Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in the Mining Center of La Oroya, Perú

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By

Centers for Disease Control and Prevention
National Center for Environmental Health/
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Division of Emergency and Environmental Health Services

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ABBREVIATIONS

ASARCO: American Smelting and Refining Company

ATSDR: Agency for Toxic Substances and Disease Registry

BLL: blood lead level

CDC: Centers for Disease Control and Prevention

DIGESA: Peruvian General Directorate of Environmental Health

INEI: National Institute for Informatics and Statistics

MEM: Ministry of Energy and Mines

NCEH: National Center for Environmental Health

NGO: nongovernmental organization

NIOSH: National Institute for Occupational Safety and Health, CDC

µg/g: micrograms per gram

µg/dL: micrograms per deciliter

UNES: The Union for Sustainable Development Consortium

USAID: United States Agency for International Development

USEPA: United States Environmental Protection Agency

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EXECUTIVE SUMMARY

La Oroya, Peru, is home to a metal smelter that has operated for more than 80 years. In October 2003, the United States Agency for International Development (USAID) asked the Centers for Disease Control and Prevention (CDC) to provide technical assistance in the development of an integrated plan for addressing the lead pollution problems in La Oroya. A team of scientists from CDC's National Center for Environmental Health (NCEH) visited Peru during March 13–22, 2004, to learn about the conditions and concerns in La Oroya. While in Peru, the NCEH team visited the Doe Run Peru La Oroya smelter facility and discussed smelter-related environmental public health issues with national, regional, and local government officials; the smelter operator; health-care providers; concerned citizens; and other stakeholders. The NCEH team also learned about the existing environmental public health infrastructure and government oversight of the mining industry in Peru. This report summarizes observations from meetings, highlights relevant findings from studies conducted in various parts of the world, and offers recommendations.

The situation in La Oroya is not a new environmental public health issue. Lead has become an increasingly important problem in Latin American and the Caribbean as a result of rapid industrialization. Studies conducted during the past 30 years in communities with metal processing plants throughout the world have documented the relations between blood lead levels (BLLs) and lead levels in air

and soil. The effects of lead are well known and range from subtle learning and behavior impairment to seizures, coma, and death.

Major findings:

- Recent (1999–2001) BLL surveys conducted in La Oroya found all children sampled had elevated BLLs (ranging from 15 to 80 micrograms per deciliter [μg/dL]). These results indicate that the children of La Oroya are being exposed to lead in their living environment.
- Emission control had not been implemented at the lead processing plant in La Oroya.
- The extent of soil contamination has not been determined, and a soil remediation plan has not been developed for implementation.
- The environmental public health infrastructure needed to control plant emissions and oversee soil remediation efforts is fragmented and lacks resources.

Recommendations:

The most immediate priority is to reduce exposure to lead and other contaminants. This is best accomplished by building the environmental public health infrastructure needed to develop and implement a comprehensive and integrated intervention plan. Stakeholders need to unite and collaborate systemically to reduce emissions, remediate soil contamination, and operate a sustainable monitoring system. Specifically, the process should

1. Reduce air lead emissions, both stack and fugitive, to levels that protect children from having BLLs ≥10 μg/dL. Until this is accomplished no other interventions will have a great impact on lowering children's BLLs.
2. Implement interventions that have been demonstrated scientifically to reduce lead exposure from historical soil contamination.
3. Develop a scientifically robust plan to monitor the impact of emission reduction efforts.

To strengthen the overall process and plan, and to improve credibility and ensure that monitoring and other needs of affected parties are met, stakeholders should participate in reduction planning, implementation, and monitoring of lead and other contaminants.

The framework presented at the closeout meeting on March 22, 2004, in Lima, Peru, and recommendations contained in this report can guide stakeholders tasked with developing and implementing a comprehensive intervention plan.

I. BACKGROUND

A. The Mining Center of La Oroya, Peru

The City of La Oroya, located in the mineral-rich department of Junín in the central sierra of Perú, is the largest and oldest smelting and refining center for lead, copper, and zinc in the country. Production processes also exist for cadmium, silver, gold, and other metals.

The La Oroya metallurgic complex has a history of mining activities spanning 80 years. La Oroya lies along the central highway and the Central Railway, the highest railway in the world. Both transportation routes wind upward from Lima, through the mountains, before reaching La Oroya at 3,371 meters. The city is 180 km northeast of Lima and has a population of approximately 35,000. (For additional site description information, see the following documents: La Oroya No Espera [Cederstav 2003]; Situación Ambiental del Aire, Aguas, y Suelos en La Provincia de Yauli–La Oroya [UNES 2002]; Estudio de Dispersión de la Contaminación Atmosférica de la Ciudad de la Oroya [DIGESA 2001]; Estudio Socio-económico 2001, Distrito La Oroya [INEI 2001]).

Results from studies conducted in Lima/Callao in 1998 and 1999 indicated that mineral concentration deposits located near homes and educational centers were the main sources of lead contamination causing elevated BLLs in children. Fifty percent of the mineral concentration deposits in Lima/Callao storage facilities originate from La Oroya. As a result of the Lima/Callao study, the General Directorate of Environmental Health (DIGESA) carried out BLL studies in selected populations in La Oroya in November 1999. Results revealed an average BLL of 33.6 µg/dL (n=346) for children 6 months to 10 years of age (Hernandez-Avila et al. 1999). More striking were results indicating that 99.1% of children examined had BLLs >10 µg/dL, the level targeted for elimination by 2010 in the United States. Given the elevated BLLs in the zone, DIGESA prioritized development of an integrated plan to improve the health of La Oroya residents.

B. Purpose and Scope of the Assessment

On October 31, 2003, the Centers for Disease Control and Prevention (CDC) received a technical assistance request developed by the United States Agency for International Development (USAID). A CDC/USAID Peru Mission interagency agreement established in 2001 allows USAID to request technical assistance from CDC on environmental and public health issues. Amendment 6 of the CDC/USAID interagency agreement Number AAG-P-00-99-00006-00 establishes the mechanism for requesting technical assistance. The request was accompanied by specific terms of reference, developed by DIGESA. The objective of the terms of reference is to support DIGESA management working to resolve health problems in the La Oroya population resulting from exposure to environmental contaminants believed to be associated with current and historical lead smelter operations. The technical assistance request specified the following activities:

- Send a CDC team to La Oroya, Peru, to assess conditions that may be contributing to reported health complaints and elevated BLLs;
- Determine pollution levels;
- Determine and assess current and planned activities to address the concerns in La Oroya by Ministry of Health officials, specifically DIGESA personnel working with mining officials, the operator of the smelter, community members, health-care providers, and nongovernmental organizations (NGOs);
- After the 10-day visit to Peru and in coordination with DIGESA, develop a work plan to address smelter-related health issues in La Oroya. The work plan

will include terms of reference for future CDC assistance and recommended actions for the ministries, mining groups, and other stakeholders.

II. CDC ASSESSMENT ACTIVITIES

In response to the technical assistance request (Appendix A) and accompanying terms of reference (Appendix B), the CDC's National Center for Environmental Health (NCEH) was assigned the task and prepared a response to USAID on December 16, 2003 (Appendix C). Dr. Sharunda Buchanan, Chief of the NCEH Environmental Health Services Branch organized and led the technical assistance team that

(1) Conducted an extensive literature review of health and environmental studies in La Oroya and other mining and mineral processing communities (Appendix D). The literature review identified 188 English-language and 15 Spanish-language documents pertinent to conditions in La Oroya. The literature review was delivered to USAID officials in December 2004. Key elements of several significant studies and notable findings are presented in the Discussion section of this report. Electronic and paper copies of lead-related documents and reports developed by U.S. government agencies were provided to DIGESA, Ministry of Energy and Mines (MEM), and USAID representatives during the March 2004 site visit. The literature review also identified the information resources listed in Appendix E.

(2) Collaborated with USAID Peru Mission, DIGESA, Doe Run Peru mining officials, and NGOs to develop a site visit agenda (Appendix F). The CDC team did not

collect human specimens or environmental samples or develop, review, or recommend an environmental sampling plan or any plans to collect and analyze human specimens.

(3) Completed technical site visits March 13–22, 2004, and met with key stakeholders in an effort to understand the complex environmental public health issues in La Oroya.

(4) Presented preliminary observations and recommendations for the development of an integrated intervention plan to Peruvian stakeholders on March 22, 2004, DIGESA Central Office, Lima, Peru (Appendix G).

(5) Developed this report as a guide for DIGESA and other stakeholders for the *Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in the Mining Center of La Oroya, Peru.*

III. FINDINGS FROM ASSESSMENT VISIT AND MEETINGS

A. Child Blood Lead Level Studies in La Oroya

During the site visit, findings from three previous studies of children's BLLs in La Oroya were presented to the CDC team. DIGESA surveyed BLLs of 139 children ages 3–10 years living in Old La Oroya in 1999. Old La Oroya is 650 meters from the main stack of the smelter. The DIGESA study reported BLLs ranging from 14.7 to 79.9 μg/dL. Mean

BLL was 43.5 µg/dL (DIGESA 1999). All children participating from Old La Oroya had BLLs >10 µg/dL. DIGESA also collected blood samples from 162 children aged 4–9 years living in New La Oroya. New La Oroya is approximately 2,500 meters from the main stack. BLLs ranged from 6.9 to 67 µg/dL, and mean BLL was 26.6 µg/dL. Forty-five children ages 3–9 years were enrolled in the study from Santa Rosa de Sacco, which is 8,100 meters from the main stack of the smelter. BLLs ranged from 14.6 to 52.5 µg/dL, and the mean BLL was 28.7 µg/dL.

UNES also surveyed BLLs of 30 children, from birth to age 3 years in 1999. Children were enrolled in the study from Old La Oroya and Santa Rosa de Sacco. BLLs ranged from 15.8 µg/dL to 64.7 µg/dL, with a mean of 41.8 µg/dL (UNES 1999). BLLs in all children surveyed were >10 µg/dL.

Doe Run Peru surveyed BLLs of 252 children from birth to age 3 years in 2000–2001. Mean BLL was 26.1 µg/dL. (PERU 2002). Mean BLLs for specific locations in the La Oroya area were 36.7 µg/dL in Old La Oroya, 27.1 µg/dL in Buenos Aries/Huaymanta, and 22.8 µg/dL in Santa Rosa de Sacco. Doe Run Peru did not report BLL ranges for children aged 0–3 years in the respective study areas.

Review of results from these three BLL studies in the La Oroya zone indicates that BLLs are elevated in the population living near to the Doe Run smelter. BLLs in La Oroya are consistent with those studies in Mexico, the United States, and other countries, which demonstrate that BLLs increase as distance to smelting activities decreases (See three

case studies in Appendix H). BLL studies provide evidence that the smelting facility in La Oroya is the main source of lead contamination in the zone.

B. Environmental Contamination

At the time of the CDC site visit (March 2004), the responsible parties had not agreed on plans to control air emissions, nor had remediation efforts needed to address historical soil contamination been implemented. In addition, the extent of contamination in the area and the magnitude of impact on surface and groundwater quality, air quality, vegetation, agricultural and ecologic systems, and human health had not been fully assessed. The geographic distribution of lead and other contaminants of concern does not appear to be well understood. No efforts have been made to remediate historical contamination. More information is necessary to develop an effective plan to remediate historical contamination

Accumulated lead resulting from the long history of smeltering activities in La Oroya is evident by numerous, large slag piles. The impact of slag waste storage practices on human health has not been fully investigated. How storage practices continue to contribute to the historical contamination in the zone is unclear. Additionally, the impact on health from transportation of material associated with smelter operations (truck, train, conveyor belt system) has not been adequately assessed.

At the time of the CDC assessment visit, the wastewater stream emanating from the smelter facility was untreated. The impact of the wastewater on drinking water supplies, surface water and groundwater, the watershed ecosystem, and downstream activities is not well understood.

C. Coordination of Activities

No one group appears to be responsible for or to manage assessment, monitoring, and remediation activities. A comprehensive plan to evaluate the environmental impact of environmental lead reduction interventions in the La Oroya zone does not exist. Similarly, no long-term coordinated plan exists to monitor BLLs as remediation efforts reduce human exposure to lead and other contaminants. Implementation activities, data collection efforts, and monitoring plans often are fragmented among agencies, incomplete, and not ongoing. These activities appear sometimes to be managed outside of the responsible governmental agency, and may not focus on the most important priorities: reduce emissions and remediate historical contamination. Data collection efforts are not coordinated and may be redundant. No one group has taken responsibility for coordinating, collecting, reviewing, and summarizing environmental and health data. Monitoring plans and data collection have not been agreed to, and the results from existing assessments and investigations do not appear to be consistently shared with stakeholders. Whether laboratory capacity exists within DIGESA for monitoring activities is not clear; lack of such capacity may limit efforts to develop effective monitoring systems for BLLs and remediation efforts.

D. Hygiene

A hygiene education program is being implemented in La Oroya. Some local officials thought hand washing and house cleaning would protect children from lead poisoning. However, studies conducted around the world have demonstrated that efforts focused solely on hygiene and behavior change will not yield significant results until reduction of emission levels and remediation of historical contamination are prioritized.

E. Communication

A health risk communication plan does not exist for the La Oroya zone, and no process is in place to develop a plan for communicating risk. The La Oroya community, national and local government officials, Doe Run Peru management, and health-care providers do not appear to have reached consensus on potential health impacts from exposure to smelter operations. Limited public health infrastructure at the national and local levels may impede collection and generation of information needed to clearly and promptly communicate health status to authorities, decision makers, Doe Run Peru, and community residents.

Health-care providers in La Oroya and Huancayo appear to place more priority on curative measures than preventive measures. Health authorities may not have sufficient information about measures that can significantly prevent and control human exposure to

lead and other contaminants from mining activities. Without the appropriate information and participation in active programs health-care providers support curative care more than preventive care. The specific issue of chelation was addressed during the CDC visit to the Regional Health Directorate in Huancayo. CDC's recommendations are located in Appendix I.

Current and culturally appropriate procedures for assessing children's behavior and symptoms for signs of lead poisoning are not widely and consistently used in La Oroya. Access to appropriately designed tools to measure the chronic behavioral changes associated with lead intoxication may afford local health-care providers a clearer understanding of the extent of human health and contamination problems in La Oroya, as well as in other mining communities. All children with elevated BLLs—virtually the entire childhood population—should be evaluated for developmental delay, speech and reading difficulties, and cognitive development at school entry.

Local residents receive conflicting educational material on environmental contaminants, health effects, and risk levels. Some community members also expressed concern that they were not fully participating in discussions and decision-making regarding health impacts from exposure to contaminants.

IV. DISCUSSION

A. Importance of Lead

Lead is a toxic metal that occurs naturally in the environment. The production and use of lead in industry and in consumer products has exposed people to lead. Because lead is a basic element, it cannot be degraded or broken down into a less toxic substance. Therefore, when lead is found near human settlements by either naturally occurring or anthropogenic processes, it may threaten public health until removed. Effective technology exists to control lead in the environment. The best way to minimize introduction of lead into the environment from industrial activities is to control emissions.

The lead industry plays an important role in the economy of La Oroya and Peru. The growing economies of other Latin American and the Caribbean countries also benefit from the collection, transportation, and processing of lead-containing ore (Romieu et al. 1997). Lead has been used for hundreds of years in industrial and manufacturing processes, and it is found in many products used today. Lead production increases with demand for this natural resource. The mining and processing of lead containing ore can release harmful contaminants into the environment. Even at low concentrations, exposure to lead can be detrimental to human health. The processing of lead ore also can emit other metals of concern, such as arsenic and cadmium (Baghurst et al. 1992; Landrigan et al.

1975; McMichael et al. 1985; Roels et al. 1980; Diaz-Barriga et al. 1997; Benin et al. 1999).

B. Lead and Human Health

Lead is not a natural constituent of the human body. Lead may enter the body by ingestion and inhalation. Exposure pathways include industrial emissions, auto emissions, lead-based paint, ambient air, indoor and outdoor dust, and soil (Figure 1). In communities where lead is processed, air emissions are a primary concern. Airborne lead from smelter operations accumulates in soil. Lead particles can be resuspended by wind and human activities. Particles <10 μg, and especially those <2.5 μg, can bypass the body's respiratory defense systems and enter the lung. Particles >10 μg can be deposited on food, and in soil and water, and ingested. Young children who commonly engage in hand-to-mouth activities are more likely than older children or adults to ingest lead contained in soil. Studies conducted around smelters suggest that direct inhalation of airborne lead is the principal route of lead absorption for adults (Roels et al. 1980; Yankel et al. 1977). In children the common route of exposure is ingestion of lead contaminated soil (Yankel et al. 1977) and dust (Roels et al. 1980).

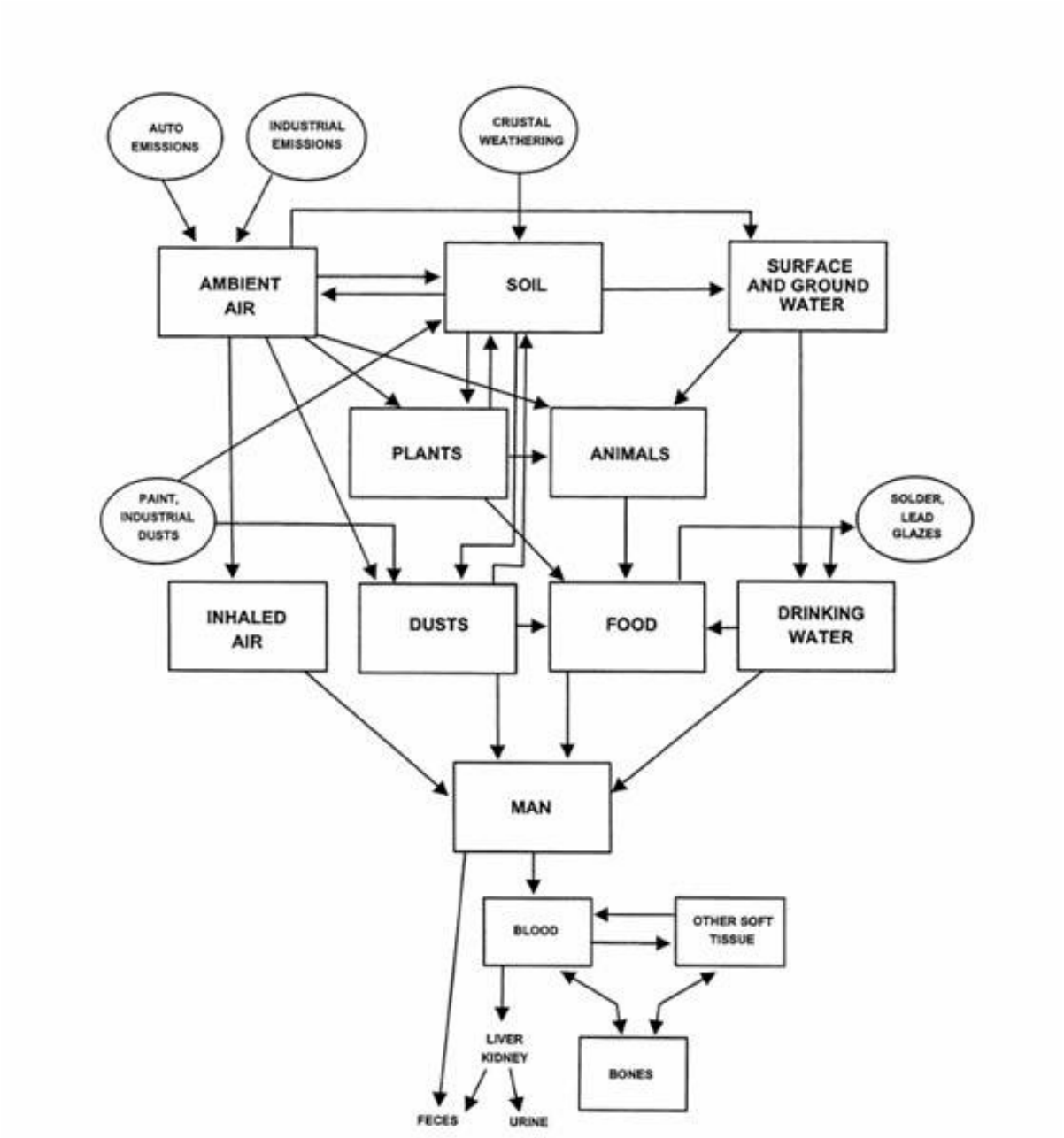
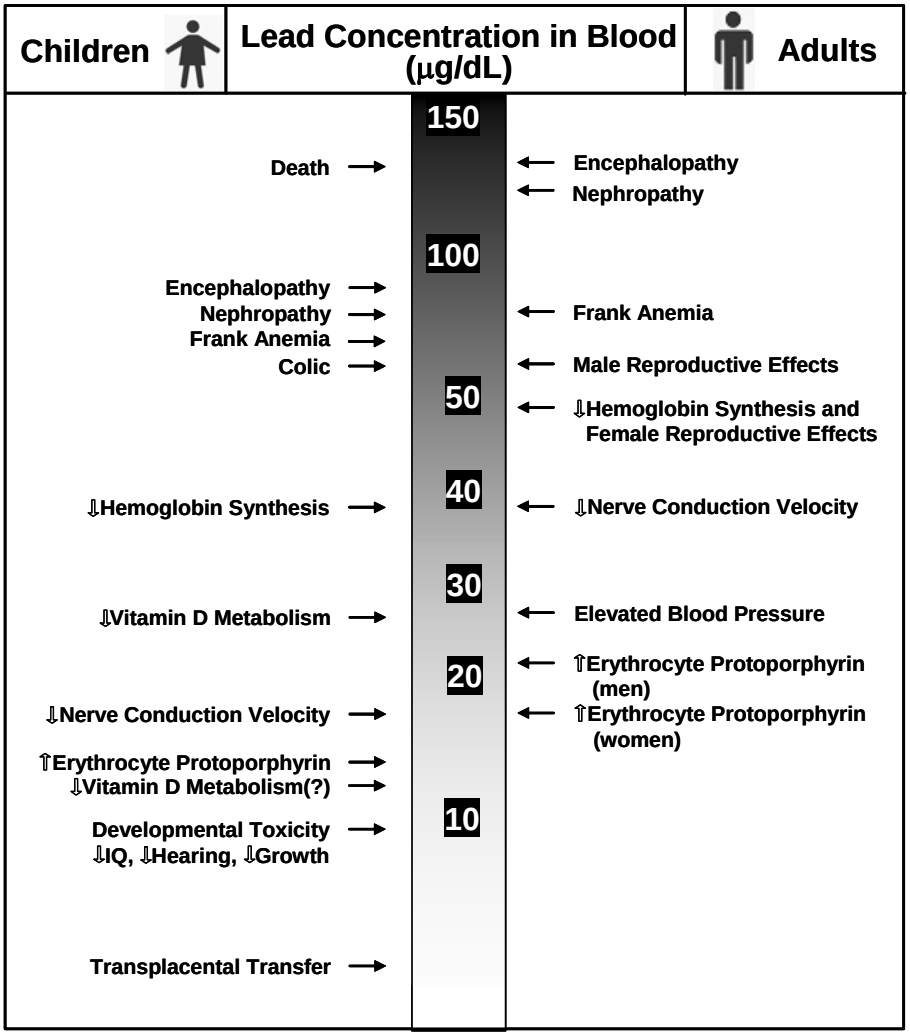


