	26.96	726.84
3b. Subsurface Intrusion Component Score (S_{ssi}) (from Table 5-11, line 12)	NS	NS
3c. Soil Exposure and Subsurface Intrusion Pathway Score (S_{sessi}) (from Table 5-11, line 13)	26.96	726.84
4. Air Migration Pathway Score (S_a) (from Table 6-1, line 12)	NS	NS
5. Total of $S_{gw}^2 + S_{sw}^2 + S_{sessi}^2 + S_a^2$		10,726.84
6. **HRS Site Score** Divide the value on line 5 by 4 and take the square root	51.78	

Notes:
NS Not scored

HRS TABLE 4-1 -Surface Water Overland/Flood Migration Component Scoresheet

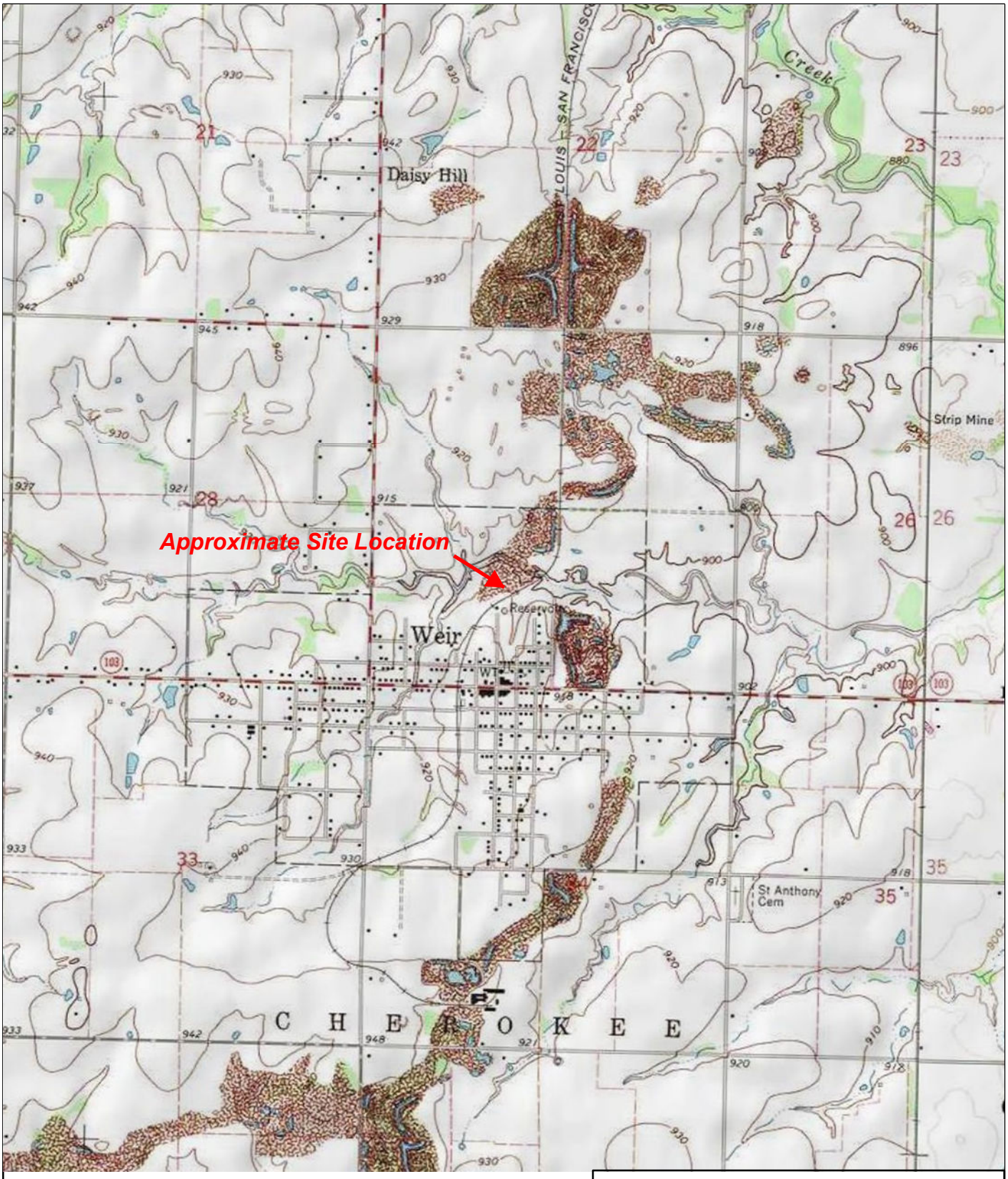
Factor Categories and Factors	Maximum Value	Value Assigned
Drinking Water Threat		
Likelihood of Release:		
1. Observed Release	550	550
2. Potential to Release by Overland Flow:		
2a. Containment	10	Not scored
2b. Runoff	25	Not scored
2c. Distance to Surface Water	25	Not scored
2d. Potential to Release by Overland Flow (lines 2a x [2b + 2c])	500	Not scored
3. Potential to Release by Flood:		
3a. Containment (Flood)	10	Not scored
3b. Flood Frequency	50	Not scored
3c. Potential to Release by Flood (lines 3a x 3b)	500	Not scored
4. Potential to Release (lines 2d + 3c, subject to a maximum of 500)	500	Not scored
5. Likelihood of Release (higher of lines 1 and 4)	550	550
Waste Characteristics:		
6. Toxicity/Persistence	(a)	Not scored
7. Hazardous Waste Quantity	(a)	Not scored
8. Waste Characteristics	100	Not scored
Targets:		
9. Nearest Intake	50	Not scored
10. Population:		
10a. Level I Concentrations	(b)	Not scored
10b. Level II Concentrations	(b)	Not scored
10c. Potential Contamination	(b)	Not scored
10d. Population (lines 10a + 10b + 10c)	(b)	Not scored
11. Resources	5	Not scored
12. Targets (lines 9 + 10d + 11)	(b)	Not scored
Drinking Water Threat Score:		
13. Drinking Water Threat Score ([lines 5 x 8 x 12]/82,500, subject to a maximum of 100)	100	Not scored
Human Food Chain Threat		
Likelihood of Release:		
14. Likelihood of Release (same value as line 5)	550	550
Waste Characteristics:		
15. Toxicity/Persistence/Bioaccumulation	(a)	5×10^{8}
16. Hazardous Waste Quantity	(a)	100
17. Waste Characteristics	1,000	320

Factor Categories and Factors	Maximum Value	Value Assigned
Targets:		
18. Food Chain Individual	50	20
19. Population:		
19a. Level I Concentrations	(b)	Not scored
19b. Level II Concentrations	(b)	Not scored
19c. Potential Human Food Chain Contamination	(b)	0.0003
19d. Population (lines 19a + 19b + 19c)	(b)	0.0003
20. Targets (lines 18 + 19d)	(b)	20.0003
Human Food Chain Threat Score:		
21. Human Food Chain Threat Score ([lines 14 x 17 x 20]/82,500, subject to a maximum of 100)	100	42.66
Environmental Threat		
Likelihood of Release:		
22. Likelihood of Release (same value as line 5)	550	550
23. Ecosystem Toxicity/Persistence/Bioaccumulation	(a)	5×10^{8}
24. Hazardous Waste Quantity	(a)	100
25. Waste Characteristics	1,000	320
Targets:		
26. Sensitive Environments:		
26a. Level I Concentrations	(b)	250
26b. Level II Concentrations	(b)	Not scored
26c. Potential Contamination	(b)	17.5
26d. Sensitive Environments (lines 26a + 26b + 26c)	(b)	267.5
27. Targets (value from 26d)	(b)	267.5
Environmental Threat Score:		
28. Environmental Threat Score ([lines 22 x 25 x 27]/82,500, subject to a maximum of 60)	60	60
Surface Water Overland/Flood Migration Component Score For A Watershed		
29. Watershed Score[c] (lines 13 + 21 + 28, subject to a maximum of 100)	100	100.00
Surface Water Overland/Flood Migration Component Score		
30. Component Score (S_{of})[c], (highest score from line 29 for all watersheds evaluated, subject to a maximum of 100)	100	100.00

[a] Maximum value applies to waste characteristics category.
[b] Maximum value not applicable.
[c] Do not round to nearest integer.

HRS Table 5-1 Soil Exposure Component Scoresheet Factor Categories and Factors	Maximum Value	Value Assigned
Resident Population Threat		
Likelihood of Exposure:		
1. Likelihood of Exposure	550	550
Waste Characteristics:		
2. Toxicity	(a)	10,000
3. Hazardous Waste Quantity	(a)	10
4. Waste Characteristics	100	18
Targets:		
5. Resident Individual	50	45
6. Resident Population:		
6a. Level I Concentrations	(b)	0
6b. Level II Concentrations	(b)	179.7
6c. Resident Population (lines 6a + 6b)	(b)	179.7
7. Workers	15	Not Scored
8. Resources	5	Not Scored
9. Terrestrial Sensitive Environments	(c)	Not Scored
10. Targets (lines 5 + 6c + 7 + 8 + 9)	(b)	224.7
Resident Population Threat Score:		
11. Resident Population Threat (lines 1 x 4 x 10)	(b)	2,224,530
Nearby Population Threat		
Likelihood of Exposure:		
12. Attractiveness/Accessibility	100	Not scored
13. Area of Contamination	100	Not Scored
14. Likelihood of Exposure	500	Not scored
Waste Characteristics:		
15. Toxicity	(a)	Not Scored
16. Hazardous Waste Quantity	(a)	Not Scored
17. Waste Characteristics	100	Not Scored
Targets:		
18. Nearby Individual	1	Not Scored
19. Population Within 1 Mile	(b)	Not Scored
20. Targets (lines 18 + 19)	(b)	Not Scored
Nearby Population Threat Score:		
21. Nearby Population Threat (lines 14 x 17 x 20)	(b)	Not Scored
Soil Exposure Component Score		
22. Soil Exposure Component Score[d] (S_{se}), (lines [11 +21]/82,500, subject to a maximum of 100)	100	26.96

[a] Maximum value applies to waste characteristics category.
[b] Maximum value not applicable.
[c] No specific maximum value applies to factor. However, pathway score based solely on terrestrial sensitive environments is limited to maximum of 60.
[d] Do not round to nearest integer.



Source: USGS Cherokee, Kansas 7.5 Minute Topo Quad, 1964

Cherokee Zinc - Weir Smelter
Weir, Kansas

Figure 1
Site Location Map

TETRA TECH

Date: 11/22/2019 Drawn By: Rachel Page Project No: X903019F0067.000

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Feet

Source: The source of this map image is Esri, used by EPA with Esri's permission., 2013, Ref. 10

Cherokee Zinc - Weir Smelter
Weir, Kansas

Figure 2
1896 Former Smelter Layout

TETRA TECH

Date: 8/10/2020 Drawn By: Rachel Page Project No: X903019F0067.000

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SITE SUMMARY

The Cherokee Zinc - Weir Smelter site is located at 413 North Washington Street, Weir, Cherokee County, Kansas, 66781. The site as scored comprises a contaminated soil source associated with the former smelter property (Source 1), an area of observed contamination (AOC A) consisting of soils on residential properties and throughout the town of Weir, Cherokee County, Kansas, and a release of site-related contaminants in the wetland adjacent on the north of Source 1 (see Figures 1, 4, and 6 of this HRS documentation record). The area of lead, cadmium and zinc contaminated soil came to be, at least in part, by the past operation of local smelter. The 2018 estimated population of Weir, Kansas was 639 with an average household size for the county of 2.54 (Ref. 21, pp. 1, 4). The former smelter property is now occupied by the City of Weir public works shop and privately owned undeveloped land that are in the northern portion of the town (Ref. 7, p. 4). The town of Weir is to the south, and to the north are pasture, forested, and agricultural land. Also north are wetlands with an unnamed intermittent tributary to Brush Creek which bisects the contaminated soil source. The tributary flows from west to east (Ref. 6, p. 7, 8). The wetland is impacted by site related contaminants, cadmium, lead, and zinc. Level I concentrations of lead and zinc are documented in the wetland (see section 4.1 of this HRS documentation record). The watershed downgradient of the site is also used for fishing (Ref. 35). Numerous residential properties are impacted by lead and cadmium (see section 5.0 of this HRS documentation record).

The Chicago Zinc Works began smelting zinc in Weir in 1872 (Refs. 6, p. 15; 32, p. 4). Chicago Zinc located the smelter in Weir due to nearby commercial coal deposits to fuel the smelter, and the proximity to the Tri-State lead and zinc mining district. Chicago Zinc abandoned the smelter, and in 1896 the Cherokee Lanyon Smelter Company purchased the smelter and owned it until 1906 (Ref. 32, p. 4). Other operators of the smelter included the Weir City Zinc Works, the Cherokee Zinc Company Smelter, and the Cherokee Lanyon Smelter Company. Several owners held the property until the Weir Smelting Company purchased the smelter in 1917 and sold it in 1920 (Ref. 32, p. 4). It is unknown if the Weir Smelting Company actively ran the smelter, as from other historical information it appears smelting operations closed in approximately 1909 when natural gas reserves in other areas of Kansas made smelter operations from coal unprofitable (Ref. 32, p. 4). The smelter property was eventually sold at auction 1948 (Ref. 32, p. 5). The current owners are the City of Weir and a private residence of Weir. The former smelter buildings are no longer present at the site except for foundations for some of the former buildings (Ref. 6, pp. 7, 8).

OPERATIONAL HISTORY OF LEAD AND ZINC SMELTERS IN KANSAS

Information on the historic smelting operations in Kansas was prepared by the Kansas Department of Health and Environment (KDHE) (Ref. 28) and is summarized as follows. The Tri-State Mining District (southeast Kansas, southwest Missouri, and northeast Oklahoma) was at one time the world's richest producer of lead and zinc ores (Ref. 28, p. 1). Southeast Kansas offered access to large quantities of fuels (coal and natural gas) (Ref. 28, pp. 1, 6, 7). The process of refining lead and zinc ores (smelting) required considerable fuel resources; therefore, southeast Kansas became a popular location for smelters. The first smelter in southeast Kansas was constructed in Weir in 1870 (Ref. 28, p. 1). The smelting process involved heating crushed zinc ore (known as sphalerite or blackjack, principally containing zinc sulfide [ZnS] with impurities such as iron, lead, and cadmium) in kilns for a period of time to oxidize the ore and drive off the sulfur (Ref. 28, pp. 3, 4). The roasted ore would be mixed with coke coal and loaded into clay cylinders called retorts where the mixture was superheated to 1975 degrees centigrade where the zinc would vaporize, move to a condenser to cool to liquid zinc (Ref. 28, p. 4). The smelting process generated a large amount of pollution including sulfur and nitrogen oxide and a large amount of soot. The soot was generally contaminated with elevated levels of arsenic, lead, cadmium, and zinc (Ref. 28, p. 5). In addition to the airborne pollution, the smelting operations left large volumes of solid waste including cinders, broken retorts, discarded building materials, and impure smelter slag (Ref. 28, pp. 5, 6).

PREVIOUS INVESTIGATIONS

Numerous investigations at the site have occurred including the following:

- March 2004 Former Focused Smelter Assessment by KDHE (Ref. 6). Activities associated with this investigation included a site visit to document current conditions and potential receptors, a description of the physical conditions (geology, hydrogeology, hydrology, etc.), a historical records search, determination of current and historical ownership, interviews with site owners, and a review of any previous investigations or corrective actions associated with the site (Ref. 6. p. 2).

- November 2004 Phase II Focused Former Smelter Assessment by KDHE (Ref. 7). The objectives of this assessment were to conduct limited sampling to characterize potential site wastes and migration pathways (Ref. 7, p. 2). Soil (34 unbiased and 8 biased locations), smelter waste (6 locations), groundwater (2 locations), surface water (1 location) and sediment (2 locations) samples were collected and analyzed using x-ray fluorescence (XRF) technology for arsenic, cadmium, lead, and zinc quantitation Ref. 7, pp. 6, 7). A subset of the samples (including all water samples) was analyzed for arsenic, cadmium, lead, and zinc by a fixed laboratory by method 6010B (Ref. 7, p. 5). Eight additional surface soil samples were analyzed via XRF methodology only (Ref. 7, pp. 7, 21). Three direct push technology (DPT) borings were advance to refusal (8 - 8.5 feet below ground surface [bgs]), and soil was collected every five feet for XRF and fixed laboratory analysis (Ref. 7, pp. 8, 21). Sampling strategy included background locations for surface water, subsurface soil and sediment (Ref. 7, p. 8).

- December 2008 Site Investigation by KDHE (Ref. 8). Objectives of this investigation were to define the extent of contamination at the former facility, assess potential receptors, and evaluate risks to human health and the environment (Ref. 8, p. 5). Field activities included the collection of surface soil samples, test trenching, sediment and surface water sampling, and drilling to establish monitoring wells (Ref. 8, pp. 8, 9). No groundwater was encountered in the auger borings, so no monitoring wells were installed (Ref. 8, p. 9). Surface soil samples were collected on a grid from an area that measured 400 by 700 feet (Ref. 8, p. 9). A total of 55 locations were field screened and 11 percent of the samples were sent to a fixed laboratory for analysis of Resource Conservation and Recovery Act (RCRA) metals plus zinc (Ref. 8, p. 10). Nine test trenches were excavated covering 1,100 linear feet (Ref. 8, p. 10). From these trenches, 30 samples were collected and screened with an XRF and 7 were submitted to a fixed lab (Ref. 8, p. 34). Ten sediment and five surface water samples were collected from an intermittent branch of Brush Creek; all were analyzed by a fixed laboratory (Ref. 8, p. 11). Ten surface soil samples were collected along transects oriented north-south. These transects were located north and south of the site to assess airborne deposition of smelter waste. These ten samples were analyzed by a fixed laboratory (Ref. 8, p. 11). Finally, three background soil samples were collected for fixed laboratory analysis (Ref. 8, p. 11).

- December 2011 Supplemental Site Investigation by KDHE (Ref. 30). This investigation involved the collection of surface soil from 5 residential properties southeast of the former smelter, sediment samples from the intermittent creek and an off-site pond east of the site, and background soil samples. Samples were screened using an XRF and 20 percent of the screened samples were submitted to a fixed laboratory (Ref. 30, p. 14).

