Environmental Characterization of Shoubra El Kheima Roads

Livelihood and Income from the Environment Program
Lead Pollution Clean-up in Qalyoubia

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ACRONYMS

Chemonics	Chemonics International
EEAA	Egyptian Environmental Affairs Agency
COPC	Chemicals of Potential Concern
COC	Contaminant of Concern
GOE	Government of Egypt
LIFE	Livelihood and Income from the Environment program
MSE	Millennium Science & Engineering, Inc.
QA/QC	Quality Assurance/Quality Control
PRG	Preliminary Remediation Goal
SAP	Sampling and Analysis Plan
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
XRF	X-Ray Fluorescence

SYMBOLS FOR METALS

As	Arsenic
Cr	Chromium
Pb	Lead
Sb	Antimony

UNITS OF MEASUREMENT

m	meter
m^2	square meter
$\mu g/ft^2$	microgram per square foot
µg/g	microgram per gram (parts per million)
µm	micrometer (micron)

EXECUTIVE SUMMARY

Industrial contamination from smelters in Shoubra El Kheima, Qalyoubia poses serious health threats to the people living and working near the former smelters. To address this problem, the United States Agency for International Development (USAID) and the Government of Egypt (GOE) designed the Livelihood and Income from the Environment Program's Lead Pollution Cleanup in Qalyoubia project (LIFE-Lead). The project is being implemented by Millennium Science & Engineering, Inc. in association with Chemonics International (MSE/Chemonics). The project has remediated seven secondary lead smelter sites, a copper smelter, two schools and a medical center. The project has recently extended its scope to provide oversight of the remediation of a lead battery assembly facility by the owner.

This report presents the environmental characterization of Shoubra El Kheima Roads located within a study area defined by a radius of 1.25 kilometers around the Awadallah Secondary Lead Smelter No. 1 and located north of the Ismailia Canal. The purpose of this characterization is to: (i) identify primary roads in Shoubra El Kheima that may need to be remediated; especially those leading to previously remediated sites; and (ii) delineate the extent of heavy metal contamination around previously remediated sites. The results of this characterization were also used in performing a Baseline Human Health Risk Assessment.

A total of 215 samples were collected from primary roads and secondary roads contiguous to the smelters remediated by the project and analyzed using the X Ray Diffraction Florescence instrument (XRF). These samples are categorized as follows:

- 124 bulk dust samples collected from primary roads in the study area.
- 91 bulk dust samples collected from secondary roads contiguous to remediated smelters.

All samples were collected and analyzed using internationally acceptable standards. The results of the analysis indicate the following:

- The Contaminant of Concern (COC) in the study area is lead. Arsenic, antimony, and chromium were detected at levels less than the limit of detection (LOD) of the XRF which are 15 µg/gm, 75 µg/gm, and 350 µg/gm; respectively. These levels are higher than the USEPA – Region 9 Preliminary Remediation Goals for arsenic (0.39 µg/gm), antimony (31 µg/gm), and chromium (210 µg/gm). Therefore, arsenic, antimony, and chromium are not included in the quantitative risk assessment, but are addressed in a qualitative manner.
- Analytical results of bulk dust samples collected from Road Nos. 1, 2, 4, 5, 6, and 8, revealed lead concentrations that are below the PRG.
- For the Ismailia Canal Street and for Road Nos. 3, 11, 12, and 13, lead was detected at concentrations exceeding the PRG in limited samples (ranging between 1 and 3 samples) along the entire length of the roads.
- For roads 7, 9, and 10, lead was detected at concentrations exceeding the PRG especially in samples collected from locations in the vicinity of previously remediated smelters.
- The majority of the samples that contain elevated levels of lead were obtained from sections of the roads that are contiguous to smelters. Therefore, these sections were considered as "hot spots".

- The horizontal extent of lead contamination in roads contiguous to remediated smelters has been delineated. Based on this delineation, the zone of lead contamination extends for a distance ranging between 50 and 350 meters in both directions from the smelter entrance.

A Baseline Human Health Risk Assessment was performed to evaluate whether there is significant health risk in the study area. This assessment showed that, considering hot spots, 75% of the children are expected to have blood lead levels greater than 10 µg/dl, which is higher than the USEPA standard of 5 percent.

Based on the results of environmental characterization of Shoubra El Kheima Roads, LIFE-Lead recommends the following:

- Roads 7, 9, and 10 should be remediated to reduce human exposure to lead.

- Remediate secondary roads contiguous to the smelters and for a distance of approximately 350 m in both directions to reduce human exposure to lead.

- Solid waste including hazardous materials should be collected and disposed of appropriately.

INTRODUCTION

Industrial contamination from smelters in Shoubra El Kheima, Qalyoubia poses serious health threats to the people living and working near the former smelters. To address this problem, the United States Agency for International Development (USAID) and the Government of Egypt (GOE) designed a lead cleanup component under the Livelihood and Income from the Environment (LIFE) Program. The cleanup project is called LIFE-Lead Pollution Clean-up in Qalyoubia (LIFE-Lead). The overall goal of the project is to empower local residents in the polluted communities to improve their living conditions.

LIFE-Lead is being implemented by Millennium Science & Engineering, Inc. in association with Chemonics International (MSE/Chemonics). To date, the project has remediated seven secondary lead smelter sites, a copper smelter, two schools, and a medical center, all located in East District of Shoubra El Kheima. The project is currently overseeing the remediation of a lead battery assembly facility that is being conducted by owner. In addition to site remediation, the project includes activities in community involvement and public participation, communications, capacity building, and policy/legal support.

In LIFE-Lead's continuing effort to reduce the potential exposure of nearby residents to industrial contamination, the LIFE-Lead project conducted an environmental characterization to: (i) identify primary roads in Shoubra El-Kheima that may need to be remediated; especially those leading to remediated sites; and (ii) delineate the extent of heavy metal contamination in primary and secondary roads contiguous to remediated smelters.

This report describes the activities and results of the environmental characterization performed for primary roads as well as secondary roads contiguous to the remediated smelters. The results will be used to conduct a Baseline Human Health Risk Assessment.

SAMPLING AND ANALYSIS PROCEDURES

All samples were collected in accordance with the Sampling and Analysis Plan (SAP) developed for this characterization. This plan was prepared in accordance with international standards and United States Environmental Protection Agency (USEPA) guidelines and protocols for bulk dust sampling. The purpose of this SAP was to provide guidance to the Project Team for the proper collection and analysis of the samples, and to establish quality assurance and quality control (QA/QC) procedures to be followed during the field activities.

Prior to initiating characterization activities, training was provided to the sampling team on all aspects of the sampling and analytical procedures, and safety requirements. The training consisted of both "classroom" discussions of the project requirements using the SAP for guidance, hands-on training with analytical equipment, and field training at the project site where all aspects of field operations will be covered.

The project has purchased a field portable X-Ray Fluorescence (XRF) instrument for sample analysis. The XRF analysis results were the basis on which this report was prepared. Bulk dust sampling was conducted at the smelter in February and March 2008.

Sampling Locations

The study area for this characterization is defined by a radius of 1.25 kilometers around the Awadallah Secondary Lead Smelter No. 1 and located north of the Ismailia Canal. Figure 1 illustrates the study area considered in this characterization as well as the locations of secondary smelters and sites remediated by the LIFE-LEAD project.

The environmental characterization included the collection of bulk dust samples from roads located within the study area. Specifically, the characterization activities included the collection of the following samples:

- Bulk dust samples from locations along primary roads in Shoubra El-Kheima.
- Bulk dust samples from secondary roads contiguous to remediated smelters.

Bulk Dust Samples along Primary Roads--

Primary Roads considered for this characterization are shown in Figure 2. It should be noted that the study area contains a number of primary paved and unpaved roads leading to the remediated sites. Therefore, the sampling approach was based on the nature of the road as described hereafter.

For primary paved roads (Road Nos. 1, 10, 11, and Ismailia Canal Street), samples were collected from locations where dust accumulations are noted along the road sides or where bare soil was encountered (judgmental sampling).

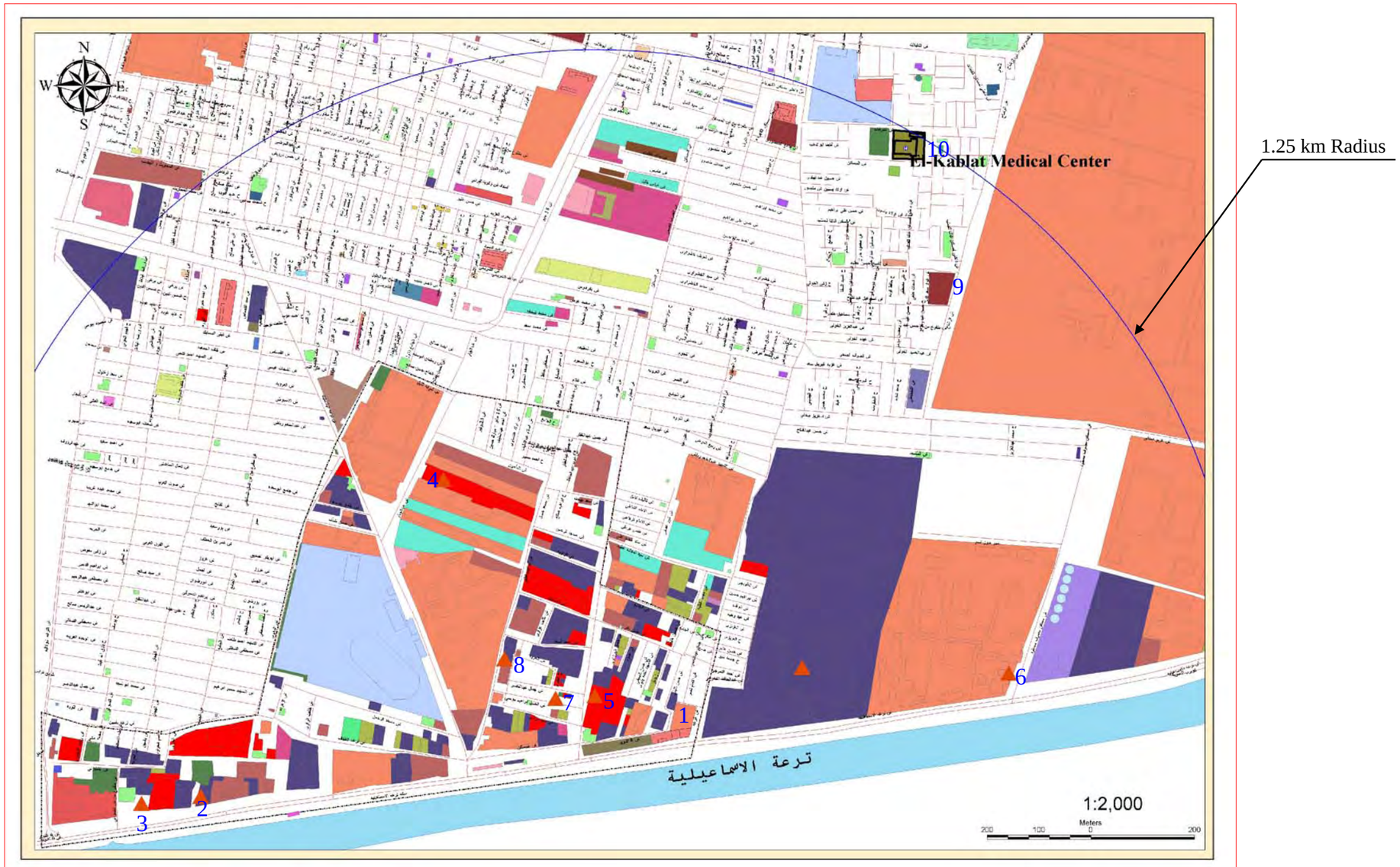
For primary unpaved roads (Road Nos. 2, 3, 4, 5, 6, 7, 8, 9, 12, and 13), bulk dust samples locations were selected by superimposing a grid pattern on each unpaved road. The size of the grid varied between 50 m in length by 7 m in width (equivalent to the width of the road) to 25 m by 7m depending on the total length of road. An example of grid pattern superimposed on an unpaved road is shown in Figure 3. Bulk dust sampling locations were randomly selected within the grid using a Research Randomizer program. A set of numbers (representing the grid numbers shown in Figure 3) was fed to the Research Randomizer program to select 10 sampling locations that provide the best distribution of sampling locations along each unpaved road as shown in Figure 4 (probabilistic sampling).

The sampling locations along primary roads are shown in Figure A-1 in Appendix A.