Figure 1. Pathways of Lead from the Environment to Humans, Main Organs of Absorption and Retention, and Main Routes of Excretion. (Sources USEPA, 1986; USEPA, 1996a)

The effects of lead are well known and range from subtle learning and behavior impairment to seizures, coma, and death (Figure 2). Children are vulnerable to lead's adverse health effects. At very high blood lead concentrations (≥80 µg/dL in children), lead can cause encephalopathy (brain damage), coma, or death. At levels <60 µg/dL distinctive symptoms may not be evident; however, children still can experience long-term adverse health effects. Studies have found low to moderate BLLs in children are related to learning and behavior problems. Even BLLs <10 µg/dL have adverse health effects in children. No safe level of lead is known. Because most children with elevated BLLs do not have symptoms that would prompt their families to seek medical care for them, lead poisoning has been called the "silent epidemic".

In adults, high BLLs are related to hypertension and cardiovascular disease. Lead can be carried from maternal to fetal circulation through the placenta and enter the growing fetal brain. That exposure of the fetus to lead, even at maternal blood levels <10 µg/dL, adversely affects fetal brain development. (For additional information about the health effects of lead exposure see Appendix D).

Figure 2. Blood lead levels associated with adverse health effects



Note: ⇑ = increased function and ⇩ = decreased function.

Source: Adapted from case studies in Environmental Medicine: Lead Toxicity, 1990, ATSDR

C. Global Lead Reduction Studies

The following series of studies summarize activities to identify and reduce human exposure to contaminants generated by mining and metal processing activities. The interventions implemented to protect human health are similar. Responsible authorities in

each community focused on control of emissions, and remediation of historical contamination. These essential interventions also should be implemented in La Oroya. The CDC technical assistance team emphasized the importance of developing an intervention plan that integrates these lead reduction and control measures during their presentation of preliminary observations and recommendations to Peruvian stakeholders on March 22, 2004, in Lima, Peru (Appendix G).

The following studies and others (Appendix D) clearly show uncontrolled air emissions from smelting activities to be correlated with high BLLs in populations residing near smelter operations. High lead levels have been measured in air, soil, and dust near smelters, and lead levels are highest closest to smelters for soil (Landrigan et al. 1975; Landrigan et al. 1976; Garcia-Vargas et al. 2001; Díaz-Barriga et al. 1997), air (Roberts et al. 1974; Roels et al. 1980; Landrigan et al. 1975; Garcia-Vargas et al. 2001), and dust (Landrigan et al. 1975; Benin et al. 1999; Vargas et al. 2001). Lead concentrations in air, soil, and dust are highly correlated with each other (Roels et al. 1980).

Elevated BLLs in children are related to high levels of lead in soil (Yankel et al. 1977; Brunekreef et al. 1981; Hertzman et al. 1991; Cook et al. 1993; Kimbrough et al. 1995; Lanphear BP 1998, Mielke and Reagan 1998), and lead in air (Landrigan et al. 1976). Consequently, children living closest to smelters have higher BLLs than children living farther away (Yankel et al. 1977; Letourneau and Gagne 1992; Landrigan et al. 1975; Roels et al. 1980; Hertzman et al. 1991; Gagne 1994; Kimbrough et al. 1995; Albalak et al. 2003; Maynard et al. 2003).

Table 1. Blood lead levels (BLLs) by distance from ASARCO smelter, El Paso, Texas, August 1972.

Distance from smelter	Age range (years)	Number tested	Percentage with BLL 40–59 µg/dL*	Percentage with BLL>59 µg/dL
<1 mile	1–4	49	55%	14%
	5–9	101	34%	11%
	10–19	109	25%	6%
	≥20	98	16%	0
1–3 miles	1–4	83	23%	4%
	5–9	124	12%	0
	10–19	292	3%	1%
	≥20	513	3%	1%

*Concentration of lead in micrograms per unit whole blood in deciliters (µg/dL whole blood)

Source: Landrigan, et al. (1975). Epidemic lead absorption near an ore smelter. The role of particulate lead. N Engl J Med 292:123–9.

When the principal pathway of lead exposure, air emissions, is controlled, BLLs decrease. Soil then replaces air as the primary source of lead exposure. A significant portion of the population can be exposed to soil lead at concentrations that may elevate BLLs to >10.0 µg/dL, the CDC-recommended action level for children. Young children can be exposed to lead in indoor dust, especially when they exhibit hand-to-mouth activities. Higher lead concentrations in indoor dust result in elevated lead concentrations

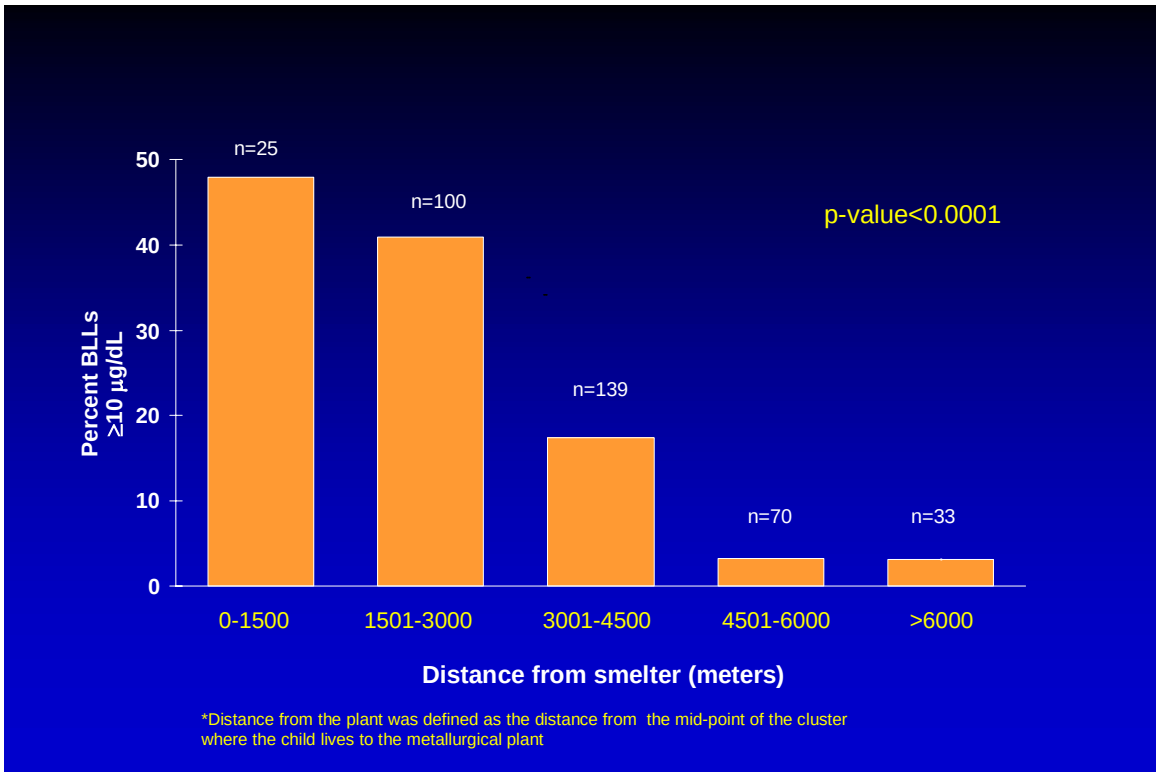
in nearby soil (Kimbrough et al. 1995; Louekari et al. 2004) and higher BLLs among children (Brunekreef et al. 1981; Hertzman et al. 1991; Kimbrough et al. 1995). Studies conducted around smelters after closure (Diaz-Barriga et al. 1997) or after a reduction in emissions (Morse et al. 1979) show lead-contaminated soil to be an important source of lead exposure for young children. This demonstrates the persistence of lead in the environment, even after the source of contamination is controlled or removed.

Table 2. Distribution of BLLs in children living in different sectors of the Anapra Neighborhood, Ciudad de Juarez, Mexico, 1997.

	Blood Lead Levels (μg/dL)		
Sector	**<10.0**	**10.0–15.0**	**>15.0**
I (within 600 meters of smelter; n=7)	57%	29%	14%
II (600–1200 meters from smelter; n=19)	79%	16%	5%
III (1200–1800 meters from smelter; n=18)	89%	6%	5%

Source: Diaz-Barriga, F., Bates A, Calderon J, Lugo A, Galvao L, Lara I, et al. (1997). The El Paso Smelter 20 years later: residual impact on Mexican children. Environ Res 74:11–16.

Figure 3. Percentage of blood lead levels (BLLs) ≥10 µg/dL by distance from the Met-Mex Peñoles metal processing plant, Torreón, Coahuila, Mexico, 2003



Source: Albalak, R, McElroy, R, et al. (2003). Blood lead levels and risk factors for lead poisoning among children in a Mexican smelting community. Arch Environ Health 58:172–183.

The feasibility of reducing children's lead absorption near smelting facilities is well established. When smelters are closed, air lead levels (TACB 1992) and children's BLLs (Diaz-Barriga et al. 1997) decrease dramatically. However, effective technology exists that can reduce dangerous lead emissions without closing smelters (Prpic-Majic et al.

1992, Hilts et al. 2003, Louekari et al. 2004). Controlling air emissions and remediation of contaminated soils have proven to substantially reduce BLLs.

Soil remediation efforts lower lead concentrations in soil (Gagne 1994; Lanphear et al. 2003), dust (Lanphear et al. 2003) and children's BLLs (Von Lindern et al. 2003; Lanphear et al. 2003). Children who place contaminated fingers, thumbs, or objects in their mouths can ingest soil and dust containing lead. This childhood behavior is an important source of exposure and highlights the need to reduce lead emissions to the air while simultaneously removing lead-contaminated soil and dust (Roels et al. 1980).

Removing lead-contaminated dust from the living environment is difficult, especially when lead emissions continue and lead-contaminated soil remains around the home. Smelter workers also may bring lead dust into the family living environment. Without reduction of air emissions and remediation of soil, home hygiene and clean neighborhood campaigns are of little value in decreasing elevated BLLs. An evaluation of a dust reduction effort that consisted of High Efficiency Particulate Air (HEPA) vacuuming once every 6 weeks for 1 year found no effect on children's BLLs and is not recommended as the main intervention strategy in a community with high smelter lead emissions (Hilts et al. 1995). Lead in house dust was decreased when lead soil remediation and air pollution controls were implemented (Von Lindern et al. 2003).

Public health education and hygiene efforts alone are of little benefit in reducing elevated BLLs. Educational interventions may help reduce BLLs after implementation of major

source-control measures, such as control of fugitive emissions and construction of new state-of-the-art smelters (Hilts et al. 1998) or smelter closure (Kimbrough et al. 1995) and soil and dust remediation (Goulet et al. 1996).

V. CONCLUSIONS

1. *Minimal lead control exists*. The Ministry of Energy and Mines, Directorate of Environmental Health, Ministry of Health, Regional Environmental Council of the Central Andean National Environmental Commission, Doe Run Peru, and NGOs recognize the need to reduce the release of lead and other contaminants from the Doe Run Peru smelter in La Oroya. However, lead reduction interventions have been delayed. No action has been taken to remediate lead-contaminated soil. An independent government authority does not monitor the effectiveness and impact of implemented interventions. The presence of lead in soil, dust, water resources, and ambient air probably will continue to keep BLLs elevated in people in and around La Oroya. Ongoing discussions delay the protection young children need in La Oroya

2. *Authorities for lead control are fragmented*. A fragmented multiagency system exists to monitor and manage the environmental public health risks associated with lead smelter operations in La Oroya. Agencies act independently. DIGESA staff report they do not have the resources or authority to address the issues in La Oroya. Several organizations, including Doe Run Peru, have requested

establishment of a multisectoral work team with active participation by the Municipality, Ministry of Health, Ministry of Energy and Mines, Ministry of Transportation, and Centromín Peru and others to develop and implement a La Oroya Environmental Health and Hygiene plan.

3. *Many stakeholders feel unrepresented*. Concerned members of the community and critical stakeholders are not part of this team. Some community members believe their opinions and concerns are not considered by Doe Run Peru management or government decision-makers. Community members and stakeholders do not have a safe and open forum to express concerns and offer solutions.

4. *No comprehensive list exists of lead health and environmental issues*. A comprehensive list of problems, issues, and concerns associated with the La Oroya metallurgic complex does not exist. Scientific literature indicates that multiple metals often coexist, and these and other waste products of the smelting process can adversely affect health. Metals and contaminants likely to affect health include arsenic, cadmium, particulate matter, sulfur dioxide, and zinc.

5. *Environmental and health impacts have not been established*. Baseline environmental and human health measures and impacts have not been established for the region. Wastewater management practices at the Doe Run La Oroya smelter are not adequately monitored by an independent government authority.

The lack of information about the impacts of wastewater may make development of a plan to manage wastewater ineffective.

VI. RECOMMENDATIONS

The most immediate priority is to reduce exposure to lead and other contaminants. This is best accomplished by building the environmental public health infrastructure needed to develop and implement a comprehensive and integrated intervention plan. (The detailed framework of such a plan is outlined in Appendix J). Stakeholders must unite and work together systematically to reduce emissions, remediate soil contamination, and operate a sustainable monitoring system. Specifically, the process should address the following areas:

1. Reduce air lead emissions, both stack and fugitive, to levels that protect children from having BLLs ≥10 µg/dL. Until this is accomplished, no other interventions will have a great impact on lowering children's BLLs.
2. Implement interventions demonstrated scientifically to reduce lead exposure from historical soil contamination.
3. Develop a scientifically robust plan to monitor the impact of emission reduction efforts.

To strengthen the overall process and plan, and to improve credibility and ensure that monitoring and other needs of affected parties are met, stakeholders should participate in

reduction planning, implementation, and monitoring not only of lead, but also of other contaminants as well.

VII. REFERENCES

Albalak R, McElroy RH, Noonan G, Buchanan S, Jones RL, Flanders DW, et al. 2003. Blood lead levels and risk factors for lead poisoning among children in a Mexican smelting community. Arch Environ Health 58:172–183.

Baghurst P, Tong S, McMichael A, Robertson E, Wigg N, Vimpani G. 1992. Determinants of blood lead concentrations to age 5 years in a birth cohort study of children living in the lead smelting city of Port Pirie and surrounding areas. Arch Environ Health 47:203–210.

Benin AL, Sargent JD, Dalton M, Roda S. 1999. High concentrations of heavy metals in neighborhoods near ore smelters in northern Mexico. Environ Health Perspect 107:279–28.

TACB. 1992. Air quality in Texas: Twenty years of environmental protection. Austin, TX: Texas Air Quality Control Board.

Brunekreef B, Veenstra S, Biersteker, Boleu J. 1981. The Arnhem lead study: Lead uptake by 1-to-3 year old children living in the vicinity of a secondary lead smelter in Arnhem, the Netherlands. Environ Res 25:441–48.

Cederstav AK, Barandiarán AG. 2002. La Oroya Cannot Wait. Oakland, CA and Lima, Peru: Peruvian Society of Environmental Law (SPDA), Inter-American Association for Environmental Defense (AIDA).

Cook M, Chappell W, Hoffman R, Mangione E. 1993. Assessment of blood lead levels in children living in a historic mining and smelting community. Am J Epidemiol 137:447–55.

Diaz-Barriga F, Bates A, Calderon J, Lugo A, Galvao L, Lara I, et al. 1997. The El Paso smelter 20 years later: residual impact on Mexican children. Environ Res 74:11–16.

DIGESA. 1999. Estudio de plomo en sangre en una población seleccionada de La Oroya. Lima, Perú: DIGESA.

DIGESA. 2001. Estudio de dispersión de la contaminación atmosférica de la ciudad de La Oroya–Junín. Lima, Perú: DIGESA.

Gagne D. 1994. Blood lead levels in Nornada children following removal of smelter-contaminated yard soil. Can J Public Health 85:163–166.

Garcia-Vargas GG, Rubio Andrade M, Del Razo LM, Borja Aburto V, Vera Aguilar E, Cebrian ME. 2001. Lead exposure in children living in a smelter community in region Lagunera, Mexico. J Toxicol Environ Health A 62:417–29.

Goulet L, Messier A. 1996. Results of a lead decontamination program. Arch Environ Health 51:68–72.

Hernandez-Avila M, Lain RE, Carbjal L. 1999. Estudio de plomo en sangre en población seleccionada de Lima y el Callao (Junio 1998–Marzo 1999). Environ Health Proj Act Rep 72.

Hertzman C, Ward H, Ames N, Kelly S, Yates C. 1991. Childhood lead exposure in Trail revisited. Can J Public Health 82:385–91.

Hilts S, Bock S, Oke T, Yates C, Copes R. 1998. Effect of interventions on children's blood lead levels. Environ Health Perspect 106:79–83.

Hilts S, Hartzman C, Marion S. 1995. A controlled trial of the effect of HEPA vacumming on childhood lead exposure. Can J Public Health 86:345–50.

Hilts SR, Goodarzi F, Sanei H, Labonte M, Duncan WF, Bock SE, et al. 2003. Effect of smelter emission reductions on children's blood lead levels. Sci Total Environ 303:51–58.