- June 2013 Residential Yard sampling by KDHE (Ref. 31). A total of 22 residential properties were sampled, with each residential yard being subdivided into a minimum of four quadrants. Biased and unbiased grid sampling around the former smelter also occurred. A total of 48 unbiased, 24 biased, and 98 residential quadrant samples were analyzed by XRF. Of these, 10 unbiased, 6 biased, and 36 residential quadrant samples were submitted for laboratory analysis (Ref. 31, pp. 9, 10, 29).

- June 2013 Integrated Assessment by KDHE (Ref. 32). This document summarizes results from previous investigations with emphasis on the residential yard sampling. The report also presents information on groundwater and surface water migration pathways and targets. The soil exposure pathway and air migration pathways are also discussed (Ref. 32, pp. 5, 6, 11).

- February 2016 Removal Assessment by EPA (Ref. 13). This report summarized sampling activities conducted in 2015 (Ref. 13, p. 9). As part of the removal assessment, 19 sediment samples were collected at 16 locations in the Brush Creek tributary north of the site; 7 surface water samples were collected from the Brush Creek tributary; 16 on-site soil samples were collected from 5 DPT boring locations; and 22 composite soil samples were collected from off-site residential and non-residential properties (Ref. 13, p. 9).

Further assessments of residential yards in Weir and cleanup of contaminated yards was conducted at the site under an EPA-led removal action (Ref. 19, pp. 2, 13). Contaminated soil from portions of 14 residential properties and a City owned park were excavated and backfilled with clean soil (Ref. 19, pp. 15, 16). In general, excavation was conducted within cells at each property where removal assessment sampling indicated the cell

contained greater than 400 mg/kg lead (Ref. 19, pp 15, 16, 178-192). Other cells on the properties were not remediated if the lead concentration in the cell was less than 400 mg/kg.

2.2 SOURCE CHARACTERIZATION

2.2.1 SOURCE IDENTIFICATION

Name of source: Former Smelter Works Area Number of source: 1

Source Type: Contaminated Soil

Description and Location of Source (with reference to a map of the site):

This source consists of contaminated soils that is comingled with slag and other smelter waste in and around the former smelter. The former Zinc smelter is located in the northeast corner of Weir Kansas at the northern end of Washington Street (Ref. 6, pp. 7, 56). Surface topography of the site slopes gently to the north toward an intermittent branch of Brush Creek (Ref. 6, p. 7). The layout of the former smelter is shown on 1893 and 1896 Sanborn maps as the Cherokee Zinc Co. Smelter; and on a 1902 Sanborn map as the Cherokee Lanyon Smelter Co. (Refs. 9; 10; 11). According to the Sanborn Map, the former smelter operations were approximately 500 feet wide and 675 feet long, or approximately 7.75 acres (Ref. 6, p. 7). The Sanborn maps from 1896 and 1902 report a "dumping grounds" to the north of the operations area (Refs. 10; 11). Sanborn maps from 1896 show the smelter had 14 zinc furnaces, 12 kilns, a reservoir, water tower and other buildings (Ref. 10). As of 2004, only a few former smelter building foundations and abandoned railroad rights-of-way remained (Ref. 6, p. 8). The smelter waste described as slag piles, scattered slag, brick, and retort remnants were reported to be found strewn across the site (Refs. 6, pp. 7, 8, 18, 31, 32, 133, 136, 137; 7 , pp. 4, 7, 18; 8, pp. 7, 157). None of the previous investigations quantified the size of the slag piles (Refs. 6, pp. 8, 18, 32; 7, pp. 7, 12, 18, 35; 8, pp. 23, 24; 13, p. 29; 32, p. 12).

Sampling of soils and slag material first occurred in 2004 as part of a focused former smelter assessment by the Kansas Department of Health and Environment (KDHE) consultant Burns & McDonnell Engineering Company (Ref. 7, pp. 2, 12). In June 2004 soil and smelter waste were collected at the site and were analyzed for arsenic, cadmium, lead and zinc using XRF technology by EPA Method 6200 (Ref. 7, p. 5). Thirteen soil and smelter waste samples were submitted to a commercial laboratory for analysis of arsenic, cadmium, lead, and zinc using EPA Method 6010B (Ref. 7, pp. 5, 27, 53-62, 69-71). A 100-foot sampling grid was created and 34 surface soil (0-0.5 foot) sample locations were designated and analyzed in situ by XRF with five samples submitted to the off-site lab (Ref. 7, pp. 6, 19). An additional 8 biased locations were established based on the XRF results (Ref. 7, pp. 6, 7, 18). At each location soils were collected at one foot, two feet, and three feet, except at one location

where bedrock was encountered at two feet (Ref. 7, p. 7). Soil samples were analyzed by XRF with four samples submitted to the off-site laboratory (Ref. 7, p. 7). Six smelter waste (slag samples) were analyzed by XRF with one sent to the off-site laboratory (Ref. 7, p. 7). Eight surface soil (0-0.5 foot) sample locations were collected from the perimeter of the former smelter operational area (locations PS-1 through PS-2) and were analyzed by XRF (Ref. 7, pp. 7, 8, 21). Three direct push borings (GP-1 through GP-3) were completed to bedrock refusal at the site with samples collected every five feet (Ref. 7, pp. 8, 21). Bedrock was encountered at 8 to 8.5 feet bgs (Ref. 7, p. 8). Nine soil samples were analyzed by XRF and three samples were submitted to the off-site laboratory for chemical analysis (Ref. 7, pp. 8, 26, 27). Six background soil sample were collected from two locations and analyzed by XRF (Ref. 7, pp. 8, 22, 26).

Sampling of soils occurred in 2008 as part of a site investigation by KDHE consultant Golder Associates, Inc. (Ref. 8, p. 8). In April and July 2008 surface soil was collected at the site and were analyzed for arsenic, cadmium, lead and zinc using XRF technology by EPA Method 6200 (Ref. 8, pp. 8, 9, 28 – 34). A 100-foot sampling grid, with overall dimensions of 400 feet by 700 feet, was created and samples collected at each node. Four impacted sample locations were selected for further XRF analysis on a 50-foot grid (Ref. 8, pp. 9, 10, 41). A total of 55 surface soil sample locations were designated and analyzed in situ by XRF with six samples submitted to an off-site laboratory for RCRA metals plus zinc analysis by Method 6010/7471 (Ref. 8, pp. 10, 73). In addition, trench sampling with an excavator was used to determine the horizontal and vertical extent of metals impact on the site. A total of nine trenches were excavated, totaling 1,100 feet (Ref. 8, pp. 10, 46-49). XRF screening was conducted at various locations and depths in each trench to create a vertical profile of metals impact (Ref. 8, p. 10). A subset of the samples were submitted to an off site laboratory (Ref. 8, pp. 10, 127).

Sampling locations used to delineate the contaminated soil source are presented on Figure 3 and are further discussed below.

Inset
Scale: 1" = 50'

SFS 40
SS-22
SFS 44
SS-23
HS-3
SFS 41
SFS 10
SFS 11
HS-1
HS-2
SS-24
GP-2
SFS 43
SFS 46
SFS 47
SFS 42
SFS 48
SFS 49
SFS 52
SFS 53
SS-28
HS-4
SFS 22
SS-27
SFS 23
HS-5
SS-29
SFS 50
SFS 51
SFS 54
HS-6
SLAG-6

Airborne 600 North
Airborne 500 North
PS-3
PS-4
Airborne 300 North
SS-6
SS-12
HS-8
SS-31
A-A' - 30'
SS-17
A-A' - 50'
SFS 03
HS-7
SFS 02
SS-21
SLAG-2
SFS 14
B-B' - 30'
PS-2
SS-25
SLAG-3
SFS 21
SFS 15
D-D' - 10'
I-I' - 100'
SFS 20
SFS 28
SLAG-1
I-I' - 0'
SLAG-5
SFS 26
SFS 25
SFS 32
H-H' - 20'
SLAG-4
SFS 39
SFS 34

Legend

- 2004 Background sample location
- 2004 GP, HA, & slag sample location
- 2004 Soil sample location
- 2008 Background sample location
- 2008 Site investigation sample location
- Ephemeral stream
- Intermittent stream
- Approximate source area (407,373 square feet)
- Emergent wetland area
- Forested emergent wetland area
- Wetland boundary

Reverse Inset

BGS-1
BGS-2
Background 1
Background 2
Background 3

N

0 75 150

Feet

Source: The source of this map image is Esri, used by EPA with Esri's permission., 2017; Refs. 7, pp. 18, 19, 21, 22; 8, pp. 40 - 45; 33, p. 39

Cherokee Zinc - Weir Smelter
Weir, Kansas

Figure 3
Source Sample Locations

TETRA TECH

Date: 11/26/2019 Drawn By: Clayton Hayes Project No: 103X903019F0067

X:\G\903\0067\000\Projects\mxd\Figure3.mxd

2.2.2 HAZARDOUS SUBSTANCES ASSOCIATED WITH THE SOURCE

According to the U.S. Geological Survey (USGS), the average concentrations of lead and zinc in Cherokee County, Kansas, are 41.123 parts per million (ppm) and 260.601 ppm, respectively (Ref. 27, pp. 1, 2). USGS did not publish county averages for cadmium.

In 2004 samples were collected north and south of the intermittent creek and included the collection of eight perimeter soil (PS) samples designated PS-1 through PS-8 (Ref. 7, pp. 7, 8, 21). These samples were field screened in-situ using the XRF (Ref. 7, pp. 7, 8, 21). None of these samples were submitted for fixed laboratory analysis. Sample PS2 was the farthest sample to the west of the former operation area, and samples PS3 and PS4 were the farthest samples north of the former operations area (Ref. 7, p. 21). The 2004 investigation also involved the collection of background surface soils (BGS) at the intersection of 120th Street and 510th Avenue which was field screened in-situ using the XRF (Ref. 7, pp. 8, 22). None of these samples were submitted for fixed laboratory analysis. Background samples were collected over ½ mile northwest of the former Bruce Mining and Smelter Company site, approximately 3 miles west of Cherokee Kansas and 7 miles northwest of Weir Kansas (Ref. 7, pp. 8, 22). Table 1 below presents the XRF results for these background samples collected in 2004. The highest lead and zinc results from these background samples were selected as the background XRF values for comparison to samples collected at the source. Sample PS-2 B contained lead at 73 milligrams per kilogram (mg/kg) and Sample PS-4 A contained zinc at 386 mg/kg. As shown in Table 1 below, the PS samples collected closer to the former smelter typically contained higher concentrations of lead and zinc than the BGS samples.

In 2008 most of the XRF analyses were conducted on samples collected from an on-site grid and from test trench samples (Ref. 8, pp. 9, 10). However, according to the site logbook and the raw XRF data, XRF screening of samples also occurred for a series of samples collected north and south of the site referred to as airborne samples (Ref. 8, pp. 11, 52, 149, 208, 213). The two farthest north samples (WEIRAIRN300 and WEIRAIRN500) are associated with locations shown on Figure 7 of the SI report and referred to as Airborne 300 north and airborne 500 north (Ref. 8, p. 52). These locations also had samples analyzed by a fixed laboratory and are further described below. In these two samples the maximum lead concentration reported was 48 mg/kg and the maximum zinc concentration reported was 293 mg/kg.

- Background Concentrations:

Table 1 - Background Concentrations Analyzed by XRF

Sample ID	Sample Type	Date	Depth ft bgs	Hazardous Substance	Concentration mg/kg	Reference
PS-2 B	Soil	6/7/2004	0 - 0.5	Lead Zinc	73 277	7, pp. 25, 43
PS-3 C	Soil	6/7/2004	0 - 0.5	Lead Zinc	49 188	7, pp. 25, 43
PS-4 A	Soil	6/7/2004	0 - 0.5	Lead Zinc	<54 386	7, pp. 25, 43
BGS-1/SS-1	Soil	6/25/2004	0 – 1	Lead Zinc	30 141	7, p. 26, 46
BGS-1/SS-2			1 – 2	Lead Zinc	<23 71	
BGS-1/SS-3			2 – 3	Lead Zinc	<25 101	
BGS-2/SS-1	Soil	6/25/2004	0 – 1	Lead Zinc	27 96	7, p. 26, 46
BGS-2/SS-2			1 – 2	Lead Zinc	31 200	
BGS-2/SS-3			2 – 3	Lead Zinc	<24 118	
WEIRAIRN300	Soil	4/12/2008	NR	Lead Zinc	16 85	8, pp. 149, 213
WEIRAIRN500	Soil	4/12/2008	NR	Lead Zinc	48 293	8, pp. 149, 213

Notes:

The Sample ID that is bolded represents the location presented on Figure 3 of this HRS documentation record. WEIRAIRN300 and WEIRAIRN500 are on Figure 3 as Airborne 300 North and Airborne 500 North respectively.

ft bgs feet below ground surface
ID Identification
mg/kg milligrams per kilogram
NR Not reported

In 2008 three background samples were collected in areas upwind from the smelter Site (Ref. 8, p.12). Two of the three samples were collected on Cherokee, Kansas' Southeast High School property (approximately 3 miles northwest of the Site). The third sample was collected at the former Scammon school site (approximately 2 miles west of the Site). All samples collected were submitted for off-Site laboratory analysis for 8 RCRA metals plus zinc by EPA Method 6010 and 7471 (Ref. 8, pp. 12, 40, 75). In addition, samples were collected north and south of the Site in order to determine how contamination may have been dispersed by winds (Ref. 8, pp. 11, 52). Five samples were collected at 100 to 200-foot intervals north of the site and five samples were collected at 100- to

400-foot intervals south of the former smelter (Ref. 8, p. 11). All samples collected were submitted for off-site laboratory analysis for 8 RCRA metals plus zinc by EPA methods 6010 and 7471 (Ref. 8, pp. 11, 52, 74). The farthest north samples, airborne 300 north, airborne 500 north, and airborne 600 north were selected as representative of background. Of the six background samples presented in Table 2 below, lead ranged in concentrations between 11.9 to 57.9 mg/kg, cadmium ranged in concentrations from 0.51 to 0.56 mg/kg and zinc ranged in concentrations between 82.7 to 226 mg/kg. The highest background concentration for lead (57.9 mg/kg), cadmium (0.56 mg/kg), and zinc (226 mg/kg) were used to compare Source 1 samples.

Table 2 - Background Concentrations Analyzed by Fixed Laboratory

Sample Identification	Sample Type	Date	Hazardous Substance	Hazardous Substance Concentration (mg/kg)	Sample Quantitation Limit (mg/kg)	Reference
Background 01	soil	4/12/08	Lead Cadmium Zinc	27.3 ND 103	1.3 1.3 26.4	8, pp. 40, 72, 102, 142, 149
Background 02	soil	4/12/08	Lead Cadmium Zinc	27.4 ND 107	1.3 1.3 26.4	8, pp. 40, 72, 103, 142, 149
Background 03	soil	4/12/08	Lead Cadmium Zinc	35.2 ND 226	1.2 1.2 24.9	8, pp. 40, 72, 104, 142, 149
Airborne 300 North	soil	4/12/08	Lead Cadmium Zinc	44.7 0.51 71.9	0.51 0.51 10.3	8, pp. 52, 72, 94, 141, 149
Airborne 500 North	soil	4/12/08	Lead Cadmium Zinc	57.9 0.56 94.7	0.48 0.48 9.5	8, pp. 52, 72, 93, 141, 149
Airborne 600 North	soil	4/12/08	Lead Cadmium Zinc	11.9 ND 82.7	0.45 0.45 9.0	8, pp. 52, 72, 92, 141, 149

Notes:
ND Not detected at or above the adjusted reporting limit (Ref. 8, p. 121)
mg/kg milligrams per kilogram

- Source Samples:

For samples collected and analyzed by XRF in 2004, the lead and zinc concentrations that are three time the background levels discussed above are 219 and 1,158 mg/kg respectively. For samples collected and analyzed by

XRF in 2008, the lead and zinc concentrations that are three time the background levels discussed above are 144 and 879 mg/kg respectively. Samples exceeding these concentrations are presented in Table 3 below.