Bulk Dust Samples from Roads around Previously Remediated Smelters--

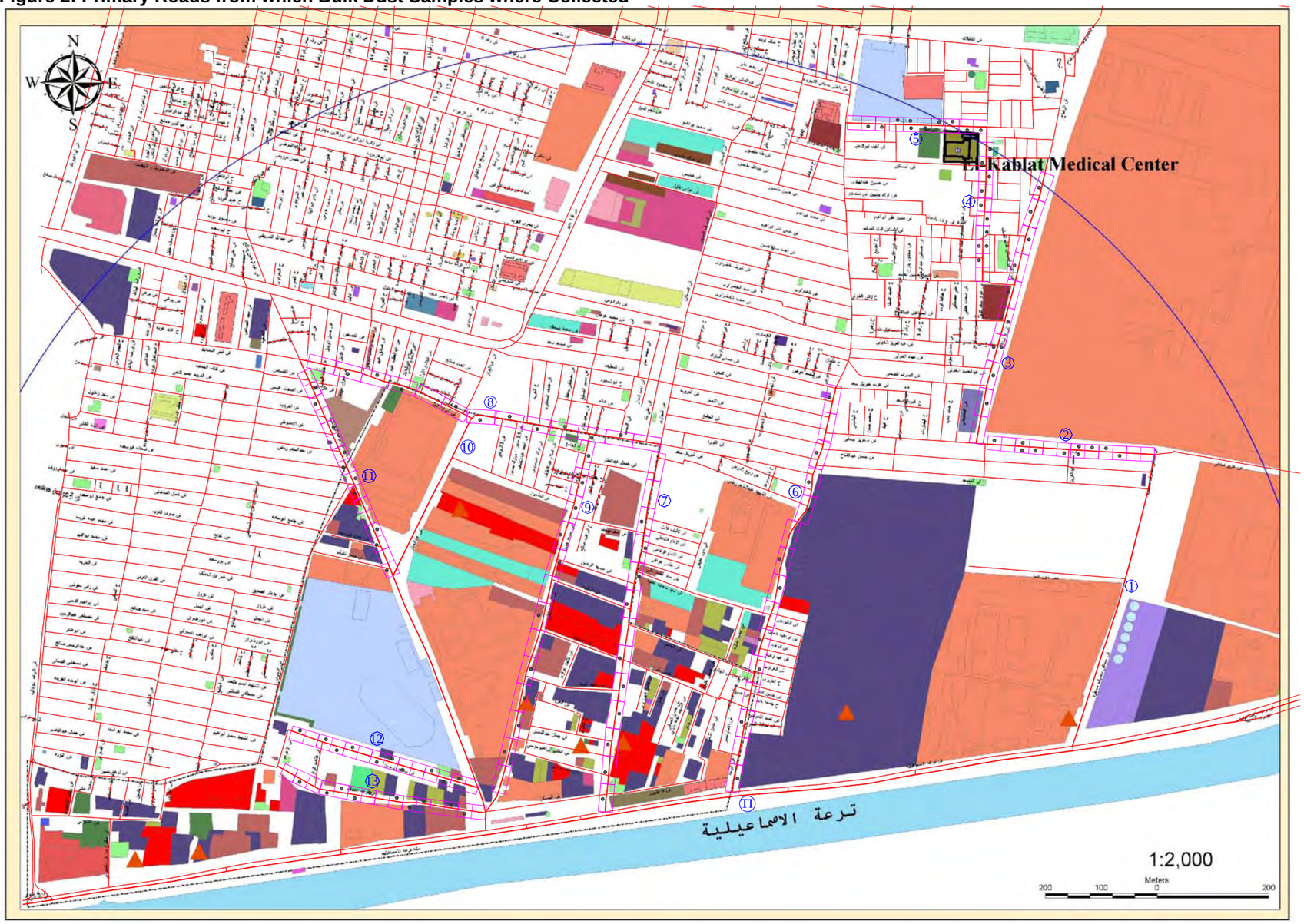
Bulk dust samples were collected from primary and secondary roads to identify the level and extent of lead contamination around remediated smelters. Specifically, sampling was conducted around Awadallah Smelter (AW) Nos. 1, 2, and 3, Seoudi (S), El Mahy, Osama Zakaria (OZ), and Khaled Saad (KS). Samples were collected at various distances and directions from the smelters and were field analyzed using the XRF device. The number and location of samples was field selected to adequately delineate the limits of the lead contaminated zone around each smelters (judgmental sampling). The locations of samples collected around each smelter are shown in Figures A-2 through A-8 in Appendix A.

Figure 1: Study Area for Road Characterization Showing Locations of Remediated Sites



1- Ahmed Shaalan School
2- Seoudi Secondary Lead Smelter
3- Awadallah 2 Secondary Lead Smelter
4- Awadallah 3 Secondary Lead Smelter
5- Awadallah 1 Secondary Lead Smelter
6- El Mahy Secondary Lead Smelter
7- Khaled Saad Secondary Lead Smelter
8- Osama Zakaria Secondary Lead Smelter
9- El Delta Solb School
10- El Kablat Medical Center

Figure 2: Primary Roads from which Bulk Dust Samples where Collected



Notes: Road Nos. 1, 10, 11, and Ismailia Canal Street (TI) are paved.
Road Nos. 2, 3, 4, 5, 6, 7, 8, 9, 12, and 13 are unpaved.

Figure 3: Grid Pattern for Unpaved Road

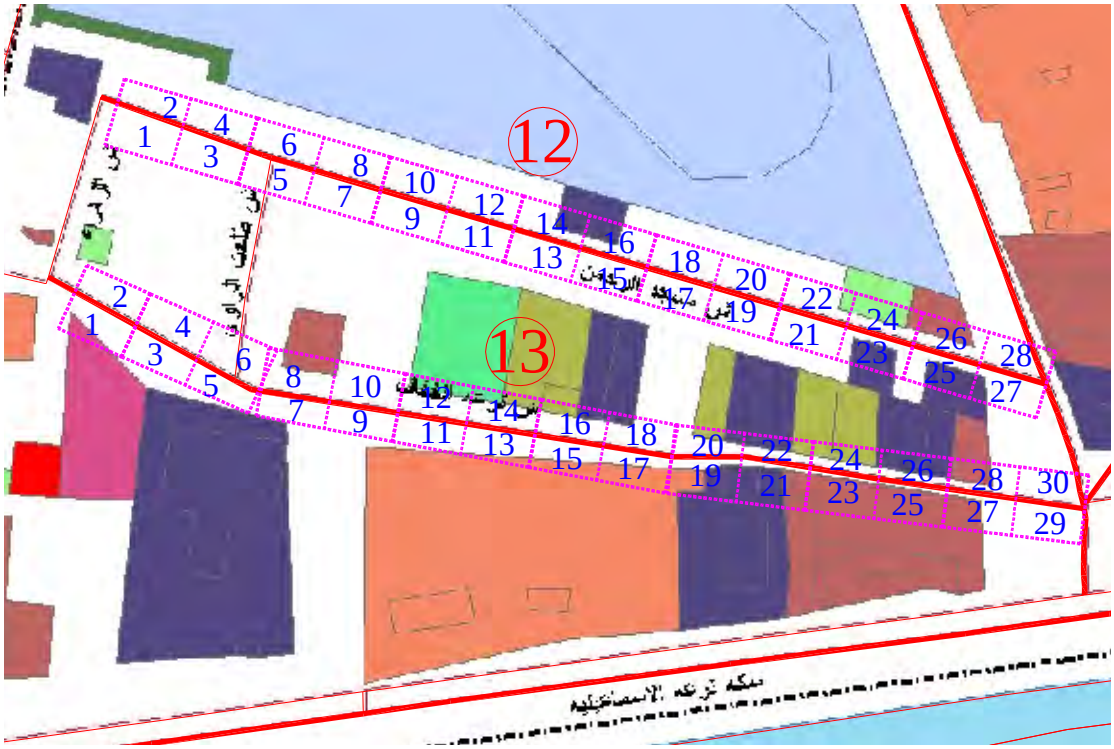
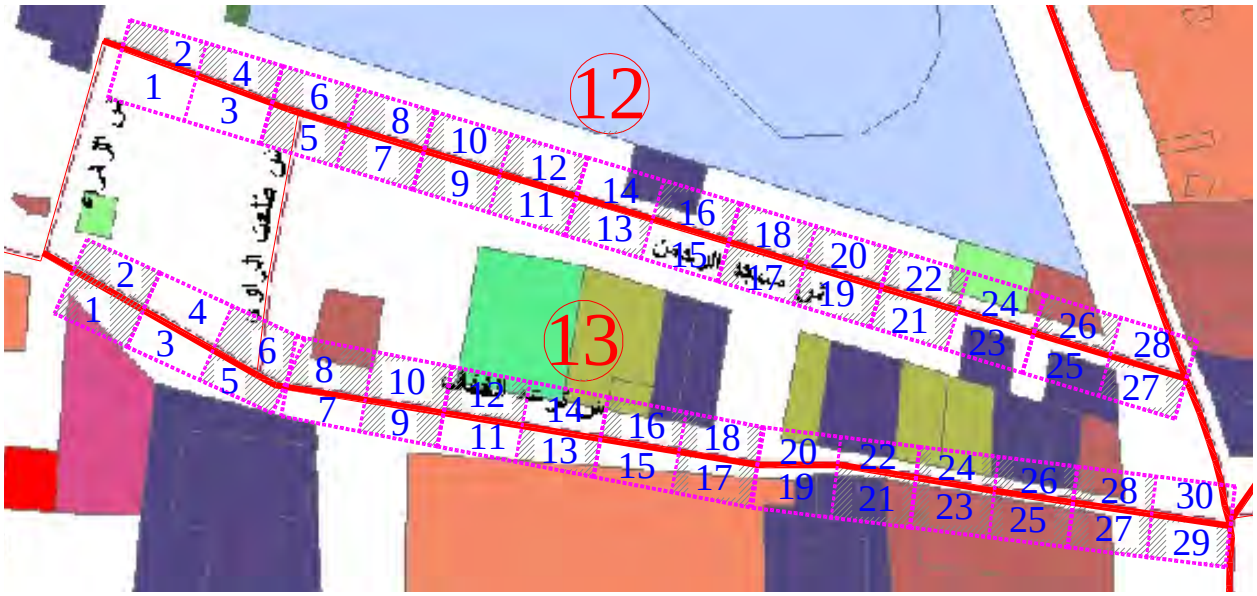


Figure 4: Distributions of Random Sampling Locations along Unpaved Road



Sampling Collection and Preparation Methods

Bulk dust samples were collected by spooning method using stainless steel sampling equipment. All samples collected for analysis were logged in the project field notebook, placed in plastic sample bags, properly labeled, packed, and analyzed using the XRF.

To ensure that no cross contamination occurred between sampling locations, the sampling equipment (spoon) was thoroughly decontaminated using suitable detergent wipes between sampling locations. Any disposable sampling equipment and latex gloves were used once and then properly disposed of after use.

Field activities involved the collection of 215 samples and analysis using the XRF. A breakdown of sample numbers is provided as follows:

- 124 bulk dust samples collected from primary roads in the study area.
- 91 bulk dust samples collected from secondary roads contiguous to remediated smelters.

Sample Analysis Technique

Bulk dust samples were field analyzed using the XRF device to detect and quantify the concentration of heavy metals in dust. The XRF analyzer can test for 17 heavy metals including lead, chromium, antimony, cadmium, arsenic, and other metals of concern.

Chemicals of Potential Concern (COPC)

The analytical results for the bulk dust samples were compared to the proposed USEPA Region 9 Preliminary Remediation Goals (PRGs) for chemicals in residential areas. Based on this comparison, Antimony (Sb), Lead (Pb), Arsenic (As), and Chromium (Cr) were detected with concentrations greater than the PRGs. Therefore, these heavy metals are considered Chemicals of Potential Concern (COPC). The PRGs for the COPC are presented in Table 1.

Table 1: PRGs for Heavy Metals in Bulk Dust Samples

Screening Level	Sb	Pb	As	Cr
U.S. EPA Region 9 PRGs for residential Areas (mg/kg)	31	400	0.39	210

Analytical Results of Samples

Bulk Dust Samples Collected from Primary Roads--

Table B.1 in Appendix B provide a summary of the XRF analytical results for bulk dust samples collected from primary roads. Based on the analytical results, the following can be deduced:

- Lead was detected in 99.2 percent (123 samples) of the samples collected of which approximately 17 percent (21 samples) of the samples have lead concentrations exceeding the PRG.
- Antimony (Sb) was detected in less than one percent (one sample) of the samples analyzed.