INEI. 2001. Estudio socio-económico 2001. La Oroya, Perú: Instituto Nacional de Estadística e Informática Junín.

Kimbrough R, LeVois M, Webb D. 1995. Survey of lead exposure around a closed lead smelter. Pediatrics 95:550–54.

Landrigan P, Baker E, Feldman G, Cox D, Eden K, Orenstein W, et al. 1976. Increased lead absorption with anemia and slowed nerve condition near a lead smelter. J Pediatr 89:904–10.

Landrigan PJ, Gehlbach SH, Rosenblum BF, Shoults JM, Candelaria RM, Barthel WF, et al. 1975. Epidemic lead absorption near an ore smelter. The role of particulate lead. N Engl J Med 292:123–9.

Lanphear B, Succop P, Roda S, Henningsen G. 2003. The effect of soil abatement on blood lead levels in children living near a former smelting and milling operation. Public Health Rep 118:83–91.

Lanphear BP, Matte TD, Rogers J, Clickner RP, Dietz B, Bornschein RL, et al. 1998. The contribution of lead-contaminated house dust and residential soil to children's blood lead levels. Environ Res 79:51–68.

Letourneau G and Gagne D. 1992. Blood lead level in children living close to a smelter area: 10 years later. Can J Public Health 83:221–25.

Louekari K, Mroueh U, Maidell-Munster L, Valkonen S, Tuomi T, Savolainen K. 2004. Reducing the risks of children living near the site of a former lead smelter. Sci Total Environ 319:65–75.

Maynard E, Thomas R, Simon D, Phipps C, Ward C, Calder I. 2003. An evaluation of recent blood lead levels in Port Pirie, South Australia. Sci Total Environ 303:25–33.

McMichael A, Baghurst P, Robertson E, Vimpani G, Wigg N. 1985. The Port Pirie cohort study; blood lead concentrations in early childhood. Med J Aust 143:499–503.

Mielke H, Reagan P. 1998. Soil is an important pathway of human lead exposure. Environ Health Perspect 106:217–29.

Morse D, Landrigan P, Rosenblum B, Hubert J, Housworth J. 1979. El Paso revisited. Epidemiologic follow-up of an environmental lead problem. JAMA 242:739–41.

DRP. 2002. Estudio de niveles de plomo en la sangre de la población en La Oroya 2000–2001. La Oroya, Perú: DOE RUN PERU.

Prpic-Majic D, Pongracid J, Hrsak J, Pizent A. 1992. A follow-up study in a lead smelter community following the introduction of an effective pollution control system. Isr J Med Sci 28:548–56.

Roberts T, Hutchinson T, Paciga J, Chattopadhyay A, Jervis R, VanLoon J. 1974. Lead contamination around secondary smelters: estimation of dispersal and accumulation by humans. Science 186:1120–2.

Roels H, Buchet J, Lauwerys R, Bruaux P, Claeys-Thoreau F, Lafontaine A, et al. 1980. Exposure to lead by the oral route and the pulmonary routes of children living in the vicinity of a primary lead smelter. Environ Res 22:81–94.

Romieu I, Lacasana M, McConnell R. 1997. Lead exposure in Latin America and the Carribbean. Lead Research Group of Pan-American Health Organization. Environ Health Perspect 105:398–405.

UNES. 1999. Evaluación de niveles de plomo y factores de exposición en gestantes y niños menores de 3 años de la ciudad de La Oroya. La Oroya, Perú: Consorcio Unión Para El Desarrollo Sustentable.

UNES. 2002. Situación ambiental del aire, aguas, y suelos en la provincia de Yaulí–La Oroya. La Oroya, Perú: Consorcio Unión para el Desarrollo Sustentable.

Vargas G, Andrade MR, Razo LD, Aburto VB, Aguilar EV, Cebrian M. 2001. Lead exposure in children living in a smelter community in Region Lagunera, Mexico. J Toxicol Environ Health 62:417–29.

Von Lindern I, Spalinger S, Bero B, Petrosyan V, Von Braun M. 2003. The influence of soil remediation on lead in house dust. Sci Total Environ 303:59–78.

Yankel A, Von Lindern I, Walter S. 1977. The Silver Valley lead study: the relationship between childhood blood lead levels and environmental exposure. J Air Poll Control Assoc 27:763–7.

Appendix A: USAID Technical Assistance Request

AGENCIA PARA
EL DESARROLLO
INTERNACIONAL

October 31, 2003

Ms. Marilyn R. DiSirio
Associate Director for Global Health/NCEH/CDC
Chief, International Emergency and Refugee Health Branch
EEHS/NCEH/CDC
4770 Buford Highway, NE, F-48
Atlanta, GA 30341-3724

Mr. Derrick Lake
Public Health Analyst
Edward R Roybal Campus
1600 Clifton Road, NE, D-69
Atlanta, GA 30333

Dear Ms. DiSirio and Mr.Lake:

I would like to make reference to the Amendment No. 6 dated April 16, 2002, to the Interagency Agreement AAG-P-0099-00006 between the Centers for Disease Control (CDC) and USAID. By this Amendment, CDC and USAID agreed to extend the services of CDC, to provide technical assistance to Peru and Peruvian Institutions implementing the USAID funded Activity Urban Environmental Health (EH). The total amount made available for these services was $100,000. Finally, the Amendment No. 6 also specified that specific Terms of Reference would be developed on each occasion that a specific task is requested.

With regard to the definition of areas of CDC's assistance, we would like to inform you that USAID/Peru and the Directorate for Environmental Health (DIGESA), which is the Government of Peru's counterpart agency for the EH Activity, have agreed to focus the assistance services on addressing the environmental health threats related to lead air pollution in the mining center of La Oroya. DIGESA has already prepared preliminary Terms of Reference, attached to this letter, for an integrated plan to improve with CDC's support, the health conditions at La Oroya. DIGESA has shared these ToR with Mr. Brian Hubbard and other CDC officers, who have confirmed that CDC has the capability of providing the required assistance.

By this letter we would like to officially request CDC's assistance for addressing the lead pollution problems in La Oroya, within the general framework of the preliminary plan prepared by DIGESA. As the first step for the provision of this assistance, we request CDC to send an assessment team to Peru for approximately 10 days to evaluate general conditions at La Oroya, determine pollution levels, meet with DIGESA and other Ministry of Health Officials, mine officials and workers, nearby communities, related non-government organizations and other stakeholders, and identify and assess ongoing and planned relief activities. Based on this assessment, the team will then prepare a work program to address threats in La Oroya. This will include terms of reference for future CDC assistance and recommended actions by the Ministry, the mine and other stakeholders to reduce the level of lead pollution.

AV. LA ENCALADA S/N CDRA. 17 MONTERRICO - SURCO
TELEFONO: 618-1200 FAX: 618-1350

It has been recommended that the initial assessment team should include specialists in lead studies and environmental health with emphasis on lead and toxicology. Likewise, the names of Drs. Mary Jean Brown and Dr. Sharunda Buchanan have been suggested for the first two areas, and a specialist from ATSDR for toxicology.

We hope that CDC will be able to put together and mobilize this team to Peru within the next few weeks. Please feel free to call me if you want to discuss in further detail the general aspects of this assistance. If you need additional technical information from the Ministry of Health on the mission, your contact person should be Mr. Jorge Albinagorta, Director of the EH Project Unit at DIGESA.

We would appreciate your prompt response to this request, and look forward to receiving the proposal for this assessment mission soon from CDC.

Sincerely,

Ediberto Alarcon
Environmental Health Activity Manager
Office of Environment and Natural Resources

Cc:
DIGESA:JAlbinagorta
CONAM/STEM:RSalas

Appendix B: DIGESA Terms of Reference

CONVENIO DIGESA-USAID
UNIDAD COORDINADORA DE LA ACTIVIDAD DE SALUD AMBIENTAL

TERMINOS DE REFERENCIA

PLAN INTEGRAL PARA MEJORAR LA SALUD DE LA POBLACION DE LA OROYA

I. JUSTIFICACION

La Ley General de Salud Ley N° 26842, establece que corresponde a la Autoridad de Salud, dictar las medidas para minimizar y controlar los riesgos para la salud de las personas derivados de elementos, factores y agentes ambientales, de conformidad con lo que establece la ley de la materia.

A partir de los resultados de monitoreo de plomo en sangre realizado en 346 niños de distintas zonas de la ciudad de La Oroya[1], llevado a cabo por la Dirección General de Salud Ambiental – DIGESA – del Ministerio de Salud en noviembre de 1999, se ha podido determinar que existe una situación crítica en la salud de la población infantil de La Oroya por intoxicación por plomo lo cual requiere de una urgente intervención.

Asimismo estudios realizados por DIGESA en el año 2001, evidenciaron que las muestras de suelo en los distritos de la Oroya Antigua y Santa Rosa de Sacco, superaron el limite permisible por el CDC[2] en el 100% de las muestras analizadas y en la Oroya Nueva en el 87.5%. Del mismo modo las evaluaciones del polvo evidenciaron valores de plomo por encima del límite[3] en el 70% de las muestras analizadas en la Oroya Antigua, 28.57% en Santa Rosa de Sacco y 18.18% en la Oroya Nueva, evidenciando de esta manera potenciales vías de exposición de plomo a la población.

El Reglamento de Estándares Nacionales de Calidad Ambiental del Aire, señala que el Ministerio de Salud es la autoridad competente en declarar los estados de alerta cuando se exceda o se pronostique exceder severamente la concentración de contaminantes del aire, así como para establecer y verificar el cumplimiento de las medidas inmediatas que deberán aplicarse en el caso de presentarse un estado de alerta.

Que de acuerdo al Reglamento de los Niveles de Estados de Alerta Nacionales para Contaminación del aire DS 009-2003-SA se ha declarado en zona de atención prioritaria La Oroya.

La Actividad de Salud Ambiental contempla dentro de su Plan operativo 2003 una línea de trabajo de apoyo específico al desarrollo de un Plan Integral para mejorar la Salud de la Población de la Oroya, el cual será elaborado con asistencia técnica del Centro de Control de

[1] *Referenciado en el Estudio "Análisis de la Contaminación Ambiental por el Complejo Metalúrgico y sus impactos en la Salud" – Ana K. Cedustrar y Alberto Barandarían AIDA/SPDA/2002.*

[2] *Límite establecido por el CDC para plomo en muestras de suelo: 400 ug Pb/g*

[3] *Límite establecido por el CDC para plomo en muestras de polvo: 800 ug Pb/g*

Enfermedades de los Estados Unidos, en el marco del Convenio Inter.-agencia entre USAID y el CDC.

Considerando que los estudios de diagnostico desarrollados por DIGESA nos muestran una ciudad en riesgo por la concentraciones de plomo en aire y sangre y siendo ésta declarada como zona prioritaria, se ha determinado desarrollar como prioridad este plan integral que permita implementar una serie de medidas de intervención en la población que tengan como objetivos reducir la exposición de la población, detección, atención y vigilancia de casos críticos, y el logro de cambios de hábitos.

II. OBJETIVO DEL PROGRAMA

El objetivo del programa es apoyar la gestión de DIGESA en la resolución de problemas de salud en la población de la Oroya, derivados de la exposición a concentraciones altas de Plomo en el aire, para lo cual se elaborará e implementará un Plan Integral de Intervención en la Ciudad de la Oroya en pro de mejorar la salud de la población, todo ello en el marco de lo establecido por la Ley General de Salud y el Reglamento de Estándares Nacionales de Calidad Ambiental del Aire.

III. DESCRIPCION DE ACTIVIDADES Y METODOLOGIA DE TRABAJO

3. Elaboración del Plan Integral

El primer paso corresponde a la elaboración de un **Plan Integral de Intervención,** como instrumento que abarque los aspectos correspondientes al manejo toxicológico, manejo de riesgos ambientales y la comunicación de los mismos a la población entre otros, de tal modo de buscar compromisos y sinergias de actuación en el nivel local, regional y central entre el estado y la sociedad civil.

El Plan Integral de Intervención especificará su estrategia de implementación, con un cronograma de actuación a corto, mediano y largo plazo, realizando un estimado de costo a cada uno de estos niveles; asimismo incorporará un plan de monitoreo de resultados, señalando los principales hitos de este.

Para la elaboración de este Plan se propone contar con la asistencia técnica del CDC, quien en conjunto con los profesionales de la DIGESA elaboraran el Plan Integral de Intervención.

4. Ejecución de Plan Integral.

Como segundo paso a partir de la elaboración del Plan Integral de Intervención y definidos los compromisos para la ejecución de este, se iniciará el proceso de desarrollo de acciones e implementación de medidas de intervención.

Dentro de las primeras acciones definidas por el Plan se identificará aquellas en las cuales será requerida la asistencia técnica del CDC, pudiendo estas abordar los siguientes temas entre otros:

Reducción de las vías de exposición

3.1.2 Elaboración de un plan de manejo de riesgo ambiental, que incluye:

- La propuesta de un conjunto de medidas destinadas a reducir los niveles de exposición de la población al plomo, de acuerdo a las diferentes vías de exposición identificadas.

3.2 Prevención

3.2.1 Elaboración de un plan de comunicación de los riesgos a la población, que incluye:

- El diseño del estudio de los comportamientos de riesgo, limitaciones y resistencias de la población para asumir comportamientos saludables.
- El diseño de un programa que contemple condiciones y practicas de higiene, organización de la comunidad y acciones relacionadas a la salud en base a una estrategia planteada.

3.2.2 Elaboración de un plan de implementación de los niveles de alerta para material particulado y dióxido de azufre en la ciudad de la Oroya.

3.3 Recuperación

3.3.1 Elaboración de un plan de manejo toxicológico, que incluye:

- El desarrollo de protocolos de actuación adaptados a la zona ante la detección en sangre de diferentes valores de plomo en niños.

Una vez iniciado el proceso de implementación de las medidas de intervención, se pondrá en marcha el monitoreo de los resultados esperados; para luego realizar la evaluación de estos.

IV. RECURSOS PROGRAMADOS

Los recursos descritos a continuación sólo consideran los programados para la elaboración del Plan Integral de Intervención; considerando que es este Plan el instrumento que nos permitirá tener un alcance de los recursos requeridos para la ejecución de una intervención integral en la Oroya a corto, mediano y largo plazo.

4.1 Recursos humanos

4.1.1 Se deberá contar con los servicios de consultoría de un profesional del CDC de los Estados Unidos, quien elaborará el Plan de Intervención.

4.1.2 Asimismo para la ejecución de cada uno de las tareas del programa se tendrá el apoyo del personal de la Dirección Ejecutiva de Ecología y Protección del Ambiente y de la UCA.

4.2 Nivel de Esfuerzo

Para la elaboración de Plan de Intervención a cargo del consultor del CDC, se prevé un tiempo de 20 días, de los cuales 10 días permanecería en el Perú y los otros 10 días en los Estados Unidos.

4.3 Recursos económicos

Para la provisión de asistencia técnica a cargo del CDC en la elaboración del Plan Integral de intervención, se ha previsto un monto de US $ 15 000.00. Es necesario mencionar que para la provisión de asistencia técnica a cargo del CDC (incluyendo la elaboración del Plan) se cuenta con un monto de hasta US $ 100 000.00 dólares americanos provenientes del Convenio Inter agencia, los cuales podrán ser utilizados para el desarrollo de las acciones en las cuales sea requerida dicha asistencia técnica.

Asimismo cabe indicar que existe un Convenio firmado entre el Ministerio de Salud – MINSA y la empresa DOE RUN PERU SRL propietaria del Complejo Metalúrgico, a partir

del cual se derivan un serie de compromisos en pro de mejorar la Salud de la Población de la Oroya.

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Appendix C: CDC/NCEH Response to USAID Technical Assistance Request

December 16, 2003

Mr. Edilberto Alarcon
Environmental Health Activity Manager
Office of Environment and Natural Resources
USAID/Perú
Av. La Encalada S/N, CDRA. 17, Monterrico – Surco
Lima, Perú

This letter is in response to your request for technical assistance on lead contamination issues in La Oroya, Peru. This request is made through the Inter Agency Agreement AAG-P-099-00006 between the Centers for Disease Control and Prevention (CDC) and USAID.

This technical assistance request has been assigned to the Environmental Health Services Branch (EHSB) of the National Center for Environmental Health/Agency for Toxic Substances and Disease Registry (NCEH/ATSDR). We look forward to working with USAID and our friends in DIGESA in developing an Integrated Intervention Plan to address lead contamination and exposure issues in La Oroya.

I have convened a technical assistance team and we have begun to formulate an approach to this complex situation. Although we have much to accomplish before a visit to La Oroya, I would like to schedule an official site visit for the week of March 14, 2004. Accompanying me will be environmental health scientists, a toxicologist, and an epidemiologist with experience in lead studies.

Between now and March 14, 2003, we will be working with Jorge Albinagorta, Director of the Environmental Health Project Unit at DIGESA, in obtaining information needed to clearly understand human exposure to high concentrations of lead and other contaminants in La Oroya. The technical assistance team will use this preliminary information to develop a draft site visit work plan. When ready, I will forward this work plan to you and Jorge Albinagorta of DIGESA for review and comments. We will also work with Mr. Albinagorta in developing a site visit agenda and meeting schedule.

If you have questions please do not hesitate to contact me at (770)-488-7362, or by email: sdb4@cdc.gov.

Sincerely,

Sharunda Buchanan, PhD.

Chief, Environmental Health Services Branch,
National Center for Environmental Health,
Centers for Disease Control and Prevention

Appendix D: Literature Review Including Spanish Language Publications

Framework in Conducting the Literature Review

This section relates to the search and procurement of articles on lead exposure, health effects from lead exposure, and mitigation activities to reduce blood lead levels. The electronic literature search was conducted from December 2003 to August, 2004. The search focused on evaluating lead exposure pathways via air emissions, fugitive dust, and water. In addition, health effects resulting from exposure and the procedures for mitigating these exposures were researched. The electronic search was carried out using on-line databases to identify article titles, abstracts, and authors that matched keywords associated with lead exposure and health effects. Those databases used in the search are presented in Table 1.

Table 1. Database Index.

Database	Description	Year(s) Searched
MEDLINE®	A bibliographic database produced by the U.S. National Library of Medicine (NLM). The database covers worldwide biomedical literature.	1970-2004
OVID	Collection of databases available for member use only. Databases available are: Journals@Ovid, ACP Journal Club, Cochrane Central Register of Controlled Trials, Conchrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects (DARE), CINAHL, Health and Psychosocial Instruments (HaPI), and Medline	1970-2004
PubMed	A service of the National Library of Medicine, includes over 15 million citations for biomedical articles back to the 1950's. These citations are from MEDLINE and additional life science journals. PubMed includes links to many sites providing full text articles and other related resources	1970-2004
ISI Journal Citation Reports	*Journal Citation Reports*® presents quantifiable statistical data that provides a systematic, objective way to evaluate the world's leading journals and their impact and influence in the global research community	1970-2004
Google	Crawler-based search engine that create listings automatically. Google "crawls" or "spiders" the web, then provides listings of information that was found.	1950-2004

Other procedures were used to identify relevant articles. These procedures included reviewing articles obtained from reference citations within articles identified in the electronic literature search. Furthermore, the EPA, CDC, and ATSDR websites provided relevant information from studies and previous literature reviews conducted by the government in the area of health effects from lead exposure and lead mitigation activities. Articles from these findings were procured and reviewed for relevance in this report.

After reviewing all articles and reports from the literature search, 188 documents were identified as being pertinent for this report in relating to lead exposure, health effects, and mitigation activities to reduce blood lead levels.

La Oroya: Literature Search Bibliography (188)

AIDA. (2003a). La Oroya Mining: Lead Poisoning and the Doe Run Lead Smelter in Peru. Retrieved December 6, 2003, from http://www.aida-americas.org/aida.php?page=laoroya&PHPSESSID=efac3be8e219650fb773c43306fa062d

AIDA. (2003b). Impacts of Contaminants from the Smelter on Human Health. Retrieved December 6, 2003, from http://www.aida-americas.org/aida.php?page=laoroya.contaminants#Pb

AIDA. (2003c). Recent Developments at Doe Run's US Operations. Retrieved December 5, 2003, from http://www.aida-americas.org/aida.php?page=laoroya&PHPSESSID=efac3be8e219650fb773c43306fa062d

Albalak, R., McElroy, R. H., Noonan, G., Buchanan, S., Jones, R. L., Flanders, W. D., et al. (2003a). Blood lead levels and risk factors for lead poisoning among children in a Mexican smelting community. Arch Environ Health, 58(3), 172-183.

