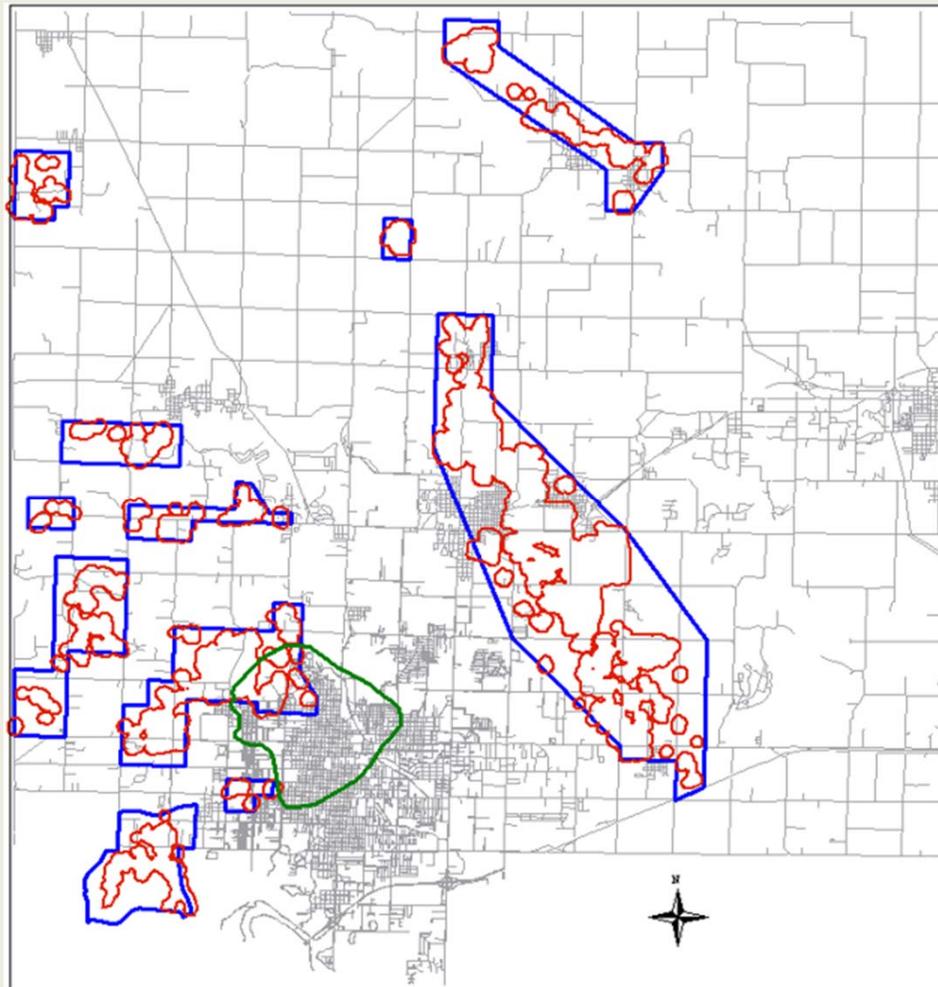


The Oronogo-Duenweg Mining Belt Superfund Site

John E. Carter, PE, RG, Senior Environmental Engineer

May 5, 2015 | Mine Design, Operations and Closure Conference

Jasper County Mine Waste Areas and Smelter Zone



Site Description

- Jasper County, Missouri portion of Tri-State Mining District of Southwestern Missouri, Northeastern Oklahoma, and Southeastern Kansas
- Majority of mining/milling operations in Jasper County run northwest from Duenweg to Oronogo
- Jasper County had 100s of mine/mills and 17 identified smelters operating from 1830s-1950s
- Most early mines were small, shallow, locally owned operations
 - In some cases, 100 x 100 foot lots
 - Ore hand mined and milled