- Arsenic (As) was detected in two percent (3 samples) of the samples analyzed all of which have concentrations greater than the PRG.

- Chromium (Cr) was detected in 5 percent (seven samples) of samples analyzed with approximately 4 percent (5 samples) having concentrations greater than PRG.

- For bulk dust samples collected from Road Nos. 1, 2, 4, 5, 6, and 8, analytical results indicate concentrations of lead that are below the PRG.

- For the Ismailia Canal Street and for Road Nos. 3, 11, 12, and 13, lead was detected at concentrations exceeding the PRG in scattered samples along the roads.

- For roads 7, 9, and 10, lead was detected at concentrations exceeding the PRG in samples collected from sections of the roads that are contiguous to remediated smelters.

Bulk Dust Samples Collected from Roads around Smelters--

Table B.2 in Appendix B provide a summary of the XRF analytical results for bulk dust samples collected from secondary roads contiguous to the remediated smelters. Based on the analytical results, the following can be deduced:

- Lead was detected in all samples analyzed of which approximately 65 percent (59 samples) of the samples have lead concentrations exceeding the PRG.

- Antimony (Sb) was detected in less than three percent (3 samples) of the samples analyzed.

- Arsenic (As) was detected in 12 percent (11 samples) of the samples analyzed all of which have concentrations exceeding the PRG.

- Chromium (Cr) was detected in 2 percent (2 samples) of the samples analyzed all of which have concentrations exceeding the PRG.

- Lead contamination zones along roads contiguous to the remediated smelters (i.e., AW1, 2, and 3, Seoudi, El Mahy, OZ, and KS) extends for a distance ranging between 50 m and 350 m away from the smelter entrance. Locations of samples with lead concentrations exceeding PRG are illustrated in Figures A-2 and A-8 in Appendix A.

Based on the above, it can be concluded that lead is considered the Contaminant of Concern (COC). Furthermore, on reviewing the results, it is observed that the majority of the samples that contain elevated levels of lead were obtained from sections of the roads that are contiguous to the smelters. Therefore, these sections were considered as “hot spots”.

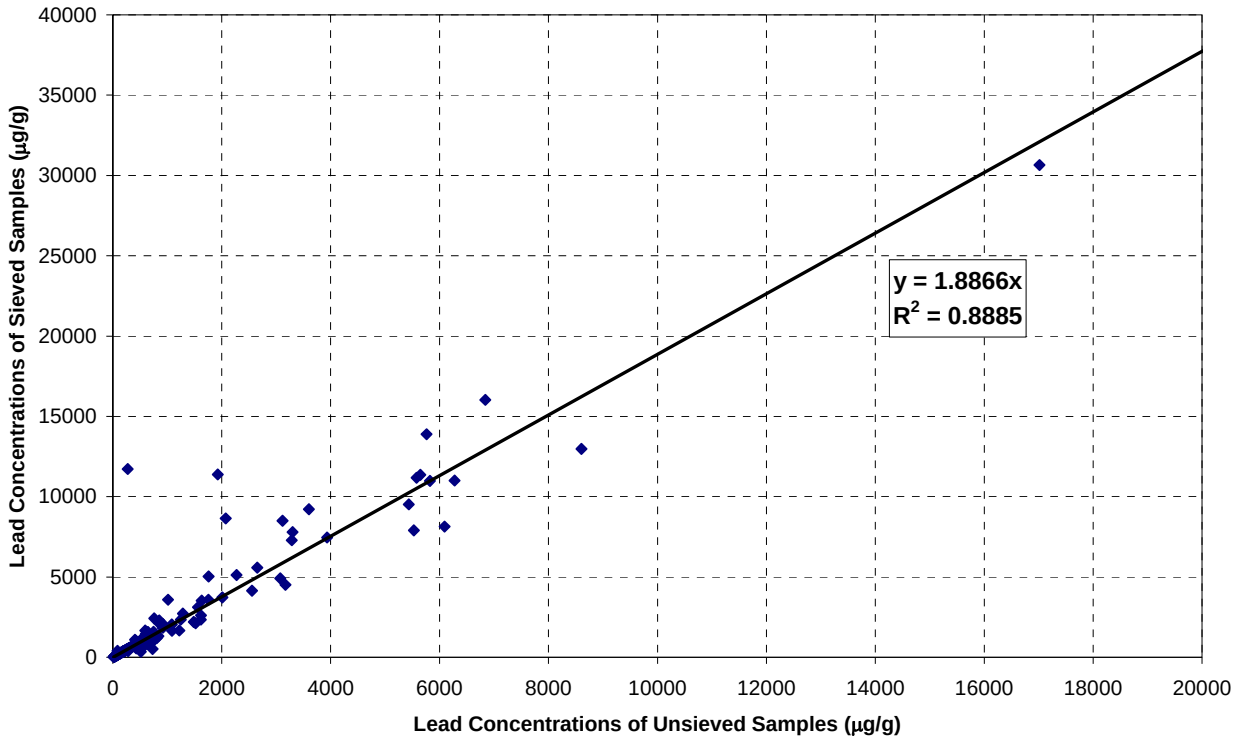
<u>Analytical Results of Sieved Samples</u>

As discussed later in this document, a human based health risk assessment was conducted as part of this characterization. For the purpose of this assessment, USEPA recommends sieving the dust samples to 250 microns when evaluating health risks due to lead exposures. The 250 micron particle size fraction is recommended because incidental ingestion is the major pathway of concern and the 250 micron size fraction is expected to adhere to hands and be ingested by hand-to-mouth.

To this end, bulk dust samples were sieved using a No. 60 sieve (sieve opening 250 µm) and analyzed using an XRF. Because of the large volume of samples collected, sieving was performed on selected bulk dust samples to establish a relationship between lead concentrations in sieved and unsieved samples in the study area. Specifically, bulk samples with lead concentrations exceeding the PRG (80 samples) were sieved and analyzed. Tables B.3 and B.4 present the analytical results for sieved samples. For the sake of comparison, analytical results of unsieved bulk dust samples were also included in Tables B.3 and B.4.

Based on the results of sieved and unsieved samples, a relationship between lead concentrations in sieved and unsieved, with acceptable regression coefficient (R^2), was established as shown in Figure 5. This relationship was used to estimate lead concentrations in sieved samples based on concentrations in unsieved samples.

Figure 5 Relationship between Lead Concentrations of Sieved and Unsieved Samples



BASELINE HUMAN RISK ASSESSMENT

Analytical results collected from the study area revealed that lead is the COC. This is attributed to previous uncontrolled operation of the lead smelters in Shoubra El Kheima that has contaminated soil, dust, and air in the area. The former lead smelter stack emissions have deposited a blanket of lead contaminated dust in the area that has concentrated near the smelters but has also been dispersed by wind and deposited inside nearby buildings and homes. Due to the mixed land uses within Shoubra El Kheima, receptors of lead contaminated soil, dust, and air include residential adults and children, school children, and commercial/ industrial workers. Among these receptors, children and fetuses are the most sensitive and have highest health risk because of the effect of lead on their developing nervous systems.

This risk assessment evaluates whether exposure to lead in soils and dust in the study area pose a potentially significant threat to human health under current (baseline) conditions. The main objective of this risk assessment is to characterize the health risk to children living in this area.

The USEPA's assumption for this exposure pathway is that ingested soil and dust lead is best represented in the particle size fraction that adheres to hands. USEPA lead models for evaluating health risks assume that the input lead concentration is due to the 250 micron size fraction (USEPA, 2000). In addition, there is a concern that metal concentrations may be enriched in the fine (sieved) fraction (USEPA, 2000). Therefore, analytical results of sieved samples collected from the study area (Tables B.3 and B.4 in Appendix B) were used in this assessment.

For lead concentrations that were below the XRF detection limits one-half of the sample detection limit (DL) was used as a proxy concentration for samples reported as non-detect (USEPA, 1989). This approach assumes that, on average, all values between zero and the DL could be present.

It is worth noting that around 88 percent of samples have arsenic, antimony, and chromium concentrations below the detection level of the XRF which are 15 µg/gm, 75 µg/gm, and 350 µg/gm; respectively. These levels are higher than the USEPA – Region 9 Preliminary Remediation Goals for arsenic (0.39 µg/gm), antimony (31 µg/gm), and chromium (210 µg/gm). Therefore, arsenic, antimony, and chromium are not included in the quantitative risk assessment, but are addressed in a qualitative manner.

Review of analytical results show that areas around smelters represent "hot spots" in the study area. Therefore, two scenarios were considered for this risk assessment as follows:

- Risk to children under the current baseline conditions.
- Risk to children assuming the removal of the hot spots.

The Center for Disease Control and Prevention (CDC) has identified a a blood lead level (PbB) of 10 micrograms of lead per deciliter (µg/dL) as the level of concern above which significant health risks occur. USEPA recommends that no more than 5 percent of children, under 7 years of age, in the study population have blood lead levels of 10 µg/dL of blood.

To assess the health risk associated with lead exposure, USEPA currently recommends using the IEUBK model for residential land uses. The model takes into account intake and

uptake components of lead exposure and allow the user to input site-specific data (e.g., exposure frequency, exposure duration, and the sources of lead) to predict PbBs.

The IEUBK model generates predicted PbB values and provides information on the percentage of the population exceeding 10 µg/dL. A brief description of the IEUBK model is provided below.

The Integrated Exposure Uptake Biokinetic Model (IEUBK)

The USEPA has recommended the IEUBK model as a predictor of potential long-term blood lead levels for children in residential settings. Comparisons between measured blood lead data and IEUBK model predictions have demonstrated close agreement between mean observed and predicted blood lead concentrations and between observed and predicted exceedances of 10 ug/dL in children (USEPA, 1998a).

The IEUBK model is used to predict the risk of elevated blood lead levels in children 0 to 7 years old that are exposed to lead from multiple sources. The model also predicts the risk (e.g., probability) that a typical child, when exposed to media-specified lead concentrations, will have a lead blood level greater or equal to the level associated with adverse health effects (10 ug/dL) USEPA, 2004a).

The IEUBK model uses four interrelated modules (exposure, uptake, biokinetic, and probability distribution) to estimate blood lead (PbB) levels in children exposed to lead from several sources and by several routes (USEPA, 2002a). A brief summary of each module is provided below.

- The exposure module uses lead concentrations in the environment and the rate at which a child breathes or ingests contaminated media to determine lead exposure. Media that can act as sources of lead include air, soil, water, diet, and other sources such as lead paint. The exposure module calculates the intake of lead from each medium for use in the uptake module.
- The uptake module modifies the lead intake rates using absorption factors to predict the uptake of lead from lungs and the gastrointestinal tract. Uptake is defined as the fraction of the total lead intake that crosses from the lungs and gastrointestinal tract to the bloodstream. The lead intake rates and absorption factors are both age and media specific. The total rate of lead uptake is calculated for use in the biokinetic module.
- The biokinetic module addresses the transfer of absorbed lead between blood and other body tissues in addition to the elimination of lead from the body via urine, feces, skin, hair and nails and the storage and/or disposition of lead in the extra-cellular fluid, red blood cells, liver, kidney, spongy bone, compact bone (femur) and other soft tissue. The total amount of lead in each body compartment is age dependent. Based on site-specific environmental exposures input by the user, a geometric PbB concentration is predicted.
- The probability distribution module uses the geometric PbB concentration to estimate a plausible distribution of PbB concentrations. From this distribution, the model calculates the probability or risk that a child's PbB concentration will exceed a user-selected PbB level of concern (typically 10 ug/dL).

The following is a summary of the significant health risks for children in the Study Area.

- Risk to children under the current baseline conditions. The IEUBK model showed that 75% of the children are expected to have blood lead levels greater than 10 µg/dl.

- Risk to children assuming the removal of the hot spots. The IEUBK model showed that 21% of the children are expected to have blood lead levels greater than 10 µg/dl. Lead model inputs and outputs are provided in Appendix C

- Lead is a toxin that causes adverse health effects. The main target for lead toxicity is the nervous system in both children and adults. Risks from lead exposure are particularly threatening to children less than 7 years of age due to their behavior and physiology. Children swallow and inhale lead in dirt, dust, or sand while playing on the floor and ground. Absorption of lead in a child's blood is estimated to be as much as five to ten times greater than in adults. Children and fetuses are most sensitive to elevated blood lead levels because it affects their developing nervous systems.

  The effects of increased blood lead in children also cause decreased intelligence, decreased hearing, and developmental delays. Studies in children have shown that a definite relationship exists between IQ score deficits and increased blood lead levels.

  In adults, the known effects of lead poisoning include elevated erythrocyte protoporphyrin levels that causes iron deficiency anemia in women at levels less than 10 µg/dl; increase systolic blood pressure, peripheral neuropathies (damage to the peripheral nerves that transmit information from the brain and spinal cord to other parts of the body), nephropathy (kidney disease), infertility in men, decreased hemoglobin synthesis, and frank anemia (low hemoglobin levels). Higher levels of lead in blood (100 µg/dl) can cause encephalopathy (brain disease).

  The US Department of Health and Human Services (DHHS) has determined that lead and lead compounds are reasonably anticipated to be human carcinogens and the EPA has determined that lead is a probable human carcinogen (ATSDR, 2005 b).

- It’s worth noting that arsenic can cause adverse health effects including the risk of skin cancer and cancer in the lungs, bladder, liver, kidney, and prostate. Inhalation of inorganic arsenic can cause an increased risk of lung cancer. The US Department of Health and Human Services (DHHS) has determined that inorganic arsenic is a known carcinogen. Non-carcinogenic health effects of inorganic arsenic range from sore throat to death in cases of very high ingestion.

- Exposure to antimony at high levels can result in a variety of adverse health effects. Breathing high levels for extended periods of time can irritate the eyes and lungs and can cause heart and lung problems, stomach pain, diarrhea, vomiting, and stomach ulcers. Ingesting large doses of antimony can cause vomiting. Antimony has not been classified for cancer effects by the Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), or the Environmental Protection Agency (EPA).

- Several studies have shown that chromium (VI) compounds can increase the risk of lung cancer. The World Health Organization (WHO) has determined that chromium (VI) is a human carcinogen. Non-carcinogenic health effects of chromium (VI) range from irritation of the respiratory system to skin and stomach ulcers.

CONCULSIONS

The major findings obtained from the environmental characterization of Shoubra El Kheima roads are summarized below.

- The Contaminant of Concern (COC) is lead. Arsenic, antimony, and chromium were detected at levels less than the limit of detection (LOD) of the XRF which are 15 µg/gm, 75 µg/gm, and 350 µg/gm; respectively. These levels are higher than the USEPA – Region 9 Preliminary Remediation Goals for arsenic (0.39 µg/gm), antimony (31 µg/gm), and chromium (210 µg/gm). Therefore, arsenic, antimony, and chromium are not included in the quantitative risk assessment, but are addressed in a qualitative manner.

- Analytical results of bulk dust samples collected from Road Nos. 1, 2, 4, 5, 6, and 8, revealed lead concentrations that are below the PRG.

- For the Ismailia Canal Street and for Road Nos. 3, 11, 12, and 13, lead was detected at concentrations exceeding the PRG in limited samples (ranging between 1 and 3 samples) along the entire length of the roads.

- For Roads 7, 9, and 10, lead was detected at concentrations exceeding the PRG in samples collected from locations in the vicinity of previously remediated smelters.

- The majority of the samples that contain elevated levels of lead were obtained from sections of the roads that are contiguous to smelters. Therefore, these sections were considered as a hot spot.

- The horizontal extent of lead contamination in roads contiguous to previously remediated smelters has been delineated. Based on this delineation, the zone of lead contamination extends for a distance ranging between 50 m and 350 m in both directions from the smelter entrance.

- The Baseline Human Risk Assessment indicates that there is significant health risk in the study area. Specifically, the assessment showed that, considering hot spots, 75% of the children are expected to have blood lead levels greater than 10 µg/dl. This percentage is higher than the health protective goal suggested by US EPA which is 5 percent.

RECOMMENDATIONS

The following recommendations are proposed based on our characterization data for Shoubra El Kheima roads:

- Roads 7, 9, and 10 should be remediated to reduce exposure to lead.

- Remediate secondary roads contiguous to the smelters and for a distance of approximately 350 m in both directions to reduce human exposure to lead.

- Solid waste including hazardous materials should be collected and disposed of appropriately.

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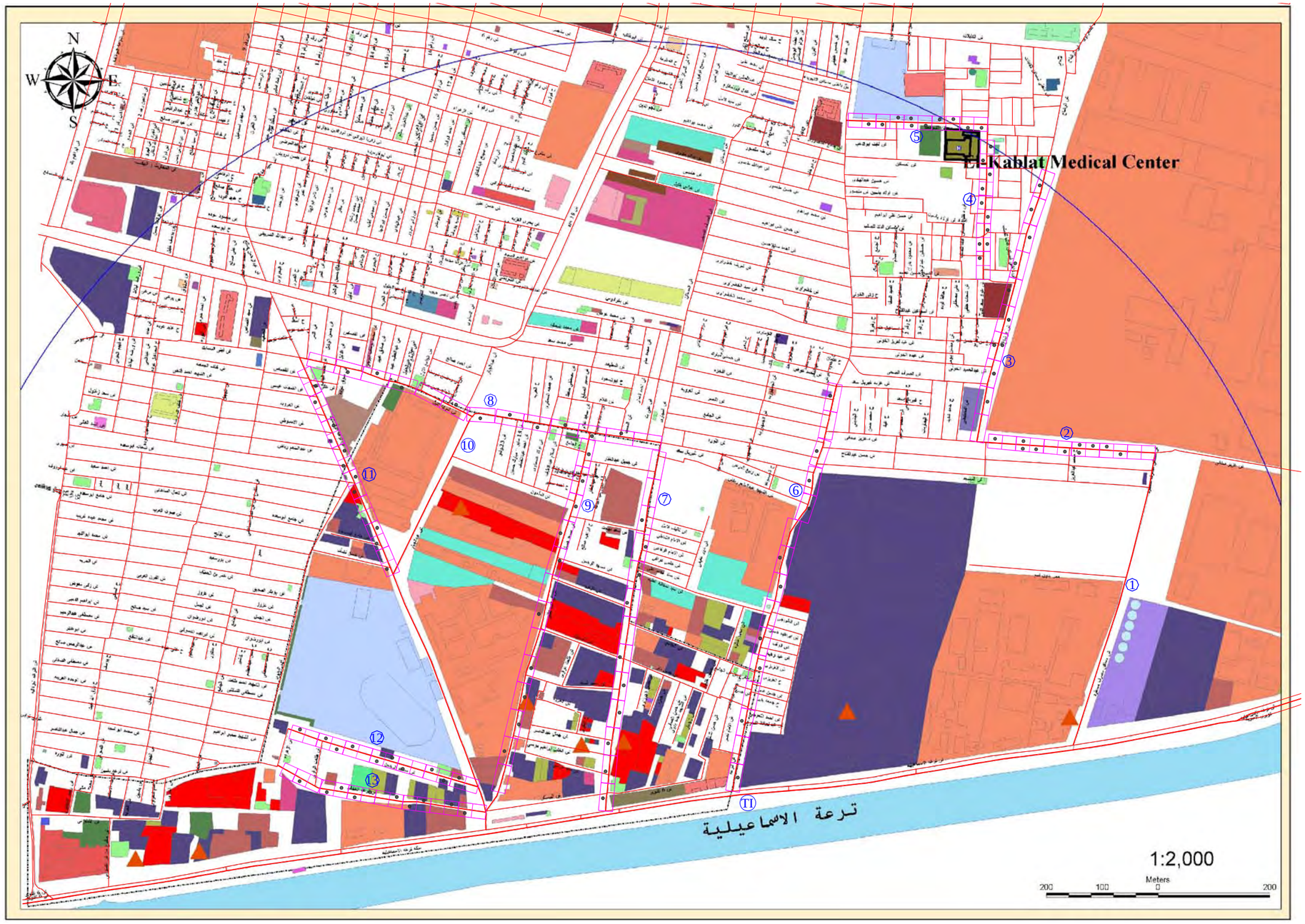
APPENDIX A: FIGURES

FIGURE A-1: Sampling Locations along Primary Roads



Notes: Road Nos. 1, 10, 11, and Ismailia Canal Street (TI) are paved.
Road Nos. 2, 3, 4, 5, 6, 7, 8, 9, 12, and 13 are unpaved.

