La Oroya Cannot Wait

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These organizations are working to improve the environment and public health in La Oroya and this publication is one product of that effort.

We have used available legal tools to gain access to monitoring and public health data as a means to empower the local population and raise consciousness about the environmental and health problems in La Oroya.

The international campaign to address the health crisis and contamination in La Oroya is only just beginning. It is crucial that we continue our efforts to fight this grave environmental problem so that we can protect our children and the most vulnerable groups of our society

We are much indebted to Meche Lu and Carlos Chirinos who contributed tremendously with the editing of both the English and Spanish versions of this report.

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The authors.

PRESENTATION

This publication is the product of a careful analysis of official environmental monitoring reports submitted for the Doe Run multi-metal smelter to the Peruvian Ministry of Energy and Mines between 1996 and 2001. By finally filling the void in public information about contamination levels in La Oroya, this work demonstrates that the right to access information is an essential pillar of citizen participation. Only with this type of facts in hand can civil society protect itself against the powerful interests of giant mining companies like Doe Run.

The reader will come to understand the severe health problems and risks suffered by the local population and particulary the children in La Oroya. But the authors go beyond this. They suggest the implementation of corrective and preventive measures that will require the participation of not only the company but also the Peruvian State. These are actions that cannot be postponed if we are to guarantee the human right to health, improve quality of life, and permit development in Peru.

The authors also provide a legal analysis of environmental protection in the minerals sector, and recommendations for making this system more effective.

Above all, this publication is an invitation to take meaningful and timely steps toward solving the extraordinary environmental and human health problems in La Oroya.

INTRODUCTION

Peru, a mining country. This phrase reveals the reality of a country that generates almost half of its income through exports from this sector, and where mining companies are so large that their mere operation represents more than one percent of the Gross National Product. Peru is one of Latin America's top producers of gold, silver, zinc and other metals, and as such, its policies are specifically directed towards increasing the level of investment in and promotion of mining activities. Mining is "money in the bank" for a country where almost half of the population is living in poverty.

Peru, a thriving, healthy country, another phrase used, but only to describe macro-economic stability. It appears that the economy is never affected by the Asian crisis, the Argentine crisis or any other crisis. However, from the point of view of public health, everything seems to indicate that we are not in a position to easily embrace this phrase, because Peru has one of the highest mortality and child mortality rates in the region. Diseases like hepatitis B and C, dengue fever, malaria, respiratory ailments, skin diseases, and many others do not seem to respond to the feeble public health campaigns undertaken by one of the poorest ministries – the Ministry of Health. The authorities justify their lack of action by claiming that health issues are not "money in the bank" and therefore are not a priority, at least in the short term.

Above all else lies the creed *Peru, a country that must grow* ("economically" is the hidden term of this phrase), a doctrine that embodies the Ministry of Economy's dominant position as head of the Church, while the Ministry of Energy and Mines is its most visible apostle.

It is therefore no coincidence that the "environmental mitigation" of an industry like the mining industry is about meeting a precise set of numbers, the Maximum Permissible Limits, the objective of which –since they were defined by the apostle– is not to protect health, but to allow for slow and gradual environmental regulation. It also ensures that lack of compliance with the regulations doesn't cause the closure of any companies, because we cannot afford this luxury, and that we not scare the investor, because the pocket is deep but the money is scarce; and, because – let's accept this once and for all – "we live in a globalized world," which, incidentally, is also not oriented towards health or sustainability, but towards transforming the world into a "market planet".[1]

Using Dante's Divine Comedy as a metaphor, we can place the various actors of our drama as follows: the macro-economy enjoys the superior circles of paradise and the peace that comes with being part of a globalized world, in the good company of the mining industry. For its part, purgatory, that place of cleansing – or environmental mitigation – is filled with various companies that know for certain that the focus placed on development by the upper circles will eventually lead them to paradise, and that they shall never descend to hell. Yet it is precisely in the very depths of this last sphere that we find many cities and communities. La Oroya is one these. La Oroya seems to be paying for being impious, a town that given the socio-economics of the day should demand the development of mining before health, and that should focus on the growth of the country's economy before demanding a better quality of life.

La Oroya is a faithful reflection of Dante's third circle. Located in the Central Andes, a short distance from the city of Lima, between the central jungle and the Peruvian coast, La Oroya's population resides around a metal smelter that is almost 80 years old. The children over ten years old have blood lead levels more than three times greater than those recommended by the World Health Organization. This was determined by the Ministry of Health –the poor ministry– without any reaction whatsoever from the apostle –the Ministry of Energy and Mines – or the head of the Church – the Ministry of Economy – to such a dramatic statistic. The quality of the air, water, and ground has serious health effects on the residents and are not conducive to human development. This, in turn, adds an additional burden on the efforts of these poor residents to combat the poverty in which they live.

This situation is aggravated by the indecision exhibited by public authorities in their inability to adopt strong positions and take urgent action,

1 Phrase coined by Jorge Caillaux, President of the Peruvian Society of Environmental Law, Sustainability Colloquia, Jujuy, Argentina, 2002.

which in turn stems from the lack of understanding of the concept *viable country* as a function of public health and education.

To all of this we add the philosophy of Doe Run Peru, a subsidiary of an American company based in the state of Missouri in the United States. Having provided a fresh layer of paint to many buildings in La Oroya, the company's environmental strategy is colorful indeed, yet produces gray results – limited by what the bottom line will allow and by what Doe Run considers to be the government's responsibility. Doe Run does not take into account that the residents do not care much about the diffuse distinction of who should do what, but rather want their basic rights to be respected – the rights to health and especially to life.

The recurring lack of information has been another persistent obstacle. The residents are aware of their medical problems and try to take corrective measures, according to their financial means and the medical services provided by the State. However, the lack of information prevents the residents from knowing the exact cause of their ailments, and from taking preventive measures that undoubtedly mean demanding that the company and the State respect the law, that basic pillar required for the development of any society.

The purpose of this document is to compensate for this absence of information, as well as to shed light upon the serious public health problems caused by the smelter in La Oroya. Such health problems have been worsened by the recent deterioration in environmental quality. We hope this document will allow both the residents of La Oroya and those in decision-making positions to understand the current situation.

This information exposes the conflict that exists in Peru between environmental mitigation and public health. Doe Run wants more time to complete its Environmental Management and Mitigation Program (EMMP), due in 2006, while the residents of La Oroya demand the adoption of urgent measures, since their health cannot afford to deteriorate further. The EMMP was never intended as a way to avoid complying with a fundamental corporate obligation: to not endanger public health.

Peru, a viable country requires a cultural change. It requires a change towards sustainability, where social equity and environmental protection are equal to and carry the same weight as economic growth. Peru is not a country that will develop based on financial strategies, selling bonds abroad, controlling inflation or focusing solely on the fiscal deficit and the payment of our external and internal debt.

Peru will owe its growth to a healthy and educated population – only this will transform the nation into an agent of change. To think otherwise is to place the wagon in front of the horse, to grow in numbers but not in capacity. We have to make decisions and correct the perversion of a philosophy that does not contemplate the nation's most important actor: the people. La Oroya is an example of this and we must rectify it.

This report, titled *LA OROYA CANNOT WAIT*, is a detailed and informative description of the environmental pollution and health impacts caused by the Doe Run Peru metal smelter in La Oroya.

It is the product of a careful analysis undertaken by Dr. Anna Cederstav, scientist with the Interamerican Association for Environmental Defense, and Alberto Barandiarán, an attorney with the Peruvian Society of Environmental Law. Based on information and monitoring reports submitted by Doe Run to the Ministry of Energy and Mines, the authors have established that the environmental pollution caused by atmospheric emissions is extremely high, and despite the implementation of the EMMP, has increased. Additionally, the authors warn that Doe Run's commitment to investment in and mitigation of environmental issues concerning the smelter are inadequate for mitigating the harm that the smelter has caused, since the levels of contamination initially reported were much lower than those that exist today.

The first chapter of Part 1 includes a review of the history and background of the metal smelter, as well as a simple explanation of the smelting process and the types of pollution produced. The second chapter describes the status of public health in La Oroya in the year 2000, and describes the impact of smelter emissions on environmental quality in La Oroya. Chapter three is a detailed analysis of the air quality data through the year 2001, while chapter four discusses the atmospheric emissions trends between 1996 and 2000. Chapter five briefly describes liquid effluents produced by the smelter during the same period. Finally, the authors present the conclusions of their investigation and recommendations for consideration in designing and implementing strategies to address the public health problem. Part 2 of the document is a legal analysis of the Environmental Management Program for the minerals and metallurgy sector, and offers recommendations for making this system more effective.

Above all, this work constitutes a candid and proactive approach to a severe pollution problem in La Oroya, and in a way, is an invitation for

the authorities, the company and the citizenry to unite their efforts in confronting this ancient problem and its serious impact on the population of our country.

MANUEL PULGAR-VIDAL
Executive Director
Peruvian Society of Evironmental Law

PART 1

A Case Study of Environmental Contamination and Health Impacts in an Andean City the Metallurgical Complex in La Oroya

I
Background

History of La Oroya and the Metallurgical Complex

The city of La Oroya is located in the central Andes of Peru, at 3,700 meters above sea level and approximately 175 km from Lima. The city has emerged without planning at the side of the metallurgical complex bearing the same name. For this reason, the city center is mere meters from the smelter. La Oroya is a long, thin city that lies along the central highway and the Mantaro River, surrounded by the peaks of the Andes. Because of the topography, climactic temperature inversions cause environmental contamination to cover the city and remain for long periods of time instead of dispersing rapidly beyond the mountains.

La Oroya is a densely populated city in which the houses, schools, and businesses lie side by side. It has approximately 30,000 inhabitants, the majority of whom have low incomes. The city has a very high poverty index and is economically dependent (both directly and indirectly) on the metallurgical complex. Basic human services are lacking, hygiene is poor, and access to medical services is severely restricted for most of the population.

The metallurgical complex was built in 1922 by the US Cerro de Pasco Copper Corporation. It consists of three main metallurgical circuits: a copper circuit, operating since 1922, a lead circuit, operating since 1928, and a zinc circuit, operating since 1952. The circuits include smelting and refining processes for these metals as well as some other processes for the production of cadmium, silver, gold, and other metals. According to information provided by the company, although copper, lead and zinc are produced in large quantities, the silver production is what actually makes the smelter profitable.[2]

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2 DRP Eng. Huayhua, February 2000.

The Complex was nationalized on January 1, 1974 by Peru's military government.[3] It became the property of Central Peru Mining Company, S.A., or CENTROMIN PERU S.A., which operated the complex between 1974 and 1997. In the 1990s and in accordance with the privitization policies of ex-president Fujimori, CENTROMIN was offered to national and foreign investors. The first attempt at privitization failed because there were no bidders for the acquisition of all the operations of CENTROMIN, which included the metallurgical complex, mines, and other installations. Therefore, the government decided to privatize the operations in parts, and the metallurgical complex was sold separately under the new name of METALOROYA.

Prior to privatization and in compliance with environmental requirements established in 1993, CENTROMIN PERU S.A. presented its Environmental Management and Mitigation Program (EMMP) to the Ministry of Energy and Mines (MEM) in August 1996.[4] The EMMP, as discussed in the Part 2 of this document, was established as a corrective instrument for environmental management, to bring mineral industry facilities into gradual compliance with the new environmental standards.

The EMMP approved for CENTROMIN PERU included a series of obligations in terms of projects intended to solve or mitigate what were considered the greatest environmental problems of the complex. While it addressed some issues, the EMMP was not a comprehensive or fully adequate control technology plan, and is not sufficient to protect the environment.

In 1997, after the withdrawal of the highest bidder (the Mexican company Peñoles), the complex was finally purchased by Doe Run Peru (DRP), a subsidiary of the American Missouri-based company Doe Run. Upon purchase, DRP assumed the obligation of complying with all the projects of the EMMP developed by CENTROMIN. Nevertheless, in December 1998 DRP requested a modification of the CENTROMIN EMMP. According to the modified EMMP, the company will perform agreed environmental improvements by the year 2006 but will delay the main investments for reduction of atmospheric emissions until 2004. Unfortunately, the DRP EMMP also does not incorporate all the measures necessary to correct the severe contamination problems. Therefore, even if the EMMP currently in

3 Headed by General Juan Velasco, who assumed the presidency of the Republic on Oct. 3, 1968.

4 A definition and analysis of the PAMA are included in the second part of this publication.

force is fully implemented, only a small part of the public health problems caused by the smelter will be adequately addressed.

THE SMELTING PROCESS IN THE PRODUCTION OF METALS

The production of metals is a complicated process that consists of the basic steps shown in Figure 1.

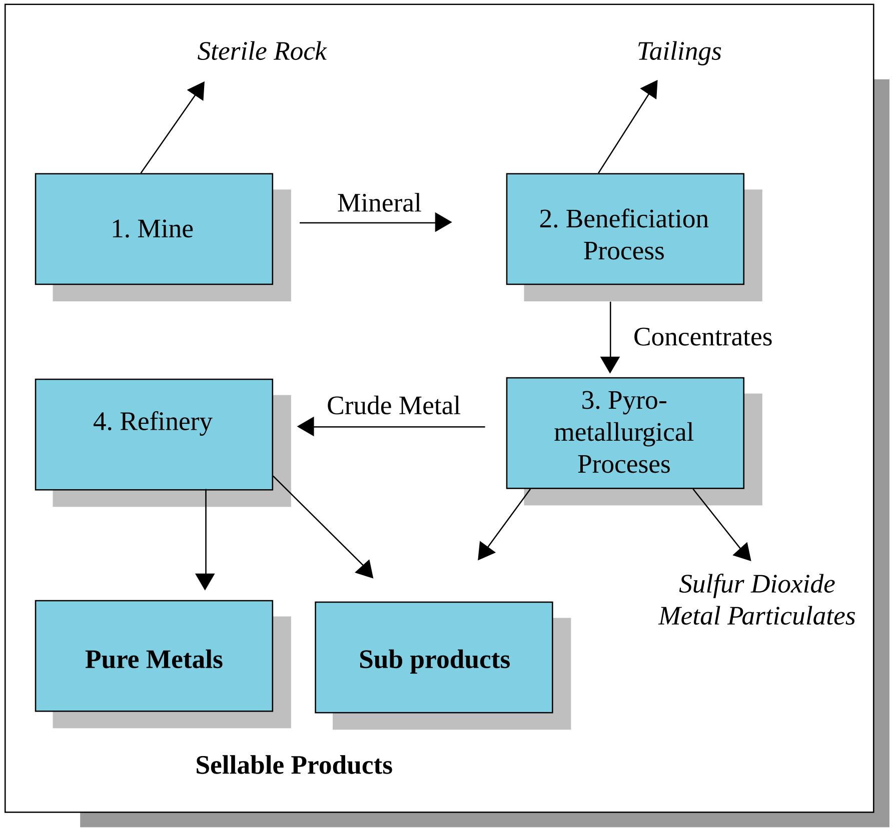


Figure 1. Metal production process via smelting.

For metal production, material with mineral content is mined from rock formations and processed to yield a profit. The first step in processing is called beneficiation, in which the size of the material is regulated by crushing and grinding, improving the quality and purity by separation of the materials with lesser metallic content. Waste materials from this process are called tailings, and are often toxic because of residual metal and chemical content. The concentrates produced in this step contain the metal to be produced along with other substances. The smelting and refining processes are required to obtain products of high purity. Because of their high metal content, the concentrates are toxic and can harm human health and the environment. A clear example of this can be seen in Puerto del Callao, Peru, where concentrates deposits cause severe and proven health problems to the neighboring residents. Concentrates require very careful management to avoid contamination by dispersion during transportation, storage, loading, or discharge.

A metallurgical complex is a plant that uses pyro- and electro-metallurgical processes to produce commercial metals. During the smelting process, the first step is roasting to reduce the sulfur content of the concentrate. This step can produce large quantities of sulfur dioxide and particulates. In the second step, the remaining material is melted in ovens to generate crude metals. Both steps include additional processes to remove subproducts and impurities. Finally, the crude metals obtained are purified further in electrolytic refineries to produce metals of high quality and purity. The metals can be commercialized in this form or converted to particular products for sale.

Depending on the metals produced, there are many variables in the production processes of a metallurgical complex. The mineral concentrates can vary in quality from almost pure (containing little sulfur or other metals) to mixed grades (with high amounts of metals and sulfur). It follows that smelting processes can have different environmental impacts, depending on the quality and characteristics of the concentrates as well as the metal produced. Therefore, an important step in minimizing adverse health and environmental impacts is the evaluation of the contents of the concentrates and the effectiveness of the metallurgical process in the recuperation of all elements not preserved as final products.

DISPERSION OF AND EXPOSURE TO CONTAMINANTS GENERATED BY SMELTERS

Studies demonstrate that in the majority of cases, the different steps of the metallurgical process generate large quantities of contaminants that are toxic

to health and the environment. For example, primary smelters[5] are an important source of lead, arsenic, cadmium and antimony contamination,[6] and many also emit considerable quantities of sulfur dioxide. These toxic substances contaminate the air and soil through what are called "fugitive emissions"[7] and monitored stack emissions. They can also pollute water via industrial effluents and contaminated rainwater.

The negative public health effects of smelter contamination have been documented extensively. Case studies include smelters located in Torreon, México[8] ; Trail, Canada[9] ; Herculaneum, Missouri[10] ; Smelterville, Idaho[11] ; and El Paso, Texas[12] , among others. Based on this information, it is evident that any smelting process where emissions are not strictly controlled will produce grave and unacceptable impacts on the health of the people living or working near these operations. Also, it is reasonable to conclude that any place with historic contamination problems from smelting poses serious health

5 Primary smelters are those that produce metal from mineral concentrates.

6 40 CFR Part 63, EPA, National Emission Standards for Hazardous Air Pollutants for Primary Lead Smelting.

7 Fugitive emissions are those that escape into the environment during the process of smelting or handling of concentrates and products, without passing through controlled emission points.

8 "Prevención y Control de Intoxicación por Plomo en Torreón, Coahuila", (Prevention and Control of Lead Poisoning in Torreón, Coahuila) Dra. Melody Kawamoto, Dr. Mauricio Pardón Ojeda, Panamerican Health Organization, April 6, 1999; "La Contaminación por Metales Pesados en Torreon, Coahuila, México", (Heavy Metal Contamination in Torreón, Coahuila, México) F. Valdéz Perezgasga, V.M. Cabrera Morelos, (Sept. 1999) *available at* http://www.texascenter.org/publications/torreon.pdf.

9 "The Environmental Renaissance of a Smelter", Graham Kenyon, Cominco Ltd. Trail Operations.

10 Proposed Administrative Agreement Pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act and the Resource, Conservation and Recovery Act; The Doe Run Resources Corporation, Herculaneum, Missouri, Docket Nos. CERCLA-7-2000-0029 and RCRA-7-2000-0018. *Available at:* http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=2000_register&docid=fr13de00-55.

11 "Bunker Hill Mining and Metallurgical Site", EPA Region 10, (April 2000) *available at* http://yosemite.epa.gov/r10/nplpad.nsf/88d393e4946e3c478825631200672c95/689ec1eec2e14d0985256594007105c0?OpenDocument; *see also* http://yosemite.epa.gov/r10/cleanup.nsf/9f3c21896330b4898825687b007a0f33/1a829ac00e6d429e882566290004a644?OpenDocument#back.

12 "The El Paso Smelter 20 Years Later: Residual Impact on Mexican Children", F. Diaz-Barriga, L. Batres, J. Calderón, A. Lugo, L. Galvao, I. Lara, P. Rizo, M. Arroyave, R. McConnell, Environmental Research 74, 11-16, 1997.

risks due to residual heavy metals. The severity of the risks will depend on the mitigation measures adopted.

The people that live or work near metal smelters are exposed to the contamination. The most direct form of exposure comes from breathing contaminated air. Another exposure route is ingestion of dust and soil contaminated by the accumulation of toxic metals via atmospheric deposition. This exposure mainly affects children who put their hands in their mouths without washing them first. The consumption of contaminated water and food further increases exposure.

According to the studies conducted in cities with smelters, the most serious health and environmental impacts result from current operation as opposed to historical contamination.[13,14] For example, when the old smelter located in Trail, Canada was re-opened with cleaner technology, Cominco reported a decrease of 25% in blood lead levels of children in the first year. The concentrations of heavy metals and sulfur dioxide were also reduced by more than 75%.[15] Similar effects were observed in El Paso. When the smelter in that city closed down, the lead concentrations in the air were immediately and drastically reduced. The principal form of lead exposure for children changed from inhalation to ingestion of dust and soil, which led to a decrease of 75% in the total quantity of lead in children's blood.[16] Similar changes were observed in Smelterville.[17] It is worth noting that the Mexican government recently ordered the Torreon smelter to decrease production by 50% for a period of time, in order to address the public health emergency of lead poisoning in that city.

IMPACTS OF THE SMELTING PROCESS ON PUBLIC HEALTH AND THE ENVIRONMENT

The health effects from exposure to smelter contamination develop over the long term and, in most cases, are not immediately perceptible. The impacts

13 Kenyon, *supra* note 9.
14 Diaz-Barriga et al., *supra* note 12.
15 Kenyon, *supra* note 9.
16 Diaz-Barriga et al., *supra* note 13.
17 "Children's Blood Lead Levels by Year, 1974", U.S. E.P.A., *available at* http://yosemite.epa.gov/R10/CLEANUP.NSF/9f3c21896330b4898825687b007a0f33/1a829ac00e6d429e882566290004a644/$FILE/5yrfig4Bloodlead1974todate.PDF.

can include irreversible deterioration of the respiratory system, cancer, adverse effects on reproduction and development, and damage to vital organs, among others. Obviously, the fact that the impacts produced by a smelter are not always immediately evident does not make them less serious or relevant.