Albalak, R., McElroy, R. H., Noonan, G., Buchanan, S., Jones, R. L., Flanders, D. W., et al. (2003b). Blood Lead Levels and Risk Factors for Lead Poisoning among Children in a Mexican Smelting Community. Archives of Environmental Health, 58(3), 172-183.

Albert, L. A., & Badillo, F. (1991). Environmental Lead in Mexico. Reviews of Environmental Contamination and Toxicology, 117.

ASARCO. (January 2003). Nearly One Year Later. The Communtiy Cornerstone, 7.

ASARCO. (2002). ASARCO Responds to EPA Supefund Notice: ASARCO.

ATSDR. (1993a). Health Consultations: National Lead Industries, incorporated Pedricktown, Salem County, New Jersey. Retrieved December 7, 2003, from http://www.atsdr.cdc.gov/HAC/PHA/nli/nli_p1.html

ATSDR. (1993b). Site Review and Update: Tar Creek (Ottawa County): U.S. Department of Health and Human Services.

ATSDR. (1997, August 1997). Public Health Statement for Lead. Retrieved December 7, 2003, from http://www.atsdr.cdc.gov/toxprofiles/phs13.html

ATSDR. (1999, June 1999). ToxFAQs: Lead. Retrieved December 7, 2003, 2003, from http://www.atsdr.cdc.gov/tfacts13.html

ATSDR. (2001a). Public Comment Draft: El Paso Multiple Sclerosis Cluster Investigation, El Paso, El Paso County, Texas: Agency for Toxic Substances and Disease Registry.

ATSDR. (2001b). Agency for Toxic Substances and Disease Registry. Exposure Investigation for Herculaneum Lead Smelter site, Herculaneum, Jefferson County, Missouri: Atlanta: US Department of Health and Human Services; September 10, 2001.

ATSDR. (2001c). Agency for Toxic Substances and Disease Registry. Health

consultation for Herculaneum Lead Smelter site: Atlanta: US Department of Health and Human Services; July 13, 2001.
ATSDR. (2002a). Health Consultation: Herculaneum Lead Smelter (DOE RUN Company). Herculaneum, Jefferson County, MO, Agency for Toxic Substances and Disease Registry.
ATSDR. (2002b). Health Consultation: Determination if Remedial Actions are Protective of Public Health. Herculaneum, Jefferson City, MO, Agency for Toxic Substances and Disease Registry. February 26, 2002.
ATSDR. (2004). Environmental and Biological Sampling Data. Retrieved April 28, 2004, from http://www.atsdr.cdc.gov/elpaso/addend.html
Associated Press. (2002). ASARCO denies reponsibility for El Paso lead contamination. Retrieved April 28, 2004, 2004, from http://www.enn.com/news/wire-stories/2002/08/08012002/ap_48014.asp
Baghurst, P., Tong, S., McMichael, A., Robertson, E., Wigg, N., & Vimpani, G. (1992). Determinants of blood lead concentrations to age 5 years in a birth cohort study of children living in the lead smelting city of Port Pirie and surrounding areas. Arch Environmental Health, 47, 203-210.
Baker, K. (1996). Trade and Environment: Peru Mining. The TED Case Studies - An Online Journal, 7(7).
Battelle. (1998). Sources of Lead in Soil: A Literature Review: Environmental Protection Agency.
Benin, A. L., Sargent, J. D., Dalton, M., & Roda, S. (1999). High Concentrations of Heavy Metals in Neighborhoods Near Ore Smelters in Northern Mexico. Environmental Health Prospectives, 107(4).
Brunekreef, B., Veenstra, S., Biersteker, & Boleu, J. (1981). The Arnhem Lead Study: Lead uptake by 1-to-3 year old children living in the vicinity of a secondary lead smelter in Arnhem, the Netherlands. Environ Research, 25, 441-448.
Businessweek. (1999). Are Mexicans Finally Going Green? A Crackdown on a big polluter could be the first of many. Businessweek Online.
Byron, E. (2002). Asarco Can't Back Cleanup Cost. Retrieved April 28, 2004, from http://www.minesandcommunities.org/Company/asarcol.htm
Calderon-Salinas, J. V., Hernandez-Luna, C., Valdez-Anaya, B., Maldonado-Vega, M., & Lopez-Miranda, A. (1996). Evolution of lead toxicity in a population of children. Hum Exp Toxicol, 15(5), 376-382.
Calderon-Salinas, J. V., Valdez-Anaya, B., Mazuniga, C., & Albores-Medina, A. (1996). Lead exposure in a population of Mexican children. Hum Exp Toxicol, 15(4), 305-311.
Canfield, R. L., Henderson, C. R., Jr., Cory-Slechta, D. A., Cox, C., Jusko, T. A., & Lanphear, B. P. (2003). Intellectual impairment in children with blood lead concentrations below 10 microg per deciliter. N Engl J Med, 348(16), 1517-1526.
CDC. (1983). East Helena Mountan Child Lead Study. 1983 Report by CDC, Public Health Services. Atlanta, GA.
CDC. (2000a). Blood Lead Levels in Young Children --- United States and Selected States, 1996--1999. MMWR, 49(50).
CDC. (2000b). The Use of Isotope Ratios to Identify Lead Sources Contributing to Pediatric Lead Poisoning in Callao Constitutional Province, Perú. Lima, Perú:

Centers for Disease Control and Prevention, National Center for Environmental Health.
CDC. (2000c). El uso de Proporción de Isótopos para Identificar Las Fuentes de Plomo Que Contribuyen a Intoxicaciones Infantiles pro Plomo en la Provincia Constitucional del Callao, Perú. Lima, Perú: Centers for Disease Control and Prevention, National Center for Environmental Health.
CDC. (2004). EIS: Officer Profile. Retrieved April 28, 2004, from http://www.cdc.gov/eis/about/landrigan.htm
Chavez, J. N., Ruiz, C. G., Lain, R. E., Zavaleta, C. S., Reategui, S. M., Condori, Q. J. L. Q., et al. (2000). Estudio para determinar las fuentes de exposicion a plomo en la provincia constitucional del Callao, Perú. Environmental Health Project, Activity Report 104.
City-data. (2004). Herculaneum, Missouri. Retrieved August 18, 2004, from http://www.city-data.com/city/Herculaneum-Missouri.html
City of El Paso. (2004). City of El Paso, Texas. Retrieved May 5, 2004, 2004, from http://www.elpasotexas.gov/quick_facts/default.asp
CONAM. (2003). Invitation letter and documents [annex 1] from the Ministry of Health with ideas about an intervention plan (Programa de intervención en la ciudad de La Oroya Antigua).
Cook, M., Chappell, W., Hoffman, R., & Mangione, E. (1993). Assessment of blood lead levels in children living in a historic mining and smelting community. American Journal of Epidemiology, 137, 447-455.
Coronejo, A. (2003). Niveles de Plomo en casa de la Oroya - Perú. La Oroya, Perú.
Crombie, J. (1999). Greenpeace highlights Mexican metals violations. Retrieved May 25, 2004, from http://domino.ips.org/sid/EnrissDb.nsf/0/3ead231842d21224802567da0022ed35?OpenDocument&ExpandSection=1
Dartmouth. (1999). Dartmouth Medical School Researchers Discover Heavy Metal Contamination in Northern Mexico. Retrieved June 12, 2004, from http://www.sciencedaily.com/releases/1999/03/990312061036.htm
Desert USA. (2004). El Paso. Retrieved May 5, 2004, 2004, from http://www/desertisa/cp,/Cities/tx/tx_elpaso.html
DHSS. (2002). Missouri Department of Health and Senior Services. Health Consultation: Determine if Remedial Actions are Protective of Public Health, Herculaneum Lead Smelter Site, Herculaneum, Jefferson County, Missouri, April 16, 2004.
Diaz-Barriga, F., Bates, A., Calderon, J., Lugo, A., Galvao, L., Lara, I., et al. (1997). The El Paso Smelter 20 years later: residual impact on Mexican children. Environ Research, 74, 11-16.
DIGESA. (1999). Evaluación de la Calidad del Aire en el Distrito de la Oroya - Junín. Lima, Perú: DIGESA.
DIGESA. (1999). Estudio de Plomo en Sangre en una Población Seleccionada de la Oroya. Lima, Perú: DIGESA.
DIGESA. (2000). Programa de Vigilancia de la Calidad del Aire de la Ciudad de La Oroya. Lima, Perú: DIGESA.
DIGESA. (2001a). Estudio de Dispersión de la Contaminación Atmosférica de la Ciudad de la Oroya - Junín. Lima, Perú: DIGESA.

DIGESA. (2001b). Programa de Vigilancia de la Calidad del Aire a Nivel Nacional: Ministerio de salud.
DIGESA. (2001c). Study on the Dispersion of Air Pollution in the City of La Oroya - Junin: DIGESA.
Díaz-Barriga, F., Batres, L., Calderón, J., Lugo, A., Galvao, L., Lara, I., et al. (1997). The El Paso Smelter 20 Years Later: Residual Impact on Mexican Children. Environmental Research, 74, 11-16.
Drexler, J. W. (2003). The Source of Anomalous Lead and Arsenic Concentrations in Soils from the El Paso Community -- El Paso, Texas. Boulder, CO: Environmental Protection Agency.
DRP. (2004). The Doe Run Company: Company Information. Retrieved August 19, 2004, from http://www.doerun.com
DRP. (1998). Informe al Ministerio de Energía y Minas sobre el PAMA y solicitud para la aprobación a modificaciones en el programa.
DRP. (2001). Study of Lead Levels in Blood of the Population in La Oroya 2000-2001. La Oroya, Perú: DOE RUN PERU.
DRP. (1996). Adaptation and Environmental Management Program (AEMP). La Oroya, Perú.
DRP. (2002a). Estudio de Niveles de Plomo en la Sangré de la Población en La Oroya 200-2001. La Oroya, Perú: DOE RUN PERU.
DRP. (2002b). Reporte a Nuestras Comunidades en La Oroya, Provincia de Yauli, Junín-Perú, Avances 1998-2002.
DRP. (2002c). Reporte a Nuestras Comunidades: Distrito de San Pedro de Coris, Provincia de Churcampa, Huancavelica-Perú, Avances 1998-2002.
DRP. (2003a). El Ciprecito: Cuaderno de Dibujo: Nivel "A". La Oroya, Perú: DOE RUN PERU.
DRP. (2003b). El Ciprecito: Cuaderno de Dibujo Nivel "B". La Oroya, Perú: DOE RUN PERU.
DRP. (2003c). El Ciprecito: Cuaderno de Dibujo: Nivel "C". La Oroya, Perú: DOE RUN PERU.
DRP. (2004a). DOE RUN PERU - The Company. Retrieved November 14, 2003, from http://www.doerun.com.pe/doerun_english/index_doerun.htm
DRP. (2004b). Plan Operatico Doe Run Peru 2004-2011. La Oroya, Perú: DOE RUN PERU.
DRP (2000, 2004).About Doe Run. Retrieved December 7, 2003, from http://www.doerun.com/ENGLISH/html/about_doe_run.htm
DRP. (2000). Overview of Accomplishments. Retrieved November 14, 2003, from http://www.doerun.com/ENGLISH/Peru%20documents/Doe%20Run%20Peru%20Accomplishments.htm
DRP. (2002). Poesía Forestal un Sueño Ecológico en Los Andes del Perú. Lima, Perú: DOE RUN PERU.
DRP. (2002). Primary Mining and Smelting Division 2002 Annual Report to our Community. St. Louis: The Doe Run Company.(2003). La Oroya Magazine, Year V(52).

Friends of the Earth. (2003). Corporate Accountability & the Johannesburg Earth Summit. Retrieved December 6, 2003, from http://www.foe.org/WSSD/doerun.html

E&MJ. (1999). Three-year shutdown planned for Asarco's El Paso smelter. E&MJ-Engineering and Mining Journal, 200(1), 9-9.

EPA. (1993). Lead and compounds (inorganic). Retrieved December 7, 2003, from http://www.epa.gov/iris/subst/0277.htm

EPA. (1995). Seasonal Rhythms of Blood-Lead Levels: Boston, 1979-1983: Environmental Protection Agency.

EPA. (1999). ASARCO will address alleged hazardous waste, clean water violations: Environmental Protection Agency.

EPA. (2001). Lead; Identification of Dangeroius Levels of Lead; Final Rule. 40 CFR Part 745. Federal Register, 66(4), 1206 - 1240.

EPA. (2002). Environmental Protection Agency. Transmittal from Bruce Morrison to Missouri Department of Health and Senior Services, January 8, 2002.

EPA. (2003). Herculaneum, Missouri, Lead Attainment Plan. Retrieved August 17, 2004, from http://www.epa.gov/region07/programs/artd/air/rules/missouri/doerunherc.htm

EPA. (2004). CERCLA Overview. Retrieved May 17, 2004, from http://www.epa.gov/superfund/action/law/cercla.htm

Espinoza, R., Hernandez-Avila, M., Narciso, J., Castanaga, C., Moscoso, S., Ortiz, G., et al. (2003). Determinants of blood-lead levels in children in Callao and Lima metropolitan area. Salud Publica de Mexico, 45, 209-219.

ECICLP. (1999). A call for action on the prevention and treatment of lead poisoning in developing countries: Recommendations on National Policy and Implementation. Bangalore, India.

Fisher, C. (2002). Request for Removal Action at the El Paso County Metals Survey Site, El Paso, TX: Environmental Protection Agency.

Gagne, D. (1994). Blood lead levels in Nornada children following removal of smelter-contaminated yard soil. Can J Pub Health, 85, 163-166.

Garcia Vargas, G. G., Rubio Andrade, M., Del Razo, L. M., Borja Aburto, V., Vera Aguilar, E., & Cebrian, M. E. (2001). Lead exposure in children living in a smelter community in region Lagunera, Mexico. J Toxicol Environ Health A, 62(6), 417-429.

Gavaghan, H. (2002). Lead, unsafe at any level.[see comment]. Bulletin of the World Health Organization, 80(1), 82.

Gelbspan, T. (2003). Environmental Analysis of La Oroya Show Serious Health Hazards. Retrieved December 6, 2003, from http://www.oxfamamerica.org/advocacy/art3870.html

Gittleman, J. L., Billig, P., Ault, S. K., & Hernandez-Avila, M. (1999). Options for Monitoring Biological and Environmental Lead During the Phase-out of Lead in Gasoline in Latin America & the Caribbean. Environmental Health Project, Activity Report 47.

Goodarzi, F., Sanei, H., & Duncan, W. F. (2001). Monitoring the distribution and deposition of trace elements associated with a zinc-lead smelter in the Trail area, British Columbia, Canada. J Environ Monit, 3(5), 515-525.

Goodarzi, F., Sanei, H., Labonte, M., & Duncan, W. F. (2002). Sources of lead and zinc associated with metal smelting activities in the Trail area, British Columbia, Canada. J Environ Monit, 4(3), 400-407.
Goulet, L., & Messier, A. (1996). Results of a lead decontamination program. Arch Environmental Health, 51, 68-72.
Gradient Corporation. (2004). Comparison for Human Health Risks Associated with Lead, Arsenic, Cadmium, and SO2 in La Oroya Antigua, Peru. Cambridge, MA: Gradient Corporation.
Gulson, B. L., Mizon, K. J., Davis, J. D., Palmer, J. M., & Vimpani, G. (2004). Identification of sources of lead in children in a primary zinc-lead smelter environment. Environ Health Perspectives, 112(1), 52-60.
Hernandez-Avila, M., Lain, R. E., & Carbjal, L. (1999). Estudio de Plomo en Sangre en Población seleccionada de Lima y el Callao (Junio 1998 - Marzo 1999). Environmental Health Project, Activity Report 72.
Herzman, C., Ward, H., Ames, N., Kelly, S., & Yates, C. (1991). Childhood lead exposure in Trail revisited. Canadian Journal of Public Health, 82, 385-391.
Hilts, S., Hartzman, C., & Marion, S. (1995). A controlled trial of the effect of HEPA vacumming on childhood lead exposure. Canadian Journal of Public Health, 86, 345-350.
Hilts, S., Bock, S., Oke, T., Yates, C., & Copes, R. (1998). Effect of interventions on children's blood lead levels. Environ Health Perspect, 106, 79-83.
Hilts, S. R., Goodarzi, F., Sanei, H., Labonte, M., Duncan, W. F., Bock, S. E., et al. (2003). Effect of smelter emission reductions on children's blood lead levels. Sci Total Environ, 303(1-2), 51-58.
Hufstader, C. (2003). Peru: Indigenous Women Participate as Leaders in Their Communities. Retrieved December 6, 2003, from http://www.aida-americas.org
INEI. (2001). Estudio Socio-Económico 2001. La Oroya, Perú: Instituto Nacional de Estadística E Informática Junín.
ISAT. (2003). Niveles de exposición de Plomo en Sangre y Estado de Salud de la población de Niños de 5 y 9 Anos de la Ciudad de La Oroya. La Oroya, Perú: Instituto Salud y Trabajo.
John, M. K., VanLaerhoven, C. J., & Bjerring, J. H. (1976). Effect of a smelter complex on the regional distribution of cadmium, lead and zinc in litters and soil horizons. Arch Environ Contam Toxicol, 4(4), 456-468.
Keenan, K., Echave, J. d., & Traynor, K. (2002). Mining and Communities: Poverty Amidst Wealth. Tagaytay City, The Philippines: Political Economy Research Institute.
Kimbrough, R., LeVois, M., & Webb, D. (1995). Survey of lead exposure around a closed lead smelter. Pediatrics, 95, 550-554.
Lancy, J. (1999). A Mexican City Awakes to an Ecological Nightmare. NY Transfer News Collective.
Landrigan, P. J., Gehlbach, S. H., Rosenblum, B. F., Shoults, J. M., Candelaria, R. M.,
Barthel, W. F., et al. (1975). Epidemic lead absorption near an ore smelter. The role of particulate lead. N Engl J Med, 292(3), 123-129.
Landrigan, P., Baker, E., Feldman, G., Cox, D., Eden, K., Orenstein, W., et al. (1976). Increased lead absorption with anemia and slowed nerve condition near a lead

smelter. J Pediatrics, 89, 904-910.
Lanphear, B. P., Dietrich, K., Auinger, P., & Cox, C. (2000). Cognitive deficits associated with blood lead concentrations <10 microg/dL in US children and adolescents. Public Health Rep, 115(6), 521-529.
Lanphear, B., Succop, P., Roda, S., & Henningsen, G. (2003). The effect of soil abatement on blood lead levels in children living near a former smelting and milling operation. Pub Health Rep, 118, 83-91.
Lanphear BP, M. T., Rogers J et al. (1998). The contribution of lead-contaminated house dust and residential soil to children's blood lead levels. Environ Res, 79, 51-68.
Laurie Barclay, M. (2003a). Lead Levels Linked to Hypertension. JAMA, 289, 1523-1532.
Laurie Barclay, M. (2003b). High Lead Levels May Contribute to Male Infertility. Human Reproduction, 18, 374-383.
Laurie Barclay, M. (2003c). New Guidelines for Global Development Delay. Neurology, 60, 367-380.
Laurie Barclay, M., & Bernard M. Sklar, M., MS. (2003d). "Acceptable" Lead Level Not Low Enough. New England Journal of Medicine, 348, 1515-1516,1517-1526,1527-1536.
Letourneau, G., & Gagne, D. (1992). Blood lead level in children living close to a smelter area: 10 years later. Canadian Journal of Public Health, 221-225.
Louekari, K., Mroueh, U., Maidell-Munster, L., Valkonen, S., Tuomi, T., & Savolainen, K. (2004). Reducing the risks of children living near the site of a former lead smelter. Sci Tot Environ, 319, 65-75.
Maynard, E., Thomas, R., Simon, D., Phipps, C., Ward, C., & Calder, I. (2003). An evaluation of recent blood lead levels in Port Pirie, South Australia. Sci Tot Environ, 303, 25-33.
McMichael, A., Baghurst, P., Robertson, E., Vimpani, G., & Wigg, N. (1985). The Port Pirie cohort study; blood lead concentrations in early childhood. Med J Aust, 143, 499-503.
MDNR. (1999). Missouri Department of Natural Resources, Division of Environmental Quality, Hazardous Waste Program. Preliminary Assessment: Herculaneum Lead Smelter Site, Jefferson County, Missouri. March 30, 1999.
MDNR. (2001). Order to Abate and Cease and Desist Violations. Jefferson City, MO.
MDNR. (2002a). Health Consultation: Blood Lead Results for 2002 Calendar Year, Herculaneum Lead Smelter Site: Herculaneum, Jefferson County, Missouri, March 14, 2003.
MDNR. (2002b). Missouri Department of Natural Resources: Total Maximum Daily Load Information Sheet, Mississippi River, August 2002.
Medscape. (2000). Study Links Environmental Contaminants With Breast Cancer. Carcinogenesis, 21, 1281-1289.
MedscapeWire. (2000). Pregnant Women With Calcium Deficiency Release Lead Faster From Bones. Retrieved December 5, 2003, from http://www.medscape.com/viewarticle/412237_print
Montana Environmental Information Center. (2004). What Would an ASARCO Bankruptcy Mean for Montana? Retrieved May 17, 2004, 2004, from http://www.meic.org/ASARCO.html