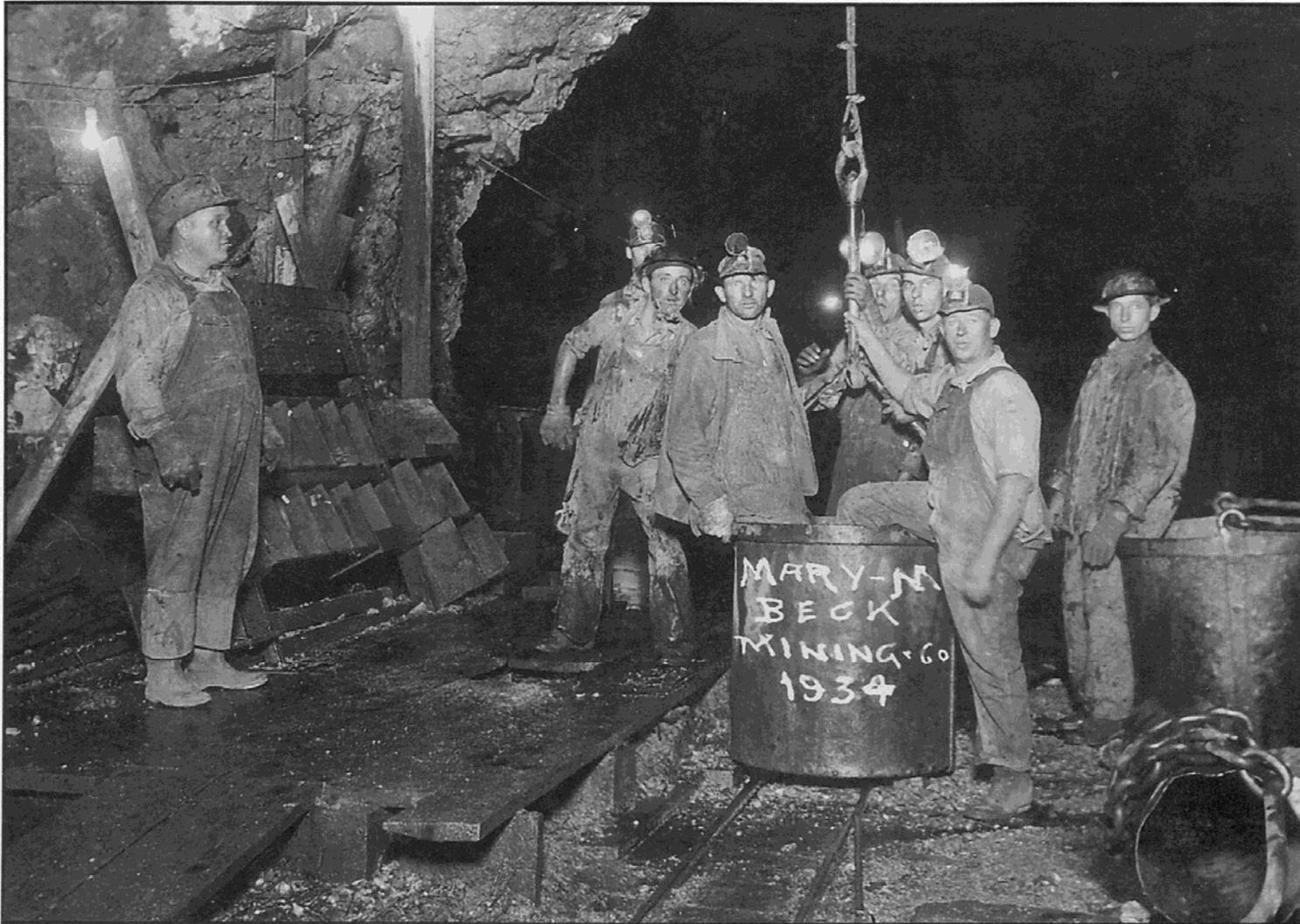
JOPLIN,
MO.