Heavy Metals

The health risks resulting from heavy metal contamination mainly depend on the amount accumulated in the body, which is why the risks are greater if exposure is prolonged. From studies conducted to date, it is kown that lead compounds affect the blood, the nervous system, the reproductive system, and the kidneys. Lead is particularly harmful to children, and there are countless studies showing that even exposure to low levels can cause decreased intelligence and physical development, as well as diminished neurological development and reduced hearing (see Appendix 4).[18] Chronic exposure to arsenic has been associated with various types of cancer, along with reproductive and developmental problems (see Appendix 3).[19] Cadmium damages the lungs, kidneys, and digestive tract and is considered a possible carcinogen (see Appendix 2).[20] Although the symptoms of metal exposure are not acute, and therefore sometimes not detected, the long term health damage is severe.

Sulfur Dioxide

Sulfur dioxide is a gaseous contaminant that presents serious threats to human health. Sulfur dioxide damages the respiratory system, aggravates existing respiratory illnesses (especially bronchitis), and diminishes the capacity of the lungs to expel foreign particles such as heavy metals. It leads to a higher mortality rate, particularly when combined with the presence of elevated levels of particulate material.

18 *Case studies in Environmental Medicine: Lead Toxicity,* U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, (Dec. 8, 2001), *available at* http://www.cdc.gov/nceh/lead/lead.htm; "Intoxicación por Plomo: de la Detección a la Prevención Primaria," (Lead Poisoning: Detection and Primary Prevention), Panamerican Center of Human Ecology and Health División of Health and the Environment, World Health Organization; *see also* http://www.atsdr.cdc.gov/toxprofiles/tp13.html.
19 *Toxicological Profile for Arsenic.* Agency for Toxic Substances and Disease Registry (ATSDR) (August 1998), *available at* http://www.atsdr.cdc.gov/toxprofiles/tp2.html.
20 *Toxicological Profile for Cadmium.* ATSDR (July 1999) *available at* http://www.atsdr.cdc.gov/toxprofiles/tp5.html.

The groups most susceptible to the effects of sulfur dioxide are asthmatics and people with cardiovascular disease. Children and the elderly are also very vulnerable.[21] As with the contaminants described earlier, the adverse effects from sulfur dioxide increase with exposure time because the damage to the respiratory system is cumulative.

Sulfur dioxide also has severe environmental impacts. The presence of sulfur dioxide and acid rain leads to soil acidification, which causes significant reductions in agricultural productivity. There is also a serious impact on surface water ecosystems.

21 *Measuring Air Quality: The Pollutant Standards Index,* Office of Air Quality Planning and Standards, US EPA, EPA 451/K-94-001 (Feb. 1994).

II
THE HEALTH EMERGENCY IN LA OROYA

PUBLIC HEALTH IN LA OROYA

The results of blood lead monitoring in 346 children from different zones in the city of La Oroya,[22] carried out in November 1999 by the Director General of Environmental Health – DIGESA – of the Ministry of Health, demonstrate that lead poisoning is a critical health problem among the children of La Oroya. (Results reported by DIGESA are shown in Tables 1-4 and Graph 1.) Data from November 1999 show that 18.3% of the children studied should have been urgently admitted to a hospital for medical attention and their homes subjected to environmental assessment, solely because of lead effects.

Sixty-seven percent of the children studied should have received medical evaluation and observation. Two children in the study were found to have levels so high (greater than 70 ug/dL) that they required immediate chelation treatment. A level of 10 ug/dL of lead in the blood is considered acceptable, but recent studies have shown that the effects of lead poisoning can occur at even lower levels.[23] According to this DIGESA study, only 0.9% of the children had lead levels less than 10 ug/dL and none of them lived in Old La Oroya, the neighborhood closest to the smelter.

22 Blood Lead Study in a Selected Population from La Oroya, DIGESA Peru.

23 *Cognitive Deficits Associated with Blood Lead Concentrations <10 µg/dL in US Children and Adolescents,* Bruce P. Lanphear**,** Kim Dietrich, Peggy Auinger, and Christopher Cox**,** Public Health Rep 2000 115: 521-529, *available at* http://phr.oupjournals.org/cgi/content/abstract/115/6/521?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&author1=Lanphear%2C+B.&searchid=1012239429177_331&stored_search=&FIRSTINDEX=0&journalcode=publhr.

Range of lead in the blood (ug/dL)[24]	Percentage and number of children in the range, of 346 children in total[25]	Recommended medical attention[26]
0 – 10	0.9%, 3	None.
10.1 – 20	13.3%, 45	Refer for case management.
20.1 – 44	67.0%, 234	Refer for medical evaluation and observation. Identify and eliminate sources of lead exposure.
44.1 – 70	18.3%, 62	Refer for urgent medical attention and environmental assessment (in the next 48 hours).
> 70	0.6%, 2	Admit for immediate chelation therapy.

Table 1. Summary of blood lead levels reported by DIGESA (1999) and recommended medical actions.

Age Group	Number of children	Percentage %	Minimum (ug/dL)	Maximum (ug/dL)	Permissible Limit (ug/dL)	Average (ug/dL)	Standard Deviation
2 a 4	8	2.3	21.7	67.7	10	38.6	11.2
4.1 a 6	84	24	6.9	79.9	10	34.1	14.7
6.1 a 8	134	38.7	10.6	68.2	10	36.3	12.1
8.1 a 10	120	34.7	9.0	58.7	10	30.6	11.3
Total	**346**	**100.0**	**6.9**	**79.9**	**10**	**33.6**	**12.3**

Table 2. Blood lead levels by age group. DIGESA, 1999.

24 The health effects correlated with the ranges of lead in the blood can be found in Appendix 4, Fig. 1.
25 Source: Director General of Environmental Health, Peru – DIGESA.
26 Center for Disease Control (CDC) of the US, the Panamerican Organization of Health, and the World Health Organization, Detection and Primary Prevention of Lead Poisoning, Public Health of Mexico, vol. 37, No. 3.

It is known from studies conducted at different smelters that heavy metal particles such as lead critically contaminate the areas closest to smelters and that levels of contamination decrease and approach baseline levels at distances of 10 km from the source. For example, in the case of the smelter in El Paso, Texas, the percentage of children with lead levels greater than 10 ug/dL were 43%, 21%, and 11% for children living 600 m, 1200 m, and 1800 m from the smelter respectively.[27] With this knowledge and an understanding of La Oroya's geography, it is clear that La Oroya Antigua (Old La Oroya) would be the region most affected by lead contamination coming from the smelter. Other sources at the complex, such as concentrates deposits, could be contaminating different areas.

DIGESA's data confirm this deduction. The geographical distribution of contamination is clearly shown, with the worst cases of lead poisoning and the greatest health risk being found La Oroya Antigua, very close to the smelter, and reduced but still substantial poisoning occurring in the districts of New La Oroya and Santa Rosa de Sacco, farther from the smelter (Table 3, Graph 1).

DIGESA also analyzed the results according to educational centers, identifying which ones had greater levels of lead poisoning among the student body. Again, the lead poisoning in Old La Oroya surpassed that in other sectors of the city. That said, lead poisoning is very serious in all three monitored sectors and the whole city is in need of urgent intervention to address the problem.

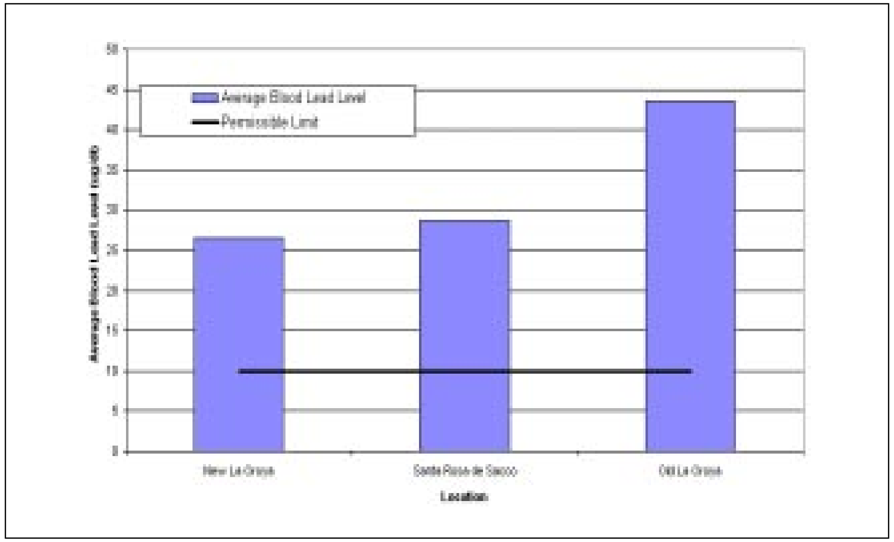
Locality	Children Tested	Age (years)	Minimum (ug/dL)	Maximum (ug/dL)	M. Geom. (ug/dL)	Average (ug/dL)	Permissible Limit (ug/dL)
La Oroya Antigua (Old La Oroya)	139	3 - 10	14.7	79.9	42.8	43.5	10
La Oroya Nueva (New La Oroya)	162	4 - 9	14.6	67	26.1	26.6	10
Sta. Rosa de Sacco	45	3 - 9	6.9	52.5	28.5	28.7	10
Total	**346**	**3 - 10**	**6.9**	**79.9**	**32.8**	**33.6**	**10**

Table 3. Average blood lead levels in children in the districts of La Oroya. DIGESA, 1999.

27 Diaz-Barriga et al., *supra* note 12.

Educational Center	Children Tested	Age (years)	Minimum (ug/dL)	Maximum (ug/dL)	Average (ug/dL)	Permissible Limitit (ug/dL)
La Oroya Antigua (Old La Oroya)						
Ntra. Sra. De Fátima	54	6 - 10	14.7	68.2	38.5	10
Manuel Scorza	51	6 - 9	27.5	65.6	42.5	10
J. Basadre	18	6 - 9	28.9	58.7	47.3	10
C.I. Basadrito	8	5 - 6	39.9	66.5	53.7	10
Herederos	8	3 - 6	29.5	79.9	55.2	10
Santa Rosa de Sacco						
Daniel A. Carrión	20	6 - 9	18.2	41.1	27.4	10
Ntra. Sra. De Fátima	18	5 - 6	14.6	38.3	28.5	10
San Pablo	7	3 - 5	15.7	52.5	32.2	10
La Oroya Nueva (New La Oroya)						
Miguel Grau	52	6 - 9	10.6	42.2	22.9	10
Francisco Bolognesi	61	6 - 9	9.0	56.4	27.8	10
Barcia Bonifaty	49	4 - 6	6.9	67	29.2	10

Table 4. Average blood lead levels in the La Oroya educational centers. DIGESA, 1999.



Graph 1. Average blood lead levels found in the different districts of La Oroya.

It is true that during the year 2000 DRP expanded its monitoring program to include measuring blood lead levels in the children of La Oroya Antigua, and that consequently a larger percentage of children receive medical observation, nutritional aid, and help with personal hygiene. However, it is also true that the program falls far short of what is needed, and that these measures will not generate the required improvements as long as the main cause of the problem (the contamination coming from the metallurgical complex) persists.

As indicated in the conclusion to the executive summary of the November 1999 DIGESA report evaluating blood lead, “It has been observed that children who receive medical treatment and return to live in their normal environment, contaminated by lead, rapidly regain the blood lead levels present before treatment.” Therefore, it cannot be supposed that improved nutrition or personal hygiene would suffice to solve this very serious health crisis while the high levels of contamination persist.

With this background and the data presented hereafter, it is also clear that the recent “Study of Blood Lead Levels in the People of La Oroya 2000-2001” disseminated by DRP presents erroneous conclusions. Among these, the report appears to argue that the smelter emissions are not the main cause of the public health problem in La Oroya.[28]

Although both the DRP and DIGESA reports are based on medical evaluations, neither presents detailed information on the methods used. Even so, and based only on what appear to be subjective evaluations of academic performance, the reports conclude that “although it is true that almost all of the children in La Oroya have high levels of lead in their blood, indicative of lead poisoning, the scholastic achievement data demonstrates that they do not suffer from the symptoms of poisioning.”

Considering the large number of medical and scientific studies that demonstrate a direct relationship between blood lead levels, severe health effects, and the intellectual development in children, and given the lack of supporting evidence, we challenge DIGESA’s and DRP’s claim that the children of La Oroya are somehow not affected by lead poisoning.

Studies to test the effect of lead contamination on intellectual development in children require repetitive sampling and long term

[28] DRP report revised by Dr. Steven Rothenberg, personal communication.

observation, the use of established methods for evaluating intellectual development (IQ and physical), and statistically valid and systematic evaluation of data. Because the studies in the DIGESA and DRP reports do not meet these requirements, the conclusions are not valid. Additionally, these reports do not explain the methods or criteria employed to conclude that the children of La Oroya are not affected or suffer impaired intellectual development. Further, the conclusions appear to be based on very subjective data (evaluations of teachers and parents), and do not consider the results of a control group (children without elevated blood-lead levels). A comparison between the children in a city in which almost all children have high blood lead levels, without a a reference to baseline data from unaffected children, is not an appropriate method for determining whether or not there are impacts.

We therefore conclude that there is no reason to believe that the results of the DIGESA and DRP studies are valid. It is important to note that established methods for the evaluation, identification, and treatment of the health impact of lead in the blood exist, but none were followed for these studies.

The DIGESA report leads us to deduce that the poisoning not only affects children but likely the adult population as well. If we also recall that other contaminants are present at high levels in the city, we can infer that the local population probably suffers additional effects from arsenic, cadmium, and sulfur dioxide to name only a few. Although most studies to date have focused exclusively on the lead problem, the significant contamination levels of the other toxic substances generated by the smelter also require immediate attention. We cannot forget that the other contaminants emitted by the complex are also very dangerous to human health.

COMPARISON BETWEEN THE IMPACTS GENERATED BY THE LOCAL HIGHWAY AND THOSE GENERATED BY THE METALLURGICAL COMPLEX

Some people have irresponsibly suggested that the local highway is the main source of lead contamination in La Oroya. On this point, we think it necessary to highlight some basic facts that should have been taken into account before making an argument of this nature.

The first of these is to compare 1) the air quality of La Oroya with that of Lima, and 2) blood lead levels found in the people of both cities.

Graph 8 of this document shows the monitoring data of atmospheric lead in La Oroya as compared to the 1996 average lead level in Lima.[29] This graph clearly shows that the current atmospheric lead contamination in the city of La Oroya is much greater than that of Lima five years ago. This is true even though in 1996 Lima consumed much more leaded gasoline and the vehicular traffic was much heavier than that of La Oroya today.

Further, a study of 2,510 children aged six months to nine years in five districts of Lima and Callao[30] yielded significantly lower blood lead levels than those found in La Oroya, even though the Lima and Callao children were exposed to vehicular traffic much heavier that that existing in La Oroya. In one sector of Callao, an open-air deposit of lead concentrates existed until recently. This caused serious health problems for the people living in the vicinity. However, even the blood lead levels found in this district were much lower than those in La Oroya.

Because lead particulate material is heavy and therefore does not travel far with the wind, the above allows us to conclude that a source of lead that is significantly greater than any source in Lima exists in La Oroya.

A second aspect to consider is that, in the case of lead contamination coming from vehicular combustion, the majority of lead is deposited within approximately 15 meters of the street because the particulate emissions are produced very close to the ground.[31,32] Therefore, the impact of lead emitted by vehicular combustion should be limited to areas very near heavy traffic.

As a third point, and to further clarify this issue, it is worthwhile to compare the maximum quantities that could be emitted by vehicles using leaded gasoline in La Oroya to the emissions from the metallurgical complex. In the DRP report on blood lead in La Oroya, the company presents data from the Gasoline and Lubricant Oil Vending Administration for the sale of leaded gasoline in La Oroya. These data show that in the year 2000 a monthly

29 "Revision, Analysis, and Evaluation of the proposed AQS for Peru Prepared in Compliance with Task 2", David Calkins (Sept. 20, 1999).

30 "Blood Lead Study on Selected Populations in Lima and Callao", Environmental Health Project (EHP-USAID), Hernández-Avila M, Activity Report No. 72 (1999).

31 "Ground Contamination Adjacent to a Major Rural Highway in the UK," Peter Wood, Land Contamination and Reclamation Vol. 8, Part 1 (Jan. 2000).

32 "Pollution Retention Capabilities of Roadside Soils," C. Dierkes, W. F. Geiger, Wat. Sci. Tech., Vol. 39, No. 2, pp. 201-208, 1999, *available at* http://www.iwaponline.com/wst/03902/0201/039020201.pdf.

average of 43,700 gallons of 84 octane gasoline was sold in the city.[33] Using this information to calculate the lead emissions from vehicles – and considering the worst case and unlikely scenario in which all of the leaded gasoline sold in La Oroya is burned inside the city limits, we find that the vehicles would emit approximately 120 kg of lead per month into the environment of La Oroya.[34]

On the other hand, the monitoring data reported by DRP to the Ministry of Energy and Mines (MEM), on which this publication is based, show that the metallurgical complex emitted an average of 1,077 cubic meters of gas per second in the year 2000, with an average lead content of 16 mg/m^3, which equals more than 44,000 kg of lead per month.[35] In other words, during the year 2000, the reported emissions (which include only a small percentage of the total emissions coming from the metallurgical complex due to the large quantity of fugitive emissions), were 360 times greater than the total from all the leaded gasoline sold in the city of La Oroya.

Based on these calculations, the absurdity of the argument that the local highway is the main source of lead contamination in La Oroya is evident. Considering also that the blood lead levels decrease progressively with distance from the metallurgical complex, we can conclude that the principal source of lead contamination in La Oroya is the smelter and not vehicular transit.

This conclusion is consistent with that of the DIGESA report: "While generally the principal source of environmental lead in urban areas is produced by gasoline, in La Oroya the principal source of atmospheric contamination is the metallurgical plant." DIGESA further states that "the results of blood lead testing of the people of La Oroya suggest an important source of environmental lead exposure, the most evident being the La Oroya metallurgical complex."

33 Study of Blood Lead Levels in the People of La Oroya 2000-2001, by DRP, p. 69.

34 One gallon of 84-octane gasoline = 3.785 liters. One liter of 84-octane contains 1.16 g of tetraethyl lead or 0.74 g of elemental lead. Therefore, one gallon of 84-octane gasoline contains 2.8 g of lead. If a monthly average of 43,700 gallons of 84-octane gasoline were burned, 43,700 x 2.8 or 122,360 g of lead would be emitted into the La Oroya environment each month. In other words, the total emissions from vehicles would be a little more than 120 kg of lead per month.

35 Emissions of 1,077 m^3/s with a lead content of 16 mg/m^3 = emission of 1,077x16=17,232 mg/s or 0.0172 kg/s of lead. There are 86,400 s in a day, or 2,592,000 s per 30 days (one month). This means that the lead emissions from the Metallurgical Complex are 0.0172 kg/s x 2,592,000 s/month or 44,700 kg per month.

ANALYSIS OF EMISSIONS DATA AND ENVIRONMENTAL QUALITY IN LA OROYA SINCE DOE RUN PERU PURCHASED THE COMPLEX

The following chapters contain an analysis of the environmental monitoring data from the La Oroya Metallurgical Complex. Because the data is taken from the official monitoring reports submitted by DRP and Centromin Peru to the MEM in compliance with legal requirements, we consider the data used as the basis for the study to be objective.

The monitoring data for air quality, atmospheric emissions, and liquid effluents were examined closely to identify trends or significant changes that occurred after the modifications in production and since the 1996 approval of the original EMMP for the complex.[36] We hope that this information will be used to develop and implement emergency measures and modifications to the EMMP currently in effect, in order to mitigate the severe and continual impacts caused by contamination from the metallurgical complex on human health in La Oroya.

36 The data from 1995-96 come from the PAMA of Centromin Peru. The rest of the data were provided in the monitoring reports presented by DRP to the MEM from 1997 to 2001, which were obtained by the authors.

III
AIR QUALITY

Air quality is closely linked to human health and quality of life. While some toxic air contaminants can cause health effects ranging from respiratory irritation to cancer, other contaminants threaten the general well being and thus quality of life by harming crops, natural vegetation, buildings, archeological treasures, and more. Thus, health and environment authorities should strictly control both stationary sources of air pollution, such as smelters, and mobile sources, such as automobiles. The technologies and programs intended to reduce contamination from these sources improve public health and well-being.

For example, in the United States, the Clean Air Act charges the US Environmental Protection Agency (EPA) with establishing National Ambient Air Quality Standards (NAAQS) that must be met by all US air quality regions. The EPA also approves implementation plans developed by the states to meet the NAAQS, sanctions the states or regions that fail to comply with the NAAQS in the predetermined time-frame, and designs and implements plans for states or regions that present proposals deemed inadequate for meeting the NAAQS. Moreover, the EPA must establish national emissions standards for hazardous pollutants (NESHAPs) for each industry, thus defining maximum emissions levels based on the best available control technologies. (For example, the NESHAP for lead smelters in the US allows maximum emissions of 500 grams of lead per ton of lead produced.)[37]

For their part, the national and regional environmental authorities have the right to require and issue operating permits for facilities that emit atmospheric pollutants. These permits contain specific emissions limits, and, in the event of non-compliance, are strictly enforced by the levying of fines according to the number of days that emissions exceeded the established

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[37] 40 CFR Section 63.1543 (a) 40.

limits. Moreover, when a facility fails to comply with the operating permits, the authorities and citizens have the ability to bring enforcement actions in the judicial system. Obviously, the EPA and other government authorities have further important responsibilities related to environmental issues such as liquid effluents, toxic solid wastes, and worker protection, among others.

