COLORADO DEPARTMENT OF HEALTH

HAZARDOUS MATERIALS AND WASTE MANAGEMENT DIVISION

ANALYTICAL RESULTS REPORT

SANTA FE AVENUE BRIDGE CULVERT

PUEBLO, COLORADO

COD #982572513

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SAMPLE REPORT
SANTA FE AVENUE BRIDGE CULVERT
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1.0 INTRODUCTION

The Hazardous Materials and Waste Management Division (HMWMD) of the Colorado Department of Public Health and Environment (CDPHE) conducted an Expanded Site Investigation (SSI) in the vicinity of the Santa Fe Avenue bridge, the historical smelters and the Arkansas River in Pueblo, Pueblo County, Colorado. This Sample Report for the Santa Fe Avenue bridge culvert has been prepared to evaluate the potential affects to human health and the environment, which may be attributable to the sites. The Expanded Site Investigation was performed under a Cooperative Agreement between the U.S. Environmental Protection Agency Region VIII (EPA) and the Colorado Department of Public Health and Environment (CDPHE). This Sample Report conforms to the requirements set forth in the CDPHE Standard Operating Procedures (SOP).

The scope of this Sample Report is three-fold: 1) to determine if environmental impacts to the Arkansas River exists due to discharge from a culvert at the Santa Fe Avenue bridge, 2) to evaluate potential hazardous constituents in the waste slag piles and at historical smelter sites and, 3) to determine residential impact to the vicinity properties due to contaminated soils. The presence of contamination was evaluated using source, soil, sediment and aqueous samples collected during the site investigation. This Sample Report was prepared to present the results of the sampling event and to assess the contaminant migration pathways.

1.1 SCOPE

Based on the above statements, the specific objectives of this screening site inspection are as follows.

- Potential surface water and sediment contamination within the Arkansas River resulting from the culvert discharge was evaluated by the collection and analysis of aqueous and sediment samples within the river.

- Source contaminants were evaluated by the collection and analysis of grab samples from the smelter waste piles and historical smelter sites.

- Potential impact to drinking water users was evaluated by the collection and analysis of surface water samples at the St. Charles Mesa Water District intake, approximately 100 yards downgradient of the culvert.

- Exposure via contaminated soils was evaluated by the collection and analysis of residential soil samples.

The sample effort resulted in:

- assessing the potential wastes sources;

- assessing the potential for contaminant migration; and

- assessing the potential impacts to public health and the environment.

2.0 BACKGROUND

2.1 LOCATION AND SITE DESCRIPTION

The Santa Fe Avenue bridge crosses the Arkansas River at the intersection of Interstate 25 and U.S. Business Route 50 in central Pueblo (Figure 1). The bridge is located in the Southwest Quarter of the Northwest Quarter of Section 6, Township 21 South, Range 64 West. The approximate coordinates are 38° 15' 18" north latitude, 104° 36' 23" west longitude. The Santa Fe Avenue bridge culvert site (also known as the Boston and Colorado Smelter) is bounded by Santa Fe Drive (aka HWY 50 or Santa Fe Trail) to the southwest, the north bank of the Arkansas River to the north, Main Street to the northwest, and Colorado Street to the east. The approximate location of the six smelters under investigation are shown on Figure 1.

The smelters are located in a predominantly residential neighborhood built around the turn of the century. Open space owned by the City of Pueblo lies immediately adjacent to the Arkansas River near the Boston and Colorado Smelter. Various light industries are also located in the vicinity of the smelters. Bluffs approximately 100 feet in height are located approximately 500 feet south of the river. The river's northern bluffs are located over one-half mile to the north.

2.2 SITE HISTORY

Coal deposits developed in Las Animas, Huerfano and Fremont County in conjunction with the large lime deposits near Pueblo and the four major railroads servicing the Pueblo area, created an ideal location for smelting operations in Pueblo. The Pueblo lead smelters obtained ores from the mines along the upper Arkansas River and smelted the ore to separate the metal contained in the ore. Six smelters operated in the vicinity of the Santa Fe Avenue Bridge in Pueblo during the 1890's. They were the Pueblo Smelting and Refining Company, the Colorado Smelting Company, the Massachusetts Smelting Company, the Philadelphia Smelting and Refining Company, the Blende Zinc Smelter, and the CF&I Smelter. The locations of these smelters are shown on a Pueblo street map (circa 1897) (Figure 2). Note that the 1897 street map shows that the Arkansas River was once located near Richmond Avenue and Smelter Hill, just south of the Pueblo Smelting and Refining Company.

Just north of the Arkansas River (Figure 2), in the area referred to as Goat Hill or Smelter Hill, Mather and Geist built the first smelter in Pueblo in 1878, which was known as the Pueblo Smelting and Refining Company. Anton Eilers of Germany, who built smelters in Leadville, established the Colorado Smelting Company (also known as the Boston and Colorado Smelting Works or the Eilers Plant) in 1883 on a mesa north of the current CF&I steel mills. The smelter imported lead-iron-carbonate ores from the Madonna Mine at Monarch, Colorado. In 1888, Guggenheim built the Philadelphia Smelting Works, located east of CF&I steel mills and west of Salt Creek. Because lead and zinc are found in the same ores, Guggenheim also built the Blende Zinc Refinery in 1903. The zinc smelter was located one mile east of the Philadelphia Smelting Works on the north side of the Santa Fe Trail (US Hwy 50). At the turn of the century, the combined daily production of the four smelters was in excess of 2,000 tons.

In 1899, the American Smelting and Refining Company (ASARCO), a national smelter trust was formed and absorbed most of the Colorado smelters. ASARCO took over the Globe and Omaha & Grant Smelters in Denver, the Colorado Smelting Company (the Eilers Plant), and the Pueblo Smelter and Refining Company in Pueblo, the Arkansas Valley and

Bimettal Smelters in Leadville, and the Durango Smelters.

By 1921, the Pueblo smelters were no longer operating. The Colorado Smelting Company was dismantled in 1915 and the Philadelphia Smelting Works were dismantled before World War 1. The Pueblo Smelter and the Blende Zinc Refinery were destroyed in a 1921 flood of the Arkansas River. The original town of Pueblo was located in the natural Arkansas River floodplain. Due to the destruction of businesses from the 1921 flood and the continuing flooding potential, the Arkansas River was moved to its present location in approximately 1926 (Figure 3). The river course is controlled on both sides by a concrete levee approximately 20 feet high, from the confluence of Dry Creek and the Arkansas to the point where Moffat Street dead ends at the Arkansas River bike path.

Remnants of destroyed buildings and slag piles remain from the former smelters in the area. Of particular note, are slag piles between Santa Fe Avenue and 1-25, south of the Arkansas River (associated with the Boston and Colorado Smelting Company), and the area known as Smelter Hill located between the former Arkansas River course and the Fountain River. A Pueblo Chieftain newspaper article (1 89 1) reported that the slag wastes had been used as ballast for railroad tracks and roads throughout the area. The location of slag piles from CF&I and other remnant sites are shown on Figure 4.

2.3 PREVIOUS WORK

In 1989, a pedestrian noticed a liquid discharge coming from an 18-inch concrete pipe located directly under the Santa Fe Avenue bridge. The culvert exits the concrete levee wall along the south side of the river. The liquid discharge enters the Arkansas River by going through a culvert installed under a bike path; but orange staining across the concrete bike path indicates that during periods of heavy runoff (such as storm events), the discharge flows across the bike path (rather than under it) to the river. (Appendix A: photos). The discharge itself is clear, but the sediment associated with it is bright reddish-orange, suggesting a high iron content. Flow rate is estimated at two to three gallons per minute.

The pedestrian who noticed the discharge informed the Pueblo County Health Department, who in turn notified the Water Quality Control Division of CDPHE. The Pueblo Wastewater Treatment Plant analyzed a grab sample of the discharge for selected inorganic compounds. Analytical results show a high iron concentration in addition to other elevated metals (Table 1).

Once the inorganic lab analysis had been received, the CDPHE Water Quality Control Division contacted the CF&I Steel Corporation (whose steel mill is located 3/4 mile south

of the Santa Fe Avenue bridge) to request information on the waste slag pile. CF&I suggested the Boston and Colorado Smelting Company waste slag pile located just south of the Santa Fe Avenue bridge culvert provided the source of the contaminated discharge. The Boston and Colorado Smelting Company, which operated at the turn of the century, has no identified relationship with CF&I.

The Boston and Colorado Smelting Company was established in 1883 and dismantled 1915. A large slag heap, forming a thirty foot high escarpment along the western side of Santa Fe Avenue, is the remaining remnant of the smelter operation in this area. The Denver and Rio Grande Railroad tracks and Interstate 25 are built adjacent to the slag heap.

City of Pueblo maps do not show the culvert to be a part of its storm sewer system. Due to the low constant discharge, the culvert does not appear to drain city streets. The levee, from which the culvert exits, was constructed in approximately 1926 when the Arkansas River course was altered. It is likely that the culvert was placed there to drain the south bank area. Water leaching through the waste slag pile may be impacting shallow ground water which may be the source of the culvert discharge causing the elevated iron and zinc concentrations found in the discharge.

A site visit by a CDPHE representative identified, what appeared to be, a topographic low which was later filled with slag and other wastes (such as solid wastes). A reconnaissance of the area revealed that a seep appeared to exit the slag waste about 1/4 mile upgradient of the culvert. The seep flowed as a surface water feature for several hundred yards then disappeared back into the subsurface. The origin of the culvert and discharge is unknown, but is assumed to be draining the topographic low now filled with slag waste.

Because a responsible party that is still in operation was not identified by the Water Quality Control Division during their investigation, they were unable to take enforcement action. ASARCO was the last identified owner of the smelter operation. The original site is now the location of small businesses, residences and a church. The Santa Fe Avenue bridge site was placed on CERCLIS in 1990 after the Hazardous Materials and Waste Management Division of CDPHE was informed of the culvert discharge entering the Arkansas River by the CDPHE/Water Quality Control District Office in Pueblo. CDPHE prepared a Preliminary Assessment (PA) on the site in the spring of 1991.

The PA discovered the following targets:

- Surface water and fisheries may be adversely impacted by this discharge.

- The area is used recreationally, specifically for biking and walking adjacent to the Arkansas River. Open space is located nearby for other forms of recreational use.

- The St. Charles Mesa Water District has a surface water intake approximately 100 yards downstream of the site. The intake removes approximately 3 acre feet/day of surface water from the Arkansas River between November 15 and March 15. The intake services 9800 people or 3200 taps corresponding to 200 commercial taps and 3,000 residential taps in neighborhoods east of Pueblo.

- Residential populations exist near the Santa Fe Avenue bridge site.

The USGS is engaged in a three year Arkansas River basin-wide study. Two of the closest USGS surface water sample points are the outfall of the Pueblo Reservoir (approximately 8 miles east of the site) and at the Moffat Street foot bridge (approximately 20 yards downgradient of the St. Charles Mesa surface water intake). The USGS analyses have shown that the water quality at the Moffat Street sample station is within the Arkansas River stream standards for Segment #3 (Tables 2 and 3).

In 1992, a Screening Site Inspection (CDPHE files) was performed on the Santa Fe Avenue bridge culvert and vicinity. In summary, the SSI found that approximately 200,000 square feet of arsenic contaminated soils affected approximately 50 resident individuals. Impact to the Arkansas River was inconclusive because of poor agreement among the duplicates and the apparent background contamination. Due to conflicting analytical results at some sample locations, the ESI repeated the majority of sample locations from the SSI and additional residential soil samples were collected in the vicinity of the historical smelters.

3.0 SOURCE CHARACTERIZATION

3.1 SOURCE CHARACTERISTICS

Source areas identified are: Boston and Colorado Smelter, Blende Zinc Smelter, Pueblo Smelter, Philadelphia Smelter, Massachusetts Smelter and CF&I Smelter. All of these sources are expected to have generally the same waste characteristics of metals contamination. With the exception of CF&I, all of the smelters ceased operation in the early

1900's. As a result, remnant waste piles and remnant building structures are all that remain, and in some cases no evidence of the historical smelters can be found. Their locations are approximated based on comparison of historical street maps with current street maps.