Mielke, H., & Reagan, P. (1998). Soil is an important pathway of human lead exposure. Environmental Health Perspectives, 106, 217-229.
MMWR. (1999). Human Lead Absorption - Texas. MMWR, 48, 95-101.
MMWR. (1997). Human lead absorption -- Texas. MMWR Morb Mortal Wkly Rep, 46(37), 871-877.
Morse, D., Landrigan, P., Rosenblum, B., Hubert, J., & Housworth, J. (1979). El Paso revisited. Epidemiologic follow-up of an environmental lead problem. JAMA, 242(8), 739-741.
MSN Encyclopedia. (2004). Peru, South America, from http://encarta.msn.com/map_701515355/Peru_(country).html
MSN Encyclopedia. (2004). La Oroya, Junín, Peru. Retrieved December 4, 2004, from http://encarta.msn.com/map_701524959/La_Oroya.html
MSN Encyclopedia. (2004). Junín, Peru. Retrieved December 4, 2004, from http://encarta.msn.com/encyclopedia_762508824/Jun%C3%ADn.html
Murgueytio, A. M., Evans, R. G., Sterling, D. A., Clardy, S. A., Shadel, B. N., & Clements, B. W. (1998). Relationship between lead mining and blood lead levels in children. Arch Environ Health, 53(6), 414-423.
Neri, L. C., Johansen, H., & Hewitt, D. (1983). Health effects of low level occupational exposure to lead: the trail, British Columbia study. Arch Environ Health, 38(3), 180-189.
Ordonez, B. R., Romero, L. R., & Mora, R. (2003). [Epidemiologic research on lead levels in children and indoor air in Ciudad Juarez , Chihuahua, related with a smelter in El Paso, Texas. 1975]. Salud Publica Mex, 45 Suppl 2, S281-295.
Orozco, E. (2002). Peru Mining town looks beyond environmental mess. Reuters.
Oxfam. (2003). Technical Committee to Advocate for a Better Environment in La Oroya. Retrieved December 7, 2003, from http://www.oxfamamerica.org/advocacy/art3871.html
PDHD, CDC, USEPA. (1986). Kellog revisted 1983: Childhood blood lead and environmental status report, 1986. Final report of the U.S. Public Health Service.
Pediatrics, A. A. (1995). Committee on Drugs: Treatment Guidelines for Lead Exposure in Children. Policy Statement. Pediatrics, 96(1), 155-160.
Pediatrics, A. A. (1998). Committee on Environmental Health: Screening for Elevated Blood Lead Levels. Policy Statement. Pediatrics, 101(6), 1072-1078.
Peñoles. (2001). 2001 Annual Report.
Peñoles. (2002). Environmental Annual Report 2002. Retrieved December 6, 2003, from http://www.penoles.com.mx/pdf/PenolesER_2002.pdf
Peñoles. (2004). Company Profile. Retrieved June 2, 2004, from http://www.penoles.com.mx/www/index.html
Perú. (2004). Virtual Peru: La Oroya. Retrieved December 6, 2004, from http://www.virtualperu.net/cities_la_oroya.html
Polk, W. W. (2002). Chamber to EPA: More tests. An El Paso-owned business and lifestyle weekly.
Post-Dispatch. (2002, July 7). Doe Run doesn't meet air standard in Q2. St. Louis Post-Dispatch.
Post-Dispatch. (2004, May 5). Doe Run meets air quality standards for 7th straight quarter. St. Louis Post-Dispatch.

Preston, J. (1999, June 25). 4,000 kids hit by poisoning. Laredo Morning Times, p. 14A.
Preston, J. (1999, May 30). Torreon's lead dust withers its area children. Laredo Morning Times.
Prpic-Majic, D., Pongracid, J., Hrsak, J., & Pizent, A. (1992). A follow-up study in a lead smelter community following the introduction of an effective pollution control system. Isr J Med Sci, 28, 548-556.
Rapuano M, Florini K. (1994). The Global Dimensions of Lead Poisoning. Washington, DC: Alliance To End Childhood Lead Poisoning and Environmental Defense Fund.
Reuters. (2003). US Names Asarco in Arsenic Contamination. Retrieved April 28, 2004, http://www.recyclingtoday.com/news/printer.asp?ID=4400&Source=news&AdID=15
Roberts, T., Hutchinson, T., Paciga, J., Chattopadhyay, A., Jervis, R., & VanLoon, J. (1974). Lead contamination around secondary smelters: estimation of dispersal and accumulation by humans. Science, 186, 1120-1122.
Roberts, C. (2002). EPA read to dig up contaminated soil in west El Paso. Retrieved April 28, 2004, from http://www.enn.com/news/wire-stories/2002/08/08062002/ap_48048.asp
Roberts, C. (2004). ASARCO wants to extend permit for El Paso copper smelter. Retrieved May 11, 2004, from http://www.myplaniview.com/APTexas/parsed/stories/D8283EEO0.shtml
Roels, H., Buchet, J., Lauwerys, R., Bruaux, P., Claeys-Thoreau, F., Lafontaine, A., et al. (1980). Exposure to lead by the oral route and the pulmonary routes of children living in the vicinity of a primary lead smelter. Environ Res, 22, 81-94.
Rom, W. N., Varley, G., Lyon, J. L., & Shopkow, S. (1982). Lung-Cancer Mortality among Residents Living near the El-Paso Smelter. British Journal of Industrial Medicine, 39(3), 269-272.
Romieu, I., Lacasana, M., & McConnell, R. (1997). Lead exposure in Latin America and the Carribbean. Lead Research Group of Pan-American Health Organization. Environmental Health Perspectives, 105, 398-405.
SVS Ingenieros S.A., Golder Associates Brasil Ltda. (2003). Evaluación Ambiental Especial de la Fundición de La Oroya. Lima, Perú.
Salins, L. L., Goldsmith, E. S., Ensor, C. M., & Daunert, S. (2002). A fluorescence-based sensing system for the environmental monitoring of nickel using the nickel binding protein from Escherichia coli. Analytical & Bioanalytical Chemistry, 372(1), 174-180.
Scharrer, G. (2004). ASARCO may get permit renewed. Retrieved April 28, 2004, from http://www.borderlandnews.com/stories/borderland/20040329-99087.shtml
Schmitt, N., Philion, J. J., Larsen, A. A., Harnadek, M., & Lynch, A. J. (1979). Surface soil as a potential source of lead exposure for young children. Can Med Assoc J, 121(11), 1474-1478.
Shapleigh, E. (2004). Senator Eliot Shapleigh Comments on ASARCO's application for tan Air Quality Permit.
Shnayerson, M. (2003). Devastating Luxury. Vanity Fair, 130-133,160-164.
US State Department. (12/6/2003). Bureau of Western Hemisphere Affairs Profile: Peru. Retrieved December 6, 2003, from http://www.state.gov/r/pa/ei/bgn/2056.htm

US State Department. (4/22/2004). U.S. Department of State Post Report's: Peru. Retrieved December 6, 2003, fromhttp://foia.state.gov/MMS/postrpt/pr_view_all.asp?CntryID=119
US State Department. (6/24/2003). Consular Information Sheet: Peru. Retrieved December 6, 2003, from http://travel.state.gov/peru.html
Sumner, L. W. (2000). El Paso and Southwestern Railroad Company. Retrieved April 24, 2004, from http://home.swbell.net/lwsumner/history.htm
Taylor, L., Jones, R. L., Kwan, L., Deddens, J. A., Ashley, K., & Sanderson, W. T. (2001). Evaluation of a Portable Blood Lead Analyzer with Occupationally Exposed Populations. American Journal of Industrial Medicine, 40, 354-362.
TDH. (2001). TDH Study Shows Increased Multiple Sclerosis Risk in Area of El Paso. Retrieved May 17, 2004, from http://www.tdh.state.tx.us/news/b_news376.htm
Tedford, D. (2002). Asarco could face stiff pollution clean-up cost. Retrieved May 14, 2004, from http://www.planetark.com/dailynewsstory.cfm/newsid/16953/story.htm
TACB. A. C. (1992). The air we share. Air Quality in Texas: Twenty years of environmental protection. 13-14.
TACB. (1992). Air Quality in Texas: Twenty years of environmental protection., pp. 13-14.
Tewfik, I. (2002). Mobilization in a Cairo Neighborhood; Community Participation and Environmental Change. Middle East Report, Winter.
Torres, M. P. (2001). Developing a Hygiene Behavior Change Program for Children with Lead Poisoning Living in Informal Urban Areas for Lima, Peru. Environmental Health Project, Activity Report 107.
UNES. (1999). Evaluación de Niveles de Plomo y Factores de Exposición en Gestantes y Niños Menores de 3 Anos de la ciudad de La Oroya. La Oroya, Perú: Consorcio Unión Para El Desarrollo Sustentable.
UNES. (1999). Evaluation of Lead Levels and Exposure Factors Among Pregnant Women and Children Under 3 Years Old in the City of La Oroya. La Oroya, Perú: Consorcio Unión Para El Desarrollo Sustentable.
UNES. (2002). Situación Ambiental del Aire, Aguas y Suelos en la Provincia de Yauli - La Oroya. La Oroya, Perú: Consorcio Unión para el Desarrollo Sustentable.
USGS. (2003). Occurrence and Transport of Cadmium, Lead, and Zinc in the Spokane River Basin, Idaho and Washington, Water Years 1999-2001. Washington D.C.: U.S, Geological Service.
Valdez, D. W. (2003). Shapleigh Calls For Cleanup as Asarco Disputes EPA Study. Retrieved April 28, 2004, from http://www.detoxamin.com/health-news/asarco_disputes_epa.html
Valdez, D. W. (2004, May 7). Lead found in children, Lead levels high in 1.2% of kids tested. El Paso Times.
Vargas, G., Andrade, M. R., Razo, L. D., Aburto, V. B., Aguilar, E. V., & Cebrian, M. (2001). Lead exposure in children living in a smelter community in Region Lagunera, Mexico. Journal of Toxicology and Environmental Health, 62, 417-429.
VicKolenc. (2002). After 3 years, ASARCO shows no signs of life. Retrieved April 28, 2004, from http://www.borderlandsnews.com/contamination2/0407nolife.html

Von Lindern, I., Spalinger, S., Bero, B., Petrosyan, V., & Von_Braun, M. (2003a). The influence of soil remediation on lead in house dust. Sci Tot Environ, 303, 59-78.
Von Lindern, I., Spalinger, S., Petroysan, V., & Von_Braun, M. (2003b). Assessing remedial effectiveness through the blood lead; soil/dust lead relationship at the Bunker Hill Superfund Site in the Silver Valley of Idaho. Sci Tot Environ, 303, 139-170.
Walker, P. (2001). Missouri Department of Health and Senior Services. Herculaneum, Missouri Lead Contamination Health Threat. September 13, 2001.
Williams, D. J. (2002, August 13). EPA, Asarco discuss plans for cleanup. El Paso Times.
Yankel, A., Von Lindern, I., & Walter, S. (1977). The Silver Valley Lead Study: the relationship between childhood blood lead levels and environmental exposure. The Journal of Air Polluion Control, 27, 763-767.
Zavaleta, C. A. S. (2001). Support for Phase II of the Peru Lead Project to Determine Blood and Ambient Lead Levels in Metropolitan Lima and to Manage the Lead Exposure Problem in Critical Areas. Environmental Health Project, Activity Report 110.

Spanish Language Literature Search

Azcona-Cruz MI, Rothenberg SJ, Schnaas-Arrieta L, Romero-Placeres M, Perroni-Hernandez E. Levels of plasmatic lead in children 8-10 years of age and its relation to changes in visual-motor system and balance. Instituto Nacional de Salud Publica (INSP), Mexico. Salud Publica Mex. 2000 Jul-Aug;42(4):279-87.
Ceto N. Environmental intervention in sites contaminated by lead: the United States of America experience. Universidad de Vermont, Seattle, Washington, USA. Salud Publica Mex. 2003;45 Suppl 2:S232-6.
Guerra-Tamayo JL, Hernandez-Cadena L, Tellez-Rojo MM, Mercado-Garcia Adel S, Solano-Gonzalez M, Hernandez-Avila M, Hu H. Time to pregnancy and lead exposure. Centro de Investigacion en Salud Poblacional, Instituto Nacional de Salud Publica, Avenida Universidad 655, colonia Santa Maria Ahuacatitlan, Morelos, Mexico. Salud Publica Mex. 2003;45 Suppl 2:S189-95.
Jimenez C, Romieu I, Palazuelos E, Munoz I, Cortes M, Rivero A, Catalan J. Environmental exposure factors and the concentrations of blood lead in Mexico City children. Centro de Investigaciones en Salud Publica, Instituto Nacional de Salud Publica, Cuernavaca, Mexico. Salud Publica Mex. 1993 Nov-Dec;35(6):599-606.
Mejia J, Carrizales L, Rodriguez VM, Jimenez-Capdeville ME, Diaz-Barriga F. A method for assessing health risks in mining sites. Facultad de Medicina, Universidad Autonoma de San Luis Potosi, Mexico. Salud Publica Mex. 1999;41 Suppl 2:S132-40.
Matte TD. Effects of lead exposure on children's health. CUES, NYAM, 1216 Fifth Avenue, Nueva York, NY 10029, USA. Salud Publica Mex. 2003;45 Suppl 2:S220-4.
Ordonez-Iriarte JM, Gomez ME, Sanchez JI, Fernandez-Aguado C, Lopez R, Ferrer JB. The environment and its impact on health: old risks, new risks. Instituto de Salud

Publica, Consejeria de Sanidad, Comunidad de Madrid, Spain. Gac Sanit. 2004 May;18 Suppl 1:222-33.
Ordonez BR, Romero LR, Mora R. Epidemiologic research on lead levels in children and indoor air in Ciudad Juarez , Chihuahua, related with a smelter in El Paso, Texas. 1975. Salud Publica Mex. 2003;45 Suppl 2:S281-95.
Ramirez AV, Paucar JC, Medina JM. Blood lead in the inhabitants of 4 Peruvian localities. Departamento de Salud Ocupacional Centromin Peru. Rev Panam Salud Publica. 1997 May;1(5):344-8.
Raquel Ordonez B, Ruiz Romero L, Mora IR. Epidemiological study of lead levels in the child population and the household environment in Ciudad JuÃ¡rez, Chihuahua, Mexico, as compared to a foundry area in el Paso, Texas. Bol Oficina Sanit Panam. 1976 Apr;80(4):303-17.
Rojas M, Espinosa C, Seijas D. Association between blood lead and sociodemographic parameters among children. Centro de Investigaciones Toxicol gicas, Universidad de Carabobo, Valencia, Venezuela. Rev Saude Publica. 2003 Aug;37(4):503-9. Epub 2003 Aug 20.
Romieu I. Use of blood lead data to evaluate and prevent childhood lead poisoning in Latin America . Instituto Nacional de Salud Publica, Avenida Universidad 655, colonia Santa Maria Ahuacatitlan, 62508 Cuernavaca, Morelos, Mexico Salud Publica Mex. 2003;45 Suppl 2:S244-51
Sanin LH, Gonzalez-Cossio T, Romieu I, Hernandez-Avila M. Accumulation of lead in bone and its effects on health. Centro de Investigacion en Salud Poblacional, Instituto Nacional de Salud Publica, Cuernavaca, Morelos, Mexico. Salud Publica Mex. 1998 Jul-Aug;40(4):359-68.
Sanz-Gallen P, Nogue Xarau S. Effects of chemical air pollution on health. Med Clin (Barc). 1997 Apr 26;108(16):615-7.
Vega J, Contreras A, Rios E, Marchetti N, Agurto M. Lead exposure and its effects on child health. Departamento de Salud Publica, Facultad de Medicina, Universidad de Chile, Campus Oriente. Rev Chil Pediatr. 1990 May-Jun;61(3):154-60.

Appendix E: Information Resources Identified Through the Literature Review

U.S. Environmental Protection Agency
• A Lead in the environment tutorial is available at: www.epa.gov/seahome/leadenv.html. This site contains information on national, state, and local lead poisoning prevention efforts.
• Technical studies can be accessed at: www.epa.gov/lead/leadtpbf.htm. At this site see the report: Risk Analysis to Support Standards for Lead in Paint, Dust, and Soil. June 1998 (EPA 747-R-97-006).
• At www.epa.gov enter the keyword *Lead* to learn about USEPA efforts to control lead exposure.
Agency for Toxic Substances and Disease Registry
• Case studies in environmental medicine focusing on lead toxicity can be found on the Agency for Toxic Substances and Disease Registry (ATSDR) website at http://www.atsdr.cdc.gov/HEC/CSEM/lead/index.html .
• Training Manual On Pediatric Environmental Health: Putting It Into Practice can be found at: http://www.atsdr.cdc.gov/child/atsdrochmedicalqts.html
• ToxFAQs can be found at: http://www.atsdr.cdc.gov/es/toxfaqs/es_toxfaqs.html
U.S. Consumer Products Safety Commission
• US Consumer Products Safety Commission Resources, Lead poisoning prevention publications can be found at: http://www.cpsc.gov/ by entering the search word, *Lead*
Centers for Disease and Control and Prevention
• The Centers for Disease Control and Prevention (CDC) has useful information pertaining to Lead and health and regulations, research, and treatment of Lead exposure can be found at: http://www.cdc.gov/lead/ .
National Institutes of Health
• The (NIH) at: www.nih.gov, Keyword, *Lead*
National Institute of Occupational Safety and Health
• The National Institute of Occupational Safety and Health (NIOSH) has useful information pertaining to occupational lead exposure and the protection of workers at: www.cdc.gov/niosh/topics/lead/
American Academy of Pediatrics
• The American Academy of Pediatrics Committee on Environmental Health Recommendations for the Screening of Elevated Blood Lead Levels as published in Pediatrics. Vol. 101, No. 6, June 1998, are accessible at: http://aappolicy.aappublications.org/cgi/reprint/pediatrics;101/6/1072.pdf
• Other information released by the Committee on Environmental Health can be found at: http://www.aap.org/visit/cmte16.htm

• The American Academy of Pediatrics home page is located at: www.aap.org
American Academy of Family Physicians
• A Spanish/Español version of Lead Poisoning in Children is available at: http://familydoctor.org/e617.xml
• Additional information can be found at: www.aafp.org. By entering the keyword, *Lead*, studies on lead poisoning and lead exposure can be found.
University of Pittsburgh
• The University of Pittsburgh, School of Medicine web search can be found at: http://www.upmc.com/ . By entering the keyword, *Lead*, information on lead exposure and childhood delinquency can be found.
• The homepage of the University of Pittsburgh School of Medicine, Children's Hospital of Pittsburgh is: www.chp.edu/
• Useful information can also be found at: www.chp.edu/greystone/poison/lead.php .
Harvard University
• The Harvard University Research Matters web page is the public entry to the latest news about medical treatments, societal research, basic science, technological advances, and earth and space exploration. The web page can be found at: www.researchmatters.harvard.edu. Enter the keyword, *Lead*, to find useful information pertaining to health effects, exposure pathways, and intervention methods.
Johns Hopkins University
• Johns Hopkins University web page can be found at: www.jhu.edu. By entering the search term, *Lead Exposure*, in the search engine useful information pertaining to lead exposure can be obtained.