FIGURE A-2: Sampling Locations for Roads Contiguous Awadallah No. 1 Smelter

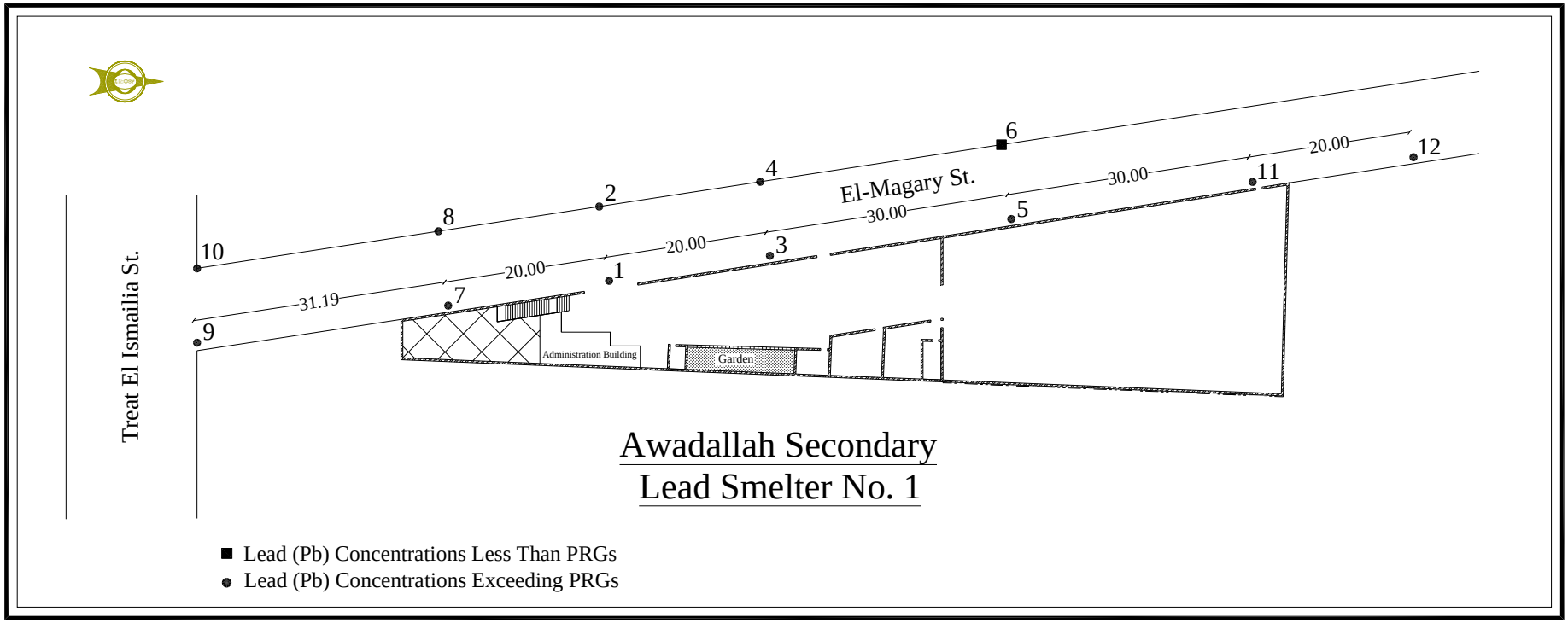


FIGURE A-3: Sampling Locations along Roads Contiguous to Awadallah No. 2 Smelter

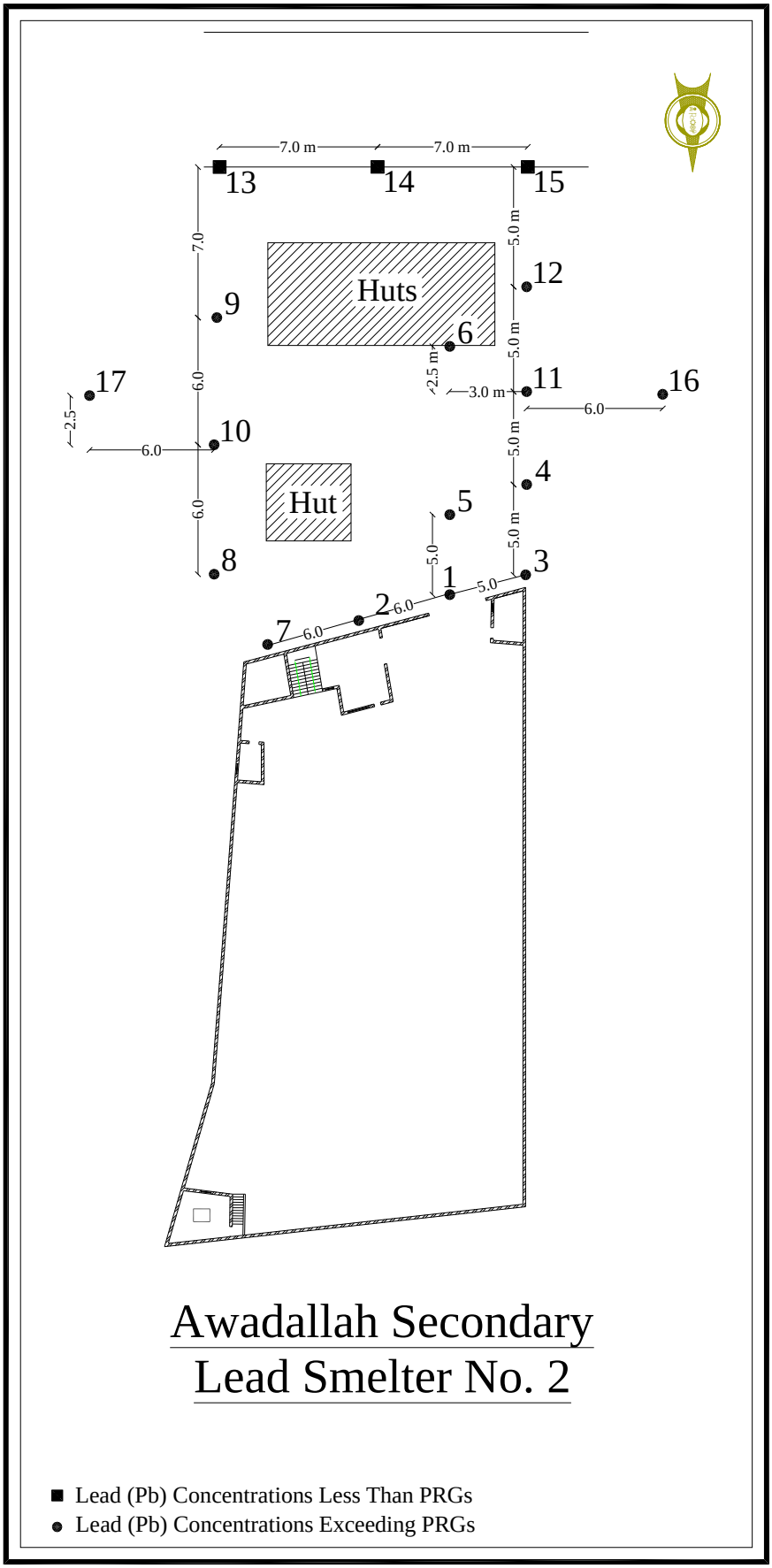


FIGURE A-4: Sampling Locations along Roads Contiguous to Awadallah No. 3 Smelter

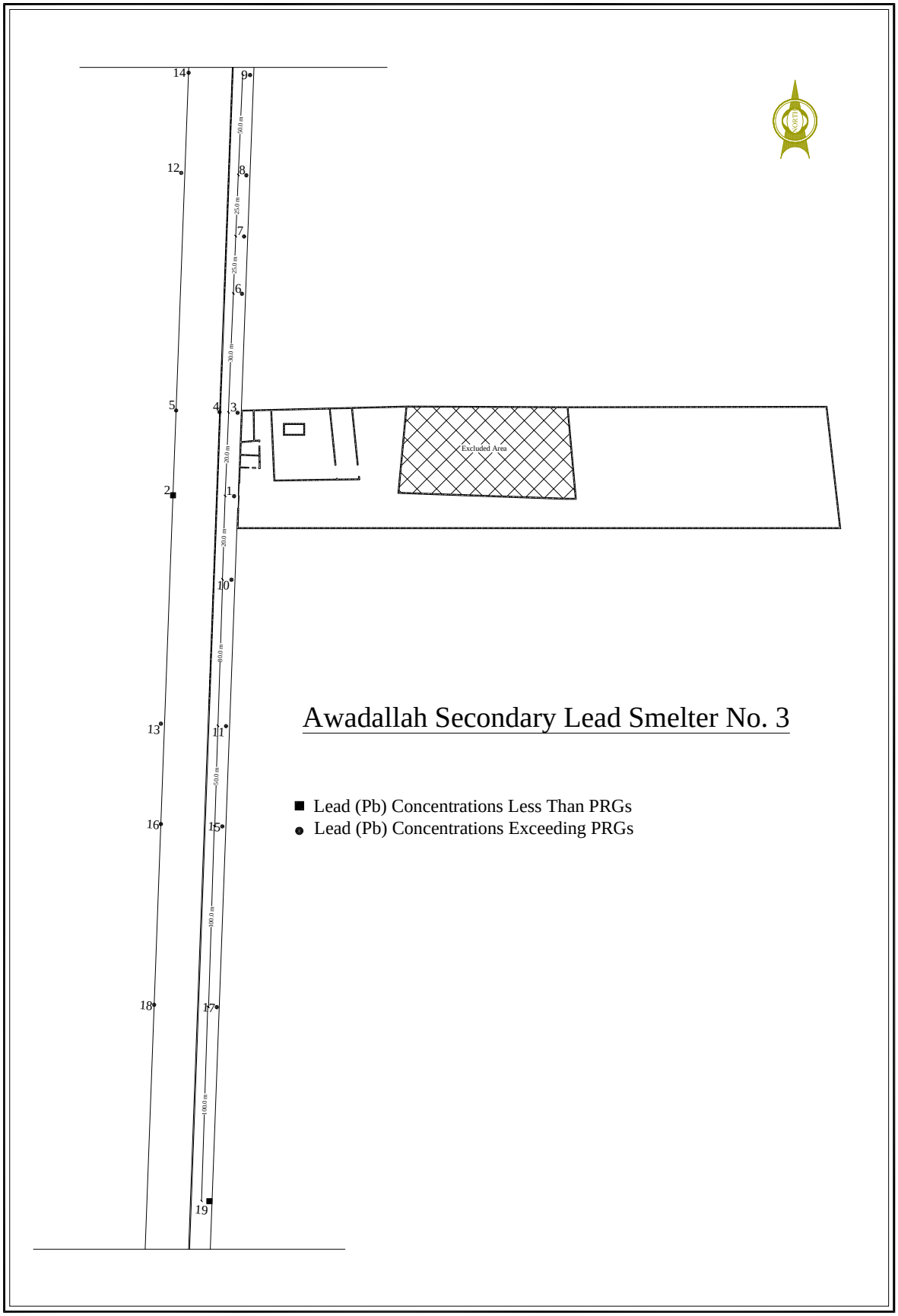


FIGURE A-5: Sampling Locations for Roads Contiguous to Seoudi Smelter

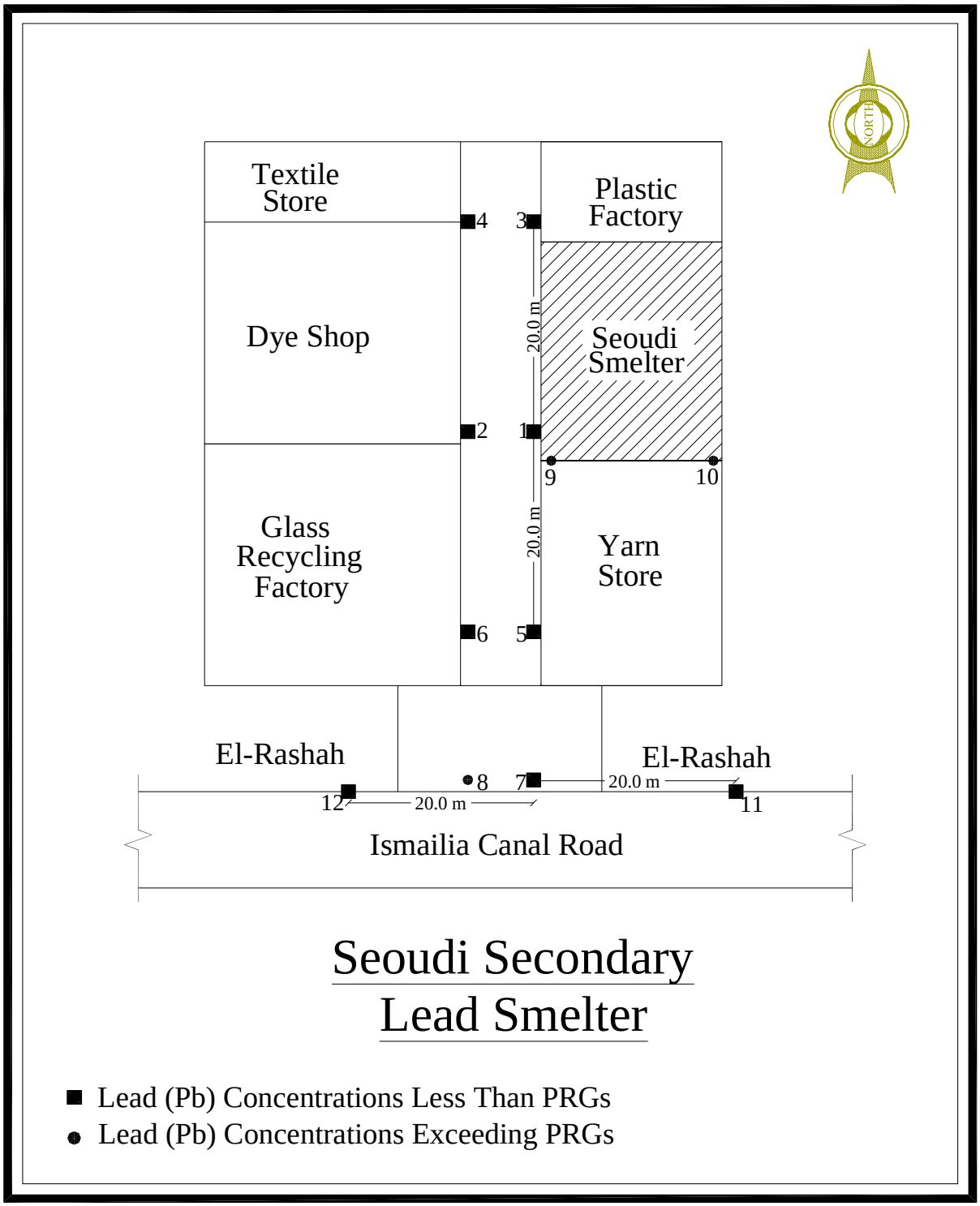


FIGURE A-6: Sampling Locations for Roads Contiguous to El Mahy Smelter

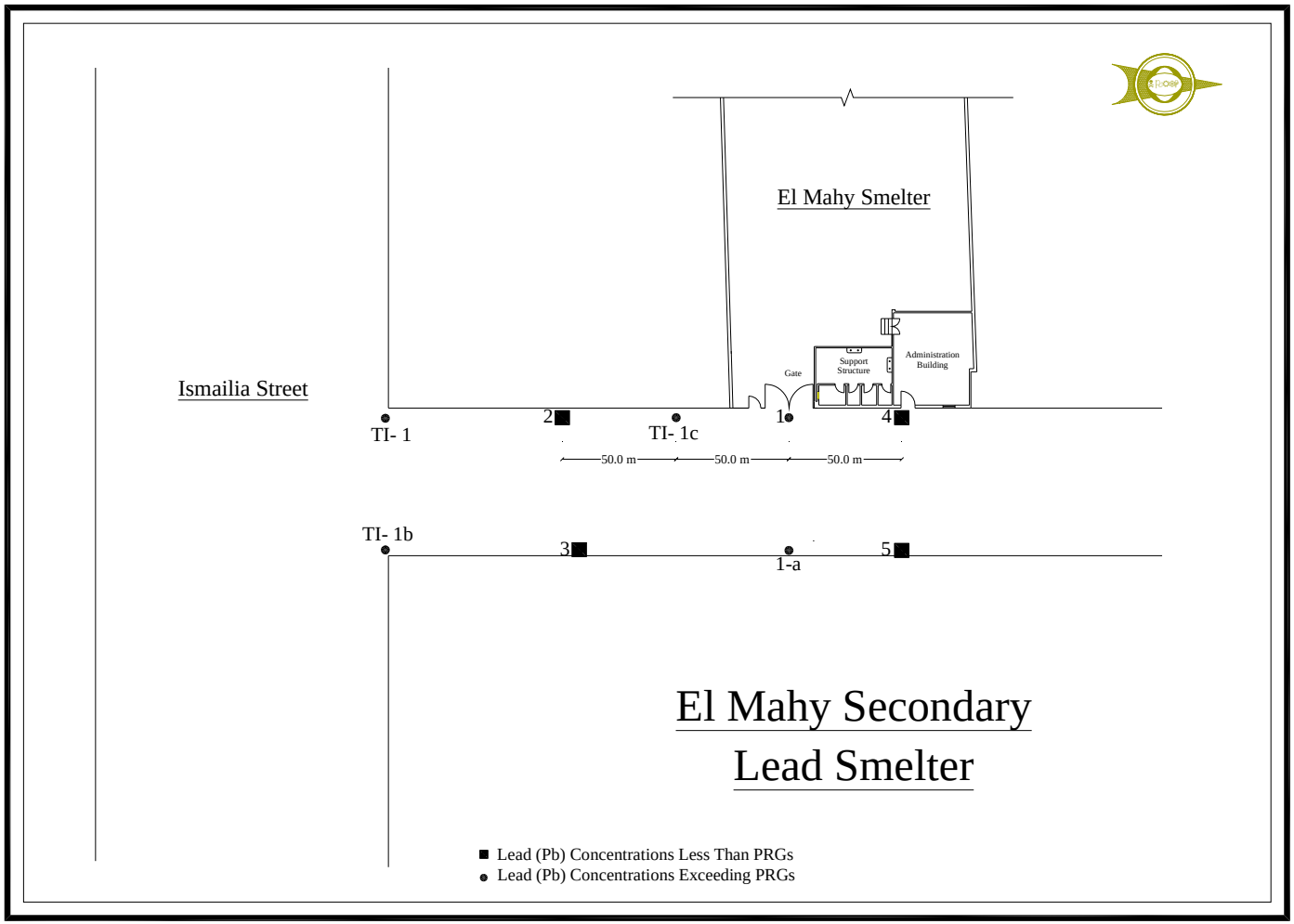


FIGURE A-7: Sampling Locations for Roads Contiguous Khaled Saad Smelter

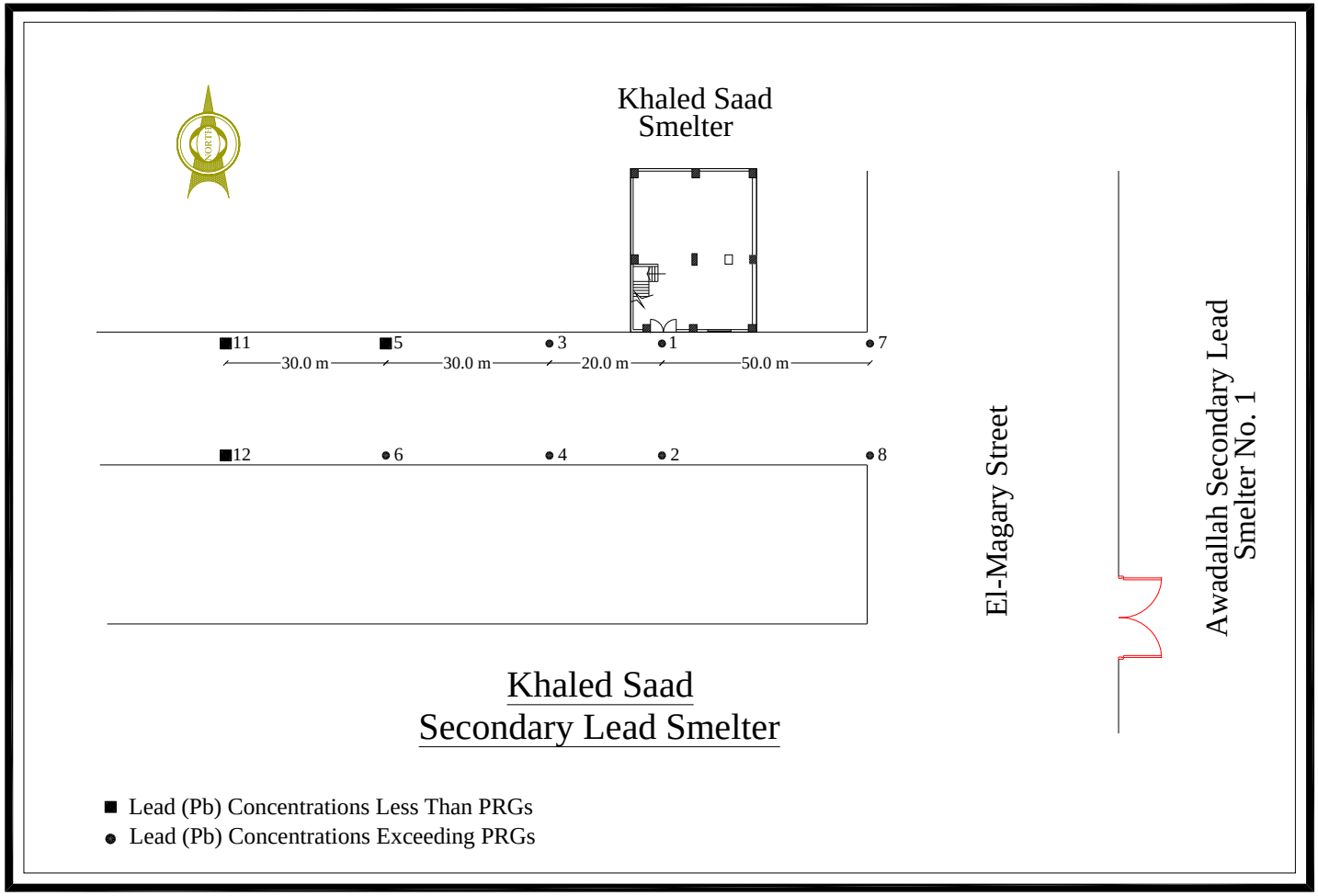
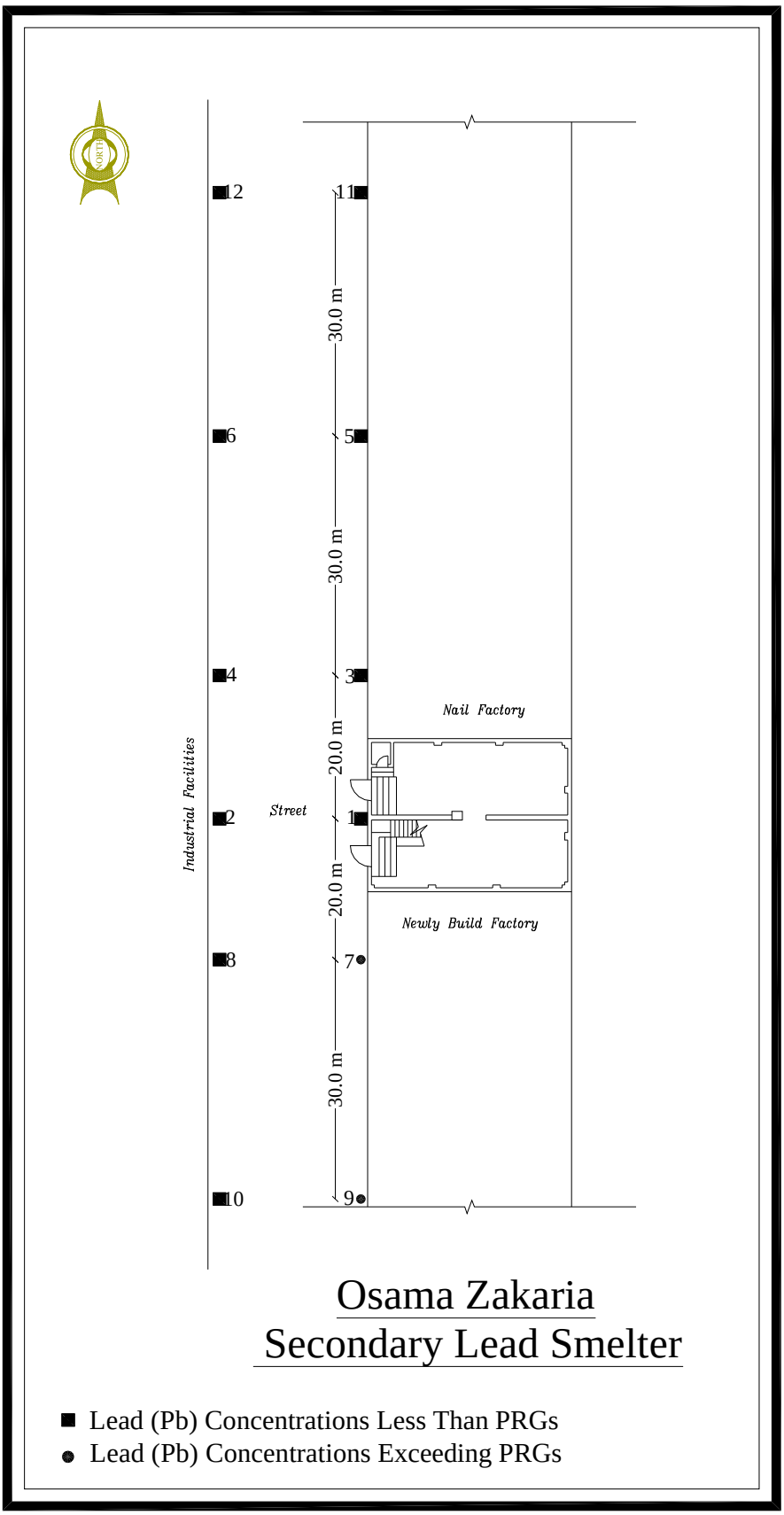


FIGURE A-8: Sampling Locations for Osama Zakaria



APPENDIX B: ANALYTICAL RESULTS OF BULK DUST SAMPLES

Table B.1; Analytical Results of Bulk Dust Samples Collected from Primary Roads (Unsieved Samples)