Waste piles can be found at Boston & Colorado, Pueblo, Massachusetts and CF&I. The remnant waste piles were not observed to have liners or run-on/run-off containment structures. Surface area, for known waste piles, is estimated at 11,200,000 square feet.

The waste ranges in size from very course gravelly materials to silts. The fine grained material may be available to the air pathway, though wind blown dusts were not observed during the sample event.

3.2 SAMPLE LOCATIONS

Thirteen source samples were collected during the ESI from seven suspected source areas and are designated SS1 to SS13.

3.3 SOURCE ANALYTICAL RESULTS

Sample results for each source area are shown on Figure 5. A summary of the inorganic results of source samples are presented in Table 4. The following summary identifies source substnaces. The values in bold represent concentrations which are greater than background or greater than the background sample quantitation limit (SQL) if undetected in the background sample.

3.4 CONCLUSIONS

The source areas evaluated are not contained with respect to run-on/run-off and ground water. Access to the sites are not restricted by fencing or other barriers. The analytical results show that substances exist within these sources that have the potential to impact human health and the environment. Substances denoted with an asterisk indicate which sources have exceeded the soil benchmarks (using Superfund Chemical Data Matrix [SCDM]). Based on the lack of containment and the targets in the vicinity, the primary pathway are surface water, ground water and the soil exposure pathways.

SOURCE ANALYTICAL RESULTS SUMMARY

(mg/kg) CONSTITUENT	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12	SS13
aluminum	**17000j**	**19300j**	10300j	13600j	**23000j**	5600j	**26400j**	**16000j**	8780j	**56300j**	6760	**17500**	5020
antimony	5.7uj	7.0uj	5.6uj	5.5uj	**1520j***	6.1j	**29.4j**	5.7uj	5.2uj	5.2uj	5.6j	5.2r	5.2r
arsenic	0.48j	**8.2j***	3.9j	**10.0j***	3.6r	**37.8j***	**79.4j***	10.7j	0.97j	2.4uj	**14.6j**	6.1j	4.8j
barium	**528j**	**313j**	162j	**273j**	**847j**	**208j**	**6520j**	**1570j**	**271j**	**736j**	**232**	**346**	129
beryllium	**3.1**	**3.5**	0.43	**0.86**	**1.8**	0.22	**1.4**	**1.3**	**1.2**	**15.2**	0.75	0.75	0.38uj
cadmium	0.86u	1.1uj	**1.4**	**4.0**	0.8uj	**9.1**	**1.1**	**1.4**	0.8u	0.79uj	0.81u	0.8u	**3.6**
calcium	27500j	**102000j**	31900j	25800j	81900j	**222000j**	72300j	34500j	4670j	**206000j**	**221000**	**189000**	13600
chromium	7.6	**91.0**	**14.2**	**16.4**	**59.0**	**13.4**	9.3	5.9	12.7	8.4	**659**	**2960***	7.7
cobalt	4.4	**10.9**	6.9	8.9	**22.6**	**13.5**	**22.7**	6.9	6.8	1.8	**18.6**	**9.0**	4.1
copper	**35.7**	**137**	**22.6**	**91.8**	**200**	**43.9**	**1720**	**132**	**45.0**	5.0j	**100**	**166**	23.4
iron	7590j	**75500j**	**20100j**	**21700j**	**105000j**	**26100j**	**237000j**	**21000j**	8530j	4660j	**146000**	**114000**	8880
lead	**33.6**	**110**	**123**	**318**	**213**	22.0	**7640**	**598**	24.5j	11.2	**54.4**	**41.5**	**201**
magnesium	**8310j**	**12500j**	3610j	3930j	**26900j**	4230j	**14200j**	2500j	3000j	**30800j**	**31000**	**16100**	2470
manganese	**920j**	**2830j**	263j	**515j**	**1510j**	89.3j	**15500j***	**1610j**	80.9j	**7690j***	**20100j***	**16400j***	288j
mercury	0.11u	0.14u	0.11u	**1.4**	**0.18**	0.11u	0.1u	0.11u	0.1u	0.1u	0.1u	0.1u	0.1
nickel	5.2	**35.5**	10.3	17.2	**96.6**	**78.9**	**33.3**	10.1	13.4	3.4u	**49.9**	**35.1**	8.1
potassium	4820	4130	2090	2430	3940	2100	**19900**	1690	2320	**21900**	1030	1000	1530
selenium	**2.0**	**0.92j**	0.33	**1.4**	**22.8j**	**21.0**	**2.2**	0.46j	**1.5**	**4.4**	0.5j	1.0	0.39j
silver	0.80u	**3.7**	0.79u	**1.9**	**4.7**	1.1	**23.6**	**1.8**	0.74u	1.1	**11.8**	**10.1**	1.7uj
sodium	**225**	**584**	**189**	**365**	**7080**	**355**	**2130**	**1010**	**703**	**1340**	**626**	**307**	110
thallium	0.20u	**0.29j**	0.20u	0.19u	1.9u	**1.5j**	1.8uj	0.20uj	0.18uj	0.18u	1.9uj	1.8u	0.18u
vanadium	13.9j	**64.6j**	52.3j	41.3j	**148j**	**150j**	45.2j	28.9j	19.4j	37.4j	**1240**	**242**	19.8
zinc	74.0j	**467j**	**110j**	**598j**	**923j**	**182j**	**37400j**	**2460j**	74.4j	34.1j	**182**	**124**	**829**
cyanide	0.55uj	**2.2j**	0.55uj	0.57uj	**1.4j**	0.53uj	**1.3j**	0.56uj	0.51uj	**5.6j**	**1.2**	**1.2**	0.53

* exceed SCDM soil benchmarks

4.0 GROUND WATER PATHWAY

4.1 HYDROGEOLOGY

Artificial fill and Quaternary Piney Creek and Post Piney Creek alluvium (ranging from 10 - 46 feet thick) comprise the surficial deposits. The alluvium consists of yellowish-gray to medium-brown silt, clay, sand and gravel. Artificial fill consists of gravel, silt, clay, concrete waste, smelter waste and slag. The alluvium is underlain by up to 4500 feet of low permeability Cretaceous Pierre Shale. The bedrock surface beneath the alluvium slopes northeast (USGS 1976). The City of Pueblo lies within the Canon City Embayment, a minor structural basin that cuts across the southern terminus of the Front Range.

The average hydraulic conductivity of the alluvial aquifer is estimated at 27 feet per day. The average transmissivity of the aquifer is estimated to be about 270 feet squared per day. The maximum pumping rate from the alluvial aquifer is estimated to be about 10 gallons per minute (USGS 1976). The unconfined alluvial aquifer apparently discharges into the Arkansas River (USGS 1976), and may also discharge through the culvert at the Santa Fe Avenue bridge.

The shallowest major aquifer, the Dakota Sandstone, is approximately 5000 feet below ground surface in the Pueblo area, making its use limited. The discontinuous sandstone lenses of the overlying Pierre Shale are not an important source of water due to its poor water quality. Considering the low permeability and tremendous thickness of the Pierre Shale, cross contamination by the shallow alluvial aquifer to the confined Dakota Sandstone aquifer is unlikely (PA 1990).

4.2 TARGETS

The shallow alluvial ground water in the Pueblo area is not used as a drinking water supply. The City of Pueblo gets most of its water from the Pueblo Reservoir located west of the city (City of Pueblo, communication). There are six ground water wells within four miles of the site and they are used for purposes other than a source of drinking water (State Engineers Office records). The nearest drinking water well, if one exists, is beyond the 4-mile radius of consideration. Because ground water is not used for drinking water, ground water samples were not collected, therefore, the ground

water pathway was not evaluated.

As stated above in Section 3, all sources may be considered to have the potential to leach to ground water because of the lack of containment.

5.0 SURFACE WATER PATHWAY

5.1 HYDROLOGY

In 1921, a flood inundated the area and destroyed a number of businesses located along the Arkansas River course within the City of Pueblo. Two smelters, the Pueblo Smelter and the Blende Zinc Refinery, were destroyed at this time. In approximately 1926, the natural course of the river was moved to its present location and its banks were reinforced with concrete levees between Dry Creek and Moffat Street (Figure 2 and 3). The river banks are steep within central Pueblo due a constructed levy. Downstream of the central Pueblo, the levy is absent and the Arkansas River broadens out into a wide flood plain.

The Arkansas River flows from west to east. Stream flow in the Arkansas River varies between 20 cubic feet per second (cfs) in December and January, to spring runoff exceeding 4000 cfs in June. Average annual stream flow is approximately 450 cfs (USGS Water Resource 1992). Classification and numeric standards for the Arkansas River Segment #3 have been developed by the Water Quality Control Division and are presented in Table 2.

The St. Charles Mesa Water District has a surface water intake at the Santa Fe Avenue Bridge. CF&I has an NPDES permit and discharges process water to the Arkansas River approximately 3 miles downstream of the intake.

5.2 TARGETS

Surface water targets identified during the PA include:

1. The fisheries of the Arkansas River

Fisheries are identified within the segment of the Arkansas River evaluated

during the site investigation. Fishing was observed during site visits made prior to the ESI and signs posted in the area indicate fishing is a common occurrence. The Arkansas River is a warm water fishery with acreage estimates in the Pueblo area of 124 pounds of fish per acre. The predominant species are long nosed sucker and white sucker (US Fish and Wildlife).

2. Wetlands along the Arkansas River

An estimated 5 miles of wetlands are identified within 15 downstream miles of the site (National Wetlands Inventory Maps).

3. A surface water intake approximately 100 yards downstream of the culvert discharge

An intermittent drinking water intake for the St. Charles Mesa Water District is located approximately 100 yards downstream from the Santa Fe Avenue bridge. Approximately 3 acre feet/day of surface water is removed by the St. Charles Mesa Water District at its intake between November 15 and March 15 of each year and serves approximately 9,800 people. The St. Charles Mesa Water District analyzes the water at the surface water intake for temperature, total dissolved solids and pH.

5.3 SAMPLE LOCATIONS

Surface water and sediment samples were collected for the purpose of evaluating the potential impact targets. They are:

1. Upstream of the culvert above the Dry Creek and Arkansas River confluence (SW/SE1).

2. Arkansas River at the culvert discharge (SW2)

3. Arkansas River at the St. Charles Mesa surface water intake (SW3/SE3 & SW6/SE6).

4. Arkansas River at HWY 227 (SW4/SE4).

5. Arkansas River at Nielson Street (SW5/SE5).

Sample locations are shown on Figure 6.

5.4 SURFACE WATER ANALYTICAL RESULTS

Surface Water Samples

The surface water inorganic results are presented in Table 5. The following summary presents analytically significant detections (3 times background or greater than the sample quantitation limit if undetected in the background sample) in downstream surface water samples with respect to the upstream surface water sample.

CONSTITUENT ug/l	BK SW-1	Culvert SW-2	Intake SW-3	HWY227 SW-4	Nielson SW-5	Intake SW6	SCDM Standard
aluminum	1240	-	-	-	4870j	-	
arsenic	1.2uj	-	-	-	2.5j	-	50[a]
beryllium	0.30u	-	-	0.42	0.48j	-	4[a]
chromium	3.7u	-	-	-	6.4j	-	11[b]
cobalt	4.6u	-	-	-	14.7j	-	
iron	4.2uj	-	-	-	7680j	-	1000[b]
lead	1340	-	-	-	18.2j	-	15[a], 3.2[b]
vanadium	7.5	-	-	-	17.8j	-	
cyanide	10.0uj	-	-	-	10.4j	-	200[a], 5.2[b]

(-) = does not meet the criteria for analytical significance
(a) = MCL/MCLG
(b) = AWQC

Sediment Samples

The following summary presents analytically significant detections in downstream sediment samples with respect to the upstream sediment sample (see Table 6). No benchmarks exist for contaminated sediments; however, the presence of these substances identify a potential to impact the drinking water resource and the fishery.

CONSTITUENT mg/kg	BK SE1	Intake SE3	HWY227 SE4	Nielson SE5	Intake SE6
mercury	0.15u	0.22	-	-	-

(-) = does not meet the criteria for analytical significance
A sediment sample at SW-2 could not be collected.