Appendix F: Work Agenda for the CDC Technical Assistance Team—La Oroya Site Visit

WORK AGENDA FOR THE CDC TECHNICAL ASSISTANCE TEAM- LA OROYA SITE VISIT

Saturday, March 13

Arrival to Lima and transport to Marriott Hotel by the DIGESA Office of Public Relations

Sunday, March 14

Preparation for La Oroya site visit.

Monday, March 15

8:15AM –9:15AM:	Transport to the Embassy of the United States of America for a meeting with USAID. Avenida La Encalada s/n block 17 – Monterrico- Surco.
10:30AM – 11:30AM	Meeting with the Ministry of Energy and Mining – the Directorate of Environmental Issues – Engineer Julio Bonelli, located in the district of San Borjas.
11:30 – 2:00PM	Free time
2:00 - 6:00PM	DIGESA Meeting located at Las Amapolas Street, #350 Urbanization San Eugenio- Lince (at the rear of the Melitón Carbajal High School). Telephone 440 0399-Annex 217 (Engineer Eusebio Robles) or annex 219 (Dr. Rocío Espinoza).
2:30PM- 3:00PM:	Formal introduction on the part of General Directorate of Environmental Health (DIGESA) and Directors: Engineer Luis Chávez Pais –Director General DIGESA, Dr. Zoila Henriquez La Cottera, Assistant to the General Director, Engineer Walter Aliaga P.-Director (e) of Executive Directorate of Ecology and Environmental Protection and Engineer Eusebio Robles García, Manager of Office for the Control and Prevention of Atmospheric Contamination.
3:00PM -3:20PM:	Presentation by DIGESA on the results of the Blood Lead Level Study from 1999 in la Oroya.
3:20PM – 3:40PM:	Presentation by DIGESA on the MINSA/Doe Run Perú Agreement.

3:40PM – 4:10PM: Presentation of the activities conducted as a part of the MINSA/Doe Run Perú Agreement. Description of the demographic situation in La Oroya and presentation of the geo-referenced maps of Old La Oroya

4:10PM - 4:30PM: Presentation on the La Oroya Air Quality Surveillance System: Doe Run Peru and DIGESA sampling regimen.

4:30PM - 5:00PM: Presentation on the Water Resource and Discharge Surveillance System

5:00PM - 5:20PM: Presentation on the proposed educational program for La Oroya.

5:20PM - 6:00PM: Presentation from the various areas involved in the solution of the La Oroya contamination problem:

- Engineer Francisco Fuentes: Air Quality Monitoring
- Engineer Isaac Lavado: Hydrological Resources Monitoring
- Dr. Rocío Espinoza Laín and Biologist Carmen Ferry: Surveillance of Illnesses Associated with Atmospheric Contamination – National Level Lead Program
- Com. Teresa Alayo, Public Relations, Nery Horna and Social Assistant, Luz Pandero: Educational Program
- Lic. Ana María Hidalgo and Engineer. Milagros Caycho Bustamante: Statistics and Geographic Information Systems Management.

Tuesday, March 16

8:00AM - 12:00PM: Continuation of workgroups in DIGESA.

12:00PM – 3:30PM: Transportation to La Oroya
The trip from Lima to La Oroya lasts 3 ½ hours. Travelers will pass through elevations as high as 4,500 meters (Ticlio) and will be lodging in a zone 3,500 meters above sea level.

WEDNESDAY, MARCH 17

Depart from the Hotel "HOTEL DE TURISTAS DE TARMA".

8:00AM - 11.00AM: Visit the Doe Run Smeltering Facility (DIGESA will manage the coordination with the DOE RUN Facility).

11:00AM - 12:00PM: Visit the contract office in Doe Run for presentations. (DIGESA will coordinate). Dr. Ramos of Doe Run's clinic

	has information on educational programs and will present results from population health studies.
2:00PM - 4:00PM:	Visit the problem areas in the City of La Oroya, especially, in Old La Oroya. Doe Run Peru and DIGESA personnel will accompany all visits. Visit to the La Oroya health center: Dr. Jesús Díaz Matos; and the Church health center.

Thursday, March 18

- Visit with the Regional Governmental Offices in Junín- City of Huancayo.
- Visit Regional Health Directorate (DISA) and work meeting with the Executive Directorate of Environmental Health (DESA) of Huancayo.
- Visit Hospital Centers of Huancayo and Jauja. (DIGESA is coordinating these visits with the Regional Health Directorate of Huancayo and the Doctor contracted by the Ministry of Health to work on the MINSA/Doe Run Perú Agreement)

Friday, March 19

- Meeting with the local authorities and civil society (MOSAO).
- Visit with the Mayor of the Yauli Province.
- Visit with the Regional Environmental Health Council Secretary- CONAM
- Lunch and return travel to Lima.

Saturday, March 20

- DIGESA facilities will be available for work and meetings.
- Peruvian Folkloric music!

Sunday, March 21

- Preparation of preliminary observations and recommendations

Monday, March 22

- Presentation of preliminary observations and recommendations.
- Closing.

Appendix G: Preliminary Observations and Recommendations to Peruvian Stakeholders, March 22, 2004

Centers for Disease Control and Prevention (CDC)

National Center for Environmental Health

CDC Technical Site Visit in La Oroya
March 13– 22, 2004

Brian Hubbard, Oscar Tarragó, Gary Noonan,
John Sarisky, Pamela Meyer, Sharunda Buchanan

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CDC – USAID Interagency Agreement

- Provide technical assistance for environmental health activities
- $100,000
- DIGESA is the counterpart agency for environmental health activities

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CDC – USAID Interagency Agreement

Objective:

- Address health threats that exist in La Oroya

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CDC Technical Team

- **Dr. Sharunda Buchanan**, Chief of Environmental Health Services Branch, National Center for Environmental Health (CNSA) – Project Leader
  - Experience in Lead Monitoring Programs

- **Dr. Oscar Tarragó,** Division Health Education and Promotion, ATSDR
  - Coordinates communication of health risks and has worked in childhood lead poisoning projects

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CDC Technical Team

- **Dr. Pamela Meyer**, Lead Scientist, Lead Poisoning Prevention Branch,
  - Coordinates scientific teams to improve the epidemiological surveillance of lead poisoning

- **Sr. Gary Noonan**, Assistant Director for Chemical Response and Terrorism and Director of Global Health Activities for the Division of Environmental Hazards and Health Effects
  - Has worked in Lima/Callao and Puerto Nuevo on Lead studies

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CDC Technical Team

- **Sr. John Sarisky**, Senior Environmental Health Official, Technical Assistance Team Leader, Environmental Health Services Branch
  - Has EPA certification as an inspector and evaluator for environmental lead contamination

- **Sr. Brian Hubbard**, Environmental Health Scientist, Environmental Health Services Branch
  - Has worked in Perú providing technical assistance to NGOs, and regional and local governments to implement community based environmental health assessments

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Government Agencies Visited

- The United States Agency for International Development (USAID)
- Ministry of Energy and Mines (MEM)
- The General Directorate of Environmental Health (DIGESA)

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DOE RUN Perú Smeltering Facility

- Dr. Juan Carlos Huyhua
  Vice President of Management and Operations
- José A. Mogrovejo
  Vice President of Corporate Environmental Issues

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Smeltering Facility Visit

Regional Government

- Engineer Manuel Duarte – Regional President
- Dr. Luis Huamaní – Regional Health Director of Junín

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Local Government and Civic Organizations

- Mayor Clemente Quincho
  - Social License
- Secretary Carlos Rojas – Regional Environmental Council (CAR)
- Movement for the Health of La Oroya (MOSAO)

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Appreciation

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Three Most Important Themes

Reduction of Emissions

Historical Contamination

Public Health and Hygiene Education

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Public Health and Hygiene Education

- A very important topic for reducing exposure to the contaminants
- Efforts should reduce exposure to other diseases as well
- However, given current levels, it should not be the first priority

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Reduction of Emissions

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Historical Contamination

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Preliminary Observations and Recommendations

Historical contamination is a very important issue the should be aggressively addressed, at the same time as reduction in air emissions.

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Preliminary Observations and Recommendations

The Peruvian Government needs to bring together all the different parties involved to take immediate and strong action in the search for a solution for historical contamination.

CDC can provide support materials, information, and contacts on environmental remediation

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Preliminary Observations and Recommendations

A valuable opportunity exists to improve the coordination and communication between all involved parties (including the community), in order to achieve a more representative and complete community participation.

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Preliminary Observations and Recommendations

One needs to define community in a more precise way and implement a process of inclusion and participation to encourage the credibility and trust between institutions and the community

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Preliminary Observations and Recommendations

- The agreement between MINSA and Doe Run Peru is very ambitious and the priorities should be based on existing resources

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Preliminary Observations and Recommendations

There is an emphasis on curative services above preventative measures, which does not solve the exposure problem. However, we recognize there is a great need for medical services in La Oroya

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Preliminary Observations and Recommendations

There exists a need for a well-designed, scientifically-based, and corroborative system to monitor:

- Reduction of air emissions
- Remediation of historical contamination

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Preliminary Observations and Recommendations

Although it appears that the principal focus is lead contamination, taking immediate action will reduce exposure to other contaminants such as cadmium, arsenic, sulfur dioxide and suspended particulates, among others.

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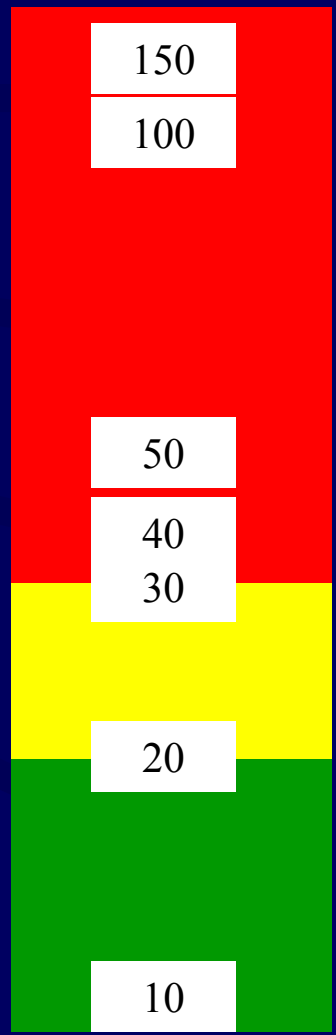
Lead Levels Associated with Observable Effects in Children

Death
Encephalopathy
Nephropathy
Severe Anemia
Colic
Synthesis of hemoglobin
Metabolism Vit. D
Speed of conduction in the nerves

Neurotoxins
IQ



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Next Steps

- Evaluation of Collected Information
- Preparation of the Final Report
- Sharing Report Findings

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Summary

As soon as the sources of contamination are reduced and controlled (new and historical) there will be less damage to the population, especially the children, the group most vulnerable.

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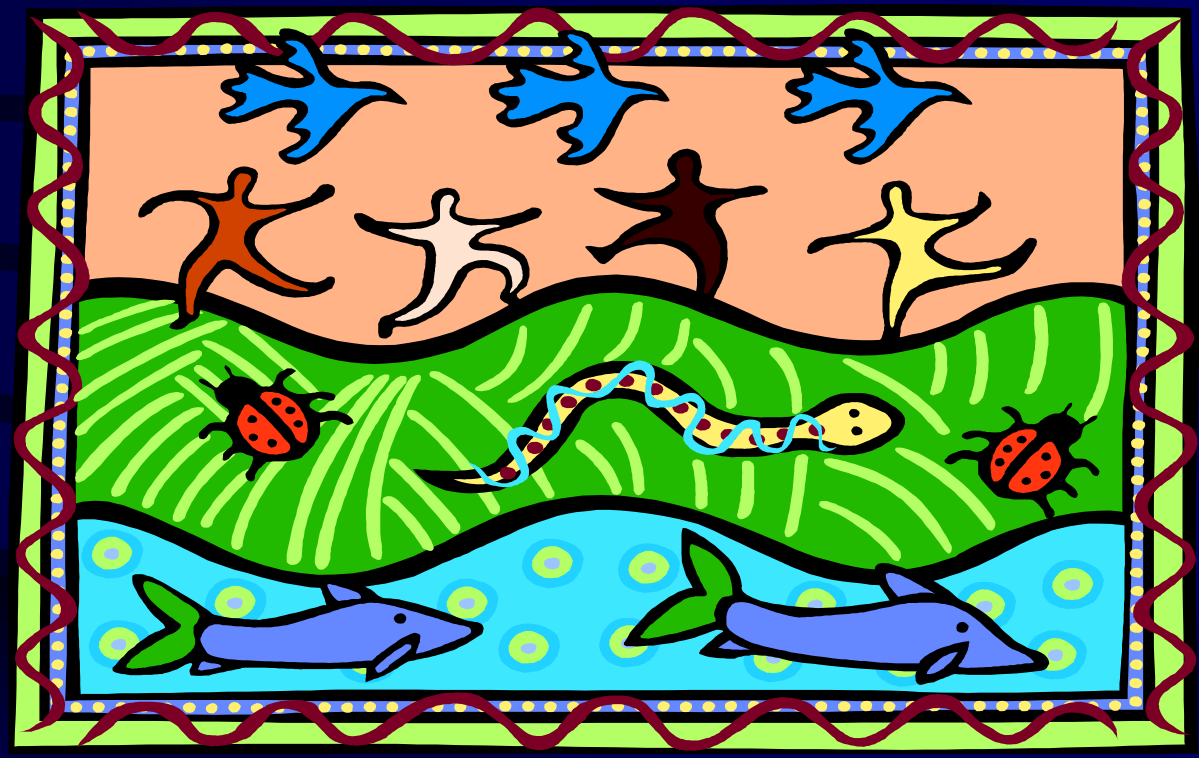
Thanks for your attention!



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Appendix H: Three Case Studies

The case studies that follow offer a historical perspective on actions taken to identify and resolve environmental public health problems associated with 3 metal smelter operations in the United States and Mexico.

I. Herculaneum, Missouri, USA

In 1864, the St. Joseph Lead Company purchased a large tract of land in the "Lead Belt" in southeastern Missouri. Two years later in 1886, the trustees of St. Joseph Lead Company granted a local management team permission to form a small company, the Doe Run Lead Company. In 1890 St. Joseph began the construction of the Herculaneum smelter, and initiated operations in 1892. Over the last 118 years, the Doe Run Lead Company, now the Doe Run Company has acquired various mining and milling operations including a predecessor, St. Joseph Lead, and competitors Homestake Mining Company and American Metal Climax (1986) and ASARCO Incorporated (1998) (DoeRun 2004).

The city of Herculaneum is located approximately 42 km southwest of St. Louis, Missouri, and rests along the Mississippi River in Jefferson County at an elevation of 129 meters. The city has an estimated population of 3043 people (2002 US Census). The climate is temperate with annual rainfall, ranging from 96 to 110 cm. Average summer and winter temperatures are approximately 25^{o}C and 0^{o}C, respectively. (City-data 2004).

The Doe Run owned and operated smelter in Herculaneum began as a 52-acre facility, which consists of a smelter plant, a 12-15 meter high slag pile that covers 24-acres, and an onsite sulfuric acid plant (MDNR 1999). The smelter property abuts residential neighborhoods on the west and north-northwest, a slag pile on the south-southwest, and the river on the east. A large part of the slag pile is located in the floodplain wetlands of Joachim Creek and the Mississippi River. Several homes are within 61 meters of the smelter, and at least three homes are within 61 meters of the slag pile (ATSDR 2001). Three schools are in the city: a high school, a middle school, and a junior high school. The city's elementary school is approximately 3 km. away in Pevely, MO.

The smelter at Herculaneum is the largest primary lead smelter in the United States with a production capacity of 250,000 tons of refined lead per year. Lead ore concentrate, consisting of about 80% lead sulfide, is processed at the smelter. The ore is transported by truck from eight lead mines operated by the company near Viburnum, MO, approximately 120 km south-southwest of Herculaneum (EPA 2003).

On August 21, 2001, the Missouri Department of Natural Resources (MDNR) investigated a citizen complaint concerning dust spilled on the streets of Herculaneum. Results from a dust sample and subsequent investigations by MDNR and the US Environmental Protection Agency (USEPA) revealed lead concentration on streets as high as 300,000 parts per million (ppm) (Walker 2001). In addition, lead was found in yard soils at concentrations up to 33,000 ppm (EPA 2002). The USEPA standard for lead

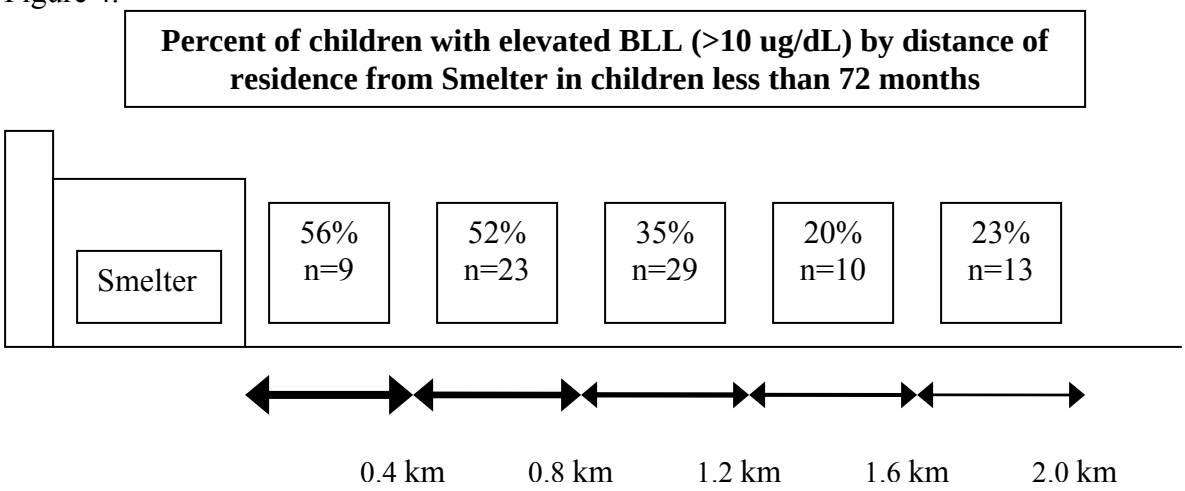
in bare soil in children's play areas is 400 ppm and for bare soil in the rest of the yard is an average of 1,200 ppm. The dust and elevated lead concentrations seemed to be associated with haul routes in and out of Herculaneum. On September 25, 2001 MDNR issued an "Abatement and Cease and Desist Order" to the Doe Run Company which detailed the steps that must be taken to reduce the public health and environmental threat due to lead contamination. The order stated Doe Run must: (MDNR 2001)

- Immediately cease all activities that cause fugitive dust to leave the facility;
- Immediately upgrade truck washing facility to include all vehicles leaving contaminated areas of the plant;
- Complete all road and facility cleaning within seven days;
- Ensure that all water from street and vehicle washing is contained and treated;
- Repave any remaining contaminated roads within 60 days of the MDNR's notice to proceed;
- Submit a detailed plan for discontinuing the use of open-backed trucks, either tarped or un-tarped, for hauling lead concentrate within 10 days;
- Cease and desist the use of open-backed trucks for hauling lead concentrate within 45 days;
- Complete all residential yard characterization and remediation outlined by USEPA;
- Fund MDNR or USEPA to characterize and cleanup indoor residential dust;
- Cease and desist transport of lead concentrate along the streets of Herculaneum.

On February 26, 2002, the Missouri Department of Health and Senior Services (DHSS) released a Health Consultation that contained the results of blood lead level (BLL) testing conducted in Herculaneum between August and October 2001. The testing was performed by DHSS and the Jefferson County Health Department (JCHD), in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). Results revealed that many residents of Herculaneum had BLLs of 10 micrograms of lead per deciliter of blood (10 ug/dL) or higher. Of a total of 935 people tested, 28% (33-118) of children less than 72 months of age had BLLs of 10 ug/dL or higher. BLLs in this age group ranged from non-detectable to 32 ug/dL. In children between the ages of 6 and 17 years, 8% (13/162) had BLLs of 10 ug/dL or higher ranging from 10ug/dL to 19 ug/dL. Two of the 655 adults tested had BLLs of 25 ug/dL or higher. The range for men was from 10 ug/dL to 31 ug/dL and for women from 10ug/dL to 55 ug/dL (ATSDR 2002).