Table 3: Source Samples Analyzed by XRF

Sample Identification	Sample Type	Date	Depth ft bgs	Hazardous Substance	Concentration mg/kg	Reference
SS-6C	Soil	6/7/2004	0 - 0.5	Lead Zinc	476 1,740	7, pp. 23, 37
SS-12B	Soil	6/8/2004	0 - 0.5	Lead	483	7, pp. 23, 38
SS-17C	Soil	6/8/2004	0 - 0.5	Lead Zinc	454 2,100	7, pp. 23, 38
SS-21B	Soil	6/8/2004	0 - 0.5	Lead Zinc	557 1,460	7, pp. 23, 41
SS-22B	Soil	6/8/2004	0 - 0.5	Lead Zinc	621 2,250	7, pp. 23, 41
SS-23A	Soil	6/8/2004	0 - 0.5	Lead Zinc	659 2,450	7, pp. 23, 41
SS-24B	Soil	6/8/2004	0 - 0.5	Lead Zinc	1,740 8,560	7, pp. 23, 38
SS-25B	Soil	6/8/2004	0 - 0.5	Lead Zinc	532 2,060	7, pp. 24, 38
SS-27A	Soil	6/8/2004	0 - 0.5	Lead Zinc	1,500 3,600	7, pp. 24, 41
SS-28C	Soil	6/8/2004	0 - 0.5	Lead Zinc	4,410 15,200	7, pp. 24, 41
SS-29B	Soil	6/8/2004	0 - 0.5	Lead Zinc	2,070 3,820	7, pp. 24, 41
SS-31C	Soil	6/9/2004	0 - 0.5	Lead Zinc	622 1,340	7, pp. 24, 42
HS-1 SS-1	Soil	6/9/2004	0 – 1	Lead Zinc	782 1,720	7, pp. 24, 39
HS-2 SS-1	Soil	6/9/2004	0 – 1	Lead Zinc	1,660 6,430	7, pp. 24, 39
HS-2 SS-2			1 – 2	Lead Zinc	1,410 5,610	
HS-2 SS-3			2 – 3	Lead Zinc	3,340 12,200	
HS-3 SS-2	Soil	6/9/2004	1 – 2	Lead Zinc	4,780 12,700	7, pp. 24, 39
HS-3 SS-3			2 – 3	Lead Zinc	4,560 26,300	

Table 3: Source Samples Analyzed by XRF

Sample Identification	Sample Type	Date	Depth ft bgs	Hazardous Substance	Concentration mg/kg	Reference
HS-4 SS-1	Soil	6/9/2004	0 – 1	Lead	762	7, pp. 24, 39
				Zinc	2,970	
HS-4 SS-2			1 – 2	Lead	804	
				Zinc	3,580	
HS-4 SS-3			2 – 3	Lead	1,760	
				Zinc	5,220	
HS-5 SS-1	Soil	6/9/2004	0 – 1	Lead	2,840	7, pp. 24, 39
				Zinc	23,900	
HS-5 SS-2			1 – 2	Lead	1,690	
				Zinc	17,800	
HS-6 SS-1	Soil	6/9/2004	0 – 1	Lead	1,490	7, pp. 24, 39
				Zinc	1,590	
HS-6 SS-2			1 – 2	Lead	1,590	
				Zinc	2,700	
HS-6 SS-3			2 – 3	Lead	2,090	
				Zinc	2,960	
HS-7 SS-1	Soil	6/9/2004	0 – 1	Lead	2,360	7, pp. 24, 39
				Zinc	3,400	
HS-7 SS-2			1 – 2	Lead	839	
			2 – 3	Lead	969	
HS-7 SS-3				Zinc	1,300	
HS-8 SS-3	Soil	6/9/2004	2 – 3	Lead	8,330	7, pp. 24, 39
				Zinc	7,900	
SLAG-1	Waste	6/9/2004	NR	Lead	3,380	7, pp. 24, 42
				Zinc	2,160	
SLAG-2	Waste	6/9/2004	NR	Lead	1,920	7, pp. 24, 42
				Zinc	1,950	
SLAG-3	Waste	6/9/2004	NR	Lead	1,220	7, pp. 24, 42
				Zinc	1,830	
SLAG-4	Waste	6/9/2004	NR	Lead	1,270	7, pp. 24, 42
				Zinc	10,100	
SLAG-5	Waste	6/9/2004	NR	Lead	2,030	7, pp. 24, 42
				Zinc	6,230	
SLAG-6	Waste	6/9/2004	NR	Lead	3,170	7, pp. 24, 42
				Zinc	5,100	
SFS 02	Soil	4/8/2008	NR	Lead	563	8, pp. 28, 209
				Zinc	1,927	
SFS 10	Soil	4/8/2008	NR	Lead	683	8, pp. 28, 209
				Zinc	2,016	
SFS 11	Soil	4/8/2008	NR	Lead	686	8, pp. 29, 209
				Zinc	2,064	

Table 3: Source Samples Analyzed by XRF

Sample Identification	Sample Type	Date	Depth ft bgs	Hazardous Substance	Concentration mg/kg	Reference
SFS 14	Soil	4/8/2008	NR	Lead Zinc	499 2,264	8, pp. 29, 210
SFS 15	Soil	4/8/2008	NR	Lead Zinc	1,216 2,788	8, pp. 29, 210
SFS 20	Soil	4/8/2008	NR	Lead Zinc	866 2,384	8, pp. 29, 210
SFS 21	Soil	4/8/2008	NR	Lead Zinc	439 1,979	8, pp. 30, 210
SFS 22	Soil	4/8/2008	NR	Lead Zinc	3,886 12,564	8, pp. 30, 210
SFS 23	Soil	4/8/2008	NR	Lead Zinc	981 1,794	8, pp. 30, 210
SFS 26	Soil	4/8/2008	NR	Lead Zinc	789 1,811	8, pp. 30, 210, 211
SFS 28	Soil	4/8/2008	NR	Lead Zinc	2,479 3,278	8, pp. 30, 211
SFS 32	Soil	4/8/2008	NR	Lead Zinc	647 1,563	8, pp. 31, 211
SFS 34	Soil	4/8/2008	NR	Lead Zinc	635 1,739	8, pp. 31, 211
SFS 39	Soil	4/8/2008	NR	Lead Zinc	711 1,443	8, pp. 31, 212
SFS 40	Soil	4/8/2008	NR	Lead Zinc	416 1,642	8, pp. 31, 212
SFS 41	Soil	4/8/2008	NR	Lead Zinc	450 1,846	8, pp. 31, 212
SFS 42	Soil	4/8/2008	NR	Lead Zinc	537 1,910	8, pp. 32, 212
SFS 43	Soil	4/8/2008	NR	Lead Zinc	1,181 2,803	8, pp. 32, 212
SFS 44	Soil	4/8/2008	NR	Lead Zinc	523 1,795	8, pp. 32, 212
SFS 46	Soil	4/8/2008	NR	Lead Zinc	1,228 4,540	8, pp. 32, 212
SFS 47	Soil	4/8/2008	NR	Lead Zinc	4,651 11,426	8, pp. 32, 212
SFS 48	Soil	4/8/2008	NR	Lead Zinc	1,575 5,377	8, pp. 32, 212
SFS 49	Soil	4/8/2008	NR	Lead Zinc	668 2,127	8, pp. 32, 212
SFS 50	Soil	4/8/2008	NR	Lead Zinc	6,960 18,172	8, pp. 32, 212

Table 3: Source Samples Analyzed by XRF

Sample Identification	Sample Type	Date	Depth ft bgs	Hazardous Substance	Concentration mg/kg	Reference
SFS 51	Soil	4/8/2008	NR	Lead Zinc	10,615 9,594	8, pp. 32, 212, 213
SFS 52	Soil	4/8/2008	NR	Lead Zinc	1,009 2,110	8, pp. 33, 213
SFS 53	Soil	4/8/2008	NR	Lead Zinc	1,269 3,064	8, pp. 33, 213
SFS 54	Soil	4/8/2008	NR	Lead Zinc	3,444 3,277	8, pp. 33, 213
XRFTRENCHAA30 1’	Soil	7/08/2008	1	Lead Zinc	9,514 24,287	8, pp. 34, 46,

Notes:
The Sample ID that is bolded represents the location presented on Figure 3 of this HRS documentation record. Sample XRFTRENCHAA30 1’ is shown on the Figure as A-A’-30’.
mg/kg Milligrams per kilogram
NR Not reported; however, the description of the sampling method suggests the readings were measured in-situ at the soil surface (Ref. 8, pp. 9, 10).
Ft bgs feet below ground surface

No background samples were analyzed by a fixed laboratory in 2004; however, in 2008 background samples were analyzed by a fixed laboratory for 8 RCRA metals plus zinc (Ref. 8, p. 12). The highest concentrations of lead, cadmium and zinc found in background samples in 2008 were 57.9 mg/kg, 0.56 mg/kg, and 226 mg/kg respectively (see Table 2 of this HRS documentation record). For samples collected and analyzed by fixed laboratory in 2004 and 2008, the lead, cadmium, and zinc concentrations that are three time the background levels discussed above are 173.7 mg/kg, 1.68 mg/kg, and 678 mg/kg respectively. Samples exceeding these concentrations are presented in Table 4 below.

Table 4: Source Samples Analyzed by Fixed Laboratory

Sample Identification	**Sample Type**	**Date**	**Hazardous Substance**	**Hazardous Substance Concentration (mg/kg)**	**Sample Quantitation Limit (mg/kg)**	**Reference**
SS-23	Soil	6/9/2004	Lead, Cadmium Zinc	430 6.5 1,900	0.25 0.25 15	7, pp. 19, 27, 61, 32, 64
SS-24	Soil	6/9/2004	Lead, Cadmium Zinc	1,000 7.6 3,900	0.25 0.25 15	7, pp. 19, 27, 62, 32, 64

Table 4: Source Samples Analyzed by Fixed Laboratory

Sample Identification	Sample Type	Date	Hazardous Substance	Hazardous Substance Concentration (mg/kg)	Sample Quantitation Limit (mg/kg)	Reference
SS-27	Soil	6/9/2004	Lead, Cadmium Zinc	750 9.3 2,200	0.25 0.25 15	7, pp. 19, 27, 60, 32, 64
SS-31	Soil	6/9/2004	Lead, Cadmium Zinc	480 5.7 2,000	0.25 0.25 15	7, pp. 19, 27, 58, 32, 64
GP-2/SS-1	Soil	6/23/2004	Lead, Cadmium Zinc	1,200 8.1 3,400	0.25 0.25 15	7, pp. 21, 27, 33, 70
HS-2/SS-1	Soil	6/8/2004	Lead, Cadmium Zinc	1,500 8.6 6,200	0.25 0.25 15	7, pp. 18, 27, 31, 53, 64
HS-4/SS-1	Soil	6/8/2004	Lead, Cadmium Zinc	940 14 3,700	0.25 0.25 15	7, pp. 18, 27, 31, 55, 64
HS-6/SS-1	Soil	6/8/2004	Lead, Cadmium Zinc	1,100 5 1,800	0.25 0.25 15	7, pp. 18, 27, 32, 56, 64
SLAG-4	Waste	6/8/2004	Lead, Cadmium Zinc	750 42 3,600	0.25 0.25 15	7, pp. 18, 27, 32, 57, 64
XRF **SFS 03**	Soil	04/08/08	Cadmium Zinc	16.7 880	0.57 11.5	8, pp. 41, 72, 81, 140
XRF **SFS 10**	Soil	04/08/08	Lead, Cadmium Zinc	495 4.4 1,650	0.46 0.46 9.1	8, pp. 41, 72, 76, 140
XRF **SFS 20**	Soil	04/08/08	Lead, Cadmium Zinc	604 16.5 3,120	0.44 0.44 44.4	8, pp. 41, 72, 78, 140
XRF **SFS 22**	Soil	04/08/08	Lead, Cadmium Zinc	4,140 9.0 9,560	2.5 0.50 49.8	8, pp. 41, 72, 80, 140
XRF **SFS 25**	Soil	04/08/08	Lead, Cadmium Zinc	559 7.1 1,010	0.56 0.56 11.1	8, pp. 41, 72, 79, 140
XRF **SFS 28**	Soil	04/08/08	Lead, Cadmium Zinc	3,120 5.4 2,100	0.99 0.50 9.9	8, pp. 41, 72, 77, 140
TRENCH **I-I′-0′**-0.5′	Soil	07/08/08	Cadmium Zinc	14.8 1,760	0.50 10.1	8, pp. 46, 126, 128
TRENCH **D-D′-10′**-4′	Soil	07/08/08	Cadmium Zinc	7.0 733	0.62 12.3	8, pp. 46, 126, 129

Table 4: Source Samples Analyzed by Fixed Laboratory

Sample Identification	Sample Type	Date	Hazardous Substance	Hazardous Substance Concentration (mg/kg)	Sample Quantitation Limit (mg/kg)	Reference
TRENCH **B-B′-30′**-3′	Soil	07/08/08	Lead Cadmium Zinc	354 25.3 6,000	0.58 0.58 57.7	8, pp. 46, 126, 130
TRENCH **A-A′-50′**-2′	Soil	07/08/08	Lead Cadmium Zinc	402 9.4 2,010	0.43 0.43 8.7	8, pp. 46, 126, 131
TRENCH **I-I′-100′**-0.5′	Soil	07/08/08	Cadmium Zinc	60.7 3,460	0.51 51.3	8, pp. 46, 126, 132
TRENCH **H-H′-20′**-2′	Soil	07/08/08	Cadmium Zinc	26.7 1,010	0.53 10.6	8, pp. 46, 126, 134

Notes:
The Sample ID that is bolded represents the location presented on Figure 3 of this HRS documentation record.
mg/kg Milligrams per kilogram

List of Hazardous Substances Associated with Source

Hazardous substances associated with source 1 include cadmium, lead and zinc.

2.2.3 HAZARDOUS SUBSTANCES AVAILABLE TO A PATHWAY

Table 5: Source Containment

Containment Description	Containment Factor Value	References
Gas release to air:	Not scored	Not applicable
Particulate release to air:	Not scored	Not applicable
Release to ground water:	Not scored	Not applicable
Release via overland migration and/or flood: As described in Section 4.1.2.1.1 of this documentation record, there is evidence of hazardous substance migration from the source area. During trenching activities there was no indication of a maintained engineered cover of functioning and maintained run-on control system and runoff management system. Therefore, based on available evidence, the highest surface water migration pathway containment factor value of 10 was assigned to Source 1 as specified in Table 4-2 of the HRS (Ref. 1, Section 4.1.2.1.2.1.1).	10	6, pp.136, 137; 8, pp. 10, 18, 46, 59-68, 157

2.4.2 HAZARDOUS WASTE QUANTITY

Insufficient information exists to evaluate Hazardous Constituent Quantity and Hazardous Wastestream Quantity. Therefore, the hazardous waste quantity value will be calculated using the higher of either Tier C (volume) or Tier D (area) of the contaminated soil.

2.4.2.1.1. Hazardous Constituent Quantity (Tier A) – Not Evaluated.

The total Hazardous Constituent Quantity for Source 1 could not be adequately determined according to HRS requirements; that is, the total mass of all Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substances in the source is not known and cannot be estimated with reasonable confidence [Ref. 2, Section 2.4.2.1.1]. Insufficient historical and current data (manifests, potentially responsible party [PRP] records, State records, permits, waste concentration data, etc.) are available to adequately calculate the total or partial mass of all CERCLA hazardous substances in the source and including associated releases from the source. Therefore, there is insufficient information to calculate a total or partial Hazardous Constituent Quantity estimate for Source 1 with reasonable confidence. Scoring proceeds to the evaluation of Tier B, hazardous wastestream quantity (Ref. 1, Section 2.4.2.1.1).

Hazardous Constituent Quantity Assigned Value: Not scored

2.4.2.1.2. Hazardous Wastestream Quantity (Tier B) – Not Evaluated

The total Hazardous Wastestream Quantity for Source 1 could not be adequately determined according to HRS requirements; that is, the total mass of all hazardous wastestreams and CERCLA pollutants and contaminants for the source is not known and cannot be estimated with reasonable confidence [Ref. 2, Section 2.4.2.1.2]. Insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, annual reports, etc.) are available to adequately calculate the total or partial mass of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and associated releases from the source. Therefore, there is insufficient information to adequately calculate or extrapolate a total or partial Hazardous Wastestream Quantity for Source 1 with reasonable confidence. Scoring proceeds to the evaluation of Tier C, Volume (Ref. 1, Section 2.4.2.1.2).

Hazardous Wastestream Quantity Assigned Value: Not scored

2.4.2.1.3. Volume

Description

Tier C, Volume, is not scored for Source 1 consisting of contaminated soil that is comingled with slag and other smelter waste; therefore, the evaluation of hazardous waste quantity proceeds to the evaluation of Tier D, Area (Ref. 2, Section 5.1.2.1.2, Table 5-2).

Sum (yd^3/gal):
Equation for Assigning Value (Ref. 1, Table 2-5): Volume (V)/2,500

Volume Assigned Value: 0

2.4.2.1.4. Area

Description

The samples shown on Figure 3 of this documentation record were used to determine an approximate area of contaminated soil. Samples SFS 34, D-D' - 10', HS-7, SS-31, SS-6, SS-12, SS-25, SFS 25 and SFS 39 delineate the approximate area of Source 1. The area was measured and determined to be approximately 407, 373 square feet. This area was determined by geographical Information system (GIS) techniques based on sample locations and results presented above and Figure 3.

Sum (ft^2): 407,373
Equation for Assigning Value (Ref. 1, Table 2-5): A/34,000

Area Assigned Value: 11.98

2.4.2.1.5. Source Hazardous Waste Quantity Value

Highest assigned value assigned from Ref. 1, Table 2-5: 11.98

SUMMARY OF SOURCE DESCRIPTIONS

Table 6: Summary of Source Descriptions

Source No.	Source Haz. Waste Quantity Value	Source Hazardous Constituent Quantity Complete? (Y/N)	Containment Factor Value by Pathway				
			Ground Water (GW) (Ref. 1, Table 3-2)	Surface Water (SW)		Air	
				Overland/flood (Ref. 1, Table 4-2)	GW to SW (Ref. 1, Table 3-2)	Gas (Ref. 1, Table 6-3)	Particulate (Ref. 1, Table 6-9)
1	11.98	No	Not scored	10	Not scored	Not scored	Not scored

4.0 SURFACE WATER MIGRATION PATHWAY

4.1 OVERLAND/FLOOD MIGRATION COMPONENT

4.1.1.1 Definition of Hazardous Substance Migration Path for Overland/flood Component

The former smelter is located north of Weir Kansas at an approximate elevation of 910-915 feet above mean sea level (Ref. 4, Sheet 1). Land slopes to the northwest, north, and northeast toward a wetland area and intermittently flowing tributary to Brush Creek which is at an elevation of 900 feet above mean sea level (Refs. 4, Sheet 1; 6, p. 7; 8, pp. 6, 39). As shown on Figures 3 of this documentation record, most of the contaminated soil encompassing Source 1 is south of the drainage. Overland flow across the source follows surface topography to the wetland and intermittent drainage (Refs. 4, Sheet 1; 8, p. 6). One of the samples analyzed by a fixed laboratory used to designate the source (sample SS-31) is located within an area designated as a wetland; others such as SS-23 and XRF-SFS-44 are within 25 feet of the wetland (Refs. 7, pp. 19, 27, 58, 61; 8, pp. 33, 45, 76; 33, p. 39, Figure 3 of this HRS documentation record). Therefore, based on sample SS-31, the overland migration distance, or the distance from the source to a wetland, is zero feet.