UNDER-
GROUND

762 - arbor - burrows - east - 1891 - 1892 - 1893 - 1894 - 1895 - 1896 - 1897 - 1898 - 1899 - 1900 - 1901 - 1902 - 1903 - 1904 - 1905 - 1906 - 1907 - 1908 - 1909 - 1910 - 1911 - 1912 - 1913 - 1914 - 1915 - 1916 - 1917 - 1918 - 1919 - 1920 - 1921 - 1922 - 1923 - 1924 - 1925 - 1926 - 1927 - 1928 - 1929 - 1930 - 1931 - 1932 - 1933 - 1934 - 1935 - 1936 - 1937 - 1938 - 1939 - 1940 - 1941 - 1942 - 1943 - 1944 - 1945 - 1946 - 1947 - 1948 - 1949 - 1950 - 1951 - 1952 - 1953 - 1954 - 1955 - 1956 - 1957 - 1958 - 1959 - 1960 - 1961 - 1962 - 1963 - 1964 - 1965 - 1966 - 1967 - 1968 - 1969 - 1970 - 1971 - 1972 - 1973 - 1974 - 1975 - 1976 - 1977 - 1978 - 1979 - 1980 - 1981 - 1982 - 1983 - 1984 - 1985 - 1986 - 1987 - 1988 - 1989 - 1990 - 1991 - 1992 - 1993 - 1994 - 1995 - 1996 - 1997 - 1998 - 1999 - 2000 - 2001 - 2002 - 2003 - 2004 - 2005 - 2006 - 2007 - 2008 - 2009 - 2010 - 2011 - 2012 - 2013 - 2014 - 2015 - 2016 - 2017 - 2018 - 2019 - 2020 - 2021 - 2022 - 2023 - 2024 - 2025 - 2026 - 2027 - 2028 - 2029 - 2030 - 2031 - 2032 - 2033 - 2034 - 2035 - 2036 - 2037 - 2038 - 2039 - 2040 - 2041 - 2042 - 2043 - 2044 - 2045 - 2046 - 2047 - 2048 - 2049 - 2050 - 2051 - 2052 - 2053 - 2054 - 2055 - 2056 - 2057 - 2058 - 2059 - 2060 - 2061 - 2062 - 2063 - 2064 - 2065 - 2066 - 2067 - 2068 - 2069 - 2070 - 2071 - 2072 - 2073 - 2074 - 2075 - 2076 - 2077 - 2078 - 2079 - 2080 - 2081 - 2082 - 2083 - 2084 - 2085 - 2086 - 2087 - 2088 - 2089 - 2090 - 2091 - 2092 - 2093 - 2094 - 2095 - 2096 - 2097 - 2098 - 2099 - 2100

Site Description

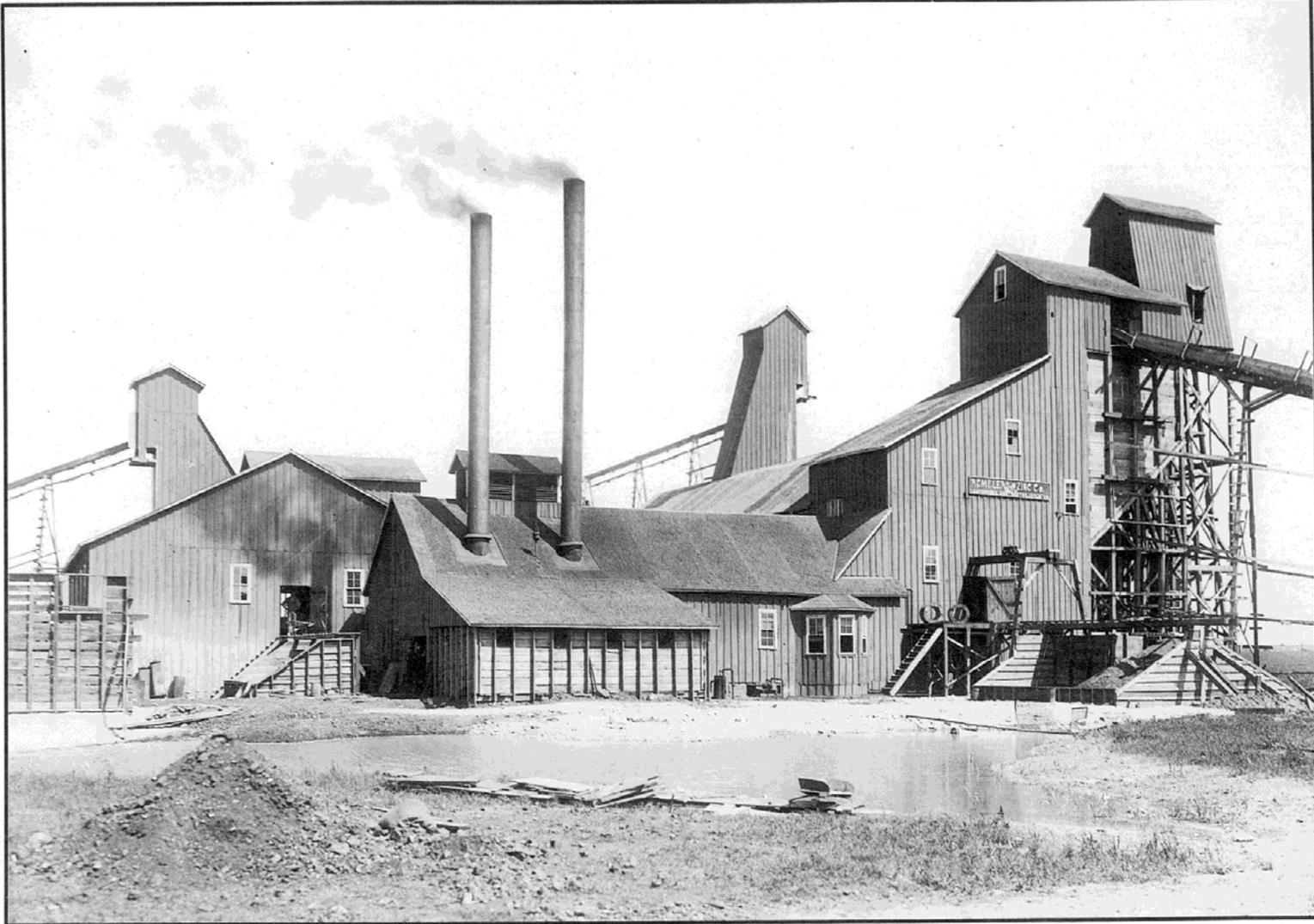
- Beginning in 1870s, coal from northern counties used in steam plants to power pumps, air compressors and milling operations
 - Allowed mine size to increase and workings go deeper
- Mining was drill and blast
 - Ore loaded into “cans,” hauled on mine rail cars to shafts where hoisted to surface and dumped into head of mill
- Cans also how miners entered/exited mines