In 2001, 28% of the children under 72 months of age who were tested had BLLs equal to 10 ug/dL or higher. Of the children tested that lived closest to the smelter 45% had BLLs equal to or greater than 10 ug/dL (MDNR 2002). The DHSS Health Consultation determined a circle of contamination existed around the smelter. The percent of children with elevated BLL by distance of residence from smelter in children less than 72 months were (MDNR 2002b):

Figure 4.



Source: MDNR (2002). "Health Consultation: Blood Lead Results for 2002 Calendar Year, Herculaneum Lead Smelter Site: Herculaneum, Jefferson County, Missouri, March 14, 2003."

Data collected from ATSDR Health Consultations in 2002 further suggest that lead contamination is attributable to the smelter. The testing of residential surface soil samples (cadmium, arsenic, and lead) showed that the range of lead was from 43-24,000 ppm, with an average of 2,300 ppm and a median of 1,300 ppm. The analysis of the findings demonstrates that the concentrations of all the metals correlated with each other, and in particular the concentrations of lead and cadmium were highly correlated. These data suggest that the arsenic, cadmium, and lead found in the soil derived from the same source (ATSDR 2002b)

Subsequently, MDNR and USEPA directed the Doe Run Company to expedite activities to clean up existing contamination and reduce/eliminate future contamination throughout Herculaneum. The Doe Run Company, with guidance from MDNR and USEPA, has implemented several exposure reduction activities, including the following (DHSS 2002):

- Smelter air emissions and fugitive dust have been reduced by installation of a number of equipment up-grades and process modifications in order to meet National Ambient Air Quality Standards (NAAQS);
- Soil removal and replacement is being performed by the Doe Run Company in public and private yards, parks, and schools, as well as along roadsides, where lead levels are greater than 400 ppm. First priority was given to those yards where children under 72 months reside
- In-house dust is being removed by the Doe Run Company in accordance with established methods, with oversight from USEPA, in those residences with elevated lead dust levels;
- Residences are being offered HEPA filter vacuums, regardless of whether their homes have been cleaned, to assist in controlling interior dust levels;
- The Doe Run Company has made modifications in the handling and transportation of the lead ore concentrate;
- The Doe Run Company is offering a voluntary property acquisition of homes within a specified geographic area approximately 3/8 mile around the smelter.

Acquisition priority was placed on those homes where children under 72 months reside. The company has agreed to buy-out homes and yards in the area on a schedule of "worst first"; it will be required to make purchase offers on about 160 homes by December 2004.

Successful Interventions Reduce Blood Lead Levels in the Children of Herculaneum

On April 11, 2003, the Missouri Department of Health and Senior Services in cooperation with ATSDR released the results of blood lead testing conducted in 2002. This testing was follow-up of initial investigations conducted in 2001. Blood lead data for Herculaneum residents in 2002 showed a marked reduction in the percentage of children with elevated blood lead levels (BLL) compared with BLLs in children tested in 2001. The 2002 blood lead data for children less than 72 months show a 50% reduction in the prevalence of elevated BLLs compared with 2001 data for children in this age group. Fourteen percent of Herculaneum children tested in 2002 had elevated BLLs, compared with 28% of the children tested in 2001. The 2002 blood lead data for children living closest to the smelter show a 62% reduction in the prevalence of elevated BLLs compared with 2001 data for children in this age group. Seventeen percent of children tested had elevated BLLs in 2002, compared with 45% of those tested in 2001 (MDNR 2002).

Several factors could be responsible for the clear reduction in BLLs in children living in Herculaneum. These factors include actions taken by MDNR and USEPA to ensure that the Doe Run Company take actions to reduce/eliminate sources of lead exposure; the communities increased knowledge of potential pathways of lead poisoning; and DHSS and ATSDR's increased efforts in monitoring blood lead levels and providing information to reduce exposure. Furthermore, another factor that could allow for a reduction of BLL prevalence in 2002 could be associated with residents who were most at risk to lead exposure in 2001 being moved. Doe Run relocated high-risk households through the property buy-out program (MDNR 2002).

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Environmental Protection Agency Region 7 Update for El Paso County:

http://www.epa.gov/region7/news_events/fac

Health consultations and educational materials:

http://www.dhss.mo.gov/EnvirConsult/H

tsheets/fs_herculaneum_lead_smelter_herculaneum_mo.pdf

erculaneumBloodLead2003.pdf

http://www.dhss.mo.gov/EnvirConsult/HercCAS-CDfnlbe.pdf

II. El Paso, Texas, USA

In 1887, Robert S. Town founded the Consolidated Kansas City Smeltering and Refining Company in El Paso, Texas. The smelter became operational in the same year and began to extract lead from minerals removed from nearby mines. The city of El Paso sits in the western corner of Texas adjoining the state of New Mexico and the country of Mexico to the South. The climate is arid with average annual rainfall of 21.97 cm. Local weather patterns are characterized by frequent thermal inversions of considerable duration because of the sheltering effect of the Franklin Mountains (Elevation 2192 meters). Average summer and winters temperatures are 25.9 C° and 8.3 C°, respectively. Dust storms are common. Naturally occurring elevations in metal concentrations are not present in the geological formation on which El Paso and the smelter were built.

In 1899 the smelter became part of the newly formed American Smelting and Refining Company (ASARCO). Throughout the smelter's 104-year history the primary mineral processed was lead but the facility adapted to meet changing market and material demands. A copper smelter was added in 1911. In the 1930's cadmium production started with the addition of a Godfrey roaster. In the early 1970's an antimony plant was added as production peaked and employment reached close to 1500 personnel.

Operating at full capacity to meet demand, the ASARCO smelter emitted approximately 1,116 tons of lead, 560 tons of zinc, 12 tons of cadmium and 1.2 tons of arsenic into the air from 1969 through 1971 (Landrigan, Gehlbach et al. 1975). A landmark 1972 study conducted by Dr. Philip Landrigan and colleagues of the CDC, revealed blood lead levels to be 40 micrograms of lead per deciliter of blood (ug/dL) and higher in 53% of the children from 1 to 9 years of age living within 1.6 km of the smelter (Landrigan, Gehlbach et al. 1975). The high blood lead levels in children prompted state and local officials to take actions to control emissions from the facility. Responding to pressure and litigation, ASARCO renovated their facilities between 1973 and 1979 to reduce emissions. The ensuing reduction in emissions that resulted from this action helped to decrease the blood lead levels of the local population. Results from a follow-up study in 1977 revealed mean blood lead levels in children aged 1 through 18 years of age, and living between 0.8 km and 1.6 km of the smelter, decreased from 31.2 to 20.2 ug/dL (Morse, Landrigan et al. 1979). In 1985 the ASARCO facility stopped lead smelting operations. This resulted in a further drop in mean blood lead levels.

ASARCO continued to make plant improvements in 1993 with the installation of continuous top-feed oxygen process technology to allow for increased production and lower emissions. However, by 1999, falling copper prices and copper mine closures forced ASARCO to suspend production. Currently the smelter is in a care and maintenance status.

Although production has been suspended, concern over human health continues. Studies conducted on both sides of the US-Mexican border have indicated that the percentages of children with blood lead levels > 10 ug/dL increases as distance from the smelter decreases. The current action level recommended by the Centers for Disease Control and Prevention of the United States is 10 ug/dL. While it is recognized that lead uptake is currently four times lower than it was in the 1970's, it has also been determined that blood lead levels in the population living near the El Paso smelter have decreased substantially (4 times lower), since the 1972 study (Diaz-Barriga, Bates et al. 1997). Engineering solutions to control plant emissions made this reduction possible. However, elevated blood lead levels remain in young children. The principal pathway for exposure to lead and other metals is no longer air emissions, but contaminated soil and dust.

A recent study by the Agency for Toxic Substances and Disease Registry (ATSDR) discovered a statistically significant twofold excess of risk for multiple sclerosis (MS) in a community located adjacent to the smelter.(ATSDR 2001) Although the study cannot draw conclusions regarding metals exposure and risk for MS, it does suggest the need to study metals exposure as a possible risk factor for MS.

An issue facing all stakeholders is the cost of cleanup. The United States Environmental Protection Agency (USEPA) has designated the ASARCO facility in El Paso as a Superfund site (http://www.epa.gov/superfund/about.htm). This has given the EPA removal authority, which has allowed for the removal of contaminated soils from residences and the study of related human health exposures. There are continuing efforts to place El Paso on the National Priorities List (NPL) (http://www.epa.gov/superfund/sites/npl/npl_hrs.htm). This would grant authority to the USEPA to take long-term action to significantly reduce dangers to human health problems related to site conditions. The USEPA has spent $6 million on removal activities at 387 residences and currently anticipates cleaning 535 more residences. Money made available under the Superfund designation will not cover the cost of all necessary remediation activities. A funding option is to include El Paso on the NPL.

Historical contamination continues to pose a problem for residents, plant operators, health care providers, public health officials, government authorities, and others.

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Environmental Protection Agency Region 6 Update for El Paso County:	Health consultations and educational materials:
http://www.epa.gov/earth1r6/6sf/el_paso_index.htm (English) http://www.epa.gov/earth1r6/6sf/pdffiles/spanish_el_paso_index.pdf (Spanish)	http://www.tdh.state.tx.us/epitox/EPsoilsum.htm

III. Torreón, Mexico

In 1887, Industrias Peñoles, S.A. de C.V. and subsidiaries incorporated to become one of Mexico's largest industrial conglomerates. Peñoles is comprised of more than 50 companies and employs 9,081 individuals. The conglomerate is the world's largest producer of refined silver, metallic bismuth and sodium sulfate. The metals division, incorporated as Met-Mex Peñoles, operates the largest non-ferrous metallurgical complex in Latin America and fourth largest in the world in Torreón, Coahuila, Mexico. It includes a lead smelter, a gold-silver-lead refinery, an electrolytic zinc plant and sulfuric acid, cadmium, bismuth, ammonium sulfate, antimonium trioxide and liquid sulfur dioxide plants (Peñoles 2004). Met-Mex Peñoles metallurgical complex is located approximately 550 km south of the U.S.-Mexico border. Torreón, founded in 1893, is located along the Nazas River in the Coahuila state of northern Mexico at an elevation of 1124 meters. With a population approaching 500,000, Torreón is the largest city of the La Laguna district, a heavily irrigated area that supports some of Mexico's finest cotton, wheat, and dairy production. The climate of this area is arid to semiarid with annual rainfall between 25 and 50 cm. Torreón is predominately dry and dusty. Average summer and winter temperatures are 31^{o}C and 16^{o}C, respectively (Benin, Sargent et al. 1999).

The smelter in Torreón was built in 1901. By 1998 the Met-Mex Peñoles industrial complex was surrounded on three sides by residential neighborhoods. Ground cover is sparse in these neighborhoods and most roads in the residential areas are unpaved. Slag piles, a remnant of a century of mining activities, and covering approximately 5300 m^2, are located in the center of the metallurgic facility.

Met-Mex Peñoles processes approximately one-third of the lead ore in Latin America and in 1996 produced 166,000 metric tons of lead and 123,000 metric tons of zinc. In addition Met-Mex Peñoles processes 200,000 metric tons of silver and gold a year, brought in from 130 mines throughout Mexico (Peñoles 2004). In 1976, Lilia Albert carried out a study on the content of lead in the hair of Mexican children. Samples were obtained from five different regions of the country that consisted of both rural and urban areas. In this study Torreón and its twin city, Gómez Palacio, were among the five areas tested. The other areas sampled included Mexico City, Puebla, Tepeaca, and the small town of Matamoros, which served as a control. Lilia Albert's study revealed that Torreón

had a mean lead hair concentration of 55.1 ug/g among 15 samples. These results were more than 10 times the mean of the control zone (Albert and Badillo 1991).

In 1998, Pediatrician Manuel Velasco noticed that his young patients who lived near the plant were anemic and began to determine their blood lead levels. The first case Dr. Velasco reported was a 1-year-old patient with a blood lead level (BLL) of 45 micrograms per deciliter (ug/dL) of blood. Dr. Alonso Garcia Vargas, a toxicologist and professor at the University of Juarez in Durango State also conducted an extensive study of BLLs in children living near the smelter. Of 394 children attending schools near the plant, 98 had BLLs above 25 ug/dL, and ten children exhibited signs of lead poisoning (Lancy 1999).

In 1999, the community of Torreón and physicians from local health clinics requested that city and state government official appeal to federal agencies, including the Health Secretary (Secretaria de Salud (SSA) in Spanish) and the Office of the Federal Attorney of Environmental Protection (Procuraduría Federal de Protección al Ambiente (PROFEPA) in Spanish) to address the problem of lead contamination. In response, in January and February 1999, the Mexican Office of Environmental Health (MOEH) conducted a study of BLLs in 736 school-aged (6-13) children in Torreón. The study found a mean BLL of 29.6 ug/dL in Torreón school children, with highest values in children living within 200 meters southeast of the smelter (Albalak, McElroy et al. 2003). The high blood lead levels in children prompted federal and state government officials to take action to control emissions from the facility. Met-Mex Peñoles was ordered to reduce production output by 25% until emission controls were modernized (this order was later amended that Peñoles must reduce production output to 50% until contamination was alleviated). Furthermore, Met-Mex Peñoles was ordered to buy 394 homes in the most contaminated 20 blocks adjacent to the plant. The houses were razed, the lead-filled soil removed, and the 12.5-acre parcel was turned into a greenbelt between the factory and the city. A $6.6 million trust fund was established to pay for clean up and medical costs. By 1999 Met-Mex Peñoles had invested US $17.5 million associated with purchase of homes and land, clean up of historical lead contamination, and establishment of a trust fund for health, medical care, and educational programs. Additionally, Met-Mex Peñoles installed new equipment designed to eliminate fugitive dust emissions. The new equipment included (Peñoles 2002):

- Total enclosure of the lead smelter including 42,000 m^2 of covered storage and warehousing for ore concentrates.
- Eight new bag houses and an electrostatic precipitator to increase emission filtration from 1,992,800 cubic meters per hour to 3,829,800 cubic meters per hour.
- Purchase of sweeper/vacuums for continuous clean-up program, both inside and outside the plant.
- Automated drive-through truck wash.
- Two new induction furnaces in the lead-silver refinery to upgrade and replace old equipment, which allow for complete elimination of metallic fume emissions and reduced costs.

A follow-up study by MOEH in February 2000 of 503 children who had participated in the 1999 study revealed a mean BLL of 16.6 ug/dL. MOEH concluded that a significant decrease in BLLs had resulted due to Met-Mex Peñoles remediation efforts. However BLLs still were higher than the United States Centers for Disease Control and Prevention (CDC) action level, therefore MOEH decided that further remediation activities and improved surveillance of BLLs were necessary to continue this downward BLL trend. Following the February 2000 MOEH study, community members of Torreón requested that an objective third party conduct a study to confirm the apparent decreasing BLLs in Torreón. In July 2000, the CDC was contacted to perform a BLL study of the children of Torreón (Albalak, McElroy et al. 2003).

In February 2001 a team from the CDC conducted a blood lead level study of children living in Torreón. A total of 367 children (average age 3.7 years) from 278 households, 70 from the area adjacent to the smelter and 208 from a random sample of Torreón were included in the sample. The mean BLL of children in this study was 6.0 ug/dL. Twenty percent of children had BLLs ≥ 10ug/dL, and 5% had BLLs ≥ 20ug/dL. Based on the 2000 Torreón census, this suggests that an estimated 11,181 children between the ages of 1-6 years in Torreón have BLLs ≥ 10ug/dL (Albalak, McElroy et al. 2003).

The results of this study revealed that BLLs in children in this study were moderately high, but lower than those observed before remediation activities were implemented by Met-Mex Peñoles (Albalak, McElroy et al. 2003).

The slow response of government agencies and Peñoles to this problem resulted in a measure of distrust in the community of Torreón. Studies documenting high blood lead levels in Torreón have existed for 20 years, actions to ameliorate contamination started in 1998.

Other problems facing community residents of Torreón are a combination of poverty and lack of knowledge of the health effects of lead. The strongest predictor of BLLs in the CDC study (and similar studies worldwide) was distance from the smelter. BLLs increase in a dose-response fashion with increasing proximity to the smelter and decrease in the same manner with decreasing proximity to the smelter. However, investigations by CDC revealed that the level of education of the primary caregiver were also strong predictors of BLLs in children. Furthermore, there was an interaction effect of distance with level of education on BLLs. Children, whose primary caregiver had no education or a primary level of education, revealed a strong inverse dose-response relation between mean BLLs and distance from the smelter. The effects of distance on BLLs were weaker in children whose primary caregiver had a higher level of education (Albalak, McElroy et al. 2003).

Herculaneum, El Paso, Torreón, and La Oroya - Similarities and Differences

Herculaneum, Missouri; El Paso, Texas; Torreón, Mexico; and La Oroya, Peru share many similarities. The first railroad constructed in Peru in 1893 made possible the delivery of mining materials from La Oroya to the Peruvian coast. Likewise, in 1888 the

Arizona and Southwestern Railroad was constructed through El Paso to transport copper anodes. El Paso, Texas and La Oroya, Peru are surrounded by mountains and subjected to frequent thermal inversions. Lead smelters located in Herculaneum, El Paso, Torreón, and La Oroya have histories spanning more than 100 years. Another similarity is that scientific studies in all these mining cities demonstrate that blood lead levels in children increase as distance from the smelters decrease. In addition, environmental sampling has revealed elevated levels of arsenic and cadmium, metal by-products of the smeltering process.

However, stark contrasts exist between La Oroya and the cities of El Paso, Herculaneum, and Torreón in efforts to mitigate threats posed by contamination. In Herculaneum, the Doe Run Company has implemented effective interventions that have reduced exposure to environmental lead. The Doe Run Company in Missouri has taken action to clean contaminated areas and implemented measures to reduce/eliminate sources of lead contamination. Moreover Doe Run in Missouri has offered a voluntary property acquisition of homes within a specified geographic area approximately 0.6 km around the smelter, resulting in the purchase of approximately 160 homes through December 2004. Missouri state and Federal health and environmental agencies took aggressive action to control environmental contamination affecting human health. El Paso authorities took forceful action to reduce smelter emissions in the 1970's, and Federal agencies in the United States are taking aggressive action in El Paso to cleanup historical contamination. Federal authorities continue advocating for a full-scale cleanup to permanently and significantly reduce exposure from environmental contaminants. The Mexican government has taken a strong stance against environmental contamination affecting human health. Industrias Peñoles has taken uncompromising actions in cleaning up historical contamination, controlled fugitive emissions, replaced old equipment, and set up a trust fund to provide medical and cleanup cost for the citizens of Torreón.

In La Oroya, needed action has not been implemented. Historical contamination has not been addressed. Fugitive emissions have not been controlled and stack emissions may not fully comply with emission standards until 2011 as currently proposed in Doe Run Environmental Management and Adjustment Program (PAMA in Spanish) for the years 2004 through 2011.

Albalak, R., R. H. McElroy, et al. (2003). "Blood Lead Levels and Risk Factors for Lead Poisoning among Children in a Mexican Smelting Community." Archives of Environmental Health **58**(3): 172-183.

Albert, L. A. and F. Badillo (1991). "Environmental Lead in Mexico." Reviews of Environmental Contamination and Toxicology **117**.

ATSDR (2001). "Agency for Toxic Substances and Disease Rgistry. Health consultation for Herculaneum Lead Smelter site: Atlanta: US Department of Health and Human Services; July 13, 2001."

ATSDR (2001). Public Comment Draft: El Paso Multiple Sclerosis Cluster Investigation, El Paso, El Paso County, Texas, Agency for Toxic Substances and Disease Registry.

ATSDR (2002). "Health Consultation: Herculaneum Lead Smelter (DOE RUN Company). Herculaneum, Jefferson County, MO, Agency for Toxic Substances and Disease Registry."

ATSDR (2002b). "Health Consultation: Determination if Remedial Actions are Protective of Public Health. Herculaneum, Jefferson City, MO, Agency for Toxic Substances and Disease Registry. February 26, 2002."