LA OROYA MONITORING STATIONS

One important aspect of governmental control and oversight of air pollution relates to monitoring programs for air quality and atmospheric emissions. According to current legislation in Peru, the owners of the La Oroya Metallurgical Complex must report regularly on the emissions and effluents from the complex, and on the air quality in the region around the smelter. There are five air-quality monitoring stations in La Oroya, all located within a radius of 10 km from the smelter (Table 5, Figure 2). The monitoring data was used for this analysis.

The quarterly reports from DRP to MEM[38] include measurements of atmospheric sulfur dioxide (SO_2), arsenic, (As), lead (Pb), cadmium (Cd) Total Suspended Particulates (PTS) and 10-micron particulate matter (PM_{10}).[39] There is no definitive information as to the quality control in the collection and analysis of samples for the monitoring program. Therefore, we cannot be certain that the information reported to MEM is completely accurate and reliable, and we consider it to be an approximation that certainly could underestimate the true contamination levels in La Oroya.

38 The air quality information obtained refers to the months of January 1995, through June 1996, and January 1997, through the end of 2000. The "annual" averages shown in the report are based on these data. Since the data only covers 6 months of 1996, it is possible that this value does not reflect the annual average.

39 Appendix 1 of this document shows more information about the way in which these parameters were monitored.

Monitoring Station	Distance to the main smoke-stack (km)	Altitude (m)	Description of the Area
Hotel Inca	2 km	3742	Urban, La Oroya
Cushurupampa	3 km	3801	Semiurban
Sindicato de Obreros	0.8 km	3731	Urban, La Oroya
Huanchán	2 km	3792	Rural, La Oroya Ant.
Smelter[40]	<0.8		Industrial

Table 5: Air quality monitoring stations in La Oroya for which Doe Run regularly reports to MEM.

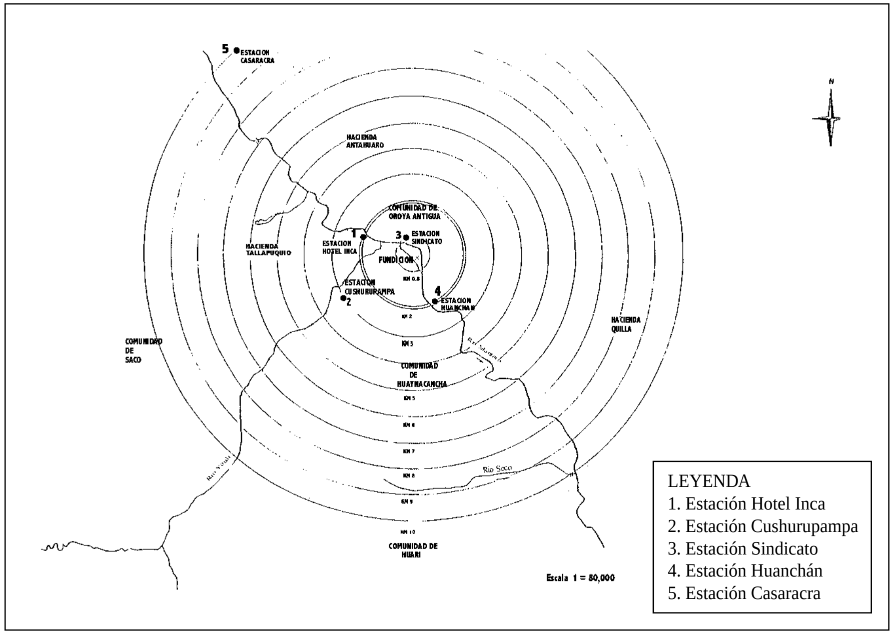


Figure 2. Map of La Oroya air quality monitoring stations.[41]

40 Very little monitoring data exist for the Fundición monitoring station, which only operated for a few months. Because of this, these data were not included in this report.

41 Source: Monitoring reports presented by DRP to the MEM.

Capacity of Existing Stations For Monitoring Impacts Near the Complex

It is possible that the existing monitoring stations do not allow for the determination of the real magnitude of contamination in La Oroya. The major acute impacts on human health are observed within a radius of 20 km from point sources of SO_2 emissions, and within 10 km of significant sources of heavy metal emissions. This does not mean, however, that any site within these distances is appropriate for a monitoring station. To measure contamination levels accurately, it is necessary to first model the dispersion patterns of pollution plumes, and then site the monitoring stations according to the results of the model.[42] We do not know whether the appropriate modeling has been conducted in the specific case of La Oroya, or, in the absence of such modeling, the technical justification for the location of the existing monitoring stations.

The Failure of Current Monitoring Stations to Determine Long-Distance Impacts

Aside from the acute health impacts caused by SO_2 sources within radii of 20 km, various studies have established that SO_2 contamination produces severe environmental impacts hundreds of kilometers from the source due to the generation of acid rain.[43] However, no monitoring station measures distant impacts of the La Oroya complex. Thus, the existing monitoring stations do not provide a complete picture of the dispersal patterns of SO_2 from the complex. Considering the great impact of SO_2 on agricultural lands, archeological ruins, and buildings, the installation of additional monitoring stations at a greater distance from the complex, particularly in the direction of most prevalent winds, is recommended. This should be required as part of the action plans being developed under the new air quality regulations.

42 Technical bases for the Appendices from Annex IV of the La Paz Agreement, July 1998, developed for the Center for Information of Air Contamination for the US – México, Bill Powers, P.E.

43 *Air Pollution: Its Origin and Control,* 2nd ed., K. Wark and C.F. Warner, Harper and Row, New York, 1981.

ATMOSPHERIC CONTAMINATION BY SO_2

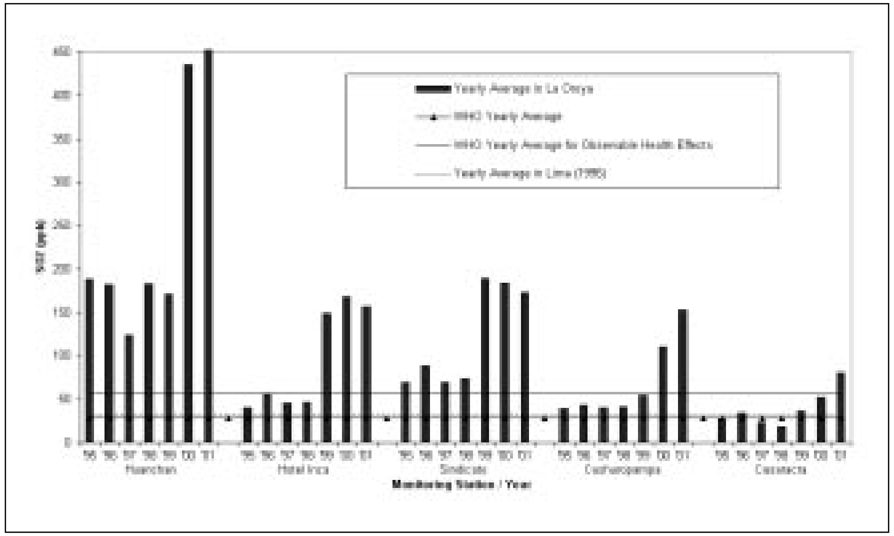
An analysis of the monitoring data shows that SO_2 contamination is a critical threat to human health in La Oroya. (A more in depth description of the risks to health associated with elevated SO_2 levels is presented in Appendix 1.) Except for the Casaracra monitoring station, all stations show an annual mean concentration exceeding the level recommended as safe by the World Health Organization (WHO) by a factor of two or three. These concentrations surpass the level recognized as harmful to human health by a great deal (graph 2).[44] This is troubling given the effects of SO_2 on human health and the environment. It is particularly disturbing that the greatest contamination levels exist within an urban area in which many people have extremely limited access to medical services. In addition, SO_2 aggravates the health impacts of particulate matter, which exists at high levels in La Oroya.[45, 46]

The data from 1999 and 2000 suggest that there was a significant increase in the average SO_2 concentrations at the monitoring stations near the smelter in these years. The concentrations nearly doubled compared to previous years at these sites. This is a significant cause for concern. It is not possible to determine the reason for the increase in the SO_2 contamination levels without additional information, but possible reasons for the increases include increased production levels, increased sulfur content in the concentrates used at the smelter, and changes to the monitoring equipment and/or procedures. Whatever the reason, it is clear that the levels of SO_2 contamination existing in La Oroya today are much worse than those considered during the development of the 1996 Environmental Management and Mitigation Program adopted for the complex. To prevent significant public health and environmental harms, there is an urgent need for attention to this problem.

44 "Sulfur Dioxide and Particulate Matter in Air-quality guidelines for Europe," WHO, 1987, p. 338.

45 "Sulfur Dioxide", Utah Department of Environmental Quality, *available at* http://www.air.dnr.state.ga.us/information/so2.html, (Dec. 14, 2001).

46 Information on sulfur dioxide *available at* http://www.atsdr.cdc.gov/tfacts116.html, ATSDR (July 11, 2001).



Graph 2. Yearly average concentrations of SO_2 at the La Oroya monitoring stations compared with the WHO guidelines (recommended annual average (WHO) = 28 ppb, WHO level for observed health effects = 57 ppb) and the annual mean for Lima in 1996.[47] Data that was unavailable and thus was not included in annual averages: all monitoring stations, 7-12/96 and after 11/01; Sindicato, 6/00; Casaracra, 9/95.

Maximum SO_2 Concentrations in La Oroya

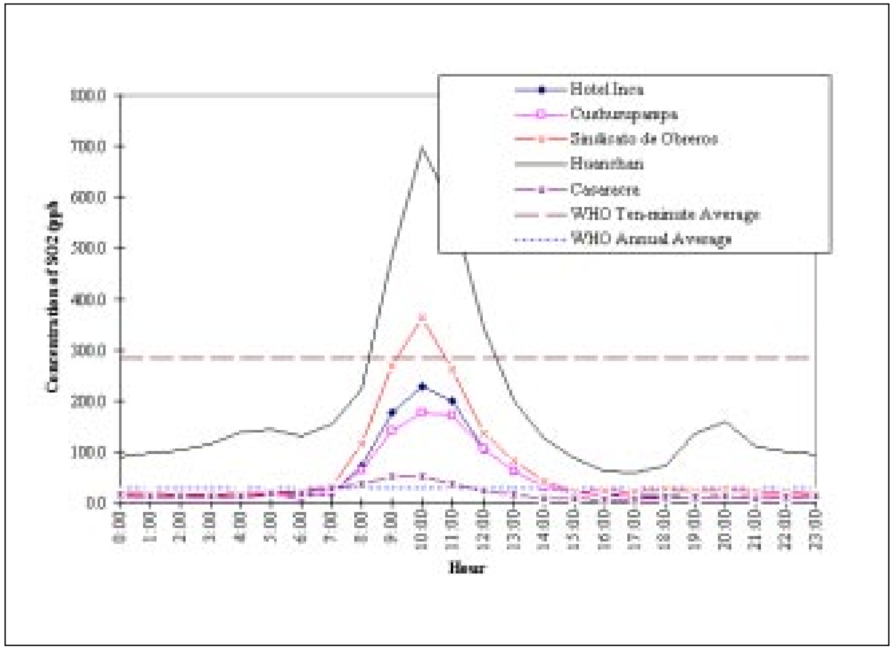
Not only the high annual average concentrations of SO_2, but also the frequency of extremely high concentrations over short time periods, are cause for concern in La Oroya. These peak events are known to generate large numbers of medical emergencies, particularly for susceptible populations such as asthmatics.[48] It is therefore necessary to control both annual or monthly average SO_2 concentrations as well as short-term averages. The one-hour standard recommended but unfortunately not adopted as part of the recently

[47] The 1996 annual average was 89.1 ug/m^3 (50.6 ppb) in Lima. *See supra* note 29, section 6.3.1, p. 12.

[48] *Assessment of New Findings on Sulfur Dioxide Acute Exposure Health Effects in Asthmatic Individuals*, Supplement to the Second Addendum (1986) to Air Quality Criteria for Particulate Matter and Sulfur Oxides (1982), EPA/600/FP-93/002 (August 1994).

adopted Peruvian Air Quality Regulations would have addressed this need. Data based only on long-term averages could lead an observer to believe that contamination levels are less severe than those observed on innumerable occasions.

The time distribution of 1998 SO_2 contamination levels is shown in Graph 3.[49] It is important to note that though this graph clearly demonstrates the trend in contamination levels in relation to time of day, the data pertains to 1998 – that is, before the enormous increase in contamination registered for the years 1999 and 2000. Even so, it is evident that the majority of extremely dangerous SO_2 contamination events occur during a limited period and that the daily average is indicative of a very high risk to human health. Unfortunately, the contamination peaks occur between 7 AM and 2 PM, when the local population is most physically active.

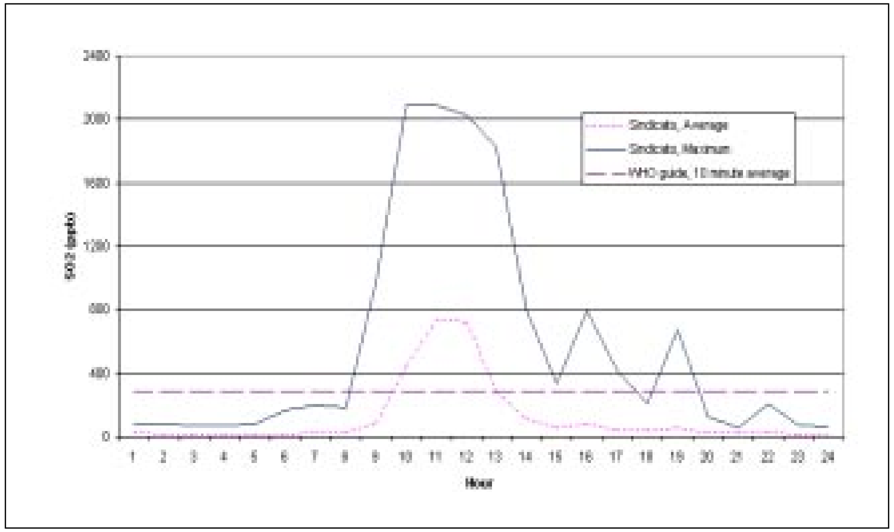


Graph 3. Annual average air quality according to time of day at La Oroya monitoring stations. (Data from 1998.)

[49] There is an almost identical distribution for the other monitoring stations.

This monitoring data show that with the increase in La Oroya contamination levels, the maximum short–term concentrations[50] considered acceptable by the WHO (500 *u*g/m^3, 286 ppb) were significantly exceeded. In fact, as can be seen in the data reported for May 2000 (Graph 4), the concentrations of SO_2 in the city reach an average of up to 2100 ppb at certain hours – almost ten times the level recommended by the WHO. The long-term annual average limit was also routinely exceeded. Although DRP has indicated that the company has implemented changes in operations to avoid the formation of extremely high concentrations of SO_2 in the city, the data show that the problem during the peak periods did not improve during the years 1998-2000, but instead became even more critical than in previous years. Thus, SO_2 contamination in La Oroya likely remains critical and the damage to the respiratory systems of the people could be extreme.

Due to the extreme levels of sulfur dioxide contamination and the health risks that these imply, we consider the installation of control techniques for pollution prevention a high priority short-term action. Such techniques are



Graph 4. Concentrations of SO_2, averages by year and average maximums by hour in comparison to the limit per ten minutes recommended by the WHO. Sindicato, May 2000.

50 Ten-minute averages.

available and have been demonstrated to be effective in various countries. If the installation of state of the art control technology were prioritized, it would be feasible to considerably reduce air contamination within a relatively short time frame. Given the very high levels of sulfur dioxide contamination, production from the smelter could be restricted until the appropriate environmental controls have been installed to protect public health. The Mexican government recently took such measures for the smelter in Torreón, Mexico.[51]

ATMOSPHERIC CONCENTRATIONS OF HEAVY METALS

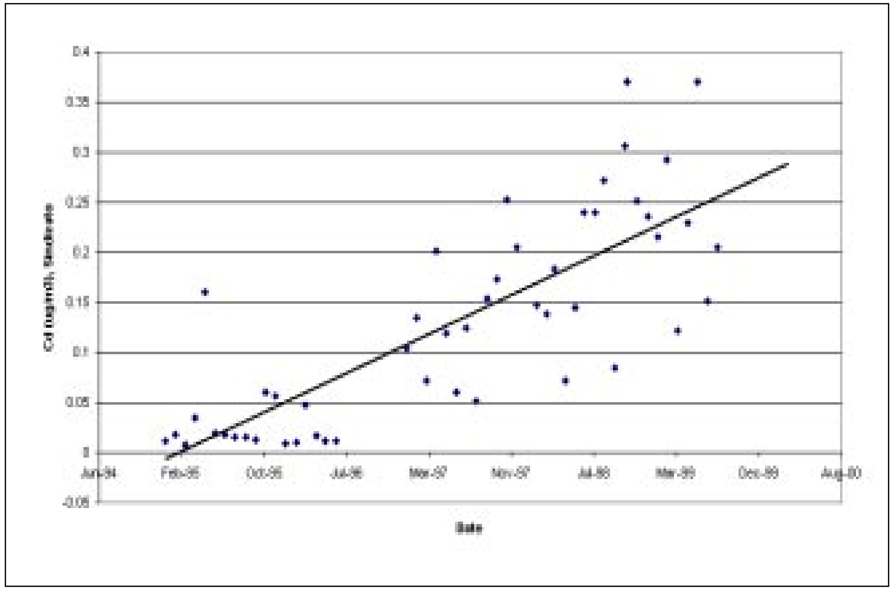
Cadmium

The data analysis shows that the concentrations of cadmium (Cd) increased dramatically (Graphs 5-6) after the approval of the EMMP and the privatization of the complex.[52] In 1995-96 the environmental concentrations of cadmium already greatly exceeded the directives of the WHO (0.005 *u*g/m^3). Nevertheless, in 1997 these concentrations increased dramatically and continued to rise during 1998-99, reaching an extremely serious level. (See Appendix 2 for the impacts of cadmium contamination on human health.)

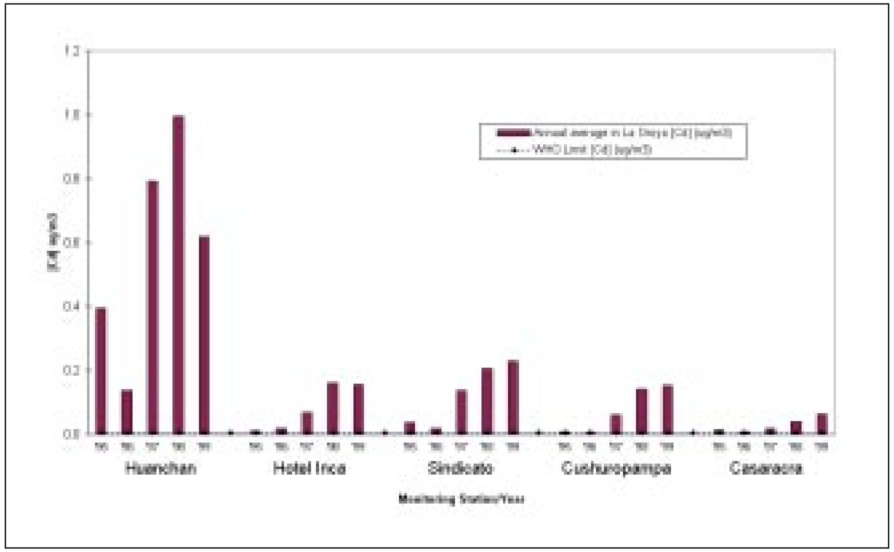
Between January and September of 1999, the average levels of cadmium observed at the Sindicato monitoring station were 0.22 *u*g/m^3, more than 40 times the limit of the WHO. The levels at Huanchán were even higher, and the other monitoring stations also greatly exceeded the international standard. Even so, and without any explanation, DRP stopped reporting cadmium monitoring data to the MEM in September of 1999. This is worrisome given the extreme risk cadmium presents to human health, especially since contamination was on the rise. The trend between 1995 and 1999 is indicative of a severe public health problem, which makes it necessary to urgently address this problem.

51 Perezgasga and Morelos, *supra* note 8, *available at* http://www.texascenter.org/publications/torreon.pdf; Kawamoto and Ojeda, *supra* note 8.

52 The 1995-1996 data was obtained from the Centromin Peru PAMA while the remaining information was obtained from DRP monitoring data supplied to MEM between 1997 and 2001.



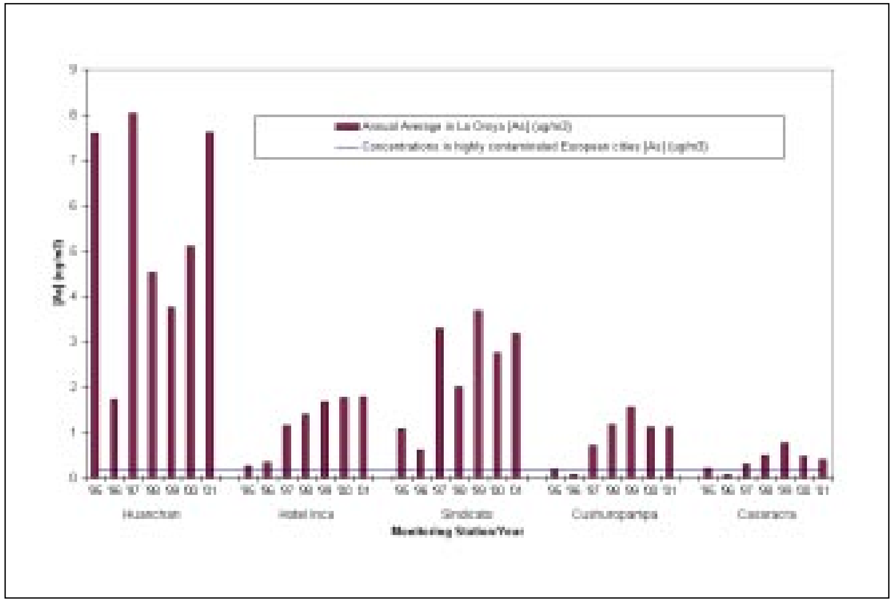
Graph 5. Trend in cadmium contamination at the Sindicato station. 1995-1999.