"Going Up In A Can"
Mary-M-Beck Mine 1934

Milling Operations

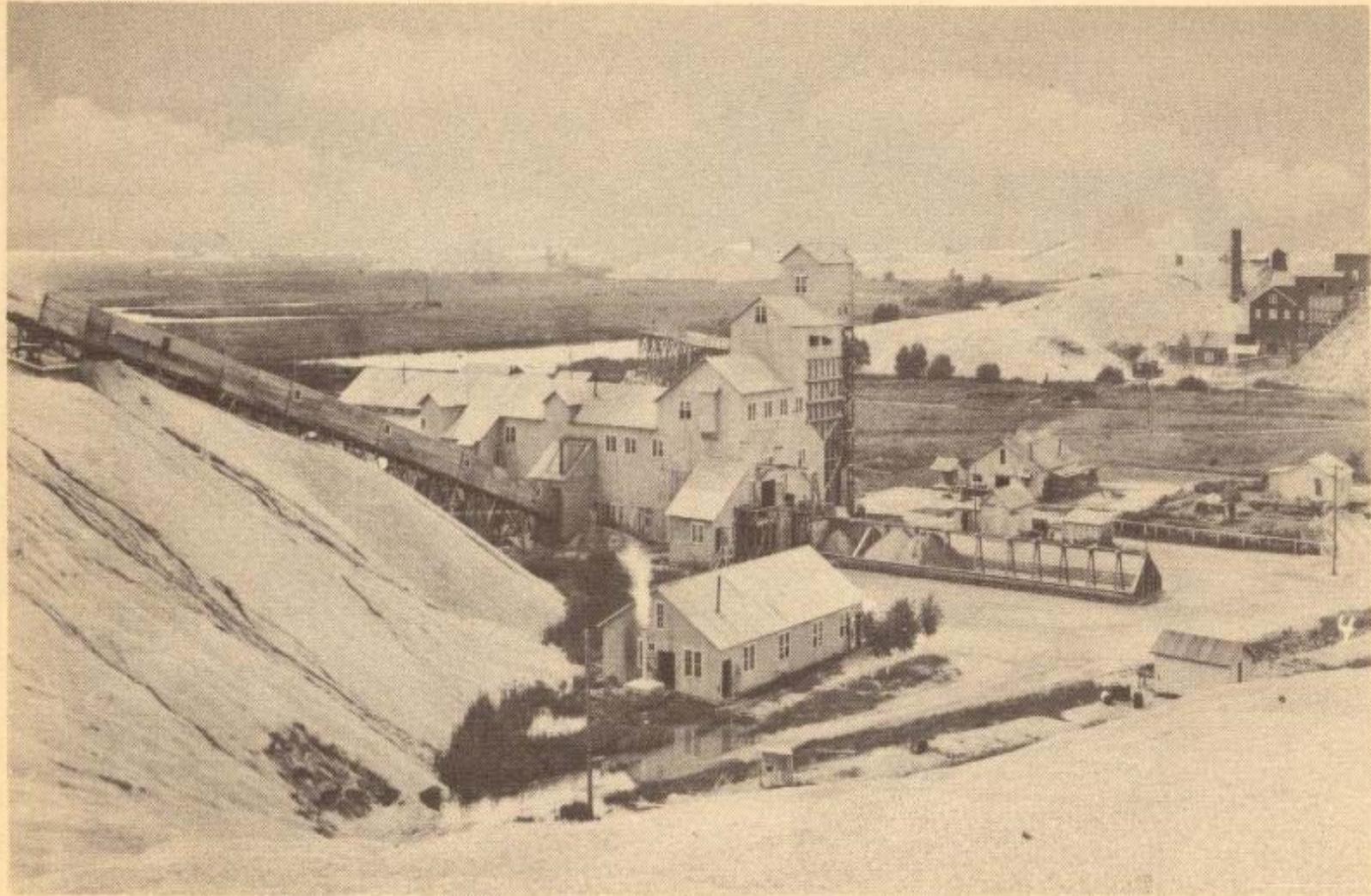
- In early mills, rock dumped from cans was hand sorted with ore chipped off large rock pieces and sent to crusher
 - This “bull rock” tossed out window, piled near shaft
- Ore went to roll crushers, then to rod mills
 - Material coming from rod mills was pea gravel size or smaller chips
 - Sent to jigs, then cleaners where lead, zinc separated from rock
 - Initially, fines from jigs went to “shaker” tables
 - In 1920s, most of mills began using froth floatation to further process fines from jigs