Because runoff from the source follows topography and there are no known drainage ditches at the source, there could be multiple points, or probable points of entry, along the wetland where lead, cadmium and zinc could enter the wetland and intermittent creek (Refs. 4, Sheet 1; 8, p. 6). Two probable points of entry, or PPEs, are shown on Figure 4 of this documentation record. PPE_1 is in the wetland on the west end of Source 1 and PPE_2 is in the wetland on the east end of Source 1. Sample location SS-31 is also a probable point of entry into the wetland and is located between PPE_1 and PPE_2 (Figures 3 and 4 of this HRS documentation record). The unnamed intermittent tributary stream to Brush Creek flows from west to east (Refs. 4; 6, p. 7). West of the former Atchison-Topeka-Santa-Fe (ATSF) railroad right-of-way described by Burns and McDonnell exists 0.25 mile of wetlands designated by the U.S. Fish and Wildlife Service, National Wetlands Inventory (NWI) program as Palustrine Emergent Persistent Temporary Flooded (PEM1A) (Refs. 6, pp. 7, 11, 12; 20, pp. 1, 2, 8, 15). This wetland was verified as an emergent wetland by an assessment conducted on June 10, 2020 (Ref. 33, pp. 3, 9, 10, 22-24, 39). East of the railroad right-of-way the intermittent creek flows east in a meandering channel for 0.48 mile to a point where effluent from the Weir Kansas wastewater treatment ponds discharge and the stream becomes perennially flowing (Refs. 33, pp. 8, 9, 22, 27, 39; 34). The now perennially flowing tributary to Brush Creek flows east northeast in a meandering channel for 2.26 miles where it joins Brush Creek (Ref. 4, Sheets 1 and 2). Brush Creek flows east southeast for 5.41 miles where it joins Cow Creek (Ref. 4, Sheet 2). Cow Creek

flows south for 6.85 miles to a point that is 15 miles downstream of PPE_2 (Ref. 4, Sheets 1, 2, and 3). Flow rates for Brush Creek were available from 1977 through 1980 (Ref. 24, p. 1). Flow rates in Brush Creek ranged from 5.21 cubic feet per second (1980) to 21.4 cubic feet per second (1978) (Ref. 24, p. 1) with an average flow rate of 17.08 cubic feet per second. Flow rate data for Cow Creek were available from 1977 to 1982 (Ref. 24, p. 3). Flow rates ranged from 35.6 cubic feet per second in 1981 to 135.6 cubic feet per second in 1982 (Ref. 24, p. 3) with an average flow rate of 107.2 cubic feet per second. The locations of these former USGS gauging stations are shown on Reference 4, Sheet 2.

NWI maps indicate the entirety of the unnamed tributary to Brush Creek is classified as wetland (Ref. 20, pp. 1-7). From the railroad right-of way heading east are 0.15 mile of Palustrine Emergent Persistent Seasonally Flooded (PEM1C) wetland (Ref. 20, pp. 3, 9, 15), followed by 0.25 mile of Palustrine Scrub Shrub Temporary Flooded (PSSA) (Ref. 20, pp. 4, 10, 15) followed by 0.19 mile of Palustrine Forested Temporary Flooded (PFOA) (Ref. 20, pp. 5, 11, 15) followed by 0.92 mile of PEM1C (Ref. 20, pp. 6, 12, 15) followed by 0.89 mile of PFOA (Ref. 20, pp. 7, 13, 15).

In June 2020, a wetland delineation study was conducted of an approximate 25-acre tract located along the upper reaches of Brush Creek north of the city of Weir Kansas (Ref. 33, pp. 3, 8, 14). The survey identified three types of wetlands in the project study area that were continuous from west to east within the floodplain of the tributary to Brush Creek (Ref. 33, pp 9-11, 39). The western most area identified was classified as an emergent wetland (Ref. 33, pp. 9, 10, 39) and was shown to be larger than what NWI maps classify as PEM1A (Ref. 20, pp. 1, 2, 8). This wetland is approximately 2,000 feet (0.38 mile) long and about 200 feet wide at its widest point (Ref. 33, p. 39). The PEM1A wetland is 0.25-mile-long (Ref. 20, p.8). The next wetland identified by the June 2020 wetlands delineation survey was a forested emergent wetland that was continuous from the emergent wetland to the west to the point where the tributary stream becomes perennially flowing at the water treatment facility outfall (Ref. 33, pp. 10, 39). This distance is approximately 2,300 feet (0.44 mile) (Ref. 33, p. 39). This wetland transitions into a forested wetland where the steam becomes perennially flowing (Ref. 33, pp. 10, 39). The last portion of the study area was downstream of NE 40th Street and access to the property was denied (Ref. 33, p, 11; Figure 4 of this HRS documentation record). This area was interpreted to be an emergent wetland by the wetland delineation (Ref. 33, pp. 11, 39) and by the NWI (Ref. 20, p. 12). Releases to the wetlands surrounding the intermittent creek which flows to Brush Creek have been documented by chemical analysis. At this site, National Wetlands Inventory maps published by the U.S. Fish and Wildlife Service classify the stream bed of the intermittent creek north of the site as either Palustrine Emergent Persistent Temporary Flooded (PEM1A),

Palustrine Emergent Persistent Seasonally Flooded (PEM1C), Palustrine Scrub Shrub Temporary Flooded (PSSA), or Palustrine Forested Temporary Flooded (PFOA). These wetlands are contiguous from the site to where the unnamed tributary to Brush Creek becomes perennial near the water treatment facility outfall (Refs. 33, pp. 8, 9, 27, 39). The in-water segment of the surface water pathway begins at PPE_1 in the emergent wetland. The in-water segment of the surface water migration route therefor consists of 0.71 mile of wetlands (emergent and forested emergent wetland (Ref. 33, p. 39; Figure 4 of this HRS documentation record)) with an intermittently flowing unnamed tributary to Brush Creek, 2.26 miles of perennially flowing tributary to Brush Creek, 5.41 miles of perennially flowing Brush Creek, and 6.85 of Cow Creek (Ref. 4, Sheets 1, 2, and 3).

4.1.2.1 Likelihood of Release

4.1.2.1.1 Observed Release

Direct Observation

- Basis for Direct Observation:

The wetland and associated intermittent creek bisect the contaminated soil that is source 1. As documented in Section 2.2.2 source 1 is contaminated with cadmium, lead and zinc. Photographs taken in June 2003 show slag, brick and retort fragments eroding out of the hillside along the drainage that passes through the site (Ref. 6, pp. 7, 31, 32, 136). The two samples defining the northern edge of Source 1 SS-6 and SS-12 were characterized using XRF and only lead and zinc were included as source hazardous substances (Ref. 7, pp. 19, 23 and section 2.2.2). In addition, sample SS-31 collected in 2004 and analyzed by a fixed laboratory contained lead (480 mg/kg), cadmium (5.7 mg/kg), and zinc (2,000 mg/kg) (Ref. 7, pp. 19, 27, 58, see also Figure 3 of this documentation record). The wetland delineation survey conducted in June 2020 indicate that this sample was collected within the boundary of the emergent wetland (See Figure 3 of the HRS documentation record).

- Hazardous Substances in Release:

Table 7: Hazardous Substances in Observed Release by Direct Observation

Hazardous Substance	Evidence	References
Lead	Wetland and associated creek bisect Source 1 Sample SS-31 was collected within a wetland	Section 2.2.2, Figure 3; 7, pp. 19, 27, 58
Cadmium	Wetland and associated creek bisect Source 1 Sample SS-31 was collected within a wetland	Section 2.2.2, Figure 3; 7, pp. 19, 27, 58
Zinc	Wetland and associated creek bisect Source 1 Sample SS-31 was collected within a wetland	Section 2.2.2, Figure 3; 7, pp. 19, 27, 58

Chemical Analysis

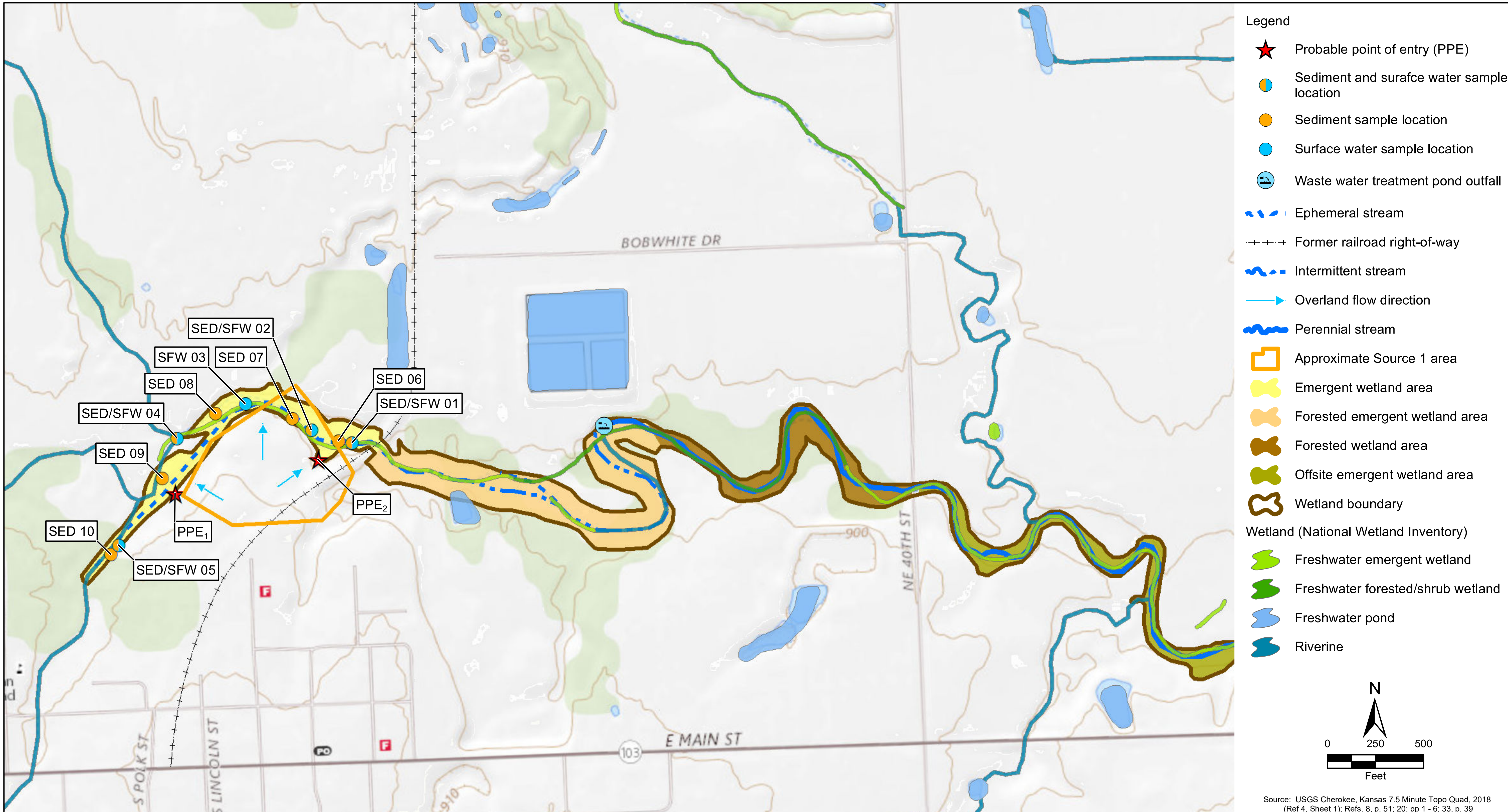
- Background Concentrations:

In 2008 ten sediment samples and five surface water samples were collected from the wetland surrounding the intermittent branch of Brush Creek that crosses through the site (Refs. 8, pp. 11, 51; 20; 33). The samples were collected at regular intervals along the tributary with one sediment/surface water pair collected from an upstream location relative to the site and a second set from a downstream location (Ref. 8, p. 11). All samples were submitted to an off-site laboratory for analysis for 8 RCRA metal plus zinc by EPA methods 6010 and 7471 (mercury solids) and 7470 (mercury water) (Ref. 8, pp. 11, 73-75). Sample locations used to document the observed release are presented in figures from the 2008 site investigation (Refs. 7, pp. 20, 22; 8, p. 51). These locations are also shown on Figure 4 of the HRS documentation record.

The table below presents the locations of the background samples collected in 2008.

Table 8: Background Fixed Laboratory Samples

Sample ID	Sample Medium	Sample Location	Depth	Date	References
SFW 05	Surface water	Emergent wetland, upstream intermittent Creek	Top of stream	04/12/2008	8, pp. 11, 35, 51, 72, 142, 149; Figure 4
SED 05	Sediment	Emergent wetland, upstream intermittent Creek	Top of Stream bed	04/12/2008	8, pp. 11, 35, 51, 73, 140, 149; Figure 4
SED 09	Sediment	Emergent wetland, upstream intermittent Creek	Top of Stream bed	04/12/2008	8, pp. 11, 35, 51, 73, 141, 149; Figure 4
SED 10	Sediment	Emergent wetland, Upstream intermittent Creek	Top of Stream bed	04/12/2008	8, pp. 11, 35, 51, 74, 141, 149; Figure 4



Source: USGS Cherokee, Kansas 7.5 Minute Topo Quad, 2018 (Ref 4, Sheet 1); Refs. 8, p. 51; 20; pp 1 - 6; 33, p. 39

Cherokee Zinc - Weir Smelter
Weir, Kansas

Figure 4
Surface Water and Sediment Sample Locations

TETRA TECH

Date: 11/26/2019 Drawn By: Clayton Hayes Project No: 103X903019F0067

The table below presents the analytical results for the background surface water and sediment samples collected in 2008.

Table 9: Background Laboratory Sample Results

Sample ID	Hazardous Substance	Concentration (mg/kg or µg/L)	Sample Quantitation Limit	References
SFW 05	Lead Cadmium Zinc	ND ND 134 µg/L	5.0 µg/L 5.0 µg/L 50 µg/L	8, pp. 35, 110, 142, 149
SED 05	Lead Cadmium Zinc	98.6 mg/kg 0.58 mg/kg 116 mg/kg	0.50 mg/kg 0.50 mg/kg 10.0 mg/kg	8, pp. 86, 140, 149
SED 09	Lead Cadmium Zinc	19.2 mg/kg ND 354 mg/kg	0.58 mg/kg 0.58 mg/kg 11.6 mg/kg	8, pp. 90, 141, 149
SED 10	Lead Cadmium Zinc	38.1 mg/kg ND 113 mg/kg	0.60 mg/kg 0.60 mg/kg 12.0 mg/kg	8, pp. 91, 141, 149

Notes:
BDL Below detection limit (Ref.7. pp. 73, 74).
ND Not detected at or above the adjusted reporting limit (Ref. 8, p. 121).

The highest concentrations of cadmium, lead, and zinc found in sediment samples designated as background were 0.58 mg/kg for cadmium, 98.6 mg/kg for lead, and 354 mg/kg for zinc. Three times these concentrations in sediment samples are 1.74 mg/kg for cadmium, 295.8 mg/kg for lead, and 1,062 mg/kg for zinc. In surface water samples designated as background, cadmium and lead were not detected and the highest zinc concentration was 134 µg/L. Three times this zinc concentration is 402 µg/L.

- Contaminated Samples:

The samples below from 2008 meet or exceed the observed release criteria specified in section 2.3 and Table 2-3 of Reference 1. Release samples are shown on Figure 4 of the HRS documentation record.

Table 10: Fixed Laboratory Release Samples

Sample Identification	Sample Medium	Sample Location	Distance from PPE	Depth	Date	References
SFW 01	Surface water	Emergent wetland, unnamed creek	About 1,330 feet downstream of PPE_1	Top of stream	04/12/2008	8, pp. 11, 51, 72, 142 , 149; Figure 4
SFW 02	Surface water	Emergent wetland, unnamed creek	About 1,110 feet downstream of PPE_1	Top of stream	04/12/2008	8, pp. 11, 51, 72, 142, 149; Figure 4
SFW-03	Surface water	Emergent wetland, unnamed creek	About 615 feet downstream of PPE_1	Top of stream	04/12/2008	8, pp. 11, 51, 72, 142, 149; Figure 4
SFW 04	Surface water	Emergent wetland, unnamed creek	This sample is about 280 feet north of PPE_1	Top of stream	04/12/2008	8, pp. 11, 51, 72, 142, 149; Figure 4
SED 01	Sediment	Emergent wetland, unnamed creek	About 1,330 feet downstream of PPE_1	Top of Stream bed	04/12/2008	8, pp. 11, 51, 72, 140, 149; Figure 4
SED 02	Sediment	Emergent wetland, unnamed creek	About 1,110 feet downstream of PPE_1	Top of Stream bed	04/12/2008	8, pp. 11, 51, 72, 140, 149; Figure 4
SED 04	Sediment	Emergent wetland, unnamed creek	This sample is about 280 feet north of PPE_1	Top of Stream bed	04/12/2008	8, pp. 11, 51, 72, 140, 149; Figure 4
SED 06	Sediment	Emergent wetland, unnamed creek	About 1,260 feet downstream of PPE_1	Top of Stream bed	04/12/2008	8, pp. 11, 51, 72, 140, 149; Figure 4
SED 07	Sediment	Emergent wetland, unnamed creek	About 990 feet downstream of PPE_1	Top of Stream bed	04/12/2008	8, pp. 11, 51, 72, 141, 149; Figure 4
SED 08	Sediment	Emergent wetland, unnamed creek	About 520 feet downstream of PPE_1	Top of Stream bed	04/12/2008	8, pp. 11, 51, 72, 141, 149; Figure 4

Notes:
PPE_1 Probable point of entry, west side of Source 1

The table below presents the analytical results for the release surface water and sediment samples collected in 2004 and 2008.

Table 11: Fixed Laboratory Release Sample Results

Sample Identification	Hazardous Substance	Concentration (mg/kg or µg/L)	Sample Quantitation Limit	References
SFW 01	Zinc	536 µg/L	50.0 µg/L	8, p. 106, 142, 149
SFW 02	Lead Zinc	5.1 µg/L 956 µg/L	5.0 µg/L 50.0 µg/L	8, p. 107, 142, 149
SFW 03	Lead	9.0 µg/L	5.0 µg/L	8, p. 108, 142, 149
SFW 04	Lead Zinc	40.3 µg/L 606 µg/L	5.0 µg/L 50.0 µg/L	8, p. 109, 142, 149
SED 01	Lead Cadmium Zinc	402 mg/kg 6.3 mg/kg 1,430 mg/kg	0.61 mg/kg 0.61 mg/kg 12.1 mg/kg	8, p. 82, 140, 149
SED 02	Lead Cadmium Zinc	359 mg/kg 5.1 mg/kg 1,270 mg/kg	0.73 mg/kg 0.73 mg/kg 14.5 mg/kg	8, pp. 83, 140, 149
SED 04	Lead Cadmium Zinc	1,320 mg/kg 7.9 mg/kg 1,490 mg/kg	0.60 mg/kg 0.60 mg/kg 12.0 mg/kg	8, pp. 85, 140, 149
SED 06	Lead Cadmium Zinc	309 mg/kg 7.6 mg/kg 1,660 mg/kg	0.68 mg/kg 0.68 mg/kg 13.6 mg/kg	8, pp. 87, 140, 149
SED 07	Cadmium Zinc	7.3 mg/kg 1,240 mg/kg	0.68 mg/kg 13.5 mg/kg	8, pp. 88, 141, 149
SED 08	Lead Cadmium Zinc	627 mg/kg 4.1 mg/kg 1,080 mg/kg	0.55 mg/kg 0.55 mg/kg 11.0 mg/kg	8, pp. 89, 141, 149

Notes:
mg/kg milligrams per kilogram
µg/L Micrograms per liter

Attribution:

The Chicago Zinc Works began smelting zinc in Weir in 1872 (Refs. 6, p. 15; 32, p. 4). Chicago Zinc located the smelter in Weir due to nearby commercial coal deposits to fuel the smelter, and the proximity to the Tri-State lead and zinc mining district. Chicago Zinc abandoned the smelter, and in 1896 the Cherokee Lanyon Smelter Company purchased the smelter and owned it until 1906 (Ref. 32, p. 4). Other operators of the smelter included

the Weir City Zinc Works, the Cherokee Zinc Company Smelter, and the Cherokee Lanyon Smelter Company. Several owners held the property until the Weir Smelting Company purchased the smelter in 1917 and sold it in 1920 (Ref. 32, p. 4). It is unknown if the Weir Smelting Company actively ran the smelter, as from other historical information it appears smelting operations closed in approximately 1909 when natural gas reserves in other areas of Kansas made smelter operations from coal unprofitable (Ref. 32, p. 4). The smelter property was eventually sold at auction 1948 (Ref. 32, p. 5). The current owners are the City of Weir and a private residence of Weir. The former smelter buildings are no longer present at the site except for foundations for some of the former buildings (Ref. 6, pp. 7, 8).

No other Zinc Smelters are known to have existed in the City of Weir. Numerous other Zinc Smelters existed in Southeast Kansas (Ref. 28, p. 12). The nearest smelters to the Cherokee Zinc Co. were the Cherokee Mining & Smelting site and the Scammon Smelter, both west of Weir (Refs. 4, Sheet 1; 28, pp. 2, 12). Cherokee Mining and Smelting is approximately 4.2 miles northwest of the Cherokee Zinc Smelter in Weir and the Scammon Smelter is 3.6 miles southwest of the Cherokee Zinc Smelter in Weir (Refs. 4, Sheet 1; 15, p. 1; 16, p. 1).

The Cherokee Mining and Smelting site operated as a smelter from 1894 to 1905 (Ref. 15, p. 1). Contaminants at the site include arsenic, lead cadmium and zinc (Ref. 15, p. 1). An estimated 13,850 cubic yards of contaminated soil and smelter waste is present at this site (Ref. 15, p. 1). Sampling of nearby residents and a high school indicated that off site properties were not impacted by the smelter (Ref. 15, p. 1). A remedial action including removal and encapsulation of contaminated soil onsite was in the design phase as of February 11, 2020 (Ref. 15, p. 2).

The Scammon Smelter site operated as a smelter from 1871 to 1898 (Ref. 16, p. 1). Contaminants at the site include arsenic, cadmium, and lead (Ref. 16, p. 1). An estimated 14,123 cubic yards of contaminated soil and smelter waste is present at this site (Ref. 16, p. 1). This site was remediated in 2012. Remediation consisted of excavation and encapsulation of impacted soil (Ref. 16, p. 2).

Source 1 at the Cherokee Zinc – Weir Smelter site consists of a contaminated soil that is comingled with slag and other smelter waste in and around the former smelter. (Ref. 6, pp. 7, 56; Figure 3). Hazardous substances associated with Source 1 includes lead, cadmium, and zinc (Tables 3 and 4). Surface topography of the site slopes gently to the north toward the wetland including an intermittent branch of Brush Creek (Ref. 6, p. 7; Figure 4).

The sample results for cadmium, lead, and zinc in sediments and lead and zinc in surface water can be attributed to source 1, contaminated soils because the metals found in surface water and sediments were also found in the upgradient source 1. Soils in the source contained lead as high as 10,615 mg/kg (in sample SFS 51), and zinc as high as 26,300 mg/kg (in sample HS-3 SS-3) as measured by XRF (Refs. 7, pp. 24, 26, 39; 8, pp. 32, 212, 213). In samples analyzed by a fixed laboratory, cadmium was reported at a maximum concentration of 60.7 mg/kg (in sample TRENCH I-I′-100′-0.5′), lead was reported at a maximum concentration of 4,140 mg/kg (in sample XRF SFS 22), and zinc was reported at a maximum concentration of 9,560 mg/kg (in sample XRF SFS 22) (Ref. 8, pp. 41, 46, 72, 80, 126, 132).

Cadmium, lead and zinc are documented at observed release concentrations in the wetlands north of Source 1 (Tables 8, 9, 10, and 11 of this HRS documentation record). Overland flow across the source follows surface topography to the wetland and intermittent drainage (Refs. 4, Sheet 1; 8, p. 6). Photographs taken in June 2003 show slag, brick and retort fragments eroding out of the hillside along the drainage that passes through the site (Ref. 6, pp. 31, 32, 136). Source 1 sample SS-31 is located within the designated boundary of the wetland. Other samples such as SS-23 and XRF SFS-44 are within 25 feet of the wetland (Refs. 7, pp. 19, 27, 58, 61; 8, pp. 33, 45, 76; 33, p. 39; Figure 3). The significant increase in contamination in the surface water pathway is at least partially attributable to a release from the site (Tables 1, 2, 3, 4, 8, 9, 10, and 11 of this HRS documentation record).

Hazardous Substances Released

Cadmium
Lead
Zinc

An observed release by chemical analysis has been established and the surface water pathway receives a likelihood of release factor value of 550.

Surface Water Observed Release Factor Value: 550

4.1.3.2 Human Food Chain Threat Waste Characteristics

4.1.3.2.1 Toxicity/Persistence/Bioaccumulation

Human food Chain toxicity, persistence, and bioaccumulation factor values for cadmium, lead, and zinc are presented in the table below.

Table 12: Human Food Chain Hazardous Substance Factor Values

Hazardous Substance	Source No.	Toxicity Factor Value	Persistence Factor Value*	Bio-accumulation Value**	Toxicity/ Persistence/ Bioaccumulation Factor Value (Ref. 1, Table 4-16)	References
Cadmium	1	10,000	1	50,000	5×10^{8}	3, p. 2
Lead	1	10,000	1	5,000	5×10^{7}	3, p. 4
Zinc	1	10	1	500	5,000	3, p. 7

Notes:

* Persistence value for Rivers
** Bioaccumulation factor value for Freshwater

Toxicity/Persistence/Bioaccumulation Factor Value: 5×10^{8}

4.1.3.2.2 Hazardous Waste Quantity

Table 13: Human Food Chain Hazardous Waste Quantity

Source No.	Source Type	Source Hazardous Waste Quantity	Source Hazardous Constituent Quantity Complete?
1	Contaminated Soil	11.98	No

Sum of Values: 11.98

In accordance with instructions in Section 2.4.2.2 of the HRS rule (Ref. 1), a hazardous waste quantity factor value of 100 is assigned to the surface water migration pathway because a target (wetlands) is subject to level I or II concentrations. This value is entered below.

Hazardous Waste Quantity Factor Value: 100
(Ref. 1, Table 2-6, Section 2.4.2.2)

4.1.3.2.3 Waste Characteristics Factor Category Value

Toxicity/Persistence Factor Value: 10,000
Hazardous Waste Quantity Factor Value: 100

Toxicity/Persistence Factor Value ×
Hazardous Waste Quantity Factor Value: 1,000,000 or 1×10^{6}

(Toxicity/Persistence Factor Value × Hazardous Waste Quantity Factor Value) × Bioaccumulation Factor Value: 50,000,000,000 or 5×10^{10}

Waste Characteristics Factor Category Value: 320
(Ref. 1, Table 2-7, Section 2.4.3.2)

4.1.3.3 Human Food Chain Threat Targets

Actual Human Food Chain Contamination

No fisheries are known to exist in the zone of contamination.

- Closed Fisheries:

No fisheries are known to be closed due to site related contamination.

- Benthic Tissue:

No benthic tissue samples have been collected.

4.1.3.3.1 Food Chain Individual

Sample ID: SED 01, laboratory sample number 6038643007 (Ref. 8, pp. 51, 73, 82)
Level I/Level II/or Potential: Potential Hazardous Substance: Cadmium
Bioaccumulation Potential: 50,000

Brush Creek (segment 26) and Cow Creek (segment 16) have been designated for food procurement and special aquatic life use in the Kansas Surface Water Register (Refs. 4, Sheet 2; 23, pp. 4, 35, 36; 25, p. 44; 26, p. 1). Cow Creek and Brush Creek both support human food chain organisms (Ref. 26, p.18). A study was conducted in 2017 by researchers from Pittsburg State University in the Cow Creek watershed to determine impact of mine related waste on fishes in the watershed (Ref. 26, pp. 1,2). Fish were collected from 25 locations in the watershed (Ref. 26, pp. 2, 4). Fish sampling locations within or near the in-water segment of Brush creek and Cow Creek are shown on Reference 4, Sheets 2 and 3. Sampling sites in Brush Creek contained Bluegill, Sunfish, Largemouth Bass, and Yellow Bullhead Catfish (Ref. 26, p. 18). Sampling sites in Cow Creek contained Bluegill, Sunfish, Largemouth Bass, Spotted Bass, White Crappie, Channel Catfish and Flathead Catfish (Ref. 26, pp. 18-20). Property owners living on Brush Creek about 3.6 miles east of Weir indicated that fish are caught in Brush Creek and consumed by the family (Ref. 35). An area of Cow Creek known as the Bush Property (Site #2) on Kansas Department of Wildlife, Parks, and Tourism owned land and is open to the public for fishing (Ref. 26, p. 1). Based on the latitude and longitude reported for Cow Creek site 2 (Ref. 26, p.18) this area is about 1.6 miles upstream of the in-water segment of Cow Creek (see Reference 4, Sheet 2). Both Brush Creek and Cow Creek are designated as fisheries and there is documentation that people catch and consume fish from Brush Creek,

therefore in accordance with the HRS rule Section 4.1.3.3.1 the food chain individual factor receives a score of 20.

Food Chain Individual Factor Value: 20

4.1.3.3.2 Population

4.1.3.3.2.1 Level I Concentrations

Not scored as no fishery is subject to actual contamination.

4.1.3.3.2.2 Level II Concentrations

Not scored as no fishery is subject to actual contamination.

4.1.3.3.2.3 Potential Human Food Chain Contamination

Potential Population Targets

No data is known to exist on the total pounds of human food chain organisms produced from Brush Creek or Cow Creek annually. One resident interviewed who lives adjacent to Brush Creek reported that fish are caught from Brush Creek and consumed by the family. An estimate of pounds caught and consumed per year was not obtained but based on the species reportedly caught (catfish), the amount is greater than zero (Ref. 35).

Table 14: Human Food Chain Threat Potential Population Targets

Identity of Fishery	Annual Production (pounds)	Type of Surface Water Body	Average Annual Flow (cfs)	References	Population Value (P_i) (Ref. 1, Table 4-18)	Dilution Weight (D_i) (Ref. 1, Table 4-13)	$P_i \times D_i$
Brush Creek	>0	Small to Moderate Stream	~ 17.08	24, p. 1; 4, Sheet 2	0.03	0.1	0.003

Sum of $P_i \times D_i$: 0.003
(Sum of $P_i \times D_i$)/10 (Ref. 1, Section 4.1.3.3.2.3): 0.0003

Potential Human Food Chain Contamination Factor Value: 0.0003

4.1.4.2 Environmental Threat Waste Characteristics

4.1.4.2.1 Ecosystem Toxicity/Persistence/Bioaccumulation

Table 15: Environmental Threat Hazardous Substance Factor Values

Hazardous Substance	Source No.	Ecosystem Toxicity Factor Value	Persistence Factor Value*	Ecosystem Bio-accumulation Value**	Ecosystem Toxicity/ Persistence/ Ecosystem Bioaccumulation Factor Value (Ref. 1, Table 4-21)	References
Cadmium	1	10,000	1	50,000	5×10^{8}	3, p. 2
Lead	1	1,000	1	50,000	5×10^{7}	3, p. 4
Zinc	1	10	1	50,000	5×10^{5}	3, p. 7

Notes:

* Persistence value for Rivers

** Bioaccumulation factor value for Freshwater

Ecosystem Toxicity/Persistence/Environmental Bioaccumulation Factor Value: 5×10^{8}

4.1.4.2.2. Hazardous Waste Quantity

Table 16: Environmental Threat Hazardous Waste Quantity

Source No.	Source Type	Source Hazardous Waste Quantity	Source Hazardous Constituent Quantity Complete?
1	Contaminated Soil	11.98	No

Sum of Values: 11.98

In accordance with instructions in Section 2.4.2.2 of the HRS rule (Ref. 1), a hazardous waste quantity factor value of 100 is assigned to the surface water migration pathway because a target (wetlands) is subject to level I or II concentrations (Ref.1, Section 4.1.4.3.1.1). This value is entered below.

Hazardous Waste Quantity Factor Value: 100
(Ref. 1, Table 2-6, Section 2.4.2.2)

4.1.4.2.3. Waste Characteristics Factor Category Value

Ecosystem Toxicity/Persistence Factor Value: 10,000
Hazardous Waste Quantity Factor Value: 100

Ecosystem Toxicity/Persistence Factor Value ×
Hazardous Waste Quantity Factor Value: 1,000,000 or 1×10^{6}

(Ecosystem Toxicity/Persistence Factor Value × Hazardous Waste Quantity Factor Value) × Environmental Bioaccumulation Factor Value: 50,000,000,000 or 5×10^{10}

Waste Characteristics Factor Category Value: 320
(Ref. 1, Table 2-7, Section 2.4.3.2)

4.1.4.3 Environmental Threat Targets

Level I Concentrations

The water samples below were collected from the wetland which contains an unnamed intermittent creek north of Source 1. The June 2020 wetlands delineation survey identified these as emergent wetland west end (Ref. 33, p. 39; Figure 4 of this HRS documentation record). National Wetlands Inventory maps indicate a Palustrine Emergent Persistent Temporary Flooded (PEM1A) wetland occurs at this location (Ref; 20, pp. 1, 2, 8, 15). Surface water samples collected within the wetland are presented in Table 17 below along with ecological-based benchmarks for hazardous substances in surface water.

Table 17: Environmental Threat Benchmarks

Sample ID	Sample Medium	Hazardous Substance	Hazardous Substance Concentration	Benchmark Concentration	Benchmark	References
SFW 04 6038643034	Surface water	Lead Zinc	40.3 µg/L 606 µg/L	2.5 µg/L 120 µg/L	Chronic, Freshwater CCC	3, pp. 5, 8; 8, p. 109
SFW 03 6038643033	Surface water	Lead	9.0 µg/L	2.5 µg/L	Chronic, Freshwater CCC	3, p. 5; 8, p. 108
SFW 02 6038643032	Surface water	Lead Zinc	5.1 µg/L 956 µg/L	2.5 µg/L 120 µg/L	Chronic, Freshwater CCC	3, pp. 5, 8; 8, p. 107
SFW 01 6038643031	Surface water	Zinc	536 µg/L	120 µg/L	Chronic, Freshwater CCC	3, p. 8; 8, p. 106

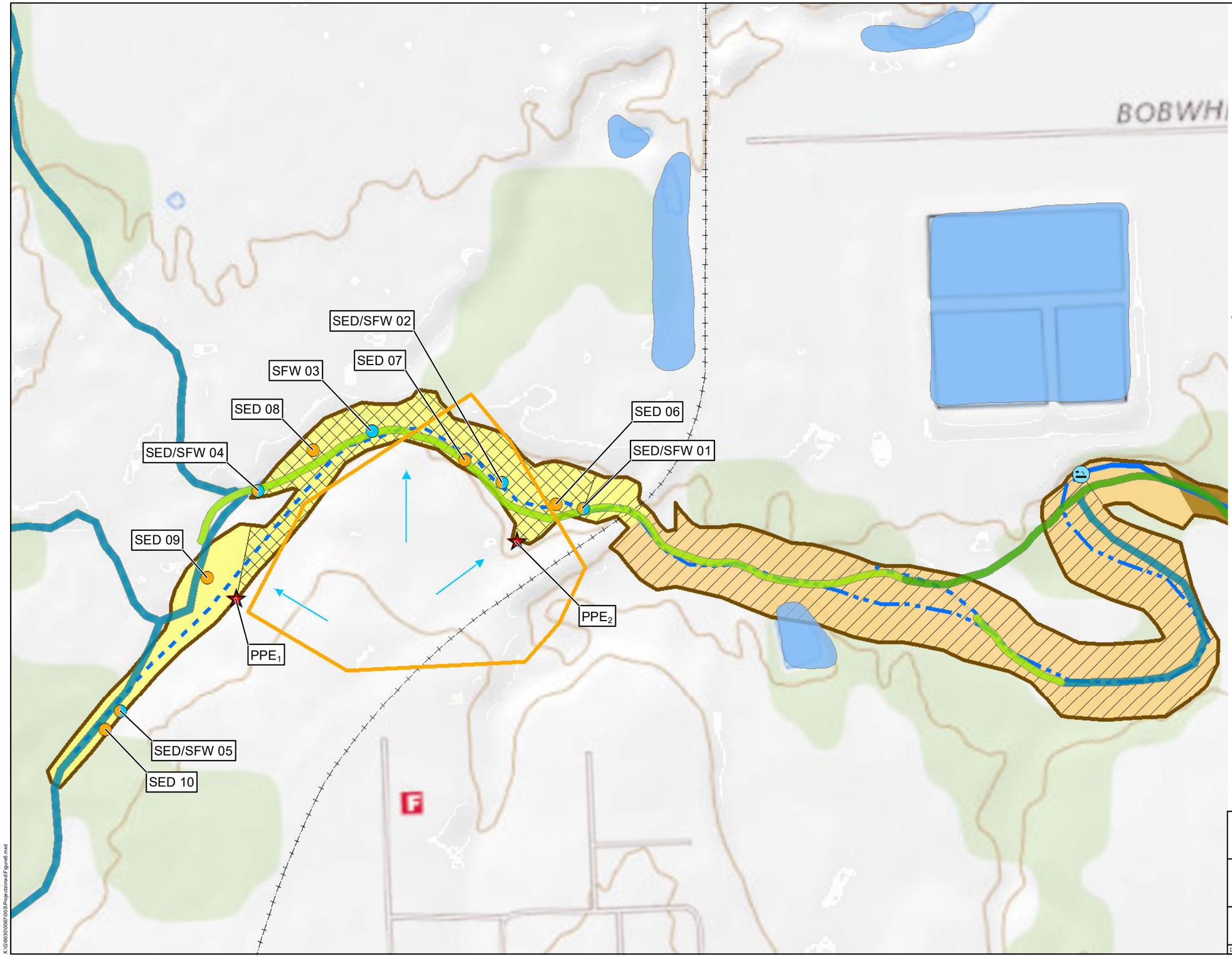
Notes:
µg/L micrograms per liter
CCC Criteria continuous concentration