Benin, A. L., J. D. Sargent, et al. (1999). "High Concentrations of Heavy Metals in Neighborhoods Near Ore Smelters in Northern Mexico." Environmental Health Prospectives **107**(4).

City-data (2004). Herculaneum, Missouri.

DHSS (2002). "Missouri Department of Health and Senoir Services. Health Consultation: Determine if Remedial Actions are Protective of Public Health, Herculaneum Lead Smelter Site, Herculaneum, Jefferson County, Missouri, April 16, 2004."

Diaz-Barriga, F., A. Bates, et al. (1997). "The El Paso Smelter 20 years later: residual impact on Mexican children." Environ Research **74**: 11-16.

DoeRun (2004). The Doe Run Company: Company Information. St. Louis, MO.

EPA (2002). "Environmental Protection Agency. Transmittal from Bruce Morrison to Missouri Department of Health and Senior Services, January 8, 2002."

EPA (2003). Herculaneum, Missouri, Lead Attainment Plan.

Lancy, J. (1999). A Mexican City Awakes to an Ecological Nightmare. NY Transfer News Collective. New York.

Landrigan, P. J., S. H. Gehlbach, et al. (1975). "Epidemic lead absorption near an ore smelter. The role of particulate lead." N Engl J Med **292**(3): 123-9.

MDNR (1999). "Missouri Department of Natural Resources, Division of Environmental Quality, Hazardous Waste Program. Preliminary Assessment: Herculaneum Lead Smelter Site, Jefferson County, Missouri. March 30, 1999."

MDNR (2001). Order to Abate and Cease and Desist Violations. Missouri Department of Natural Resources. September 25. Jefferson City, MO.

MDNR (2002). "Health Consultation: Blood Lead Results for 2002 Calendar Year, Herculaneum Lead Smelter Site: Herculaneum, Jefferson County, Missouri, March 14, 2003."

MDNR (2002b). "Missouri Department of Natural Resources: Total Maximum Daily Load Information Sheet, Mississippi River, August 2002."

Morse, D., P. Landrigan, et al. (1979). "El Paso revisited. Epidemiologic follow-up of an environmental lead problem." JAMA **242**(8): 739-41.

Peñoles (2002). Environmental Annual Report 2002.

Peñoles (2004). Company Profile.

Walker, P. (2001). Missouri Department of Health and Senior Services. Herculaneum, Missouri Lead Contamination Health Threat. September 13, 2001.

Appendix I: Chelation

During the March 2004 Assessment visit, Peruvian officials asked the CDC assessment team members to offer advice regarding the use of chelation as means for treating lead poisoned children. In the United States, CDC recommends chelation for children with blood lead levels of 45 µg/dL or higher. The purpose of chelation is to reduce the amount of lead in the person and thereby prevent further progression of its toxic effects. However, it is only one component in a multifaceted approach to treatment. These guidelines are based on the assumption that the chelated child will be placed in a lead-free environment.

In La Oroya widespread lead contamination results in continued lead exposure for the population from lead in soil and dust as well as lead in the air. Although short-term reductions in blood lead levels should be achievable, there is no evidence that chelation therapy will result in long-term reduction of either blood lead levels or the children's body lead burdens. There is also a lack of information regarding chelation's efficacy in preventing adverse developmental and intellectual outcomes in the face of such ongoing active exposure. However, existing data indicate that even for children whose exposure stops, chelation therapy does not reverse intellectual or developmental delays resulting from lead exposure. In addition, there is concern that repeated courses of chelating agents will also deplete the child of essential metals such as zinc and iron. Thus caution should be exercised in chelating children living in La Oroya.

As a final concern, there is evidence that lead absorption increases when patients are given oral chelating agents. In a study of a handful of adult volunteers given only small amounts of lead and succimer, a frequently used chelating agent, lead absorption increased; although because of increased lead excretion there was no overall increase in body lead burden. However, we do not know what would happen if a population of children were given succimer while they continued to be exposed to very high environmental lead levels.

On the other hand, chelation is definitely life saving when used in the highest risk patients, primarily those with blood lead levels greater than 70 ug/dL. These children are at risk of lead related encephalopathy and death. Physicians should consult with a physician with expertise in chelation and decide, on a case-by-case basis, whether the benefits of chelation therapy out weigh the possible negative consequences. Any guidelines that are developed must emphasize the importance of ensuring a lead-free environment for children both during and after treatment.

Appendix J: Plan Development Framework

The CDC team working with DIGESA representatives during a preliminary review of the findings outlined the following plan development framework. The CDC team and DIGESA recommend initiating the planning process at a national workshop convened to examine the 46 problems (APPENDIX K) listed in this report.

Recommended Plan Framework

Goal: Improve the health status of the residents of La Oroya, Peru

Problem Statement: Lead smelting operations in La Oroya emit pollutants into the environment. These pollutants and historical contamination are believed to be associated with environmental degradation and health problems identified in the local population.

Outcome Objective: Strengthen the environmental public health capacity of local, regional, and national governmental agencies responsible for responding to the situation in La Oroya.

Process Objective: Develop an integrated intervention plan to reduce exposure to lead and other contaminants in the mining center of La Oroya, Peru.

Task 1: Convene a national workshop.

Activities: Those invited to the national workshop will complete the following activities.

1. Category: Using problem statement forms located in Appendix L of this report, participants establish problem categories and place each problem in the appropriate category. Participants may add additional problems/issues/concerns to the original list of 46.

2. Priority: Each problem will be assigned a priority (high, medium, low or other ranking determined by the group) later in the process.

3. Problems/Issues/Concerns: Workshop participants are assigned to small workgroups. Each workgroup will be assigned problems most appropriate for the composition of the group. The group reviews each problem statement and decides if problem statement is clear and accurate. If problem statement is not understood it is rewritten. Some problems may need to be divided into 2 or more problem statements. The group may add additional

problems/ issues/ concerns to this original list of 46. Group agrees on the wording and meaning of each problem statement.

4. Supporting Information: Group discusses what is known about each problem. What data/information exists? If data/information is available, the group leader is responsible for the collection, organization and summary of existing data/information.

5. Information Needed: Group determines additional information needs. What information is needed to better understand and solve this problem? Does this information exist? If needed information does not exist, the group will describe the information needed and develop a plan to obtain it. The group leader is responsible for the collection, organization and summary of this new data/information.

6. Subject Matter Experts: Group determines what subject matter experts may be needed to work on this problem. Does necessary technical expertise exist within the country, can existing staff develop this expertise quickly, will outside assistance be needed to fully understand and solve this problem?

Task 2: An intervention is developed for each problem statement.

Activities:

1. Workgroup explores options available to resolve each problem. The group describes the people, processes, and equipment needed and the economic cost of implementing the recommended intervention.

2. The group develops a plan with a timeline to implement the selected intervention.

Task 3: Proposed intervention plans prioritized, approved and implemented.

Activities:

1. Recommended interventions are provided to DIGESA for integration into an overall intervention plan.

2. DIGESA and partners finalize comprehensive intervention plan and agree on implementation schedule.

3. DIGESA and partners secure resources and authority needed to implement and sustain the interventions.

4. Partners implement and evaluate the comprehensive intervention plan

Appendix K: Problems/Issues/Concerns Clearly Stated

1. Child blood lead level studies conducted in La Oroya indicate children are being exposed to high levels of environmental lead. Actions needed to prevent exposure, control lead emissions, and remediate historical lead contamination have not been implemented.

2. In La Oroya there is no coordinated long-term plan to monitor blood lead levels and associated health effects in the residents.

3. In addition to lead, other contaminants associated with smelting operations in La Oroya include: particulate matter, sulfur dioxide, arsenic, zinc, and cadmium. The concentration of these contaminants, their geographical distribution in La Oroya and the potential for human exposure to these contaminants has not been thoroughly assessed.

4. Environmental and health data related to smelter operations is collected intermittently in La Oroya by several governmental agencies, non-governmental organizations, and Doe Run. These activities are not coordinated and results do not appear to be shared with stakeholders and the residents of La Oroya.

5. National, regional, and local health and environmental authorities do not have, and have not identified, the information needed to develop a comprehensive intervention plan to control exposure to emissions from the Doe Run facility.

6. Stakeholders have not agreed on the design or implementation of health and environment data collection efforts in La Oroya.

7. Existing La Oroya health and environmental data has not been organized, analyzed, and summarized for review. Relevant information is not maintained in a central clearinghouse or organization.

8. The extent and magnitude of historical lead contamination in La Oroya is unknown. The geographic distribution of contaminated soil and dust is not well understood. A thorough investigation has not been conducted to identify and map contaminated areas and "hot spots" in La Oroya.

9. The adequacy of a plan to remediate historical contamination can not be determined without a better understanding of the situation. Detailed site specific information needed to determine best soil and dust remediation practices may not be available.

10. Health and environmental authorities may need additional technical capacity and resources to develop, implement, and manage an environmental remediation program.

11. In an effort to control exposure to lead, health authorities and Doe Run officials developed a personal and home hygiene educational campaign for the residents of La Oroya. This plan proposes that exposure to lead can be significantly reduced gradually over time by improved personal hygiene and home cleaning practices. Considering the long history of uncontrolled emissions and the concentration of contaminants in the local environment, personal hygiene and home sanitation may afford only a minimal reduction in opportunities for exposure. Unless combined with a reduction in emissions and the remediation of historical contamination this activity alone will not significantly reduce exposure and may provide a false sense of protection from environmental contaminants.

12. The resources and effort dedicated to implementing the proposed health and hygiene program may not result in significant reduction in exposure to contaminants.

13. The Ministry of Health may not have the information needed to determine the magnitude of exposure to lead and other contaminants in La Oroya.

14. The current and pending consequences on health and environment from continued exposure to agents released from the smelter facility is not well understood by local decision-makers and local residents.

15. Regarding the declaration of a public health emergency the Ministry of Health may not have the capacity to determine if a public health emergency exists or the resources needed to justify the declaration of a public health emergency in La Oroya.

16. If heavily contaminated areas are found, it may be necessary to temporarily, or permanently, relocate families. A mechanism and the resources for the relocation of families from heavily contaminated areas of La Oroya may not exist.

17. Past, present, and proposed PAMAs do not contain measurable health objectives.

18. The technical capacity and resources needed to design, implement, and manage a wastewater monitoring program may not exist.

19. Wastewater discharged from the Doe Run smelter is not adequately monitored.

20. Current laboratory capacity to analyze human blood and environmental samples for lead and other contaminants may be barrier to the development of an effective monitoring system.

21. The design and operation of the Doe Run air emissions monitoring plan may not accurately describe the release, movement, and impact of air emissions.

22. The geographic distribution and impact of smelter air emissions on downwind communities and ecosystems has not been investigated.

23. Doe Run proposes to prioritize the reduction of fugitive emissions over stack emissions. The impact of this proposal on total emissions released from the facility, reduction in exposure, and environmental degradation has not been fully assessed.

24. The effectiveness of the Doe Run proposed fugitive and stack emission intervention has not been evaluated by independent technical experts.

25. There is no comprehensive plan to evaluate the impact of implemented interventions on health and the environment.

26. The impact of wastewater discharged from the Doe Run facility on drinking water supplies, surface and ground water quality, aquatic life, and the watershed ecosystem has not been fully investigated.

27. The plan proposed to improve management of wastewater generated at the Doe Run facility has not been reviewed by independent technical experts.

28. The potential impact on the environment and human health from zinc oxide storage operations has not been assessed.

29. The potential impact on the environment and human health from arsenic trioxide storage operations has not been assessed.

30. The potential impact on the environment and human health from slag waste storage operations has not been fully assessed.

31. The potential impact on the environment and human health from dusts and particulates that become airborne during the transportation (truck, train, conveyor belt system) of materials associated with smelter operations has not been assessed.

32. A comprehensive solid waste management plan may not exist for the Doe Run facility.

33. An environmental health risk monitoring system to track changes in emissions and changes in human blood lead levels over time does not exist.

34. An environmental health monitoring system to track remediation efforts and reduction in human exposure to harmful agents over time does not exist.

35. Community members, government officials, Doe Run management and smelter workers, health care providers, and public health authorities have not reached

consensus on the potential health impacts from exposure to smelter emissions, waste management operations, and historical environmental contamination.

36. Health care providers do not have current and culturally appropriate procedures for assessing children for signs and symptoms of exposure to lead and other toxins.

37. La Oroya health clinic data indicates a high rate of respiratory illness among local residents. The cause of the high morbidity of respiratory illness has not been investigated.

38. Health care providers in La Oroya have not fully supported preventive measures and have opted to emphasize curative care like chelation therapy, treatment plans and the need for a toxicological center to treat lead poisoned individuals.

39. Educational material on exposure to environmental contaminants, health effects, and exposure prevention currently available to the residents of La Oroya may be confusing and/or misleading.

40. Community members and health care providers may not understand the limitations of nutrition in reducing health impacts from lead exposure.

41. A well-designed risk communication program does not exist in La Oroya.

42. Community members are not actively involved in discussions and decision-making activities on topics that may impact their health and well-being.

43. Existing health and environment regulations may not adequately address current smelter emission issues and historical contamination.

44. Maximum Permissible Levels (MPL) for all contaminants associated with smelter operations may not exist in Peru. Existing MPLs have not been recently reviewed.

45. Regulatory authorities may not have capacity to enforce existing environmental and health regulations related to smeltering operations.

46. Public health resources and authority needed to address health and environmental issues associated with mining and mineral processing in Peru should be strengthened.

Appendix L: Problem Statement Worksheets

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Child blood lead level studies conducted in La Oroya indicate children are being exposed to high levels of environmental lead. Actions needed to prevent exposure, control lead emissions, and remediate historical lead contamination have not been implemented.

Supporting Information:
Information obtained/reviewed leading to the identification of this as a problem.

Information needed:
- Information needed to support, clarify, or eliminate this problem.
- Information needed to develop a recommendation to address this problem.

Subject Matter Experts/Resources:
CDC/LPPB
CDC/EHSB
USEPA
STATE HEALTH & ENV. DEPT.

Recommendation: BLL in children living in La Oroya should be reduced to 10 ug/dl. Action necessary to reduce emissions and remediate historical contamination should be implemented as soon as possible.

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: In La Oroya there is no coordinated long-term plan to monitor blood lead levels and associated health effects in the residents.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: In addition to lead, other contaminants associated with smelting operations in La Oroya include: particulate matter, sulfur dioxide, arsenic, zinc, and cadmium. The concentration of these contaminants, their geographical distribution in La Oroya and the potential for human exposure to these contaminants has not been thoroughly assessed.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Environmental and health data related to smelter operations is collected intermittently in La Oroya by several governmental agencies, non-governmental organizations, and Doe Run. These activities are not coordinated and results do not appear to be shared with stakeholders and the residents of La Oroya.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: National, regional, and local health and environmental authorities do not have, and have not identified, the information needed to develop a comprehensive intervention plan to control exposure to emissions from the Doe Run facility.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Stakeholders have not agreed on the design or implementation of health and environment data collection efforts in La Oroya.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Existing La Oroya health and environmental data has not been organized, analyzed, and summarized for review.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: The extent and magnitude of historical lead contamination in La Oroya is unknown. The geographic distribution of contaminated soil and dust is not well understood. A thorough investigation has not been conducted to identify and map contaminated areas and "hot spots" in La Oroya.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: The adequacy of a plan to remediate historical contamination can not be determined without a better understanding of the situation. Detailed site specific information needed to determine best soil and dust remediation practices may not be available.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Health and environmental authorities may need additional technical capacity and resources to develop, implement, and manage an environmental remediation program.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: In an effort to control exposure to lead, health authorities and Doe Run officials developed a personal and home hygiene educational campaign for the residents of La Oroya. This plan proposes that exposure to lead can be significantly reduced gradually over time by improved personal hygiene and home cleaning practices. Considering the long history of uncontrolled emissions and the concentration of contaminants in the local environment, personal hygiene and home sanitation may afford only a minimal reduction in opportunities for exposure. Unless combined with a reduction in emissions and the remediation of historical contamination this activity alone will not significantly reduce exposure and may provide a false sense of protection from environmental contaminants.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: The resources and effort dedicated to implementing the proposed health and hygiene program may not result in significant reduction in exposure to contaminants.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: The Ministry of Health may not have the information needed to determine the magnitude of exposure to lead and other contaminants in La Oroya.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: The current and pending consequences on health and environment from continued exposure to agents released from the smelter facility is not well understood by local decision-makers and local residents.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Regarding the declaration of a public health emergency the Ministry of Health may not have the capacity to determine if a public health emergency exists or the resources needed to justify the declaration of a public health emergency in La Oroya.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: If heavily contaminated areas are found, it may be necessary to temporarily, or permanently, relocate families. A mechanism and the resources for the relocation of families from heavily contaminated areas of La Oroya may not exist.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Past, present, and proposed PAMAs do not contain measurable health objectives.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: The technical capacity and resources needed to design, implement, and manage a wastewater monitoring program may not exist.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Wastewater discharge from the Doe Run smelter is not adequately monitored.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Current laboratory capacity to analyze human blood and environmental samples for lead and other contaminants may be inadequate for the development of an effective monitoring system.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: The design and operation of the Doe Run air emissions monitoring plan may not accurately describe the release, movement, and impact of air emissions.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: The geographic distribution and impact of smelter air emissions on downwind communities and ecosystems has not been investigated.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Doe Run proposes to prioritize the reduction of fugitive emissions over stack emissions. The impact of this proposal on total emissions released from the facility, reduction in exposure, and environmental degradation has not been fully assessed.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: The effectiveness of the Doe Run proposed fugitive and stack emission intervention has not been evaluated by independent technical experts.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: There is no comprehensive plan to evaluate the impact of implemented interventions on health and the environment.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: The impact of wastewater discharged into the river from the Doe Run facility on drinking water supplies, surface and ground water quality, aquatic life, and the watershed ecosystem has not been fully investigated.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: The plan proposed to improve management of wastewater generated at the Doe Run facility has not been reviewed by independent technical experts.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: The potential impact on the environment and human health from zinc oxide storage operations has not been assessed.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: The potential impact on the environment and human health from arsenic trioxide storage operations has not been assessed.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: The potential impact on the environment and human health from slag waste storage operations has not been fully assessed.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: The potential impact on the environment and human health from dusts and particulates that become airborne during the transportation (truck, train, conveyor belt system) of materials associated with smelter operations has not been assessed.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: A comprehensive solid waste management plan may not exist for the Doe Run facility.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: An environmental health risk monitoring system to track changes in emissions and changes in human blood lead levels over time does not exist.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: An environmental health monitoring system to track remediation efforts and reduction in human exposure to harmful agents over time does not exist.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Community members, government officials, Doe Run management and smelter workers, health care providers, and public health authorities have not reached consensus on the potential health impacts from exposure to smelter emissions, waste management operations, and historical environmental contamination.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Health care providers do not have current and culturally appropriate procedures for assessing children for signs and symptoms of exposure to lead and other toxins.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: La Oroya health clinic data indicates a high rate of respiratory illness among local residents. The cause of the high morbidity of respiratory illness has not been investigated.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Health care providers in La Oroya have not fully supported preventive measures and have opted to emphasize curative care like chelation therapy, treatment plans and the need for a toxicological center to treat lead poisoned individuals.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Educational material on exposure to environmental contaminants, health effects, and exposure prevention currently available to the residents of La Oroya may be confusing and/or misleading.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Community members and health care providers may not understand the limitations of nutrition in reducing health impacts from lead exposure.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: A well designed risk communication program does not exist in La Oroya.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Community members are not actively involved in discussions and decision-making activities on topics that may impact their health and well-being.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Existing health and environment regulations may not adequately address current smelter emission issues and historical contamination.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Maximum Permissible Levels MPL for all contaminants associated with smelter operations may not exist in Peru. Existing MPLs have not been recently reviewed.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: Regulatory authorities may not have capacity to enforce existing environmental and health regulations related to smeltering operations.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation:

Development of an Integrated Intervention Plan to Reduce Exposure to Lead and Other Contaminants in La Oroya, Peru

Problems, Issues, and Concerns

Category:	**Priority:**

Problem Statement: The public health infrastructure needed to address health and environmental issues associated with mining and mineral processing does not exist in Peru.

Supporting Information:

Information needed:

Subject Matter Experts/Resources:

Recommendation: