UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF ILLINOIS

EPA Region 5 Records Ctr.
257725

UNITED STATES OF AMERICA, - Plaintiff, vs. NL INDUSTRIES, et al., Defendants, and CITY OF GRANITE CITY, ILLINOIS Intervenor/Defendants.	)	Civil Action No. 91-CV-00578-JLF

EXHIBITS ATTACHED TO GRANITE CITY MEMORANDUM

EX. A

Ex. B.

RESUME

Geoffrey J.D. Hewings, B.A. (Hons.), M.A., Ph.D.

Director,
Regional Economics Applications Laboratory,
University of Illinois/Federal Reserve Bank of Chicago
607 S. Mathews, #220,
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Brief Biography

Geoffrey Hewings' major interests are in the modeling of socio-economic activities at the local, state and regional levels with a particular focus on impact assessment. Since data availability at the sub-national level is often a problem, he has specialized in developing modelling techniques that operate in an environment of limited information. The models have been applied to a variety of problems:

- employment projections to provide a link to environmental models
- project selection in developing a regional growth strategy
- impacts of opening and closing of firms on a regional economy
- forecast of alternative scenarios on output, income employment and occupations in regional economies

Since 1989, he has served as Director of the **Regional Economics Applications Laboratory [REAL]**, a joint venture between the *Federal Reserve Bank of Chicago* and the *University of Illinois*. The major focus of **REAL** is on the development of models of urban and regional economies; in January, 1990, the first version of a model for the Chicago economy was completed providing capabilities for forecasting socio-economic activities on an annual basis through the year 2014. In addition, he is also directing a project designed to provide insights into the effects of the *US-Canada Free Trade Agreement* on the Midwestern states. His international work is currently focused on Indonesia where he is directing efforts towards the completion of a set of interregional input-output, social accounting and computable general equilibrium models for that economy.

Hewings obtained his undergraduate training at the University of Birmingham in England and received his graduate degrees from the University of Washington in Seattle, with the Ph.D. being conferred in 1969. He spent two years directing a research project on input-output analysis at the University of Kent in England prior to accepting a position at the University of Toronto in Canada. Since 1974, he has been at the University of Illinois at Urbana-Champaign where he is currently Professor of Geography and Regional Science and of Urban and Regional Planning. Between 1983 and 1990, he served as Head of the Department of Geography. He has accepted short-term visiting positions at the University of Massachusetts at Amherst, University of Queensland (Australia), Bar Ilan University (Israel), Korea Research Institute for Human Settlements (Seoul) and the Universitas Indonesia (Jakarta). Since 1978, he has assumed the positions of Executive Secretary and Executive Director of the Regional Science Association International, an interdisciplinary professional organization with over 2000 members in 50 countries.

He has published over 60 articles in professional journals and is the author or editor of five books. He has served as a consultant to a number of state and federal agencies in the United States, Greece, Australia, Indonesia and Korea.

THE REGIONAL ECONOMICS APPLICATIONS LABORATORY

Since January, 1989, Hewings has assumed the position of Director of the Regional Economics Applications Laboratory, a joint venture between the Federal Reserve Bank of Chicago and the University of Illinois. The primary focus of REAL is on the development and application of a set of regional analytical models of the Chicago, Illinois and Midwestern economies. Current models include:

A detailed forecasting model for the Chicago Regional economy with projections through the year 2011for employment, output, income for 36ectors.

Models of the Chicago and Illinois economies these that provide information on the linkages between industries within the region and facilitate the estimation of the impacts of changes in activity levels in one industry on the rest of the economy (through the estimation of ripple effects).

The major goal for REAL is to develop a client base from the corporate and public sectors; the *Commonwealth Edison Company* and the *Chicago Economic Development Commission* are currently the major clients. Several smaller companies have provided support for specific projects. Considerable use is made of doctoral level students from a variety of departments (economics, urban and regional planning and geography) on client-based projects with supervision and support provided by faculty at the University of Illinois and the Research Staff of the Federal Reserve Bank of Chicago.

Summary of Projects Undertaken or In Progress (marked with asterisk).

[*Client listed in parentheses*]

1. Local or County Level

Evaluation of Threshold Analysis as a technique for assessing the optimum size of urban areas from the perspective of infrastructure (Canadian Ministry of Urban Affairs, Ottawa)

The project required an evaluation of Threshold Analysis as a potential technique for assessing the alternatives open for the promotion of urban growth without significant expenditures on new infrastructure (sewage treatment facilities, water treatment plants etc.) in relatively small and medium sized cities.

Active contributor over several years to the development of a comprehensive county-based socio-economic impact system for the United States (US Construction Engineering Research Laboratory, Champaign, Illinois)

The Economic Impact Forecast System (EIFS) is part of a set of county-based models developed initially to handle environmental impact statements associated with military logistics. Subsequently, the system has been used extensively in other federal government agencies and in the private sector. The model will provide assessments of the impacts of any change in activity on a wide variety of measures - business volume, local spending, income, employment and output. Sector-specific multipliers are now available allowing the analyst to pinpoint the impacts of changes in activity on individual sectors.

Development of impacts of the location of the Diamondstar Mitsubishi automobile assembly plant on the economy of Central Illinois and the rest of the state of Illinois*

Using an integrated socio-economic model [REMI], estimates were made of the impact of the new plant on the county in which it was built and the adjacent regions in the state. The model provided annual estimates of the impacts and distinguished between construction and production phases. Subsequent work has focused on prior work experience and locations, attitudes towards employment in [illegible] ventures of a stratified sample of employees; a supplier survey is currently being evaluate[illegible]

Economic Impact of the Closure of Chanute Air Force Base on Rantoul and Champaign County, Illinois (Village of Rantoul)

The EIFS system noted above was used to generate a "worst-case" scenario to estimate the impacts of the closure of the USAF facility on a community and the county in terms of employment, income, business volume, school enrollment and municipal revenue and expenditures.

Forecasts of Socio-Economic Indicators in the Chicago region through 2014 (Chicago Economic Development Commission)

Development of a combined econometric-input-output model of the Chicago metropolitan area to measure likely future levels of output by economic sector, income, population, employment, wages rates and investment through the year 2014.

Occupational Projections for Chicago (Chicago Economic Development Commission)

Projection of occupational demands by industry annually over the period 1990-2010 and comparison with national projections under several alternative scenarios.

2. State, Regional and Metropolitan Level

The impact of National Parks on the Washington State economy (US National Park Service)

Development of an input-output model to handle the impacts of tourist expenditures associated with visits to the two National Parks in the State of Washington. While the level of expenditures was significant, a large percentage was made outside the state, thus reducing the impact on the Washington economy.

Application of Interregional Input-Output Analysis for State Planning and Program Activities (Department of Commerce, State of Washington)

A feasibility study designed to explore the possibilities of developing an integrated interregional input-output model to be used for assessing the impact of state government programs on different parts of the state.

Projection of Sub-state Employment for Air Quality Maintenance Area Planning (Illinois EPA)

An evaluation of alternative step-down projection techniques which could be used to allocate state-level population and employment figures to regions within the state. These data would then be used to estimate levels of pollution in certain, key metropolitan regions.

Macro-economic impact of environmental legislation (Illinois Institute for Environmental Quality)

Development of a state input-output model which was then used to measure the impact of proposed environmental legislation on output, income and employment in the state.

Development of an Energy-Economic Input-Output Model for the Ohio Basin Energy Demand Study (US EPA)

This component of a very large study involved the estimation of a linked input-output/linear programming model to assess alternative energy scenarios on the region's (part or all of six states) economy.

Measurement of Regional Development Indicators (US Army Corps of Engineers)

Evaluation of standard socio-economic indicators as measures of regional development at the sub-state level.

Development of Sub-State input-output tables from State input-output tables (Illinois Bureau of the Budget)

A comparative analysis of alternative non-survey techniques for generating regional and interregional tables to estimate the links between the regions of the state's economy

Organization of Regional Centers for the Provision of Energy Management and Conservation Assistance to Communities (Argonne National Laboratory)

Development of procedures for collection and dissemination of appropriate energy conservation assistance material to communities.

Economic and Physical Impacts from Extreme Fluctuations in Lake Michigan Levels along the Illinois Shoreline (US EPA)

Feasibility study designed to explore ways in which economic and physical models can be linked to provide an assessment of the socio-economic impact of lake-shore fluctuations on a local economy.

Assessing the Impacts of Increased Agricultural Value-Added Activity on the Illinois Economy: an Input-Output Model Application. (US Dept. Agriculture)

Feasibility and marketing study of the impact of increasing agricultural product processing prior to export (i.e., the possibilities of exporting a set of products derived from grains rather than the export of the raw grains). Considerable use will be made of a state input-output model for this purpose.

The Economic Integration of Illinois' Regions (Chicago United Business Organization)

A contribution to the debate about the degree to which "downstate" Illinois benefits from activities in the Chicago region. Using employment, a set of econometric equations were developed to [illegible] the "spillovers" within a five region division of the state's economy. The results reveal[illegible]iderable interconnection.

Measurement of the Impacts of Energy Conservation Programs (Illinois Commerce Commission)

Preparation of testimony comparing alternative methods for assessing the impacts of energy conservation programs on energy and employment within utility districts.

Assessment of Future Socio-Economic Indicators on Recreation Demands (Illinois Department of Conservation)

Evaluation of projections of socio-economic indicators and their use in estimating needs for recreation within the state.

Impact of the University of Illinois on the State's Economy, 1975 and 1987 (University of Illinois)

Estimation of the employment and income impacts of the University on the economy. In 1987, it was estimated that about 90-100,000 individuals' employment could be attributed to the University as a result of its purchases of goods and services and the expenditures (and their impacts) of its employees.

The Structure of the Chicago Economy, 1982-2013* (Chicago Economic development Commission)

Using a combined econometric-input-output model, information is available on the nature and strength of the interactions between sectors within the Chicago economy. Projections of activity levels through the year 2013 have been made.

The Role of Electricity Expenditures in the Chicago Regional Economy (Commonwealth Edison)

This study analyzed the allocation of electricity expenditures by thirty-six sectors in comparison to expenditures on wages and salaries and other intermediate goods and services. Estimation was also made of the ripple effects of the expenditures and the changes observed between 1982 and 1987.

The Nature of Linkages Between High-Tech Firms and the Chicago Economy

Using a survey questionnaire, a model of the degree of integration of high-tech firms was developed. The model revealed substantial backward (purchase of intermediate inputs) linkages but rather week forward (sales) linkages.

Impacts of New Automobile Plants on Economies*

Two studies [redacted] been completed (Volkswagon in New Stanton, PA and Diamondstar-Mitsubishi in [redacted]ington-Normal, IL); a third study will provide an on-going monitoring of the impact of [redacted]mondstar-Mitsubishi plant, tracing the possible relocations of suppliers into the region and the impacts of new technological developments on production organization and scale.

Airline Network Structure and Economic Efficiency

Using data provided by Continental Airlines, measures of the effect of the hub-and-spoke system on airline efficiency were developed. The procedure also provided information on the optimal usage of aircraft equipment on the network.

Defense Spending and Regional Growth

The procedure attempted to document the dependence of regions within the US on defense spending in terms of both direct (primary contracts) and indirect effects (sub and sub-sub contracts)

New York State Aviation Activity Forecasts Study* (New York State Department of Transportation)

Broadly based assessment of the impact of future growth and development trends on the organization and structure of aviation in New York State with primary emphasis on scheduled carrier service.

Development of an Integrated Econometric Input-output Model for Iowa (State of Iowa)

The model will be similar in scope to the one developed for Chicago; the model will provide the capability to undertake impact analyses and provide annual forecasts for the period 1990-2010.

Competition and Complementarity Among the US Regions

Analysis has been conducted to examine the degree to which growth and decline in one part of the US is associated with growth and decline in other regions. Using US Census Regions, the analysis has revealed significant changes in the shares of gross national product allocated across regions and projections of theses shares have been made to 2050.

3. International

Development of an Input-Output Model for SE Kent (U.K.)

Feasibility study for the construction of an input-output model for this region.

Development of an Interregional Computable General Equilibrium Model for Korea for Development Planning and Policy Evaluation

The model linked factor and product markets and was used to assess the impacts of increased exports, increased spending and investment on individual sectors and regions within the Korean economy. This model was the first of its kind to be developed at the regional and interregional levels.

Development of an Interregional Social Accounting Model for Bangladesh for Measurement of the Impact of Agricultural Programs

The model was developed to assist in estimating the degree to which projects undertaking in one region to raise agricultural output provided employment and income impacts elsewhere in the country.

Development of a Social Accounting Model for Evros, Greece, for Policy Selection, Monitoring and Evaluation (Greek Ministry of Coordination)

Using a semi-survey method, a reduced form social accounting system was developed for this small region in NE Greece to facilitate planning development in anticipation of Greece's entry to the Common Market.

Comparative Analysis of the Structure of Australian Regional Economies (Queensland Department of the Treasury)

An attempt to isolate the degree to which economies of different size might share some common "fundamental economic structure" and thus facilitate the preparation and development of future models of their economies.

Impact of the US-Canada Free Trade Agreement on the Midwest Economies* (Economic Development Administration, U.S. Department of Commerce)

This project has focused on the regional (state level) impacts of the US-Canada Free Trade Agreement, with particular attention to the Midwest states' economies and those of New York, Pennsylvania and new England. The preliminary results suggest that the impacts are likelt to be very small although for some specific industries, the results indicate changes that exceed the annual growth in that industry for a typical year. Consideration is now being given to extending this work to include the effect of adding Mexico to the Free Trade Area in North America.

Development of a Set of Interregional Models for Impact Analysis and Policy Evaluation in Indonesia* (University of Indonesia/Midwest Universities Consortium for International Activities/Government of Indonesia/World Bank)

Development of a set of models for a 5-region division of the Indonesian economy for purposes of evaluation of alternative regional development policies. The 5-region interregional input-output models for 1980 and 1985 are complete; a two-region social accounting model has been produced and plans are now being made to develop a 5-region social accounting system and a computable general equilibrium model.

IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF ILLINOIS

UNITED STATES OF AMERICA, Plaintiff, vs. NL INDUSTRIES, INC., et al., Defendants, and City of Granite City, Illinois, Lafayette H. Hochuli, and Daniel M. McDowell, Intervenor-Defendants.	)))))))))))))))))	CASE No. 91-CV-578-JLF

AFFIDAVIT OF GEOFFREY J. D. HEWINGS

Comes Now Affiant, Geoffrey J. D. Hewings, upon his oath, and states as follows:

1. I am Geoffrey J. D. Hewings. I live at 1110 West Park, Champaign, Illinois 61821.

2. In 1965, I graduated with a Bachelor of Arts with honors from the University of Birmingham (England). Thereafter, I earned my Masters and Doctoral degrees in geography and economics from the University of Washington (Seattle).

3. I am a professor in the Departments of Geography and Urban and [illegible]onal Planning at the University of Illinois (Champaign - Urbana). In addition, I am the Director of the Regional Economics Applications Laboratory which is a joint venture between the Federal Reserve Bank of Chicago and the University of Illinois.

4. A true and accurate copy of my curriculum vitae is attached hereto as Exhibit A.

5. I was asked to study the social and economic impact of the remedy selected by the United States Environmental Protection Agency ("EPA") for the City of Granite City, Illinois. As I understand it, that remedy calls for the excavation and removal of ground soils in parts of Granite City in order to reduce the level of lead in the soils.

6. In the past, I conducted similar studies to determine the social and economic impact on cities relating to decisions by government and private industry. For example, I studied the social and economic impact on Rantoul and Champaign County, Illinois, of the closure of Chanute Air Force Base. I also studied the social and economic impact of the recent flood in Chicago on the businesses in the affected area and the potential losses that resulted. Other studies in which I participated are found in my resume, a true and accurate copy of which is attached hereto as Exhibit B.

7. In order to conduct my study, I researched the history of Granite City, its demographics, its employment trends, its manufacturing changes, and its income levels in the area. In addition, [redacted]nducted site investigations throughout Granite City. I [redacted] conducted surveys of residents and businesses in Granite City.

8. I reached several opinions concerning the social and economic impact on Granite City if the remedy chosen by the EPA

is commenced. My opinions are based upon my extensive background and experience and my research concerning Granite City. They are founded upon a reasonable degree of scientific certainty using the standard methods and procedures commonly employed in the field of regional economic analysis.

9. In my opinion, the remedy chosen by the EPA will adversely impact the residents and businesses in Granite City.

10. For the residents of and businesses in Granite City, the EPA's actions to this point have created great confusion and uncertainty. They are vitally interested in the EPA's claims about the lead in the soils but believe that inadequate and unintelligible information has been distributed to them. As a result, they do not know what is the problem, how the EPA wishes to rectify the problem if one exists, how extensive the remedy may be, and how long it may take.

11. The EPA's remedy has reduced property values in Granite City. This decrease has affected the residents directly, and many now are unable to move from the area without suffering a great financial loss on the sale of their homes. Others are simply unable to sell their property. At a minimum, these decreased property values will continue during the ten years that the EPA e[illegible]s to take to complete the remedy.

12. [illegible]he remedy is commenced, the impact on businesses in Granite City will be devastating. Residents and customers, who frequent businesses in the downtown area of Granite City, will face increased traffic, congestion, and delays relating to the

remedy. Rather than put up with these inconveniences, residents and visitors will shop and do business in the surrounding areas away from Granite City. As a result, the potential exists for businesses in downtown Granite City to fail.

13. The impact on decreased property values and less businesses in Granite City will directly affect tax revenues. Simply put, as property values and the number of viable businesses decrease, tax revenues will decrease. The net effect is less money available to provide municipal services to the residents of Granite City.

14. I understand that the EPA recently embarked on a piecemeal approach to the selected remedy. A piecemeal approach will increase the already existing uncertainty among the residents and businesses in Granite City. Regardless of how the remedy is approached, the social and economic impact on Granite City remains the same. A piecemeal approach, however, has the potential to accelerate the social and economic impact on the residents and businesses in Granite City.

FURTHER AFFIANT SAYETH NOT.

VERIFICATION

In accordance with 28 U.S.C. § 1746, I, Geoffrey J. D. Hewings, declare, certify, verify and state under penalty of perjury under the laws of the United States of America that the foregoing affidavit is true and correct. Executed this 10 day of June, 1996.

Geoffrey J D Hewings

Geoffrey J. D. Hewings

Ex. A

CURRICULUM VITAE

NAME	Geoffrey John Dennis Hewings
DATE OF BIRTH	March 12, 1943
CURRENT POSITION ADDRESS	Professor and Director, Regional Economics Applications Laboratory University of Illinois at Urbana-Champaign, 607 S. Mathews, #220, Urbana, Illinois 61801-3671
PHONE/FAX	(217) 333-4740/(217) 244-1785 (312) 322-5842/(312) 322-2357

EDUCATION	B.A.(Honors)	University of Birmingham, England 1965
	M.A.	University of Washington, Seattle 1967
	Ph.D.	University of Washington, Seattle 1969

M.A. Thesis: *Persistence of Precipitation and No Precipitation Described by a Markov Chain Probability Model: Case Studies from Selected Stations in Washington State*

Ph.D. Dissertation: *Regional Interindustry Models Derived from National Data: The Structure of the West Midlands Economy*

PRIMARY POSITIONS HELD

1965-68	***Teaching Assistant/Pre-Doctoral Associate,*** Department of Geography, University of Washington, Seattle
1968-69	***Woodrow Wilson Dissertation Fellow***, Department of Geography, University of Washington, Seattle
1969	***Instructor*** (fall), Olympic College, Bremerton, Washington
1970-71	***Senior Research Associate***, Center for Research in the Social Sciences and ***Seminar Instructor***, Economics, University of Kent, Canterbury, England
1971-74	***Assistant Professor***, Division of Social Sciences, Scarborough College and Department of Geography, St. George Campus, University of Toronto, Ontario
1974-82	***Associate Professor***, Department of Geography, University of Illinois, Urbana, Illinois.
1982	(Jan-Jun) ***Acting Head***, Department of Geography, University of Illinois, Urbana, Illinois.
1982-83	***Associate Professor***, Departments of Geography and Urban and Regional Planning, University of Illinois, Urbana, Illinois.
1983-1990	***Head of Geography Department***, University of Illinois, Urbana, Illinois.
1983-	***Professor***, Departments of Geography and Urban and Regional Planning.
1989-	***Director***, Regional Economics Applications Laboratory [Joint venture between the Federal Reserve Bank of Chicago and the University of Illinois]

SHORT-TERM POSITIONS HELD

1968 ***Visiting Lecturer*** (Summer Session), Department of Geology and Geography, University of Massachusetts, Amherst

1981 ***Visiting Scholar*** (May-August) Department of Economics, University of Queensland, St. Lucia, Queensland, Australia.

1983 ***Visiting Scholar***, (May-June) Korea Research Institute for Human Settlements, Seoul, Korea

1985 ***Visiting Scholar*** (May-August) Department of Economics, University of Queensland, St. Lucia, Queensland, Australia.

1987 ***Visiting Scholar*** (January) Department of Geography, Bar Ilan University, Ramat Gan, Israel

1989 [July], **1990** [July], **1991** [February and June] ***Visiting Scholar*** Interuniversity Center in Economics, Universitas Indonesia, Jakarta

RESEARCH EXPERIENCE

Consultant, *National Park Economic Impact Study*, University of Washington, 1969

Consultant, *Research in the Application of Input-Output Interregional Analysis to State Planning and Program Activities: Subarea Economic Analysis*, University of Washington, 1969

Senior Research Associate, *South-East Kent Input-Output Study*, University of Kent, Canterbury, England 1970-71

Co-Principal Investigator, *Development of a System for Projecting Sub-State Employment and Population for the State of Illinois*, 1975, University of Illinois ($16,000)

Co-Principal Investigator, *Macro-Economic Impact of Environmental Legislation*, 1975-1976, University of Illinois ($26,000)

Consultant, *Macro-Economic Impact of Environmental Legislation*, Illinois Institute of Environmental Quality, 1976-77

Consultant, *Evaluat[illegible] the Rational Threshold Value System of the Economic Impact Forecast System*, U.S. Army [illegible]ction Engineering Research Laboratory, 1977

Associate Investigator, *Ohio River Basin Energy Demand Study*, USEPA 1977-1978 ($108,000)

Consultant, *Measurement of Regional Development Indicators*, U.S. Army Corps of Engineers Waterways Experimental Station, 1978.

Principal Investigator, *Evaluation of Methods for Generating Sub-State Input-Output Tables from State Input-Output Models*, Bureau of the Budget, State of Illinois, 1978 ($2,500).

Principal Investigator, *Space-Time Employment Modeling*, NSF, 1978-1980 ($46,000).

Consultant, *Organization of Regional Centers for the Provision of Energy Management and Conservation Assistance to Communities*, Argonne National Laboratory, 1978

Consultant, *Development of a Model for Monitoring and Evaluation of Regional Development Projects, Ministry of Coordination*, Athens, Greece, 1979-1980

Principal Investigator, *Preparation and Testing of Alternative Methods for Disaggregating County Data*, U.S. Army CERL, 1980 ($13,000)

Co-Principal Investigator, *Development of Regional and Interregional Accounting Systems for Project Selection, Monitoring and Evaluation in Developing Rural Economies*, US AID Title XII Strengthening Grant, 1980-1981 ($20,000)

Principal Investigator, *Holistic and Partitive Accuracy in Regional Input-Output Analysis*, NSF, 1982-84 ($76,000)

Principal Investigator, *Feasibility Analysis for Incorporation of Sector Specific Input-Output Type Multipliers in EIFS*, U.S. Army CERL, 1982 ($9,600)

Principal Investigator, *Sensitivity Analysis in Regional Interindustry Modelling*, NSF 1984-86 ($56,000)

Principal Investigator, *Incorporation of Migration Impacts into EIFS* U.S. Army CERL, 1985 ($9,800)

Co-Principal Investigator, *Assessing the Impacts of Increased Agricultural Value-Added on Illinois' Economy: an Input-Output Model Application*, College of Agriculture, University of Illinois, 1987-88 ($37,500)

Co-Principal Investigator, *Economic and Physical Impacts from Extreme Fluctuations in Lake Michigan Levels along the Illinois Shoreline*, US EPA, 1987-88 ($36,000)

Principal Investigat[redacted]*ensions to an Interregional Computable General Equilibrium Model for Korea*, SSRC, 1988-[redacted]2,000)

Co-Principal Investigator, *Development of an Illinois Input-Output Model and Extensions*, Federal Reserve Bank of Chicago, 1988-89 ($50,000)

Principal Investigator, *New Directions in Input-Output Modeling*, NSF, 1989-1991 ($114,000)

Co-Principal Investigator, *Development of an Integrated Forecasting Model of the Chicago Economy*, Chicago Economic Development Commission, 1989-90 ($45,000)

Principal Investigator, *Development of a Prototype Computable General Equilibrium Model to Estimate the Impacts of the US-Canada Free Trade Agreement on the Midwest and Northeast Economies*, Economic Development Administration, US Department of Commerce, 1989-1991 ($117,000)

Principal Investigator, *Development of an Integrated Forecasting Model for the State of Iowa*, Legislative Fiscal Bureau, State of Iowa, 1990-1991 ($100,000)

Principal Investigator, *Scenario Development and Occupational Forecasts for the Chicago Economy*, Chicago Economic Development Commission, 1990-1991 ($35,000)

AWARDS

Fulbright Travel Grant, 1965

Woodrow Wilson Dissertation Fellowship, 1968-1969

PUBLICATIONS

(1) Monographs

Geoffrey J.D. Hewings: **Regional Industrial Analysis and Development** (1977, Methuen, London, St. Martin's Press, N.Y.).

John Rees, Geoffrey J.D. Hewings and Howard A. Stafford eds.: **Industrial Location and Regional Systems** (1981 Bergin, New York: Croom Helm, London).

Geoffrey J.D. Hewings: **Regional Input-Output Analysis** (Beverley Hills: Sage Scientific Geography Series 1985; Second Printing, 1989)

I. Orishimo, Geoffrey J.D. Hewings and P. Nijkamp eds.: **Information Technology and Urban-Environmental Systems** (Springer-Verlag, 1988)

John J. LL Dewhu[illegible]offrey J.D. Hewings and Rodney C. Jensen eds: **Regional Input-Output Modelling: New D[illegible]ments and Interpretations** (Avebury, 1991)

(2) Chapters in Books

Geoffrey J.D. Hewings and Breandan O'hUallachain "The Role of Industrial Factors in the Development of Regional Systems," in F.E.I. Hamilton and G.R. Linge (eds) **Spatial Analysis, Industry and Industrial Environment**, Volume 3 (Wiley, 1983), 41-57.

Geoffrey J.D. Hewings and Peter Dicken "The Changing Organisational Structure of Regional Economies and the Role of Transnational Corporations: Some Research Issues in B. T. Robson and J. Rees (eds.) **Geographical Agenda for a Changing World** SSRC, London, 1982, 57-77.

Geoffrey J.D. Hewings "Regional and Interregional Accounting Systems for Development Planning under Conditions of Limited Information" in P. Nijkamp and L. Chatterji (eds.) **Urban and Regional Policy Analysis in Developing Countries** (Croom Helm, London 1983), 181-202.

Geoffrey J.D. Hewings and Yong-Jae Lee "National-Regional Accounting Systems for Regional Development for Regional Development in Developing Countries" in G-C. Lim (ed.). **Urban Planning and Spatial Strategies in Rapidly Changing Societies**, Princeton: Woodrow Wilson School, 1983, pp. 187-206.

Geoffrey J.D. Hewings "Limited information in spatial analysis and development planning" in G. Bahrenberg, M. Fischer and P. Nijkamp (eds.), **Theory and Measurement in Spatial Data Analysis**, (Gower, London 1984), 145-162.

Geoffrey J.D. Hewings "Problems of Integration in the Modelling of Regional Systems" in P. Batey and M. Madden (eds.) **Integrated Analysis of Regional Systems** (London, Pion 1986).

Geoffrey J.D. Hewings and R.C. Jensen "Regional and Interregional Input-Output Models" in E.S. Mills and P. Nijkamp (eds.) **Handbook in Urban and Regional Economics** (Amsterdam, North Holland, 1986), 295-355

Geoffrey J.D. Hewings "Transportation and Energy" in S. Hanson (ed.) **Urban Transportation** (Guildford Press, New York, 1986), 280-300

Geoffrey J.D. Hewings "Industrial Complex Analysis" in J. Clapp and S. Messner (eds) **Real Estate Market Analysis** (New York,Praeger, 1988), 17-46

Geoffrey J.D. Hewings, R.C. Jensen and M. Sonis "Fields of influence of technological change in input-output models," in I. Orishimo, P. Nijkamp and G.J.D. Hewings (eds) **Information Technology and Urban-Environmental Systems** (Springer-Verlag, New York & Berlin 1988), 163-194

M. Sonis and Geoffrey J.D. Hewings, "Superposition and decomposition principles in hierarchical social accounting and input-output analysis," in F. Harrigan and P. McGregor (eds.) **Recent Advances in Regional Economic Modelling** (London, Pion, 1988), 46-65

M. Sonis and Geoffrey J.D. Hewings "Error and sensitivity input-output analysis: a new approach," in R.E. Miller, K.R. Polenske, A. Rose (eds.) **Frontiers of Input-Output Analysis** (New York, Oxford, 1989)

M. Sonis and Geoffrey J.D. Hewings "The `Matrioshka Principle' in the hierarchical decomposition of multiregional social accounting systems," in L. Anselin and M. Madden (eds.) **New Directions in Regional Analysis: Integrated and Multiregional Approaches** (London, Pinter, 1990)

A.J. Reynolds and Geoffrey J.D. Hewings, "Airline network structure and regional economic development: US case studies," in K. Peschel (ed) **Infrastructure and the Space Economy** (Berlin: Springer-Verlag)

Geoffrey J.D. Hewings, "Death as final demand: the contributions of Sir Richard Stone to Regional Science," in I. Gordon (ed) **Cambridge Economists and Regional Science** (London, Macmillan, forthcoming, 1991)

Michael Sonis and Geoffrey J.D. Hewings, "Fields of influence and extended input-output analysis: a theoretical account," in John J. Ll. Dewhurst, Geoffrey J.D. Hewings and Rodney C. Jensen eds: **Regional Input-Output Modelling: New Developments and Interpretations** (Avebury, 1991)

Michael Sonis, Geoffrey J.D. Hewings and Rodney C. Jensen, "Structure of Regional Economic Activities: Input-Output Analysis Perspectives," in Frank Dietz, Willem Heijman and Daniel Shefer (Eds.) **Location and Labor Considerations for Regional Development** (Aldershot, Avebury, 1991)

Edison Hulu, Geoffrey J.D. Hewings and Iwan Jaya Azis, "Spatial implications of the export promotion strategy in Indonesia," in T.John. Kim. Gerrit Knaap, Iwan J. Azis (Eds.) **Spatial Development in Indonesia: Review and Prospect**, (Avebury, forthcoming, 1992)

(3) Journal Articles

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Geoffrey J.D. Hewings, "A Note on Forecasting the Economic Base," **Professional Geographer**, 21(5) 1969, 315-318.

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Geoffrey J.D. Hewings, "Threshold Analysis and Urban Development: An Evaluation," **Annals of Regional Science**, 9(3) 1975, 21-31.

Geoffrey J.D. Hewings, "On the Accuracy of Alternative Models for Stepping-Down Multi-County Employment Projections to Counties," **Economic Geography**, 52(3) 1976, 206-217.

Geoffrey J.D. Hewings, "Evaluating the Possibilities for Exchanging Regional Input-Output Coefficients," **Environment and Planning**, 9(8) 1977, 927-944.

Geoffrey J.D. Hewings, D.M. Chicoine and G.A. Silbert "The Economic Impact of the University of Illinois on the State of Illinois," **Illinois Business Review**, (November 1977).

Geoffrey J.D. Hewings, "The Trade-Off Between Aggregate National Efficiency and Interregional Equity: Some Recent Empirical Evidence," **Economic Geography**, 54(3) 1978, 254-263.

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Geoffrey J.D. Hewings, R.C. Jensen, G.R. West, M. Sonis and R.W. Jackson "The spatial organization of production: an input-output perspective," **Socio-Economic Planning Sciences**, 23 (1989) 67-86

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Michael Sonis and Geoffrey J.D. Hewings "Coefficient change in input-output models: theory and applications," (**Economic Systems Research**, forthcoming, 1992)

MANUSCRIPTS UNDER REVIEW

M. Madden and Geoffrey J.D. Hewings (eds.) **Essays in Honour of Sir Richard Stone** [Collection of original articles in honor of the 1984 Nobel Laureate in Economics] (Cambridge University Press)

Geoffrey J.D. Hewings, Michael Sonis, Jong Kyun Lee and Sarwar Jahan, "Alternative decompositions of interregional social accounting matrices: applications with reference to Bangladesh," in M. Madden and Geoffrey J.D. Hewings (eds.) **Essays in Honour of Sir Richard Stone** (Cambridge University Press)

Michael Sonis, Geoffrey J.D. Hewings and Jong Kyun Lee, "Interpreting spatial economic structure: three perspectives," (**Geographical Analysis**)

Sarwar Jahan and Geoffrey J.D. Hewings, "Spatial impacts of regional development programs in Bangladesh using a four-region social accounting model," (**Papers in Regional Science**)

Federico Cuello, Fayçal Mansouri and Geoffrey J.D. Hewings, "The identification of structure at the sectoral level: Implications of reformulating the Hirschman-Rasmussen key-sector indices," (**Economic Systems Research**)

MANUSCRIPTS IN PREPARATION

M. Hatfield, Geoffrey J.D. Hewings, and M. Sonis "Comparative analysis of structural change in the Soviet Economy: a decomposition approach"

Edison Hulu and Geoffrey J.D. Hewings, "The development and use of interregional input-output models for Indonesia under conditions of limited information"

Geoffrey J.D. Hewings, Michael Sonis, Sarwar Jahan and J.H. Lee, "Alternative decompositions of social accounting matrices: an application to Bangladesh"

CURRENT RESEARCH INTERESTS

1. The development of regional general equilibrium and social accounting models.

2. Holistic matrix descriptors of regional interindustry systems and measures of regional interindustry structure over time and space.

3. The development of integrated socio-economic models for metropolitan and state planning and impact analysis.

TEACHING INTERESTS

Introductory:

Business Location Decision Making

Upper Undergraduate/Graduate:

Transportation Systems and Spatial Development
Regional Science Methods: Demographic and Economic
Advanced Methods of Regional Science
Issues in Regional Development

INVITED PRESENTATIONS

University of Washington
Australian National University, Canberra
Arizona State University
U.S. Air Force Academy
West Virginia University

Interamerican University, Puerto Rico
Sangamon State University, IL
Governor's Recreation Conference, IL
Korea Research Institute on Human Settlements
Bar Ilan University
Tel Aviv University
CSIRO, Melbourne
York University, Canada
Universita Bocconi, Milano
University of Colorado
University of Maryland
University of Tsukuba

Portland State University
University of Queensland
Rutgers University
University of Iowa
University of New England, Armidale
Seoul National University, Korea
Northern Illinois University

Haifa University
Hebrew University of Jerusalem
University of Chicago
CLAS, Milano
Universitas Indonesia
University of Manchester, UK
North Carolina University
CRIEPI, Tokyo

ADMINISTRATIVE EXPERIENCE

Departmental

Awards and Admissions Committee 1975-78
Chairman, Cartography Position Search Committee 1976-77
Advisory Committee, 1977-79 1980-83 1991-
Acting Head, January-June, 1982 May-August 1983
Head, August 1983-1990

Defense Spending and Regional Growth

The procedure attempted to document the dependence of regions within the US on defense spending in terms of both direct (primary contracts) and indirect effects (sub and sub-sub contracts)

New York State Aviation Activity Forecasts Study* (New York State Department of Transportation)

Broadly based assessment of the impact of future growth and development trends on the organization and structure of aviation in New York State with primary emphasis on scheduled carrier service.

Development of an Integrated Econometric Input-output Model for Iowa (State of Iowa)

The model will be similar in scope to the one developed for Chicago; the model will provide the capability to undertake impact analyses and provide annual forecasts for the period 1990-2010.

Competition and Complementarity Among the US Regions

Analysis has been conducted to examine the degree to which growth and decline in one part of the US is associated with growth and decline in other regions. Using US Census Regions, the analysis has revealed significant changes in the shares of gross national product allocated across regions and projections of theses shares have been made to 2050.

3. International

Development of an Input-Output Model for SE Kent (U.K.)

Feasibility study for the construction of an input-output model for this region.

Development of an Interregional Computable General Equilibrium Model for Korea for Development Planning and Policy Evaluation

The model linked factor and product markets and was used to assess the impacts of increased exports, increased spending and investment on individual sectors and regions within the Korean economy. This model was the first of its kind to be developed at the regional and interregional levels.

Development of an Interregional Social Accounting Model for Bangladesh for Measurement of the Impact of Agricultural Programs

The model was developed to assist in estimating the degree to which projects undertaking in one region to raise agricultural output provided employment and income impacts elsewhere in the country.

Development of a Social Accounting Model for Evros, Greece, for Policy Selection, Monitoring and Evaluation (Greek Ministry of Coordination)

Using a semi-survey method, a reduced form social accounting system was developed for this small region in NE Greece to facilitate planning development in anticipation of Greece's entry to the Common Market.

Comparative Analysis of the Structure of Australian Regional Economies (Queensland Department of the Treasury)

An attempt to isolate the degree to which economies of different size might share some common "fundamental economic structure" and thus facilitate the preparation and development of future models of their economies.

Impact of the US-Canada Free Trade Agreement on the Midwest Economies* (Economic Development Administration, U.S. Department of Commerce)

This project has focused on the regional (state level) impacts of the US-Canada Free Trade Agreement, with particular attention to the Midwest states' economies and those of New York, Pennsylvania and new England. The preliminary results suggest that the impacts are likelt to be very small although for some specific industries, the results indicate changes that exceed the annual growth in that industry for a typical year. Consideration is now being given to extending this work to include the effect of adding Mexico to the Free Trade Area in North America.

Development of a Set of Interregional Models for Impact Analysis and Policy Evaluation in Indonesia* (University of Indonesia/Midwest Universities Consortium for International Activities/Government of Indonesia/World Bank)

Development of a set of models for a 5-region division of the Indonesian economy for purposes of evaluation of alternative regional development policies. The 5-region interregional input-output models for 1980 and 1985 are complete; a two-region social accounting model has been produced and plans are now being made to develop a 5-region social accounting system and a computable general equilibrium model.

EX. B

IN THE UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF ILLINOIS

UNITED STATES OF AMERICA, Plaintiff, vs. NL INDUSTRIES, INC., ET AL Defendants, and CITY OF GRANITE CITY, ILLINOIS, et al Defendants/Intervenors	)	Civil Action No. 91-CV-00578-JLF

AFFIDAVIT

I, William Baudendistel, being duly sworn, depose and state as follows:

1. Affiant is a Vice President of Juneau Associates, Inc. P. C., which firm is the contract engineer for the City of Granite City, and has held said position since 1992. In the firm's capacity as City Engineer, Affiant advises the City Council and City officials on all engineering matters referred to him, makes reports regarding public improvements, repairs of streets, bridges and sidewalks and, from time to time, is responsible for the design, construction, reconstruction, and repair of municipal sewers [redacted]structures, including the grading and improvement of street[redacted]eys, highways, and sidewalk spaces.

2. In the aforementioned capacity, Affiant has been directly involved in the City of Granite City's efforts to improve 16th Street. The construction includes a 30 foot face-to-face curb concrete pavement with a closed storm sewer system from Madison Avenue to Niedringhaus Avenue. The total cost of the project is

estimated to be approximately $1.5 million. Funding for the project is to come from a grant of approximately $770,000 from the Illinois Department of Transportation which is to be matched by Madison County and City of Granite City funds. The State fund will pay for nearly 1/2 of the construction costs, and County funds will pay for nearly 1/4 of said costs.

3. The 16th Street corridor is a vital, economic link for Granite City Steel, a Division of National Steel Corporation. Granite City Steel has modified the entrance/exit from its south plant so as to expedite truck traffic carrying galvanized steel from Madison Avenue to 16th Street, to Niedringhaus Avenue, and then to the interstate or to the railroad yard or barge terminal for distribution. Granite City Steel is the largest employer in Granite City and its existence and prosperity is critical to the City's economic viability.

4. A recent environmental sampling of soils from locations along the 16th Street alignment performed by SCI Engineering Inc., identified a number of samples below and greater than 500 ppm for total lead. The environmental engineering analysis provided by SCI Engineering Inc. to the City surmises that because the project site is cons[illegible]d to be a portion of the NL Superfund site which dictate[illegible] excavation to a 500 ppm standard, that health and safety procedures as outlined in 29 CFR 1910.120 for hazardous waste sites must be followed. It is concluded that excavation of and along certain portions of 16th Street may result in special or hazardous waste, which will cause health and safety procedures to be implemented during construction due to the concentrations of

total lead, and result in the special or hazardous waste being hauled to an appropriate landfill.

5. Based on the foregoing, construction estimates for the 16th Street project have been significantly increased, and it has been preliminary determined the additional construction and project costs due to the City having to abide by the 500 ppm standard, will range from $400,000 to $1.5 million.

6. The City of Granite City does not have available the funding for the additional clean-up costs associated with the 500 ppm standard and, unless some other resolution is reached, the funding promised for the project is jeopardized. In this event, there is no immediate expectation that 16th Street will be constructed.

Further Affiant sayeth not.

William Baudendistel, P.E.
Juneau & Associates
2100 State Street
Granite City, IL 62040

SUBSCRIBED AND SWORN to me, a Notary Public, on this 4 day of June, 1996.

NOTARY PUBLIC

21850

"OFFICIAL SEAL"
DIANE SIGNALL
NOTARY PUBLIC - STATE OF ILLINOIS
COMMISSION EXPIRES APR 23, 19

IN THE UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF ILLINOIS

UNITED STATES OF AMERICA, Plaintiff, vs. NL INDUSTRIES, INC., ET AL Defendants, and CITY OF GRANITE CITY, ILLINOIS, et al Defendants/Intervenors	)	Civil Action No. 91-CV-00578-JLF

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2. In the aforementioned capacity, Affiant has been directly involved in the City of Granite City's efforts to improve 16th Street. The construction includes a 30 foot face-to-face curb concrete pavement with a closed storm sewer system from Madison Avenue to Niedringhaus Avenue. The total cost of the project is

estimated to be approximately $1.5 million. Funding for the project is to come from a grant of approximately $770,000 from the Illinois Department of Transportation which is to be matched by Madison County and City of Granite City funds. The State fund will pay for nearly 1/2 of the construction costs, and County funds will pay for nearly 1/4 of said costs.

3. The 16th Street corridor is a vital, economic link for Granite City Steel, a Division of National Steel Corporation. Granite City Steel has modified the entrance/exit from its south plant so as to expedite truck traffic carrying galvanized steel from Madison Avenue to 16th Street, to Niedringhaus Avenue, and then to the interstate or to the railroad yard or barge terminal for distribution. Granite City Steel is the largest employer in Granite City and its existence and prosperity is critical to the City's economic viability.

4. A recent environmental sampling of soils from locations along the 16th Street alignment performed by SCI Engineering Inc., identified a number of samples below and greater than 500 ppm for total lead. The environmental engineering analysis provided by SCI Engineering Inc. to the City surmises that because the project site is considered to be a portion of the NL Superfund site which dictates excavation to a 500 ppm standard, that health and safety procedures as outlined in 29 CFR 1910.120 for hazardous waste sites must be followed. It is concluded that excavation of and along certain portions of 16th Street may result in special or hazardous waste, which will cause health and safety procedures to be implemented during construction due to the concentrations of

total lead, and result in the special or hazardous waste being hauled to an appropriate landfill.

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6. The City of Granite City does not have available the funding for the additional clean-up costs associated with the 500 ppm standard and, unless some other resolution is reached, the funding promised for the project is jeopardized. In this event, there is no immediate expectation that 16th Street will be constructed.

Further Affiant sayeth not.

William Baudendistel, P.E.
Juneau & Associates
2100 State Street
Granite City, IL 62040

SUBSCRIBED AND SWORN to me, a Notary Public, on this 4 day of June, 1996.

NOTARY PUBLIC

21850

"OFFICIAL SEAL"
DIANE SIGNALL
NOTARY PUBLIC - STATE OF ILLINOIS
COMMISSION EXPIRES APR 23, 19

EX. C

STATEMENT OF
DR. RENATE D. KIMBROUGH
SENIOR MEDICAL ASSOCIATE
INSTITUTE FOR EVALUATING HEALTH RISKS
SUITE 608, 1101 VERMONT AVENUE, N.W.
WASHINGTON, DC 20005
BEFORE THE
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION
U.S. HOUSE OF REPRESENTATIVES
TUESDAY, JUNE 9, 1992

Good Morning, Mr. Chairman and members of the Subcommittee. I am Dr. Renate D. Kimbrough, Senior Medical Associate with the Institute for Evaluating Health Risks, Washington, DC. I am pleased to have this opportunity to provide information on the Granite City Blood Lead Study.

The subject of my testimony is a discussion of preliminary results of a recent health study in Granite City, Illinois, to determine blood lead levels in children living around a defunct smelter, the National Lead Industries/Taracorp site. The study was conducted because high concentrations of lead in soil were found in areas around the defunct smelter and in yards of adjacent residential areas. The citizens had requested a health study because of statements made by the U.S. Environmental Protection Agency regarding the hazards of lead and the potential for harm associated with lead-contaminated soil. The study was funded by the Agency for Toxic Substances and Disease Registry through the Illinois Department of Public Health. The Institute for Evaluating Health Risks, a non-profit Organization where I am employed, conducted the study for the Illinois Department of Public Health.

The focus of the study was on children under 6 years of age. Children of this age group are more likely to get exposed and to take up lead from lead contaminated environments. We recruited children from the proposed EPA clean up area (determined as soil in excess of 500 ppm lead) but also from areas outside the clean up area. We also determined blood lead levels in older children and adults, including some pregnant women. Contractors hired by the EPA collected soil samples, dust samples in the houses, tap water samples, and measured the lead in indoor paint. The Illinois Department of Public Health collected soil samples and measured the lead in outdoor paint. This work was completed in October of 1991. At the moment we have the results of the blood lead analyses which were performed at the laboratory of the Centers for Disease Control. We have received the results of the soil analyses collected by the Illinois Department of Public Health and the results of the measurements of lead in inside and outside paint. We have not received the results from the analyses of soil, house dust and tap water collected by the EPA and have no indication when these sample results will be available.

In the study area most houses were built before 1920 and have old paint with high concentrations of lead. Predominant sources of lead were paint in houses and lead in soil. Eight hundred and twenty-seven people from 389 households participated in the study (Table 1). The mean venous blood lead in 492 children under age six was 6.9 ug/dl (range 0.7 - 40.2 ug/dl); 78

had blood lead levels above 10 ug/dl, the present level of concern established by the Centers for Disease Control in October 1991; 7 children (less than 1%) had blood lead levels of 25 ug/dl or greater, the previous level of concern of the Centers for Disease Control. Two hundred and twelve children (ages 6-14) had mean blood lead of 4.4 ug/dl with a range of 0.2 - 18.8 ug/dl and 8 children had blood lead levels above 10 ug/dl. Among the population over 15 years of age, 123 were tested. Their mean blood lead level was 3.6 ug/dl and three participants had blood lead levels over 10 ug/dl as a result of occupational exposure or hobbies. Furthermore, in the initial testing 58 of the children with elevated blood lead levels had only slightly elevated blood lead levels for which CDC recommends only counseling and which were no greater than 15 ug/dl.

Intervention consisted of home visits and counseling of parents of children with blood lead levels of 10 ug/dl or above. The parents were told where in their homes paint with high lead levels existed, these areas were inspected and suggestions for short-term and long-term remediation were made, such as covering peeling paint with contact paper and putting furniture in front of peeling paint on window sills. They were instructed in house cleaning. They were warned to contact the Illinois Department of Public Health prior to starting any renovations of their homes. The parents were also instructed to wash children's hands before eating and before putting them to bed, to clip their fingernails short, and assure that they receive an adequate diet. The

affected children and their older siblings were also given these instructions and the older children were asked to help in the supervision of their younger brothers and sisters. A repeat blood lead test 4 months later in children with initial blood lead levels above 10 ug/dl showed a pronounced drop with most blood lead levels below the CDC 10 ug/dl level of concern (Table 2).

An examination of the reason for why some children had elevated blood lead levels is not complete since results of the analysis of the environmental samples collected by the EPA have not been reported to the Institute for Evaluating Health Risks, the Illinois Department of Public Health or the Agency for Toxic Substances and Disease Registry. Based on our results of soil analyses and measuring lead in paint inside and outside of the houses and by looking at the distribution of the houses where children lived with elevated blood lead levels some preliminary conclusions can be drawn. Children with higher blood lead levels did not necessarily live in houses surrounded by higher soil lead levels. Houses with high soil lead levels were about as likely to have children with low blood lead levels (Figures 1 and 2). The analysis of lead in soil revealed that lead levels in soil close to the houses were much higher (probably paint contamination) than in other parts of the yard. Children with elevated blood lead levels or with low blood lead levels were relatively evenly distributed throughout the entire study area, suggesting that soil lead levels had a minor effect on blood lead levels

(accounting for less than 7% of the variance in blood lead). Thus, it would appear that children do not get clinically important amounts of lead from soil in the Granite City area. The total percent of elevated blood lead levels is similar to what one would expect to find in many communities even if no smelter existed.

When visiting all of the families whose children had elevated blood lead levels we found that reasons for the elevations varied, they included renovation of old houses, houses with peeling indoor or outdoor paint, fill dirt in a garage with very high levels of lead, production of lead sinkers in the basement of a house to give a few examples. The parents and their children received extensive counseling in the prevention of lead exposure. The repeat blood lead level determination demonstrates that this counseling seems to have been effective. However, it must be kept in mind that blood lead levels fluctuate somewhat and additional monitoring of this population should be done. Unfortunately, I will not have the opportunity to continue this follow up.

This study shows that blood lead levels in the Granite City area are similar to blood lead levels in other urban areas of the United States and are much better than national blood lead levels reported in the late 1970s and early 1980s. There are many sources of lead. Lead in soil, although perhaps a contributing source in some cases, does not per se explain elevated blood lead levels in young children in the Granite City area. The study

further shows that counseling and educating parents and children about lead was effective in reducing blood lead levels.

Mr. Chairman, I appreciate the opportunity to provide the Subcommittee with this statement. I will be pleased to answer any questions you may have.

Table 1. Distribution of blood lead levels[a]

Age	No.	M	F	Mean BPb ug/ dl	Range BPb ug/ dl	No. 10 ug/ dl or above
6-71 mo.	492	261	231	6.9	0.7-40.2	78
6-14 yr.	212	111	101	4.4	0.2-18.8	8
15 yr.+	123	47	76	3.6	0.3-17.9	3
Total	827	419	408	5.8	0.2-40.2	89

[a] These levels are preliminary and may be subject to minor changes following additional data review.

Table 2.

Comparison of repeat blood lead levels (ug/dl) with original lead levels in 61 participants*

Age (No.)	First BPb ug/dl	Mean ug/dl	Second BPb range ug/dl	Mean ug/dl	Range of diff ug/dl	Mean range of diff ug/dl
6-71 mo (51)	10 - 35	15	3.5 - 12.7	7.8	2.9 - 24.1	7.2
6-14 yr (7)	10 - 19	13	5.6 - 9.2	7.3	2.8 - 10	5.9
15 yr+ (3)	12 - 18	14	5.5 - 9.7	7.4	6.2 - 8.2	7.0
Total	10 - 35	15	3.5 - 12.7	7.7	2.9 - 24	7.0

* These levels are preliminary and may be subject to minor changes, following additional data review.

Fig. 1: Children with High Blood Lead (n=74)

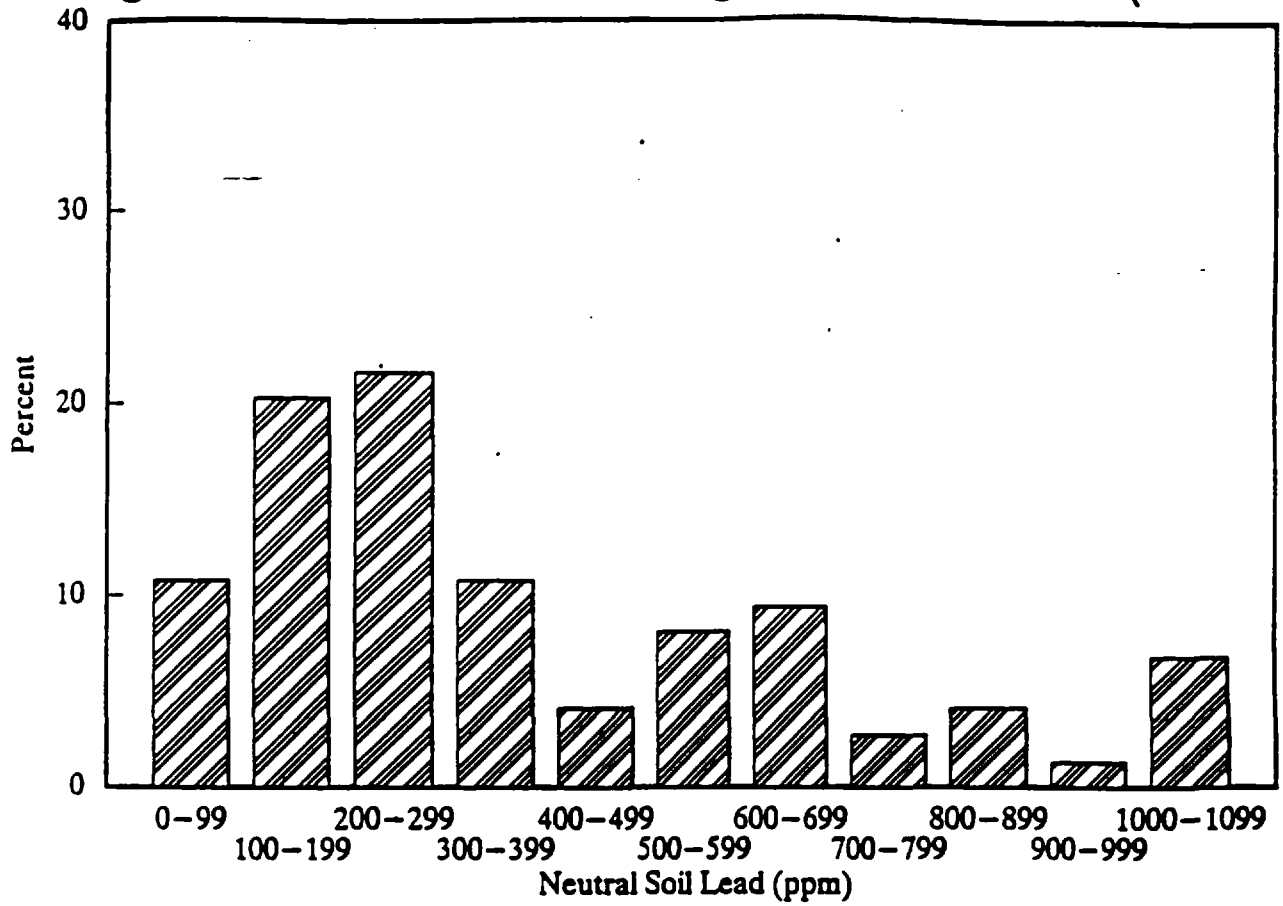
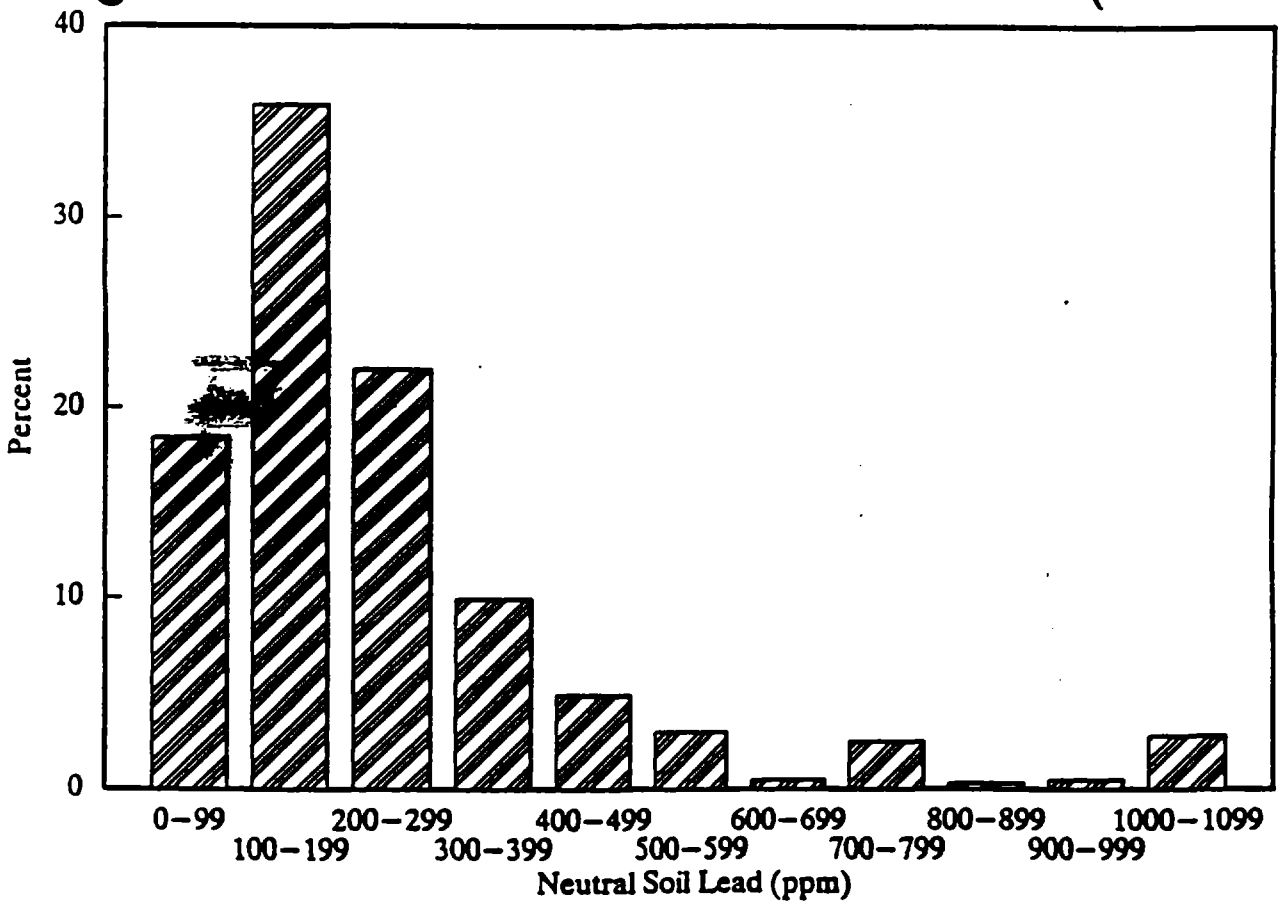


Fig. 2: Children with Low Blood Lead (n=392)



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Dirty Issue

Post 3/2

Two Mayors Want Tests On Residents Close To Slag Heap

By Sofi Ahmed
Of the Post-Dispatch Staff

The mayors of Granite City and Madison asked the U.S. Environmental Protection Agency on Thursday to conduct blood tests of thousands of residents in their cities before beginning a proposed $25 million cleanup of lead-contaminated soil.

"We want to make sure that if they are going to spend $25 million on a lead cleanup plan, that all appropriate agencies are convinced there is a serious health problem," said Granite City Mayor Van Dee Cruse, who has opposed the cleanup plan because he is unconvinced people are being harmed.

Cruse issued the statement after a meeting Thursday at the Washington office of U.S. Rep. Jerry Costello, D-Belleville. Also present at the meeting were Frank Covington, the EPA's deputy regional administrator, and Madison Mayor John Bellcoff.

Meanwhile, Thomas Long, a state health official, agreed with the mayors on the need for a detailed health study. He estimated that it would cost $200,000. He added that the state agency had no money to conduct such a study.

Although Covington agreed to look into the mayors' request, Brad Bradley, the federal environmental agency's remedial project manager in Chicago, said he doubted that the agency would change its cleanup plans

See LEAD, Page 6

Lead

From page one

based on blood tests.

"We really, at this point, would not use blood-lead data to change the cleanup level," Bradley said.

Bradley said that blood tests would provide information only on short-term effects, while the agency's proposal is designed to be a long-term solution.

Under the agency's proposal, the lead-contaminated soil in Granite City, in Madison and in some alleys in Venice would be dug up to bring the levels down to no more than 500 parts of lead for each million parts of soil. The levels in residents' yards now range from a few hundred to 30,000 parts of lead for each million parts of soil.

Under the plan, the contaminated soil would be dug up and taken back to its source: a 250,000-ton slag heap at the Taracorp Industries plant at 19th Street and Cleveland Boulevard in Granite City. The slag heap itself contains about 300,000 parts per million, or 30 percent, lead.

Cruse

Bellcoff

The entire heap would then be contained under layers of plastic, rock, clay and topsoil.

Under the plan, every yard and all exposed areas within a half-mile of the Taracorp site would be dug up, next to a depth of six inches, and the dirt hauled to the slag heap.

Lead poses a greater danger to children than to adults. In children, particularly those younger than 3, lead can cause damage to the nervous system, leading to learning, behavioral and psychological problems. Prolonged exposure at high levels can cause mental retardation.

Despite the warnings about lead contamination from Taracorp, no state or federal agency has ever conducted any detailed health study of the area's residents.

Long, a senior toxicologist at the Illinois Department of Public Health, said Thursday that he would very much like to conduct a thorough health study of residents in the Granite City area, but he said it would cost as much as $200,000. His agency lacks money for such a study, he said.

While he is not opposed to the EPA's cleanup plan, Long said he believes the EPA has picked an arbitrary cleanup level of 500 parts of lead for each million parts of soil.

"If that number has any validity, then let's test out those studies," Long said, adding that he wants any cleanup level to be based on a detailed health study.

"If they really want to protect the public health, they should clean it down to zero parts per million," he said.

The federal environmental agency held a public hearing last month on its proposal and will be taking public comments until March 12. Soon after, a decision on the cleanup will be made.

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GRANITE CITY PRESS-RECORD
Journal

Sunday, March 4, 1990

Verify lead level first, EPA told

By Jason Moody
Staff writer

WASHINGTON — Mayors from Granite City and Madison asked a senior Environmental Protection Agency official Thursday to explore alternatives to a $35 million plan for cleaning up lead deposits near Taracorp's lead products plant.

At a meeting on Capitol Hill attended by U.S. Rep. Jerry Costello, Mayors Von Dee Cruse of Granite City and John Bellcoff of Madison asked the EPA to consider conducting blood tests on local residents for any evidence of high lead levels before going forward with the plan.

"We want to make sure that if they are going to spend $35 million on a lead cleanup plan, that all appropriate agencies are convinced there is a serious health problem," said Cruse.

The EPA made no commitments at the meeting and has not yet decided on a plan of action, said John Grand of the EPA's regional office.

The EPA's $35 million plan would include removal of about 6 inches of soil from residential

(See LEAD, Page 6A)

•Lead

(Continued from Page 1A)

areas surrounding the Taracorp waste pile at 15th and State streets in Granite City. Local officials have expressed concern that the activity might disrupt business and inconvenience nearby residents.

"They told the EPA they don't want to get halfway through digging up people's yards and find out about new statistics that show the whole project wasn't necessary," said Costello spokesman Brian Lott about Thursday's meeting.

Brad Bradley, the EPA's Taracorp project manager, said the agency would welcome blood tests but the results would have no bearing on its extensive cleanup plans.

"Blood tests would give residents an indication of short-term impact of the lead and could help alleviate fears," Bradley said. "But they only provide a snapshot and are not a good indication of long-term effects."

High exposure to lead can damage the nervous and digestive system. It is most hazardous to children, often impairing mental development and stunting growth, according to the EPA.

The EPA is scheduled to make a final decision on a cleanup plan by March 30 and is accepting public comment until March 12.

NL (National Lead) Industries Inc., which sold its lead smelting company to Taracorp in 1979, has submitted its own cleanup proposal, which would cost about $6.8 million.

That plan would clean up all areas with lead levels of more than 1,000 parts per million, affecting about 1,000 residents. The EPA's plan would affect 3,000 to 4,000 households, and clean up all areas with lead levels higher than 500 parts per million.

Costello said he would continue to work with Frank Covington, the EPA official who met with the mayors Thursday, and try to reach a compromise.

"I was pleased with the cooperative attitude exhibited by Mr. Covington, and his willingness to listen to the mayors and commit to close communication with them on this very important matter," Costello said.

"I will continue to work with local officials and residents of the area to make sure that their concerns are heard by the U.S. EPA."

E002194

(Staff Photo by Mike Myers)

EN-YEAR-OLD Richard Berney holds 75 grams of contaminated dirt, the amount the U.S. Environmental ion Agency predicts a child eats each year.

EPA's figures don't add up scientifically, expert says

By Mike Myers
Staff writer

GRANITE CITY — The U.S. Environmental Protection Agency is being "almost intellectually dishonest" when it sets a soil lead level of 500 parts per million or greater as sole criteria for determining a health hazard, in the opinion of an industry expert.

And area mayors are "right on target" when demanding blood lead studies of local residents before cleaning up the Taracorp lead pile in Granite City, according to Daniel Vornberg, environmental manager for the Doe Run Company's Herculaneum (Mo.) Lead Smelter.

Vornberg is the industry member of the International Society of Environmental Geochemistry and Health task force which has spent two years preparing guidelines on lead in soil.

He said the scientific community is on the threshold of being able to establish a cause/effect formula for soil lead levels to blood lead levels. The results of the task force's study are due to be released in July.

"Until you can predict over and over again what (blood lead level) people will have based on the level of lead in the soil, you're not being honest when you set a number," Vornberg said.

But the EPA's Brad Bradley, project manager for the $25 million Superfund Taracorp lead contamination cleanup plan, said the cutoff level of 500 ppm is not going to change, no matter what a study of blood lead might show.

"A blood study is under consideration," Bradley said. "But we're not going to use it to set the cleanup level. ... It's not useful to us."

Bradley said a blood lead study would "only be useful" in establishing how much contamination has already taken place and not in establishing future risk.

"There is nothing wrong with the EPA wanting to reduce risk," Vornberg said. "But reduce risk based on science. The (soil lead) numbers they're using don't necessarily fit what current studies

(See LEAD EXPERT, Page 10A)

Child: 'Naw, I don't eat dirt'

GRANITE CITY — Seven-year-old Richard Berney looked at the handful of dirt a photographer had asked him to hold.

"Do you think you eat that much dirt a year?" he was asked.

"Naw, I don't eat dirt," he said.

"I do. I eat it all the time," bragged 10-year-old Joe Sitton.

Seeing that Richard didn't believe him, Joe added: "Mostly at night, when nobody else can see me."

Richard and Joe were playing in the alley between the 1700 blocks of Delmar Avenue and Cleveland Boulevard — near the middle of the Taracorp lead contamination cleanup area proposed by the U.S. Environmental Protection Agency.

Along with their neighbors — 8-year-old Jesse Lee Thompson, 7-year-old Chris Caldwell and 9-year-old Barbara Sitton — they were turning backflips and somersaults on an old mattress that was waiting for the trashman. Parents watched from nearby.

The photographer interrupted their play to ask Richard to pose with 75 grams of dirt — the amount the EPA model presumes a child eats in a year. That figure has been handled about recently as part of continuing developments in the Taracorp case.

The children said they play together outside from the time they get home from school at Prather Elementary until dark.

"Even after dark, sometimes," Richard said.

"Unless I'm grounded," Barbara said.

All of them had heard about lead in the dirt in their yards and looked toward the prospect of heavy equipment digging up their yards as an adventure.

Deciding which yards will be removed, and how deeply, is one of the EPA's next steps, according to Brad Bradley, EPA cleanup project manager.

The decision will be based on soil samples, he said, and not all the yards in the area shown on past maps will be torn up.

It's also possible, he said, some yards not included on current maps will be removed.

Bradley said the soil testing, and its accompanying design period, should take about a year.

•Lead expert

(Continued from Page 1A)

show."

Blood lead levels in children living around a Herculaneum, Mo., smelter were part of a nationwide study conducted in 1975 of heavy metal contamination in children living near primary non-ferrous smelters.

In 1984, Vornberg and Pat Phillips of the Missouri Department of Health repeated the study around the Herculaneum smelter based on the 1975 model.

At the same time, the study attempted to relate those blood lead levels to environmental sources such as soil lead using the EPA Biokinetic Uptake Model. Vornberg said that, using the model, the predicted blood level and actual blood level were close enough to merit further study.

For the 1984 study, soil lead and household dust lead levels were not measured, but, using the EPA model were predicted at 500 ppm in the areas closest to the smelter.

In 1985, actual soil and household dust samples were taken and, in the area closest to the smelter, were found to be 1,458 ppm and 2,080 ppm, respectively.

Using the actual data collected, a scientific paper presented at the "Lead in Soil: Issues and Guidelines" conference held in 1988 at Chapel Hill, N.C., by Vornberg, Phillips and James Lanzafame suggested modification of the amount of dirt eaten daily by children in the EPA's predictive model.

The EPA's model [illegible] a child eats an average of .2 grams, or 200 micrograms, of dirt a day. Based on field data from Herculaneum and three other sources, Vornberg and several other scientists say the actual amount should be 60 micrograms, or .06 grams a day.

The modified model matches actual data collected in 1975 and 1984 and, using the model, Vornberg was able to make a baseline projection for 1990. And, by varying the amounts of lead in the air, dust and soil, modified projections were made of what effect reductions in those levels would have.

The projected baseline blood lead level for 1990 would drop 3.9 micrograms per deciliter from the 1984 level of 13.8 micrograms per deciliter, to 9.9 micrograms per deciliter.

Using the same model, an 85 percent reduction in the soil lead level would lead to a blood lead level of 8.6 micrograms per deciliter or a 13.1 percent reduction.

A 50 percent reduction in indoor dust lead would lead to a blood lead level of 6.6, or a 33.3 percent reduction, and a 75 percent reduction in indoor dust lead would bring a blood lead level of 5.0, or a 49.5 percent reduction.

The conclusion to the Vornberg, Phillips and Lanzafame study says:

"As a result of the study at Herculaneum, the authors are advocating that the biokinetic uptake model or a subsequent, more sophisticated version be used in developing a strategy to reduce blood lead levels in a community where a documented health problem exists.

"It is clear from the predictive power of this tool that we have moved beyond designating a simple soil lead standard or air lead standard and we must attack the problem on a case-by-case basis analyzing all of the sources and pathways.

"In addition, we must not overlook house-specific plumbing, paint or ceramic ware problems."

Bradley said the 500 ppm level would continue to be used as the criteria for cleanup of lead-contaminated soil in Granite City, Madison, Venice and Eagle Park.

The plan calls for removal of soil in residential areas with a lead level of 500 ppm or greater.

He said the level was set because there is no current standard for safe lead levels in soil and because a complete quantitative risk assessment cannot be done.

"To be considered our guideline is 500 ppm to 1,000 ppm for residential soil," Bradley said. "Our only question is where to go in that range.

"In Granite City we decided on 500 ppm because the contamination came from a smelter stack, making it the most transmittable, because residential areas are located directly around the site and because Granite City is an industrial town with additional health risks beyond the lead."

Military

Larry Brock

Navy Seaman Recruit Larry G. Brock, son of Larry G. and Mary F. Brock of Mitchell, has completed recruit training at Recruit Training Command, Orlando, Fla.

In the eight-week training cycle, Brock studied general military subjects designed to prepare him for further academic and on-the-job training in one of the Navy's 85 basic fields.

His studies included seamanship, close order drill, Naval history and first aid. Personnel who complete this course of instruction are eligible for three hours of college credit in physical education and hygiene.

A 1989 graduate of Granite City High School, Brock joined the Navy in August 1989.

Leslie Holik

Army Sgt. 1st Class Leslie H. Holik has been decorated with the sixth award of the Good Conduct Medal in West Germany.

The award was presented for exemplary conduct while in the active service of the United States.

He is a quality assurance inspector with Headquarters and Headquarters Detachment, Combat Equipment Battalion East, West Germany.

Holik is the son of Virginia Holik of Granite City.

The sergeant is a 1969 graduate of Granite City High School.

Forms for free bridal announcements are available at the paper, 1815 Delmar Ave., Granite City, Ill. 62040. Contact us at 876-2000.

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By John Milazzo
Staff writer

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By Martin Richter
Staff writer

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By John Milazzo
Staff writer

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and Visitors Bureau

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Granite City Press-Record

(USPS226-160)

Volume 89, Number 25 | Thursday, June 20, 1991 | 2 Sections, 20 Pages | PRICE 35¢

Lead tests ordered by state

By Mike Myers
Staff writer

GRANITE CITY — An extensive study to determine the level of lead exposure in area residents has been approved by the Illinois Department of Health.

Plans for the 18-month, $500,000 study were announced Wedensday by Dr. John R. Lumpkin, state health director.

The study will include the residents of approximately 4,000 Granite City and Madison homes located within a mile of the Taracorp lead waste pile at 15th and State streets

The IDPH will hold a public hearing on the study at 7 p.m. Thursday, June 27, at the Granite City Township Hall, 2060 Delmar Ave

The lead waste pile and its surrounding area, as well as some areas of Venice and Eagle Park, are part of the U.S. Environmental Protection Agency's $25 million Superfund lead contamination cleanup.

That cleanup calls for the removal of contaminated soil from approximately 1,000 yards. The removed soil would be placed on the existing pile, which then would be sealed over.

The IDPH's lead exposure study was added to the EPA's Record of Decision, the legal document that establishes the remedial cleanup, as a result of public comments made on the EPA's plan.

The first phase of the IDPH study, scheduled to begin in July, will involve contacting the residents about being part of the study. This will include the identification of a control group outside the contaminated area to be used in the study.

The second phase, scheduled to begin in late August, will include a detailed questionnaire, blood and urine sampling, and the sampling of soil, dust and air for lead levels in and around selected houses.

"The purpose of this study is to address the concerns of the area residents about their health and the health of their children," Lumpkin said.

"In addition, given the widespread occurrence of lead in the environment, understanding how and when it becomes a hazard is important to protect the health and welfare of Illinois citizens."

While he said he was pleased to hear about the IDPH study, Brad Bradley, the EPA's project manager for the Taracorp cleanup, said the results of the IDPH study will have no effect on the EPA's cleanup plan.

Bradley said the urine and blood tests "will only show the amount of lead exposure to residents within the last several months ... They are not an indication of the long-term risks or effects."

The EPA will not be using the results of the IDPH soil and dust tests, either, Bradley said, but will be running its own soil tests starting in September.

Although Bradley said at one time that the EPA and IDPH had considered doing the tests together, he said they had decided "it just wouldn't work.

"They're interested in finding the ways lead gets into people, while we're looking for how much lead is there," Bradley said.

"They're looking at the surface, while we need deeper samples."

Bradley said letters requesting consent for testing, to be used by both the IDPH and the EPA, have been mailed to a number of residents in Madison and will be mailed to Granite Citians this week.

According to the IDPH, in children excess lead can cause learning and behavior problems plus, in some cases, mental retardation.

Although the IDPH said adults are less sensitive to problems from lead exposure, in older adults elevated lead levels can cause high blood pressure, kidney damage and reproductive difficulties

As a preventive measure, the EPA suggests that parents provide children with a well-balanced diet that includes milk, cheese, spinach, liver and dark green leafy vegetables.

2 nabbed after guns are fired

By Bob Slate
Staff writer

VENICE — Shots fired into a street crowd, followed by a long police chase involving several jurisdictions, have resulted in charges against 19-year-olds from Cahokia and Centreville.

According to Venice police, Sean Flakes of Cahokia was charged with unlawful use of a weapon and failure to possess a firearms identification card. David McCall of Centreville was charged with reckless conduct, unlawful use of a weapon and failure to possess an FOID card, following the Tuesday night incident

Police from Venice, Madison, Granite City and Madison County were involved in the pursuit and apprehension. The chase ended in the 1400 block of Madison Avenue.

According to Madison Garrett, of Garrett's Cut Rate Liquors on Weaver Street, a red and white Chevrolet pickup truck containing six men pulled in front of the tavern, where he was standing with his niece at about 10:30 p.m.

Garrett said the occupants of the truck yelled at some

(See SHOOTING, Page 8A)

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—Granite City Journal—Wednesday, August 12, 1992

Study fails to link soil, blood lead

By Bob Slate
Staff Writer

A $15 million study designed to prove a correlation between the level of lead in soil and that in children's blood has "failed miserably," Craig Tarpoff said this week.

Tarpoff, chairman of the Citizens Advisory Committee for the Taracorp Lead Cleanup Project, attended the Symposium on Urban Soil Lead Abatement and the annual meeting of the Society for Environmental Geochemistry and Health, both held in North Carolina last week.

Tarpoff

A $15 million three-city study, sponsored by the United States Environmental Protection Agency, was the focus of each of the conferences.

The study attempted to prove that "a [illegible] lead in residential soil accessible to children will result in a decrease in their blood-lead levels," according to the executive summary of the project.

But in some cases the problem became worse after a soil cleanup, he said.

Baltimore, Boston and Cincinnati were chosen for the study. Blood-lead levels were tested in a study group and a control group in each city, both prior to and after removing lead-contaminated soil from areas of the cities.

"[illegible] down the line, the control groups did better (in reducing blood-lead) than the study groups," said Tarpoff, a Granite City alderman.

The study failed miserably. This [illegible] for the EPA and their [illegible] for soil-lead remediation in Granite City.

The EPA plans to remove soil with a lead-concentration of more than 500 parts per million from a 55-block area of Granite City, Madison, Venice and [illegible]

(See STUDY, Page [illegible])

•Study

(Continued from Page 1A)

Park, add the soil to an existing lead pile at Taracorp, 15th and State streets, and cap the pile with clean soil and grass. The project is estimated to cost $30 million.

Granite City has filed a lawsuit in federal court seeking to have the EPA reconsider its Taracorp plans. The city wants removal of the lead pile, and battery casings used to pave alleys, but wants the EPA to look alternatives to removing residential soil.

While the formal report is yet to come, Tarpoff said the results of the three-city study were discussed at length at the conference.

In Baltimore, where 408 children with a pre-remediation mean blood-lead level of 12.3 micrograms per deciliter were studied, blood-lead levels in the control group declined slightly after the cleanup, but those of children in the study group actually increased, Tarpoff said.

"I can't say for certain that the remediation process created increased dust levels, causing the results, but common sense tells me that," Tarpoff said.

"Chances are we'll find an elevation in blood-lead in Granite City (after cleanup), based on the Baltimore findings," he said.

In Cincinnati, where 225 children with a mean pre-remediation blood-lead level of 11.7 micrograms per deciliter were studied, a project manager reported that "no statistically significant correlation between soil-lead and blood-lead was found," Tarpoff said.

And in Boston, where the mean level of soil contamination was more than 2,000 parts per million — much higher than the mean of 750 ppm in the Granite City target area — the mean blood-lead level in children was reduced by 1.4 micrograms per deciliter, from 12.6 to 11.2, Tarpoff said.

He said these numbers, while statistically significant, were "practically insignificant when you consider the cost and scope of the cleanup."

EPA officials had predicted that the Boston children's mean blood-lead level should have been reduced by twice that amount, Tarpoff said.

Asked if he thought the study would affect the EPA's Taracorp plan, Tarpoff said, "It should, but I wouldn't be surprised if EPA tries to discredit the study."

Brad Bradley, EPA project manager for the Taracorp remediation, said he is familiar with the three-city study but not its results.

He said the agency "will consider all (pertinent) information that comes in (regarding blood lead). But as far as changing the plan, I'm not sure."

Bradley reiterated the EPA position that such studies are only a "snapshot in time" and do nothing to reveal long-term effects.

177828

Agency for Toxic Substances and Disease Registry

Division of Health Studies

FINAL REPORT

Madison County Lead Exposure Study

Illinois Department of Public Health Springfield, Illinois

April 1995

U.S. DEPARTMENT OF HEALTH & HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Atlanta, Georgia 30333

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY
ATLANTA, GEORGIA

MADISON COUNTY
LEAD EXPOSURE STUDY
GRANITE CITY, ILLINOIS

ILLINOIS DEPARTMENT OF PUBLIC HEALTH
SPRINGFIELD, ILLINOIS

April 1995

This stu[redacted] partially supported by funds from the Comprehensive Environmental Respons[redacted]pensation, and Liability Act trust fund provided to the Illinois Departm[redacted] Public Health under Grant Number H75/ATH590119 with the Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services. This document, presented in its entirety as submitted by the grantee, has not been revised or edited to conform with Agency guidance.

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ABSTRACT

A lead exposure study of 827 participants was conducted around a closed secondary lead smelter in August and September of 1991 in Granite City, Illinois. The arithmetic mean venous blood lead level in 490 children under 6 years of age was 0.33 μmol/L (6.9 μg/dl), with a range of 0.03 to 1.94 μmol/L (0.7 to 40.2 μg/dl). The blood lead levels were log-normally distributed with a geometric mean of 0.27 μmol/L (5.58 μg/dl). Of the 78 children under 6 years of age with blood lead levels ≥0.48 μmol/L (≥10 μg/dl) only 5 children had a blood lead level >1.21 μmol/L (>25 μg/dl). Blood lead levels in 214 youths from 6 through 15 years of age were lower, with a mean of 0.33 μmol/L (4.4 μg/dl) and a range of <0.03 to 0.90 μmol/L (<0.6 to 18.8 μg/dl). Only 8 children in this group had blood lead levels ≥0.48 μmol/L (≥10 μg/dl). Mean blood lead levels in adults were 0.17 μmol/L (3.6 μg/dl) and in 14 pregnant women 0.08 μmol/L (1.6 μg/dl). Complete blood counts and a battery of clinical laboratory tests revealed occasional abnormal findings unrelated to lead exposure.

Many houses in this community were built before 1920 and some were in poor condition. Seventy percent (70%) of interior paint and eighty percent (80%) of outside paint in those houses contained >1 mg/cm^2 of lead, and many lead paint measurements were >6 mg/cm^2. The levels of lead in composite soil from the yards of these houses ranged from 37 to 3,010 mg/kg (37 to 3,010 ppm) and the concentration of lead in house dust ranged from 5.2 to 71,000 mg/kg (5.2 to 71,000 ppm) on a weight basis and from 0.02 to 58,800 μg/m^2 on a surface area basis.

Blood lead levels in children tended to be higher as the condition of the house they lived in and their parents' education and income level decreased. Houses with higher lead paint levels had higher soil lead levels but the soil had little effect on blood lead levels.

The mean blood lead level of children living in houses in good condition was 0.29 μmol/L (6 μg/dl). Children living in houses in fair condition had mean blood lead levels of 0.4 μmol/L (8.2 μg/dl) and children living in houses in poor condition had mean blood lead levels of 0.57 μmol/L (11.8 μg/dl). The dust load was higher in houses in poor condition than in houses in good condition.

Regression analysis showed that lead in paint alone accounted for 3% of the variance in children's blo[redacted] levels. Lead in paint and the condition of the houses together accounted for 11% of t[redacted]ice in blood lead. Adding soil lead to the regression equation for lead in paint and the [redacted]on of the houses accounted for an additional 3% of the variance in blood lead. Only 40% of the variance in blood lead could be accounted for by including all of the variables in the study.

MADISON COUNTY
LEAD EXPOSURE STUDY
GRANITE CITY, ILLINOIS

INTRODUCTION

The NL Industries/Taracorp site is located in a mixed industrial and residential area in the City of Granite City, Illinois. Taracorp is one of 41 National Priority List (NPL or Superfund) hazardous waste sites in Illinois. The Illinois Department of Public Health (IDPH), in conjunction with the Agency for Toxic Substances and Disease Registry (ATSDR), evaluates each Illinois Superfund site's potential to harm public health.

The study described in this report was undertaken as part of a larger study of lead contamination at Superfund sites in several states. The objectives of the Illinois part of this study were:

1. To determine the concentration of lead and cadmium in blood and urine in target populations.

2. To determine the level of lead and cadmium contamination in environmental media in target areas.

3. To compare these levels with levels of contamination observed in a comparable nontarget area which in this part of the study was a continuum of the target area.

4. To determine how distance from the point source was related to blood lead levels, levels of lead in soil and in paint and to the condition of the houses and other elicited variables.

5. To evaluate the contributions of various environmental sources of lead (paint, soil, drinking water and house dust) to the overall lead exposure of children.

6. To examine the impact of a number of variables (such as socioeconomic factors, be[illegible] factors of the children and awareness of parents of the pathways of le[illegible]ure) on lead exposure and lead uptake by children.

In addition to the Illinois study, the multistate study included three mining and/or smelting sites where the potential for exposure to lead and cadmium existed. The objectives in these studies were similar. Cadmium was not present in higher than background concentrations in the Granite City, Illinois area, however, for the sake of consistency, cadmium data were collected.

BACKGROUND

The population within a 3-mile radius of the Taracorp site numbers 34,000 and the closest residents live within 100 yards of the boundary of the site. Although the site is located in Granite City, two other towns, Madison and Venice, are also located in close proximity to the site. A map is attached to illustrate the area (Figure 1).

Industrial History

Operations at the site started in 1895 as the Markle Lead Works. The Markle Lead Works manufactured lead shot and clay pigeons. Fire destroyed most of the facility in November 1900. In 1901, the plant was rebuilt and included a lead smelter. Prior to 1903, processes at the site included manufacturing lead shot, sealing wax, mixed metal, rolled sheet metal, and dross refining. Between 1895 and 1903, Hoyt Metals purchased the site from the Markle Lead Works. In 1903, United Lead purchased the smelter from Hoyt Metals and added secondary smelting capabilities. In 1928, NL Industries (formerly National Lead Company) acquired the smelter from United Lead. Battery recycling began in the 1950s. In 1979, NL Industries sold the site to its present owner, Taracorp Industries.

Taracorp operated a secondary smelter with the capacity to produce 22,000 tons of lead products per year. In 1983, Taracorp ceased smelting in an effort to reduce lead air emissions but continued to operate the metal refining and fabricating facilities at the site. A slag storage area is located on the southern boundary of the site. A preliminary site assessment performed in May 1983, estimated that 200,000 tons of lead waste were present at the site. Most of this waste was in and around the slag storage area. The slag storage area contains slag, metallic lead, lead oxide, cadmium, arsenic, iron oxide, silica, rubber and plastic battery cases, general refuse, drums, and matte.