5.5 CONCLUSIONS

Sample SW-5 exceeded aluminum, arsenic, beryllium, chromium, cobalt, copper, iron, lead, vanadium and cyanide background concentrations. This may be the result of upstream discharge from the CF&I impoundment. At SW-5, the lead MCL was exceeded, and the iron and cyanide Ambient Water Quality Criteria were exceeded.

Although sediment benchmarks do not exist, an observed release of mercury was documented at SE-3. Figure 7 illustrates the 15-mile target distance limit, the probable point of entry, impacted and potentially impacted segments, as well as the wetland locations. Approximately 5 miles of wetlands were found within the 15-mile target distance limit and within the impacted segment of the Arkansas River (National Wetlands Inventory Maps).

6.0 SOIL EXPOSURE PATHWAY

6.1 PHYSICAL CONDITIONS OF THE SITE

The smelter sites are situated within light industrial and residential neighborhoods adjacent to the Arkansas River and near the central business district of the City of Pueblo. Recreational areas are developed along the Arkansas River that include a bike path, picnicking, open space and fishing. Public access to the sources are generally unrestricted by fencing or other barriers.

6.2 TARGETS

Resdients livining in the area; workers at businesses; and recreational users of the Arkansas River, open space and bike path are potentially exposed to contaminated soils. The following table illustrates the number of persons living within four miles of the site at the radii of interest (measured from the slag pile and culvert).

DISTANCE RADII FROM SITE (MILE)	NUMBER OF PERSONS (est.)
ON-SITE	40
0 - 1/4	3000
1/4 - 1/2	2250
1/2 - 1	8000
1 - 2	24500
2 - 3	25000
3 - 4	25000

6.3 SAMPLE LOCATIONS

Residential exposure to contaminated soils was evaluated by collecting a total of 34 samples which included three background and 31 residential soil samples. The sample locations are represented on Figure 8. The residential samples were collected on residential properties and within 200 feet of a resident.

6.4 SOIL ANALYTICAL RESULTS

Inorganic soil analysis data are presented in Table 7. The following table presents the substances that meet the criteria for analytical significance in the residential soils as compared to the background samples.

6.5 CONCLUSIONS

Arsenic met the criteria of analytical significance and exceeded the SCDM benchmarks in 7 of 31 residential soil samples. Figure 8 illustrates the polygon of potentially exposed residential individuals residing on soils contaminated with arsenic above the soil benchmark concentrations. Based on the SSI & ESI sample data, the area of contaminated soil is estimated at 1,000,000 ft^2. The contaminated soils are assumed unlined and uncapped. Due to the numerous smelters historically operating in the area, the arsenic contaminated soils may be the result of widespread atmospheric deposition.

Approximately 800 persons reside on arsenic contaminated soils (assuming 2.5 persons per household), and an estimated 40 persons work on arsenic contaminated soils. Nearby populations potentially exposed (evaluated up to 1 mile from the area of contamination) is estimated at 15,000 persons.

RESIDENTIAL SOIL SAMPLES

"Background"

CONSTITUENT mg/kg	SO1	SO2	SO3	SO4	SO5	SO6	SO7	SO8	SO9	SO10	SO11	SO12	SO13	SO14	SO15	SO16	SO17	SCDM#
arsenic	5.5j*	5.0j*	6.1j*	-	-	-	-	18.5j*	-	-	-	-	19.4j*	-	44.0j*	-	-	0.33
cadmium	0.85u	0.93u	0.83u	-	-	-	-	-	-	3.2	3.0	-	-	-	12.7	4.9	3.2	290
copper	22.4	18.1	21.1	-	-	-	-	-	-	93.2	85.8	-	-	-	131j	-	-	
lead	32.5	13.9	28.2	-	240	142	-	322	124	303	553	-	155j	111j	682j	175j	164	
mercury	0.11u	0.12u	0.11u	-	0.13	-	-	0.19	-	0.26	0.30	-	0.14	0.12	0.81	0.19	0.14	170
silver	1.5uj	0.13uj	1.4uj	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2900
sodium	184	152	123	-	-	-	-	-	-	-	-	1190	-	-	-	-	-	
zinc	81.4	66.9	73.5	-	-	-	-	-	-	421	921	-	268	269	616	390	258	170000
cyanide	0.54u	0.59u	0.53u	-	-	-	-	-	-	0.60	-	-	0.72	-	-	3.6	0.53u	12000

CONSTITUENT mg/kg	SO1	SO2	SO3	SO4	SO5	SO6	SO7	SO8	SO9	SO10	SO11	SO12	SO13	SO14	SO15	SO16	SO17	SCDM#
arsenic	5.5j*	5.0j*	6.1j*	-	-	-	-	18.5j*	-	-	-	-	19.4j*	-	44.0j*	-	-	0.33
cadmium	0.85u	0.93u	0.83u	-	-	-	-	-	-	3.2	3.0	-	-	-	12.7	4.9	3.2	290
copper	22.4	18.1	21.1	-	-	-	-	-	-	93.2	85.8	-	-	-	131j	-	-	
lead	32.5	13.9	28.2	-	240	142	-	322	124	303	553	-	155j	111j	682j	175j	164	
mercury	0.11u	0.12u	0.11u	-	0.13	-	-	0.19	-	0.26	0.30	-	0.14	0.12	0.81	0.19	0.14	170
silver	1.5uj	0.13uj	1.4uj	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2900
sodium	184	152	123	-	-	-	-	-	-	-	-	1190	-	-	-	-	-	
zinc	81.4	66.9	73.5	-	-	-	-	-	-	421	921	-	268	269	616	390	258	170000
cyanide	0.54u	0.59u	0.53u	-	-	-	-	-	-	0.60	-	-	0.72	-	-	3.6	0.53u	12000

CONSTITUENT mg/kg	SO18	SO19	SO20	SO21	SO22	SO23	SO24	SO25	SO26	SO27	SO28	SO29	SO30	SO31	SO32	SO33	SO34	SCDM#
arsenic	-	-	-	-	38.9j*	22.9j*	-	-	-	-	-	66.6*	-	20.3j*	-	-	-	0.33
cadmium	-	4.8	6.1	-	46.1	24.1	-	-	-	-	2.8	2.8	-	-	-	-	-	290
copper	-	174	-	-	228	107	-	-	-	-	-	88.1	-	-	-	-	-	
lead	-	336j	169j	102	2130	968	605	187	136	-	248	276	122	250j	-	-	124j	
mercury	-	0.13	0.12	-	7.5	0.80	0.64	-	-	-	0.28	0.24	-	0.15	-	-	0.14	170
silver	-	5.0	-	-	11.1	5.0	-	-	-	-	-	-	-	-	-	-	-	2900
sodium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
zinc	-	2430	590	268j	6910j	2920j	718j	272j	-	-	296j	657j	-	417j	-	-	-	170000
cyanide	-	-	0.90	-	7.9j	-	1.2j	-	-	-	-	-	-	-	-	-	-	12000

CONSTITUENT mg/kg	SO18	SO19	SO20	SO21	SO22	SO23	SO24	SO25	SO26	SO27	SO28	SO29	SO30	SO31	SO32	SO33	SO34	SCDM#
arsenic	-	-	-	-	38.9j*	22.9j*	-	-	-	-	-	66.6*	-	20.3j*	-	-	-	0.33
cadmium	-	4.8	6.1	-	46.1	24.1	-	-	-	-	2.8	2.8	-	-	-	-	-	290
copper	-	174	-	-	228	107	-	-	-	-	-	88.1	-	-	-	-	-	
lead	-	336j	169j	102	2130	968	605	187	136	-	248	276	122	250j	-	-	124j	
mercury	-	0.13	0.12	-	7.5	0.80	0.64	-	-	-	0.28	0.24	-	0.15	-	-	0.14	170
silver	-	5.0	-	-	11.1	5.0	-	-	-	-	-	-	-	-	-	-	-	2900
sodium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
zinc	-	2430	590	268j	6910j	2920j	718j	272j	-	-	296j	657j	-	417j	-	-	-	170000
cyanide	-	-	0.90	-	7.9j	-	1.2j	-	-	-	-	-	-	-	-	-	-	12000

(#) = Superfund Chemical Data Matrix Soil Pathway Benchmarks, blank if no benchmark
(*) = exceeds SCDM benchmarks

7.0 AIR PATHWAY

Air samples were not collected during the screening site investigation. Direct observation of fugitive dust emissions was not observed during the site reconnaissance or during the sample event. Since air samples were not taken, the air pathway was not evaluated.

7.1 TARGETS

The following table (from Section 7.2) illustrates the number of persons within the target distance radii.

DISTANCE RADII FROM SITE (MILE)	NUMBER OF PERSONS (est.)
ON-SITE	40
0 - 1/4	3000
1/4 - 1/2	2250
1/2 - 1	8000
1 - 2	24500
2 - 3	25000
3 - 4	25000

8.0 CONCLUSIONS

The area is generally industrial and has had a history of smelter operations located in central Pueblo during the turn of the century. The ores used in smelting operations contained elevated metal concentrations, specifically iron, lead, copper, silver, and zinc. From aerial photos and topographic maps, the area of smelter waste associated with each site is summarized in the following table.

SMELTER	WASTE AREA (sf)
Boston and Colorado	500,000
Pueblo	300,000
Blende Zinc	300,000
Philadelphia	unknown
Massachusetts	1,100,000
CF&I	9,000,000

(sf) = square feet

Smelter wastes were widely distributed throughout the area and have been used to ballast railroad tracks and roads. Several piles of slag waste from former smelters remain in the area. The location of these slag piles with respect to the subject sites are illustrated in Figure 4.

All of the analyzed inorganic substances were present in the waste sources. Inorganics which were significantly elevated in the sources include antimony, arsenic, barium, chromium, lead, manganese, and zinc.

GROUND WATER PATHWAY

The ground water pathway was not sampled because the shallow aquifer is not used for a drinking water source within the 4-mile target distance radius. However, due to the lack of source containment, a ground water to surface water migration route is possible.

SURFACE WATER PATHWAY

Maximum Contaminant Levels were exceeded for lead and Ambient Water Quality Criteria standards were exceeded for iron, lead and cyanide in the surface water aqueous sample SW-5 (approximately 3 miles downstream of the culvert). Between SW-2 and SW-5, there was no apparent impacts to the Arkansas River in the aqueous samples. Therefore, the substances detected at SW-5 are presumed to be the result of discharge from the CF&I ponds located immediately upstream of the sample point. Surface water sediment samples exceeded background concentrations for mercury at SE3 (St. Charles Mesa intake).

The river is a freshwater fishery and fishing was observed during site reconnaissance. Based on the SE-3 mecury dectection, approximately 5 miles of wetland environments (within the fifteen mile target distance) may be considered as potentially potentially

impacted.

SOIL EXPOSURE PATHWAY

Approximately 800 persons reside on contaminated soils above the SCDM arsenic benchmark. Approximately 15,000 persons are nearby population potentially exposed to the contaminated soils. The arsenic contaminated area is approximately 1,000,000 square feet.