Graph 6. Annual average cadmium concentration measured at the monitoring stations in La Oroya, compared to the limit of the WHO (0.005 *u*g/m^3). Data that was unavailable and thus was not included in annual averages: all monitoring stations 7-12/96 and after 8/99; Cushuropampa 12/97.

Arsenic[53]

Even though there are no international limits for environmental arsenic concentrations, there is a consensus that arsenic is a toxic agent and a carcinogen affecting human beings. According to the WHO, European cities highly contaminated from combustion of coal with high arsenic content have annual average arsenic levels of 0.25 *u*g/m^3.[54] Graph 7 compares the air quality at La Oroya monitoring stations with this value. It is evident that the contamination in La Oroya is many times greater than highly



Graph 7. Arsenic [As] in the environment at the monitoring stations of La Oroya compared with the environmental concentrations in the most highly contaminated European cities. Data that was unavailable and thus was not included in annual averages: All monitoring stations 7-12/96 and after 11/01; Cushuropampa, 12/97.

53 Because volatile arsenic particles can evaporate from filters during the collection period, it is possible that the atmospheric concentrations found are underestimated with the monitoring methods used. Nevertheless, the monitoring data would still accurately represent the trends in environmental quality.

54 *Air quality guidelines for Europe*, World Health Organization Regional Office for Europe and Copenhagen, WHO, 1987.

contaminated cities in Europe, and that the concentrations of arsenic have increased significantly since 1996. This rise was observed at all the monitoring stations.

Applying the WHO arsenic risk factor[55] to the air quality in La Oroya leads to the conclusion that many of the people residing in the area will develop lung cancer due to environmental arsenic exposure. Obviously, the effects could be greater in more contaminated zones like La Oroya Antigua. (See Appendix 3 for additional impacts of arsenic contamination on human health.) Regrettably, the limited health services in the region and the economic conditions of the population have to date precluded studies to confirm these effects. The life expectancy data for the region should be reviewed.

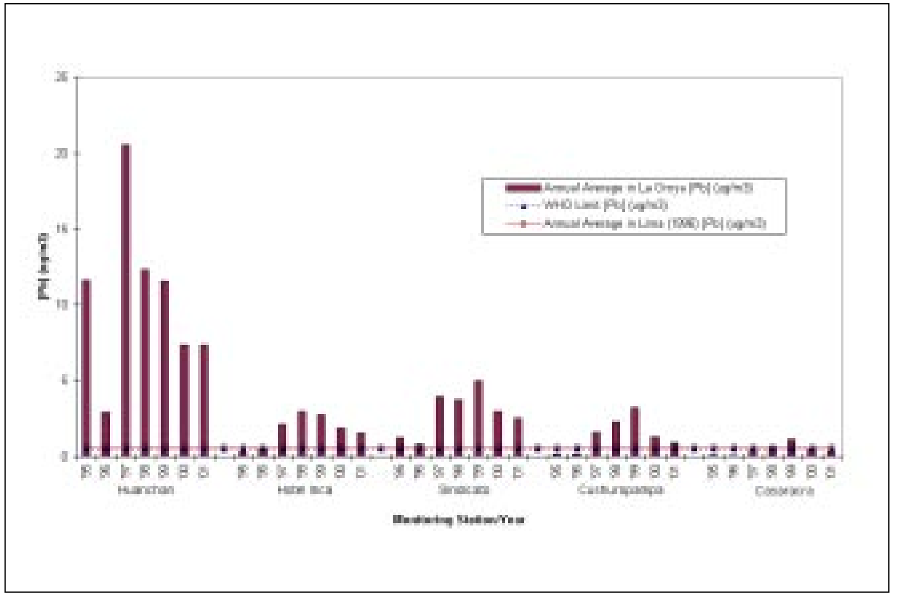
Lead

The analysis of monitoring data also indicates that the atmospheric concentrations of lead have increased substantially since the approval of the EMMP.[56] Lead concentrations in the environment were compared with the air quality standards of the WHO. With the exception of the slag deposit at Huanchán, all of the monitoring stations were below or near the WHO limit for lead in 1995 and 1996. But as with cadmium, a marked increase in the atmospheric levels of lead occurred from 1997-99 and only the distant station of Casaracra met the WHO standards for lead in 1999 (Graph 8).

It seems that the atmospheric lead concentrations in La Oroya decreased during the year 2000, quite possibly because of improvements implemented by DRP in the Cottrell Central during that year. Nevertheless, even considering the recent improvement, the amount of lead in the urban environment of La Oroya represents a serious risk to public health and greatly exceeds the level contemplated in the EMMP design. Lead contamination poses a severe and well-known risk to public health and should be stopped as soon as possible. (See Appendix 4 for the impacts of lead contamination on human health.)

55 The WHO considers the lifetime risk factor of cancer from arsenic to be 4 x 10^{-3}, which means that for every 1000 people who breathe air containing 1 *u*g/m^3 of arsenic, four are expected to develop cancer during their lifetime.

56 *See supra* note 52.

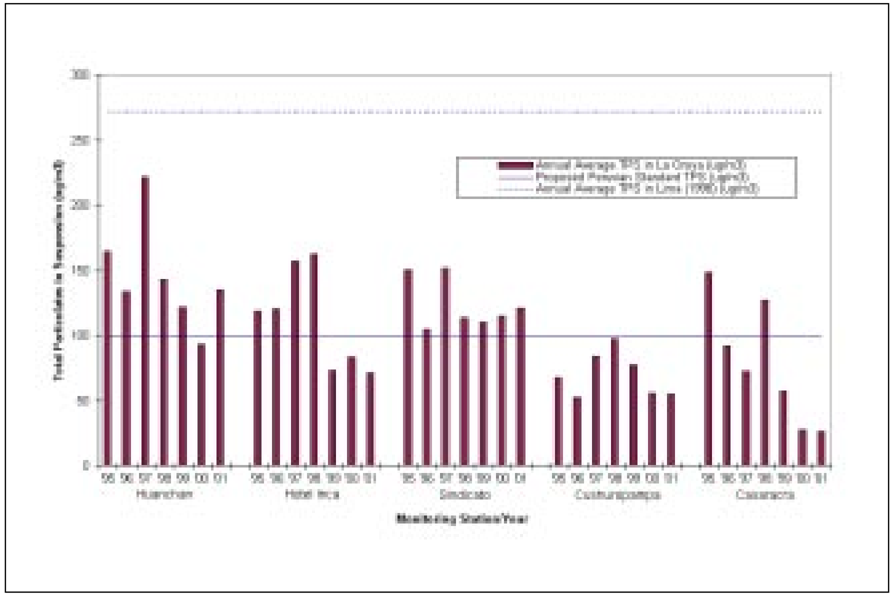


Graph 8. Annual average lead concentrations taken at La Oroya monitoring stations, compared with the WHO limit (0.5 *u*g/m^3) and the 1996 annual average for Lima (0.576 *u*g/m^3).[57] Data that was unavailable and thus was not included in annual averages all monitoring stations 7-12/96 and after 11/01; Cushuropampa, 12/97.

SUSPENDED PARTICULATE MATTER

Particulate matter with a diameter less than 10 microns (PM_{10}), and specifically that with a diameter less than 2.5 microns ($PM_{2.5}$ or "fine" particulates), is known to cause serious public health risks. These particulates should be monitored. The monitoring in La Oroya has mostly been of particulates greater than 100 microns. Until March of 2000, only some of the stations measured PM_{10} concentrations, although presently all stations monitor for PM_{10}. As of the year 2000, $PM_{2.5}$ concentrations were not yet measured. We suggest that such monitoring be undertaken to evaluate the risk of particulate matter contamination in La Oroya. Standards should also be established to control the serious impacts of

57 Calkins, *supra* note 29, section 6.3.8, p. 18.



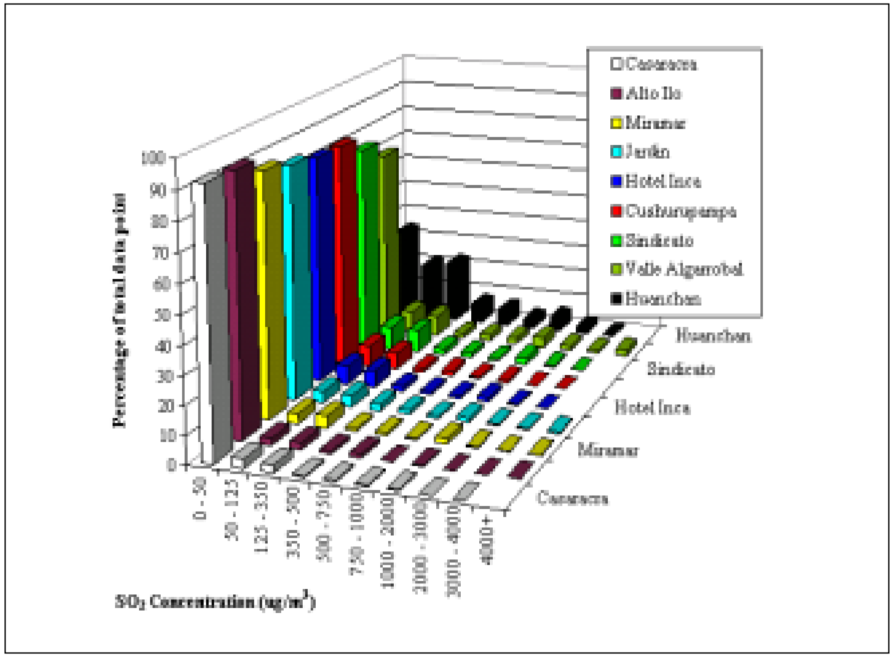
Graph 9. Levels of total suspended particulates at the monitoring stations of La Oroya compared with the air quality standards proposed by DIGESA (1998). Data that was unavailable and thus was not included in annual averages: all monitoring stations 7-12/96 and after 11/01; Huanchán 9-12/99, 1-3/00; Sindicato 6/00; Cushuropampa 9-12/99, 1-3/00; Casaracra 9-12/99, 1-2/00.

$PM_{2.5}$ on public health.[58] This data analysis did not lead to any conclusive determination of trends in particulate matter contamination between 1995-2000 (Graph 9).

58 *See* “EPA’s Updated Air Quality Standards for Smog (Ozone) and Particulate Matter”, E.P.A. Office of Air and Radiation, *available at* http://www.epa.gov/ttn/oarpg/naaqsfin/ , (17 oct. 2000); *see also* “Six Principal Pollutants: Particulate Matter (PM-10)”, E.P.A. Office of Air and Radiation, *available at* “http://www.epa.gov/oar/aqtrnd97/brochure/ pm10.html” http://www.epa.gov/oar/aqtrnd97/brochure/pm10.html, (Sept. 6, 2001); *see* “PM 2.5: Objectives and History”, E.P.A. Region 4, *available at* http://www.epa.gov/ region4/sesd/pm25/p2.htm, (June 12, 2001); *see* “PM 2.5 Monitoring (Fine Particulate Matter)”, NYS Department of Environmental Conservation, *available at* http:// www.dec.state.ny.us/website/dar/baqs/pm25mon.html, (Jan. 24, 2002).

Comparison of La Oroya Air Quality with that of Ilo-Moquegua

The air quality of La Oroya was compared to that of Ilo-Moquegua, Peru, because the Ilo region is the site of the Southern Peru Limited (SPL) smelter and is internationally renown for its extremely high levels of environmental SO_2 (Graph 10).[59] In order to make definitive statements regarding the contamination at the Ilo smelter, data from the company’s monitoring stations (located north of the smelter) would have to be evaluated. However, the comparison does show that the contamination levels in urban areas affected



Graph 10. Histogram of the monitoring stations of La Oroya (Huanchán, Sindicato, Cushurupampa, Hotel Inca, Casaracra) and Ilo (Valle Algarrobal, Jardín, Miramar, Alto Ilo) showing the percentage of air quality samples within specified SO_2 ranges.

59 Data from the La Oroya monitoring stations (1-11/98) were compared with data from Ilo monitoring stations (9-12/98). The data used to conduct the comparison with Ilo come from “Permanent Air Quality Monitoring in Ilo”, published by the Association Committee for Environmental Management – Ilo. The comparison is not totally equivalent because the distance between the monitoring stations and SPL smelter in Ilo is much greater than the distance between the stations and the smelter in La Oroya.

by the La Oroya smelter (Sindicato, Hotel Inca) are worse than those found in the city of Ilo (Miramar, Alto Ilo). If one considers only the heavy metal contamination, the situation is likely to be more serious in La Oroya because the urban population lives very close to the smelter, whereas in Ilo there is a greater distance between the city and the smelter.

SUMMARY OF AIR QUALITY TRENDS

The comparison of air quality parameters from 1995 to 2001 demonstrate that air quality deteriorated dramatically during this time with respect to sulfur dioxide content and heavy metals such as cadmium, lead, and arsenic.[60] From the data reported to the MEM by DRP, it is obvious that five years of EMMP implementation has not reduced the atmospheric contamination in La Oroya. To the contrary, the contamination rose dramatically. As a result, the risk to public health is many times greater than it was thought to be in 1996. It is likely that the mitigation measures selected, based on the much lower contamination levels known to exist in 1995 and 1996, are not adequate to treat the extreme contamination that exists today, or to solve the medical emergency that has been caused by the contamination. For this reason, it is urgent that the EMMP be re-evaluated by competent authorities. It must become a priority to implement, improve, and strengthen the EMMP to include all necessary control technologies, taking into account current contamination levels and the medical emergency in La Oroya.

60 The concentrations of other toxic heavy metals possibly emitted from the smelter (antimony, beryllium, cadmium, chrome, cobalt, copper, manganese, mercury, nickel, and selenium) are not monitored, but represent additional risk to public health and the environment. This is a problem that should also be addressed urgently.

IV
ANALYSIS OF ATMOSPHERIC EMISSIONS DATA

Atmospheric emissions monitoring differs from air quality monitoring in that the former provides information about the quantity of contaminants that a company is emitting into the environment from specified sources, while the latter reports information about the levels of atmospheric contamination to which human beings are exposed.

Another difference between the two types of monitoring is the sampling location. To monitor emissions, the monitoring points are located at the source of the emission (the smoke-stack, for example). To monitor air quality, the monitoring points are located farther from the source (like the Casaracra station located several kilometers from the complex).

Obviously, the monitoring of registered emissions is not a complete indicator of environmental contamination. Often, as is the case at the La Oroya metallurgical complex, only a small percentage of sources are monitored and there is no monitoring of fugitive gas emissions. Despite the fact that the EMMP for the metallurgical complex recognizes that 95 secondary sources exist in addition to the main stack,[61] emissions are reported for only seven sources. Although these sources generate a considerable percentage of the total atmospheric emissions, the failure to monitor other sources constitutes a major weakness of the monitoring program. This is particularly problematic considering the variety of installations and types of sources that exist at the metallurgical complex.

Since the reported emissions do not include fugitive emissions, the reports undoubtedly greatly underestimate the total emissions from the complex. For example, it has been found that reported emissions can represent as little as 48% of actual smelter lead emissions.[62] Because the

61 PAMA, La Oroya Metallurgical Complex, Central Peru Mining Company, 1996, p. 20.

62 *Draft Summary Report, Primary Copper Smelters – National Emission Standard for*

complex is very old and not equipped with the technology to prevent fugitive emissions, the fugitive emissions from the La Oroya smelter are sure to be substantial.

Because even in the best scenario the reported emissions would represent only a portion of the environmental contamination generated by the smelter, one cannot necessarily expect to see a correlation between reported emissions and observed air quality. Emissions reports based on mass balance calculations can be more exact,[63] but are subject to approximations and do not provide information as to where and when emissions occur.

RESULTS

The La Oroya monitoring data was taken from the quarterly reports presented to MEM.[64] DRP provides emissions data from seven source points but in the majority of cases records only some of the emitted substances (see Table 6). The reports present "monthly averages" of contaminant concentrations in the emissions and averages of the flow rates for each source. From these, it is possible to calculate the total contamination, in weight, emitted by the Complex. Unfortunately, the scant information in the monitoring reports does not allow for verification of the reliability of these data.

As the main stack is the major source of reported contaminants to date, the emission trends for total contamination were calculated by comparing the monthly average emissions from this source (Graphs 11-14). The analysis showed little correlation between emission levels and air quality. This is likely due to the fact that many of the principal sources of emissions from the smelter, such as the concentrate deposits and the fugitive emissions, are not monitored.

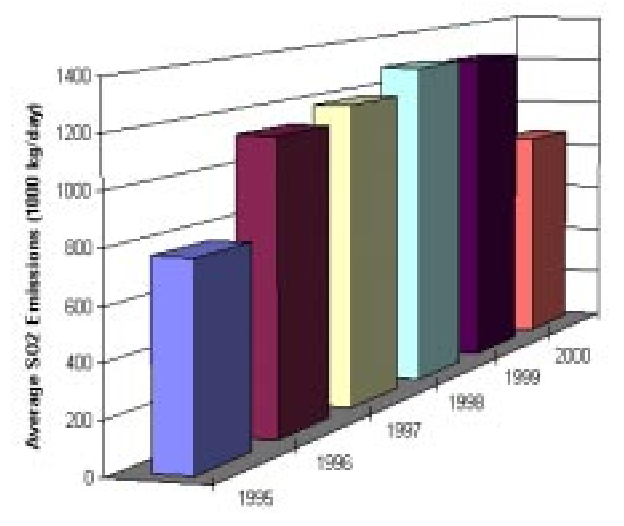
Hazardous Air Pollutants, ESD Project No. 91/61, Research Triangle Institute (Jan. 20, 1994).

63 Mass balance calculations contrast the chemical makeup of entering concentrates with the products formed during the smelting process. The emissions are calculated as the difference between the two — materials expelled into the environment during the process.

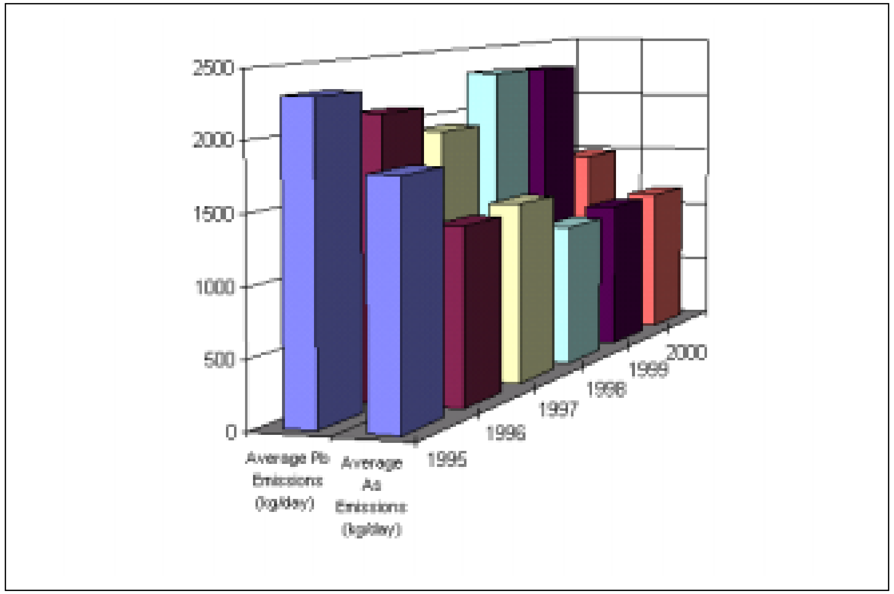
64 MEM has put forth information with respect to the periods from January 1995 to April 1996 and from June 1996 to the end of 2000 respectively.

Source	Solids	As	Cd	Pb	SO_x
Main Chimney	X	X	X	X	X
Coking Chimney (bank A)	X	-	-	-	X
Coking Chimney (bank B)	X	-	-	-	X
Ventilation System (bismuth pots)	X	-	-	X	-
Ventilation System (converters)	X	-	-	X	-
Ventilation System (Copelas)	X	-	-	X	-
Ventilation System (zinc roasters)	X	X	X	X	-

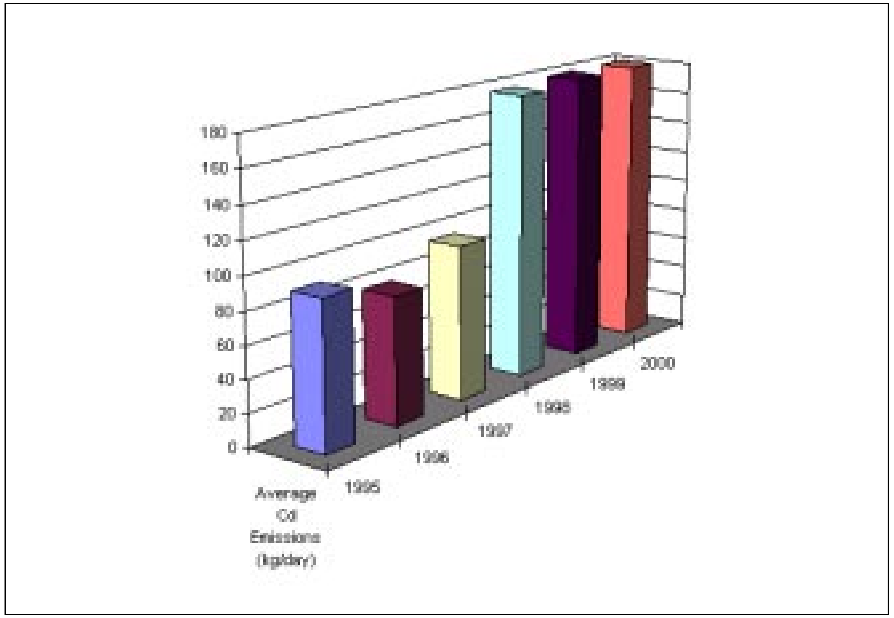
Table 6. Monitored emission parameters from the various sources.