St. Louis Lead Recyclers (SLLR) borders Taracorp on its southwest boundary. SLLR was originally established in 1980 to reclaim lead from batteries. In 1982, SLLR reached an agreement with Taracorp, allowing SLLR to recycle various materials from Taracorp. From 1981 to 1983, SLLR processed an estimated 11,000 tons of material from Taracorp's slag pile. Materials that could not be recycled (for example, slag and hard rubber) were placed southwest of the slag pile. In June 1983, SLLR discontinued recycling lead from the slag pile.

[redacted]54, Terminal Railroad Associates Inc., Illinois Central Gulf Railroad, Chicago and North[redacted] Railroad, and Tri-Cities Trucking Inc. own properties bordering the site. SLLR is the p[redacted] tenant on the land owned by Trust 454.

Dross is the name given waste products or impurities from the surface of molten metal.

Secondary smelting is the process of smelting lead-bearing materials other than ores such as slag or matte (a by-product of smelting containing metal sulfides and metal oxides).

The now closed secondary lead smelter contributed to off-site soil contamination during 80 years of airborne lead emissions related to smelting, surface runoff, and fugitive dust emissions from contaminated on-site surface soil and slag piles. The site achieved NPL status in 1984 and ceased smelting operations in 1983.

Characterization of the Site Prior to the Study

Soil

Soil samples collected from the industrial site in 1988 contained lead in concentrations ranging from 1,500 to 48,000 mg/kg (1,500 to 48,000 ppm). Slag piles and other surface wastes were estimated to contain up to 300,000 mg/kg (300,000 ppm) of lead. On-site cadmium soil concentrations in 37 samples ranged from <2 to 12 mg/kg (<2 to 12 ppm). Off-site samples collected from residential yards and gardens revealed lead concentrations that ranged from 106 to 9,493 mg/kg (106 to 9,493 ppm) (mean = 1,030 ppm, median = 905 ppm, n = 40 ppm) and cadmium concentrations of 0.4 to 15.7 mg/kg (0.4 to 15.7 ppm).

Surface Water

The two main surface bodies of water, the Mississippi River and Horseshoe Lake are located at least two miles from the site. The Mississippi River is monitored regularly for compliance with quality standards and drinking water standards and has thus far not shown any discernable site-related heavy metal contamination. Although monitored less frequently, Horseshoe Lake has no history of potentially site-related contamination. The distance from the site and the potential environmental mobility of site-related contaminants make such contamination unlikely.

Air

Ambient air monitoring has been performed since the late 1970s by the Illinois Environmental Protection Agency (IEPA). Air lead levels taken from monitors closest to the site regularly exceeded the 1.5 $\mu g/m^3$ National Ambient Air Quality Standard (NAAQS) for lead during the 1970s and early 1980s. The highest quarterly average recorded during the final months of 1981 was 7.3 $\mu g/m^3$, while the 1981 yearly average was 3.03 $\mu g/m^3$. Because of persistent air standard violations, Taracorp was denied a state license to operate the smelter in 1983. Since the [redacted] ceased operations, air lead levels have remained below the NAAQS standard.

Groundwater and Dust Samples

Groundwater contamination by inorganics directly under the site has occurred. However, this water is not used for drinking purposes and the contamination does not appear to have moved any distance off-site. No information was available on concentrations of lead or cadmium in house dust prior to this study.

Human Exposure

In 1982 and 1983, IDPH determined blood lead levels in a total of 99 individuals from 43 households within 3.2 km of the secondary lead smelter in Granite City and Madison. This group included 47 children under 6 years of age. The mean blood lead level of these children at that time was 0.64 μmol/L (13.2 μg/dl) with a range of 0.05 to 1.79 μmol/L (1 to 37 μg/dl). In 1983, similar blood lead levels were found in 31 children in Venice, an adjacent town to Granite City. At that time, the mean blood lead level in the United States for children under 6 years of age was 0.73 μmol/L (15 μg/dl).

The IDPH, together with ATSDR, completed a health assessment of the Taracorp NPL site in 1991. Based on the extent of lead contamination and possible human exposure, a potential health risk was deemed to exist. That finding, along with citizen concerns, prompted this exposure study.

METHODS

Rationale for Study Design

In the absence of a totally geographically separate comparison area, the primary hypothesis to be tested for this cross-sectional study using regression analysis was whether lead in soil contributed significantly to blood lead levels in children. It was postulated that, if soil lead was an important source of lead exposure, participants living farther away from the smelter would be less likely to have elevated blood lead levels than those living nearer.

Although other age groups were included in the study, the major focus was on children aged 6 through 71 months who had lived for at least three months at their present address. Blood lead levels are largely reflective of recent exposure and a three month residency was used to ensure that blood lead levels were associated with the current residence. Since young children are more susceptible to the effects of lead, and are more likely to be exposed, the sampling strategy for selecting study participants required the intentional over-sampling of this group. Smaller numbers of other eligible residents, aged 6 through 45 years and some older persons were included from the target and comparison areas.

Selecti[illegible]e Target and Comparison Areas

[illegible], the NPL site or proposed cleanup area extended 0.8 km from the smelter. Following a site visit and a census by IDPH and Institute for Evaluating Health Risks (IEHR) in May of 1991, participants were recruited from within and from outside this area in concentric rings extending for another 3.2 km. No suitable comparison group that was not a continuum of the declaration area (the area proposed as the cleanup area by United States Environmental Protection Agency [USEPA]) could be identified. An attempt was made to include another residential area, Pontoon Beach; however, the houses there were built sometime during the last three decades or represented trailer parks of recent vintage. Within a reasonable distance from

the study site, no other small-to-medium sized towns could be identified with a housing stock of similar age and a population of similar socioeconomic status as the study area. It was, therefore, decided to recruit study participants from regions of Granite City, Madison, and Venice with similar housing stock but differing in proximity to the closed lead smelter. Since no separate control group was available, hypothesis testing comparisons in the Illinois part of the study primarily consisted of regression analyses. However, dichotomous analyses of the data were also performed by dividing the population into two groups using soil lead concentrations < 500 mg/kg (< 500 ppm) and ≥ 500 mg/kg (≥ 500 ppm) as cutoff points. This comparison reduced the sensitivity of the study, and might have introduced a bias since other relevant risk factors in the study population varied with soil lead concentration and distance from the closed smelter. Regression analyses were, therefore, the more appropriate approach.

Phase I: Census Survey and Enrollment of Participants

In the summer of 1991, a census of part of Granite City and all f the two adjacent towns of Venice and Madison was conducted by IDPH. Four residential sampling regions were defined based on IEPA data that suggested that the soil lead concentrations decreased with distance from the smelter. It was presumed that sampling region one, closest to the smelter, had the highest soil lead concentrations. This was the area placed on the NPL by the USEPA. Sampling region two was presumed to have soil lead concentrations ranging from slightly above to slightly below 500 mg/kg (500 ppm), while the soil lead concentrations in sampling regions three and four were presumed to be lower.

The initial definition of sampling regions was somewhat arbitrary without knowledge of exact soil lead concentrations in the four sampling regions. The objective was to achieve a fairly representative range of soil lead values. Exact soil lead data collected during the study replaced the initial sampling area designations.

A copy of the census form is attached (Appendix A). IDPH trained the interviewers and conducted the census. The census takers interviewed the head of household or a knowledgeable adult surrogate at each house. The census data were grouped into four sampling regions. Sampling region one occupied the smallest geographic area. Some houses in the second sampling region were still in the USEPA cleanup area while the houses in sampling region three and four were outside the cleanup area. Age, sex, and length of residence were recorded for each individual i[redacted]household. A 90-day residency was required to participate in the second phase of the stu[redacted] requirement insured that the children had spent the summer at their present residenc[redacted]d time to develop blood lead levels indicative of their environment. The second phase consisted of collecting household and personal interview data, blood and urine specimens, and environmental samples.

Phase II: Interviews

All families in the census area with children under six years of age were contacted during the latter part of August and through September 1991 and invited to participate in the study.

The household identification number for each household that participated in the census was retained and used for the household questionnaire and the environmental samples. In addition, each participant received an identification number which was linked to the household identification number. All females listed as pregnant on the census forms were invited to participate in the study unless they had given birth in the interim. A number of families participated who did not have children under six years of age because the age of their children was entered erroneously on the census form or the children were six years old or older by the time the study was done. Overall, 33 families without a child under 6 years of age participated. One of these families was chosen because of pregnancy.

Appointments were made for interviews and specimen collection; participants were asked to come to a centrally located office to be interviewed and to visit St. Elizabeth Medical Center to donate blood and urine specimens. A consent form (Appendix B) approved by a human studies review board was explained to the participants, and each participant was asked to sign. A parent or guardian was asked to sign for each minor child. Minors capable of signing were also asked to do so. Participants were informed that all identifying information would be kept confidential and that personal identifiers would be removed prior to release of the data for publication or use by any government agency. Permission to obtain environmental samples at a later date was also obtained at the time of the interview.

The interview questionnaire (Appendix C) was administered by trained interviewers. Questions were asked about the household, occupation, hobbies, income, and education of the parents; behavior of the children; and all potential exposures to lead. The questionnaire consisted of two parts, one dealing with the household and one with the participant. Some questions in the household questionnaire dealing with mining activities and hobbies had fewer than 10 affirmative responses. The mining questions were irrelevant for the study in Illinois since this population did not engage in this occupation. They were included since the same questionnaire was also used for studies at the mining sites. These infrequent affirmative responses were not included in the statistical analyses. The questions concerning time spent in different locations were transformed to create a single variable expressing the average time spent at home. The participant questionnaires were separated by age: 6 through 71 months, 6 through 14 years, and 15 years and older.

Phase III: Biological Specimens

[redacted] the interview, the participants donated venous blood and urine specimens at St. El[redacted] Medical Center. Blood specimens were obtained by trained pediatric phlebotomists. Urine was collected in either 250 ml sterile collection cups or 150 ml sterile collection bags for children not yet toilet trained. Details of the collection and handling of specimens, and laboratory methods are reported by Midwest Research Institute (MRI), Kansas City, Kansas (Appendix D).

Laboratory Methods and Quality Control

Clinical laboratory tests of blood and urine specimens are listed in Table 1. These tests were performed by either the Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia, St Elizabeth Medical Center in Granite City, Illinois or the LaRoche Laboratories, Kansas City, Kansas (Appendix D). The transport and handling of specimens was supervised by MRI and CDC. The blood was analyzed for lead at CDC using a published method[1]. This method has a limit of detection of 0.03 μmol/L (0.6 μg/dl). Additional venous blood specimens were collected four months and one year later from children with an initial blood lead level greater than or equal to 0.48 μmol/L (10 μg/dl) and analyzed for lead at CDC. Urine samples were analyzed for cadmium according to the method reported by Pruszkowska et al.[2] with a limit of detection of 0.1 μg/L. Duplicate samples and quality control samples were also analyzed. This is described in detail by MRI in Appendix D.

Environmental Samples

Soil, house dust, and drinking water were collected by a contractor for USEPA-Region V (Chicago). In situ indoor paint analyses were performed by an experienced lead paint inspector on contract to USEPA using an X-ray fluorescence (XRF) device. A copy of the USEPA sampling protocol is appended (Appendix E). Up to 18 readings were taken in 3 frequently occupied rooms from walls and woodwork. The XK-3 XRF instruments used in this study lose their sensitivity at lead paint concentrations >10 mg/cm^2. The amount of lead in paint >10 mg/cm^2 was estimated using the average weekly calibration time to get a 10 mg/cm^2 reading and dividing the test reading by the ratio of the time to obtain a reading over the average calibration time. The condition of the paint where a reading was made on the inside of the house were rated as (1) intact, (2) slightly peeling, (3) moderately peeling, and (4) extremely deteriorated. The measurement of lead in outdoor paint was contracted through IDPH and the IEHR with the same contractor used by USEPA-Region V, (Chicago). Up to 12 exterior readings per house were made. For the outside of the house, three conditions were used: good, fair, and poor. Ratings for the exterior condition of the house were missing for 59 houses or 15%. A mean building condition score of 1.389 was assigned to those houses so that building condition could be used in the regression analyses. Building condition missing values were not associated with any other variable and regression analyses including a missing value dummy variable showed that this procedure had no effect on the calculations.

Soil samples were analyzed by EPA method 6010[3] using inductively coupled argon plasma (ICAP emission spectroscopy. Both wet and dry soil lead levels and total solids were determined. The dry weight lead levels are reported here. Obvious paint chips were removed prior to analysis. A detailed description of the methods used to collect and analyze the environmental samples is appended (Appendices E, F, G, and H). Thirty-nine duplicate samples were analyzed as a quality control measure.

Lead in dust was analyzed using a technique similar to that used to analyze soil (Appendix H). The concentration of lead in house dust was not the best indicator of potential

lead exposure because the size of the different areas that had to be vacuumed to obtain sufficient dust varied. A variable, "dust load", was calculated by dividing the dust sample weight by the surface area vacuumed and multiplying that ratio by the dust lead concentration. The concentration of lead in drinking water was determined in a first draw sample from the kitchen tap of each household by graphite furnace atomic absorption spectrophotometry.

Cadmium was determined in house dust and soil by ICAP emission spectroscopy and in water by graphite furnace atomic absorption spectrophotometry.

The limit of detection for lead in house dust was 20 mg/kg (20 ppm), for soil $\leq$20 mg/kg ($\leq$20 ppm), and for drinking water $\leq$2.0 μg/L ($\leq$2.0 ppb). The limit of detection for cadmium in house dust was 2.0 mg/kg (2.0 ppm), for soil 1.0 mg/kg (1.0 ppm), and for drinking water $\leq$0.5 μg/L ($\leq$0.5 ppb).

Reporting of Results to Participants

The participants were informed of their individual clinical and environmental results by letter. The results of the clinical tests were presented at a public meeting in the spring of 1992 without revealing the identity of the participants to reassure residents and encourage parents or guardians of untested children to have them tested. All families with at least one child with a blood lead level of 0.48 μmol/L (10 μg/dl) or above were visited, and potential sources of lead in the immediate environment of the child were identified. The parents or guardians were instructed in nutrition, in personal hygiene of the children, and in reducing exposure through housekeeping and minor remediation of trouble spots in or outside of the residences.

DATA ANALYSIS METHODS

Data Entry and Transformation

Information from the census forms was entered into ASCII files and was manipulated by two microcomputer database management programs (dBase IV and BMDP-EM Data Manager). The precoded questionnaire data were directly entered into electronic data files. Key data were entered twice to assure accuracy. All laboratory data were supplied electronically and in hard copy by the different laboratories and contractors. For values below the limit of detection, half of the [illegible] the limit of detection was used. For the XRF readings, the value 0.001 mg/cm^2 was u[illegible] zero readings to ensure that no cases were dropped during the calculations, since the log of 0 is treated as missing in the statistical program used for data analysis. This value of 0.001 mg/cm^2 did not affect the analysis.

The XRF data for five houses, lead levels in dust for six samples, lead levels in drinking water for four samples and the rating for 15% of the outside condition of the houses were missing. The missing data appeared to be random and no significant association was found between missing building condition and any other variable.

Since intact paint is less likely to result in exposure, the XRF reading was transformed by multiplying each paint XRF reading by its surface condition. The sum of all indoor paint conditions multiplied by the XRF readings for a house was divided by the number of measures taken to yield an average condition times XRF for each house. The same transformation was performed for the outdoor XRF readings. The transformed XRF variables produced modest improvements in correlations with blood lead.

The approximate distance and the direction of each house from the closed smelter was estimated by locating the houses on a map and measuring the distance with a ruler.

Statistical Analyses

The Statistical Analysis System (SAS)[4] for the microcomputer was used. Univariate (descriptive) statistics were run on all variables. Only summary statistics (means, medians, and ranges) are reported here. Distributions of the biologic and environmental data were positively skewed. Log transformation of these data resulted in more normal distribution. Where log-transformations were performed the geometric means of these variables were also reported.

Variable Selection

Simple bivariate Pearson correlations, analysis of variance, t-tests, and chi-square analyses (with high/low blood lead grouping of subjects under 6 years of age) were inspected to eliminate variables that did not appear to be associated with blood lead. However, some variables (for example, water lead) that could have been eliminated at this stage were retained based upon *a priori* hypotheses that all of the environmental samples would contain some lead and would have some impact on blood lead levels.

Bivariate analyses are presented for many combinations of variables. Blood lead values ≥ 0.48 μmol/L (≥ 10 μg/dl) were used to define the high blood lead group among children under 6 years of age for group comparisons and the more important predictor variables. The group living in regions with composite soil lead levels <500 mg/kg (<500 ppm) were compared to the group living in regions where the soil lead levels were ≥ 500 mg/kg (≥ 500 ppm).

Multiple regression/correlation modelling[5], which produces a set of multiple correlation coefficients, was [illegible]cted for three purposes. First, multiple regression was used to help identify variable[illegible] had some utility in predicting blood lead levels in this population. Second, a maximum regression coefficient R^2 improvement analysis was conducted to identify the set of variables with the greatest predictive utility. Finally, hierarchical regression modelling was conducted to evaluate the contribution of soil lead to blood lead and house dust lead. Hierarchial regression modelling involves the sequential addition of variables to a multiple regression equation. At each step in the sequence, a set of one or more variables is added to those already entered and a standard regression equation is derived. The incremental change in R^2 represents the independent contribution of the last set of variables to the total variance

accounted for by the regression model at that point. Hierarchical regression provides a means of testing the significance of a relationship while controlling statistically for the effects of other variables that could confound or modify the relationship.

Controlling for variables such as age, sex, and SES (socioeconomic status) can "overadjust" the relationship with blood lead and other key variables in the regression analysis. Therefore, only a very small set of predictor variables was analyzed through hierarchical regression.

RESULTS

Participation Rates

Census

The census resulted in the collection of 5,734 household census forms. Census workers were unable to interview anyone at 600 addresses (10.5%). Some of these addresses were believed to be vacant houses and apartments, but no definite occupancy determination could be made. There were 5,134 usable census forms. A total of 906 (17.6%) households met the initial qualification criterion for participation in the study. One or more children under 6 years of age had lived in these dwellings for at least 3 months. After screening visits or telephone calls, 116 households were disqualified because the family had moved since the census, they were away on vacation; all of the children were younger than 6 months or older than 6 years; the family had lived at the address for less than 3 months or the child in the family under 6 years of age no longer lived there, or had not yet lived there for 3 months.

Residents of the neighboring community of Pontoon Beach were included in the initial census; they were considered as a possible second group of study control subjects adjacent to the eastern border of Granite City and about 7.2 km removed from the closed smelter. However, Pontoon Beach residents were dropped from the final study target population because there appeared to be only 26 Pontoon Beach families in the census who qualified for selection and because the houses were newer or the children resided in a trailer park. This process of elimination resulted in a final "nominal" target population of 790 households. This number included households where, subsequent to administering the census questionnaire, no further con[illegible] made.

Ex[illegible] Interviews

Of the 790 target households, 355 (45%) participated in the study. Another 33 participating families (not counted in the 45% participation rate) lived in the target regions, but none had a child under 6 years of age. The data for this group of 33 households were not used in the main analyses of this report.

A total of 266 (34%) households refused to participate. Most of the families that refused stated that they did not want to subject their child to the study's blood sampling procedure. Some of the adults contacted expressed hostility or distrust, in some cases confusing our study activities with the USEPA proposed cleanup of the site listed on the NPL.

Another 169 (21%) target households listed in the census could not be contacted, or were scheduled for, but missed, numerous appointments. Many of those who missed appointments did so for seemingly valid reasons (sickness, vacation, or work schedule conflicts), while some were rescheduled so many times that they were considered to be refusals. Most of households in this group population were difficult to contact. Of the 790 target households with young children, 30% had no telephone number on the census form, making follow-up contacts difficult even though the residences were visited several times. Study qualification, participation, and refusal rates are presented in Table 2.

Participation by Sampling Regions

The target population for this study was geographically divided into four sampling regions. The regions can be described as four approximate concentric circles, around the Taracorp site. The sampling regions were of unequal size, with sampling region one (closest to Taracorp) containing the smallest number of houses. This region, when the study was done in 1991, represented the potential cleanup area. It extended roughly 0.8 to 1.0 km in all directions from the Taracorp boundary. Sampling regions two and three were each roughly 0.8 to 1.0 km in width, and sampling region four was roughly 1.2 km in width. Participation by sampling regions is presented in Table 3. Participation rates were similar for each sampling region, with a slightly lower rate of participation in region four, the region farthest from Taracorp.

The participants lived in 388 separate households. Occasionally more than 1 family shared a household. There were 230 families with 1 child under the age of 6 years, 106 families with 2 children under the age of 6 years, and 14 families with 3 or more children under the age of 6 years. In some of the larger families, not all children had the same parents. A total of 212 youths aged 6 through 14 from 107 households were included in the study. Of these, 56 households had 1 youth and 51 had 2 or more, resulting in an average of 1.98 youths aged 6 through 14 years per household. A total of 123 youths, more than 14 years old, and adults also participated [illegible] study. These adults came from 87 households, with 51 households supplying only [illegible]. There were 101 nonwhite children in the study population; of these 87% were of A[illegible]merican descent.

Participant Characteristics

Participant characteristics differed by sampling region. Overall, 17% of the heads of households had not finished high school, 45% had graduated from high school, and 38% had education beyond high school. The education level achieved by the parents of children under 6 years of age with blood lead levels of ≥ 0.48 μmol/L (≥ 10 μg/dl) differed significantly from

parents with children under 6 years of age with blood lead levels of <0.48 μmol/L (<10 μg/dl) ($p<0.001$). Among the heads of household whose children had blood lead levels ≥ 0.48 μmol/L (≥ 10 μg/dl), 35% had not finished high school, 42% had a high school diploma, and 23% had some higher education. For the heads of household with children with blood lead levels <0.48 μmol/L (<10 μg/dl), 14% had not finished high school, 46% had a high school diploma, and 40% had some higher education. Fifty-eight percent of the heads of households with children under 6 years of age with blood lead levels ≥ 0.48 μmol/L (≥ 10 μg/dl) had incomes of less than $15,000 per year. Only 41% of parents with children whose blood lead levels were <0.48 μmol/L (<10 μg/dl) were in this group. In the $15,000 to 25,000 income group, 24% had children with blood lead levels ≥ 0.48 μmol/L (≥ 10 μg/dl), while 22% had children with blood lead levels <0.48 μmol/L (<10 μg/dl). At income levels of $25,000 or above, 37% had children with blood lead levels <0.48 μmol/L (<10 μg/dl), while 18% had children with blood lead levels ≥ 0.48 μmol/L (≥ 10 μg/dl). This difference was statistically significant ($p<0.01$). As income increased, the chance that a child in the family had an elevated blood lead level decreased; however, education was a better predictor of blood lead levels than income.

At least 1 smoker was present in 263 (68%) of the households. In 5% of the households, 6 or more smokers were present. The mean number of cigarettes smoked per household per day was 16, with a range of 0 to 88. A total of 341 (87.8%) of the 388 households had air-conditioning.

In households with air-conditioning, the average number of cigarettes smoked per day was 17.6, and in houses without air-conditioning, the average number of cigarettes smoked per day was 35.4 ($p<0.01$). There were an average of 2.4 smokers, smoking a mean of 33 cigarettes per day, in households with children whose blood lead levels were ≥ 0.48 μmol/L (≥ 10 μg/dl), and an average of only 1.6 smokers per household, smoking a mean of 18 cigarettes per day, with children whose blood lead levels were <0.48 μmol/L (<10 μg/dl). This difference was also statistically significant ($p<0.01$).

For the children under 6 years of age, the amount of time spent at home did not appear to affect blood lead levels. The time spent sleeping, playing outside, and playing on the floor were of some predictive value and were used in the regression analyses.

Clinical Laboratory Results

[redacted]d and urine specimens were collected between August 23, 1991, and Se[redacted]20, 1991. Results of blood lead analyses are given in Tables 4 through 6. The arithmetic mean blood lead levels for each age group were below 0.48 μmol/L (10 μg/dl), the current CDC level of concern[6]. Blood lead was measured in 490 children (261 males and 229 females) from 6 through 71 months of age. Figure 2 shows the distribution of the blood lead levels by year of age in the children under 6 years of age. As shown in Figures 2a through 2c, blood lead levels peaked in the children around 2 years of age and then gradually declined in older children to the same values observed in children around 1 year of age.

Blood lead levels were also determined in 214 youths (111 males and 103 females) aged 6 through 15 years and in 47 males and 76 females older then 15 years. Thus, 827 blood lead determinations were made in all. The arithmetic mean blood lead levels for the youngest age group (between 6 and 71 months of age) was 0.33 μmol/L (6.9 μg/dl), with a range of 0.03 to 1.94 μmol/L (0.7 to 40.2 μg/dl). In that group, 78 children (16%) had blood lead levels ≥0.48 μmol/L (≥10 μg/dl). For the children from 6 through 14 years of age, the arithmetic mean blood lead level was 0.21 μmol/L (4.4 μg/dl), the range was from <0.03 to 0.90 μmol/L (<0.6 to 18.8 μg/dl). In this group, eight children had blood lead levels of ≥0.48 μmol/L (≥10 μg/dl).

Among a total of 101 nonwhite children under 6 years of age, 87% were African-American. Of these children, 19% had elevated blood lead levels; the arithmetic mean for this group was 0.35 μmol/L (7.4 μg/dl). The arithmetic mean blood lead level of white children under 6 years of age was 0.32 μmol/L (6.8 μg/dl). Thus, the blood lead levels of African-American children were quite similar to those of white children (t = - 1.1; NS). These two groups of children were, therefore, combined in the analysis.

Among the children 6 years of age and older, 17 African-American boys and 16 African-American girls participated in the study. Their arithmetic mean blood lead levels were 0.20 μmol/L (4.2 μg/dl) and 0.23 μmol/L (4.7 μg/dl), respectively. None of these children had blood lead levels of ≥0.48 μmol/L (≥10 μg/dl).

The 43 white adult males had an arithmetic mean blood lead level of 0.28 μmol/L (5.8 μg/dl) and included 3 male adults with elevated blood lead levels. One of these 3 males had made lead sinkers, 2 were engaged in scrap metal recovery at home and wire cutting, and all 3 did auto body repair work at home. Their children, who were also exposed to high paint and soil lead, had elevated blood lead levels as well. The arithmetic mean blood lead level of 69 adult white females was 0.12 μmol/L (2.4 μg/dl). Among the 69 adult females, 14 were pregnant at the time blood specimens was drawn. Their blood lead levels ranged from <0.03 to 0.16 μmol/L (<0.6 to 3.4 μg/dl) with an average of 0.08 μmol/L (1.6 μg/dl). Three African-American adult males and 7 African-American adult females with arithmetic mean blood lead levels of 0.18 μmol/L (3.8 μg/dl) and 0.17 μmol/L (3.5 μg/dl), respectively, also participated in the study.

In the youngest age group, 78 (16% of total participants in this age group) had blood lead levels ≥0.48 μmol/L (≥10 μg/dl); however, 46 of these (9%) had blood lead levels from 0.48 to 0.72 μmol/L (10 to 15 μg/dl) and only 5 (1%) were above the pre-1991 CDC level of concern of 1.21 μmol/L (25 μg/dl) (Table 5). A total of 61 children with blood lead levels ≥0.48 μmol/L (≥10 μg/dl) and some of their siblings donated a second blood specimen in January of 1992 (Table 6), about 4 months after the initial collection, following extensive counselling of parents and children. The repeat blood lead levels of most of these 61 children were <0.48 μmol/L (<10 μg/dl) and had dropped to about half or more of their original value (Table 6). The highest blood lead level was 0.61 μmol/L (12.7 μg/dl). A subset of 30 children of this group of 61 children was retested about a year after the first testing. At the second

testing in January 1992, a mean blood lead level of 0.39 μmol/L (8 μg/dl) was found in this group. The mean blood lead level at the third testing (July, 1992) was 0.43 μmol/L (9 μg/dl) suggesting that, following the initial drop, the blood lead levels remained stable.

The data on complete blood counts (CBCs) of the children under six years of age are given in Tables 7 and 8. No difference in the CBCs is seen between the children with blood lead levels ≥0.48 μmol/L (≥10 μg/dl) and those with levels <0.48 μmol/L (10 μg/dl).

Among the youths 6 through 14 years of age, 8 white males had elevated blood lead levels. Four youths had blood lead levels of 0.48 μmol/L (10 μ/dl) and the other four had blood lead levels of 0.6, 0.6, 0.7, 0.9 μmol/L (12.6, 12.7, 13.8 and 18.8 μg/dl), respectively. All but one of the families involved had at least one smoker in the household. In three instances, work had recently been done on the residences. In three of the other households, the father worked at home on automobile bodies, was engaged in wire cutting and scrap metal recovery, cleaned and repaired fire arms, or was engaged in soldering and automobile radiator repair. Thus, in six instances repair work on the residence or work with metals at the residence could have contributed to exposure.

Urine Cadmium Analyses

Results of the urine analysis for cadmium showed that, in many specimens, cadmium was below the limit of detection of <0.1 μg/L. A total of 6 urine specimens contained cadmium at 2 μg/l or greater. Three urine specimens contained about 2 μg/L of cadmium. Additional urine specimens were collected from 3 other participants whose initial urine specimens contained cadmium at concentrations of ≥5 μg/L; however, the results of the reanalyses were below the limit of detection of 0.1 μg/L suggesting contamination of the initial sample.