ACME Lead and Zinc Company"

Waste Materials

- Tailings from jigs were pea gravel, or smaller rock pieces, locally called “chat”
- Dozens of chat piles in Jasper County, some over 100 feet high with bases of 10 acres or more
- In initial USEPA studies, found 10 million tons of mine waste covering approximately 7,000 acres
- Since most operations small, locally owned, USEPA able to find Potentially Responsible Parties for < 20% of sites
- USEPA using Federal money for clean-ups—our tax dollars at work in Jasper County, Missouri



OUTSIDE VIEW OF ORE MINE



TYPICAL VIEW OF CHAT & STONE PILES IN MINING DISTRICT

Mining Production

- US Bureau of Mines production records for Jasper County show 196 million tons of ore mined and milled
- 885 thousand tons of lead, 3.6 million tons of zinc produced
 - Leaving 191.5 million tons of mine/mill wastes

Where Did the Chat Go?

- Chat considered valuable commodity in area
 - Numerous railroads built sidings up to chat piles, loaded chat into rail cars for use as ballast, rail bed material
 - Most, if not all of local roads, streets have chat bases
 - Many local buildings have chat under foundations
- Total chat used locally or transported out of area had to be 181.5 million tons since all large chat piles are gone!



USEPA Determined Site Risks

- Heavy metals found in mine wastes, soils, streams and ponds exceeding safe levels for people, wildlife



USEPA Determined Site Risks

- Developers were building residential homes near, and, in some cases, on mine wastes





USEPA Determined Site Risks

- Continual heavy metals runoff from mine wastes into area streams



USEPA Determined Site Risks

- 1994 study by Missouri Department of Health, Agency for Toxic Substances and Disease Control concluded higher number of children with elevated blood leads than national average

USEPA Created Five Operable Units

- OU-1 – To address mine/mill wastes
- OU-2 and OU-3 – To address residential yards contaminated by smelter and mine/mill wastes or emissions
- OU-4 – To address mineralized, shallow ground water
- OU-5 – To address Spring River to Grand Lake of Cherokees

Operable Unit – 1 Remedial Objectives

- Source material
 - Mitigate risks to terrestrial animals from exposure to mine/mill wastes
- Sediment
 - Mitigate risks to aquatic biota in streams, tributaries by controlling transport of mine/mill wastes
- Surface water
 - Mitigate exposure of aquatic biota to contaminants transported from mine/mill wastes areas and overflowing mine pits to streams where Federal water quality criteria is exceeded

USEPA Remedial Action Levels

- Terrestrial RALs
 - Cadmium – 40 ppm
 - Zinc – 6,400 ppm
 - Lead – 800 ppm
- Sediment RALs
 - Cadmium – 17 ppm
 - Zinc – 2,950 ppm
 - Lead – 250 ppm

OU 1 Preferred Alternative: Alternative 4

- Source removal
 - Excavation, removal of source material exceeding terrestrial and/or aquatic cleanup criteria including:
 - In- and near-stream barren, vegetated chat/tailings
 - Flood-plain and tributary chat/tailings
 - Upland chat/tailings exceeding terrestrial criteria
 - Chat/tailings located within 500 feet of residential areas

- Sediment removal
 - Excavation, removal of all sediments in tributaries draining source areas to Class P streams
 - Excavation, removal of sediment delta deposits at tributary mouths in Class P streams above low water level

Preferred Alternative (continued)

- Disposal in subsidence pits
 - All excavated and removed source, sediment material disposed in flooded mine subsidence pits
 - Filled subsidence pits covered with engineered soil cap and vegetated
- Disposal pit selection
 - Pits within ½ mile of Class P streams excluded
 - Pits with direct connection to surface water excluded
 - Pits with high quality habitat, low metals concentration excluded
 - Preference to low quality habitat, low dissolved oxygen, and low oxidation/reduction potential

Mine Subsidence Pit



Filling a Pit



Preferred Alternative (continued)

- Re-contouring, re-vegetating, soil amendments
 - Excavated areas re-contoured to promote proper drainage
 - Vegetated chat areas, transition zone soils deep-tilled; bio-solids added to improve soil structure for plant growth
 - Excavated, deep-tilled areas re-vegetated
- Shaft plugging
 - Overflowing shafts which drain to stream plugged
 - Diversion structure installed to prevent surface discharge to mine openings

Preferred Alternative (continued)

- Institutional controls
 - Implement property use restrictions for capped disposal, remediated areas, if necessary
 - Develop and implement building ordinance for residential construction in contaminated areas
- Health education
 - Continue funding HE program developed under OU 2/3
- Stream monitoring
 - Develop monitoring program to assess improvement in water and sediment quality in Class P streams resulting from cleanup actions
- Operation and maintenance
 - Develop O&M plan to establish program that maintains disposal and remediated areas

OU-1 Actions – Costs to Date

- USEPA Project Manager for Jasper County estimates USEPA has spent about \$75 million on remediated “orphan sites”
- USEPA estimates may spend another \$100 million completing OU-1 efforts
- Mining companies that remediated sites in Jasper County do not release cost figures, but my estimate is collectively spent \$20 million

GeoEngineers' Involvement

- GeoEngineers performed Oversight/Quality Assurance-Quality Control role during Remedial Action Work on 200-acre Remediation Area in City of Oronogo
- GeoEngineers prepared Remedial Design Work Plan for Remedial Action Work on 6 parcels totaling over 200 acres in Center Creek Bottoms/Quick Seven Remediation Areas

GeoEngineers' Involvement

- GeoEngineers currently performing Oversight/Quality Assurance-Quality Control role for Remedial Action Work on Center Creek Bottoms/Quick Seven Remediation Areas
- GeoEngineers presently performing Pre-Design Studies necessary to write Remedial Design Work Plan for 5 parcels totaling over 300 acres located in East Joplin Remediation Area

Muddy Areas

- It took ATV and rubber-tired backhoe to get me out



Muddy Areas

- You know you're having an interesting day when Cat 336 excavator is this stuck!
- It took about 2 hours of careful work to get this guy out