Most Distant Level I Sample

Sample ID: SFW 01, laboratory sample number 6038643034
Distance from the probable point of entry: About 1,330 feet (0.25 mile) downstream of PPE_1
Reference: 8, p. 51; Figure 4

Most Distant Level II Sample

Sample ID: SED 01, laboratory sample number 6038643007
Distance from the probable point of entry: About 1,330 feet (0.25 mile) downstream of PPE_1
Reference: 8, p. 51; Figure 4



Legend

- Probable point of entry (PPE)
- Sediment and surafce water sample location
- Sediment sample location
- Surface water sample location
- Waste water treatment pond outfall
- Ephemeral stream
- Former railroad right-of-way
- Intermittent stream
- Overland flow direction
- Perennial stream
- Approximate Source 1 area
- Emergent wetland area
- Forested emergent wetland area
- Forested wetland area

Wetland (National Wetland Inventory)

- Freshwater emergent wetland
- Freshwater forested/shrub wetland
- Freshwater pond
- Riverine
- Zone of actual contamination (Level 1) Perimeter = 2,956 feet
- Zone of potential contamination Periemter = 5,216 feet

N

0 125 250

Feet

Source: USGS Cherokee, Kansas 7.5 Minute Topo Quad, 2018 (Ref 4, Sheet 1); Refs. 8, p. 51; 20; pp 1 - 6; 33, p. 39

Cherokee Zinc - Weir Smelter
Weir, Kansas

Figure 5
Sensitive Environments

TETRA TECH

Date: 8/11/2020 Drawn By: Clayton Hayes Project No: 103X903019F0067

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4.1.4.3.1 Sensitive Environments

4.1.4.3.1.1. Level I Concentrations

Level I Sensitive Environment Targets

No sensitive environments are known to exist in the zone of actual contamination.

Sum of Level I Sensitive Environments Value: 0

Level I Wetland Frontages

A zone of Level I contamination has been documented in the Emergent wetlands directly north of Source 1. The zone is defined by surface water samples SFW-04, SFW-03, SFW-02 and SFW-01 as described above. The approximate perimeter of this zone is 2,956 linear feet or 0.56 mile. This perimeter was determined using GIS techniques (Figure 5 of this HRS documentation record).

Table 18: Environmental Threat Level I Wetland Frontage

Wetland	Wetland Frontage (miles)	References
Wetland 1 PEM1C Emergent Wetland	0.56 mile	20, pp 1, 2; 33, p. 39, Figure 5

Sum of Level I Wetland Frontages: 0.56 mile, represents the perimeter of the wetland from PPE_1 to SFW-01
Wetlands Value (Ref. 1, Table 4-24): 25

Sum of Level I Sensitive Environments Value + Wetlands Value: 25
(Sum of Level Sensitive Environments Value + Wetlands Value) x 10 (Ref. 1, Section 4.1.4.3.1.1): 250

Level I Concentrations Factor Value: 250

4.1.4.3.1.2. Level II Concentrations

Level II Sensitive Environment Targets

No other samples downstream of SFW-01 have been evaluated to establish any other zone of actual contamination.

Level II Concentrations Factor Value: Not Scored

4.1.4.3.1.3 Potential Contamination

Potential Sensitive Environment Targets

None identified.

Potential Wetland Frontages

The table below presents wetland located on the unnamed intermittent Creek which flows toward Brush Creek. Flow rate of this creek is unknown. However, the flow rate of Brush Creek averages 17.08 cubic feet per second (cfs) (Ref. 24, p. 1). The location of the former USGS gaging station is presented on Reference 4, Sheet 2. Because this unnamed tributary is both intermittently flowing and perennially flowing downstream of the wastewater treatment facility outfall, it is assumed the flow rate is less than 10 cfs. The perimeter of the wetland from SFW-01 to the point where the unnamed tributary becomes perennial was measured (Figure 5 of this HRS documentation record). Downstream of this point, wetland frontage along the creek was measured.

Table 19: Environmental Threat Potential Wetland Frontages

Type of Surface Water Body	**Wetland Frontage (miles)**	**References**	**Wetlands Value (Ref. 1, Table 4-24)**
Wetland contiguous to perennially flowing water. The perimeter of the wetland from SFW-01 to the water treatment outfall where the intermittent creek becomes perennial.	Combination of emergent wetland and forested emergent wetland. NWI maps classify this as PEM1A, PEM1C, and part of PSSA **(0.99 mile)**	20, pp. 1-4; 8-10; 33, p.39, Figure 5	This perimeter measures 5,216 linear feet or 0.99 mile. Wetlands value of 25
Minimal Stream. Perennially flowing unnamed tributary to Brush Creek from water treatment outfall to Brush Creek	Part of wetland 3 PSSA; 0.13 Wetland 4 PFOA; 0.19 Wetland 5 PEM1C; 0.92 Wetland 6 PFOA; 0.89 Total (2.13 miles)	20, pp. 1, 4-7, 10-13; 33, p.39, Figure 4	When considering both sides of the channel, a total of 4.26 miles of wetland frontage are scored for a wetland value of 150
			Total Value: 175

Table 20: Environmental Threat Potential Targets

Type of Surface Water Body	**Sum of Sensitive Environments Values (S_j)**	**Wetland Frontage Value (W_j)**	**Dilution Weight (D_j) (Ref. 1, Table 4-13)**	**$D_j(W_j + S_j)$**
Minimal Stream	0	175	1	175

Sum of $D_j(W_j + S_j)$: 175
(Sum of $D_j(W_j + S_j)$)/10 (Ref. 1, Section 4.1.4.3.1.3): 17.5

Potential Contamination Factor Value: 17.5

5.0 SOIL EXPOSURE

5.0.1 GENERAL CONSIDERATIONS

The Cherokee Zinc - Weir Smelter site consists of an area of cadmium, and lead-contaminated surface soils meeting observed contamination criteria on residential properties throughout the town of Weir, Kansas (see Tables 23 and 24 and Figure 6 of this HRS documentation record). The area of observed contamination (AOC A) came to be, at least in part, by historical operations at the Cherokee Zinc - Weir Smelter (Ref. 32, p. 12). Historically, the smelting process involved heating crushed ore (zinc sulfide [ZnS] also known as sphalerite or blackjack) in kilns for a period of time to oxidize the ore and drive off the sulfur (Ref. 28, pp. 3, 4). The roasted ore would be mixed with coke coal and loaded into clay cylinders called retorts where the mixture was superheated to 1975 degrees centigrade and the zinc would vaporize and move to a condenser to cool to liquid zinc (Ref. 28, p. 4). The smelting process generated a large amount of pollution including sulfur and nitrogen oxides and a large amount of soot (Ref. 28, p. 5). The soot was typically contaminated with lead, cadmium, arsenic, and zinc (Ref. 28, p. 5).

The Cherokee Zinc Co smelter had one or more stacks ranging from 10 to 70 feet tall associated with roasting furnaces and kilns (Refs. 9, 10). During operations, lead particles and other heavy metal particles associated with the smelter's operations became airborne and settled onto surrounding properties (Ref. 28, p. 5). Wind likely would have transported and deposited soot from the smelter stacks to the surrounding area. Predominant wind direction at the nearest airports in Pittsburg, Kansas and Joplin, Missouri is from the south or south southwest however during winter months, winds tend to also blow from the north (Ref. 22).

Letter by which this area is to be identified: A

Name of area: Contaminated Residential Yards

Location and description of area (with reference to a map of the site):

As shown on Figure 6 of this HRS documentation record AOC A includes a multitude of residential property in town of Weir, Kansas. The area to the north of the city was not sampled extensively because the focus was on residential properties. The area is bounded by samples analyzed by a fixed laboratory meeting the observed contamination criteria of three times or more above the background concentrations for cadmium or lead (Ref. 1, Table 2-3).

Reverse Inset
Scale: 1" = 7,000'

Background 1
Background 2
Background 3
Weir

SS-31
SS-24
SS-23

Bobwhite Dr
30th St
Turt Ave
W Forest St
W Main St
E Main St
Pine St
E Pine St
Oak St
W Sycamore St
Olive St
W Catalpa St
E Catalpa St
NE 30th St
Humbert St
S High St
Dreher Ave
Polk St
Lincoln St
Garfield St
S McKinley St
S Madison St

Legend

- 2004 Surface soil sample location
- Background sample location
- Area of observed contamination (12,522,328 sq. ft. or 287.5 acres)
- Approximate source area
- Property boundary (remediated)
- Property boundary (background)
- Property boundary (contaminated fixed laboratory)
- Property boundary (contaminated XRF)
- Property boundary (sampled)

Sq. Ft. Square feet
XRF X-ray fluorescence

N

0 475 950
Feet

Source: The source of this map image is Esri, used by the EPA with Esri's permission.

Cherokee Zinc - Weir Smelter
Weir, Kansas

Figure 6
Property Locations Map

TETRA TECH

Date: 8/20/2020 Drawn By: Clayton Hayes Project No: 103X903019F0093.000

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Lead contamination of residential yards at the site is reasonably assumed to be a result of local smelting operations that date back to about a century ago. The former Cherokee Zinc Co smelter had numerous chimneys and stacks ranging from 10 to 70-foot-tall (Refs. 9, 10, 11). The former smelter was on the northern side of the current developed area in the city; reported wind directions were generally from the south and southwest with a larger northern component in the winter months (Refs. 10; 22, pp. 1-4). The smelting process in Kansas generated a large amount of soot, which was generally contaminated with elevated levels of arsenic, lead, cadmium, and zinc (Ref. 28, p. 5). Over time, lead particles in the soot from those smelters and related operations likely became airborne and settled onto area properties.

This area of observed contamination includes sampling locations with observed contamination from the former smelter and the area lying between those locations, unless available information, such as analytical data, or field screening data, indicates otherwise (Ref. 1, Section 5.0.1). The inference of contaminated properties is supported by data (samples) collected from residential properties and analyzed by XRF spectrometer via EPA SW-846 Method 6200 (Tables 25 and 26 and Ref. 29) as described below. The primary analyte of concern at the site driving removal program decisions is lead, and XRF data was reported only for lead. During the removal assessment (RA), samples collected and submitted to the EPA Region 7 laboratory were analyzed for RCRA metals, excluding mercury (arsenic, barium, cadmium, chromium, lead, selenium, and silver) by inductively coupled plasma atomic emission spectroscopy (ICP-AES) (Refs. 12, pp. 15, 16; 13, pp. 13, 80, 81). All samples collected as part of the RA have followed the procedures specified by the site-specific Quality Assurance Project Plan (QAPP) except a deviation in the number of aliquots for on-site soil samples (Ref. 13, p. 27). EPA initiated a removal action 2018 (Ref. 14, p. 5). Two activities conducted under the removal action were oversight of the removal of lead contaminated properties and initial sampling of additional yards not previously sampled (Ref. 14, p. 5). For the removal action property screening activity, all samples were analyzed in the field by XRF screening in accordance with method 6200 and a subset of the samples were analyzed by the EPA Region 7 laboratory for lead only by ICP-AES methods (Refs. 14, pp. 14, 15, 18; 19, pp. 18, 344, 346, 352, 355, 379, 381).

A signed access agreement from each property owner was obtained prior to initiation of sampling activities (Ref. 17). After receiving access permission from the property owner, the property was divided into distinct areas or cells for screening purposes. While the maximum size of a cell is ideally 100 by 100 feet, actual sizes of cells were determined in the field based on site features during pre-removal sampling (Ref.19, p. 13). A cell extended from the circumference defined by the outer edge of the drip zone around the building or house in all directions 100 feet or to the property line (or inner edge of the road easement, as applicable), whichever distance is shorter.

Additional areas intended to be screened outside of the cells included: the drip zone; fine-grained material if used for driveways, sidewalks, or under carports; road easements; vegetable gardens; and children's play areas (Refs. 14, pp. 14, 15). "Cells" (numbered in Table 1 and discussions below) were generally yards (i.e., of conditions not meeting the additional specialized area descriptions, such as play areas or gardens). Not all residential properties contained all features, and properties typically had between two and five cells (e.g., C-1 through C-5). It should be noted that the drip zone and road easement screening and samples were not used to establish background and will not be used below to establish observed contamination at the properties. A composite sample consisting of nine aliquots, each from 0 to 1 inch bgs (to get below the root zone), was collected in each cell/area, and placed in a labeled, sealed plastic bag (Refs. 14, p. 15; 19, p. 13).

All soil and gravel samples were transported back to a sample preparation facility with their corresponding screening forms (Ref. 19, p. 13). At the sample preparation facility, each sample was transferred to a clean, dedicated aluminum pie pan or paper tray (Ref. 19, p. 13). Because moisture content of a soil or gravel sample can adversely affect accuracy of XRF spectrometer readings for lead, the samples were allowed to completely air dry(Ref. 19, p. 13). Once dried, pre-removal samples were homogenized, passed through a number 10 sieve (2-millimeter), and then screened for lead by use of an XRF spectrometer (Ref. 19, p. 13). XRF screening of soils followed EPA Method 6200 (Ref. 14, p. 18). Three separate XRF readings were taken from each sample, and then the average of the three readings was calculated and recorded on the screening form (Refs. 14, pp. 15, 18; 19). The following codes were used when referring to a sample's location (Ref. 14, pp. 12, 13):

C	Cell	LS	Landscape
DW	Driveway	DZ	Drip zone
G	Garden	RE	Road easement
PA	Play Area		

In 2008, three background soil samples were collected in areas upwind from the smelter site (Ref. 8, pp. 12, 40). Two of the three samples were collected on the Cherokee Kansas Southeast High School property (approximately 3 miles northeast of the site and the third sample was collected at the former Scammon school site (approximately 2 miles west of Weir (Ref. 8 pp. 12, 40). Samples were analyzed for RCRA metals plus zinc by EPA method 6010/7471 (Ref. 8, pp. 75, 102-104). Background samples from the removal assessment included properties 18 and 20. Property 20 is a daycare located approximately 1.15 mile northwest of the former smelter and property 18 is an elementary school located approximately 0.8 mile southwest of the former smelter (Refs. 13, pp. 25, 26, 35, 69, 71, 115, 117; 19 pp. 47, 49).

- Background Concentrations:

The table below presents the locations of the background samples collected in 2008 and 2015.

Table 21: Background Fixed Laboratory Samples

Sample Identification	Property Number and Cell/ Area ID	Sample Medium	Depth inches	Date	References
Background 1 6038643027	Southeast High school	Soil	Not specified	4/12/08	8, pp. 12, 40, 72, 142, 149
Background 2 6038643028	Southeast High school	Soil	Not specified	4/12/08	8, pp. 12, 40, 72, 142, 149
Background 3 6038643029	Scammon School	Soil	Not specified	4/12/08	8, pp. 12, 40, 72, 142, 140
6821-19	18-B	Soil	0-2	06/01/15	12, p. 15; 13, pp. 35, 40, 80, 94, 115
6821-21	20-D	Soil	0-2	06/03/15	12, p. 15; 13, pp. 35, 43 80, 94, 117

The table below presents the analytical results for the background soil samples collected in 2008 and 2015.

Table 22: Analytical Results for Background Soil Samples

Sample Identification	Hazardous Substance	Concentration (mg/kg)	Reporting Limit* (mg/kg)	References
Background 1 6038643027	Cadmium Lead	ND 27.3	1.3 1.3	8, pp. 40, 102, 142, 149
Background 2 6038643028	Cadmium Lead	ND 27.4	1.3 1.3	8, pp. 40, 103, 142, 149
Background 3 6038643029	Cadmium Lead	1.2 35.2	1.2 1.2	8, pp. 40, 104, 142, 149
6821-19	Lead Cadmium	49.1 0.99	0.85 0.42	13, pp. 35, 40, 80, 87, 94; 18, p. 5
6821-21	Lead Cadmium	58.3 1.3	0.72 0.36	13, pp. 35, 43, 80, 88, 94; 18, p. 5

During the SI in 2008, the background soil samples were not analyzed using the XRF (Ref. 8, p. 12). During the 2015 removal assessment, properties 18 and 20 were analyzed in the field with the XRF. The highest XRF lead reading from property 18 was 46.28 mg/kg and from property 20 the highest XRF lead reading was 72.95 mg/kg (Ref. 13, pp. 25, 26, 69, 71). Other residences sampled in 2018 and 2019 which were only assessed using XRF and would be representative of background include properties 113 and 139 located east and west of the former smelter (see Figure 6 of this documentation record). Of the cells sampled at property 113, the highest concentration of lead detected was 36 mg/kg (Ref. 19, p. 142). Of the cells sampled at property 139, the highest concentration of lead detected was 46 mg/kg (Ref. 19, p. 168). Three times the highest lead reading of all these samples is 218.85 mg/kg.