Clinical Chemistry Tests

Urine specimens were tested for albumin, glucose, occult blood, and specific gravity, and were examined microscopically. Abnormal urine specimens were noted in one adult female and in six female children ranging in age from one to five years. These urine specimens were cloudy in appearance, and had white and/or red blood cells and bacteria. These findings appeared to be incidental and consistent with bladder infections.

[redacted] chemistry tests were also performed on the blood specimens. The electrolytes potassi[redacted]um, and chlorides; the liver function tests aspartate aminotransferase (AST or SGOT), alanine aminotransferase (ALT or SGPT), gamma-glutamyl transpeptidase (GGT); total protein; albumin; blood urea nitrogen (BUN); and creatinine were measured. The electrolytes of all participants were within normal range. One child with a blood lead level of 0.42 μmol/L (8.9 μg/dl) had an elevated blood urea nitrogen of 50 mg/dl, while two additional children had levels just outside the reference range (6 to 26 mg/dl) of the clinical laboratory. The child with the elevated BUN also had elevated liver function test results, with an AST (SGOT) of 171 international units per liter (IU/L), a GGT of 103 IU/L, and an ALT (SGPT) of 68 IU/L.

Two other children under 6 years of age had elevated ASTs (SGOTs) of 437 and 83 IU/L. One child had an elevated GGT of 83 IU/L, and another had an elevated ALT (SGPT) of 472 IU/L. One youth had a slightly elevated ALT (SGPT) of 63 IU/L. Among the adults, four females had one or more slightly elevated liver function tests. The highest GGT was 75 IU/L, and the highest ALT (SGPT) was 61 IU/L. The AST (SGOT) was not elevated in any of the adult female or male participants. Abnormal liver function tests were present in six adult male participants. The highest GGT was 195 IU/L and the highest ALT (SGPT) was 83 IU/L. Immunoglobulin A and G were within the normal range in the study population according to Wallach[7]. Immunoglobulin M was elevated in 36 (4.4%) of the participants. Three of these participants had abnormal liver function test results as well. The elevated immunoglobulin M in participants with normal liver function test results was probably the result of a chronic infection. Since no clinical information was collected in this study, no definite interpretation of these results can be made.

Environmental Data

A total of 34% of all participants did not know the age of the house they were living in. Among the 412 children under 6 years of age with blood lead levels of <0.48 μmol/L (<10 μg/dl), data on the ages of the houses were available for 278. Of the children living in those houses, 196 (70%) lived in houses that were built before 1950. Of the 78 children with blood lead levels of ≥0.48 μmol/L (≥10 μg/dl) data on the ages of the houses they were living in was available for 43 houses. Of the children living in these 43 houses, 35 (81%) lived in houses built before 1950. Of the children with elevated blood lead levels who lived in the eight houses built after 1950, one child lived in a mobile home and the father was involved in lead-related activities. The remaining seven houses were built between 1950 and 1970 and remodelling activity or refinishing of furniture had taken place between 1990 and 1991.

Lead levels measured in the paint and soil of the houses are given in Tables 9a and 9b. Houses in which children with elevated blood lead levels lived were not clustered. However, those children were more likely to live closer to the smelter (Figure 1). Of the children under 6 years of age with blood lead levels <0.48 μmol/L (<10 μg/dl), 16% percent lived in sampling region 1, 43% in sampling region 2, 24% in sampling region 3, and 16% in sampling region 4. Among the children whose blood lead levels were ≥0.48 μmol/L (≥10 μg/dl) 27% lived in sampling region 1, 53% in sampling region 2, 12% in sampling region 3, and 8% in sampling region [redacted]. Many of the children of both groups lived in houses with high paint lead concentrations [redacted] or more of the areas measured (Table 9a). Either recent renovation or poor maintenance of the houses seemed to contribute to the exposure of the children. When the houses were in good condition, increased lead exposure was not as much of a problem.

Overall, about 50% of the families had done some repair work or renovations on their residences in 1990 or 1991. For families with children under 6 years of age whose blood lead levels were <0.48 μmol/L (<10 μg/dl), 48% had done some work on their house in the last year and 52% had not. In contrast, 63% of the families whose children had blood lead levels

were ≥ 0.48 μmol/L (≥ 10 μg/dl) had done some repair work in the year before the study, while 37% had not. The difference was statistically significant ($p < 0.02$).

In many yards, the lead concentrations in soil were above background levels, which in the United States can range from < 1 to 200 mg/kg (< 1 to 200 ppm). The mean soil lead level for the 375 analyzed soil samples was 450 mg/kg (450 ppm) with a range from 37 to 3,010 mg/kg (37 to 3,010 ppm) (Table 9b). A total of 39 duplicate (split) samples were also analyzed. These duplicate samples were homogenized and divided in the field. The analyzing laboratory was unaware of the fact that they were duplicates. The concentration of lead in these duplicate soil samples ranged from 106 to 1,610 mg/kg (106 to 1,610 ppm). The average difference between the 39 primary and the 39 duplicate samples was 89 mg/kg (89 ppm).

It is evident from Tables 9a and 9b that there were some very high environmental lead values. For example, the minimum dust lead value was 5.2 mg/kg (5.2 ppm) while the maximum value was 71,000 mg/kg (71,000 ppm). The standard deviation was nearly four times as great as the mean. Most of the other data were also not normally distributed. Log-transformed data was, therefore, used for most of the statistical analyses.

A total of 375 composite soil samples were also analyzed for cadmium. The arithmetic mean cadmium concentration in soil was 3.1 mg/kg (3.1 ppm) with a standard deviation of 1.37. Cadmium was not detected in 8 soil samples at a limit of detection of 1.0 mg/kg (1.0 ppm) and all but 7 soil samples were < 6 mg/kg (< 6 ppm). The background concentrations of cadmium in soil generally found in other studies ranges from 0.3 to 11 mg/kg (0.3 to 11 ppm) according to Page and Bingham[8] and Lund et al.[9]. Thus, cadmium concentrations were within the background range of concentrations found by others.

Lead in drinking water was below the limit of detection of the analytical method of 2.0 μg/L (2.0 ppb) in 62% of the samples from 373 households. A total of 86% of the samples had levels ≤ 5 μg/L (≤ 5 ppb) and 97% were < 15 μg/L (< 15 ppb), the present USEPA action level. In 13 instances, levels of lead in drinking water were higher, with a range from 15.4 to 95.5 μg/L (15.4 to 95.5 ppb). However, study participants using this water did not have elevated blood lead levels. The correlation between the log water measure and log blood lead was very low ($r = 0.07$, NS).

O[redacted]rinking water samples, the concentrations of cadmium in 322 drinking water samples [redacted]elow the limit of detection of ≤ 0.5 μg/L (≤ 0.5 ppb). The maximum concentr[redacted]ected in any water sample was 9.9 μg/L (9.9 ppb). Only 11 samples were > 2 μg/L (> 2 ppb). In a survey of 969 community water supply systems in the United States, the average cadmium concentration was 1.3 μg/L (1.3 ppb) according to Craun and McCabe[10] which did not differ from the findings in this study. Furthermore, all of the measurable concentrations in our study were in compliance with the federal drinking water standard of 10 μg/L (10 ppb) for cadmium.

Levels of lead in dust are also listed in Table 9b. They varied widely, both on a weight basis in mg/kg (ppm) (the concentration of lead in dust) and on the amount of lead present on a given surface area, (the loading of dust with lead) in $\mu g/m^2$. Among all environmental measures, dust load (the amount of lead in dust based on surface area) was the best predictor of blood lead levels in small children. The log dust load was the highest Pearson correlation of any variable with blood lead levels ($r = 0.42$, $p < 0.0001$).

Bivariate Analyses

Although bivariate analyses ignore the effects of possible confounding or effect modification from the influence of other variables, they provide a simple first screening of the complex relationships among the many variables in this study. Since bivariate analysis can not be used to adjust for possible confounding, this type of analysis greatly oversimplifies the true nature of relationships among the variables. For this reason, bivariate analysis results can not be interpreted out of context. They also do not constitute evidence of causal relationships. However, detailed inspection of the large matrix of bivariate results produced by pairwise analyses of key variables can reveal patterns of relationships that can then be explored by more appropriate multivariate analysis.

Soil Lead, Comparing Levels ≥500 mg/kg (≥500 ppm) with Lower Levels

A total of 143 children under 6 years of age lived in houses with composite soil samples of ≥500 mg/kg (≥500 ppm) lead and 347 children in the same age group lived in houses with soil lead levels <500 mg/kg (<500 ppm). Comparisons between these two groups identified differences in blood lead levels, dust lead levels, indoor and outdoor paint lead levels, the number of cigarettes smoked per day in the house, and the age of the houses. However, the differences were very small for blood lead levels, even though they were statistically significant. The geometric mean blood lead level of children living in houses with soil lead levels of ≥500 mg/kg (≥500 ppm) was 0.32 μmol/L (6.6 μg/dl) compared with 0.25 μmol/L (5.2 μg/dl) for children living in houses with soil lead levels <500 mg/kg (<500 ppm) ($p < 0.01$). The differences were larger for other measured parameters. The geometric mean dust load in houses with soil lead levels ≥500 mg/kg (≥500 ppm) was 400 $\mu g/m^2$, compared with 100 $\mu g/m^2$ in houses with soil lead levels <500 mg/kg (<500 ppm) ($p < 0.01$). The mean lead concentration in dust on a weight basis was 780 mg/kg (780 ppm) for houses with soil lead levels ≥500 mg/kg (≥500 ppm) and 309 mg/kg (309 ppm) for houses with soil lead levels <500 mg/kg (<500 ppm) ($p < 0.01$). The geometric mean indoor paint lead level in houses with soil lead levels ≥500 mg/kg (≥500 ppm) was 1.4 mg/cm^2 compared to 0.5 mg/cm^2 for houses with soil lead levels <500 mg/kg (<500 ppm) ($p < 0.01$). The geometric mean outdoor paint lead level in houses with soil lead levels ≥500 mg/kg (≥500 ppm) was 8.6 mg/cm^2 compared with 3.0 mg/cm^2 in houses with soil lead levels <500 mg/kg (<500 ppm) ($p < 0.01$). In houses with soil lead levels ≥500 mg/kg (≥500 ppm), 25.5 cigarettes per day were smoked compared with 17.9 cigarettes smoked per day in houses with soil lead levels <500 mg/kg (<500 ppm) ($p < 0.01$). Houses with soil lead levels ≥500 mg/kg (≥500 ppm) were, in general, built sometime during the period 1920 through 1929, while houses with soil lead

levels <500 mg/kg (<500 ppm) were usually built sometime during the period 1940 through 1949.

Blood Lead

All of the following blood lead correlations are statistically significant at $p<0.01$: lead in indoor paint, $r = 0.16$; composite soil lead, $r = 0.25$; dust lead level, $r = 0.25$; dust load, $r = 0.42$; distance of the house from the closed lead smelter, $r = 0.26$; parents' education, $r = -0.29$; parents' income, $r = -0.26$; number of smokers in the household, $r = 0.16$; number of cigarettes smoked per day in the residence, $r = 0.23$; number of hours played outdoors, $r = 0.23$; and number of baths taken per week, $r = 0.21$.

In addition, the following categorical variables were associated ($p<0.01$) with blood lead when children with high (≥ 0.48 μmol/L [≥ 10 μg/dl]) and low (<0.48 mol/L [<10 μg/dl]) blood lead levels are compared: air-conditioning present/absent; renting versus owning the residence; condition of the residence; and refinishing of the residence or furniture ($p<0.02$).

With so many correlates of blood lead, it is clearly not possible to draw causal inferences without first considering how all of these blood lead predictor variables can influence one another, and confound their relationships with blood lead.

Soil Lead

The most important confounder of the relationship between soil lead and blood lead is the high degree of correlation between composite soil lead and lead in indoor paint, $r = 0.34$. Other correlates of composite soil lead are house dust load, $r = 0.43$; distance from the smelter, $r = -0.48$; education, $r = -0.11$; income, $r = -0.11$ ($p<0.02$); cigarettes per day, $r = 0.17$; and year the house was built, $r = -0.45$. All correlations are statistically significant at $p<0.01$ unless otherwise noted.

Distance

In the study population, distance from the closed lead smelter was a correlate of blood lead ($r = -0.26$; $p<0.01$). It is tempting to think of distance as a proxy for soil lead exposure bec[redacted]stance was correlated with composite soil lead ($r = -0.48$; $p<0.01$). However, the rel[redacted]p of distance, composite soil lead, and blood lead was confounded by other variables. Di[redacted]as negatively correlated with the number of smokers ($r = -0.24$; $p<0.01$) and the number of cigarettes smoked per day in the house ($r = -0.30$; $p<0.01$). The year the participant's residence was built correlated with distance ($r = 0.16$; $p<0.01$). The older houses were closer to the smelter. The parents' education level ($r = 0.16$; $p<0.01$) and income ($r = 0.18$; $p<0.01$) correlated with distance. The condition of the houses improved with distance from the smelter (chi-square = 440.0, df = 6; $p<0.01$) and the use of air-conditioning increased (chi-square = 10.8, df = 1; $p<0.01$). As distance increased, dust lead decreased ($r = -0.21$; $p<0.01$.) while home ownership increased (chi-square = 14.3, df = 3; $p< 0.01$).

All of these correlates of distance were also associated with one another, and were among the better predictors of blood lead in this study.

Building Condition

Building condition was significantly associated with the following variables ($p<0.01$, except as noted): the number of cigarettes smoked per day; indoor and outdoor paint lead levels, soil lead levels, water lead levels ($p<0.08$), and dust lead levels; parents' education level, and parents' income; hours of outdoor play; and the number of baths per week ($p<0.03$). Each variable increased steadily over the three levels of building condition, with the exception of water lead levels.

Building condition was one of the better predictors of blood lead in this population. The mean blood lead level of children living in residences in good condition was 0.29 μmol/L (6 μg/dl). Children living in houses in fair condition had a mean blood lead level of 0.4 μmol/L (8.2 μg/dl) and children living in residences in poor condition had a mean blood lead level of 0.57 μmol/L (11.8 μg/dl). The condition of the house influenced its dust load (a measure that combines dust level and lead concentration). The dust load was seven times higher in residences in poor condition than in houses in good condition and about three time higher in residences in fair condition. Building condition was also relatively highly associated with every other predictor of blood lead in this study, and was a confounder in the relationship of composite soil lead and blood lead. Houses in good condition had a mean soil lead concentration of 287 mg/kg (287 ppm). The mean soil lead concentration for houses in fair condition was 361 mg/kg (361 ppm), and for houses in poor condition was 459 mg/kg (459 ppm). Building condition differed from other potential confounders of the composite soil lead/blood lead association in that the condition of the house was not likely to be a pathway for soil lead exposure. It was one of the few confounders of the soil lead/blood lead relationship that could be controlled for statistically.

Cigarettes Per Day

In this data set, smoking was associated with blood lead. The number of smokers ($r = 0.16$; $p<0.01$), and the number of cigarettes smoked per day ($r = 0.23$; $p<0.01$), both predicted blood lead levels to some extent. However, while the number of cigarettes smoked per day was als[redacted]elated with dust load ($r = 0.15$; $p<0.01$), it was not correlated with the dust level (that [redacted] weight of the dust sample divided by the area vacuumed $r = 0.005$; $p = 0.92$). Th[redacted]er of cigarettes smoked per day was also correlated with composite soil lead ($r = 0.17$; $p<0.01$), distance from the smelter, parents' education level ($r = -0.34$; $p<0.01$), income ($r = -0.20$; $p<0.01$), and outdoor paint lead levels ($r = 0.11$; $p<0.02$). Furthermore, smokers in residences without air-conditioning smoked an average of 35.4 cigarettes per day, while smokers in residences with air-conditioning smoked 17.5 cigarettes per day ($t = -3.8$; $p<0.01$) on average. More cigarettes were smoked in houses in poorer condition ($r = 17.2$, $df = 2$, $p<0.01$) and in older houses ($r = 0.16$; $p<0.01$). It was not possible to determine whether cigarette smoke made any independent contribution to

blood lead in passive smokers, or was simply a proxy for other environmental, socioeconomic, and behavioral factors. Other authors have reported such a contribution[11], although in a later paper they were unable to confirm their findings[12].

Regression Analysis

Because of the many variables in this study expressed as continuous measures, regression analysis provided the best method of analysis. The advantages of regression analysis in this instance were twofold: the ability to simultaneously analyze many variables and the ability to observe the influence of each variable on every other variable. Since in this study interrelationships among the variables are complex, regression analysis may be the only way to express the many relationships[5].

Stepwise Regression

Once the list of potential predictor variables was narrowed, the maximum R^2 improvement method was used to select and assign priority to the most important predictors. The first variable was dust lead ($R^2 = 0.17$), accounting for about 17% of the total blood lead variance; second was distance, raising R^2 to 0.21; third was parents' education level, raising R^2 to 0.24; finally distance, education, refinishing activities, hours of outside play, and participant's age all traded places in and out of the model for several more steps, bringing R^2 to 0.32. Ethnicity and lead in drinking water raised R^2 to 0.35.

It is noteworthy that neither ethnicity nor lead in drinking water were significantly associated with blood lead levels in bivariate tests. The fact that they entered the regression ahead of more obvious measures indicated that these two variables might have been serving as proxies for other exposures, or that they did not share with other variables any of the variance in blood lead that they accounted for individually.

As shown in Table 10, with 10 variables in the regression model, R^2 reached 0.37. These variables represented parents' education level, the number of cigarettes smoked per day, rent/own home, refinishing activities, ethnicity, dust load, age, water lead levels, distance, and the number of hours of outdoor play per day. Apparently, variations in individual behavior accounted for most of the remaining blood lead variance in this group. Errors in lead measurements were probably of secondary importance in explaining the blood lead variance not accounted for. While the preceding approach gives some idea of the role of different variables as predictors of blood lead, the value of the approach is limited. Since this method capitalizes on chance, the statistical p-values associated with partial regression coefficients could not be interpreted. The hierarchical regression modeling that follows focuses specifically on the contribution of paint and soil lead to blood lead.

Hierarchical Regression: The Contribution of Soil Lead to Blood Lead

The intercorrelation among independent variables in this study, and their correlations with both soil lead and blood lead, suggested that the association of soil lead with blood lead was confounded to some extent by other factors in the study. To assess the independent contribution of soil lead to blood lead, it would have been desirable to control statistically for potential confounding through hierarchical regression. First, the set of variables that might have confounded the relationship of soil lead and blood lead could have been introduced, and then the soil lead variable to evaluate the increment in blood lead variance accounted for by soil lead levels. However, in order to avoid over-adjusting (that is, inappropriately removing variance in blood lead that could be due to soil lead exposure), a very limited set of potential confounders was used. House dust was an important secondary source of lead exposure in young children. However, house dust was not included as a potential confounder since the source of lead in dust was mostly paint and soil. Thus, house dust represented a vector, or pathway, for the two primary sources of lead: soil and paint.

As shown in Table 11, Model 1; water lead levels, house paint lead levels, recent household refinishing activities, and the rating of the overall condition of each building (that is, the general state of repair/disrepair of the residence) accounted for 11% of the blood lead variance in this study (adjusted $R^2 = 0.11$). These were the only potential confounders of the soil lead/blood lead relationship that were statistically controlled. When composite soil lead measures were added, as shown in Table 11, Model 2, the adjusted R^2 increased only slightly to adjusted $R^2 = 0.14$. Thus, only 3% of the variance in blood lead observed in the study population was accounted for by soil lead.

The Contribution of Soil Lead to Dust Lead

As shown in Table 12, Model 1; indoor and outdoor paint lead levels, and the condition of the building accounted for 26% of the variance in dust lead. When composite soil data were added (Table 12, Model 2), R^2 increased to 0.32, an increase of 6% in dust lead variance. Thus, paint lead levels and building condition accounted for about four times as much variance in dust lead as did soil lead.

Effect of Including More Than One Child Per Family in Analyses

Using [redacted] the children in each family, or only the child with the highest or lowest blood lead lev[redacted] e various analyses did not affect outcome (Table 13). The conditions of the houses and [redacted] concentrations of lead in soil, paint, and dust were quite similar among families with one child or more than one child under 6 years of age. The distances of the houses from the closed smelter were similar as well. The participants rather than the households were, therefore, used in most statistical analyses.

DISCUSSION

This study was primarily undertaken to determine whether children, under the age of six years, living in an environment with elevated lead levels in soil had elevated blood lead levels. Results showed that, in addition to lead in soil, other sources of high lead levels (for example, indoor and outdoor paint) in residences also existed in the community.

It was not possible to find, in the vicinity of the study area, a separate community of similar socioeconomic makeup and housing stock with no history of high soil lead concentrations. Therefore, the residents of areas without high concentrations of lead in soil adjacent to the NPL declaration area were used as the comparison population. Although this control population lived in houses of similar age and with similar concentrations of lead in paint, some other differences existed. As distance from the smelter increased, the conditions of the houses improved; fewer houses had peeling paint and most houses were owned rather than rented. Furthermore, the education level of the parents increased, the number of smokers and the amount of smoking decreased, the use of air-conditioning increased, and other behavioral variables also changed with distance. As anticipated, the concentration of lead in soil also decreased with distance from the closed smelter. The covariance of risk factors with distance from the smelter made it more difficult to interpret and analyze study results. The study showed that lead exposure risk factors do not occur in isolation. Most of the important lead exposure risk factors occur in and around poorly maintained houses.

The participation rate in this study was not optimal. However, as many people living close to the smelter as living further away were included in the study. If anything, the participation rate closer to the closed smelter was better. Thus, if high levels of lead in soil were a prominent factor of exposure, a soil effect would more likely be detected.

In this particular population the primary exposure of concern was the exposure of young children to lead. It has been documented in many studies that children, because of their hand-to-mouth activities, ingest lead primarily through dust; however, they may also ingest paint chips and soil that contain lead. In addition, children are exposed to lead through food, water, and air. How much environmental lead a child will receive from these various sources depends on many behavioral variables and also on the child's nutrition[3].

This study details a number of interesting findings, the most important of which was that most s[illegible]articipants had comparatively low blood lead levels. This is consistent with results obtain[illegible]others in recent surveys. Blood lead levels in the population as a whole and in young [illegible]n are now much lower than they were one or two decades ago[13]. The decrease in blood lead levels has resulted from the reduction of lead in gasoline and the decreased use of leaded gasoline. Lead in food, particularly in infant food, has also been reduced[14]. Lead levels in children in many communities are now around 0.25 μmol/L (5 μg/dl) or less. In this study, the mean blood lead levels were consistent with these observations.

In spite of elevated lead levels in soil and in indoor and outdoor paint, many children had very low blood lead levels. Even the group with elevated blood lead levels had mean blood lead levels that 20 years ago were representative of small children in the general population and were mostly below the CDC level of concern (1.21 μmol/L [25 μg/dl]) for elevated blood lead levels in effect until recently. In the National Health and Nutrition Evaluation Survey (NHANES II)[15] conducted from 1976 through 1980, the arithmetic mean blood lead levels for young children were 0.7 to 0.97 μmol/L (15 to 20 μg/dl)[13] after high outliers had been removed. Most of the elevated blood lead levels in this study are lower than the NHANES II levels. At blood lead levels >1.21 μmol/L (>25 μg/dl), determination of erythrocyte protoporphyrin (EP or ZPP) is not useful since it will be normal in most cases[16]. EP measurements were, therefore, not made. The findings in this study suggest that, once the major sources of high levels of lead in air and in food have been removed, high lead levels in soil and in paint might make less of a contribution to overall lead exposure than previously assumed. However, lead uptake is largely influenced by individual factors of behavior, such as improper renovation of old houses, pica, or poorly maintained residences.

As a predictor for blood lead level, the education level of the parents was more important than income. Smoking, remodelling or other repair of the residence, lead levels in paint and soil, and the age of the house were all positively correlated with blood lead levels. Education level and income were inversely correlated with proximity to the closed smelter.

Blood lead measures in children were used as the dependent variable in a series of regression analyses designed to interpret the contributions made by selected independent variables. The independent variables were grouped differently depending upon the question under investigation. To the extent that these variables predicted blood lead levels and were also correlated with soil lead, they should be considered to represent confounders of the relationship of blood lead and soil lead.

Some measures are clearly influenced by both soil lead and paint lead. House dust lead is a mixture of soil lead and house paint lead. House dust is actually an important secondary source of lead for young children because of their hand-to-mouth activities. Lead in house dust comes primarily from soil and from paint and represents a vector or pathway for lead exposure. House dust was, therefore, not included in the hierarchical regression against blood lead. The apparent contribution of soil and paint would have been overadjusted had this been done. Furthermore, s[illegible]neous regression of all three factors against blood lead levels resulted in a related probl[illegible]ulti-colinearity. Simultaneous regression of lead in paint, lead in soil and lead in dust ag[illegible]ood lead would have produced unpredictable and invalid partial correlation coefficients.

The number of hours spent at home and the number of hours spent outside, the age and sex of the child, and most behavioral variables can serve as predictors of exposure for paint and soil lead. Using these variables to make statistical adjustments is not likely to resolve problems of confounding, and might introduce additional problems of overadjustment.

A number of variables predicted blood lead levels in young children. These included the condition of the residence; lead levels in paint, in dust, and in soil; smoking in the residence; proximity to the closed smelter; education and income levels of the parents; and behavioral factors ~~of~~ the children, such as hand-to-mouth activities. Comparing these factors showed that they were all correlated with each other. Only about 40% of the exposure could be accounted for in the data analyses. Of this 40%, lead from soil appeared to make a very minor contribution, at most 3%, while the condition of the house and the amount of lead in paint may have been responsible for as much as 11%. The percent of the variance reflects the degree of importance a given environmental factor has for the total exposure of the child. Eliminating a variable such as soil that accounted for only 3% of the variance may only result in a minimal change in measured blood lead levels without any clinical significance.

The large unaccounted portion of lead exposure (60%) is partly attributable to lead in food, ambient air, imprecision in the blood and environmental lead measurements, changes of the dust load and unique variables in specific households. For instance, in addition to high lead concentrations in soil and in paint in one family's home, the father made lead sinkers, worked on automobile bodies and salvaged metal at home. Dust was also only collected at one point in time. A one time dust sample may not be representative for the dust over a period of several months.

Most of the important variables in this study (such as the education and income levels of the parents; lead levels in paint, soil, and dust; behavior variables; smoking; and air-conditioning) were all highly correlated. Thus, correlations, t-tests, and chi-square tests, if taken out of context could be misleading. Furthermore, confounding could not be adequately controlled for in this data set. House dust serves as a pathway of exposure for soil lead and house paint lead in small children. Many important behavioral variables could affect the degree of exposure to house dust. Small but statistically significant differences in the percent variance have no clinical importance as far as their potential contribution to blood lead levels is concerned. This study attempted to determine, by stepwise regression of 22 variables, the overall contribution of these variables to lead exposure. However, as some variables were added to the analyses, other variables dropped out and variables that had previously dropped out were in the regression again. This suggested that some of the variables were also proxies for other variables and that they did not constitute meaningful contributions to the exposure of small children.

[redacted]ce most of the youths and adults had very low blood lead levels, we concentrated our eva[redacted]on the children under 6 years of age. In the older age group, the few participants with elevated blood lead levels acquired their lead through hobbies, occupation pursued by themselves or family members, or repair of their residences. No detailed statistical analyses were conducted on this group, since the number of affected individuals was small and their elevated blood lead levels had individual, logical explanations.

An important and often ignored method of preventing lead exposure is education about effective ways of reducing exposure and increasing awareness and understanding among

parents/guardians. Following extensive counselling of the parents/guardians of children with blood lead levels ≥0.48 μmol/L (≥10 μg/dl) about pathways of lead exposure for children, the follow-up blood lead determinations showed a marked and persistent decline in blood lead levels. In the past, seasonal fluctuations in children's blood lead levels have been reported with principal emphasis on the summer peak[17,18]. However, Marrero et al.[19] reported two peaks, one in late winter, and one in midsummer. Marrero et al.[19] found the low levels to be at most about a third less than the peak value. Our initial blood lead level determinations were made in late August and in September when the midsummer peak had already been passed.

The seasonal fluctuations observed many years ago were closely associated with the sale of leaded gasoline, fluctuations in lead air levels, weather patterns, traffic density[20], and outdoor activity. Since lead in gasoline has been reduced, seasonal variation is less of an issue now. However, children's blood lead levels also decrease as the children get older. In a recently published study to determine the effect of soil and interior loose paint removal on blood lead levels, the mean decline in blood lead levels between preabatement and 11 months after abatement was 0.12 μmol/L (2.44 μg/dl) in children under 6 years of age with blood lead levels quite similar to the blood lead levels in this study in children of similar age. Loose paint removal per se only resulted in a drop of 0.02 μmol/L (0.52 μg/dl)[21]. These differences are very small in comparison to our findings. Fluctuations in blood lead levels are also affected by the analytical method that must be very accurate, precise and free of drift over time.