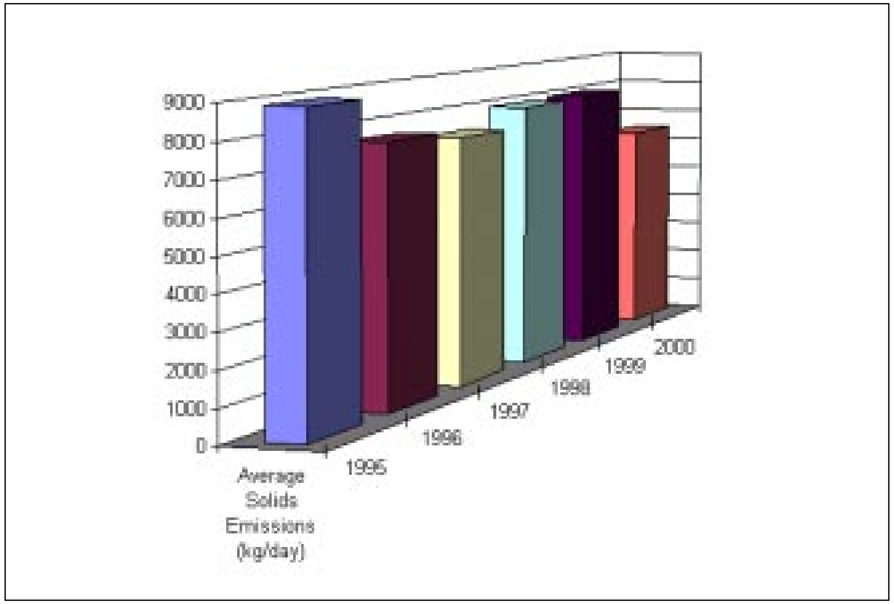
Graph 11. Daily average SO_2 (kg/day) emissions reported from the main chimney, 1995-2000.



Graph 12. Daily average of lead and arsenic emissions (kg/day) reported from the main chimney, 1995-2000.



Graph 13. Daily average of cadmium emissions (kg/day) reported from the main chimney, 1995-2000.



Graph 14. Daily average of particulate emissions (kg/day) reported from the main chimney, 1995-2000.

The reported lead emissions decreased in the year 2000 (Graph 12). Even so, much remains to be done for the smelter to have acceptable emissions levels and for the air in the city to be safe. As shown in Graph 8, the 2000 levels of lead in the air at four of the five monitoring stations continue to be greater than the levels observed in 1995 and 1996, the years in which the EMMP was developed. And recent contamination levels remain significantly above those considered safe for public health.

CONTROL TECHNOLOGIES FOR EMISSIONS REDUCTIONS

The lead smelter operated by DRP's parent company in Herculaneum, Missouri, generates emissions of less than one pound of lead for each ton of lead produced.[65] This is 1/17 of the La Oroya emissions in 1998. These

65 State Implementation Plan for Missouri, the state in which DR has its US operations.

reduced contamination levels result from strict management of dust, fugitive gases, and emissions, as per the requirements of the US government. Even so, the US government recently demanded that the company implement a strict program of environmental improvements, to further reduce the contamination in Herculaneum and thus reach acceptable levels of lead contamination.[66] Doe Run was granted terms between 60 and 120 days for the development of various control, remediation, and monitoring programs. This comparison shows that the changes implemented by DRP in La Oroya in the year 2000 are only a small fraction of what must be done to sufficiently control lead contamination and protect public health.

Some have suggested that the type of concentrates smelted at the metallurgical complex (concentrates that contain substantial impurities such as sulfur and other metals) and the thermal inversions of the region make it impossible to compare the two smelters and demand the same operational standards of Doe Run in Missouri and in La Oroya. This is not necessarily so. First of all, it is possible to change the types of concentrates used. Secondly, the control technologies that should be implemented to avoid atmospheric emissions are largely changes in processes and technologies for treating the emissions before they leave the complex. Many of these can be implemented regardless of the type of process or concentrates used. One easily implemented measure, for example, is to isolate and cover the concentrates storage area. This is a relatively easy and cost-effective way to significantly improve environmental quality at smelters.

Doe Run has implemented several programs to protect public health in Herculaneum. These programs could easily be replicated in La Oroya. Because the company has experience with many of the technologies and management plans necessary to prevent contamination, it shouldn't be necessary to grant a long period of time for compliance with the EMMP or the air quality standards. It is the prioritization of the financial investments required to protect the environment and public health that is lacking.

A highly effective method for eliminating heavy metals in gaseous smelter emissions is the installation of double contact sulfuric acid plants. This was proposed in the original EMMP developed by CENTROMIN, and later modified at the request of DRP. One requirement for the operation of a

66 *Administrative Order of Consent*, United States Environmental Protection Agency, Region VII (Sept. 29, 2000).

sulfuric acid plant is excellent prior removal of particulates. Thus, the installation of acid plants can significantly reduce the emissions of dangerous heavy-metal contaminants. It is possible to reduce the emissions of heavy metals from controlled point sources up to 98% with the adoption of measures to produce sulfuric acid.

It is also necessary to significantly reduce fugitive emissions at the smelter, including emissions generated by sintering, grinding, material management, charging of the ovens, and discharge of smelted material to waste piles. Fugitive emissions also include those emissions produced as the wind blows over the different mounds of mineral concentrate, sintering dust, coke, and other materials at the complex. Measures to control fugitive emissions are urgently needed. These include the complete enclosure and remediation of contaminating processes and areas, with installation of ventilation systems and control technologies for particulate removal. Moreover, efforts should be made to reduce the amount of impurities in the feedstock.

Heavy metal emissions will be reduced to acceptable levels only when measures to control both fugitive emissions and point-source emissions are taken. It is troublesome that the company, conscious of the enormous health risk that the contamination poses, has not yet prioritized these changes. It is even more disconcerting that the authorities responsible for health in Peru have not demanded such measures.

V
LIQUID EFFLUENT MONITORING

AVAILABILITY AND LIMITATIONS OF INFORMATION

This analysis is based on monitoring data from January 1996 to October 1998 and from January 1999 to December 2000.[67] The quarterly reports presented to MEM provide data on liquid effluents in 12 sampling locations (Table 7).[68] It is not clear why only these 12 points were monitored, given that the EMMP contained monitoring data for 37 different locations, and the Peruvian guidelines for water quality monitoring in mining operations establish that all the discharges into surface water shall be monitored regularly.

The effluent data were analyzed to determine 1) trends in contaminant concentrations, 2) the total amount of contaminants discharged to surface water, and 3) the total volume of effluents.

EFFLUENT CONCENTRATIONS

It is important to know the concentrations of toxic contaminants to determine the impacts of effluents on surface waters at the point of discharge. This is why standards exist for the maximum contaminant concentrations in liquid effluents. Although the rate of dispersion or dilution is also important when

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67 The MEM did not provide the official October-December 1998 reports on liquid effluents to AIDA and SPDA. Rather, the October values were obtained from an unofficial MEM transcript. Therefore, the AIDA analysis with respect to the effluent information of 1998 is fundamentally based on the official data of nine months and the transcription of data for one month. In addition, the values reported for November 1998, were identical to those reported in August, raising doubts as to their validity. The average concentrations of the effluents and of the flow rate for 1995 were obtained from table 2.3 of the 1996 PAMA.

68 For the purpose of this analysis, AIDA assumes that the flow rates reported were estimates of the effluent flow rates (m^3/min) emitted 24 hours/day, 365 days/year.

Sampling code	Effluent description
R-1	Acidic solution of the copper refinery, 5m from the Rio Yauli
R-3	Asarco effluent, 80m from the Rio Yauli
115	Electrolytic plant, 15m from the Rio Mantaro
118	Lead/copper smelter, water with granulated slag, discharged into the Rio Mantaro
119	Lead/copper smelter, channel #2, discharged into the Rio Mantaro
123	Anodic residue plant, sedimentation lagoon, 7m from the Rio Mantaro
126	Zinc refinery, outlet for purification and leaching solutions
131	Cadmium plant, 20m from the Rio Mantaro
134	Indio plant, waste solution before discharge into Rio Mantaro
135	Channel #1, before discharge into Rio Mantaro
136	Channel parallel to channel #1, before discharge into Rio Mantaro
137	Effluent from zinc ferrites lagoon

Table 7. Liquid effluents monitored at the complex.

considering the short-term toxic effect in surface water, the standards refer to the concentration at the point of discharge.

The analysis of the monitoring data through 2000 shows that the contaminant concentrations in the effluents from the metallurgical complex are very high, and much greater than those permitted by Peruvian and international standards (Appendix 7). The concentrations in several of the effluents increased significantly after the approval of the original EMMP,[69, 70] and consequently, these effluents pose a greater toxic risk to surface waters than at the time the EMMP was developed. There are also a number of effluents for which the contaminant concentrations have decreased. All discharges, including those that are not monitored, should be treated or eliminated as soon as possible to protect surface water quality.

69 *See supra* note 52.

70 Some of the concentrations that have increased are: lead in effluent 123, copper in effluent 136, zinc in effluents 134, 136, and 137, and arsenic in effluent 123.

TOTAL LOADING OF CONTAMINANTS TO SURFACE WATERS

It seems obvious, and it is often argued, that while a highly concentrated toxic effluent can kill organisms at the point of discharge, one with a lower concentration has less immediate effect. This logic is not sufficient, however, because the total mass of contaminants added to the ecosystem (total contaminant load) must also be considered. In other words, the concentrations of effluents is an important indication of environmental harm, but as is also true with atmospheric emissions, the total mass of contaminants added to the ecosystem can be more important than the concentration at the point of discharge. This is especially true with heavy metals and other substances that are not rapidly removed or biodegraded in surface water and sediment.

The change in the total contaminant load[71] to surface waters in La Oroya was determined from 1996 to 2000.[72] With significant fluctuations in the annual averages, there was no verifiable trend as to total contamination (Appendix 8). There are several toxic substances handled in the Complex that are not monitored at all. These include all organic substances and heavy metals such as cadmium.

71 The total load is determined by multiplying the flow rate of the effluent by the concentration of the contaminant in that effluent.

72 The calculation was done multiplying the monthly flows by the concentrations of contaminants for each effluent, and adding these monthly values to obtain the total annual discharge.

VI
CONCLUSIONS

THE PUBLIC HEALTH EMERGENCY IN LA OROYA

Due to the increase in concentrations of toxic contaminants, the risk to health and the environment in La Oroya is even more serious than thought to be case when the original EMMP was developed. The critical situation has been confirmed by epidemiological studies published by DIGESA and DRP, which show lead poisoning in the great majority of the children of La Oroya. This public health emergency is a severe problem that should be addressed immediately and jointly by state authorities, the company, and civil society to avoid further harm to the people of La Oroya. For this reason we recommend that an emergency plan be developed and implemented in the short term.

ENVIRONMENTAL QUALITY

The atmospheric concentrations of arsenic and cadmium have increased drastically since 1995. There were substantial increases in lead concentrations up to the year 1999, followed by an important (although insufficient) improvement in the year 2000. Considering the elevated concentrations of heavy metals in the environment and the long history of unmitigated contamination in the region, the risk to the health of the people of La Oroya and the surroundings areas from heavy metal contamination is severe. The levels of sulfur dioxide in La Oroya have also increased greatly since the approval of the original EMMP.[73] The gaseous nature of sulfur dioxide contamination allows it to have impacts over long distances, which means that the contamination not only affects La Oroya but also remote communities.

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[73] *See supra* note 52.

A simple comparison showed that a direct relationship between the reported emissions and the observed atmospheric concentrations does not exist, which leads to the conclusion that significant sources of emissions are not being monitored. For this reason, both the treatment of emissions from point sources and identification and treatment of emissions from all fugitive sources should be a priority.

The deterioration of air quality in La Oroya may be a result of increased production, a change in production processes, or a change in the heavy metal content in the concentrates processed in the smelter. It could also be argued that air quality is being affected by changes in climatic patterns. Some might suggest that the apparent deterioration actually results from differences in the monitoring protocols used by DRP and CENTROMIN PERU. Without debating the reasons for the significant increases in contamination levels, it is a fact that contamination levels recorded and confirmed by the authorities in La Oroya between 1998 and 2001 were much greater than those known to exist when the 1996 EMMP was approved. In light of this, the existing EMMP should be reconsidered and modified to insure the rapid implementation of environmental improvements and control technologies that will in fact control the current levels of contamination.

ENVIRONMENTAL MONITORING PROGRAM

The existing environmental air-quality monitoring program for the La Oroya metallurgical complex has many weaknesses. In addition, effective oversight and enforcement by the MEM and the Ministry of Health is lacking. One of the main concerns is the apparent absence of an established program to ensure and verify the quality of the data. The fact that only five monitoring stations are used, with no confirmation that these stations are ideally located, is also cause for concern. In addition, after September 1999 the quarterly reports did not include air quality monitoring for cadmium in spite of the enormous rise in atmospheric levels of this substance. Moreover, other potentially important contaminants such as zinc and $PM_{2.5}$ are not monitored.

The monitoring of atmospheric emissions from the La Oroya smelter is also inadequate. The initial design phase of the gaseous emissions monitoring

[74] MEM Monitoring Protocol for Air Quality and Emissions, II, 1, 1.

program should identify and evaluate all of the fugitive and point sources of atmospheric emissions.[74] This does not seem to have been systematically done, and many significant emissions sources may not yet be known. For the program to be adequate, regular samples should be taken according to a sampling schedule defined for all emissions (gaseous and liquid) and the samples should be analyzed for all contaminants of potential interest.[75]

By not presenting monitoring reports electronically and with graphical summaries, the company makes the work of tracking environmental emissions unnecessarily difficult. These reports should be submitted to MEM in electronic format to facilitate data sharing, and should always include graphical representations and summaries of observed trends or abnormalities. The results should be freely accessible to the public and other government entities, and should be duly considered in processes for environmental and public health planning. The MEM should carefully and regularly review the reports and solicit clarifications or additional monitoring as necessary. When an irregularity in the implementation of the monitoring program is identified, the MEM should impose sanctions.

RECOMMENDATIONS

For the MEM

- Require a modification of the current EMMP, given that it was developed and based on contamination levels much lower than those existing today. The situation was not corrected via the modification approved in 1999. It is essential that DIGESA, CONAM, the affected population, and other representatives of civil society participate in the modification process to ensure that their opinions and experience are considered and incorporated into the plan.
- Require that the company prioritize the treatment of gaseous emissions and rapidly install control technologies and adequate treatment methods for all emissions, including fugitive emissions. Such measures will also greatly reduce the timeframe for the mitigation process the company will have to undertake beginning in 2006 as part of the compliance with

[75] MEM Monitoring Protocol for Water Quality, Sections 2-3.

the new Air Quality Law. Regrettably, the previous modification of the EMMP sought by DRP did not guarantee the use of the best available control technology. In the words of DRP officials, "it is uncertain whether the implementation of the current EMMP is an adequate way to address the environmental problems in La Oroya."

- Require an assessment of groundwater quality, especially to determine potential impacts of slag and arsenic deposits, and incorporate measures to remedy any groundwater problems in the EMMP.
- Verify and improve the quality of the monitoring and enforcement mechanisms to ensure compliance with environmental law.
- Require that the company develop a dispersion model[76] that includes geographical and meteorological conditions in order to determine the movement of the contamination plume and impacts both near and far from the smelter. The precision of the model should be verified by cross-referencing emissions and air quality data.
- Based on the dispersion model, reconsider the effectiveness of the monitoring stations and require installation of additional monitoring stations as appropriate. Also, a monitoring station should be established to serve as a true control and provide baseline data.
- Establish strict protocols for quality control, for all sampling and laboratory analyses. The quality control protocols and monitoring results should be reviewed and verified by independent auditors and by inspectors from the MEM.
- Require that the company report the monitoring data in electronic form, with graphs summarizing trends as well as brief explanations and analyses of the data to facilitate environmental oversight and control over the emissions from the complex.
- Initiate a monthly program of compliance reporting focused on maximum permissible limits and progress of EMMP implementation.

[76] The EPA short-term model for Industrial Complex Sources 3 (ISCST3) might be an appropriate dispersion model (EPA 1995 Guidelines on Air Quality Models (Revised) and Supplements, 40 CFR 51, Appendix W).

For the Company

- Prioritize and immediately implement the actions necessary to reduce atmospheric contamination generated by the complex to levels that are acceptable for public health.
- Completely enclose the concentrate and slag deposits. These are currently open to the air, and wind dispersal constitutes a significant source of contamination.
- Mitigate or remove contaminated structures inside the complex and in the city in collaboration with competent health authorities, making sure that the mitigation activities do not contribute to further contamination.
- Regularly clean public areas in the city (walkways, pavement, plazas, schools, and children's recreation centers).
- Continue and increase reforestation programs and replace contaminated materials with uncontaminated soils and green areas with the participation of the local population. All remediation must be undertaken with appropriate consideration for worker and public health.
- Expand the programs for nutritional support and hygiene assistance to all the children known to suffer from lead poisoning.
- Assist the State with relocating the population in critically contaminated areas until such time that the emissions from the complex have reached acceptable levels, as a means to prevent further unacceptable harm to human health.

For DIGESA

- Raise public awareness of the health problem in La Oroya, and share the results of the study on blood lead levels with local residents, municipalities, health authorities, and civil society organizations.
- Seek support from international organizations, for example the US EPA, that have experience with the technical modifications, necessary management plans, and supervision systems to control the contamination produced by smelters.
- Design and implement an Emergency Plan for Public Health Protection for the city of La Oroya and critically affected populations. This plan

should guarantee the protection of public health, and include remedial and preventive measures, to ensure that these problems do not recur.

- As part of this emergency plan, and in the absence of the plans that will be developed to comply with air quality standards, require that the company temporarily reduce production levels to ensure acceptable air quality levels in La Oroya.
- Identify areas with critical heavy metal contamination via a program of soil and dust sampling in La Oroya. This sampling should be used to help determine emergency response actions, which could include the relocation of residents from highly contaminated areas.
- Assess groundwater quality, paying special attention to contamination from the slag and arsenic deposits, but also considering potential contamination from toxic organic chemicals.
- Relocate the schools currently located in highly contaminated areas to safe areas, and take the necessary steps to provide transportation to and from school.
- Together with the company, implement a program of medical evaluation and monitoring for all residents of La Oroya, especially children and pregnant women. The goals of the program should be to attend to emergency situations and to prevent serious health impacts.
- In collaboration with the Ministry of Education, the company, and civil society organizations, implement environmental and public health education programs. The programs should inform the people about the environmental and public health problems in La Oroya, including the characteristics of the contaminants, the potential effects and symptoms of exposure to contaminants, routes of exposure, testing methods, and treatments, including means prevent and reduce both exposure and adverse health impacts.
- Create a process for the follow-up and control of the health and environmental policies for which the company is responsible. DIGESA, the Public Defender, CONAM, the Church, and other civil society organizations should participate in such a process.
- Implement a quality control regimen and audit the monitoring program implemented by DRP and MEM rather than implementing a parallel monitoring system. The regimen for quality control should include data validation, control procedures for sampling, the use of independently certified laboratories, and the taking and analysis of duplicate and split samples. It could also include the establishment of an independent monitoring station in La Oroya.

- Seek support from international organizations, such as CEPIS and the US EPA, that have experience with emergency plans to treat widespread lead poisoning.
- Initiate a monthly oversight program to ensure compliance with the maximum permissible limits, and verify appropriate implementation of the EMMP.

For CONAM

- Collaborate with DIGESA on the above actions.
  ßEstablish a monthly oversight program to monitor compliance with the maximum permissible limits and progress of EMMP implementation.
- Accelerate the design process, approval, and implementation of the air quality control Action Plan for La Oroya, in compliance with the Air Quality Regulation.
- Promote dialogue between public authorities, the company, the affected population, and civil society organizations to ensure implementation of the recommendations set forth here.

PART 2

Legal Analysis of Environmental Management Tools Applicable to the La Oroya Metallurgical Complex

I

The Environmental Mitigation and Management Program for the Mining and Metallurgical Industry

The energy and mining sector initiated a process for environmental mitigation in mining-metallurgy operations through the enactment of environmental protection regulations, via Supreme Decree number 016-93 EM on May 1, 1993. The regulation recognized the Ministry of Energy and Mines (MEM) as the government authority in charge of 1) establishing environmental protection policies for mining and metallurgy activities, 2) approving Environmental Mitigation and Management Programs (EMMP) and Environmental Impact Studies (EIS) and authorizing their implementation, 3) entering into environmental administrative stability agreements with owners of mining operations, and 4) overseeing the environmental impacts of mining activities. The regulations also established that owners of mining-metallurgical operations are responsible for emissions, discharges, and wastes generated by their facilities.

In addition to assigning these responsibities, the law articulated the environmental mitigation processes via two environmental management tools, the EMMP and the EIS. The EMMP (Spanish acronym is PAMA) is the environmental management instrument that applies to operations that existed when the environmental protection regulations went into effect An EMMP is defined as the program of actions and investments required to reduce or eliminate emissions and discharges so as to comply with the maximum permissible levels established by the authorities. Thus, advanced technologies and alternative processes are incorporated into existing mining/metallurgical operations via the EMMP. The EIA,[77] on the other hand, is the instrument that applies to new mining projects and to those that increase production or plant size by more than 50%. For exploration activities, Supreme Decree

[77] Art. 2 of the Regulations defines the EIS as the study that should be carried out for projects involving work on mining concessions, including processing, general labor, and mineral transport. The EIS should contain a description and evaluation of the physical, biological, socio-economic, and cultural aspects in the affected area. It should

number 007-99-EM[78] requires the presentation of an Environmental Assessment (EA) in place of an EIS. The two instruments are quite similar, with the only difference being that the approval process for an EIS includes a public hearing and comment stage, while the one for the EA does not.