Street No.	Sample ID	Sb (µg/g) (1)(2)(3)	Pb (µg/g) (1)(2)(3)	As (µg/g) (1)(2)(3)	Cr (µg/g) (1)(2)(3)
1	6	<LOD	75	<LOD	<LOD
	7	<LOD	131	<LOD	185
	8	<LOD	153	<LOD	<LOD
	9	<LOD	122	<LOD	<LOD
	10	<LOD	110	<LOD	<LOD
2	1	<LOD	87	<LOD	<LOD
	3	<LOD	97	<LOD	<LOD
	2	<LOD	61	<LOD	<LOD
	4	<LOD	37	<LOD	<LOD
	5	<LOD	39	<LOD	<LOD
	6	<LOD	41	<LOD	<LOD
	7	<LOD	10	<LOD	<LOD
	8	<LOD	51	<LOD	<LOD
	9	<LOD	41	<LOD	<LOD
	10	<LOD	69	<LOD	<LOD
3	1	<LOD	40	<LOD	<LOD
	2	<LOD	112	<LOD	<LOD
	3	<LOD	88	<LOD	<LOD
	4	<LOD	32	<LOD	<LOD
	5	<LOD	724	<LOD	340
	6	<LOD	43	<LOD	<LOD
	7	<LOD	49	<LOD	<LOD
	8	<LOD	291	<LOD	<LOD
	9	<LOD	53	<LOD	<LOD
	10	<LOD	38	<LOD	<LOD
4	1	<LOD	60	<LOD	<LOD
	2	<LOD	104	<LOD	<LOD
	3	<LOD	15	<LOD	<LOD
	4	<LOD	47	<LOD	<LOD
	5	<LOD	58	<LOD	<LOD
	6	<LOD	65	<LOD	<LOD
	7	<LOD	74	<LOD	<LOD
	8	<LOD	32	<LOD	<LOD
	9	<LOD	50	<LOD	<LOD
	10	<LOD	62	<LOD	<LOD
5	1	<LOD	77	<LOD	<LOD
	2	<LOD	45	<LOD	<LOD
	3	<LOD	40	<LOD	<LOD
	4	<LOD	73	<LOD	<LOD