Blood lead levels fluctuate somewhat if repeated samples are taken. This fluctuation can occur because of variations in the analytical method[22]. Lead levels in capillary blood specimens are usually higher than in venous blood specimens. Venous blood samples provide more accurate results and are preferred by health care providers although parents may be reluctant to submit their children to venipuncture.

Not all of the parents invited to participate in the study accepted the invitation. A primary reason for refusal was the unwillingness of parents/guardians to have blood specimen drawn from their children because of the emotional trauma associated with the event. Parents/guardians need to be educated on the importance of such testing and of preventing excessive exposure to lead. Based on the findings in this study, two years of age would be the optimal age for testing, since blood lead levels seemed to peak at that age.

CONCLUSIONS

1. Blood lead levels of children under 6 years of age and in older children and adults were, for the most part, below the new level of concern of 0.48 μmol/L (10 μg/dl).

2. In the study population, the highest percentage of children with elevated blood lead levels were from 1.5 through 2.5 years of age suggesting that this could be an optimal age for screening.

3. Children with higher blood lead levels lived in houses near the closed smelter, but they also lived in houses further away from the site, and as of 1991, outside the USEPA area targeted for soil clean up.

4. The soil lead levels decreased as distance from the smelter increased.

5. For small children, house dust served as a major vector of exposure. The source of lead in house dust was the lead in paint and soil.

6. High concentrations of lead in paint in well-maintained houses did not contribute noticeably to lead exposure. Many of the children with low blood lead levels lived in houses in good condition, but with very high lead paint levels.

7. Lead uptake was influenced by many personal variables (such as behavior, socioeconomic status, education, smoking), and variables present in each house. These individual factors were difficult to assess. The inability to account for 60% of the variance in lead uptake underscores that point.

8. Education of the parents/guardians about the lead hazards in their homes, suggestions for remedial action, and changes in behavior had a favorable impact on children's blood lead levels.

9. Lead in water, lead in paint, condition of the house, refinishing of the house within the last year, and lead in soil made statistically significant contributions to the variance in blood lead levels. However, the model using a hierarchical regression analysis was only able to ex[illegible]5% of the variance in children's blood lead levels.

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Acknowledgements
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Springfield, Edwardsville, and Peoria, IL
John Lumpkin, MD, Director
Catherine Copley
Mike Hungerford
Tom Long
Kevin Marshall
Mike Moomey
Clinton Mudgett
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Officials, merchants, and citizens of Granite City, Madison, and Venice, IL
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Catherine Andrea
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McDonalds
Capri Sun, Inc.
Prairie Farms

ABBREVIATIONS OF UNITS AND MEASURES

g/dl	= grams per deciliter
IU/L	= international units per liter
km	= kilometer
mEq/L	= milliequivalent per liter
mg/cm^2	= milligram per square centimeter
mg/kg	= milligram per kilogram
mg/dl	= milligram per deciliter
mg/cm^2	= milligram per square centimeter
ppb	= parts per billion
ppm	= parts per million
$\mu g/L$	= microgram per liter
$\mu g/dl$	= microgram per deciliter
$\mu g/m^3$	= microgram per cubic meter
$\mu mol/L$	= micromole per liter

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TABLES

Table 1.—Biomedical tests (blood and urine).

Test	Reference Range*		Expected Coefficient of Variability*
AST (SGOT)†	0-6 mo	0-120 IU/L	5.41
	7-12 mo	1-110 IU/L	
	1-5 mo	0-75 IU/L	
	6-10 yr	0-60 IU/L	
	>10 yr	0-50 IU/L	
ALT (SGPT)§		0-50 IU/L	8.33
GGT¶	Male	0-65 IU/L	6.45
	Female	0-45 IU/L	
Albumin		3.5-5.5 IU/L	2.78
Total Protein	Newborn	4.6-7.2 g/dl	3.23
	<2 yr	5.7-8.2 g/dl	
	≥2 yr	60.0-8.5 g/dl	
Creatinine		0.5-1.5 mg/dl	4.76
BUN**		7-26 μg/dl	7.14
Sodium		135-148 mEq/L	1.43
Potassium		3.5-5.5 mEq/L	2.44
Chloride		94-109 mEq/L	1.98

*Provided by the testing laboratories: IU/L = international units/liter; g/dl = grams/deciliter; mg/dl = milligrams/deciliter; μg/dl = microgram/deciliter; mEq/L = milliequivalent/liter.
†Aspartate aminotransferase (SGOT).
§Alanine aminotransferase (SPGT).
¶Gamma-glutamyltransferase.
**Blood urea nitrogen.

Table 2.—Study population household census data.

Census forms with address	5,734
Households indicating occupancy	5,134
Households with at least one child <6 yrs of age	906
Disqualified households (moved, Pontoon Beach)	116
Target households	790
Refused to participate	266
Participating households with no child <6 yrs of age	33
Households unaccounted for (no contact, no show)	169
Total households in study sample	388

Table 3.—Household* participation by target sampling region.

Sampling area 1 (closest to Taracorp)	39 target households 20 (51%) households participated
Sampling region 2	201 target households 120 (60%) households participated
Sampling region 3	242 target households 128 (53%) households participated
Sampling region 4 (farthest from Taracorp)	308 target households 120 (39%) households participated

*Thirty-three participating households did not have a child under six years of age at the time of testing, or no blood was obtained from that child.

Table 4.—Distribution of blood lead levels (BPbs) by age of participant*.

Age of Participant	6-71 Months	6-15 Years	>15 Years	Total
Total number	490	214	123	827
Male	261	111	47	419
Female	229	103	76	408
Mean BPb** μmol/L μg/dl	0.33 6.9	0.21 4.4	0.17 3.6	0.28 5.8
Range BPb μmol/L μg/dl	0.03 - 1.94 0.7 - 40.2	<0.03 - 0.90 <0.6 - 18.8	<0.30 - 0.86 <0.6 - 17.9	<0.03 - 1.94 <0.6 - 40.2
≥0.48 μmol/L (10μg/dl)	78	8	3	89

*Nine children included in this table lived at their present residence less than 3 months at the time of the study.
**BPb = blood lead.

Table 5.—Distribution of blood lead levels in children from 6 months to 6 years of age with blood lead levels ≥0.48 μmol/L (≥10 μg/dL).

Blood Lead Level	Number	Percent of Total 490 Children
≥0.48 μmol/L (≥10 μg/dl)	78	16
≥0.48 μmol/L and <0.72 μmol/L (≥10 μg/dl and <15 μg/dl)	46	9
≥0.72 μmol/L and <1.21 μmol/L (≥15 μg/dl and <25 μg/dl)	27	5.5
≥1.21 μmol/L (≥2.5 μg/dl	5	1

Table 6.—Comparison of original blood lead determination with 4-month follow-up lead level determination in 61 participants*.

Age	N	First Lead Range†	First Mean Lead†	Second Lead Range†	Second Mean Lead†	Range of Difference†	Mean Difference†
6-71 months	51	0.48-1.69 (10-35)	0.72 (15)	0.17-0.61 (4-13)	0.38 (7.8)	0.14-1.16 (3-24)	0.35 (7.2)
6-15 years	7	48-0.92 (10-19)	0.63 (13)	0.27-0.44 (6-9)	0.35 (7.3)	0.14-0.48 (3-10)	0.28 (5.9)
>15 years	3	0.58-0.87 (12-18)	0.68 (14)	0.27-0.47 (6-10)	0.36 (7.4)	0.3-0.4 (6-8)	0.34 (7.0)

*Seventeen participants either refused to be followed up or were lost to follow-up.
†Ranges, means, and differences are given in μmol/L and in (μg/dl).

Table 7.—Complete blood counts (CBCs) for 388 children 6 months to 6 years of age with blood lead levels <0.48 μmol/L (<10 μg/dl)*.

Complete Blood Counts	Mean	Range
White blood cells	8,332/mm³	3,400-18,400/mm³
Hemoglobin	12.2 g/dl	90.0-14.5 g/dl
Hematocrit	36%	25.6-41.7%
Red blood cells	4.4 x 10^6/mm³	3.2-5.5 x 10^6/mm³

*CBCs were not done for 22 children because insufficient blood was available.

Table 8.—Complete blood counts (CBCs) for 75 children* 6 months to 6 years of age with blood lead levels ≥0.48 μmol/L (≥10/μg/dl).

Complete Blood Counts	Mean	Range
White blood cells	9,116/mm³	5,000-17,600/mm³
Hemoglobin	12.3 g/dl	80.0-14.7 g/dl
Hematocrit	36%	26.6-42.8%
Red blood cells	4.5 x 10^6/mm³	3.7-5.3 x 10^6/mm³

*Three children did not have CBCs done because insufficient blood was available.

Table 9a.—Results from x-ray fluorescence readings of lead in paint.

Location of Reading	Houses Tested	Houses with >6 mg/cm² Lead (%)
Indoor paint*	372	154 (40.8)
Outdoor paint†	380	193 (51.0)
Indoor and outdoor paint	371	111 (30.1)

*Thirty percent of the houses had readings <1 mg/cm² and 29% had readings from 1 to 6 mg/cm².
†Twenty-two percent of houses had readings <1 mg/cm² and 27% had readings from 1 to 6 mg/cm²

Table 9b.—Lead in environmental samples: soil, dust, and water.

Environmental Sample	N	Mean Lead	Minimum	Maximum	Standard Deviation
Soil-dry composite	375	450	37	3,010	411
Dust by weight (mg/[illegible]	371	1,283	5.2	71,000	5,236
Dust by surface (μg/[illegible]	367	885	1.6	58,800	4,489
Tap water μg/L (ppb)	373	3.3	<2	96	8
Indoor paint (mg/cm²)†	372	1.2	0	10.4	1.6
Outdoor paint (mg/cm²)†	380	5.3	0	31.2	6.4

*The "dust load" was calculated by dividing the dust sample weight by the surface area vacuumed and multiplying this ratio by the dust lead concentration.

†The paint values represent means of 18 indoor and 12 outside readings. Readings of zero were included in the calculations.

Table 10.—Stepwise regression analysis, dependent variable: blood lead level in children from 6 months through 71 months of age.

$R^2 = 0.37$	$F = 21.61$; (Prob $> F = 0.0001$)			
Variable	Parameter Estimate	Standard Error	F Statistics*	Prob > F
Intercept	2.88	0.28	106.77	0.0001
Years of education	-0.04	0.01	5.98	0.0149
Cigarettes per day	0.00	0.00	4.57	0.0331
Rent or own home	-0.12	0.05	4.52	0.0342
Recent remodeling	-0.17	0.05	9.89	0.0018
Ethnicity	0.20	0.05	12.45	0.0005
Log of "dust load"	0.13	0.01	59.16	0.0001
Age	-0.08	0.01	20.29	0.0001
Log of lead in water	0.09	0.03	7.81	0.0055
Distance	-0.05	0.01	10.28	0.0015
Hours of outdoor play	0.06	0.01	24.13	0.0001

*F is the ratio of the regression mean squares over residual mean squares. $F = R^2 (n - k - 1) / (1 - R^2) k$. The distribution of the F statistic is used to test the significance of R in regression analysis (that is to test the null hypothesis that the linear relationship between a set of k independent variables and a dependent variable is zero in the population).

Table 11.—Hierarchical regression analysis, dependent variable: log blood lead in children from 6 months through 71 months of age.

MODEL 1

Adj R^2 = 0.12; N = 433; Potential confounders P < 0.0001			
Variable	Parameter Estimate	Standard Error	P <
Intercept	1.54	0.11	0.0001
Log of lead in water	0.03	0.02	0.15
Log of CXI*	0.04	0.02	0.03
Log of CXO*	-0.01	0.01	0.6
Condition of residence†	0.34	0.05	0.0001
Refinish	-0.17	0.06	0.006

MODEL 2

Adj R^2 = 0.15; N = 433; Potential confounders and log soil			
Variable	Parameter Estimate	Standard Error	P <
Intercept	0.58	0.23	0.03
Log of lead in water	0.03	0.02	0.2
Log of CXI*	0.03	0.02	0.2
Log of CXO*	-0.01	0.01	0.2
Condition of residence†	0.3	0.05	0.0001
Refinish	-0.16	0.06	0.01
Soil composition	0.17	0.04	0.0001

*Log of CXI, Log CXO are the logarithms of the sum of indoor and outdoor lead paint measurements multiplied by ratings of the condition of the paint where each XRF reading was made.

†Condition of residence is the rating of the overall state of repair/disrepair of the house.

Table 12.—Hierarchical regression analysis, dependent variable: log "dust load".

MODEL 1

Adj R^2 = 0.26; N = 433; Potential confounders			
Variable	Parameter Estimate	Standard Error	P <
Intercept	-2.47	0.16	0.0001
Log of Water	0.01	0.05	0.9
Log of CXI*	0.24	0.04	0.0001
Log of CXO*	0.06	0.02	0.02
Condition of residence†	0.77	0.11	0.0001
Refinish	-0.06	0.14	0.7

MODEL 2

Adj R^2 = 0.32; N = 433; Potential confounders and log soil			
Variable	Parameter Estimate	Standard Error	P <
Intercept	-5.44	0.55	0.0001
Log of Water	-0.004	0.04	0.9
Log of CXI*	0.20	0.04	0.0001
Log of CXO*	0.04	0.02	0.2
Condition of residence†	0.67	0.11	0.0001
Refinish	-0.03	0.13	0.9
Soil composition	0.53	0.09	0.0001

*Log of CXI, Log of CXO are the logarithms of the sum of indoor and outdoor lead paint measurements m[illegible]d by ratings of the condition of the paint where each XRF reading was made.

†Condition of residence is the rating of the overall state of repair/disrepair of the house.

Table 13.—Geometric means of environmental testing from families with more than one child under 6 years of age and families with only one child under 6 years of age.

	Households with Two or More Children Under 6 Years of Age		Households with One Child Under 6 Years of Age	
Parameter	Mean Level of Parameter*		Mean Level of Parameter*	
	BPb <10 μg/dl	BPb ≥10 μg/dl	BPb <10 μg/dl	BPb ≥10 μg/dl
Distance to smelter†	5.3	4.5	5.4	4.7
CXRFI§	0.7	1.2	0.6	10.0
CXRFO¶	3.8	6.7	3.4	5.7
Indoor lead/paint**	0.8	1.1	0.7	10.0
Composite soil sample††	310	503	303	488
"Dust load"§§	200	700	150	600

*All environmental measurements are statistically significantly different at the $p < 0.05$ level between the high blood lead (≥0.48 μmol/L, ≥10 μg/dL) and the low blood lead groups for households with one child and households with more than one child.
†Distance to the smelter is an arithmetic mean.
§CXRFI is the average indoor XRF reading in mg/cm^2 multiplied by the condition code of the residence.
¶CXRFO is the average outdoor XRF reading in mg/cm^2 multiplied by the condition code of the residence.
**Indoor lead paint is the average indoor XRF lead paint reading in mg/cm^2.
††EPA soil sample is the lead concentration in ppm (mg/kg) of a composite soil sample taken from different areas of the yard, including play areas.
§§"Dust load" is the amount of dust (in μg) collected from a m^2 of area in the residence.

FIGURES

Figure 1.—Map of the study area showing the distribution of the residents. The closed circles represent residents with children with blood lead levels <0.48 μmol/L (<10 μg/dl). The open squares represent houses with children with blood lead levels of ≥ 0.48 μmol/L (≥ 10 μg/dl).

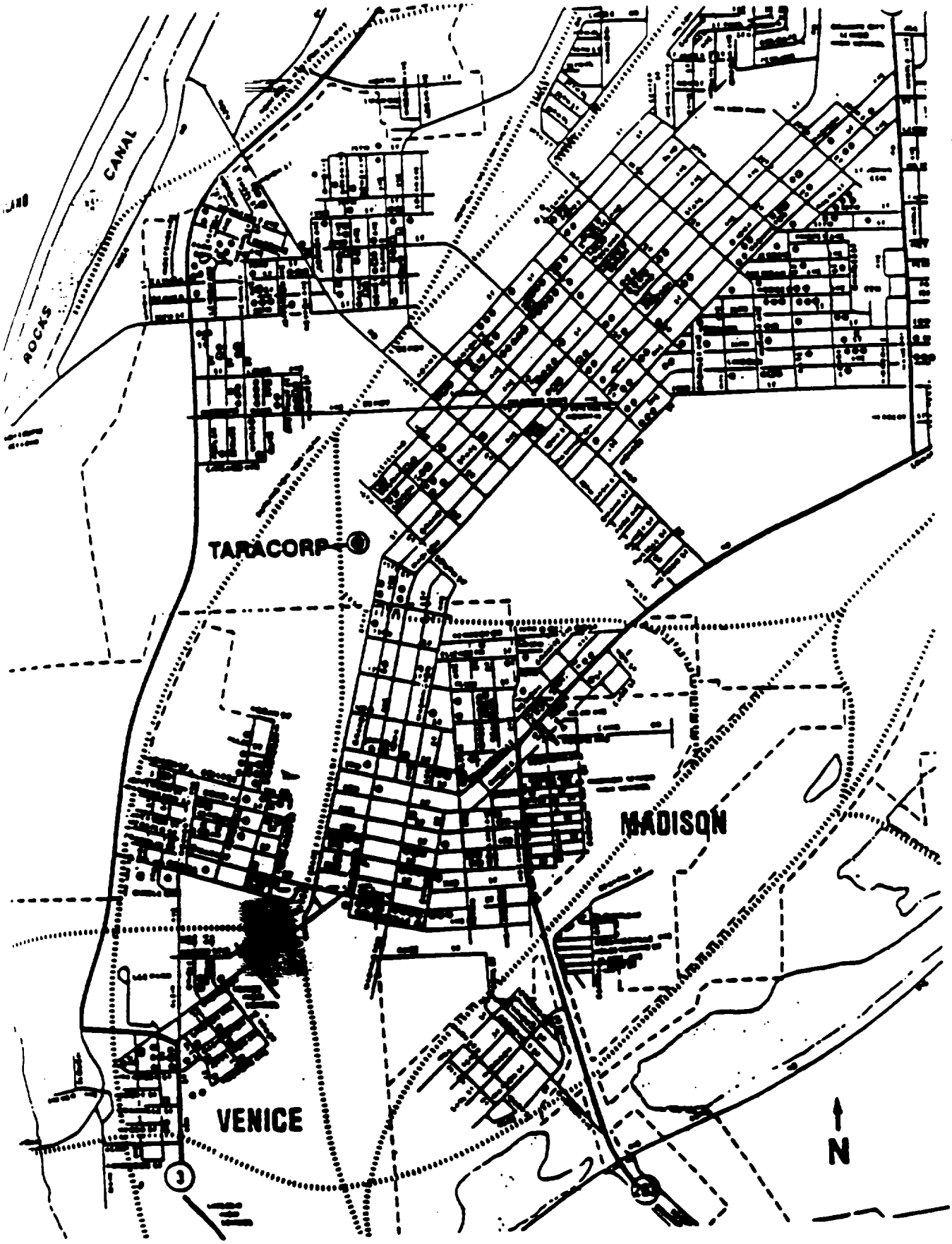
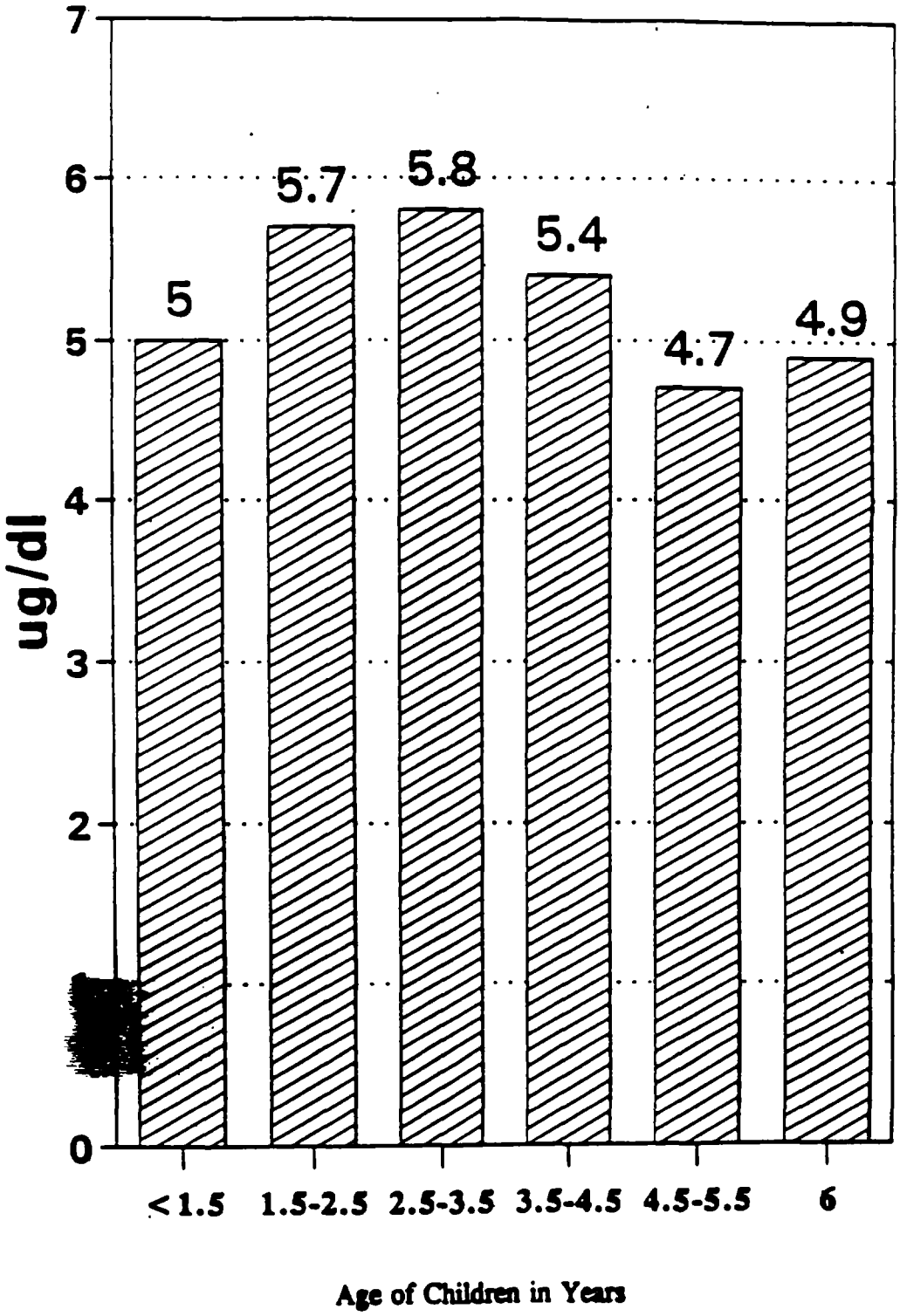

CANAL
ROCKS
TARACORP
MADISON
VENICE
N

Figure 2a.—Mean blood lead levels by age group for children with blood lead levels ≤ 0.48 μmol/L (≤ 10 μg/dl).


7
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5
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3
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0
ug/dl
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5.7
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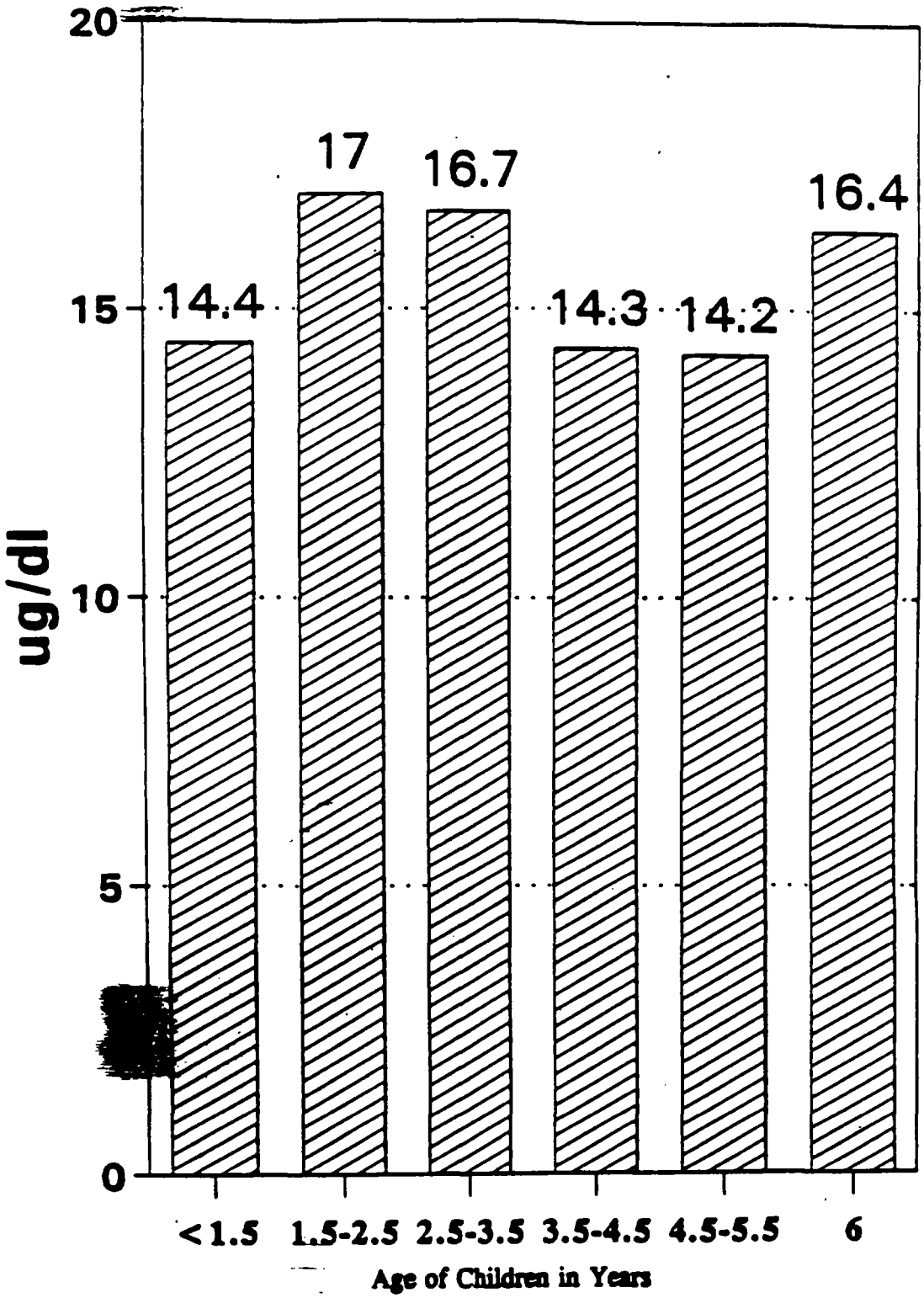
4.9
< 1.5
1.5-2.5
2.5-3.5
3.5-4.5
4.5-5.5
6
Age of Children in Years

Figure 2b.—Mean blood lead levels by age group for children with blood lead levels ≥ 0.48 μmol/L (≥ 10 μg/dl).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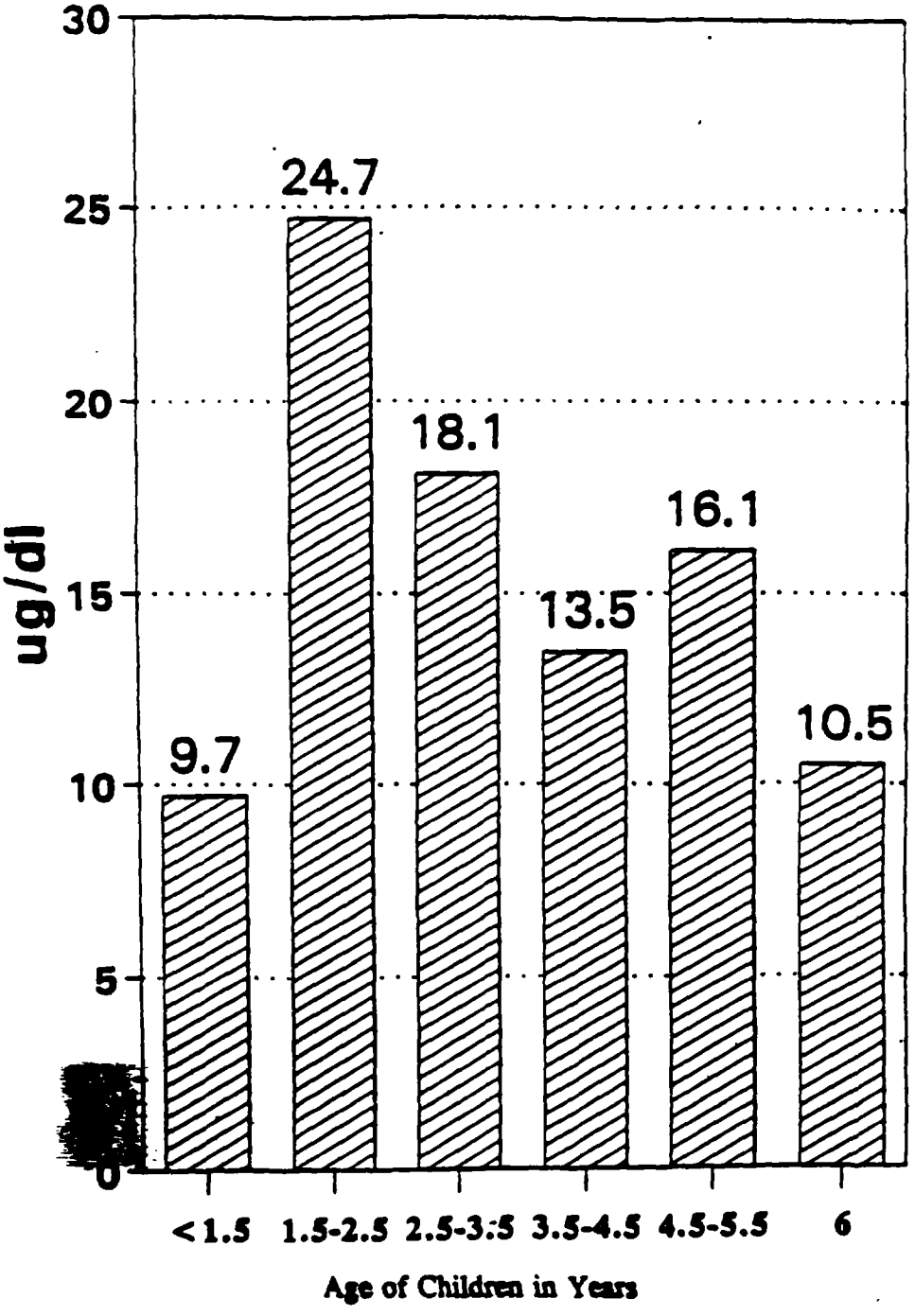
10
5
0
ug/dl
14.4
17
16.7
14.3
14.2
16.4
<1.5
1.5-2.5
2.5-3.5
3.5-4.5
4.5-5.5
6
Age of Children in Years

Figure 2c. Percent of children in each age group with blood lead levels ≥ 0.48 μmol/L (≥ 10 μg/dl).


30
25
20
15
10
5
0
ug/dl
24.7
18.1
16.1
13.5
10.5
9.7
<1.5
1.5-2.5
2.5-3.5
3.5-4.5
4.5-5.5
6
Age of Children in Years

APPENDICES

The contents of Appendices A through I are presented in their entirety as submitted by the authors and have not been revised to conform with the Agency for Toxic Substances and Disease Registry editorial guidelines.

Appendix A—Census Form

Illinois Department of Public Health
Madison County Lead Study
Census Form
Summer 1991

Census Block # _____
Census Taker ID _____
Census Household # _____

House Address _____
City _____ Zip _____ Phone _____

Check here if refused to answer all questions _____

List on the numbered lines below the names of each person living in this house or apartment. Begin with the head of the household and include all persons staying here who have no other home.

INCLUDE	DO NOT INCLUDE
Everyone who usually lives here such as family members, housemates and roommates, foster children, roomers, boarders, and live-in workers.	Persons who usually live somewhere else.
Persons who are temporarily away on a business trip, on vacation, or in a general hospital.	Persons who are institutionalized.
College students who stay here while attending college.	College students who live somewhere else while attending college.
Persons in the Armed Forces who live here.	Persons in the Armed Forces who live somewhere else.
Newborn babies still in the hospital.	
Children in boarding schools below the college level.	
Persons who stay here most of the week while working even if they have a home somewhere else.	Persons who stay somewhere else most of the week while working.

	Last	First	Initial
Person 1 (head):			
Person 2:			
Person 3:			
Person 4:			
Person 5:			
Person 6:			
Person 7:			
Person 8:			
Person 9:			
Person 10:			
Person 11:			
Person 12:			

Illinois Department of Public Health
Madison County Lead Study

Census Form

Summer 1991

Census Block # _____

Census Taker ID _____

Census Household # _____

CIRCLE THE BEST ANSWER AND WRITE NUMBER IN LOWER RIGHT HAND CORNER OF BOX

#1

Which describes this building best?

1. Mobile home or trailer
2. One family house detached from any other house
3. Duplex
4. Row house
5. Building with 2 apartments or less
6. Building with 3 or 4 apartments
7. Building with 5 to 9 apartments
8. Building with 10 or more apartments
9. Don't know

#2

How many rooms are in this house or apartment, excluding bathrooms or halls?

1. 2 or less
2. 3 to 4 rooms
3. 5 to 6 rooms
4. 7 to 8 rooms
5. 9 to 10 rooms
6. 11 or more rooms
7. Refused response
9. Don't know

#3

What year was this house or apartment built?

1. Before 1879
2. 1880 to 1899
3. 1900 to 1919
4. 1920 to 1939
5. 1940 to 1959
6. 1960 [illegible]
7. 1980 [illegible]nt
8. Refu[illegible]nse
9. Don't [illegible]

#4

Is this house or apartment

1. Owned by you or someone in this household with mortgage or loan?
2. Owned by you or someone in this household free and clear (without a mortgage)?
3. Rented for cash rent?
4. Occupied without payment of cash rent?
5. Other _____
6. Refused response
9. Don't know

#5

Which of the following best describes the highest level of education completed by the head of this household?

1. Grade school
2. Some high school
3. High school
4. Some college
5. College (BA, BS, BM, LPN, etc.)
6. Some postgraduate work
7. Postgraduate work (Master's, Ph.D. J.D., M.D., etc.)
8. Refused response
9. Don't know

#6

How long have you and your family occupied this apartment or house?

1. Less than 2 months
2. 3 months to 11 months
3. 1 year to 2 years
4. 3 years to 5 years
5. 6 years to 8 years
6. 9 years or more
7. Refused response
9. Don't know

#7

Is anyone in this residence pregnant?

1. Yes
   If yes, please give first name(s)
   _____
   _____
2. No
3. Refused response
9. Don't know

illinois Department of Public Health
adison County Lead Study

Form

ummer 1991

Census Block #_____

Census Taker ID_____

Census Household # _____

CIRCLE THE BEST ANSWER AND WRITE NUMBER IN LOWER RIGHT HAND CORNER OF BOX

Fill one column for each person listed on second page	Person # 1 Name	Person # 2 Name	Person # 3 Name	Person # 4 Name
#8 Is person 2 and others related to person 1?				
1. Yes (go to #9A)		1	1	1
2. No (go to #9B)		2	2	2
#9 A. How are they related?				
1. Husband/wife		1	1	1
2. Natural-born/adopted/ son/daughter		2	2	2
3. Step or foster child		3	3	3
4. Father/mother		4	4	4
5. Grandchild		5	5	5
6. Other		6	6	6
7. Refused response		7	7	7
9. Don't know		9	9	9
B. If not related:				
1. Roomer, boarder		1	1	1
2. Housemate, roommate		2	2	2
3. Unmarried partner		3	3	3
4. Other non-relative		4	4	4
5. Refused response		5	5	5
9. Don't know		9	9	9
#10 Describe race of persons in your household.				
1. Caucasian	1	1	1	1
2. African-American	2	2	2	2
3. Indian American	3	3	3	3
4. Eskimo or Aleut	4	4	4	4
5. Asian/Pacific Islander	5	5	5	5
6. Other	6	6	6	6
7. Refused response	7	7	7	7
9. Don't know	9	9	9	9
11 Sex	1. M 2. F	1. M 2. F	1. M 2. F	1. M 2. F
12 Age in Years				
13 Date of Birth (MM/DD/YY)	/ /	/ /	/ /	/ /
14 Marital Status				
1. Now married	1	1	1	1
2. Widowed	2	2	2	2
3. Divorced	3	3	3	3
4. Separated	4	4	4	4
5. Single	5	5	5	5
6. Refused response	6	6	6	6
9. Don't know	9	9	9	9

Illinois Department of Public Health
Madison County Lead Study

Census Form

Summer 1991

Census Block # _____

Census Taker ID _____

Census Household # ___

CIRCLE THE BEST ANSWER AND WRITE NUMBER IN LOWER RIGHT HAND CORNER OF BOX

Fill one column for each person listed on second page	Person # 5 Name	Person # 6 Name	Person # 7 Name	Person # 8 Name
#8 Is person 2 and others related to person 1?				
1. Yes (go to #9A)	1	1	1	1
2. No (go to #9B)	2	2	2	2
#9 A. How are they related?				
1. Husband/wife	1	1	1	1
2. Natural-born/adopted/son/daughter	2	2	2	2
3. Step or foster child	3	3	3	3
4. Father/mother	4	4	4	4
5. Grandchild	5	5	5	5
6. Other	6	6	6	6
7. Refused response	7	7	7	7
9. Don't know	9	9	9	9
B. If not related:				
1. Roomer, boarder	1	1	1	1
2. Housemate, roommate	2	2	2	2
3. Unmarried partner	3	3	3	3
4. Other non-relative	4	4	4	4
5. Refused response	5	5	5	5
9. Don't know	9	9	9	9
#10 Describe race of persons in your household.				
1. Caucasian	1	1	1	1
2. African-American	2	2	2	2
3. Indian American	3	3	3	3
4. Eskimo or Aleut	4	4	4	4
5. Asian/Pacific Islander	5	5	5	5
6. Other	6	6	6	6
7. Refused [illegible]	7	7	7	7
9. Don't k[illegible]	9	9	9	9
#11 Sex	1. M 2. F	1. M 2. F	1. M 2. F	1. M 2. F
#12 Age in Years				
#13 Date of Birth (MM/DD/YY)	/ /	/ /	/ /	/ /
#14 Marital Status				
1. Now married	1	1	1	1
2. Widowed	2	2	2	2
3. Divorced	3	3	3	3
4. Separated	4	4	4	4
5. Single	5	5	5	5
6. Refused response	6	6	6	6
9. Don't know	9	9	9	9

Illinois Department of Public Health
Madison County Lead Study

Form

Summer 1991

Census Block #_____

Census Taker ID_____

Census Household # _____

CIRCLE THE ANSWER AND WRITE NUMBER IN LOWER RIGHT HAND CORNER OF BOX

Fill one column for each person listed on second page	Person # 9 Name	Person # 10 Name	Person # 11 Name	Person # 12 Name
#8 Is person 2 and others related to person 1?				
1. Yes (go to #9A)	1	1	1	1
2. No (go to #9B)	2	2	2	2
#9 A. How are they related?				
1. Husband/wife	1	1	1	1
2. Natural-born/adopted/son/daughter	2	2	2	2
3. Step or foster child	3	3	3	3
4. Father/mother	4	4	4	4
5. Grandchild	5	5	5	5
6. Other	6	6	6	6
7. Refused response	7	7	7	7
9. Don't know	9	9	9	9
B. If not related:				
1. Lodger, boarder	1	1	1	1
2. Housemate, roommate	2	2	2	2
3. Unmarried partner	3	3	3	3
4. Other non-relative	4	4	4	4
5. Refused response	5	5	5	5
9. Don't know	9	9	9	9
#10 Describe race of persons in your household.				
1. Caucasian	1	1	1	1
2. African-American	2	2	2	2
3. Indian American	3	3	3	3
4. Eskimo or Aleut	4	4	4	4
5. Asian/Pacific Islander	5	5	5	5
6. Other	6	6	6	6
7. Refused response	7	7	7	7
9. Don't know	9	9	9	9
#11 Sex	1. M 2. F	1. M 2. F	1. M 2. F	1. M 2. F
#12 Age in Years				
#13 Date of Birth (MM/DD/YY)	/ /	/ /	/ /	/ /
#14 Marital Status				
1. Now married	1	1	1	1
2. Widowed	2	2	2	2
3. Divorced	3	3	3	3
4. Separated	4	4	4	4
5. Single	5	5	5	5
6. Refused response	6	6	6	6
9. Don't know	9	9	9	9

Illinois Department of Public Health
Madison County Lead Study

Census Form

Summer 1991

Census Block #_____

Census Taker ID_____

Census Household #_____

ANIMAL DATA - CIRCLE THE ANSWER THAT BEST APPLIES

1. Do you keep a cat or dog at your dwelling?

   1. Yes (if yes go to next question)
   2. No

2. If yes, what is the species, sex, age, and how long had you had each individual animal?

Animal #	1	2	3	4	5	6
Name						
Species 1. Dog 2. Cat	 1 2	 1 2	 1 2	 1 2	 1 2	 1 2
Sex 1. Male 2. Female 3. Neutered	 1 2 3	 1 2 3	 1 2 3	 1 2 3	 1 2 3	 1 2 3
Age in months or DK*	___ DK	___ DK	___ DK	___ DK	___ DK	___ DK
Months of Possession or DK*	___ DK	___ DK	___ DK	___ DK	___ DK	___ DK

*DK-don't know

Years	Months	Years	Months	Years	Months
0.5	6	5.5	66	10.5	126
1.0	12	6.0	72	11.0	132
1.5	18	6.5	78	11.5	138
2.0	24	7.0	84	12.0	144
2.5	30	7.5	90	12.5	150
3.0	36	8.0	96	13.0	156
3.5	42	8.5	102	13.5	162
4.0	48	9.0	108	14.0	168
4.5	54	9.5	114	14.5	174
5.0	60	10.0	120	15.0	180

Illinois Department of Public Health

Madison County Lead Study Census Block # _____

Summer 1991

The Illinois Department of Public Health thanks you for your cooperation. The census information given to the Illinois Department of Public Health will be used to help determine which particular areas to study. We need some of this information to choose groups of residents that may be exposed to lead as well as similar groups of residents that are not exposed.

You should have received a copy of the consent form that will be used for this study. We are distributing this now so that you have plenty of time to read it in advance if you are asked to participate.

If you did not receive a copy of the consent form or if you have any further questions regarding this study, please contact:

Tom Long
Illinois Department of Public Health
Division of Environmental Health
525 West Jefferson Street
Springfield, Illinois 62761
(217) 782-5830

David Webb
Illinois Department of Public Health
22 Kettle River Drive
Edwardsville, IL 62025
(618) 656-6680

Cathy Copley, Illinois Department of Public Health
2125 S. First Street
Champaign, IL 61820
(2[redacted]33-6914

• LEAVE THIS PAGE AT HOUSEHOLD AFTER CENSUS COMPLETED •

Printed by Authority of the State of Illinois
P.O. 53010 7M 7/91

Appendix B—Consent Form

PROTECTION OF HUMAN SUBJECTS
ASSURANCE/CERTIFICATION/DECLARATION

☐ ORIGINAL ☐ FOLLOWUP ☐ EXEMPTION (previously undesignated)

Continuation continuation

APPLICATION IDENTIFICATION NO. *(if known)*

POLICY: A research activity involving human subjects that is not exempt from HHS regulations may not be funded unless an Institutional Review Board (IRB) has reviewed and approved the activity in accordance with Section 474 of the Public Health Service Act as implemented by Title 45, Part 46 of the Code of Federal Regulations (45 CFR 46—as revised). The applicant institution must submit certification of IRB approval to HHS unless the applicant institution has designated a specific exemption under Section 46.101(b) which applies to the proposed research activity. Institutions with an assurance of compliance on file with HHS which covers the proposed activity should submit certification of IRB review and approval with each application. (In exceptional cases, certification may be accepted up to 60 days after the receipt date for which the application is submitted.) In the case of institutions which do not have an assurance of compliance on file with HHS covering the proposed activity, certification of IRB review and approval must be submitted within 30 days of the receipt of a written request from HHS for certification.

TITLE OF APPLICATION OR ACTIVITY

Multisite heavy metals exposure study in Illinois, Kansas, and Missouri (Summer 1991)

PRINCIPAL INVESTIGATOR, PROGRAM DIRECTOR, OR FELLOW

Thomas F. Long

FOOD AND DRUG ADMINISTRATION REQUIRED INFORMATION *(see reverse side)*

HHS ASSURANCE STATUS

☐ This institution has an approved assurance of compliance on file with HHS which covers this activity.

M1911 Assurance identification number 01 IRB identification number

☐ No assurance of compliance which applies to this activity has been established with HHS, but the applicant institution will provide written assurance of compliance and certification of IRB review and approval in accordance with 45 CFR 46 upon request.

CERTIFICATION OF IRB REVIEW OR DECLARATION OF EXEMPTION

☐ This activity has been reviewed and approved by an IRB in accordance with the requirements of 45 CFR 46, including its relevant Subparts. This certification fulfills, when applicable, requirements for certifying FDA status for each investigational new drug or device. *(See reverse side of this form.)*

6/20/91 Date of IRB review and approval. *(If approval is pending, write "pending." Followup certification is required.)*
(month/day/year)

☒ Full Board Review ☐ Expedited Review

☐ This activity contains multiple projects, some of which have not been reviewed. The IRB has granted approval on condition that all projects covered by 45 CFR 46 will be reviewed and approved before they are initiated and that appropriate further certification *(Form HHS 596)* will be submitted.

☐ Human subjects are involved, but this activity qualifies for exemption under 46.101(b) in accordance with paragraph _____ *(insert paragraph number of exemption in 46.101(b), 1 through 5)*, but the institution did not designate that exemption on the application.

Each official signing below certifies that the information provided on this form is correct and that each institution assumes responsibility for ensuring required future reviews, approvals, and submissions of certification.

APPLICANT INSTITUTION	COOPERATING INSTITUTION
NAME, ADDRESS, AND TELEPHONE NO. Board of Trustees of Southern Illinois University Carbondale, Il 62901 217/782-3318	NAME, ADDRESS, AND TELEPHONE NO. Illinois Department of Public Health 525 West Jefferson Springfield, Il 62761 217/782-5830
NAME AND TITLE OF OFFICIAL *(print or type)* Richard C. Moy, Dean and Provost, for John C. Guyon, Ph.D., President, SIU	NAME AND TITLE OF OFFICIAL *(print or type)* John R. Lumpkin, M.D., Director 6/25/91
SIGNATURE OF OFFICIAL LISTED ABOVE *(and date)* Richard H. Moy 6/26/91	SIGNATURE OF OFFICIAL LISTED ABOVE *(and date)* John R. Lumpkin 6/27/9

(If additional space is needed, please use reverse side under "Remarks")

HHS 596 (Rev. 1/82)

Southern Illinois University
School of Medicine
Springfield Committee
for Research Involving Human Subjects

Protocol #: 91-37
(to be assigned by Office of ADR)

Application for Approval of a Research Protocol

Instructions to Principal Investigators: Complete either A, B, or C as appropriate to your protocol. Please call the Office of the Associate Dean for Research, 782-7936, if you have questions.
Please Submit: One (1) copy of this application form along with the appropriate number of copies of other materials as indicated below to the Office of the Associate Dean for Research, 801 North Rutledge, Springfield, Illinois.

I. Investigator: Thomas F. Long

Department: Illinois Department of Public Health Telephone: (217) 782-5830

Co-Investigator(s): Catherine Copley

Title of Protocol: Multisite Heavy Metal Exposure Study in Illinois, Kansas and Missouri

Funding: ___ Departmental ___ CRC. X External (Specify) Agency for Toxic Substances and Disease Registry

Approval of Department Chair Indicated by Signature: [signature] Associate Director, Office of Health Protection, ID.

Other Department Involved: ___ Yes X No

If Yes, Approval of Department Chair Indicated by Signature: _____

This Protocol will be implemented at:

___ Memorial Medical Center

___ St. John's Hospital

X Neither

A. **[illegible] presenting risk to subjects:** e.g. drug and medical device trials, surgical and other invasive procedures, studies involving randomization, placebo controls, etc.

Please Submit:
1. Thirty (30) copies of the complete protocol;
2. Thirty (30) copies of a consent form prepared on Form SCRIHS-B 12/82.

B. **Research presenting minimal risk to subjects:** In order for your study to be categorized as a "MINIMAL RISK" project, it must fall into one or more of the following areas. Please indicate the category:

___ 1. Collection of hair and nail clippings in a nondisfiguring manner; deciduous teeth; and permanent teeth if patient care indicates a need for extraction.

financial standing or employability; and (iii) the research deals with sensitive aspects of the subject's own behavior, such as illegal conduct, drug use, sexual behavior, or use of alcohol.

____ 4. Research involving the observation (including observation by participants) of public behavior, except where all of the following conditions exist: (i) observations are recorded in such a manner that the human subjects can be identified, directly or through identifiers linked to the subjects; (ii) the observations recorded about the individuals, if they became known outside the research, could reasonably place the subject at risk of criminal or civil liability or be damaging to the subject's financial standing or employability; and (iii) the research deals with sensitive aspects of the subject's own behavior such as illegal conduct, drug use, sexual behavior, or use of alcohol.

____ 5. Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Please submit

1. Three (3) copies of the protocol.

II. All investigators must sign the following statement of assurance:

The proposed investigation involves the use of human subjects. I am submitting this form with a description of my protocol prepared in accordance with institutional policy for the protection of human subjects participating in research. I am responsible for:

- insuring that informed consent is documented by the use of a written consent form approved by the IRB and signed by the subject or the subject's legally authorized representative and that each person signing the form is given a copy;
- placing the consent documents signed by human research subjects in a repository approved by the Associate Dean for Research;
- reporting the progress of the research to the Associate Dean for Research as often as and in the manner prescribed by SCRIHS but no less than once per year;
- reporting promptly through my department head to the Associate Dean for Research any injuries to human subjects or any unanticipated problems which involve risks to the human research subjects or others;
- reporting promptly through my department head to the Associate Dean for Research proposed changes in my research activity. I understand that changes in research during the period for which SCRIHS approval has already been given, shall not be initiated by me without SCRIHS review and approval, except where necessary to eliminate apparent immediate hazards to the subject;
- reporting promptly to the Associate Dean for Research and SCRIHS any serious or continuing noncompliance with the requirements of the SCRIHS General Assurance or the determinations of SCRIHS.

Signature of Principal Investigator — Date 4/26/91

Note: Please refer to Southern Illinois University School of Medicine, Springfield Committee for Research Involving Human Subjects Assurance of Compliance with HHS Regulations for Protection of Human Research Subjects for policy regarding research involving human subjects.

INFORMED CONSENT FORM

Informed consent consists of the following elements:

-A fair explanation in terms the subject can understand, of the procedures to be followed and their purposes including an identification of those which are experimental and a statement of the expected duration of the subject's participation;

-A description of any reasonably foreseeable discomforts or risks:

-A description of any benefits reasonably to be expected;

-A disclosure of any appropriate alternative procedures that might be advantageous for the subject;

-A statement describing the extent, if any, to which confidentiality of records identifying the subject will be maintained. If the protocol is a FDA study, a statement should be added to the standard paragraph on confidentiality that the subject understands his or her identity will be revealed to the FDA;

-An explanation of compensation for injuries incurred in research;

-A offer to answer any inquiries concerning procedures;

-An instruction that the subject is free to withdraw his/her consent and to discontinue participation in the project or activity at any time without prejudice to the subject;

-No language through which the subject is made to waive or to appear to waive any of his/her legal rights or to release the institution or its agents from liability or negligence.

The following additional elements may be required depending on the nature of the protocol:

-A statement that the particular treatment or procedure may involve risks to the subject (or to the embryo or fetus, if the subject is or may become pregnant) which are currently unforeseeable;

-Anticipated circumstances under which the subject's participation may be terminated by the research investigator without regard to the subject's consent;

-Any additional costs to the subject that may result from participation in the research;

-The consequences of a subject's decision to withdraw from the research and procedures for orderly termination of participation by the subject;

-A statement that significant new findings developed during the course of the research which may relate to the subject's willingness to continue participation will be provided to the subject; and

The approximate number of subjects involved in the study.

Individuals responsible for this research protocol:

Fred Stallings
Sara Sarasuwa
Agency for Toxic Substances and Disease Registry
Executive Park
Atlanta, Georgia
(404) 639-0564

Thomas Long
Catherine Copley
Illinois Department of Public Health
Division of Environmental Health
525 West Jefferson
Springfield, IL 62761
(217) 782-5830

Title of protocol: Multisite Heavy Metal Exposure Study in Illinois, Kansas, and Missouri

Expected duration of patient involvement in study: It may take approximately a total of two hours to review this consent form, answer questions about activities in and around the home, take my (child's/ward's) blood pressure, collect the urine sample, and draw the blood sample. It may take approximately three hours for researchers to do the necessary environmental work which may include collection of soil, water, and dust samples as well as a paint survey of the home.

I (My child [illegible]d) agree(s) to participate as a subject in this research project, the main purpose of which is: To determine levels of heavy metals in blood and urine in people living in the study area to compare to those levels found in people living outside the study area as well as to currently accepted health guidelines; to determine any relationship between heavy metal levels found in blood and urine and those levels in environmental samples (soil, dust, paint, and water); to determine if those circumstances which may present greater risks of exposure to heavy

metals; and to determine if measurements of some blood components can be identified that may indicate heavy metal exposures.

Description of research protocol (to include objectives, purposes, selection of patients, procedures to be followed, treatment plan, etc.): The Illinois Department of Public Health (IDPH) with assistance for the Agency for Toxic Substances and Disease Registry of the U.S. Public Health Service, is conducting an exposure study of heavy metal contamination in residential areas surrounding the N L Industries/Taracorp National Priority List (NPL) site in Granite City, Illinois. The goals of the study are as follows:

1. To compare my (child'/ward's) heavy metal levels in blood and urine to those found in people living in other areas.

2. To compare the amount of heavy metals in my environment with those found in other areas.

3. To analyze some of my blood components and see how they compare with those found in people living in other areas.

4. To compare the results of the tests of blood mentioned above with the standard reference ranges for these tests.

5. To determine if there is a statistical relationship between activities and/or situations in and around the home and the amount of heavy metals found in my (child's/ward's) body.

6. To compare the levels of heavy metals found in my (child's/ward/s) blood and the levels of blood components.

7. To compare the results of my community's exposure with people living in areas contaminated by both industrial and mining emissions.

As a resident, I am being asked to participate in order to determine the degree of my (child's/ward's) exposure to heavy metals. This study will include some people living within two miles of the NPL site. The individuals doing this study would like to [illegible]ude all children between the ages of 6 months through 71 mon[illegible] Some older children and adults, chosen randomly, like tos[illegible] a coin, will be asked to participate. My (child's/ward's) part in the study may include:

1. Answering questions about habits and activities in and around the home and about the occupations of adults in the home. Questions concerning financial status will be asked as well. This interview will require about one hour.

2. Having blood pressure measured.

3. Permitting a blood sample not to exceed 30 milliliters (about 2 tablespoons) to be taken with a sterile needle from a vein in the arm. I (My child/ward) may be asked to provide a second sample at a future date to measure changes over time.

4. Providing a urine sample by voiding into a container. A container and instructions will be given to me. The sample may be picked up later. No urine is to be collected from infants.

5. Allowing testing on blood and urine samples for heavy metals and associated biological measurements. Some of the blood work for immunological tests is considered experimental.

6. Allowing environmental samples to be collected from in and around the home. This will require IDPH or their representatives to enter the home and conduct a survey of paint. In addition, water, dust, and soil samples may be collected to be analyzed for heavy metals. The sample collection may require up to three hours.

I understand that of the procedures described above, the following are experimental procedures: None.

I understand that the reasonable foreseeable risks or discomforts may be as follows: There is little risk associated with the blood drawing procedure. The needle will be left in my (child's/ward's) arm for a few minutes. I (My child/ward) can expect to experience some pain at the moment the needle goes into the arm. In about 10 percent of cases, a small amount of bleeding under the skin will produce a bruise (hematoma). There is a very small risk of temporary clotting of the vein, infection, or fainting.

I understand that the benefits which may reasonably be expected from my (my child's ward's) participation in this study are: I will know what kind of environment I live in and if I have been exposed to lead. A copy of this consent form will be given to me. Results of [redacted]od, urine, and immediate environment tests will be provided t[redacted] and/or our physician at no charge. I will be provided w[redacted]recommendations to reduce the amount of exposure to heavy metal[redacted] results reflect potential of excessive heavy metal exposure. We will be included on a mailing list and will receive a copy of the final report.

I am aware that the following alternative procedures could be advantageous to me: Getting the same tests done by a private company or laboratory. I could choose to do nothing.

Discussion of additional elements of informed consent, if applicable. If none are applicable, please state.

Confidentiality is assured since IDPH will take every reasonable precaution to keep my (my child's/ward's) records confidential. Any information shared with the Agency for Toxic Substances and Disease Registry or Centers for Disease Control will be kept in accordance with the Federal Privacy Act of 1974 and will not include information which identifies me (my child/ward) personally. Any reports of this study will not identify specific individuals and will only give group information.

We understand that we may be asked to participate in future studies to measure heavy metal blood levels and environmental contamination concentration changes over time.

This protocol has been reviewed and approved by the Springfield Committee for Research Involving Human Subjects as preserving safeguards of subjects' privacy, welfare, and civil liberties. The Chairman of the Committee may be reached through the Office of the Dean and Provost, Southern Illinois University School of medicine, 801 North Rutledge Street, Springfield, Illinois 62708, telephone (217) 782-3318

I may contact the following person to answer any inquiries I may have concerning this research protocol and my rights as a research subject: Catherine Copley; Illinois Department of Public Health 525 West Jefferson; Springfield, IL 62761; (217) 782-5830 or David Webb; Illinois Department of Public Health; 22 Kettle River Drive; Edwardsville, IL 62025; (618) 656-6680.