Of the background samples identified in Table 22 above, the highest cadmium, and lead concentrations reported by a fixed laboratory were 1.3 mg/kg for cadmium (from property 20 [sample 6821-21]), and 58.3 mg/kg for lead (from property 20 [sample 6821-21]). Three times these highest concentrations are 3.9 mg/kg for cadmium, and 174.9 mg/kg for lead. These concentrations will be used to establish observed contamination for all samples analyzed by the fixed laboratory.

- Contaminated Samples

Contaminated sample locations are shown on Figure 6 of this HRS documentation record. The cells from which the samples were collected can be found in the XRF screening maps (Ref. 19). The samples in Tables 23 and 24 below contain lead or cadmium at concentrations establishing actual contamination. Note that zinc was not analyzed for during the 2015 removal assessment or the 2018-2019 removal action.

Area Letter: A

Table 23: Observed Contamination Fixed Laboratory Samples

Sample Identification	Property Number and Cell/ Area ID	Sample Medium	Depth (inches)	Date	References
6821-20	1-D	Soil	0-2	06/02/15	12, pp. 5, 8, 15; 13, pp. 41, 80, 94, 116
6821-24	5-B	Soil	0-2	06/02/15	12, pp. 5, 8, 15; 13, pp. 41, 80, 94, 120
6821-25	6-A	Soil	0-2	06/02/15	12, pp. 5, 8, 15; 13, pp. 41, 80, 95, 121
6821-16	11-A	Soil	0-2	06/01/15	12, pp. 5, 8, 15; 13, pp. 40, 80, 94, 112
6821-3	16-B	Soil	0-2	06/01/15	12, pp. 5, 8, 15; 13, pp. 80, 94, 99
8004-1	23, C1	Soil	0-1	09/17/18	14, pp. 14, 15; 19, pp. 52, 265, 337, 345
8004-2	23, C3	Soil	0-1	09/17/18	14, pp. 14, 15; 19, pp. 52, 266, 337, 345
8004-3	24, C1	Soil	0-1	09/17/18	14, pp. 14, 15; 19, pp. 53, 267, 337, 345
8004-4	24, DW	Soil	0-1	09/17/18	14, pp. 14, 15; 19, pp. 53, 268, 337, 345
8004-5	25, C1	Soil	0-1	09/17/18	14, pp. 14, 15; 19, pp. 54, 269, 337, 345
8004-6	25, C2	Soil	0-1	09/17/18	14, pp. 14, 15; 19, pp. 54, 270, 337, 345
8004-8	27, C4	Soil	0-1	09/17/18	14, pp. 14, 15; 19, pp. 56, 272, 337, 345
8004-11	29, C2	Soil	0-1	09/27/18	14, pp. 14, 15; 19, pp. 58, 275, 337, 345

Table 23: Observed Contamination Fixed Laboratory Samples

Sample Identification	Property Number and Cell/ Area ID	Sample Medium	Depth (inches)	Date	References
8350-3	109, C2	Soil	0-1	08/01/19	14, pp. 14, 15; 19, pp. 138, 280, 338, 353
8350-5	111, C1	Soil	0-1	08/01/19	14, pp. 14, 15; 19, pp. 140, 282, 338, 353
8350-6	112, C2	Soil	0-1	08/01/19	14, pp. 14, 15; 19, pp. 141, 283, 338, 353
8350-15	117, C1	Soil	0-1	08/01/19	14, pp. 14, 15; 19, pp. 146, 292, 338, 353
8350-17	119, C4	Soil	0-1	08/01/19	14, pp. 14, 15; 19, pp. 148, 294, 338, 353
8350-19	120, C1	Soil	0-1	08/01/19	14, pp. 14, 15; 19, pp. 149, 296, 338, 353
8350-23	123, C2	Soil	0-1	08/01/19	14, pp. 14, 15; 19, pp. 152, 300, 338, 353
8350-29	128, C2	Soil	0-1	08/02/19	14, pp. 14, 15; 19, pp. 157, 306, 339, 353
8350-31	130, G	Soil	0-1	08/02/19	14, pp. 14, 15; 19, pp. 159, 308, 339, 353
8350-37	134, C2	Soil	0-1	08/02/19	14, pp. 14, 15; 19, pp. 163, 314, 339, 353
8350-41	138, C1	Soil	0-1	08/02/19	14, pp. 14, 15; 19, pp. 167, 318, 339, 353
8350-48	144, C3	Soil	0-1	08/02/19	14, pp. 14, 15; 19, pp. 173, 325, 339, 354
8446-2	147, C3	Soil	0-1	11/13/19	14, pp. 14, 15; 19, pp. 176, 327, 341, 380

Table 24: Analytical Results for Fixed Laboratory Observed Contamination Samples

Sample Identification	Hazardous Substance	Concentration (mg/kg)	Reporting Limit* (mg/kg)	References
6821-20	Lead Cadmium	609 28.2	0.73 0.36	18, p. 5
6821-24	Lead Cadmium	432 4.6	0.73 0.37	18, p. 6

Table 24: Analytical Results for Fixed Laboratory Observed Contamination Samples

Sample Identification	Hazardous Substance	Concentration (mg/kg)	Reporting Limit* (mg/kg)	References
6821-25	Lead Cadmium	280 5.6	0.78 0.039	18, p. 6
6821-16	Lead Cadmium	426 6.3	0.87 0.43	18, pp. 4, 5
6821-3	Lead Cadmium	521 9.6	0.85 0.43	13, pp. 80, 81, 83; 18, pp. 2, 3
8004-1	Lead	320	5.0	18, p. 11; 19, pp. 345, 347
8004-2	Lead	269	5.0	18, p. 11; 19, pp. 345, 347
8004-3	Lead	236	5.0	18, p. 11; 19, pp. 345, 347
8004-4	Lead	248	5.0	18, p. 11; 19, pp. 345, 347
8004-5	Lead	375	5.0	18, p. 11; 19, pp. 345, 348
8004-6	Lead	307	5.0	18, p. 11; 19, pp. 345, 348
8004-8	Lead	314	5.0	18, p. 12; 19, pp. 345, 348
8004-11	Lead	263	5.0	18, p. 12; 19, pp. 345, 349
8004-12	Lead	365	5.0	18, p. 12; 19, pp. 345, 349
8350-3	Lead	528	5.1	18, p. 13; 19, pp. 353, 356
8350-5	Lead	463	5.2	18, p. 13; 19, pp. 353, 357
8350-6	Lead	300	5.1	18, p. 13; 19, pp. 353, 357
8350-15	Lead	393	5.0	18, p. 14; 19, pp. 353, 359
8350-17	Lead	257	5.0	18, p. 15; 19, pp. 353, 360
8350-19	Lead	224	5.0	18, p. 15; 19, pp. 353, 360
8350-23	Lead	1,170	5.0	18, p. 15; 19, pp. 353, 361
8350-29	Lead	294	5.1	18, p. 16; 19, pp. 353, 363
8350-31	Lead	292	5.1	18, p. 16; 19, pp. 353, 363

Table 24: Analytical Results for Fixed Laboratory Observed Contamination Samples

Sample Identification	Hazardous Substance	Concentration (mg/kg)	Reporting Limit* (mg/kg)	References
8350-37	Lead	323	5.1	18, p. 17; 19, pp. 353, 365
8350-41	Lead	318	5.0	18, p. 17; 19, pp. 353, 366
8350-48	Lead	418	5.0	18, p. 18; 19, pp. 354, 367
8446-2	Lead	416	NR	19, pp. 380, 382

Notes:
* The reporting limit in this table takes into account any dilution factor, volume adjustment, and percent solids for the sample and is sometimes called the sample quantitation limit or SQL (Ref. 18, pp. 2, 11, 13).
mg/kg milligrams per kilogram
NR Not reported

Table 25: Properties Sampled in 2015 by XRF Used to Infer Contamination in AOC A

Property ID	XRF Lead Measurement (in ppm) and Sample Location							Reference
	A	B	C	D	E	F	G	
1	234.3			590.15				13, pp. 23, 35; 19, p. 30
2	274.91	245.91		263.15	258.5			13, pp. 23, 35; 19, p. 31
3 (also Property CZC-136)	278.61	240.06						13, pp. 23, 35; 19, p. 32, 165
4	221.58	501.28						13, pp. 23, 35; 19, p. 33
5	524.83	440.4	433.23			262.69		13, pp. 23, 35; 19, p. 34
6	310.13		312.27	331.66				13, pp. 24, 35; 19, p. 35
7	577.87	539.06						13, pp. 24, 35; 19, p. 36
8	813.11							13, pp. 24, 35; 19, p. 37
9	**417.29**		**484.31**	348.38				13, pp. 24, 35; 19, pp. 38, 178
10	242.63	377.49	246.07					13, pp. 24, 35; 19, p. 39
11	384.83	306.38	226.93					13, pp. 24, 35; 19, p. 40
13			311.13	**625.64**	**775.29**	**803.08**		13, pp. 25, 35; 19, pp. 42, 180
14	228.77	290.58	226.25	**436.8**				13, pp. 25, 35; 19, pp. 43, 181
16		451.1						13, pp. 25, 35; 19, p. 45
17				416.03				13, pp. 25, 35; 19, p. 46
22	332.4	309.35		258.8				13, pp. 26, 35; 19, p. 51

Notes:
Bolded numbers indicate the cell was removed (Ref. 19, pp. 16, 178-192)

Table 26: Properties Sampled by XRF in 2018 and 2019 Used to Infer Contamination in AOC A

Property ID	XRF Lead Measurement (in ppm) and Sample Location									Reference
	C1	C2	C3	C4	C5	DW	GA	PA	LS	
CZC-23	292		309			222				19, p. 52
CZC-24	226					265				19, p. 53
CZC-25	394	329				471				19, p. 54
CZC-27	238			286						19, p. 56
CZC-29	**418**	235	**387**	**359**					**1,472**	19, pp. 58, 185
CZC-30	384.	298								19, p. 59
CZC-31	667	298	368							19, p. 60
CZC-32		790	957							19, p. 61
CZC-33	389			223		300				19, p. 62
CZC-34	**423**	**635**	**405**	295						19, pp. 63, 186
CZC-35	558	395	708	600	483					19, p. 64
CZC-37	**993**	377	341	**1,304**						19, p. 27, 66, 188
CZC-38	455	434	457	432	502	821				19, p. 67
CZC-39	245	252								19, p. 68
CZC-41	695	482				503				19, p. 70
CZC-42	280	320	760	992						19, p. 71
CZC-44		258	253							19, p. 73
CZC-45		463	318			246				19, p. 74
CZC-47	384	397				517				19, p. 76
CZC-48	223	279	351							19, p. 77
CZC-49	335	300								19, p. 78
CZC-50	485	375								19, p. 79
CZC-51	576	432	436							19, p. 80
CZC-54		252								19, p. 83
CZC-60	251									19, p. 89
CZC-63	387	410	508				700			19, p. 92
CZC-64	269	441	878							19, p. 93
CZC-65		314				338				19, p. 94
CZC-66	348	304	297			426				19, p. 95
CZC-67	430	571	339							19, p. 96
CZC-68	370									19, p. 97
CZC-69	308	**435**								19, p. 98, 190
CZC-72				260						19, p. 101
CZC-74	438	236	389							19, p. 103
CZC-77	436	484	317							19, p. 106
CZC-78	252	944	741			391				19, p. 107
CZC-86	**426**	229	312							19, p. 115, 192
CZC-88	885	341	434			297				19, p. 117
CZC-89	435									19, p. 118
CZC-95	272					353				19, p. 124
CZC-98	384	372								19, p. 127

Table 26: Properties Sampled by XRF in 2018 and 2019 Used to Infer Contamination in AOC A

Property ID	XRF Lead Measurement (in ppm) and Sample Location									Reference
	C1	C2	C3	C4	C5	DW	GA	PA	LS	
CZC-100	490	525	454	486	280	254				19, p. 129
CZC-101	428	401								19, p. 130
CZC-102	224					349				19, p. 131
CZC-104	229	231				355				19, p. 133
CZC-106	442	503								19, p. 135
CZC-108	305									19, p. 137
CZC-109	298	633								19, p. 138
CZC-111	468	374								19, p. 140
CZC-112		365	250			235				19, p. 141
CZC-117		360								19, p. 146
CZC-119	272			257						19, p. 148
CZC-120	244	232		327						19, p. 149
CZC-121	321	532						351		19, p. 150
CZC-123	834									19, p. 152
CZC-124		238								19, p. 153
CZC-128	234	355						519		19, p. 157
CZC-129	220	235				441				19, p. 158
CZC-130	308		249							19, p. 159
CZC-134	277	476				374				19, p. 163
CZC-135		1,072								19, p. 164
CZC-136 (also Property ID 3)	332	452	256			350				19, pp. 32, 165
CZC-137			3,202			280				19, p. 166
CZC-138	399					317				19, p. 167
CZC-141	745		254							19, p. 170
CZC-142		228								19, p. 171
CZC-143	665	232	243							19, p. 172
CZC-144		243	588					317		19, p. 173
CZC-147	266	225	409							19, p. 176

Notes:
Bolded numbers indicate the cell was removed (Ref. 19, pp. 16, 178-192)

C	cell	NR	Not reported
DW	Driveway	PA	Play area
GA	Garden area	XRF	X-ray fluorescence spectrometer
LS	Landscape feature	ppm	Parts per million

ATTRIBUTION

The Cherokee Zinc - Weir Smelter area of observed contamination (AOC A) consists of lead-, and cadmium-contaminated soil due, at least in part, to releases from a former zinc smelter that operated in Weir, Kansas. As explained below, lead, and cadmium contamination in residential soils likely came from both air deposition from smelter stacks and possibly from direct deposition of smelter wastes used for driveway paving, construction backfill and landscape material.

Historically, the smelting process involved heating crushed ore (zinc sulfide [ZnS] also known as sphalerite or blackjack) in kilns for a period of time to oxidize the ore and drive off the sulfur (Ref. 28, pp. 3, 4). The roasted ore would be mixed with coke coal and loaded into clay cylinders called retorts where the mixture was superheated to 1975 degrees centigrade and the zinc would vaporize and move to a condenser to cool to liquid zinc (Ref. 28, p. 4). The smelting process generated a large amount of pollution including sulfur and nitrogen oxides and a large amount of soot. The soot was typically contaminated with lead, cadmium, arsenic, and zinc (Ref. 28, p. 5).

The Cherokee Zinc Co smelter had one or more stacks over ranging from 10 to 70 feet tall associated with roasting furnaces and kilns (Refs. 9, 10). During operations, wind likely would have transported and deposited soot from the smelter stacks to the surrounding area. Predominant wind direction at the nearest airports in Pittsburg, Kansas and Joplin, Missouri is from the south or south southwest (Ref. 22).

In addition to the airborne pollution, the smelting operations left large volumes of solid waste including cinders, broken retorts, building materials, and impure smelter slag (Ref. 28, pp. 5, 6). Since the smelters ceased operation, lead particles and other heavy metal particles associated with the smelter operations may have become airborne and settled onto area properties.

Soils in the source contained lead as high as an average of 10,615 mg/kg (in sample SFS 51), and zinc as high as 26,300 mg/kg (in sample HS-3 SS-2) as measured by XRF (Refs. 7, pp. 24, 25, 26, 40; 8, pp. 32, 212, 213). In samples analyzed by a fixed laboratory, cadmium was reported at a maximum concentration of 60.7 mg/kg (in sample TRENCH I-I′-100′-0.5′), lead was reported at a maximum concentration of 4,140 mg/kg (in sample XRF SFS 22), and zinc was reported at a maximum concentration of 9,560 mg/kg (in sample XRF SFS 22) (Ref. 8, pp. 41, 46, 72, 80, 126, 132).

Area Hazardous Waste Quantity

2.4.2.1.1 Hazardous Constituent Quantity

The total Hazardous Constituent Quantity for AOC A could not be adequately determined according to the HRS requirements; that is, the total mass of all Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substances in the source is not known and cannot be estimated with reasonable confidence [Ref. 1, pp. 51590-51591 (Section 2.4.2.1.1), pp. 51546-51647 (Section 5.1.2.2) and p. 51647 (Table 5-2)]. Because the smelter operated in the late 1800's and early 1900's, insufficient historical and current data (manifests, potentially responsible parties [PRPs] records, State records, permits, waste concentration data, etc.) are available to adequately calculate the total or partial mass of all CERCLA hazardous substances in the source and the associated releases from the source. Therefore, there is insufficient information to calculate a total or partial Hazardous Constituent Quantity estimate for AOC A with reasonable confidence.

Hazardous Constituent Quantity Assigned Value: Not Scored
Hazardous Constituent Quantity Complete? No

2.4.2.1.2 Hazardous Wastestream Quantity

The total Hazardous Wastestream Quantity for AOC A could not be adequately determined according to the HRS requirements; that is, the total mass of all hazardous wastestreams and CERCLA pollutants and contaminants for the source is not known and cannot be estimated with reasonable confidence [Ref. 1, pp. 51591 (Section 2.4.2.1.2) and 51546-51647 (Section 5.1.2.2); 51647 (Table 5-2)]. Insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, annual reports, etc.) are available to adequately calculate the total or partial mass of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and the associated releases from the source. Therefore, there is insufficient information to adequately calculate or extrapolate a total or partial Hazardous Wastestream Quantity for AOC A with reasonable confidence.

Hazardous Wastestream Quantity Assigned Value: Not Scored
Hazardous Wastestream Quantity Complete? No

2.4.2.1.3 Volume

Tier C, Volume, is not scored for AOCs consisting of contaminated soil; therefore, the evaluation of hazardous waste quantity proceeds to the evaluation of Tier D, Area (Ref. 2, Section 5.1.1.2.2, Table 5-2).