REQUIREMENTS AND TERMS OF THE EMMP

The issues to address in the EMMP vary with the type of mining activity being conducted. (Table 8)

The deadline for EMMP approval or disapproval by the Director General of Mining (DGM) is a total of 120 days after submission, including endorsement from the Director General of Environmental Affairs (DGAA). Any observations or questions regarding the proposed PAMA must be issued within 60 days of submission. If no response has been received after sixty days, the EMMP is automatically approved.

According to Article 17 of the environmental protection regulations, the DGM can modify the EMMP via a Resolution from the office of the DGM, or in response to a request submitted by an interested party and supported by technical, economic, social, ecological, and environmental data. An officially-mandated modification may be put into effect up to twelve months after approval of the program. Modifications may not alter environmental mitigation activities that have required investments, capital acquisition or infrastructure works, if these will achieve compliance with the corresponding permissible contamination levels. The rejection and/or modification of an EMMP can be challenged before the Council of Mining as a final administrative recourse.

The EMMP differs from the EIS[79] in that there is no rule qualifying EMMPs as public documents and guaranteeing citizen access to the documents. This omission has caused access to EMMPs to be very restricted.

evaluate existing conditions (baseline data) and the capacity of the environment. It should also determine the type and magnitude of potential impacts and establish control measures to achieve development in harmony with the environment.

78 Environmental Regulation for Mining Exploration Activities, published Nov. 30, 1998.

79 Art. 11 of Legislative Decree 613 Environmental and Natural Resources Code recognizes that EISs should be accessible to the public, with the exception of information that would adversely affect the industrial and commercial property rights or personal safety of the operator.

Activity	Condition
Exploration for and/or mineral exploitation via open pit mining.	Gas, noise, and particulate emissions. Quality and flow of surface and ground waters. Alteration of aquifers. Slope stability. Ground instability. Soil and vegetation removal. Adequate disposition of waste materials. Disturbance of other land use in surrounding populated areas, during the mining activity. Others that could affect the property or the ecosystem.
Dredging operations	All of the above, and also measures to minimize the impacts on flora and fauna.
Earthmoving activities	Environmental contamination by dust, gas, and particulate matter. Contamination of surface waters due to leaks, spills, and metallurgical process effluents. Aquifer contamination by leaching of colored sustances, tailings, and slag. Contamination of soil, fields, and surface waters by wind transport of wastes discharged on land. Waste disposal.
Hydrometallurgical operations	Prevention of contamination stemming from solutions, spills, leaching, washing, and incomplete neutralization. Controls for pile stability, process solutions, wind erosion, and water runoff. Effective mitigation of: - Alterations in soils and vegetation. - Air contamination from particulate and gaseous emissions. - Contamination of surface and groundwaters. - Danger to wildlife and livestock from ponds.
Amalgamation operations	Prevent mercury contamination of soil and water. Prohibit the use of mercury in the gravimetric concentraction process. Installations should use amalgamators or retorts and sedimentation pools. Utilize measures to recuperate mercury.

Table 8. Issues to address in EMMPs for various mining-metallurgical activities.

Legal arguments support the citizen right to access EMMPs. The 1993 Peruvian Constitution generally recognizes the right to information that is public in nature. Similarly, Art. 13 of the CMARN (Environment and Natural Resources Code), which was enacted three years prior to the environmental protection regulations for mining-metallurgical activities, states that the authority can require an EIS for any ongoing activity. These have now been implemented in the form of the EMMP. Thus, Art. 11 of the CMARN which permits access to all EISs can be applied to the EMMP. Finally, court rulings such as SPDA *v.* MEM on *Habeas Data* recognize the citizen right to access this type of information.

One noteworthy aspect is that owners of existing mining/metallurgical operations can enter into legal and administrative stability contracts with the MEM based on the EMMP or EIS presented. Such contracts establish that during the mitigation or implementation stage, there will be no change to: 1) agreed deadlines; 2) the frequency of sampling and the sampling points; 3) the maximum permissible limits in effect at the signing of the contract; and 4) the fines and punishments provided in the mitigation regulations. The DGM is charged with verifying compliance with the contract every six months.

II

IMPLEMENTATION OF ENVIRONMENTAL MITIGATION AND MANAGEMENT PROGRAMS IN THE MINING-METALLURGY SECTOR

The Environmental Mitigation and Management Program (EMMP) was created to achieve the gradual application of environmental standards to mining operations in existence. The law sets different timelines for smelting, refining, and sintering processes. These programs are now in the implementation stage, and in most cases this is the last year in which to complete the program.

In the several years that have passed since the creation of the EMMP, it has become evident that there are implementation difficulties and regulatory deficiencies that weaken the EMMP as an instrument for environmental management. Without questioning its utility or the contribution the EMMP has made to environmental and natural resource protection, the following analysis presents a brief description of these difficulties or deficiencies from a legal perspective, and suggests solutions for overcoming these challenges.

LACK OF CITIZEN PARTICIPATION IN THE EMMP APPROVAL PROCESS

A major deficiency is the absence of citizen participation in the EMMP approval process as compared to that for the EIS. The EMMP document is not shared with the affected population, and observations, comments, or alternative proposals are not sought from the public. Because the EMMP approval process has not invited participation from local populations, the invaluable information these can provide with regard to the effective mitigation of environmental damage caused by ongoing mining activities has been lost.

Equal degrees of transparency and public input should be required in the EIS and EMMP processes to prevent discriminatory treatment of new mining operations that are subject to the EIS, as compared to the many decades-old operations subject to the EMMP. Citizens should have access to information about, and the opportunity to comment on, the obligations and mitigation measures established in an EMMP, the timeline for implementation, and any progress made. Such transparency will allow for public input that can contribute to improved quality of living and environmental health.

LACK OF OPTIMAL MONITORING SYSTEMS

Based on the experience with Doe Run Peru, the optimization of monitoring protocols at mining-metallurgical centers should be a priority. There is currently insufficient quality control for sampling and analysis, as well as instrument maintenance. In some cases, a review of the monitoring points may be needed.

LEGAL-ADMINISTRATIVE STABILITY

Another challenge is to better define the extent of the legal administrative stability afforded via the EMMPs. The stability granted by the EMMP is convenient insofar as it leads to completion of the goals stated in the program. Unfortunately, this stability has been interpreted as giving the mine owners an “untouchable” status. In reality, an EMMP does not necessarily cover all mitigation measures required to make the mining activity safe for the environment. During the implementation phase, serious impacts to health and the ecosystem can be generated as a result of factors that were not foreseen or incorporated into the EMMP. Full liability for these harms lies with the owners, and they should not be able to evade responsibility by pointing to the approval of the EMMP.

The EMMP grants administrative stability to those who comply with the obligations or mitigation measures for the production levels at which the EMMP was approved. If production increases, and contamination levels rise as a result, it would be logical to assume that the mitigation measures in the EMMP would be insufficient for mitigating the increased pollution. A mechanism for reevaluation of the EMMP should exist in such cases.

The regulations establish that owners must submit an EIS when production or plant size increases by more than 50%. This rule is inadequate because it is not sufficiently detailed. The plant size is very subjective and does not consider that a plant could include various facilities and processes that make it impossible to determine what constitutes a 50% increase. The requirement for presenting an EIS should be determined by the amount of risk produced by the increase. Because the purpose of the regulation is to control health and environmental risks, it would be appropriate to establish a

risk matrix to determine the need for an EIS. Moreover, total growth must be considered as compared to the date of PAMA approval, to insure that significant production increases do not occur over time as a result of many smaller increases, thus evading the requeirement for presenting an EIS.

LACK OF CITIZEN PARTICIPATION IN THE EMMP MODIFICATION PROCESS

The absence of citizen participation – public hearings or consultation – in the process of EMMP modification is another deficiency. Neither the environmental protection regulations nor the complementary rules governing the EMMP mention the possibility that the affected population would be informed of the modification proposal, much less that they be given the opportunity to state their concerns, doubts, or observations.

For example, AIDA and the SPDA reviewed the “PAMA Modification Proposal” presented by DRP to the MEM in December of 1998. The groups sent DRP comments and questions on both the positive and negative aspects of the proposal, and requested further information. The groups also submitted the analysis to MEM to highlight concerns raised by some of the proposed modifications, and requested that the affected citizens be allowed to intervene and become part of the administrative approval process for EMMP modification.

In this case, AIDA and the SPDA pointed to inappropriate deadlines and the lack of technical grounds for some of the proposed modifications. We also called for greater participation from public authorities such as CONAM and DIGESA and civilian representatives of the population potentially affected by the development of activities in the jurisdiction. The necessity of holding a public hearing to allow different points of view to be heard and contribute technical support to the prosal, was reiterated. Unfortunately, the observations and suggestions presented by AIDA and the SPDA were not accepted, and the modification of the EMMP for DRP was approved.

III

SPECIAL ENVIRONMENTAL MANAGEMENT PROGRAMS – SEMPS

On July 21, 2001, Supreme Decree number 041-2001-EM established the Special Environmental Management Program (SEMP). This new instrument permits owners of mining, hydrocarbon, or electricity generating facilitites who have not complied with their EMMP or Closure or Abandonement Plans, to request authorization to present a SEMP for projects or activities that could not be executed due to an accident or act of nature. Requests are directed to the DGM or the Supervisor of Energy Investment (OSINERG), as appropriate. The SEMP must be supported on technical, economic, ecological, environmental, and social grounds. It should also contain a timeline for actions and investments for project implementation, a monitoring program, and emission and effluent controls. This special program is presented to the DGAA following approval by the DGM. The DGAA may approve or reject the SEMP within 60 days; failure to act within 60 days leads to automatic approval.

It is troubling that this regulation contains no defined deadlines for SEMP implementation. Rather, the DGAA may freely set terms longer or shorter than those fixed for the EMMP (5 to 10 years). Thus, the authorities in charge could easily use the SEMP to postpone indefinitely requirements for environmental mitigation at certain facilities.

Another disconcerting aspect of the SEMP regulation is Article 8, which establishes that a "resolution that approves or denies the EIS, PEIS (preliminary environmental impact statement), EA, SEMP, Plan of Closure or Abandonment, its extension or modification, and EMMP modification, can be challenged by the owner of the mining operation, or by those with a legitimate, direct, personal, current, and proven interest before the Mining Council, within 15 days of official notification" of the resolution. This article recognizes only the right of an owner or a third party with a demonstrated direct personal interest to challenge the approval or denial. It fails to recognize and is inconsistent with existing Peruvian administrative law that acknowledges the protection and support of diffuse interests, and specifically permits any person to present a petition or challenge for the protection of the environment and public health, in representation of the public interest.

Similarly, Peruvian civil law allows for the participation of third parties in civil processes for the protection of diffuse interests. Art. 82 of the Code of Civil Procedure defines a diffuse interest as one whose ownership corresponds to an indeterminate group of people, with respect to rights of incalculable value such as the defense of the environment, cultural rights and consumers' rights. Thus, although the SEMP regulations purport to restrict the participation of third parties that are not directly affected by the approval or denial of an EMMP, SEMP, or EIS, the current procedural laws in fact allow open access to the administrative justice system in these cases.

An additional weakness concerns the time limit on challenges. According to the law, the deadline is 15 days from notification of parties to the process. Obviously, this necessarily implies prior recognition from the authorities of a legitimate third "party" in the administrative process. However, the rule does not consider those cases in which legitimate third parties are unaware of the existence of these administrative SEMP approval processes. This problem is considerable given that there is neither a mechanism for public participation in these processes nor a rquirement to make the information public. It is thus in most cases impossible for legitimate third parties to have prior knowledge of the administrative process. The result is that their right to recourse and protection under the law is severely limited. For this reason we suggest that public consultation and participation be incorporated into the process. The initiation of such processes, and the approval or rejection of programs, should be publicized in the most widely circulated national and local newspapers and other media including the radio, to guarantee participation of affected communities in the consultation process.

IV

AIR QUALITY STANDARDS (AQS)

After approximately two years of work by the Air Technical Environmental Study Group (GESTA) the National Standards for Environmental Air Quality in Peru were finally approved on June 24, 2001.[80] The GESTA, which was created and facilitated by the National Environmental Council (CONAM), was charged with developing a consensus proposal for air quality standards, and designing a strategic program for implementation. These primary air quality standards have the stated objective of preventing risk to human health. They were created as the result of an intense struggle between public and private entities. The priority zones for implementation of the AQS are: Arequipa, Chiclayo, Chimbote, Cuzco, Huancayo, Ilo, Iquitos, La Oroya, Lima, Callao, Pisco, Piura, Trujillo and Cerro de Pasco.

Standards were approved for the following contaminants: sulfur dioxide (SO2), particulate matter with a diameter less than or equal to 10 micrometers (PM10), carbon monoxide (CO), nitrogen dioxide (NO2), ozone (O3), and lead (Pb). A standard for hydrogen sulfide (H2S) and an annual average standard for lead were also proposed by some members of the GESTA, but the final regulation provided that these should be established within a period of 15 months from the date of publication of the AQS, based on epidemiological studies and continual monitoring. These studies were to be conducted according to terms of reference developed by the GESTA and approved by the Transector Environmental Commission (a commission composed of the Viceministers of State that form part of the organizational structure of CONAM).

Particulate matter with a diameter of 2.5 micrometers or less (PM2.5) was only regulated as a reference value to be monitored for a correlation with PM10. We believe that there is already sufficient information to justify the regulation of PM2.5 via an AQS.

[80] Supreme Decree 074-2001-PCM, published June 24, 2001.

It is important to note that the AQS are not obligatory or enforceable. Article 8 explicitly states that no administrative or judicial authority may sanction a juridical person based on the AQS. The regulation further clarifies that the AQS are obligatory only for the design and application of environmental policies, and for general public policies, plans, and programs. In other words, the AQS do not determine whether an activity is legal or illegal. They merely serve as references for different sectors of the State to use in developing plans or investment programs or authorizing or rejecting an activity. The regulation does allow for enforcement of the maximum permissible limits of geseous and particulate emissions, the action plans for air quality improvement, air quality monitoring requirement, the EIS, and others.

Lastly, it is significant that it is not known how many years smelters such as the one in La Oroya will have to comply with the maximum permissible limits. The smelter need not comply with any such limits until 2006. Further, the maximum permissible limits do not yet exist, but rather are to be established as a consequence of the AQS regulation. Therefore, the risk of significant delays in the adoption of the control technology required to decrease contamination from the metallurgical complex is substantial. Until this contamination is reduced to acceptable levels, the grave health harms to the local population will continue.

APPENDICES

Appendix 1

HEALTH EFFECTS OF SULFUR DIOXIDE (SO_2)

Sulfur dioxide (SO_2) initially gained notoriety for its indirect effect on human health through acid rain. Scientists identified acid rain as the main cause of destruction of agricultural lands, deterioration of archeological treasures (the Taj Majal, the Pantheon, Westminster Abbey, the Cathedral of Cologne, the Cathedral of Notre Dame, and countless statues around the world), acidification of surface waters and soils, and wildlife extinction. Although many governments implemented internal policies to reduce atmospheric SO_2 contamination in the 60's and 70's, a comprehensive international treaty to deal with acid rain was not developed until 1979, when 44 countries representing diverse economies and governments signed the 1979 Convention on Long Range Transboundary Air Pollution.

Policies aimed at reducing the concentrations of SO_2 and other air pollutants were originally motivated by the desire to protect the environment. Now, however, the important direct impact of SO_2 on public health is known. It is necessary to reduce SO_2 emissions in many countries to protect human health, specifically the respiratory and circulatory systems.

RISK ASSESSMENT OF SO_2

A risk analysis consists of four stages: hazard identification, dose-response, exposure assessment, and risk characterization (Table A1.1). Hazard identification is the initial appraisal of whether a substance might adversely affect public health. The process draws on epidemiological studies and clinical trials to predict the effect that the contaminant will have at given concentrations.

SO_2 HAZARD IDENTIFICATION

Epidemiological studies indicate that SO_2 presents a serious health hazard. High concentrations of SO_2 correlate with premature death, chronic

Hazard Identification	A review of biological and chemical studies to determine whether an agent presents a carcinogenic risk or if the toxic effects of a determined dose will occur in other doses.
Dose-response	Evaluation of the relationship between dose and response or adverse health effects from the administered dose.
Exposure Assessment	The determination or assessment (qualitative or quantitative) of the magnitude, duration, and route of exposure.
Risk Characterization	The final step in estimating public health risk by providing a score to define the significance of the risk.

Table A1-1. The four steps of risk assessment, *taken from J.M. Samet, "Risk Analysis and Atmospheric Contamination" in* *Atmospheric Contamination and Health, p. 883.*

respiratory illness, greater hospital admissions, aggravation of asthmatic symptoms, more days of restricted activity, and acute respiratory symptoms. Clinical studies have also revealed reduced pulmonary function and bronchial clearance rates from exposure to SO_2.

SO_2 DOSE-RESPONSE STUDIES

Epidemiological studies from various US cities indicate a significant change in mortality with elevated SO_2 concentrations. An EPA investigation demonstrated a clear increase in mortality with higher concentrations of SO_2, with five studies reporting an increase of 0.3% to 1.4% mortality per ug/m^3 of SO_2.

While the elderly are most vulnerable to premature death as a result of atmospheric SO_2 pollution, the majority of non-fatal respiratory complications from SO_2 exposure occur in asthmatics. Asthmatics suffer from narrower airways than other people (Figure A1-1), making them more vulnerable to the inflammatory effects of pollutants and the obstructive nature of particulate matter. Clinical studies show that asthmatic adults suffer from respiratory difficulties with short term SO_2 concentrations of 450 ug/m^3, and asthmatic adolescents have similar reactions to concentrations as low as 68 ug/m^3.

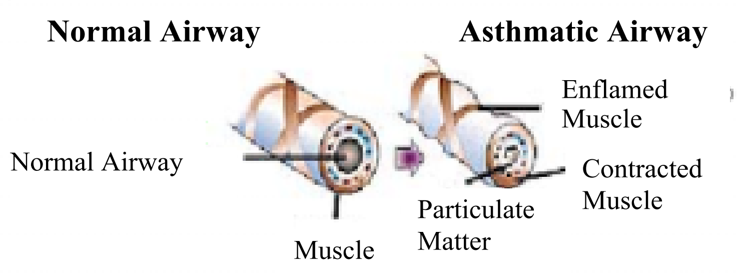

Figure A1-1. Differences between normal and asthmatic air passages. *Figure adapted from Healthy Way: the Health Journal.*

Animal studies have demonstrated that exposure to SO_2 at 160 ug/m^3 for longer than two years produces severe pulmonary damage and reduced airflow in the respiratory system. Reduced bronchial clearance was demonstrated in both rabbits and donkeys exposed to similar concentrations.

SO_2 EXPOSURE ASSESSMENT:

Sulfur dioxide exposure primarily occurs via inhalation. The SO_2 enters the respiratory system through the airways. When respiration occurs through the nose, the SO_2 particles enter through the nasal cavity, then pass through the pharynx and the larynx (upper respiratory system). Eventually they reach the trachea, the bronchial tubes, and the lungs (lower respiratory system). In the upper respiratory system, the highly soluble SO_2 particles are easily absorbed by the mucous membranes. The absorption of SO_2 is facilitated by the cilia, hairlike projections that line the epithelium to protect against infection. One epithelial cell typically has approximately 200 cilia.

In the absence of noxious agents, the cilia form a mucus escalator moving particles trapped in the mucus away from the lungs and up to the pharynx, where they are eventually swallowed The coordinated movement of the cilia normally keeps the mucus moving at 10 mm/min in the trachea and the upper respiratory system. Once harmful particles enter the digestive tract, they are rapidly expelled from the body. The mucociliary transport system is the respiratory system's first line of defense against potentially harmful particles and is essential to pulmonary health. Exposure to SO_2, however, severely inhibits mucosal cilia mobility. With exposure to high concentrations or after significant duration, the cilia often die from epithelial damage. When this deciliation occurs, the respiratory organs become more susceptible to infection and existing infections become more serious.

If the concentrations of SO_2 are high enough to provoke deciliation, the mucous escalator shuts down. The cilia stop moving, allowing more particles to adhere to the epithelium and enter the lower respiratory system. Imagine a large number of people trying to descend an escalator that is going up. Normally, it is difficult for the people to get down such an escalator, but if it stops moving the people can descend much faster. This is what happens when SO_2 immobilizes the mucociliary transport system: bacteria and particles of other damaging material can move freely into the lower respiratory system. A high concentration of particles in the lower respiratory system overwhelms the capacity of the normal immunological response, causing illness and reduced respiratory volume. Failure of the mucous escalator is the biological mechanism commonly used to explain the strong association between chronic respiratory illness and high SO_2 concentrations.

Damage to the respiratory system caused by SO_2 is especially severe during intense physical activity, which causes panting and allows more particles to enter the lungs. When SO_2 particles reach the lungs, they present a much greater health risk by significantly diminishing the flow of air and making breathing difficult, especially for asthmatics. The combination of rapid breathing, deeper inhalation, and oral respiration can make SO_2 exposure during heavy physical activity particularly fatal.

SO_2 RISK CHARACTERIZATION

As mentioned above, sulfur dioxide presents a significant risk to public health. Airborn SO_2 particles enter the respiratory system via inhalation and destroy the primary immune response: the mucociliary transport system. Once SO_2 defeats the body's first line of defense, the particles accumulate in the lower respiratory tract. Maintaining a high respiratory volume is important for lung function, and the accumulation of particulate matter seals off airways to reduce volume. Asthmatics, children, and the elderly are particularly vulnerable to the consequences of high concentrations of SO_2. The desire to protect this significant segment of the population from the danger of SO_2 has prompted governments in many countries to reduce SO_2 emissions. The known routes of exposure and proven response to high doses require fast action to reduce the risk that SO_2 presents to public health.