9.0 REFERENCES

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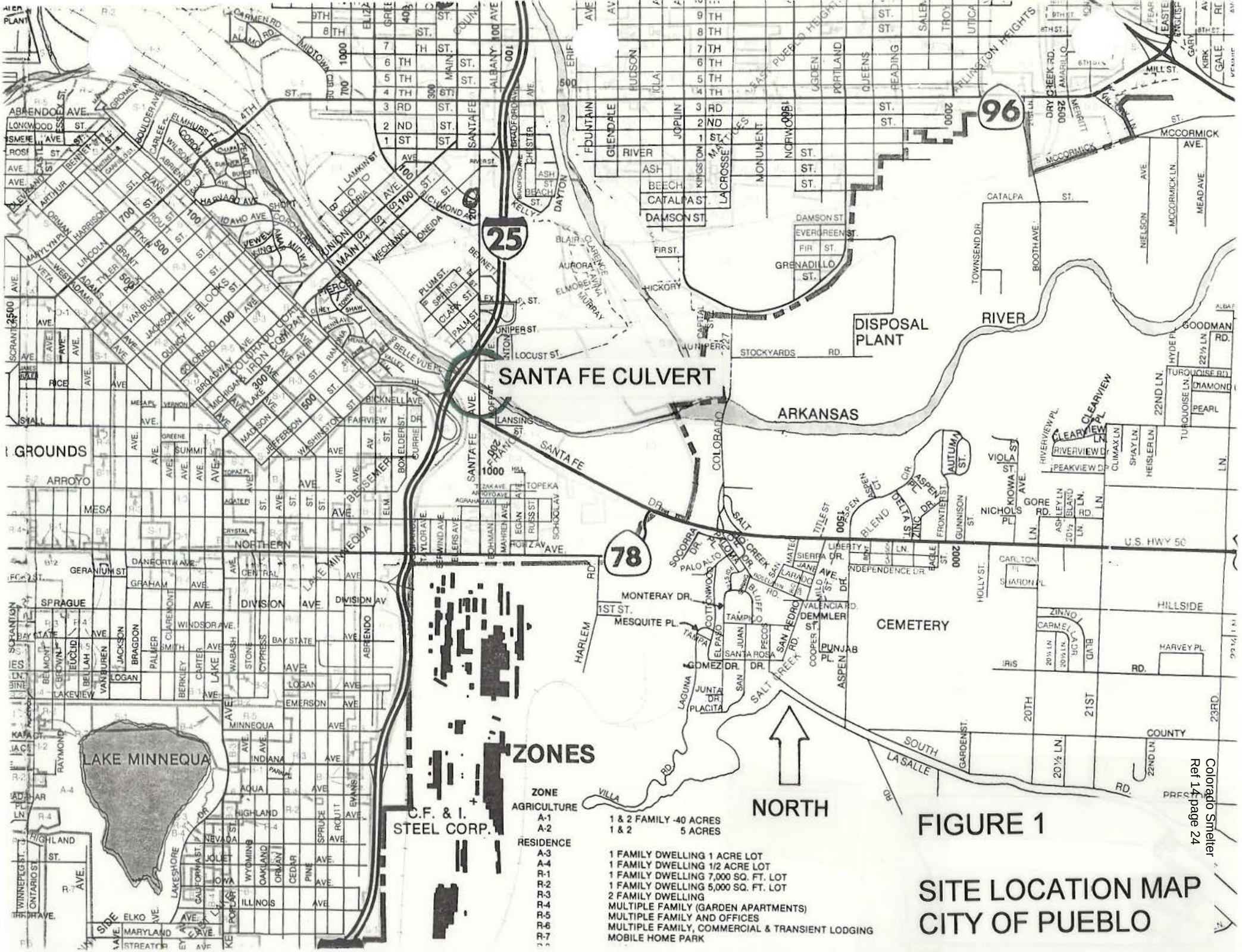