Volume Assigned Value: 0

2.4.2.1.4 Area

Description

The boundary of AOC A is defined by samples analyzed by the fixed laboratory using ICP-AES test methods for metals (see Figure 6 and Tables 23 and 24 of this HRS documentation record). The area of AOC A was calculated by geographic information system (GIS) techniques to be 12,522,328 square feet or 287.5 acres (see Figure 6 of this HRS documentation record).

Also within this boundary are approximately 52 additional distinct properties that were only screened using XRF spectrometer analysis. These properties contained one or more cells/areas with lead at or exceeding 219 ppm, which was the value selected to support inference of lead contamination at the property (see Figure 6 and Tables 25, 26, and 29 of this HRS documentation record).

Removal actions, or partial removal actions have occurred at one or more cells/areas within 15 properties in Weir through November 2019. These properties include numbers 9, 12, 13, 14, 15, 21, 26, 29, 34, 36, 37, 43, 69, 79, and 86 (Ref. 19, pp. 16, 178-192). Since the contaminated cells/areas have been removed and replaced with clean fill, those cells/areas should be subtracted from the AOC A area calculation. Other features that should be excluded include paved roadways and sidewalks, buildings or other structures, and cells/areas that were sampled and shown not to be contaminated (Ref. 1, Section 5.0.1).

The approximate areas of roadways, sidewalks, buildings or other structures, cells/areas subject to removal actions, or cells/areas not meeting the observed contamination criteria could not be estimated or measured with reasonable confidence or accuracy to determine a defensible estimate of the area of AOC A. However, this area is certainly greater than 0 square feet.

Sum (ft^2): >0
Equation for Assigning Value (Ref. 1, Table 5-2): Area (A)/34,000

Area Assigned Value: >0

Area Hazardous Waste Quantity Value: >0

5.1 RESIDENT POPULATION THREAT

5.1.1 LIKELIHOOD OF EXPOSURE

Tables 23 through 24 of this HRS documentation record list surface soil samples collected during the removal assessment and removal action and includes 21 residential properties located within AOC A (see also Table 29 of this HRS documentation record). Also within AOC A are approximately 52 additional distinct properties that were only screened using XRF spectrometer analysis. These 52 properties contained one or more cells/areas with lead at or exceeding 219 ppm, which was the value selected to support inference of lead contamination at the properties (see Table 25, 26, and 29 of this HRS documentation record).

The locations of the properties are shown on Figure 6 of this HRS documentation record. All surface soil samples listed in Tables 23 and 24 of this HRS documentation record were collected within the individual property boundaries and are part of AOC A. The locations of the cells/areas sampled in relation to the properties are shown on residential screening forms (Refs. 13, pp. 52, 56-57, 62, 67; 19, pp. 52-54, 56, 58, 138, 140-141, 146, 148-149, 152, 157, 159, 163, 167, 173, 176, 185). Because there are multiple residential properties meeting the observed contamination criteria, a likelihood of exposure factor value of 550 is assigned in accordance with Section 5.1.1 of Reference 1 and Section 5.1.1.1 of Reference 2.

Resident Population Threat Likelihood of
Exposure Factor Category Value: 550

5.1.2 WASTE CHARACTERISTICS

5.1.2.1 Toxicity

The toxicity values for the hazardous substances detected in samples collected in AOC A are summarized in Table 27 below.

Table 27: Soil Exposure Toxicity

Hazardous Substance	Toxicity Factor Value	References
Cadmium	10,000	3, p. 2
Lead	10,000	3, p. 5

Cadmium and lead have the highest toxicity values of 10,000. This value will be assigned and entered on line 2 of Table 5-1.

Toxicity Factor Value: 10,000

5.1.2.2 Hazardous Waste Quantity

Table 28: Hazardous Waste Quantity

Area Letter	Source Type	Area Hazardous Waste Quantity	Area Hazardous Constituent Quantity Complete?
A	Contaminated soil	Undetermined but greater than zero	No

The approximate areas of roadways, sidewalks, buildings, cells/areas subject to removal actions, or cells/areas not meeting the observed contamination criteria could not be estimated or measured with reasonable confidence or accuracy to determine the area of AOC A. The area of AOC A is greater than 0 square feet and, because the hazardous constituent quantity is not adequately determined, per HRS Section 2.4.2.2, the hazardous waste quantity (HWQ) factor value is assigned a default factor value of 10 for the soil exposure component of the soil exposure and subsurface intrusion pathway (Refs. 1, Section 2.4.2.2; 2, Section 2.4.2.2).

Hazardous Waste Quantity Factor Value: 10
(Refs. 1, Sections 2.4.2.2 and 5.1.2.2, Table 2-6 and Table 5-2; 2, Sections 2.4.2.2 and 5.1.1.2.2)

5.1.2.3 Calculation of Waste Characteristics Factor Category Value

Two hazardous substances, cadmium and lead, were evaluated for waste characteristics. Cadmium and lead each have a toxicity factor value of 10,000 (Ref. 3, pp. 2, 5). The waste characteristics factor value category is obtained by multiplying the toxicity and HWQ factor values. Based on this product, a value was assigned in accordance with Reference 1, Table 2-7.

Toxicity Factor Value: 10,000
Hazardous Waste Quantity Factor Value: 10

Toxicity Factor Value x Hazardous Waste Quantity Factor Value: 100,000

Waste Characteristics Factor Category Value: 18
(Refs. 1, Section 5.1.2.3, Table 2-7; 2, Section 5.1.1.2.3, Table 2-7)

5.1.3 TARGETS

Individuals whose residence is both on the property of and within 200 feet of the area of observed contamination are included as resident population threat targets (Refs. 1, Section 5.1.3; 2, Section 5.1.1.3; and Tables 23-26 and Figure 6 of this HRS documentation record).

Level I Concentrations

The hazardous substances associated with the former smelter are lead and cadmium. There are no benchmarks for lead (Ref. 3, p. 6). Cadmium has a non-cancer risk screening concentration of 39.1 mg/kg (Ref. 3, p 3). No soil sample collected from a residential property contained cadmium at concentrations exceeding these benchmarks (see Tables 23 and 24 of this HRS documentation record). Therefore, no level I populations are scored.

Level II Concentrations

Tables 23 and 24 of this HRS documentation record list surface soil samples collected during the removal assessment and removal action and includes numerous residential properties located within AOC A. The locations of the samples from the properties are shown on property screening forms (Refs. 13, pp. 52, 56-57, 62, 67; 19, pp. 52-54, 56, 58, 138, 140-141, 146, 148-149, 152, 157, 159, 163, 167, 173, 176, 185) which show the cells/areas sampled are within 200 feet of the homes. The locations of the properties are shown on Figures 5 of this documentation record. The soil samples contained lead, or cadmium at concentrations three times greater than background concentrations (see Tables 21 - 24 of this documentation record), but below applicable health-based benchmarks (Ref. 3, pp. 3, 6).

5.1.3.1 Resident Individual

Area Letter: A
Level of Contamination (Level I/Level II): II

As presented in Tables 21 through 24, of this HRS documentation record, all samples collected from residential yards meet the criteria for Level II concentrations (Refs. 1, Table 2-3; 2, Table 2-3; 3, pp. 3, 6) (see also Figure 6).

Resident Individual Factor Value: 45
(Refs. 1, Section 5.1.3.1; 2, Section 5.1.1.3.1)

5.1.3.2 Resident Population

5.1.3.2.1 Level I Concentrations

No level I concentrations have been documented.

Level I Concentrations Factor Value: 0

5.1.3.2.2 Level II Concentrations

Level II Samples

The soil samples listed in Tables 23 and 24 of this HRS documentation record were collected during the EPA removal assessment and removal action. (Refs. 13, pp. 2, 23-26; 19, p. 15). All of the samples in the tables meet the criteria for Level II concentrations as summarized in section 5.1.3 of this HRS documentation record (Refs. 1, Table 2-3; 2, Table 2-3; 3, pp. 3, 6; see also Tables 21-24 of this HRS documentation record). Populations associated with the residential yards from which the samples were collected are presented in Table 29 below. Also presented in Table 29 are properties where contamination is inferred. The inference is supported by XRF readings from one or more cells/areas from the property where removal actions have not occurred (see Tables 25 and 26 of this HRS documentation record). Note that unsampled properties in between properties with sample concentrations meeting observed contamination criteria are not included in the scoring, and the population is not calculated for these properties, but those properties and residents would qualify for inclusion based on inference of contamination (Refs. 1, Section 5.0.1; 2, Section 5.1.0). Removal actions have occurred at the site and the population associated with those properties are not considered in the package, if all cells on the property were remediated (Ref. 19, p. 16).

Level II Resident Population Targets

Resident populations were obtained from property access agreement forms (Ref. 17). The number of permanent residents and children under 7 years of age was self-reported by the property owners. On some forms the owner of the property did not report the number of occupants. In other cases, the owner of the property may have indicated the home was a rental property and did not report the number of people in the rental. Occasionally, the access agreement indicated the property was vacant or the home was being renovated or was for sale. In these cases, the property was not included in Table 29 below.

In cases where the access form indicated the property was occupied by a renter or the name of the tenant was identified but the number of tenants was not specified, then the property was assigned a resident population of 2.54, which is the 2018 estimated persons per household in Cherokee County, Kansas (Ref. 21).

Table 23 identifies by Property ID Number the fixed laboratory sample ID numbers and impacted cells/areas. Tables 25and 26 identifies by Property ID Number those impacted cells/areas determined by XRF.

Table 29: Level II population within AOC A based on sampling data

Property Number	Sample Identification	Rationale for Inferring Contamination	Cells/Areas Impacted	Number of Residents	County Multiplier	References
1	6821-20	XRF	A, **D**		2.54	17, pp. 123, 124; 19, p. 30; 21
2		XRF	A, B, D, E		2.54	19, p. 31; 21
3		XRF	A, B	1		17, pp. 26, 27; 19, pp. 32, 165
CZC-136		XRF	C-1, C-2, C-3, DW			
4		XRF	A, B		2.54	17, pp. 123, 124; 19, p. 33; 21
5	6821-24	XRF	**A, B**, C, F		2.54	17, pp. 24, 25; 19, pp. 34, 163, 164; 21
CZC-134	8350-37	XRF	C-1, **C-2**, DW			
CZC-135		XRF	C-2			
6	6821-25	XRF	**A,** C, D		2.54	19, p. 35; 21
7		XRF	A, B		2.54	19, p. 36; 21
10		XRF	A, B, C		2.54	19, p. 39; 21
11	6821-16	XRF	**A**, B, C		2.54	19, p. 40; 21
13		XRF	C	3		17, pp. 179, 180; 19, pp. 42, 180
14		XRF	A, B, C		2.54	19, pp. 43, 181; 21
22		XRF	A, B, D		2.54	19. p. 51; 21
CZC-23	8004-1 8004-2	XRF	**C-1, C-3,** DW		2.54	19, p. 52; 21
CZC-24	8004-3 8004-4	XRF	**C-1**, **DW**		2.54	19, p. 53; 21
CZC-25	8004-5 8004-6	XRF	**C-1, C-2**, DW		2.54	19, p. 54; 21
CZC-27	8004-8	XRF	C-1, **C-4**		2.54	19, p. 56; 21

Table 29: Level II population within AOC A based on sampling data

Property Number	Sample Identification	Rationale for Inferring Contamination	Cells/Areas Impacted	Number of Residents	County Multiplier	References
CZC-29	8004-11	XRF	**C-2**		2.54	19, pp. 58, 185: 21
CZC-30		XRF	C-1, C-2	4		17, pp. 193, 194; 19, p. 59
CZC-31		XRF	C-1, C-2, C-3	2		17, pp. 197, 198; 19, p. 60, 62
CZC-32		XRF	C-2, C-3			
CZC-33		XRF	C-1, C-4, DW	2		17, pp. 125, 126; 19, p. 62
CZC-34		XRF	C-4	2		17, pp. 181, 182; 19, pp. 63, 186
CZC-37		XRF	C-2, C-3	3		17, pp. 185, 186; 19, pp. 66, 188
CZC-38		XRF	C-1, C-2, C-3, C-4, C-5, DW		2.54	19, p. 67; 21
CZC-39		XRF	C-1, C-2		2.54	19, p. 68; 21
CZC-41		XRF	C-1, C-2, DW	4		17, pp. 165, 166; 19, p. 70
CZC-42		XRF	C-1, C-2, C-3, C-4	5		17, pp. 137, 138; 19, p. 71
CZC-44		XRF	C-2, C-3	2		17, pp. 189, 190; 19, p. 73
CZC-45		XRF	C-2, C-3, DW		2.54	19, p. 74; 21
CZC-47		XRF	C-1, C-2, DW	2		17, pp. 161, 162; 19, pp. 76, 77
CZC-48		XRF	C-1, C-2, C-3			
CZC-54		XRF	C-2	2		17, pp. 118, 119; 19, p. 83
CZC-60		XRF	C-1	1		17, pp. 171, 172; 19, p. 89
CZC-63		XRF	C-1, C-2, C-3, GA	2		17, pp. 159, 160; 19, p. 92
CZC-64		XRF	C-1, C-2, C-3	1		17, pp. 155, 156; 19, p. 93
CZC-65		XRF	C-2, DW	3		17, pp. 149, 150; 19, p. 94
CZC-66		XRF	C-1, C-2, C-3, DW	3		17, pp. 151, 152; 19, p. 95

Table 29: Level II population within AOC A based on sampling data

Property Number	Sample Identification	Rationale for Inferring Contamination	Cells/Areas Impacted	Number of Residents	County Multiplier	References
CZC-67		XRF	C-1, C-2, C-3	2		17, pp. 18, 19; 19, p. 96
CZC-69		XRF	C-1	2		17, pp. 145, 146; 19, p. 98, 190
CZC-72		XRF	C-4	2		17, pp. 127, 128; 19, p. 101
CZC-74		XRF	C-1, C-2, C-3	1		17, pp. 129, 130; 19, p. 103
CZC-77		XRF	C-1, C-2, C-3	4		17, pp. 102, 103; 19, p. 106
CZC-78		XRF	C-1, C-2, C-3, DW	2		17, pp. 96, 97; 19, p. 107
CZC-86		XRF	C-2, C-3	3		17, pp. 68, 69; 19, p. 115, 192
CZC-88		XRF	C-1, C-2, C-3, DW	4		17, pp. 62, 63; 19, p. 117
CZC-89		XRF	C-1	1		17, pp. 114, 115; 19, p. 118
CZC-95		XRF	C-1, DW	1		17, pp. 66, 67; 19, p. 124
CZC-100		XRF	C-1, C-2, C-3, C-4, C-5, DW	4		17, pp. 56, 57; 19, p. 129
CZC-101		XRF	C-1, C-2	8		17, pp. 50, 51; 19, p. 130
CZC-102		XRF	C-1, DW	5		17, pp. 48, 49; 19, p. 131
CZC-104		XRF	C-1, C-2, DW	6		17, pp. 40, 41; 19, p. 133
CZC-106		XRF	C-1, C-2	3		17, pp. 36, 37; 19, p. 135
CZC-117	8350-15	XRF	**C-1,** C-2	1		17, pp. 62, 63; 19, p. 146
CZC-119	8350-17	XRF	C-1, C-3, **C-4**	3		17, pp. 60, 61; 19, p. 148
CZC-120	8350-19	XRF	**C-1**, C-2, C-4	2		17, pp. 58, 59; 19, p. 149

Table 29: Level II population within AOC A based on sampling data

Property Number	Sample Identification	Rationale for Inferring Contamination	Cells/Areas Impacted	Number of Residents	County Multiplier	References
CZC-121		XRF	C-1, C-2, PA	3		17, pp. 50, 51; 19, p. 150
CZC-123	8350-23	XRF	C-1, **C-2**	1		17, pp. 46, 47; 19, p. 152
CZC-124		XRF	C-2	6		17, pp. 16, 17; 19, p. 153
CZC-128	8350-29	XRF	C-1, **C-2**, PA	4		17, pp. 42, 43; 19, p. 157
CZC-129		XRF	C-1, C-2, DW	2		17, pp. 8, 9; 19, p. 158
CZC-130	8350-31	XRF	C-1, C-3, **G**	2		17, pp. 10, 11; 19, p. 159
CZC-137		XRF	C-3, DW	5		17, pp. 32, 33; 19, p. 166
CZC-138	8350-41	XRF	**C-1**, DW	4		17, pp. 36, 37; 19, p. 167
CZC-141		XRF	C-1, C-3	1		17, pp. 36, 37; 19, p. 170
CZC-142		XRF	C-2	3		17, pp. 20, 21; 19, p. 171
CZC-143		XRF	C-1, C-2, C-3	2		17, pp. 22, 23; 19, p. 172
CZC-144	8350-48	XRF	C-2, **C-3**, PA	5		17, pp. 3, 4; 19, p. 173

Notes: Bolded cell indicates the sample submitted for fixed laboratory analysis

C Cell
DW Driveway
GA Garden area
LS Landscape
PA Play area
XRF X-ray fluorescence

The total number of self-reported residents subject to level II concentrations of lead, or cadmium is 134 persons. Eighteen properties were also subject to level II concentrations; however, the number of residents was not provided. The 2018 Cherokee County estimate of 2.54 persons per household (Ref. 21) was used to assign population to these 18 properties to obtain a rental property population of 45.7.

Sum of individuals subject to Level II concentrations: 134 + 45.7= 179.7

Level II Concentrations Factor Value: 179.7
(Refs. 1, Section 5.1.3.2.2; 2, Section 5.1.1.3.2.2)

5.1.3.3 Workers

Sampling has focused on residential properties. No workplaces are known to have been accessed. This factor was not scored.

Workers Factor Value: Not scored
(Ref. 1, Table 5-4; 2, Table 5-4)

5.1.3.4 Resources

No resources such as commercial agriculture, silviculture of livestock production are known to occur within the area of observed contamination. The resource factor was not scored.

Resources Factor Value: Not scored

5.1.3.5 Terrestrial Sensitive Environments

No known terrestrial sensitive environments meeting the definitions presented in Table 5-5 of the HRS rule are known to be present within the area of contamination. The terrestrial sensitive environments factor was not scored.

Terrestrial Sensitive Environments Factor Value: Not scored

5.2 NEARBY POPULATION THREAT

The nearby population threat was not evaluated.