Street No.	Sample ID	Sb (µg/g) (1)(2)(3)	Pb (µg/g) (1)(2)(3)	As (µg/g) (1)(2)(3)	Cr (µg/g) (1)(2)(3)
	5	<LOD	137	27	<LOD
	6	<LOD	73	<LOD	<LOD
	8	<LOD	33	<LOD	<LOD
	7	<LOD	19	<LOD	<LOD
	9	<LOD	50	<LOD	<LOD
	10	<LOD	30	<LOD	<LOD
6	1	<LOD	75	<LOD	<LOD
	2	<LOD	28	<LOD	<LOD
	3	<LOD	57	<LOD	<LOD
	4	<LOD	148	<LOD	<LOD
	5	<LOD	69	<LOD	<LOD
	6	<LOD	80	<LOD	<LOD
	7	<LOD	30	<LOD	<LOD
7	1	<LOD	551	<LOD	<LOD
	1a	<LOD	763	<LOD	<LOD
	1b	<LOD	918	<LOD	<LOD
	2	<LOD	5,577	<LOD	<LOD
	2a	<LOD	3,302	<LOD	<LOD
	2b	3,334	8,606	249	<LOD
	3	<LOD	119	<LOD	<LOD
	4	<LOD	344	<LOD	<LOD
	4b	<LOD	318	<LOD	<LOD
	5	<LOD	203	<LOD	1,622
	6	<LOD	259	<LOD	<LOD
	7	<LOD	390	<LOD	<LOD
	8	<LOD	176	<LOD	<LOD
	9	<LOD	431	<LOD	<LOD
	10	<LOD	308	<LOD	<LOD
8	1	<LOD	125	<LOD	<LOD
	2	<LOD	82	<LOD	<LOD
	3	<LOD	63	<LOD	<LOD
	5	<LOD	215	<LOD	<LOD
	4	<LOD	226	<LOD	<LOD
	6	<LOD	181	<LOD	<LOD
	7	<LOD	202	<LOD	<LOD
	8	<LOD	121	<LOD	<LOD
	9	<LOD	221	<LOD	<LOD
	10	<LOD	46	<LOD	<LOD
9	1	<LOD	214	<LOD	<LOD
	2	<LOD	852	<LOD	<LOD
	3	<LOD	107	<LOD	<LOD

Street No.	Sample ID	Sb (µg/g) (1)(2)(3)	Pb (µg/g) (1)(2)(3)	As (µg/g) (1)(2)(3)	Cr (µg/g) (1)(2)(3)
	2b	<LOD	568	<LOD	<LOD
	4	<LOD	287	<LOD	<LOD
	5	<LOD	197	<LOD	<LOD
	6	<LOD	1,087	<LOD	464
	7	<LOD	914	<LOD	357
	8	<LOD	209	<LOD	<LOD
	9	<LOD	136	<LOD	<LOD
	10	<LOD	181	<LOD	<LOD
11	1	<LOD	431	<LOD	<LOD
	2	<LOD	192	<LOD	<LOD
	3	<LOD	289	<LOD	<LOD
	4	<LOD	153	<LOD	<LOD
	5	<LOD	237	<LOD	<LOD
	1a	<LOD	295	<LOD	<LOD
12	1	<LOD	507	<LOD	<LOD
	3	<LOD	479	<LOD	<LOD
	2	<LOD	83	<LOD	<LOD
	4	<LOD	284	<LOD	<LOD
	5	<LOD	134	<LOD	<LOD
	6	<LOD	17	<LOD	<LOD
	7	<LOD	73	<LOD	<LOD
	8	<LOD	78	<LOD	<LOD
	9	<LOD	39	<LOD	<LOD
	10	<LOD	106	<LOD	<LOD
13	1	<LOD	681	<LOD	<LOD
	2	<LOD	56	<LOD	<LOD
	3	<LOD	426	<LOD	203
	4	<LOD	88	<LOD	<LOD
	5	<LOD	248	<LOD	<LOD
	6	<LOD	13,104	406	707
	7	<LOD	192	<LOD	<LOD
	8	<LOD	10	<LOD	<LOD
Ismailia Canal Street	2	<LOD	314	<LOD	<LOD
	3	<LOD	147	<LOD	<LOD
	4	<LOD	112	<LOD	<LOD
	5	<LOD	423	<LOD	<LOD
	5b	<LOD	646	<LOD	<LOD
	6	<LOD	287	<LOD	<LOD
	7	<LOD	280	<LOD	<LOD
	8	<LOD	298	<LOD	<LOD
	9	<LOD	530	<LOD	<LOD

Street No.	Sample ID	Sb (μg/g) (1)(2)(3)	Pb (μg/g) (1)(2)(3)	As (μg/g) (1)(2)(3)	Cr (μg/g) (1)(2)(3)
	9c	<LOD	209	<LOD	<LOD
	10	<LOD	200	<LOD	<LOD
	9b	<LOD	60	<LOD	<LOD
PRGs (μg/g)		**31**	**400**	**0.39**	**210**

Notes ; (1) < LOD = Less than level of detection,

(2) Limit of detection for COPC as provided by XRF device manufactures are as follows:

LOD for lead = 20 μg/g LOD for antimony = 75 μg/g

LOD for Arsenic = 15 μg/g LOD for Chromium = 350 μg/g

(3) Highlighted cells indicate metal concentrations greater than PRG.

Table B.2: Analytical Results of Bulk Dust Samples Collected from Roads Contiguous to Smelters (Unsieved Samples)

Smelter	Sample ID	Sb (µg/g) (1) (2) (3)	Pb (µg/g) (1) (2) (3)	As (µg/g) (1) (2) (3)	Cr (µg/g) (1) (2) (3)
AW1	1	490	5,436	<LOD	<LOD
	2	<LOD	6,273	<LOD	<LOD
	3	<LOD	3,115	109	<LOD
	4	<LOD	3,170	<LOD	<LOD
	5	<LOD	1,285	69	<LOD
	6	<LOD	305	<LOD	<LOD
	7	<LOD	1,247	<LOD	<LOD
	8	<LOD	861	<LOD	<LOD
	9	<LOD	545	<LOD	<LOD
	10	<LOD	748	<LOD	<LOD
	11	<LOD	506	<LOD	<LOD
	12	<LOD	415	<LOD	<LOD
AW2	1	<LOD	1,015	<LOD	<LOD
	2	<LOD	2,274	<LOD	<LOD
	3	<LOD	1,927	<LOD	<LOD
	4	<LOD	3,934	116	<LOD
	5	<LOD	741	<LOD	<LOD
	6	<LOD	755	<LOD	<LOD
	7	<LOD	68,098	2,279	<LOD
	8	<LOD	1,630	<LOD	<LOD
	9	281	5,526	<LOD	<LOD
	10	<LOD	3,601	<LOD	<LOD
	11	<LOD	597	<LOD	<LOD
	12	<LOD	836	<LOD	<LOD
	13	<LOD	272	<LOD	<LOD
	14	<LOD	248	<LOD	<LOD
	15	<LOD	90	<LOD	<LOD
	16	<LOD	408	<LOD	<LOD
	17	<LOD	2,652	<LOD	<LOD
AW3	1	<LOD	17,012	<LOD	<LOD
	2	<LOD	261	36	<LOD
	3	<LOD	5,823	237	325
	4	<LOD	6,840	<LOD	<LOD
	5	<LOD	1,619	<LOD	<LOD
	6	<LOD	5,759	<LOD	<LOD
	7	<LOD	2,074	<LOD	<LOD
	8	360	3,286	<LOD	<LOD
	9	<LOD	563	<LOD	<LOD
	10	<LOD	6,090	<LOD	<LOD

Smelter	Sample ID	Sb (µg/g) (1) (2) (3)	Pb (µg/g) (1) (2) (3)	As (µg/g) (1) (2) (3)	Cr (µg/g) (1) (2) (3)
	11	<LOD	1,562	<LOD	<LOD
	12	<LOD	805	<LOD	<LOD
	13	<LOD	1,753	<LOD	<LOD
	14	<LOD	610	<LOD	<LOD
	15	<LOD	1,614	<LOD	<LOD
	16	<LOD	1,219	60	<LOD
	17	<LOD	731	<LOD	<LOD
	18	<LOD	562	<LOD	<LOD
	19	<LOD	300	39	<LOD
Seoudi	1	<LOD	242	24	<LOD
	2	<LOD	205	<LOD	<LOD
	3	<LOD	95	<LOD	<LOD
	4	<LOD	142	<LOD	<LOD
	5	<LOD	397	<LOD	<LOD
	6	<LOD	386	<LOD	<LOD
	7	<LOD	183	<LOD	<LOD
	8	<LOD	761	<LOD	<LOD
	9	<LOD	2,011	<LOD	<LOD
	10	<LOD	1,082	<LOD	303
	11	<LOD	353	<LOD	<LOD
	12	<LOD	227	<LOD	<LOD
KS	1	<LOD	547	56	<LOD
	2	<LOD	410	<LOD	<LOD
	3	<LOD	731	<LOD	<LOD
	4	<LOD	514	<LOD	<LOD
	5	<LOD	282	<LOD	<LOD
	6	<LOD	589	<LOD	<LOD
	7	<LOD	1,485	<LOD	<LOD
	8	<LOD	3,073	<LOD	<LOD
	11	<LOD	208	<LOD	<LOD
	12	<LOD	151	<LOD	<LOD
OZ	1	<LOD	194	<LOD	<LOD
	2	<LOD	192	<LOD	<LOD
	3	<LOD	286	<LOD	<LOD
	4	<LOD	177	<LOD	<LOD
	5	<LOD	264	<LOD	<LOD
	6	<LOD	362	<LOD	<LOD
	7	<LOD	767	<LOD	<LOD
	8	<LOD	321	<LOD	<LOD
	9	<LOD	1,519	<LOD	<LOD
	10	<LOD	215	<LOD	<LOD

Smelter	Sample ID	Sb (μg/g) (1) (2) (3)	Pb (μg/g) (1) (2) (3)	As (μg/g) (1) (2) (3)	Cr (μg/g) (1) (2) (3)
	11	<LOD	267	<LOD	<LOD
	12	<LOD	246	<LOD	<LOD
El Mahy	**1--1**	<LOD	1,759	88	<LOD
	1--1a	<LOD	5,644	<LOD	<LOD
	1--2	<LOD	166	<LOD	<LOD
	1--3	<LOD	357	<LOD	<LOD
	1--4	<LOD	207	<LOD	<LOD
	1--5	<LOD	163	<LOD	<LOD
	TI-1	<LOD	2,556	<LOD	<LOD
	TI-1b	<LOD	604	<LOD	<LOD
	TI-1c	<LOD	606	<LOD	<LOD
PRGs		**31**	**400**	**0.39**	**210**

Notes ; (1) < LOD = Less than level of detection,

(2) Limit of detection for COPC as provided by XRF device manufactures are as follows:

LOD for lead = 20 μg/g LOD for antimony = 75 μg/g

LOD for Arsenic = 15 μg/g LOD for Chromium = 350 μg/g

(3) Highlighted cells indicate metal concentrations greater than PRG.

Table B.3: Analytical Results of Sieved Bulk Dust Samples Collected from Primary Roads

Street No.	Sample ID	Pb (µg/g) (1)	
		Unsieved	Sieved (2)
1	6	75	141
	7	131	247
	8	153	288
	9	122	229
	10	110	208
2	1	87	163
	3	97	182
	2	61	116
	4	37	69
	5	39	74
	6	41	77
	7	*10*	19
	8	51	95
	9	41	77
	10	69	130
3	1	40	75
	2	112	211
	3	88	167
	4	32	61
	5	724	1,201
	6	43	81
	7	49	92
	8	291	548
	9	53	100
	10	38	72
4	1	60	113
	2	104	197
	3	15	28
	4	47	90
	5	58	109
	6	65	122
	7	74	139
	8	32	60
	9	50	95
	10	62	116
5	1	77	145
	2	45	84
	3	40	76

Street No.	Sample ID	Pb (µg/g) [1]	
		Unsieved	Sieved [2]
	4	73	138
	5	137	259
	6	73	139
	8	33	63
	7	19	37
	9	50	94
	10	30	57
6	1	75	142
	2	28	53
	3	57	107
	4	148	280
	5	69	130
	6	80	151
	7	30	56
7	1	551	857
	1a	763	1,477
	1b	918	1,836
	2	5,577	11,172
	2a	3,302	7,797
	2b	8,606	12,982
	3	119	225
	4	344	648
	4b	318	600
	5	203	382
	6	259	488
	7	390	736
	8	176	333
	9	431	677
	10	308	582
8	1	125	236
	2	82	154
	3	63	119
	5	215	406
	4	226	425
	6	181	341
	7	202	381
	8	121	229
	9	221	417
	10	46	87
9	1	214	404

Street No.	Sample ID	Pb (µg/g) [1]	
		Unsieved	Sieved [2]
	2	852	2,297
	3	107	201
	2b	568	1,196
	4	287	541
	5	197	371
	6	1,087	1,656
	7	914	2,091
	8	209	394
	9	136	256
	10	181	341
10	*Same as samples collected along road contiguous to AW3 (Table B.4)*		
11	1	431	559
	2	192	363
	3	289	544
	4	153	289
	5	237	447
	1a	295	556
12	1	507	969
	3	479	903
	2	83	402
	4	284	536
	5	134	253
	6	17	32
	7	73	137
	8	78	146
	9	39	73
	10	106	200
13	1	681	1,029
	2	56	105
	3	426	804
	4	88	166
	5	248	467
	6	13,104	9,106
	7	192	363
	8	*10*	19
Ismailia Canal Street	2	314	593
	3	147	278
	4	112	211

Street No.	Sample ID	Pb (μg/g) (1)	
		Unsieved	Sieved (2)
	5	423	1,037
	5b	646	1,573
	6	287	**541**
	7	280	**529**
	8	298	**561**
	9	530	**1,000**
	9c	209	**395**
	10	200	**378**
	9b	60	**114**
PRG (μg/g)		400	

Notes: (1) highlighted cells indicate lead concentrations exceeding PRG.