FIGURE 1

SITE LOCATION MAP
CITY OF PUEBLO

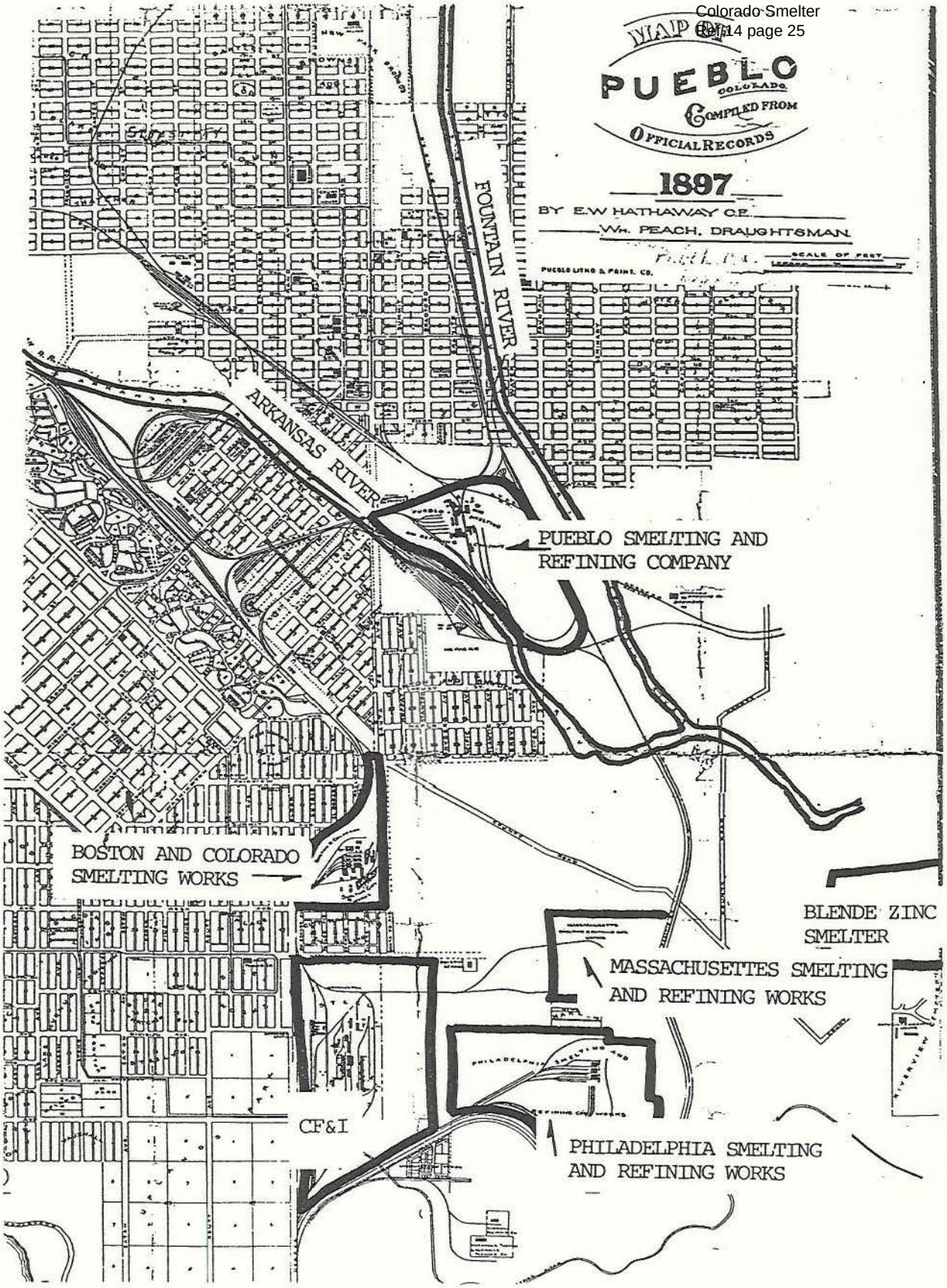

FIGURE 2

1897 PUEBLO STREET MAP

NORTH

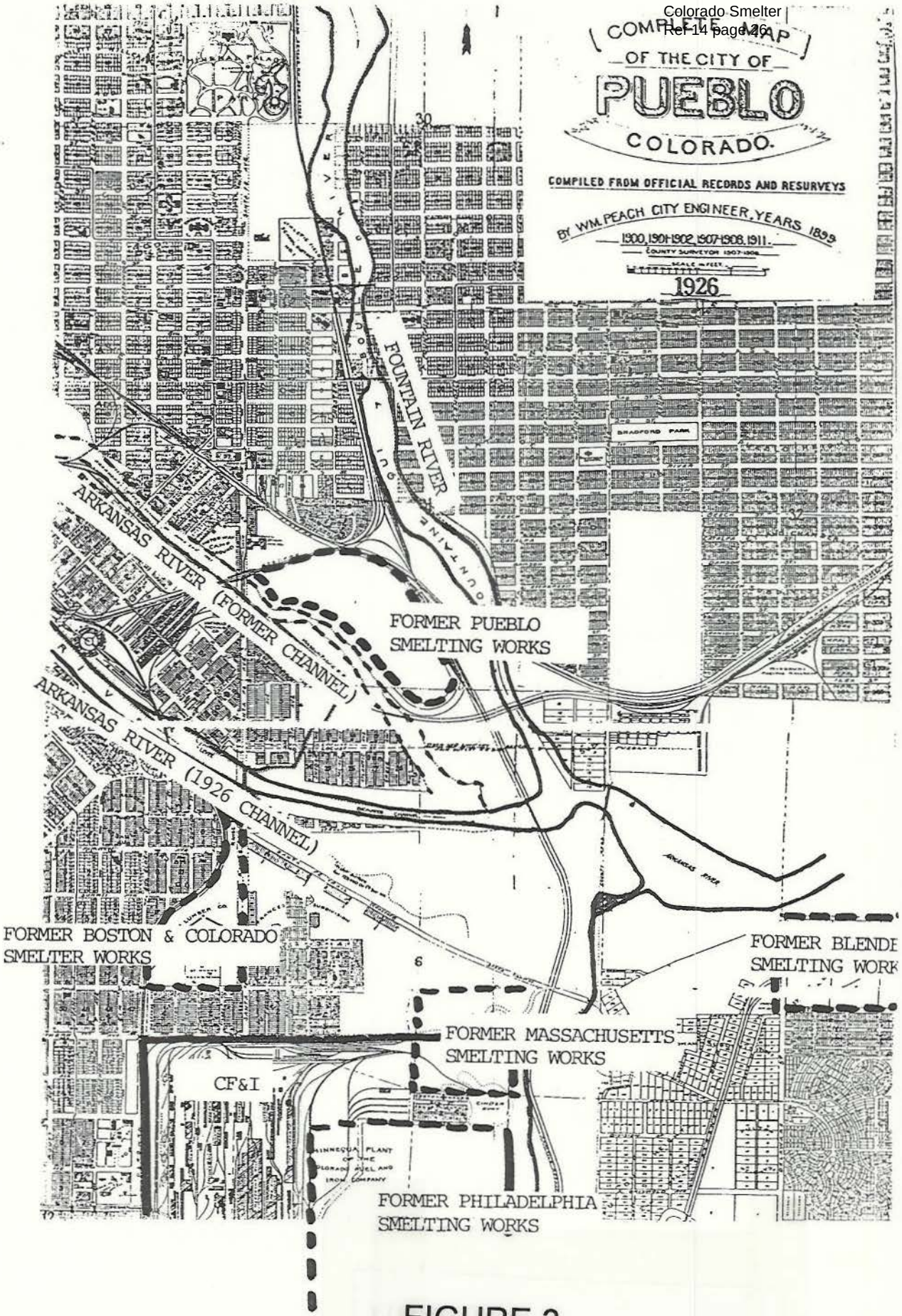

FIGURE 3

1926 PUEBLO STREET MAP

NORTH

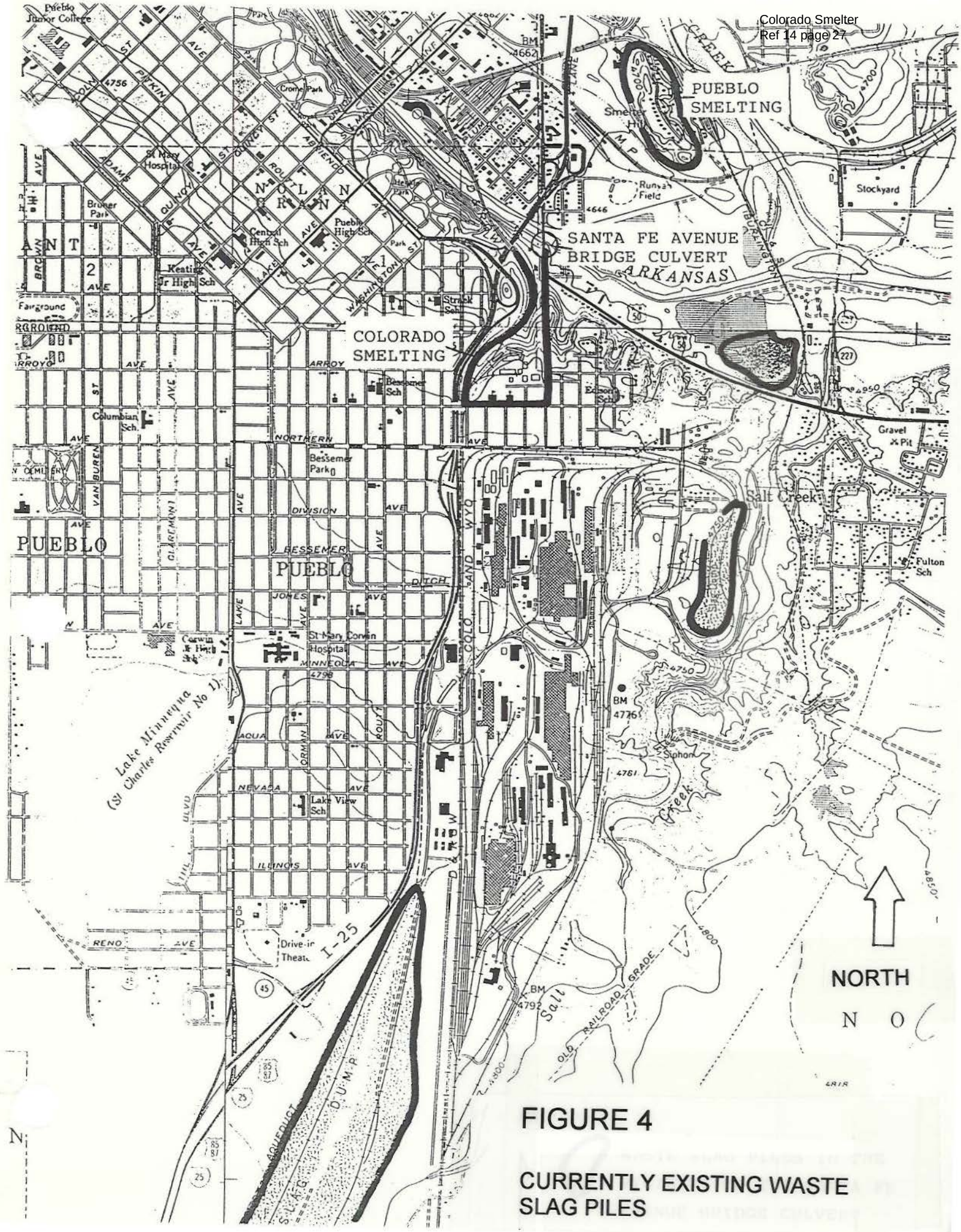

FIGURE 4

CURRENTLY EXISTING WASTE SLAG PILES

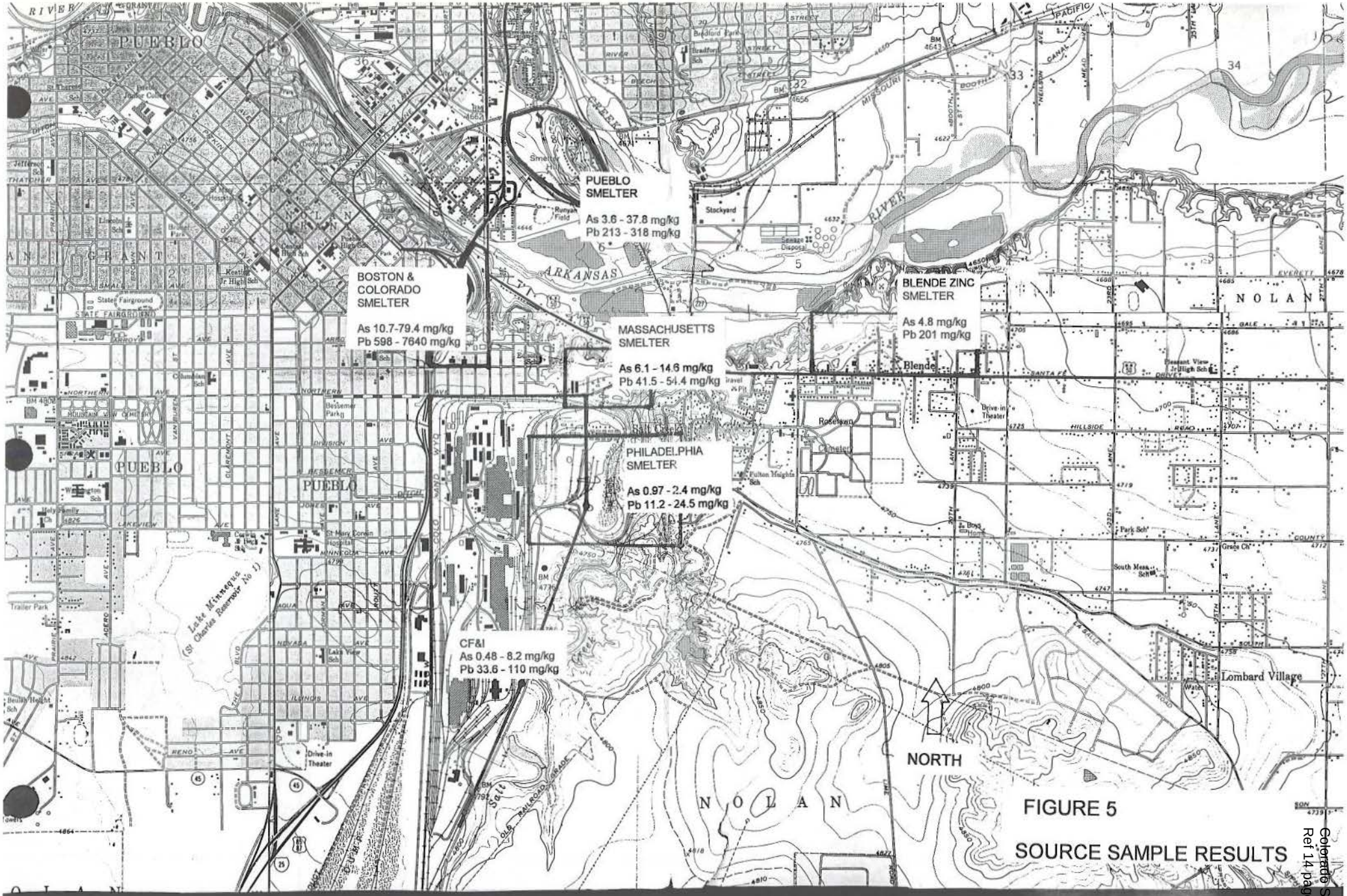

FIGURE 5

SOURCE SAMPLE RESULTS

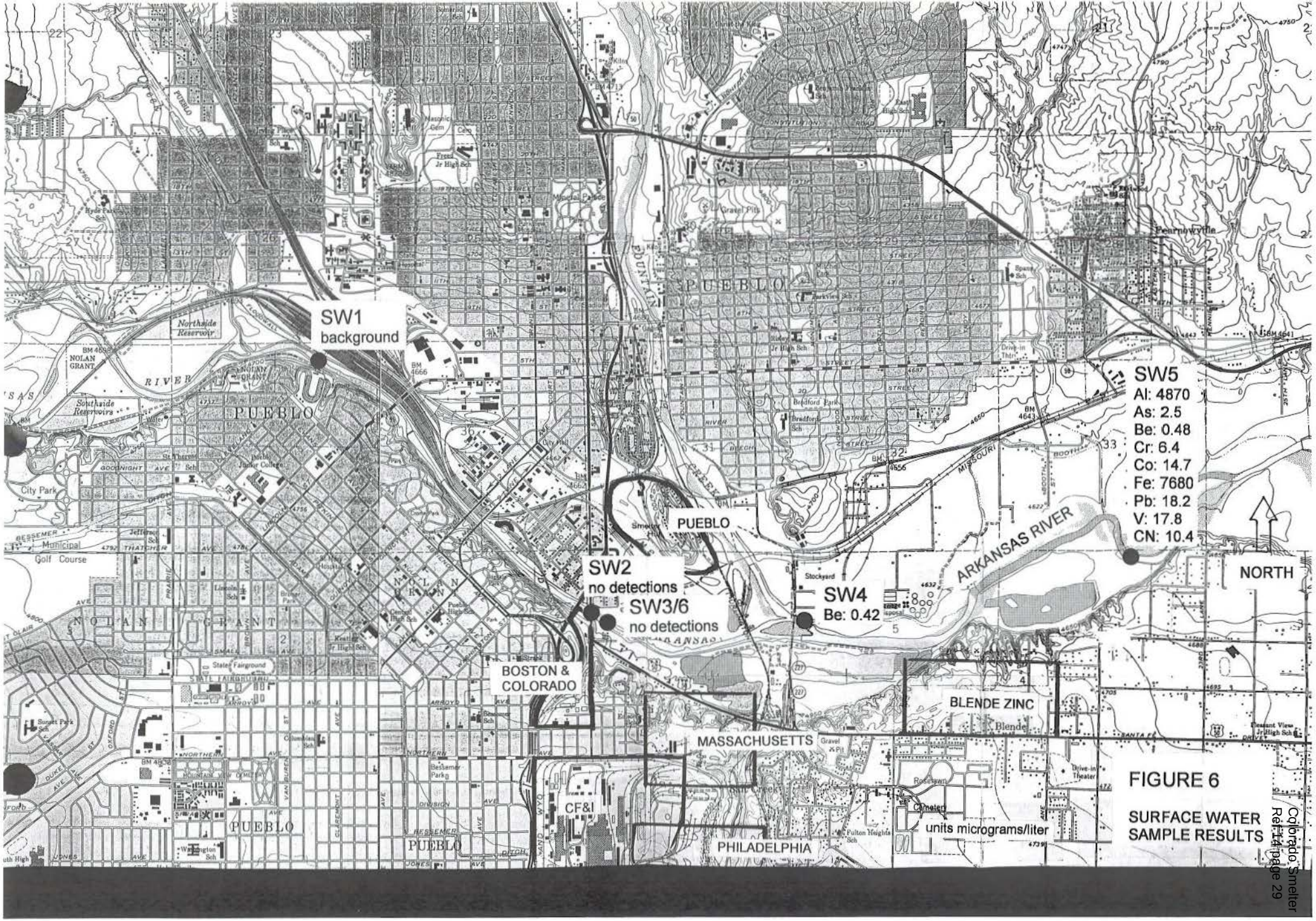

FIGURE 6

SURFACE WATER SAMPLE RESULTS

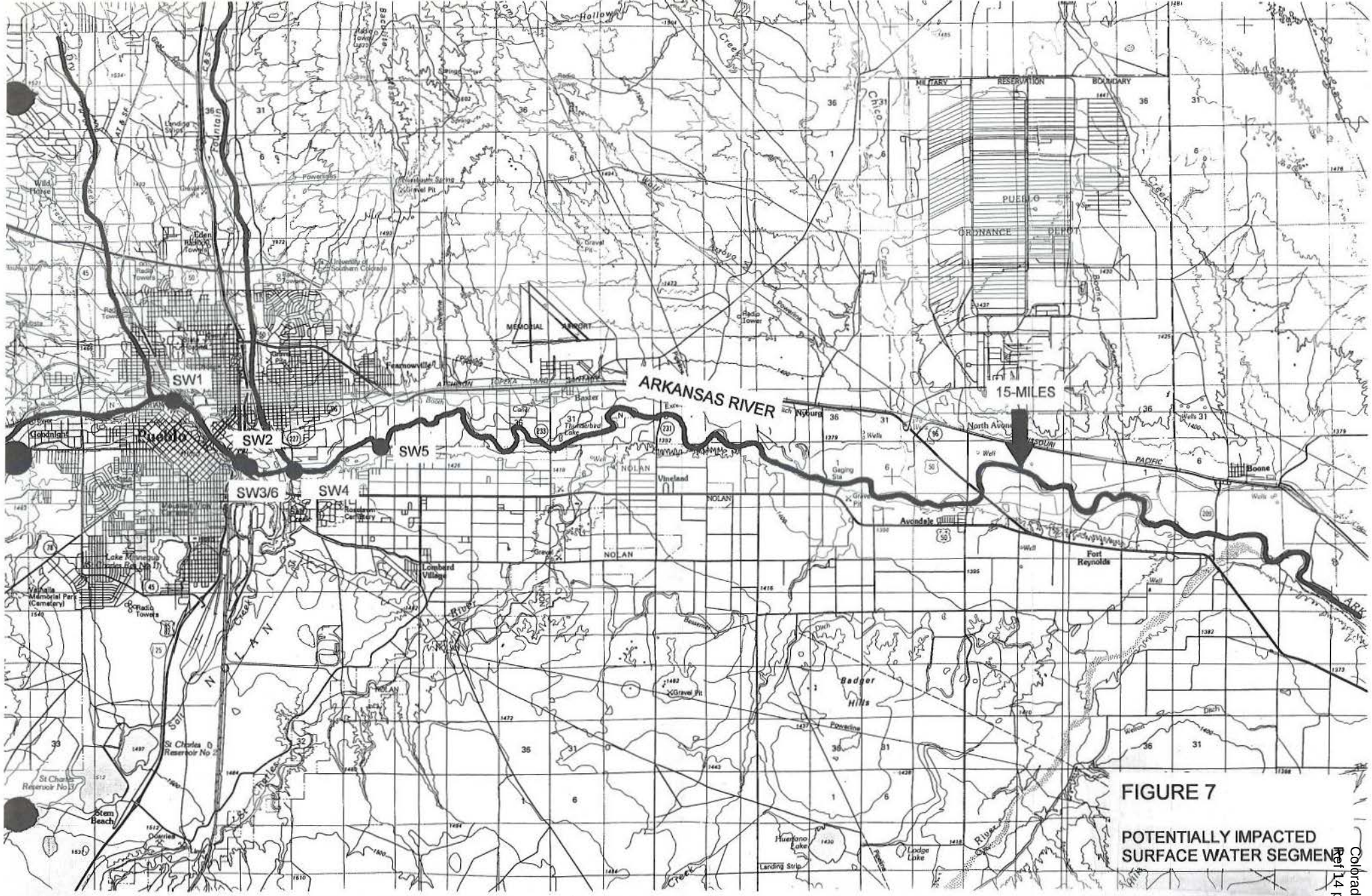

FIGURE 7

POTENTIALLY IMPACTED SURFACE WATER SEGMENTS

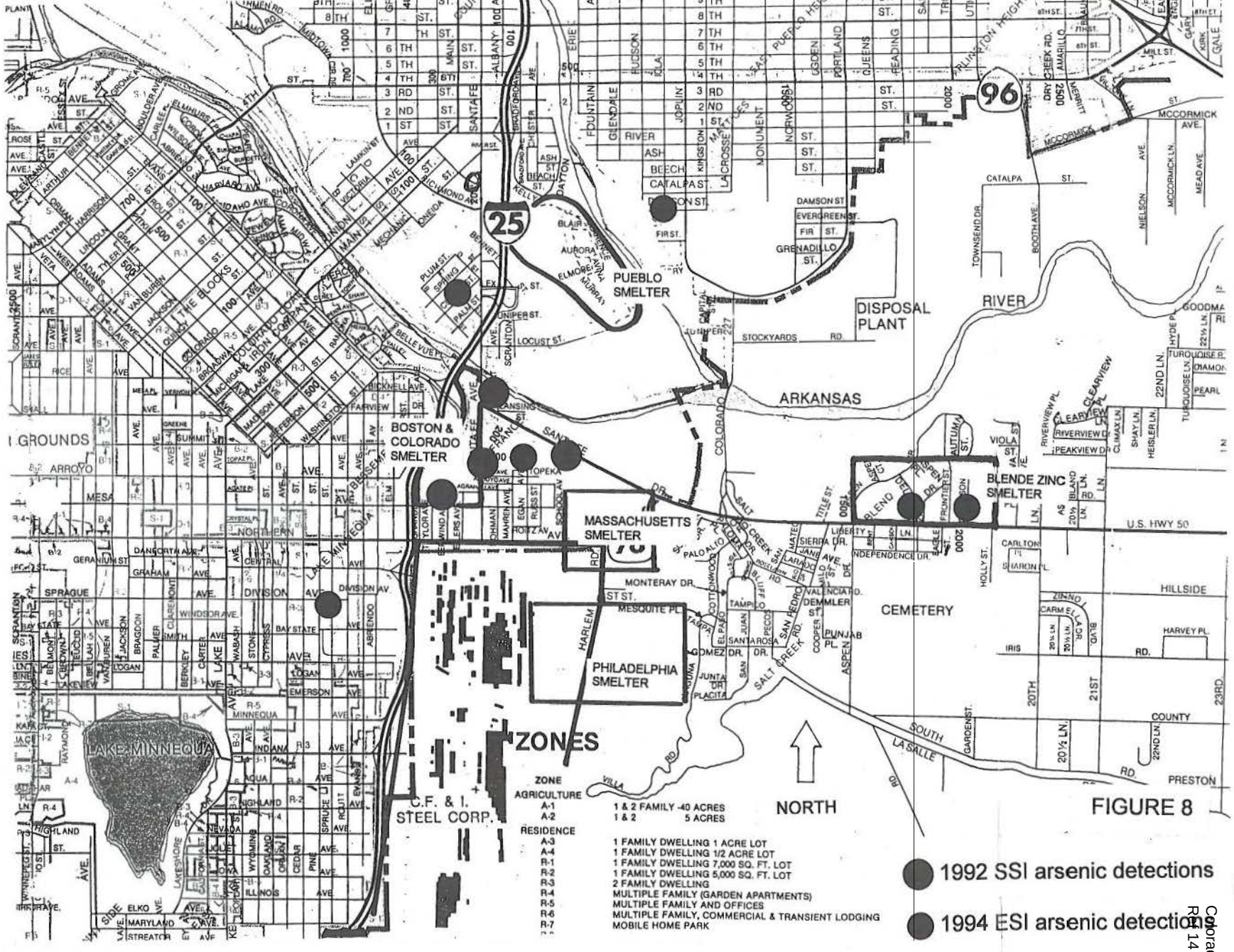
PUEBLO SMELTER
DISPOSAL PLANT
RIVER
ARKANSAS
BOSTON & COLORADO SMELTER
MASSACHUSETTS SMELTER
BLENDE ZINC SMELTER
PHILADELPHIA SMELTER
C.F. & I. STEEL CORP.
CEMETERY
LAKE MINNEQUA
ZONES
NORTH
ZONE
AGRICULTURE
A-1 1 & 2 FAMILY -40 ACRES
A-2 1 & 2 5 ACRES
RESIDENCE
A-3 1 FAMILY DWELLING 1 ACRE LOT
A-4 1 FAMILY DWELLING 1/2 ACRE LOT
R-1 1 FAMILY DWELLING 7,000 SQ. FT. LOT
R-2 1 FAMILY DWELLING 5,000 SQ. FT. LOT
R-3 2 FAMILY DWELLING
R-4 MULTIPLE FAMILY (GARDEN APARTMENTS)
R-5 MULTIPLE FAMILY AND OFFICES
R-6 MULTIPLE FAMILY, COMMERCIAL & TRANSIENT LODGING
R-7 MOBILE HOME PARK
1992 SSI arsenic detections
1994 ESI arsenic detections

FIGURE 8

TABLE 1

ANALYSIS AT THE SANTA FE AVENUE BRIDGE CULVERT

Sample Date:	9-26-89
Date Received:	9-26-89
Sample Location:	Santa Fe Avenue Bridge Culvert
Sampler:	Paul Cozzetta Pueblo Waste Water Treatment Plant
Sample Type:	Grab

Parameter Arkansas River Std.	Impact to the Results	
total cadmium	.04 mg/l	possibly acute
total chromium	.14 mg/l	
total copper	.22 mg/l	possibly acute
total iron	8400 mg/l	possibly acute
total nickel	.18 mg/l	
total lead	.34 mg/l	possibly acute
total zinc	7.00 mg/l	possibly acute

TABLE 3

COMPUTED ARKANSAS RIVER SEGMENT #3 STREAM STANDARDS BASED ON AVERAGE HARDNESS OF 250 MG/L*

Arkansas River Stream Standard	USGS Moffat Street Analyses
Cadmium	Cadmium
acute < 1 ug/l min.	27.74922 ug/ trec
chronic 2 ug/l max.	2.32903 ug/l trec
Chromium	
acute < 1 ug/l min.	3677.822 ug/l trec
chronic 6 ug/l max.	438.375 ug/l trec
Copper	
acute 2 ug/l min.	41.54285 ug/l trec
chronic 22 ug/l max.	25.87011ug/l trec
Lead	
acute < 1 ug/l min.	420.9045 ug/l trec
chronic 33 ug/l max.	14.2521 ug/l trec
Nickel	
acute 1 ug/l min.	1850.411 ug/l trec
chronic 10 ug/l max.	191.773 ug/l trec
Zinc	
acute < 10 ug/l min.	254.3556 ug/l trec
chronic 90 ug/l max.	230.3808 ug/l trec

SOURCE: USGS PUEBLO OFFICE
A 30-day average should be compared to chronic exposure.
Dissolved maximum values should be compared to acute.
trec = total recoverable
diss = dissolved

TABLE 1

ANALYSIS AT THE SANTA FE AVENUE BRIDGE CULVERT

Sample Date:	9-26-89
Date Received:	9-26-89
Sample Location:	Santa Fe Avenue Bridge Culvert
Sampler:	Paul Cozzetta Pueblo Waste Water Treatment Plant
Sample Type:	Grab

Parameter Arkansas River Std.		Impact to the Results
total cadmium	.04 mg/l	possibly acute
total chromium	.14 mg/l	
total copper	.22 mg/l	possibly acute
total iron	8400 mg/l	possibly acute
total nickel	.18 mg/l	
total lead	.34 mg/l	possibly acute
total zinc	7.00 mg/l	possibly acute

TABLE 3

STREAM CLASSIFICATIONS and WATER QUALITY STANDARDS

REGION: 7

BASIN: MIDDLE ARKANSAS RIVER

Stream Segment Description	DESIG: HI QUAL 1	DESIG: HI QUAL 2	DESIG: USE PROT	CLASSIFICATIONS: REC CL 1	REC CL 2	AQUATIC LIFE CL1 C	AQUATIC LIFE CL1 W	AQUATIC LIFE CL2 C	AQUATIC LIFE CL2 W	WATER SUPP	AGRICULT	NUMERIC STANDARDS: PHYSICAL and BIOLOGICAL	INORGANIC ug/l		METALS ug/l			TEMPORARY MODIFICATIONS and QUALIFIERS
1. Pueblo Reservoir.				I		I				I	I	D.O. = 6.0 mg/l D.O.(sp)= 7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH3(ac)=0.43 /PT/PPB/2 NH3(ch)=0.02 CL2=0.003 CN=.005 S=0.002	B=0.75 NO2=0.05 NO3=10.0 Cl=250.0 SO4=250.0	As(ac)=50(Trec) Cd(ac)=TTS(tr) Cd(ch)=TTS CrIII(ac)=50(Trec) CrVI(ac/ch)=TTS Cu(ac/ch)=TTS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TTS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=.01(Trec)	Ni(ac/ch)=TTS Se(ac)=10(Trec) Ag(ac)=TTS Ag(ch)=TTS(tr) Zn(ac)=TTS(tr) Zn(ch)=TTS	
2. Mainstem of the Arkansas River from the outlet of Pueblo Reservoir to a point immediately above the confluence with Wildhorse/Dry Creek Arroyo.				I		I				I	I	D.O. = 6.0 mg/l D.O.(sp)= 7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH3(ac)=0.43 /PT/PPB/2 NH3(ch)=0.02 CL2=0.003 CN=.005 S=0.002	B=0.75 NO2=0.05 NO3=10.0 Cl=250.0 SO4=250.0	As(ac)=50(Trec) Cd(ac)=TTS(tr) Cd(ch)=TTS CrIII(ac)=50(Trec) CrVI(ac/ch)=TTS Cu(ac/ch)=TTS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TTS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=.01(Trec)	Ni(ac/ch)=TTS Se(ac)=10(Trec) Ag(ac)=TTS Ag(ch)=TTS(tr) Zn(ac)=TTS(tr) Zn(ch)=TTS	
3. Mainstem of the Arkansas River from a point immediately above the confluence with Wildhorse/Dry Creek Arroya to a point immediately above the confluence with Fountain Creek.			I	I		I				I	I	D.O. = 5.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	NH3(ac)=0.62 /PT/PPB/2 NH3(ch)=0.06 CL2=0.003 CN=0.005 S=0.002	B=0.75 NO2=0.5 NO3=10.0 Cl=250 SO4=250	As(ac)=50(Trec) Cd(ac)=TTS Cd(ch)=TTS CrIII(ac)=50(Trec) CrVI(ac/ch)=TTS Cu(ac/ch)=TTS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TTS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=.01(Trec)	Ni(ac/ch)=TTS Se(ac)=10(Trec) Ag(ac)=TTS Ag(ch)=TTS Zn(ac)=TTS Zn(ch)=TTS	
4. All tributaries to the Arkansas River and Pueblo Reservoir from the inlet to Pueblo Reservoir to the Colorado Canal headgate, except for specific listings in the Fountain Creek Subbasin and in Segments 5 through 21 and 24.			I	I				I		I		D.O. = 5.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml						
5. Mainstem of the Saint Charles River, including all tributaries, lakes, and reservoirs, from the source to a point immediately above the CF & I diversion canal near Burnt Hill, except for specific listings in Segment 6.		I		I		I				I	I	D.O. = 6.0 mg/l D.O.(sp)= 7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH3(ac)=0.43 /PT/PPB/2 NH3(ch)=0.02 CL2=0.003 CN=.005 S=0.002	B=0.75 NO2=0.05 NO3=10.0 Cl=250.0 SO4=250.0	As(ac)=50(Trec) Cd(ac)=TTS(tr) Cd(ch)=TTS CrIII(ac)=50(Trec) CrVI(ac/ch)=TTS Cu(ac/ch)=TTS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TTS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=.01(Trec)	Ni(ac/ch)=TTS Se(ac)=10(Trec) Ag(ac)=TTS Ag(ch)=TTS(tr) Zn(ac)=TTS(tr) Zn(ch)=TTS	
6. Mainstem of Squirrel Creek, South Creek, and Middle Creek, from their sources to their confluence with the Saint Charles River.		I		I		I				I	I	D.O. = 6.0 mg/l D.O.(sp)= 7.0 mg/l pH = 6.5-9.0 F.Coli=-200/100ml	NH3(ac)=0.43 /PT/PPB/2 NH3(ch)=0.02 CL2=0.003 CN=.005	B=0.75 NO2=0.05 NO3=10.0 Cl=250.0 SO4=250.0	As(ac)=50(Trec) Cd(ac)=TTS(tr) Cd(ch)=TTS CrIII(ac)=50(Trec) CrVI(ac/ch)=TTS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TTS Mn(ch)=50(dis) Mn(ch)=1000(Trec)	Ni(ac/ch)=TTS Se(ac)=10(Trec) Ag(ac)=TTS Ag(ch)=TTS(tr) Zn(ac)=TTS(tr)	

TABLE 3

COMPUTED ARKANSAS RIVER SEGMENT #3 STREAM STANDARDS BASED ON AVERAGE HARDNESS OF 250 MG/L*

Arkansas River Stream Standard	USGS Moffat Street Analyses
Cadmium	Cadmium
acute < 1 ug/l min.	27.74922 ug/ trec
chronic 2 ug/l max.	2.32903 ug/l trec
Chromium	
acute < 1 ug/l min.	3677.822 ug/l trec
chronic 6 ug/l max.	438.375 ug/l trec
Copper	
acute 2 ug/l min.	41.54285 ug/l trec
chronic 22 ug/l max.	25.87011ug/l trec
Lead	
acute < 1 ug/l min.	420.9045 ug/l trec
chronic 33 ug/l max.	14.2521 ug/l trec
Nickel	
acute 1 ug/l min.	1850.411 ug/l trec
chronic 10 ug/l max.	191.773 ug/l trec
Zinc	
acute < 10 ug/l min.	254.3556 ug/l trec
chronic 90 ug/l max.	230.3808 ug/l trec

SOURCE: USGS PUEBLO OFFICE
A 30-day average should be compared to chronic exposure.
Dissolved maximum values should be compared to acute.
trec = total recoverable
diss = dissolved

TABLE 4
INORGANIC SOURCE ANALYSIS

SAMPLE LOCATION	SS-1	SS-2	SS-3	SS-4	SS-5	SS-6	SS-7	SS-8	SS-9	SS-10	SS-11	SS-12	SS-13
SAMPLE ID	MHAS52	MHAS53	MHAS55	MHAS56	MHAS59	MHAS69	MHAS61	MHAS62	MHAS63	MHAS64	MHAS65	MHAS66	MHAS67
INORGANIC (mg/kg)	CFI-S	CFI-S	Eilers	Eilers	Pueblo	Pueblo	Boston	Boston	CFI-N Phil	CFI-N Phil	Mass NE	Mass NE	Blende
aluminum	17000j	19300j	10300j	13600j	23000j	5600j	26400j	16000j	8780j	56300j	6760	17500	5020
antimony	5.7uj	7.0uj	5.6uj	5.5uj	1520j	6.1j	29.4j	5.7uj	5.2uj	5.2uj	5.6j	5.2r	5.2r
arsenic	0.48j	8.2j	3.9j	10.0j	3.6r	37.8j	79.4j	10.7j	0.97j	2.4uj	14.6j	6.1j	4.8j
barium	528j	313j	162j	273j	847j	208j	6520j	1570j	271j	736j	232	346	129
beryllium	3.1	3.5	0.43	0.86	1.8	0.22	1.4	1.3	1.2	15.2	0.75	0.75	0.38uj
cadmium	0.86u	1.1uj	1.4	4.0	0.80uj	9.1	1.1	1.4	0.8u	0.79uj	0.81u	0.80u	3.6
calcium	27500j	102000j	31900j	25800j	81900j	222000j	72300j	35400j	4670j	206000j	221000	189000	13600
chromium	7.6	91.0	14.2	16.4	59.0	13.4	9.3	5.9	12.7	8.4	659	2960	7.7
cobalt	4.4	10.9	6.9	8.9	22.6	13.5	22.7	6.9	6.8	1.8	18.6	9.0	4.1
copper	35.7	137	22.6	91.8	200	43.9	1720	132	45.0	5.0j	100	166	23.4
iron	7590j	75500j	20100j	21700j	105000j	26100j	237000j	21000j	8530j	4660j	146000	114000	8880
lead	33.6	110	123	318	213	22.0	7640	598	24.5j	11.2	54.4	41.5	201
magnesium	8310j	12500j	3610j	3930j	26900j	4230j	14200j	2500j	3000j	30800j	31000	16100	2470
manganese	920j	2830j	263j	515j	1510j	89.3j	15500j	1610j	80.9j	7390j	20100j	16400j	288j
mercury	0.11u	0.14u	0.11u	1.4	0.18	0.11u	0.10u	0.11u	0.10u	0.10u	0.10u	0.10u	0.10
nickel	5.2	35.5	10.3	17.2	96.6	78.9	33.3	10.1	13.4	3.4u	49.9	35.1	8.1
potassium	4820	4130	2090	2430	3940	2100	19900	1690	2320	21900	1030	1000	1530
selenium	2.0	0.92j	0.33	1.4	22.8j	21.0	2.2	0.46j	1.5	4.4	0.50j	1.0	0.39j
silver	0.80u	3.7	0.79u	1.9	4.7	1.1	23.6	1.8	0.74u	1.1	11.8	10.1	1.7uj
sodium	255	584	189	365	7080	355	2130	1010	703	1340	626	307	110
thallium	0.20u	0.29j	0.20u	0.19u	1.9u	1.5j	1.8uj	0.20uj	0.18uj	0.18u	1.9uj	1.8u	0.18u
vanadium	13.9j	64.6j	52.3j	41.3j	148j	150j	45.2j	28.9j	19.4j	37.4j	1240	242	19.8
zinc	74.0j	467j	110j	598j	923j	182j	37400j	2460j	74.4j	34.1j	182	124	829
cyanide	0.55uj	2.2j	0.55uj	0.57uj	1.4j	0.53uj	1.3j	0.56uj	0.51uj	5.6j	1.2	1.2	0.53

TABLE 5
INORGANIC SURFACE WATER ANALYSIS

SAMPLE LOCATION	SW-1	SW-2	SW-3	SW-4	SW-5	SW-6	SW-7	SW-8	SW-9
SAMPLE ID	MHAS79	MHAS78	MHAS74	MHAS70	MHAS72	MHAS75	MHAS80	MHAS69	MHAS68
INORGANIC (ug/l)	bk	culvert	intake	hwy227	nielson	intake	rinsate	rinsate	rinsate
aluminum	1240	312	351	1050	4870j	402	28.4u	28.4u	28.4u
antimony	25.6u	25.6u	29.9uj	27.4uj	25.6uj	25.6u	25.6u	25.6u	25.6u
arsenic	1.2uj	1.2uj	1.2uj	1.2uj	2.5j	1.2u	1.7	1.2u	1.2u
barium	84.0	68.2	70.2	69.9	138j	71.1	1.1u	1.4	1.1u
beryllium	0.30u	0.30u	0.30u	0.42	0.48j	0.30u	0.30u	0.30u	0.30u
cadmium	3.9u	3.9u	3.9u	3.9u	3.9uj	3.9u	3.9u	3.9u	3.9u
calcium	64900	72800	71200	87300	75800j	71300	98.3uj	142uj	142uj
chromium	3.7u	3.7u	3.7u	3.7u	6.4j	3.7u	3.7u	3.7u	3.7u
cobalt	4.6u	4.6u	4.6u	4.6u	4.8j	4.6u	4.6u	4.6u	4.6u
copper	4.2uj	3.0uj	3.0uj	5.4uj	14.7j	5.3uj	2.8u	2.8u	2.8u
iron	1340	504	380	1430	7680j	380	55.3uj	6.5u	20.7uj
lead	5.6j	2.8j	4.5j	4.5j	18.2j	2.5j	0.90u	0.90u	1.0j
magnesium	16600	20100	19600	32300	26800j	19400	34.3u	34.3u	34.3u
manganese	148	38.5	43.0	63.9	372j	45.9	1.7u	1.7u	1.7u
mercury	0.20u	0.20u	0.20u	0.20u	0.20uj	0.20u	0.20u	0.20u	0.20u
nickel	16.7u	16.7u	16.7u	16.7u	20.5uj	16.7u	16.7u	16.7u	16.7u
potassium	2970	3010	2980	4560	5150j	2920	530u	530u	530u
selenium	4.7j	10.0j	9.0j	20.3j	7.6j	9.3j	1.0uj	1.0uj	1.0uj
silver	3.6u	3.6u	3.6u	3.6u	3.6uj	3.6u	3.6u	3.6u	3.6u
sodium	22300	30800	29700	81800	44000j	29600	35.7	27.4u	91.5
thallium	0.90u	0.90u	0.90u	0.90u	0.90uj	0.90uj	0.90uj	0.90uj	0.90uj
vanadium	7.5	4.7	5.6	5.6	17.8j	5.1	3.7u	3.7u	3.7u
zinc	20.0	5.3	9.4	10.5	56.7j	7.3	2.6u	2.6u	5.3
cyanide	10.uj	10.0uj	10.0uj	10.0uj	10.4j	10.0uj	10.0uj	10.0uj	10.0uj

TABLE 6
INORGANIC SEDIMENT ANALYSIS

SAMPLE LOCATION	SE-1	SE-3	SE-4	SE-5	SE-6
SAMPLE ID	MHAS81	MHAS76	MHAS71	MHAS73	MHAS77
INORGANICS (ug/kg)	bk	intake	hwy227	nielson	intake
aluminum	6320	6370	8130	12000	8990
antimony	7.5r	9.9r	8.3r	8.8r	8.8r
arsenic	4.3j	6.5j	7.6j	11.3j	6.6j
barium ~~beryllium~~	166	193	189	195	209
beryllium	0.48uj	0.59uj	0.57uj	1.0	0.66uj
cadmium	1.9	2.4	1.3u	1.3u	2.0
calcium	55000	47000	13000	15000	43800
chromium ~~cobalt~~	9.6	11.0	8.3	13.0	14.1
cobalt	5.7	6.4	5.5	9.7	7.3
copper ~~copper~~	21.8	35.1	17.3	25.7	39.6
iron	14100	13500	14700	21700	16400
lead	242	107	24.2	58.8	104
magnesium	3080	4620	3510	6860	4800
manganese	571j	297j	244j	422j	281j
mercury ~~mercury~~	0.15u	0.22	0.16u	0.17u	0.17
nickel	15.9	21.0	7.4	19.1	21.9
potassium	1820	1800	1580	2370	2530
selenium	3.0j	4.6j	1.3j	1.7j	3.8j
silver	1.9uj	1.6uj	2.3uj	2.6uj	1.8uj
sodium ~~sodium~~	296	197	363	266	218
thallium	0.26u	0.35u	0.29u	0.31u	0.31u
vanadium	45.9	32.6	29.4	37.6	48.4
zinc ~~cyanide~~	114	215	65.4	122	213
cyanide	0.73u	0.97u	0.81u	0.86u	0.85u

TABLE 7
INORGANIC SOURCE ANALYSIS

ELEMENTAL CONCENTRATIONS	SAMPLE LOCATION	SO-1	SO-2	SO-3	SO-4	SO-5	SO-6	SO-7	SO-8
WESTERN U.S.	SAMPLE ID	MHAS51	MHAS57	MHAS58	MHZ688	MHZ689	MHZ690	MHZ691	MHZ692
MEAN NORMAL RANGE	INORGANIC (mg/kg)	back ground	resident	resident	resident	resident	resident	resident	resident
29000-116000	aluminum	14500	15400	12800	16400	4500	5840	13500	9140
.22-1.01	antimony	5.6r	6.1r	5.4r	5.7r	5.5r	5.4r	5.8r	6.2r
2.8-10.9	arsenic	5.5j	5.0j	6.1j	15.5j	10.0j	8.6j	9.3j	18.5j
37-998	barium	184	166	196	217	182	105	196	245
.01-2	beryllium	0.74	0.75	0.66	0.72	0.34uj	0.37	0.73	0.58
	cadmium	0.85u	0.93u	0.83u	0.87u	2.2	1.3	1.8	2.7
	calcium	39200	32600	88100	13200	13600	15400	26100	30000
19-90	chromium	13.2	12.3	11.6	22.5	9.8	7.3	14.1	10.2
36-14	cobalt	8.9	8.0	8.3	12.5	4.3	3.7	7.9	6.3
10-43	copper	22.4	18.1	21.1	38.1	34.2	26.6	32.6	46.9
10600-41000	iron	17900	17100	14700	27000	9560	9810	17700	15500
9-31	lead	32.5	13.9	28.2	29.3	240	142	93.3	322
	magnesium	6120	5000	5060	9100	2160	1780	4510	3280
192-752	manganese	381j	424j	333j	567j	179j	171j	326j	281j
.02-.11	mercury	0.11u	0.12u	0.11u	0.11u	0.13	0.11u	0.11u	0.19
7-32	~~potassium~~ nickel	15.5	15.8	21.1	30.6	11.1	8.5	17.9	13.1
	potassium	4100	4830	3640	4030	1220	1560	3490	2940
.09-.56	selenium	0.60j	0.71j	0.56j	1.6j	1.2j	1.1j	1.1j	1.6j
.1-.8	silver	1.5uj	1.3uj	1.4uj	2.1uj	0.88uj	1.9	2.1	2.3
.1-.8	sodium	184	152	123	169	87.9	192	162	215
	thallium	0.20uj	0.21uj	0.26j	0.20uj	0.25j	0.19u	0.20	0.22u
36-136	vanadium	48.0	46.3	53.9	58.7	27.1	31.7	49.9	42.6
31-98	zinc	81.4	66.9	73.5	120	211	95.4	154	230
	cyanide	0.54u	0.59u	0.53u	0.56u	0.53u	0.53u	0.56u	0.61u

TABLE 7 (cont.)
INORGANIC SOURCE ANALYSIS

ELEMENTAL CONCENTRATIONS	SAMPLE LOCATION	SO-9	SO-10	SO-11	SO-12	SO-13	SO-14	SO-15	SO-16
WESTERN U.S.	SAMPLE ID	MHZ693	MHZ694	MHZ695	MHZ696	MHZ697	MHZ698	MHZ699	MHZ700
MEAN NORMAL RANGE	INORGANIC (mg/kg)	resident	resident	resident	resident	resident	resident	resident	resident
29000-116000	aluminum	6780	4780	14600	4860	9220	7480	7360	7790
.22-1.01	antimony	6.1r	5.4r	6.9r	9.5j	5.6u	5.5r	7.8j	5.7r
2.8-10.9	arsenic	10.0j	8.4j	9.0j	1.0j	19.4j	5.0j	44.0j	10.7j
37-198	barium	199	279	375	147	146	171	299	202
.01-2	beryllium	0.51	0.43	1.1	0.83u	0.72	0.49	0.81	0.54
	cadmium	1.4	3.2	3.0	0.98	2.1	2.0	12.7	4.9
	calcium	27700	28000	31200	13300	19700	27700	25000	50700
19-90	chromium	7.4	7.6	39.2j	2.8j	9.8j	8.3j	7.8j	18.9j
36-14	cobalt	5.4	4.9	12.5	5.5	6.0	5.0	6.9	7.1
10-43	copper	40.1	93.2	85.8	18.3j	41.3j	34.4	131j	60.8j
10600-41000	iron	11100	11000	21400	4790j	15500	12900	13700	17100
9-31	lead	124	303	553	23.8j	155j	111j	692j	175j
	magnesium	2130	2450	6650	910	3520	3690	2950	5260
192-752	manganese	207j	368j	657	103	429	396	578	309
.02-.11	mercury	0.12u	0.26	0.30	0.13u	0.14	0.12	0.81	0.19
7-32	potassium	12.5	13.4	24.9	7.1	12.8	8.5	12.8	23.9
	nickel	1940	1760	3580	738	2330	1790	1070	2400
.09-.56	selenium	1.5j	1.5j	1.5j	0.90j	0.81j	0.40	0.43j	2.7j
.1-.8	silver	1.6	2.2	2.2	0.91u	1.0	0.98	3.9	1.1
.1-.8	sodium	224	235	197	1190	195	203	436	359
36-136	thallium	0.21u	0.19u	0.24u	0.23u	0.38	0.19	0.35	0.61
	vanadium	31.2	20.9	43.7	18.1	33.7	27.0	25.2	50.4
31-98	zinc	154	421	912	38.3	268	269	616	390
	cyanide		0.60	0.67u	0.63u	0.72	0.54	0.55u	3.6

TABLE 7 (cont.)
INORGANIC SOURCE ANALYSIS

ELEMENTAL CONCENTRATIONS	SAMPLE LOCATION	SO-17	SO-18	SO-19	SO-20	SO-21	SO-22	SO-23	SO-24	SO-25
WESTERN U.S.	SAMPLE ID	MHAS34	MHAS35	MHAS36	MHAS37	MHAS38	MHAS39	MHAS40	MHAS41	MHAS42
MEAN NORMAL RANGE	INORGANIC (mg/kg)	resident	resident	resident	resident	resident	resident	resident	resident	resident
29000-116000	aluminum	7490	6050	7820	10500	9880j	9420j	16900j	9170j	5540j
.22-1.01	antimony	5.4r	6.6j	9.4j	7.0j	5.4uj	5.5j	5.5uj	5.6uj	5.2uj
2.8-10.9	arsenic	13.2j	8.0j	13.5j	10.6j	7.3j	38.9j	22.9j	7.9j	5.4j
337-998	barium	165	154	123	214	140j	558j	247j	363j	133j
.01-.96	beryllium	0.49	0.42uj	0.39uj	0.90	0.40	0.75	0.84	0.89	0.36
	cadmium	3.2	1.6	4.8	6.1	2.0uj	46.1	24.1	1.8uj	1.5uj
	calcium	27500	29200	16300	33900	35700j	28300j	25500j	25600j	18300j
19-90	chromium	10.4j	7.0j	10.7j	9.6j	16.2	11.7	17.7	13.9	7.2
36-14	cobalt	7.4	4.0	7.4	5.8	5.6	7.7	10.7	7.2	3.8
10-43	copper	49.7j	23.8j	174j	31.1j	29.2	228	107	56.2	43.5
10600-41000	iron	16800	9750	17700	14000	15400j	17700j	24300j	17100j	11100j
9-31	lead	164j	77.6j	336j	169j	102	2130	968	605	187
	magnesium	4030	2520	3210	6590	3170j	4240j	6600j	2780j	2310j
192-752	manganese	287	265	328	519	322j	555j	682j	409j	289j
.02-.11	mercury	0.14	0.11	0.13	0.12	0.11u	7.5	0.80	0.64	0.11
7-32	nickel	22.1	9.6	11.4	13.8	14.8	11.9	18.0	10.2	7.9
	potassium	3300	1840	2170	2900	2220	1850	4410	1980	1520
.09-.86	selenium	1.8j	0.62j	0.38j	0.82j	0.65	1.6	0.81	0.80	0.73
	silver	1.6	0.78u	5.0	1.1	0.76u	11.1	5.0	1.3	0.88
.1-.8	sodium	206	113	91.9	266	180	325	218	393	106
	thallium	0.49uj	0.20u	0.21uj	0.20uj	0.25j	0.19uj	0.19uj	0.20u	0.18u
36-136	vanadium	53.6	24.7	39.0	34.1	55.2j	35.2j	51.7j	30.8j	22.0j
31-98	zinc	258	153	2430	590	268j	6910j	2920j	718j	272j
	cyanide	0.53u	0.54u	0.51u	0.90	0.53uj	7.9j	0.53uj	1.2j	0.51uj

TABLE 7 (cont.)
INORGANIC SOURCE ANALYSIS

ELEMENTAL CONCENTRATIONS	SAMPLE LOCATION	SO-26	SO-27	SO-28	SO-29	SO-30	SO-31	SO-32	SO-33	SO-34
WESTERN U.S.	SAMPLE ID	MHAS43	MHAS44	MHAS45	MHAS46	MHAS47	MHAS48	MHAS49	MHAS50	MHAS54
MEAN NORMAL RANGE	INORGANIC (mg/kg)	resident	resident	resident	resident	resident	resident	resident	resident	resident
29000-116000	aluminum	6530j	7400j	9080j	11500j	9120j	9120	6380	9060	5750
.22-1.01	antimony	5.3uj	5.4uj	5.3uj	5.4uj	5.5uj	5.4uj	5.3r	5.7r	5.3r
2.8-10.9	arsenic	5.7j	4.1j	9.8j	66.6j	10.8j	20.3j	16.8j	6.1j	8.3j
37-998	barium	270j	115j	185j	266j	173j	151	111	131	137
	beryllium	0.41	0.38	0.50	0.81	0.49	0.55	0.48	0.55	0.40uj
.01-2	cadmium	1.4	0.83u	2.8	2.8	0.85u	1.4	0.81u	1.9	1.8
	calcium	31100j	32000j	32900j	36800j	43900j	29800	19600	19600	25600
19-90	chromium	10.5	10.1	23.7	13.5	10.8	14.5	7.6	10.1	7.3j
36-14	cobalt	4.4	4.6	6.9	7.8	5.8	6.1	5.2	7.1	4.7
10-43	copper	37.9	30.1	36.2	88.1	36.3	60.7	38.1	37.4	29.0j
10600-41000	iron	10900j	11400j	17400j	20700j	14800j	20200	9780	14700	9400
9-31	lead	136	81.9	248	276	122	250j	89.0	67.0	124j
	magnesium	2960j	3510j	3450j	3630j	3970j	3520	3040	4210	3310
192-752	manganese	261j	258j	302j	567j	313j	439	309j	338j	295
.02-.11	mercury	0.10u	0.11u	0.28	0.24	0.11u	0.15	0.10	0.11u	0.14
7-32	potassium	9.2	9.1	13.9	15.6	13.7	13.0	13.5	13.9	11.0
	nickel	1710	1540	2250	2150	2250	1810	2540	2540	1840
.09-.56	selenium	0.81	0.57	0.75	0.91	0.48	0.99	1.6j	0.98j	0.48j
.1-.8	silver	0.75u	0.76u	1.3	1.6	0.78u	1.6	2.1uj	1.7uj	0.75u
	sodium	147	180	182	349	116	132	103	179	94.4
.1-.8	thallium	0.19u	0.19u	0.20	0.19uj	0.20u	0.19u	0.19u	0.39j	0.19u
36-136	vanadium	25.1j	28.1j	43.3j	35.5j	36.8j	40.7	22.2	32.5	23.3
31-98	zinc	220j	149j	296j	657j	234j	417j	180	191	157
	cyanide	0.52uj	0.53uj	0.52uj	0.53uj	0.54uj	0.52u	0.57	0.56u	0.52u