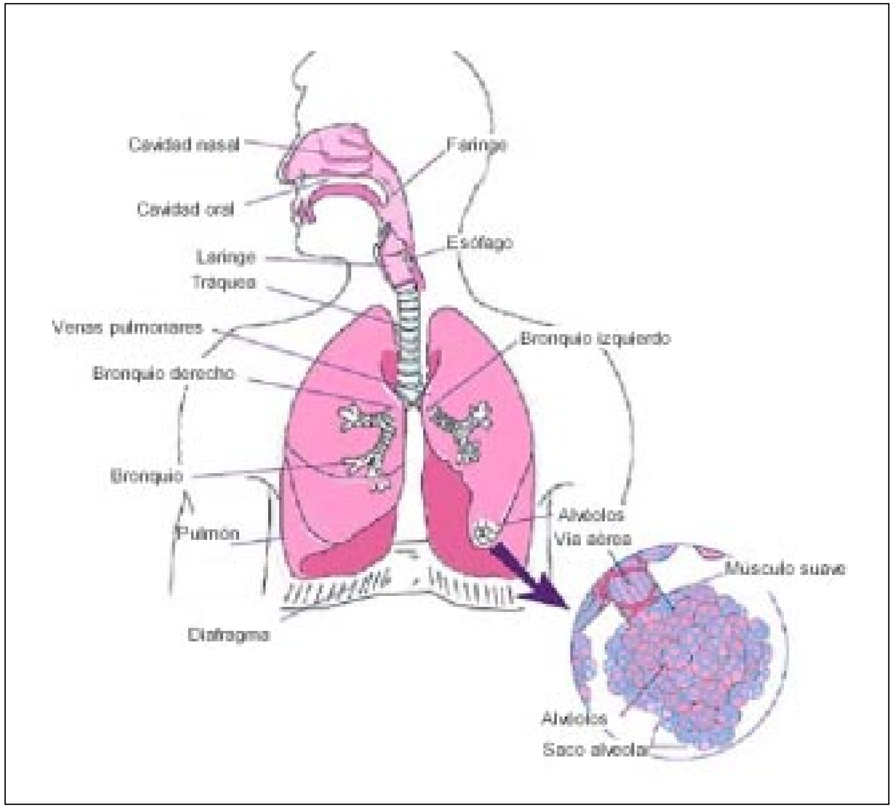

Figure A1-2. Anatomy of the human respiratory system. *Figure adapted from Methodist Health Care System.*

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Appendix 2

HEALTH EFFECTS OF CADMIUM

Human exposure to cadmium occurs by accidental ingestion and through inhalation of contaminated air. Exposure can also occur via skin contact with contaminated soil or trash. Because only a small quantity of cadmium is absorbed through the skin, the latter method of exposure is not a major concern.

Cadmium accumulates in smooth tissue like that found in the kidneys. Because it is an accumulative toxin with high retention in the body, exposure over a long period of time to low doses produces effects similar to those from exposure over a short period of time to high doses.

Reduced lung function is associated with chronic inhalation of low levels of cadmium. Bronchitis and alveolitis can occur, and respiratory illnesses such as emphysema have been observed in people whose work exposes them to cadmium.

Epidemiological studies of workers exposed to cadmium also suggest a possible tie between cadmium inhalation and lung and prostate cancer. Animal studies show that chronic inhalation of cadmium chloride leads to a higher frequency of lung cancer. There are no human or animal studies showing that oral or skin exposure to cadmium causes cancer. Based on animal studies, however, the EPA has classified cadmium as a probable human carcinogen when it is inhaled.

Some populations can be especially sensitive to cadmium exposure. People with dietary calcium and protein deficiency, kidney illness, and smokers are at a high risk for adverse effects of cadmium.

SUMMARY OF THE EFFECTS OF CADMIUM ON HUMAN HEALTH

- Lung damage and probable lung cancer
- Kidney damage
- Bladder illnesses

- Bone breaking and skeletal weakness
- Emphysema
- Chronic bronchitis
- Heart disease
- Anemia
- Depression of the immune system

Toxicological Profile of Cadmium, The Agency for Toxic Substances and the Registry of Diseases (Oct. 1991), *available at* http://www.atsdr.cdc.gov/toxprofiles/tp13.html.

Appendix 3

HEALTH EFFECTS OF ARSENIC

Arsenic exposure is widely associated with lung cancer. Studies of smelter workers have found a relationship between occupational exposure to arsenic and lung cancer mortality. Other forms of cancer attributed to arsenic exposure include non-melanoma skin cancer, cancer of the bladder, and cancer of the liver. In addition, acute human exposure to arsenic from inhalation can cause gastrointestinal effects such as nausea, diarrhea, vomiting, and abdominal pain, and central and peripheral nervous system disorders such as migraines, weakness, delirium, and loss of feeling in the palms or the soles of the feet. Arsenic can lead to skin problems including non-cancerous skin lesions, increased pigmentation, wart-like lesions on the palms or soles of the feet, and white lines on the fingers. Finally, oral exposure to low levels of inorganic arsenic has caused problems in the gastrointestinal tract (nausea and vomiting), the central nervous system, the cardiovascular system (hypertension and anemia), the liver, and the kidneys.

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Appendix 4

HEALTH EFFECTS OF LEAD

HAZARD SUMMARY

- Lead is a very toxic element that causes numerous effects at small dose levels.
- Brain damage, kidney damage, and gastrointestinal distress are caused by acute (short-term) exposure to high levels of lead in humans.
- Chronic (long-term) human exposure to lead impacts the blood, central nervous system (CNS), blood pressure, kidneys, and Vitamin D metabolism. Children are particularly sensitive to the chronic effects of lead, with slowed cognitive development, reduced growth and other effects reported.
- Effects on the reproductive functions, such as reduced sperm counts in men and spontaneous abortions in women, have been associated with lead exposure.
- The developing fetus is at particular risk from maternal lead exposure, with low birth weight and slowed postnatal neurobehavioral development noted.
- Human studies evaluating the relationship between lead exposure and cancer are still underway, but animal studies have shown an increased frequency of kidney cancer with lead ingestion. The EPA has classified lead as a Group B2 substance, a probable human carcinogen.

EXPOSURE ROUTES

Most lead studies discuss adverse health effects in terms of blood lead level rather than external exposure levels because exposure occurs via multiple routes; lead can be simultaneously ingested, inhaled, and absorbed through the skin. Exposure via inhalation generally contributes a greater proportion of the dose for occupationally exposed groups or those who live in very polluted environments. Oral exposure tends to contribute a greater proportion of the dose for the general population through contaminated dust and soil. Children normally ingest small quantities of soil (up to 200 mg per day) while playing, and children with the habit of ingesting non-food substances can ingest 5,000 mg of soil or more in a day. The health effects of lead are the same regardless of the exposure route.

HEALTH EFFECTS OF LEAD

Health Effects of Lead on the Children and Adults

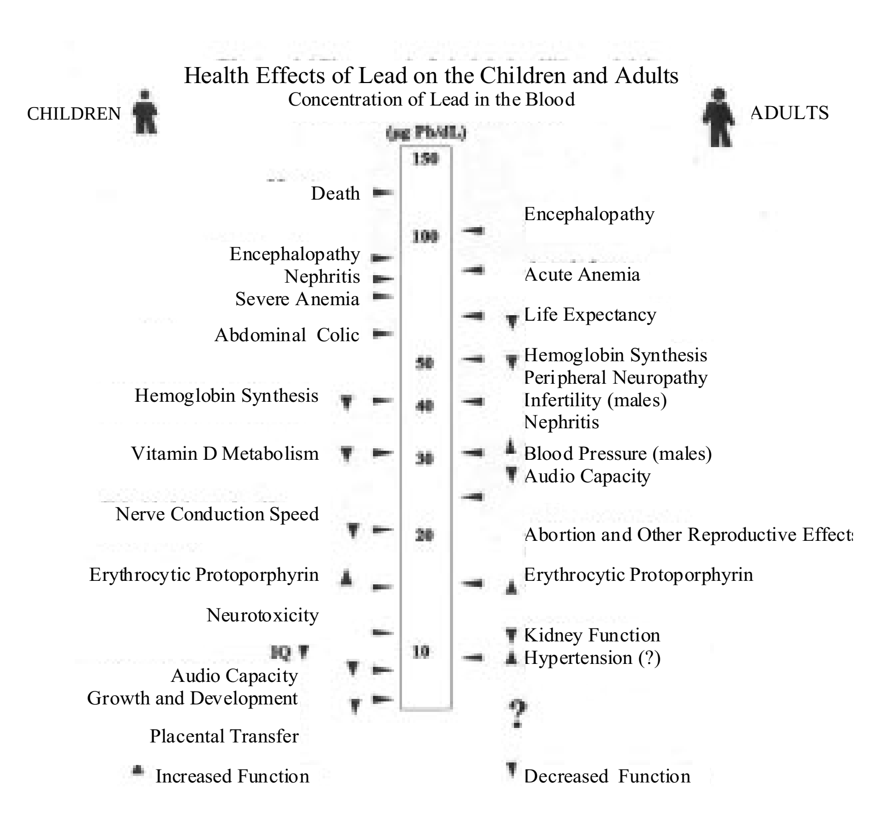


Figure A4-1. Health impacts correlated to blood lead levels in children and adults. *Figure adapted from "Blood Lead Study on Selected Populations in Lima and Callao," Environmental Health Project (EHP-USAID), Hernández-Avila M, Activity Report No. 72 (1999).*

ADVERSE EFFECTS ON LEARNING AND BEHAVIOR

Both animal and human studies have demonstrated that lead exposure can impair learning and behavior. Lead also affects the nervous system. Neurological symptoms have been reported in workers with blood lead levels of 40 to 60 µg/dL, and slowed nerve conduction in peripheral nerves in adults occurs at blood lead levels of 30 to 40 µg/dL.

SPECIAL DANGER TO CHILDREN

Children are more sensitive than adults to the adverse health effects of lead. Recent information has shown that delayed neurobehavioral development occurs in children with lead blood levels in the range of 10 to 25 µg/dl and in children whose mothers had blood lead levels in that range during pregnancy. There is some indication that adverse effects occur even from levels below 10 µg/dL.

Death from lead poisoning may occur in children who have blood lead levels greater than 125 µg/dL. Brain and kidney damage have been reported at blood lead levels of approximately 100 µg/dL in adults and 80 µg/dL in children. Gastrointestinal symptoms, such as colic, have also been noted in acute exposures at blood lead levels of approximately 60 µg/dL in adults and children.

The primary target for lead toxicity in children is the central nervous system. Blood lead concentrations of 10 µg/dL are associated with neurobehavioral problems, hearing impairments, and inhibited hemoglobin synthesis in children. Blood lead levels of 10-20 µg/dL have been shown to result in a 4- to 5-point decrease in Intelligence Quotient (I.Q.) and changes in children's brain activity. Blood lead concentrations greater than 33 µg/dL in children produce neurotoxic effects as well as decreased levels of Vitamin D in the plasma. Neurotoxic effects of lead are of great concern because they may be irreversible even after blood lead levels return to a normal level.[81] Recent studies have indicated that the adverse effects on the central nervous system persist into adulthood.[82]

81 *Preventing Lead Poisoning in Young Children.* Position Statement: October 1991. Centers for Disease Control (CDC).

82 "The Long-Term Effects of Exposure to Low Doses of Lead in Childhood: An 11-Year Follow-up Report." Herbert Needleman et al., New England Journal of Medicine 1990; 322: 83-88.

The Centers for Disease Control and Prevention in the United States has recommended therapeutic intervention at blood lead levels of 10 μg/dL. In addition, blood testing is recommended every three months for children whose blood lead level is between 10 and 14 μg/dL.[83]

REPRODUCTIVE EFFECTS

High levels of lead exposure can have effects on the reproductive system. Studies of male lead workers have shown severely depressed sperm counts and decreased function of the prostate and/or seminal vesicles with blood lead levels of 40 to 50 μg/dL. Both acute and chronic exposure can lead to these results. Occupational exposure to high levels of lead has long been associated with increased likelihood of spontaneous abortions and stillbirths in pregnant women. The lowest blood lead levels at which these effects occur, however, have not yet been established.

EFFECT ON BLOOD

Chronic lead exposure can cause changes in blood enzyme activity, hemoglobin synthesis, and altered motor activity.[84] Anemia has been reported in adults at blood lead levels of 50 to 80 μg/dL, and in children at blood lead levels of 40 to 70 μg/dL. Very little data exist concerning adverse effects associated with lead inhalation, but minor hematological changes have been observed in people after long exposure to concentrations of 11 $\mu g/m^3$.

CARCINOGENICITY

The US EPA has concluded that there are insufficient data to determine the potential carcinogenic effects of lead exposure. While human studies have been inconclusive, the EPA has classified lead as a possible carcinogen based on several animal studies. Four major human studies of workers exposed to lead have been conducted; two studies did not show an association between lead exposure and cancer, one found an increased incidence of respiratory

83 CDC, *supra* note 81.

84 *Toxicological Profile for Lead.* Agency for Toxic Substances and Disease Registry (ATSDR), (June 1990) *available at* http://www.atsdr.cdc.gov/toxprofiles/tp13.html.

tract and kidney cancers, and the fourth recorded increases in lung and stomach cancers.

MULTIPLE EXPOSURES

Information on the health effects of multiple contaminants is limited. The effects of multiple contaminants can be synergistic, or greater than the sum of the effects caused by exposure to each contaminant individually. Simultaneous exposure to contaminants that are known or probable carcinogens could increase the risk of developing cancer. Cadmium may act synergistically with lead when a person is exposed to both metals simultaneously. Increased mortality rates and behavioral changes have been reported in animal studies using both metals.[85]

85 *Id.*

instruments was not included in the quarterly reports to the MEM. Therefore, although it is assumed that the company performs maintenance on the equipment, it is not possible to verify whether the samples were taken and analyzed correctly.

Appendix 5

ENVIRONMENTAL MONITORING DATA PROVIDED TO MEM BY CENTROMIN AND DRP

In March 2000, when new air quality monitoring equipment began operating in the Cushurupampa, Huanchán, and Casaracra stations, all stations were fitted with new equipment. The DRP monitoring in 2000 consisted of the following:

- Using gas analyzers (Horiba), SO_2 concentrations were recorded every hour in parts per billion (ppb) at all stations 24 hours per day. Maximum and minimum values, hourly values, and daily averages, as well as corresponding monthly values from all stations, were reported to the MEM. Data on three-hour SO_2 concentrations were not reported, even though they were required by the Air Quality and Emissions Monitoring protocol of the MEM. Due to the majority of SO_2 standards being established in units of ug/m^3, it was necessary in some cases to convert the data from ppb to ug/m^3 before conducting a comparison with the international standards. This conversion should be adjusted for possible differences between standard temperature and pressure conditions (STP) and the conditions of the La Oroya monitoring stations (Appendix 6).
- The concentrations of Total Particulate Materials in Suspension were measured using low volume monitors (BAM 1020).
- Particulates with a diameter up to 10 um were monitored with high volume monitors (Graseby). The hourly averages were reported to the MEM with daily and monthly averages, maximums, and minimums. Before this time, the PM_{10} concentrations were recorded only at two stations.
- Atmospheric concentrations of heavy metals (Pb, As) were measured every three days, and these data were reported along with average, maximum, and minimum values. The concentrations of cadmium had also been measured in the past. For unknown reasons, DRP stopped reporting environmental concentrations of cadmium in September 1999.

Although required by the Air Quality and Emissions Monitoring Protocol, calibration and quality control information for the monitoring

Appendix 6

CALCULATION OF CONVERSION FACTOR FOR UNITS FROM PPB TO *U*G/M^3

Conversion from ppb SO_2 to *u*g/m^3 SO_2

1000 ppb = 1 ppm
1 ppm = 1 cm^3/m^3
STP = standard temperature and pressure = 1 atmosphere, 0 degrees Celsius

x *u*g/m^3 = 1 cm^3/m^3 (1 L/1000 cm^3)(1mol gas at STP/22.4 L)(64.059 g SO_2/1 mol SO_2)(1,000,000 *u*g/1 g)
Therefore, at STP, 2860 *u*g/m^3 = 1 ppm and 2.86 *u*g/m^3 = 1 ppb

To adjust this conversion factor without STP conditions, one should correct for altitudinal pressure differences and ambient temperatures.
New conversion factor = (2.86)(273.15/T)(P/P_0) where T is in Kelvin and P/P_0 is the ratio of atmospheric pressure.

Estimating the conditions for La Oroya, we assume an average daily temperature of 14 degrees (287.15 K) and an altitude of 3700 m (P/P_0 = 0.6464).

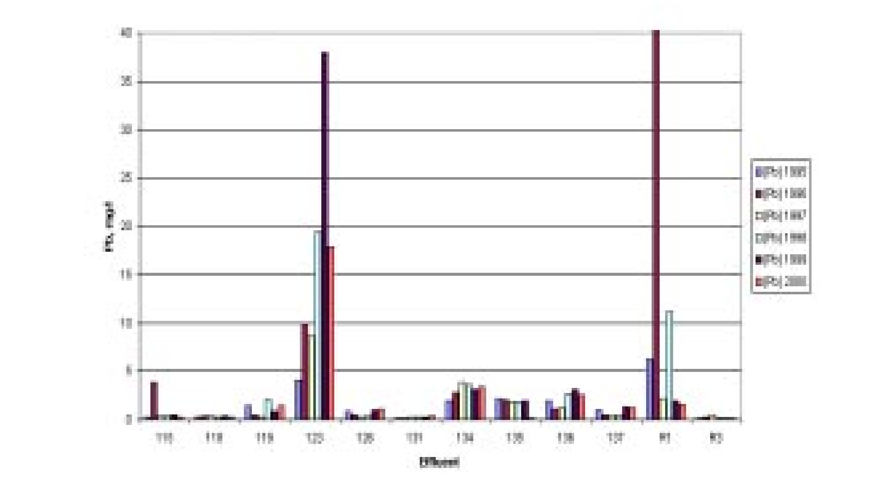
Therefore the approximate conversion factor for the La Oroya conditions is (2.86)(273.15/287.15)(0.6464) = 1.76.

For the purpose of this analysis, the following conversions were used:

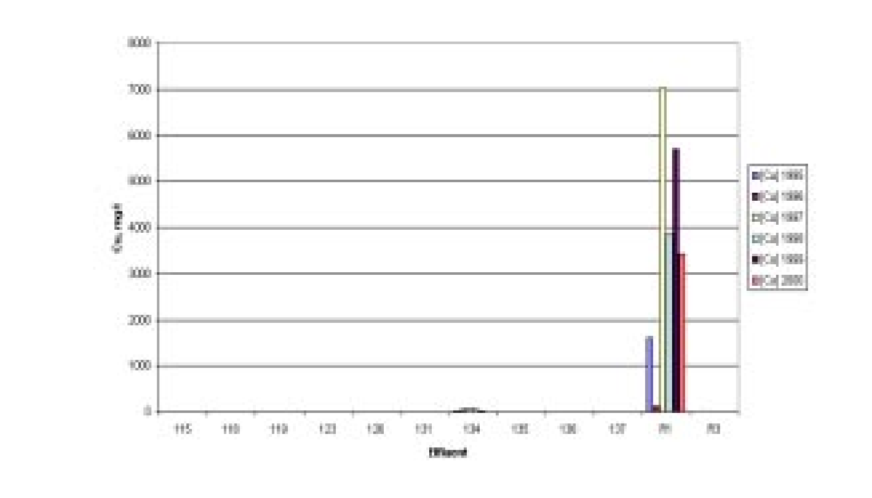
To convert values from ppb SO_2 to units of *u*g/m^3, multiply the value in ppb by 1.76.
To convert values from *u*g/m^3 SO_2 to units of ppb, divide the value in *u*g/m^3 by 1.76.

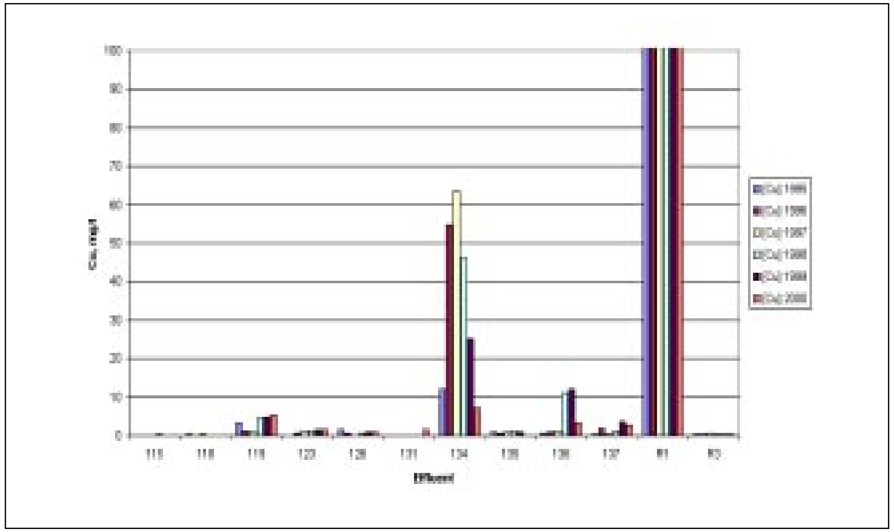
Appendix 7

CONCENTRATION OF CONTAMINANTS, LIQUID EFFLUENTS

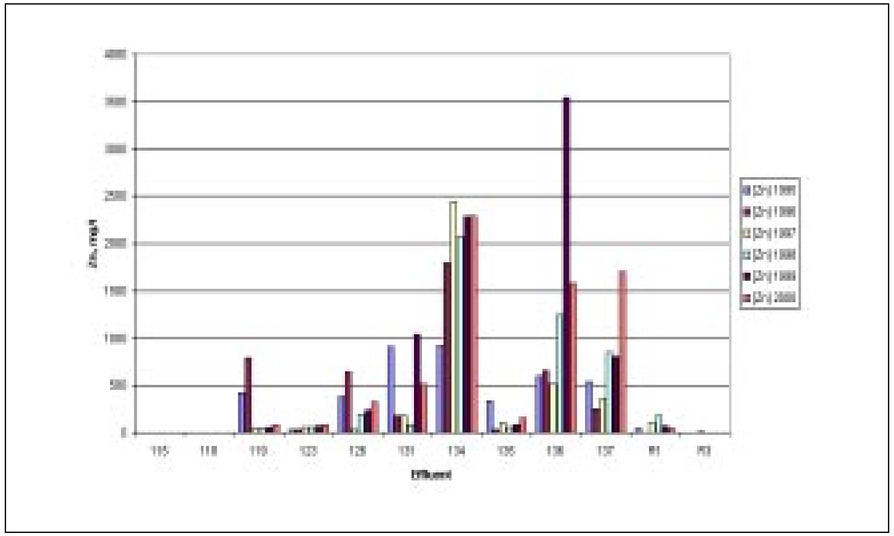


Graph A7-1. Lead concentration in the monitored effluents between 1995 and 2000. The MEM standard for a maximum annual average in a discharge is 0.2 mg/l. (The 1998 values are ten-month averages. The 1995 values are those reported in the EMMP.)