(2) Bold values indicate lead concentrations estimated based on relationship shown in Figure 5.

(3) Same as analytical results of AW3

Table B.4: Analytical Results of Sieved Bulk Dust Samples Collected from Roads Contiguous to Smelters

Smelter	Sample ID	Pb (μg/g) [1]	
		Unsieved	Sieved [2]
AW1	1	5,436	9,517
	2	6,273	11,009
	3	3,115	8,505
	4	3,170	4,515
	5	1,285	2,720
	6	305	**574**
	7	1,247	**2,353**
	8	861	2,090
	9	545	986
	10	748	1,586
	11	506	692
	12	415	705
KS	1	547	**1,031**
	2	410	673
	3	731	515
	4	514	358
	5	282	391
	6	589	754
	7	1,485	2,198
	8	3,073	4,915
	11	208	**392**
	12	151	**285**
OZ	1	194	**366**
	2	192	**361**
	3	286	**540**
	4	177	**333**
	5	264	**498**
	6	362	**682**
	7	767	1,159
	8	321	**605**
	9	1,519	2,125
	10	215	**405**
	11	267	**503**
	12	246	**464**
Seoudi	1	242	**457**
	2	205	**387**
	3	95	**179**
	4	142	**268**

Smelter	Sample ID	Pb (μg/g) [1]	
		Unsieved	Sieved [2]
	5	397	748
	6	386	729
	7	183	345
	8	761	2,427
	9	2,011	3,726
	10	1,082	2,054
	11	353	666
	12	227	429
AW2	1	1,015	3,592
	2	2,274	5,126
	3	1,927	11,391
	4	3,934	7,460
	5	741	1,377
	6	755	1,070
	7	68,098	103,316
	8	1,630	3,530
	9	5,526	7,904
	10	3,601	9,220
	11	597	1,671
	12	836	1,315
	13	272	11,724
	14	248	468
	15	90	171
	16	408	1,093
	17	2,652	5,576
AW3	1	17,012	30,652
	2	261	492
	3	5,823	10,982
	4	6,840	16,033
	5	1,619	2,602
	6	5,759	13,895
	7	2,074	8,646
	8	3,286	7,294
	9	563	701
	10	6,090	8,143
	11	1,562	3,120
	12	805	1,201
	13	1,753	3,581
	14	610	881
	15	1,614	2,352
	16	1,219	1,663

Smelter	Sample ID	Pb (μg/g) [1]	
		Unsieved	Sieved [2]
	17	731	**1,378**
	18	562	1,254
	19	300	**567**
El Mahy	1--1	1,759	5,030
	1--1a	5,644	11,366
	1--2	166	**314**
	1--3	357	**673**
	1--4	207	**389**
	1--5	163	**307**
	TI-1	2,556	4,151
	TI-1b	604	1,186
	TI-1c	606	1,458
PRG (μg/g)		400	

Notes: (1) highlighted cells indicate lead concentrations exceeding PRG.

(2) bold values indicate lead concentrations estimated based on relationship shown in Figure 5.

APPENDIX C: LEAD MODEL INPUTS AND OUTPUTS

Risk Assessment to children under the current baseline conditions

LEAD MODEL FOR WINDOWS Version 1.0

==========

Model Version: 1.0 Build 261

User Name:

Date:

Site Name:

Operable Unit:

Run Mode: Research

==========

The time step used in this model run: 1 - Every 4 Hours (6 times a day).

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (ug Pb/m^3)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

****** Diet ******

Age	Diet Intake(ug/day)
.5-1	5.530
1-2	5.780

2-3	6.490
3-4	6.240
4-5	6.010
5-6	6.340
6-7	7.000

****** Drinking Water ******

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 ug Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used

Average multiple source concentration: 1218.900 ug/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.000

Use alternate indoor dust Pb sources? No

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
.5-1	1727.000	1218.900
1-2	1727.000	1218.900
2-3	1727.000	1218.900
3-4	1727.000	1218.900
4-5	1727.000	1218.900

5-6	1727.000	1218.900
6-7	1727.000	1218.900

****** Alternate Intake ******

Age	Alternate (ug Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

****** Maternal Contribution: Infant Model ******

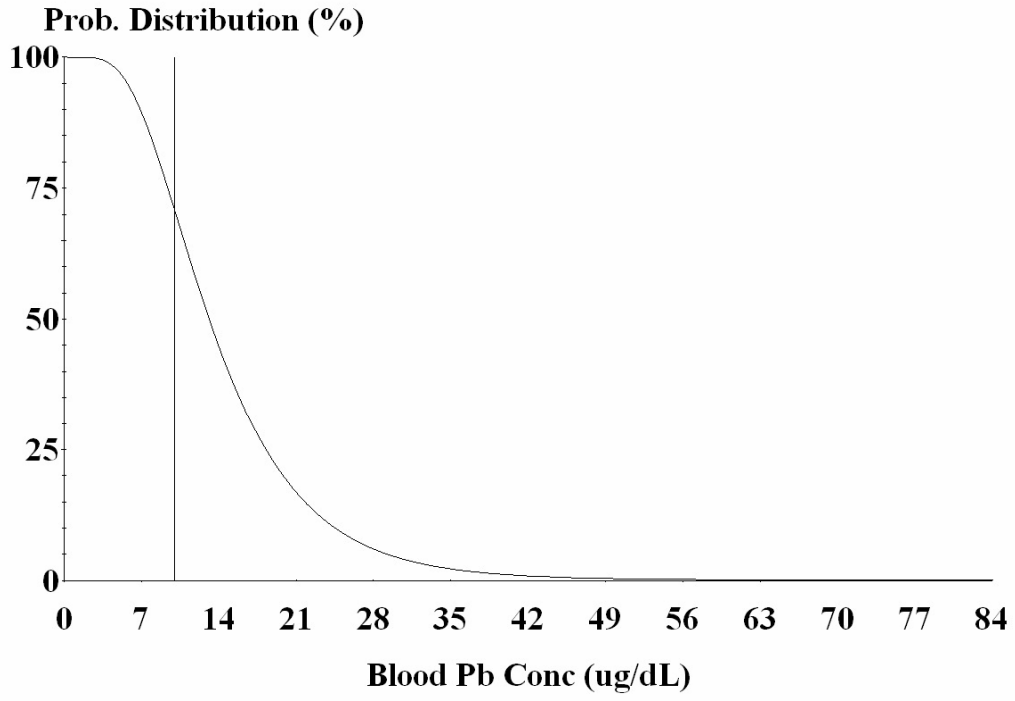
Maternal Blood Concentration: 2.500 ug Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Year	Air (ug/day)	Diet (ug/day)	Alternate (ug/day)	Water (ug/day)
.5-1	0.021	1.971	0.000	0.285
1-2	0.034	1.959	0.000	0.678
2-3	0.062	2.295	0.000	0.736
3-4	0.067	2.297	0.000	0.780
4-5	0.067	2.420	0.000	0.886
5-6	0.093	2.645	0.000	0.968
6-7	0.093	2.978	0.000	1.004

Year	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)

.5-1	26.307	28.583	14.7
1-2	39.741	42.412	17.0
2-3	41.467	44.560	16.1
3-4	43.155	46.298	15.7
4-5	34.969	38.341	13.3
5-6	32.615	36.321	11.4
6-7	31.403	35.478	10.1



Cutoff = 10.000 ug/dl
Geo Mean = 13.755
GSD = 1.600
% Above = 75.123

Age Range = 0 to 84 months
Time Step = Every 4 Hours
Run Mode = Research

Risk Assessment to children assuming removal of hot spots

LEAD MODEL FOR WINDOWS Version 1.0

==========

Model Version: 1.0 Build 261

User Name:

Date:

Site Name:

Operable Unit:

Run Mode: Research

==========

The time step used in this model run: 1 - Every 4 Hours (6 times a day).

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (ug Pb/m^3)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

****** Diet ******

Age	Diet Intake(ug/day)
.5-1	5.530
1-2	5.780

2-3	6.490
3-4	6.240
4-5	6.010
5-6	6.340
6-7	7.000

****** Drinking Water ******

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 ug Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used

Average multiple source concentration: 451.700 ug/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.000

Use alternate indoor dust Pb sources? No

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
.5-1	631.000	451.700
1-2	631.000	451.700
2-3	631.000	451.700
3-4	631.000	451.700
4-5	631.000	451.700

5-6	631.000	451.700
6-7	631.000	451.700

****** Alternate Intake ******

Age	Alternate (ug Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

****** Maternal Contribution: Infant Model ******

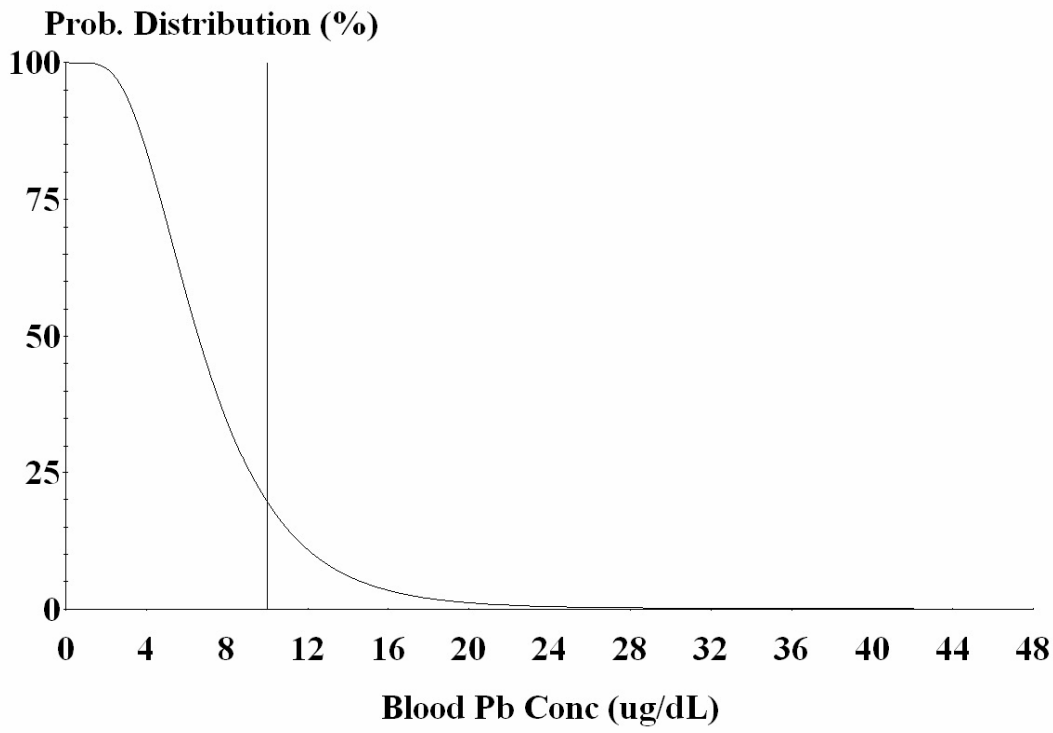
Maternal Blood Concentration: 2.500 ug Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Year	Air (ug/day)	Diet (ug/day)	Alternate (ug/day)	Water (ug/day)
.5-1	0.021	2.345	0.000	0.339
1-2	0.034	2.392	0.000	0.828
2-3	0.062	2.747	0.000	0.881
3-4	0.067	2.701	0.000	0.918
4-5	0.067	2.717	0.000	0.995
5-6	0.093	2.914	0.000	1.066
6-7	0.093	3.244	0.000	1.094

Year	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)

.5-1	11.512	14.217	7.6
1-2	17.846	21.100	8.6
2-3	18.256	21.946	8.1
3-4	18.665	22.350	7.7
4-5	14.443	18.221	6.4
5-6	13.212	17.286	5.5
6-7	12.582	17.013	4.9



Cutoff = 10.000 ug/dl
Geo Mean = 6.884
GSD = 1.600
% Above = 21.347

Age Range = 0 to 84 months
Time Step = Every 4 Hours
Run Mode = Research