Operable Units 002 and 003

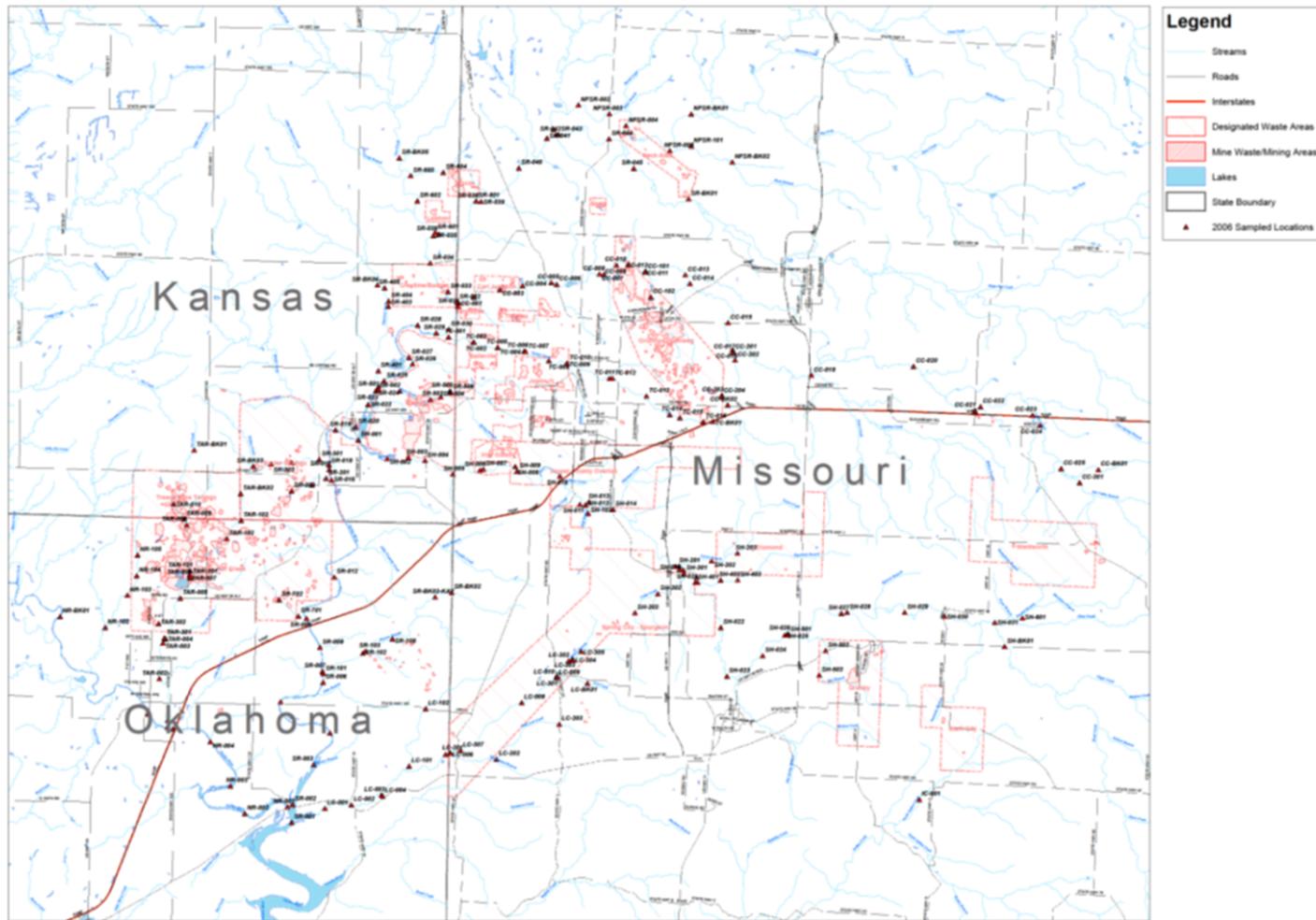
- USEPA remediated 2,600 residential yards, mainly in area around largest lead smelter—cost over \$30 million
- Jasper County Commission adopted county-wide ordinance requiring property be tested for lead contamination before building permit issued
 - Testing program conducted by Jasper County Health Department
- Jasper County Health Department through USEPA grants, ATSDR has county-wide lead education program
- To date, these actions show 78% decrease in blood lead levels in young children

Operable Unit 004 – Ground Water

- USEPA (in some cases with contributions from mining companies that operated in specific areas) created Public Drinking Water Districts
- Installed deep well/distribution systems to take water to residences where shallow ground water was mineralized
- At residences too distant to be served by Drinking Water Districts, USEPA has paid for deep well installation
- Total cost to date almost \$7 million

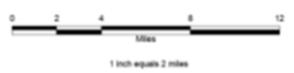
Operable Unit 005 – Spring River

- Mark Doolan, USEPA Project Manager for Jasper County/Oronogo-Duenweg Superfund Site, is designated USEPA Project Manager for OU-005
- US Geological Survey Water Resources Division, US Fish and Wildlife Service, State of Missouri, State of Kansas, State of Oklahoma, and several Native American nations in Oklahoma will be contributing to study



Legend

-  Streams
-  Roads
-  Interstates
-  Designated Waste Areas
-  Mine Waste/Mining Areas
-  Lakes
-  State Boundary
-  2006 Sampled Locations



2006 Regional Stream Investigation
 Sample Locations
 Tri-State Mining District
 Kansas, Missouri, and Oklahoma



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