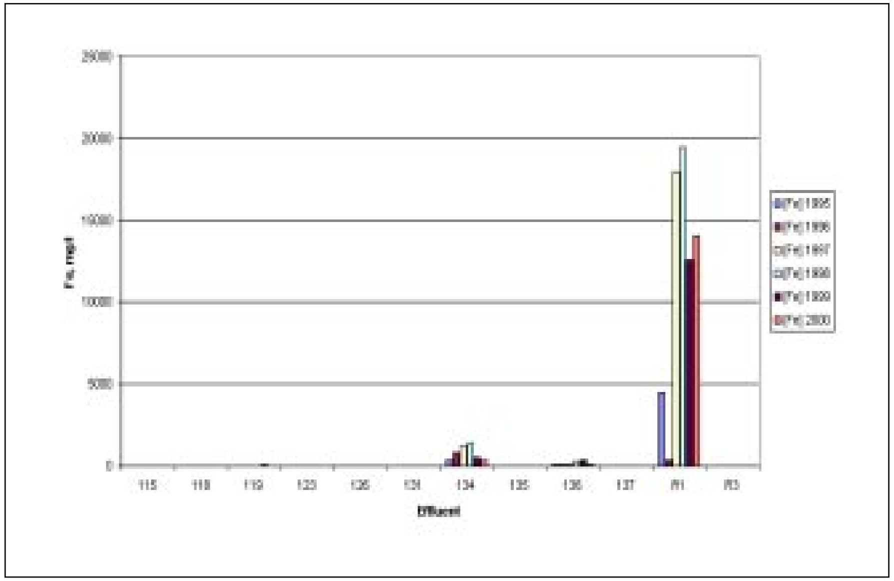


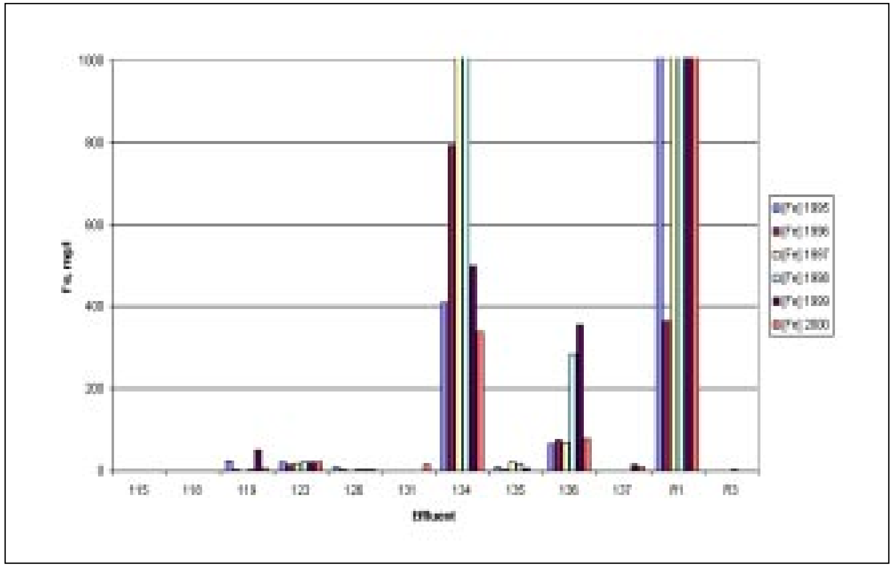


Graph A7-2 a and b. Copper concentration of monitored effluents between 1995 and 2000. The MEM standard for maximum annual average in a discharge is 0.3 mg/l. (R1 1998 concentration = 3856; R1 1995 concentration = 1602). (The 1998 values are ten-month averages. The 1995 values are those reported in the EMMP.)

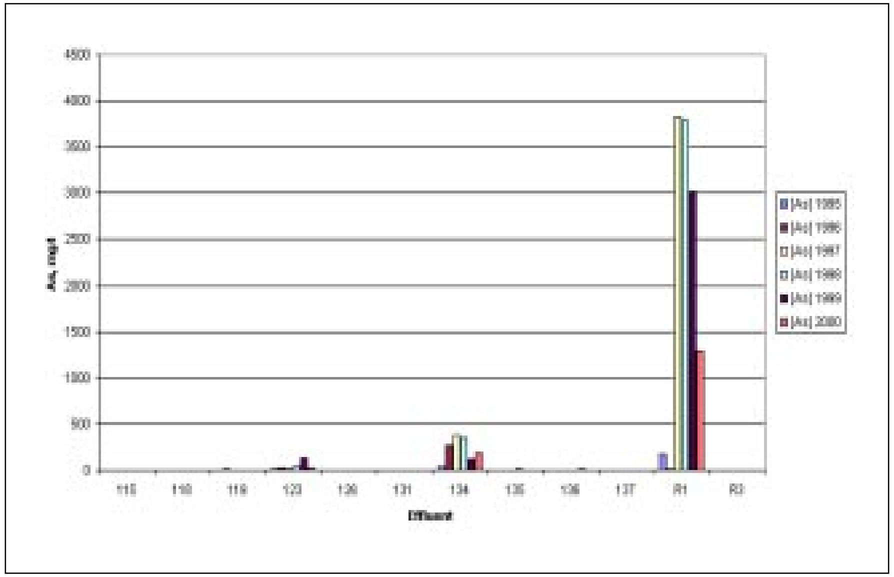


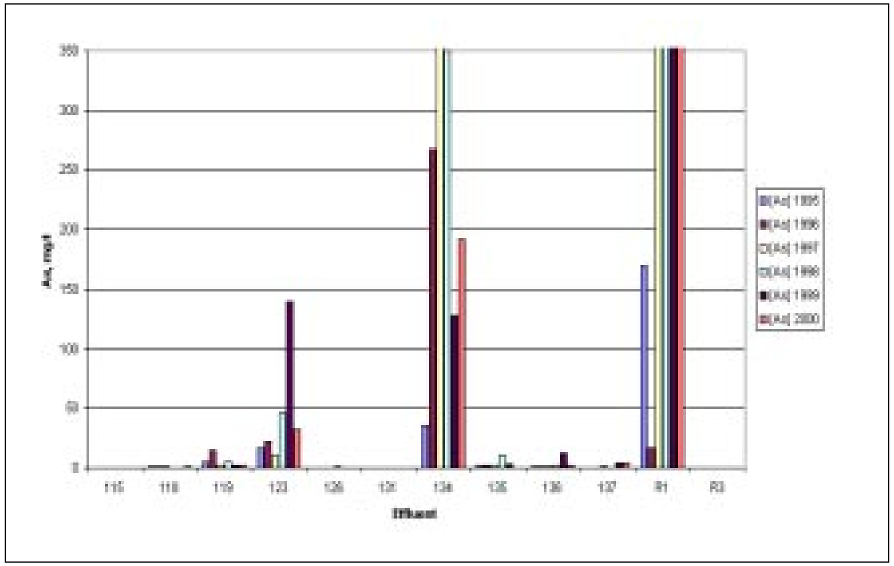
Graph A7-3. Zinc concentration in the monitored effluents between 1995 and 2000. The MEM standard for a maximum annual average in a discharge is 1.0 mg/l. (The 1998 values are ten-month averages. The 1995 values are those reported in the EMMP.)



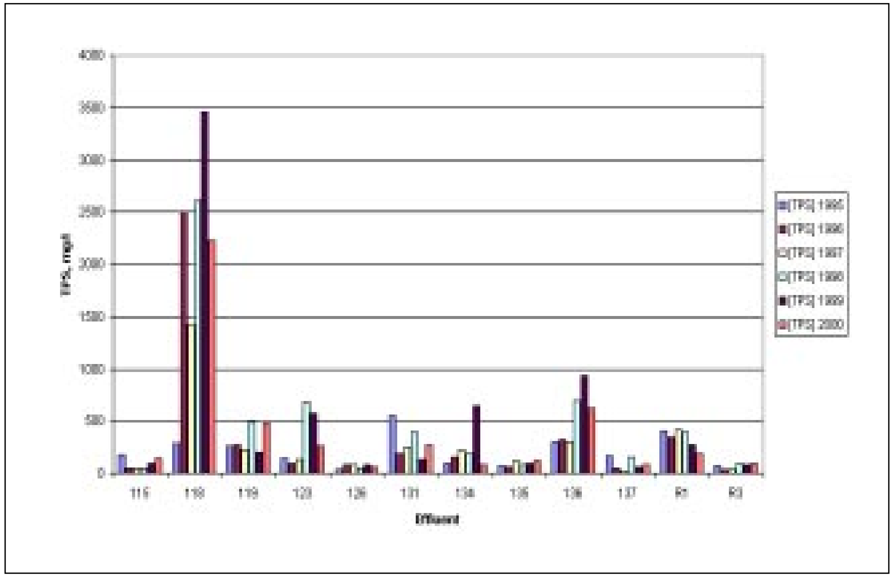


Graph A7-4 a and b. Iron concentration of monitored effluents between 1995 and 2000. The MEM standard for maximum annual average in a discharge is 1.0 mg/l. (R1 1998 concentration = 19,479). (The 1998 values are ten-month averages. The 1995 values are those reported in the EMMP.)





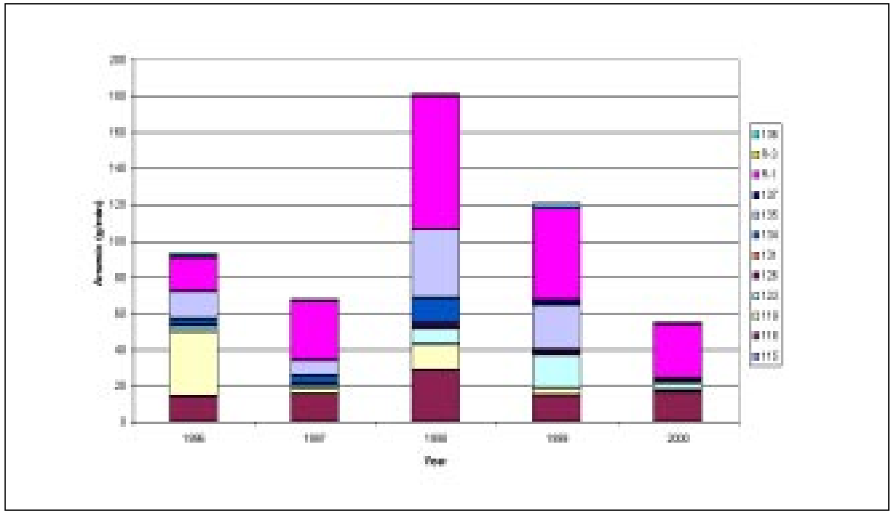
Graph A7-5 a and b. Arsenic concentration of monitored effluents between 1995 and 2000. The MEM standard for maximum annual average in a discharge is 0.5 mg/l. (R1 1998 concentration = 3780). (The 1998 values are ten-month averages. The 1995 values are those reported in the EMMP.)



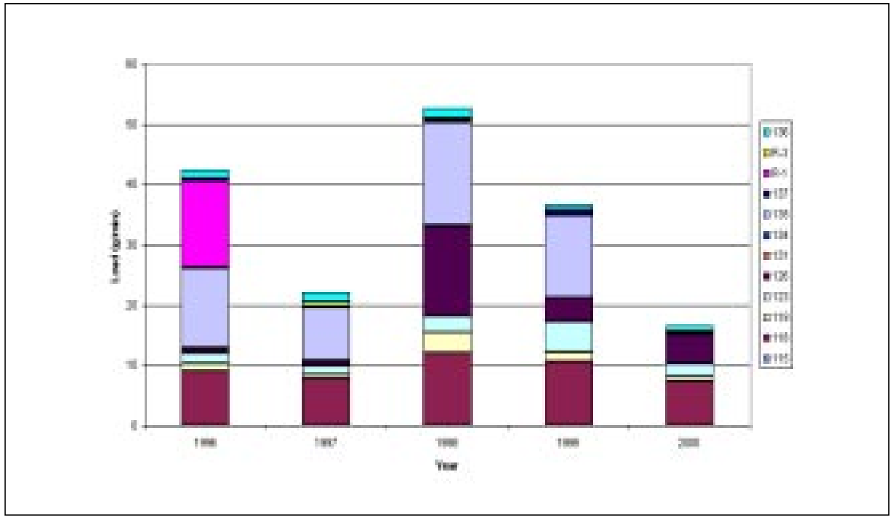
Graph A7-6. Total Suspended Particulates in monitored effluents between 1995 and 2000. The World Band standard for an average annual maximum is 50 mg/l. (The 1998 values are ten-month averages.) (The 1995 values are those reported in the EMMP.)

Appendix 8

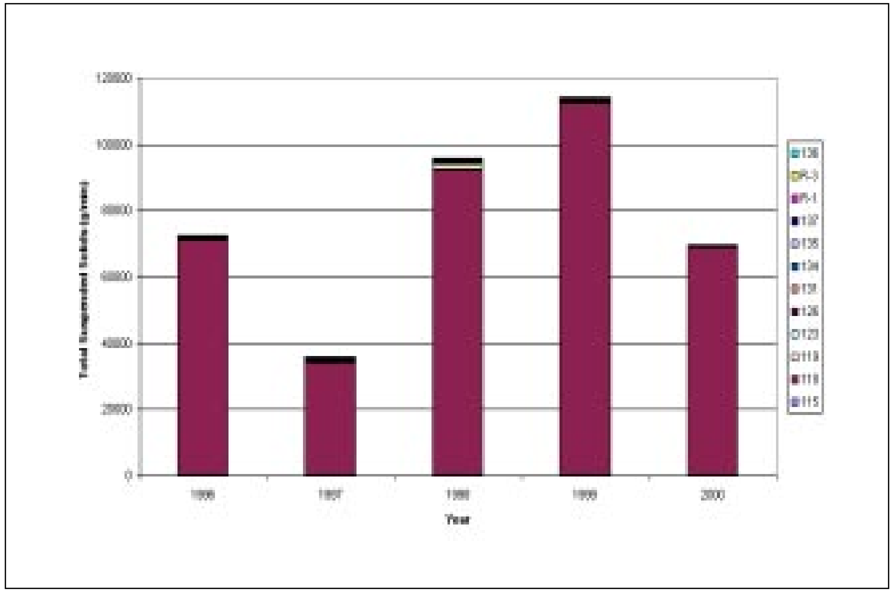
Total Discharge of Contaminants, Liquid Effluent



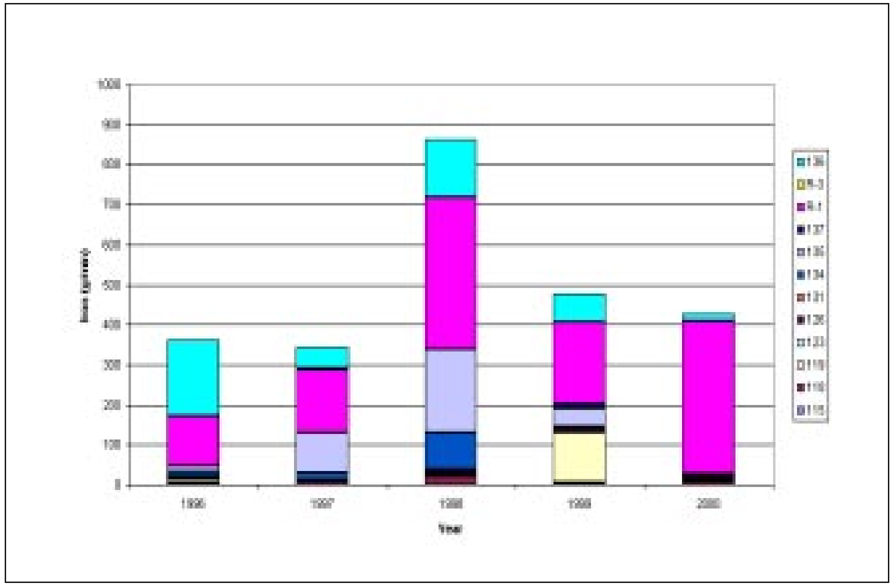
Graph A8-1. Total arsenic discharged in 12 effluent streams.



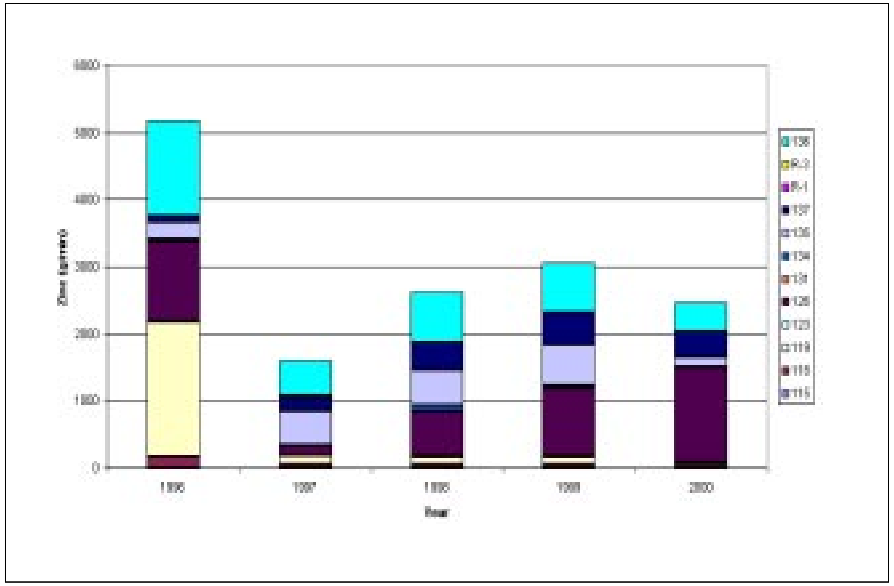
Graph A8-2. Total lead discharged in 12 effluent streams.



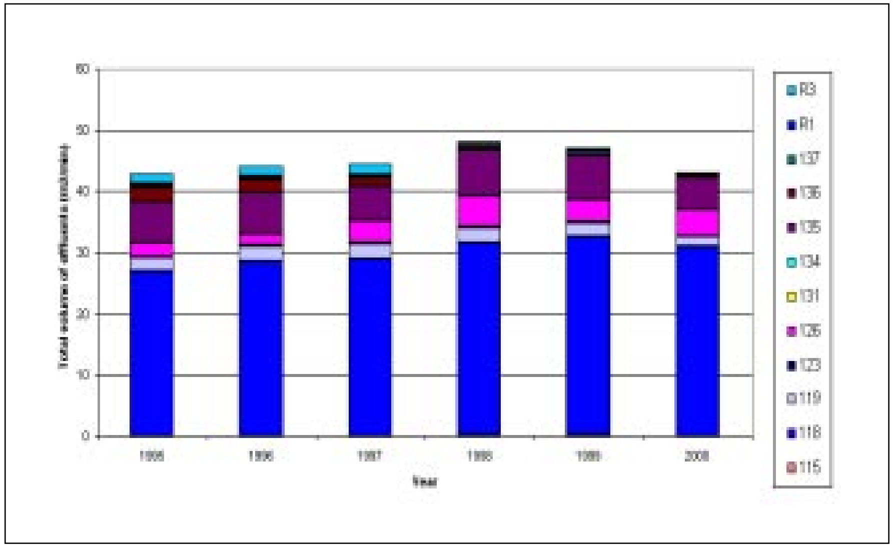
Graph A8-3. Total suspended solids discharged in 12 effluent streams.



Graph A8-4. Total iron discharged in 12 effluent streams.



Graph A8-5. Total zinc discharged in 12 effluent streams.



Graph A8-6. Total volume of effluent.

Investigator's references

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Alberto Barandiarán is an specialist lawyer in environmental law and legal actions. He holds a degree in law from Universidad de Lima. He is currently part of the Citizen Interest Defense Program for The Peruvian Society of Environmental Law (SPDA) since November 1998.

Before he had worked as independent lawyer, had co-founded a Legal Office in 1995, been there still September 1998. During that part of his professional work, he had worked as business, natural persons and public institutions assessor in: Trade, Corporative, Labour, Mining, Civil Law(Contracts and Obligations) and Administrative Law (Ministries, Councils, Decentralized Public Organisms, Public Institutions, others).

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