I understand that my (child's/ward's) participation in this study is entirely voluntary and that I may decline to enter this study or withdraw from it any time. If I wish to withdraw, I understand that it is important to notify my doctor so that he or she can plan for my continuing medical care.

Any information obtained from this investigation which can be identified with me will remain confidential or will be disclosed only with my permission. Should any publication or public presentation result from this study, my (child's/ward's) identity will not be revealed.

I understand, in the event of any research-related injury resulting from research procedures, that financial compensation is not available, but that immediate medical treatment for injuries is available at usual and customary fees at St. Elizabeth's Medical Center in Granite City, Illinois. I also understand that should I (my child/ward) suffer any physical injury as a result of participation in the research program, I may contact the Chairman, Springfield Committee for Research Involving Human Subjects,

Southern Illinois University School of Medicine, 801 North Rutledge Street, Springfield, Illinois, 62708, telephone number (217) 782-3318, who will review the matter with me and identify any other resources that may be available to me.

Printed Name ~~of~~ Participant: _____

Signatures:

_____
Subject, Legal Guardian, or Next of Kin — Date

_____
Participant under 18 Years of Age — Date

_____
Principal Investigator — Date

_____
Witness — Date

(Date consent form approved by SCRIHS: 6/20/91)

Illinois Department of Public Health
August 1991

SCRIHS
6-20-91
Date

Protocol #91
Revision
amended 7/
approved 7/
amended 7/
approved

INFORMED CONSENT FORM

Informed consent consists of the following elements:

-A fair explanation in terms the subject can understand, of the procedures to be followed and their purpose including an identification of those which are experimental and a statement of the expected duration of the subject's participation;

-A description of any reasonably foreseeable discomforts or risks;

-A description of any benefits reasonably to be expected;

-A disclosure of any appropriate alternative procedures that might be advantageous for the subject;

-A statement describing the extent, if any, to which confidentiality of records identifying the subject will be maintained. If the protocol is a FDA study, a statement should be added to the standard paragraph on confidentiality that the subject understands his or her identity will be revealed to the FDA;

-An explanation of compensation for injuries incurred in research;

-An offer to answer any inquiries concerning procedures;

-An instruction that the subject is free to withdraw his/her consent and to discontinue participation in the project or activity at any time without prejudice to the subject;

-No language through which the subject is made to waive or to appear to waive any of his/her legal rights to release the institution or its agents from liability or negligence.

The following additional elements may be required depending on the nature of the protocol:

-A statement that the particular treatment or procedure may involve risks to the subject (or to the embryo fetus, if the subject is or may become pregnant) which are currently unforeseeable;

-Anticipated circumstances under which the subject's participation may be terminated by the research investigator without regard to the subject's consent;

-The consequences of a subject's decision to withdraw from the research and procedures for orderly termination of participation by the subject;

-A statement that significant new findings developed during the course of the research which may relate to the subject's willingness to continue participation will be provided to the subject; and;

-The approximate number of subjects involved in the study.

Individuals responsible for this research protocol;

Fred Stallings
Sara Sarasuwa
Agency for Toxic Substances and Disease Registry
Executive Park
Atlanta, Georgia
(404) 639-0564

Thomas Long
Catherine Copley
Illinois Department of Public Health
Division of Environmental Health
525 West Jefferson
Springfield, IL 62761
(217) 782-5830

Title of protocol: Multisite Heavy Metals Exposure Study in Illinois, Kansas, and Missouri

Expected duration of patient involvement in study: It will take approximately 1 and 1/2 hours to review this consent form, complete the questionnaire, collect the urine sample, and collect the biological samples. It will take at least 1 hour to collect soil, water, paint, and dust samples from my home.

I (My child/ward) agree(s) to participate as a subject in this research project, the main purpose of which is: To determine levels of heavy metals in blood and urine in people living in the study area to compare to those levels found in people living outside the study area as well as to currently accepted health guidelines; to determine any relationship between heavy metal levels found in blood and urine and levels in soil, dust, paint, and water; to determine risk factors for exposure to lead and cadmium.

Description of research protocol (to include objectives, purposes, selection of patients, procedures to be followed, treatment plan, etc.): The Illinois Department of Public Health (IDPH) with assistance from the Agency for Toxic Substances and Disease Registry of the U.S. Public Health service, is conducting an exposure study of heavy metal contamination in residential areas surrounding the N L Industries/Taracorp National Priority List (NPL) site in Granite City Illinois. I am being asked to participate in this study:

1. To determine if there is a statistical relationship between activities and/or situations in and around the home and the amount of heavy metals found in my (child's/ward's) body.

2. To compare the levels of heavy metals found in my (child's/ward's) blood to the levels of blood components.

3. To compare the results of my community's exposure with people living in areas contaminated to both industrial and mining emissions.

As a resident, I am being asked to participate in order to determine the degree of my (child's/ward's) exposure to heavy metals. This study will include some people living within two miles of the NPL site. The individuals doing this study would like to include all children between the ages of 6 months through 71 months. Some older children and adults, chosen randomly, like tossing a coin, will be asked to participate. My (child's/ward's) part in the study may include:

1. Answering questions about habits and activities in and around the home and about the occupations of adults in the home. *This interview will require about one hour.*

2. Permitting a blood sample not to exceed 30 milliliters (about 2 tablespoons) to be taken with a sterile needle from a vein in the arm.

3. Providing a urine sample by voiding into a cup in the privacy of an enclosed area. Instructions will be given to help my (my child/ward) use the cup to collect urine. Parents will be asked to help small children.

4. Allowing environmental samples to be collected from in and around the home at a later date. This will require IDPH representatives to enter my home and conduct a test of exterior and interior paint which will cause minimal damage to paint. In addition, water, dust, and soil samples will be collected to be analyzed for lead and cadmium.

I understand that of the procedures described above, the following are experimental procedures: None.

I understand that the reasonable foreseeable risks or discomforts may be as follows: There is little risk associated with the blood drawing procedure. The needle will be left in my (child's/ward's) arm for a few minutes. I (My child/ward) can expect to experience some pain at the moment the needle goes into the arm. In about 10 percent of cases, a small amount of bleeding under the skin will produce a bruise (hematoma). There is a small risk of fainting.

I understand that the benefits which may reasonably be expected from my (my child's/ward's) participation in this study are: In 6 to 8 months IDPH will send me a letter with my (my child's/ward's) test results and results of the environmental sampling, at no charge. If the results of medical tests indicate a possible problem, I will be notified as

soon as possible. Otherwise, IDPH will notify me of the results as soon as all tests are done. If further medical evaluation is indicated, recommendations will be given to seek further medical advice. Test results will be sen family physician if I request it in writing. Recommendations to reduce the amount of exposure to lead and/-- cadmium will be provided if results reflect excessive lead or cadmium exposure.

I am aware that the following alternative procedures could be advantageous to me: Getting the same tests don private company or laboratory. I could choose to do nothing.

Discussion of additional elements or informed consent, if applicable. If none are applicable, please state.

IDPH will take every reasonable precaution to keep my (my child's/ward's) records confidential.

This protocol has been reviewed and approved by the Springfield Committee for Research Involving Human Su as preserving safeguards of subjects' privacy, welfare, and civil liberties. The Chairman of the Committee may reached through the Office of the Dean and Provost, Southern Illinois University School of Medicine, 801 Nor Rutledge Street, Springfield, Illinois 62708, telephone (217) 782-3318.

I may contact the following person to answer any inquiries I may have concerning this research protocol and m rights as a research subject: Catherine Copley; Illinois Department of Public Health; 525 West Jefferson; Spri IL 62761; (217) 782-5830 or David Webb; Illinois Department of Public Health; 22 Kettle River Drive; Edward IL 62025; (618) 656-6680.

I understand that my (child's/ward's) participation in this study is entirely voluntary and that I may decline to this study or withdraw from it any time.

Any information obtained from this investigation which can be identified with me will remain confidential or disclosed only with my permission. Should any publication or public presentation result from this study, my (child's/ward's) identity will not be revealed.

I understand, in the event of any research-related injury resulting from research procedures, that financial compensation is not available, but that immediate medical treatment for injuries is available at usual and cust fees at St. Elizabeth's Medical Center in Granite City, IL. I also understand that should I (my child/ward) suff physical injury as a result of participation in the research program, I may contact the Chairman, Springfield Committee for Research Involving Human Subjects, Southern Illinois University School of Medicine, 801 North Rutledge Street, Springfield, IL, 62708, telephone number (217) 782-3318, who will review the matter with m identify any other resources that may be available to me.

Printed Name of Participant: _____

Signatures:

_____

Subject, Guardian, or Next of Kin

_____

Participant under 18 Years of Age

_____

Principal Investigator

_____

Witness

APPROVED BY
SCRIHS
6/20/91
Date

Amended 7/3/97 amended 4/92

Appendix C—Questionnaires

HEAVY METAL EXPOSURE ASSESSMENT QUESTIONNAIRE

PARTICIPANT ID NUMBER __ __ __ __ - __ __ __ __

HOUSE ID NUMBER __ __ __ __

Street Address:

Street _____ Apt._____

City _____ State_____

Zip code _____

Mailing Address:

Street _____ Apt._____

City _____ State_____

Zip code _____

Telephone number:

home (__ __ __) __ __ __ - __ __ __ __

work (__ __ __) __ __ __ - __ __ __ __

1 = Phone
2 = No phone
8 = REFUSED
9 = DON'T KNOW

(001-004) HOUSE ID ___ ___ ___ ___

(005-010) DATE __ __/__ __/__ __

100 HOUSEHOLD QUESTIONNAIRE

THE FOLLOWING QUESTIONS MUST BE ANSWERED BY PARENT OR LEGAL GUARDIAN IF THE SUBJECT IS AGED 14 OR YOUNGER.

First, I would like to ask you some questions about the home you/SUBJECT lives (WHERE SUBJECT LIVES MOST OF THE TIME IN THE LAST 90 DAYS)

(Circle applicable answer.)

(011-012) 101. What year was this house built? (OLDEST PART)

00 = <1900-1909
01 = 1910-1919
02 = 1920-1929
03 = 1930-1939
04 = 1940-1949
05 = 1950-1959
06 = 1960-1969
07 = 1970-1979
08 = 1980-1989
09 = 1990-present
99 = DON'T KNOW

(013) 102. What type of exterior does your/SUBJECT'S home have?

1 = wood
2 = brick
3 = block
4 = mobile home
5 = vinyl/metal siding
6 = Other _____
9 = DON'T KNOW

(014) 103. Is the home you/SUBJECT live in rented or owned?

1 = rent
2 = own
3 = other _____
8 = REFUSED
9 = DON'T KNOW

(015) 104. What type of water pipes does the home contain?

1 = lead
2 = plastic
3 = galvanized steel
4 = copper
5 = iron
6 = mixed (specify) _____
7 = Other (specify) _____
9 = DON'T KNOW

HOUSE ID ___ ___ ___ ___

105. What type of water does your/SUBJECT'S household normally use most for:

	Drinking (016)	Cooking (017)
Private well water	1	1
Public water (city or district)	2	2
Bottled	3	3
Local spring or brook	4	4
Cistern	5	5
Other _____	6	6
DON'T KNOW	9	9

106. Which fuel do you use most for: (Circle one per column)

	House Heating (018)	Water Heating (019)	Cooking (020)
Gas--bottled or tank	1	1	1
Gas--pipes (natural gas)	2	2	2
Electricity	3	3	3
Fuel oil or kerosene	4	4	4
Coal or coke	5	5	5
Wood	6	6	6
Other _____	7	7	7
DON'T KNOW	9	9	9

107. Has any part of your house been repainted, sanded, or chemically or heat stripped, or otherwise refinished within the last year?

(021)
1 = Yes
2 = No
9 = DON'T KNOW

IF YES, Approximately when was this most recently done?

(022-025) ___ ___ / ___ ___
(MONTH / YEAR) (ENTER 99 IF DON'T KNOW MONTH)

108. Do you use air conditioning in your/SUBJECT'S home?

(026)
1 = Yes
2 = No
9 = DON'T KNOW

HOUSE ID ___ ___ ___ ___

HOUSEHOLD ACTIVITIES/OCCUPATIONS

Now I'd like to ask you some questions about the work and hobbies of all persons living in this home. (ALL household members included)

(027) 109. Have any members of the household worked in mining or a mining related job such as mine material handling or transportation in the last 90 days?

1 = Yes
2 = No (GO TO 114)
9 = DON'T KNOW (GO TO 114)

110. What type of mining or mine related work have household members done in the last 90 days? (Circle all that apply.)

			Yes	No	Don't know
(028)	a.	Underground	1	2	9
(029)	b.	Surface	1	2	9
(030)	c.	Milling	1	2	9
(031)	d.	Transportation/ handling	1	2	9
(031)	e.	Clerical/Admin.	1	2	9
(032)	f.	Smelter	1	2	9
(033)	g.	Other	1	2	9

IF OTHER, SPECIFY: _____

111. What type of mine or mine materials have household members worked with in the last 90 days? (Circle all that apply.)

			Yes	No	Don't know
(034)	a.	Lead	1	2	9
(035)	b.	Zinc	1	2	9
(036)	c.	Silver	1	2	9
(037)	d.	Molybdenum	1	2	9
(038)	e.	Coal	1	2	9
(039)	f.	Limestone	1	2	9
(040)	g.	Clay	1	2	9
(041)	h.	Other	1	2	9

IF OTHER, SPECIFY: _____

112. Does any household member(s) that works in a mine or mining related job wear HIS/HER work clothing home after working?

(C42)
1 = Always
2 = Sometimes
3 = Never
9 = DON'T KNOW

113. Does any household member(s) that works in a mine or mining related job come home from work without showering?

(C43)
1 = Always
2 = Sometimes
3 = Never
9 = DON'T KNOW

HOUSE ID ___ ___ ___ ___

Next I have some questions about a number of activities you or other household members may do or may have done in the last three months. These include things you may have done for work, hobbies, or chores and at home or other places.

114. In the last 90 [redacted] ve any members of your household: (Circle all that [redacted]	Yes	No	Don't know	114a. Was this done at home, work, or elsewhere? HOME	OTHER	WORK/	BOTH	Don't know	..4B. IF WORK/OTHER: Were those clothes worn home? Yes	No	Don't know	Did he/she shower before coming home? Yes	No	Don't know
a. Painted pictures with artists paints? (not children's paints)	1	2 (044)	9	3		4 (045)	5	9	1	2 (046)	9	1	2 (047)	9
b. Painted, stained or refinished furniture?	1	2 (048)	9	3		4 (049)	5	9	1	2 (050)	9	1	2 (051)	9
c. Painted the inside or outside of a home or building?	1	2 (052)	9	3		4 (053)	5	9	1	2 (054)	9	1	2 (055)	9
d. Work with stained glass?	1	2 (056)	9	3		4 (057)	5	9	1	2 (058)	9	1	2 (059)	9
e. Cast lead into fishing sinkers, bullets or anything else?	1	2 (060)	9	3		4 (061)	5	9	1	2 (062)	9	1	2 (063)	9
f. Worked with soldering in electronics?	1	2 (064)	9	3		4 (065)	5	9	1	2 (066)	9	1	2 (067)	9
g. Soldering pipes or sheets of metal?	1	2 (068)	9	3		4 (069)	5	9	1	2 (070)	9	1	2 (071)	9
h. Repaired auto radiators?	1	2 (072)	9	3		4 (073)	5	9	1	2 (074)	9	1	2 (075)	9

HOUSE ID ___ ___ ___ ___

114. (Continued)
In the last 90 days, have any members of your household:
(Circle all that apply)

114a. Was this done at home, work, or elsewhere?

114b. IF WORK/OTHER: Were those clothes worn home?

Did he/she shower before coming home?

[redacted]	Yes	No	Don't know	HOME	WORK/ OTHER	BOTH	Don't know	Yes	No	Don't know	Yes	No	Don't know
i. Worked on auto bodies or auto maintenance? (includes mechanics)	1	2 (076)	9	3	4 (077)	5	9	1	2 (078)	9	1	2 (079)	9
j. Worked at a sewage treatment plant?	1	2 (080)	9	3	4 (081)	5	9	1	2 (082)	9	1	2 (083)	9
k. Made pottery?	1	2 (084)	9	3	4 (085)	5	9	1	2 (086)	9	1	2 (087)	9
l. Ridden a dirt bike, mountain bike or ATV in the local area?	1	2 (088)	9	3	4 (089)	5	9	1	2 (090)	9	1	2 (091)	9
m. Welding?	1	2 (092)	9	3	4 (093)	5	9	1	2 (094)	9	1	2 (095)	9
n. Cleaned or repaired firearms?	1	2 (096)	9	3	4 (097)	5	9	1	2 (098)	9	1	2 (099)	9
o. Visited indoor firearm target ranges?	1	2 (100)	9	3	4 (101)	5	9	1	2 (102)	9	1	2 (103)	9
p. Wire/cable cutting or splicing?	1	2 (104)	9	3	4 (105)	5	9	1	2 (106)	9	1	2 (107)	9
q. Casting or smelting lead?	1	2 (108)	9	3	4 (109)	5	9	1	2 (110)	9	1	2 (111)	9

HOUSE ID ___ ___ ___ ___

114. (Continued)
In the last 90 day[redacted]any members of your household:
(Circle all that apply)

114a. Was this done at home, work, or elsewhere?

114B. IF WORK/OTHER: Were those clothes worn home? Did he/she shower before coming home?

	Yes	No	Don't know	HOME OTHER	WORK/	BOTH	Don't know	Yes	No	Don't know	Yes	No	Don't know
r. Plastics manufacture?	1	2 (112)	9	3	4 (113)	5	9	1	2 (114)	9	1	2 (115)	9
s. Battery manufacture?	1	2 (116)	9	3	4 (117)	5	9	1	2 (118)	9	1	2 (119)	9
t. Pipe machining?	1	2 (120)	9	3	4 (121)	5	9	1	2 (122)	9	1	2 (123)	9
u. Electroplating with lead solutions?	1	2 (124)	9	3	4 (125)	5	9	1	2 (126)	9	1	2 (127)	9
v. Refining gasoline?	1	2 (128)	9	3	4 (129)	5	9	1	2 (130)	9	1	2 (131)	9
w. Paint, glaze, and ink manufacture?	1	2 (132)	9	3	4 (133)	5	9	1	2 (134)	9	1	2 (135)	9
x. Rubber manufacture?	1	2 (136)	9	3	4 (137)	5	9	1	2 (138)	9	1	2 (139)	9
y. Scrap metal recovery?	1	2 (140)	9	3	4 (141)	5	9	1	2 (142)	9	1	2 (143)	9
z1. Other lead related job or activity? SPECIFY_____	1	2 (144)	9	3	4 (145)	5	9	1	2 (146)	9	1	2 (147)	9
z2. Other cadmium related job or activity? SPECIFY_____	1	2 (148)	9	3	4 (149)	5	9	1	2 (150)	9	1	2 (151)	9

Now I'd like to ask you some questions about your diet and food preparation:

115. When food or drinks are prepared, served, or stored, are they often placed in clay pottery or ceramic dishes which were homemade or made in another country?

(152)
1 = Yes
2 = No
9 = DON'T KNOW

116. When food or drinks are prepared, served, or stored, are they often placed in copper or pewter dishes or containers?

(153)
1 = Yes
2 = No
9 = DON'T KNOW

117. When food or drinks are stored or put away, are they sometimes stored in the original can after being opened?

(154)
1 = Yes
2 = No
9 = DON'T KNOW

Now I have a few other questions about your household.

118. Does anyone smoke in your/SUBJECT'S home?

(155)
1 = Yes
2 = No (GO TO 121)
9 = DON'T KNOW

119. How many people smoke in this home? (including regular visitors/babysitters)

(156-157) ___ ___ (number of people)
(99 = DON'T KNOW)

120. Does anyone smoke TOBACCO PRODUCT in your/SUBJECT's home?

(Circle responses).

		Yes	No	Don't know	IF YES, How many:
(158)	a.Cigarettes	1	2	9	___ ___ Cigarettes per day (159-160) in the house? (1 pack=20)
(161)	b.Cigars	1	2	9	___ ___ Cigars per day in (162-163) the house?
(164)	c.Pipes	1	2	9	___ ___ Pipe bowls per day (165-166) in the house?

121. Do you have any dogs or cats that go in and out of the house?

(167)
1 = Yes
2 = No
9 = DON'T KNOW

If yes, specify number _____

122. Has anyone ever used any materials from mines or smelters, such as chat or slag, or lead industry material in or around your house or yard?

(168)
1 = Yes
2 = No
9 = DON'T KNOW

IF YES, SPECIFY WHAT MATERIALS AND HOW THEY WERE USED:

_____

_____

123. What is the highest year of education that was completed by the head of this household? (RESPONDENT MUST DECIDE WHO HEAD OF HOUSEHOLD IS)

(169-171) (circle one)

No Schooling	000
Elementary School	001 002 003 004 005 006 007 008
High School (GED=012)	009 010 011 012
Technical or Trade School	T13 T14
Junior or Community College	J13 J14
Four year College or University	013 014 015 016
Attended Graduate School (or higher)	017
REFUSED TO ANSWER	088
DON'T KNOW	099

(172) 124. What is your total, gross household income before taxes?

01 =$4,999 or less	07 =$30,000 to $34,999
02 =$5,000 to $9,999	08 =$35,000 to $39,999
03 =$10,000 to $14,999	09 =$40,000 or more
04 =$15,000 to $19,999	88 = REFUSED TO ANSWER
05 =$20,000 to $24,999	99 = DON'T KNOW
06 =$25,000 to $29,999	

Now we have a set of questions to ask about (SUBJECT'S NAME)

IF PARTICIPANT IS 6 - 71 MONTHS OF AGE, THEN GO TO SECTION 200.

IF PARTICIPANT IS 6 - 14 YEARS OF AGE, GO TO SECTION 300

IF PARTICIPANT IS 15 YEARS OF AGE OR OLDER, GO TO SECTION 400

200 CHILD QUESTIONNAIRE
AGE 6 - 71 MONTHS

HOUSE ID __ __ __ __

PERSON ID __ __ __ __ - __ __ __ __

QUESTIONS ABOUT THE CHILD 6 - 71 MONTHS OLD (LESS THAN 6 YEARS OLD) SHOULD BE ANSWERED BY THE PARENT OR LEGAL GUARDIAN OF THE CHILD.

Child's full legal name:_____

(005-012) PERSON ID ___ ___ ___ ___-___ ___ ___ ___

Now I need to ask a number of questions about (CHILD'S NAME).

(013) 201. Who is answering these questions?
1 = Child's mother
2 = Child's father
3 = Child's grandparent
4 = Child's other relative
5 = Other _____

202 How long has (subject's name) been living in this home?

Years ___ ___ (014-015) Months ___ ___ (016-117)

IF LESS THAN 90 DAYS, OBTAIN PREVIOUS ADDRESS.

Address: ----------

(018-023) 203. What is (CHILD'S NAME) date of birth?
(MO/DA/YR) ___ ___ /___ ___ /___ ___
88 = REFUSED
99 = DON'T KNOW

(024) 204. Is (CHILD'S NAME) a boy or girl?
1 = Male
2 = Female

(025) 205. Which of the following best describes HIS/HER racial background?
1 = White
2 = Black
3 = Asian or Pacific Islander
4 = American Indian/Alaska native
8 = REFUSED
9 = DON'T KNOW

(026) 206. Is this child Hispanic or of Spanish origin or descent?
1 = Yes
2 = No
8 = REFUSED
9 = DON'T KNOW

IF CHILD LESS THAN 3 YEARS OLD:

(027) 207. Does this child breast feed?

1 = Yes
2 = No
7 = Not applicable, over 3 years old
8 = REFUSED
9 = DON'T KNOW

208. In the last 90 days, where does (CHILD'S NAME) usually spend HI time each 24 hour period? (approximate number of hours) (99 = DON'T KNOW)

	Babysitter (outside of home)	Day Care (commercial facility)	Other Location	Home	Total (24 hrs)
Monday	(028-029)	(030-031)	(032-033)	(034-035)	(036-037
Tuesday	(038-039)	(040-041)	(042-043)	(044-045)	(046-047
Wednesday	(048-049)	(050-051)	(052-053)	(054-055)	(056-057
Thursday	(058-059)	(060-061)	(062-063)	(064-065)	(066-067
Friday	(068-069)	(070-071)	(072-073)	(074-075)	(076-077
Saturday	(078-079)	(080-081)	(082-083)	(084-085)	(086-087
Sunday	(088-089)	(090-091)	(092-093)	(094-095)	(096-097

209. How many hours, on average, does CHILD spend sleeping?

(098-099) ___ ___ (99 = DON'T KNOW)

210. How many hours during the day do you think (CHILD'S NAME) usuall spends playing on the floor when indoors in this home?

(100-101) ___ Hours (99 = DON'T KNOW)

(102) 211. Does (CHILD'S NAME) play outdoors around the house or in the neighborhood?

1 = Yes
2 = No (GO TO QUESTION 217)
9 = DON'T KNOW (GO TO QUESTION 217)

212 IF YES, then how many hours a day on the average does (CHILD'S NAME) play outdoors?

(103-104) ___ ___ Hours 99 = DON'T KNOW

213. Where does (CHILD'S NAME) usually play when outdoors around the house? CIRCLE ONE

(105)
1 = Back yard
2 = Front yard
3 = Side yard
7 = Other (specify)_____
9 = DON'T KNOW

214. Where does (CHILD'S NAME) usually play outdoors (in the last 90 days) when he/she is not playing in your own home yard? CIRCLE ONE

(106-107)
01 = Neighbor's yard
02 = Playground
03 = Near or around creek or ditch
04 = On or near tailings or slag piles
05 = On sidewalks or streets
06 = Park
07 = Only plays at home
08 = Other (SPECIFY) _____
99 = DON'T KNOW

215. Is the ground where (CHILD'S NAME) usually plays mainly grassy, concrete/asphalt, plain dirt or soil, just a sandbox, or some other stuff? CIRCLE ONE

(108)
1 = Grassy
2 = Concrete/asphalt
3 = Dirt/soil
4 = Sandbox
7 = Other (SPECIFY)_____
9 = DON'T KNOW

216. Does (CHILD'S NAME) often take food, snacks, candy or a bottle or pacifier with him/her outside to play?

(109)
1 = Yes
2 = No
9 = DON'T KNOW

(110) 217. Are (CHILD'S NAME) hands or face usually washed before eating?
1 = Yes
2 = No
9 = DON'T KNOW

(111) 218. Are (CHILD'S NAME) hands or face usually washed before going to
1 = Yes
2 = No
9 = DON'T KNOW

(112) 219. Are (CHILD'S NAME) hands or face usually washed after playing wi dirt or sand?
1 = Yes
2 = No
9 = DON'T KNOW

220. How many times is (CHILD'S NAME) bathed or given a shower?

(113-114) ___ ___ per week (99 = DON'T KNOW)

(115) 221. Has (CHILD'S NAME) used a pacifier in the last 6 months?
1 = Yes
2 = No
9 = DON'T KNOW

(116) 222. Does (CHILD'S NAME) suck HIS/HER thumb or fingers?
1 = Yes
2 = No
9 = DON'T KNOW

(117) 223. Does (CHILD'S NAME) chew on HIS/HER fingernails?
1 = Yes
2 = No
9 = DON'T KNOW

(118) 224. Does (CHILD'S NAME) have a favorite blanket or toy?
1 = Yes
2 = No (GO TO QUESTION 227)
9 = DON'T KNOW

(119) 225. Does (CHILD'S NAME) carry this around during the d
1 = Yes
2 = No
9 = DON'T KNOW

(120) 226 Does (CHILD'S NAME) often put this in HIS/HER mout
1 = Yes
2 = No
9 = DON'T KNOW

227. Many children put some things other than food into their mouths. Would you say that (CHILD'S NAME):

(121)
1 = Does this a lot
2 = Just once in a while
3 = Almost never
4 = Never
9 = DON'T KNOW

228. Does (CHILD'S NAME) put HIS/HER mouth on furniture or on the window sill?

(122)
1 = Does this a lot
2 = Just once in a while
3 = Almost never
4 = Never
9 = DON'T KNOW

229 Sometimes children swallow things other than food. Would you say that (CHILD'S NAME) swallows things other than food?

(123)
1 = Does this a lot
2 = Just once in a while
3 = Almost never
4 = Never
9 = DON'T KNOW

If yes, specify items swallowed. ----------

230. Does (CHILD'S NAME) ever put paint chips in HIS/HER mouth?

(124)
1 = Does this a lot
2 = Just once in a while
3 = Almost never
4 = Never
9 = DON'T KNOW

231. Does your household have a vegetable garden in your yard?

(125)
1 = Yes
2 = No (GO TO 236)
9 = DON'T KNOW (GO TO 236)

232. Has soil been hauled in and placed on your garden?

(126)
1 = Yes
2 = No
9 = DON'T KNOW

IF YES, SPECIFY FROM WHERE? ----------

233. How often does (CHILD'S NAME) eat vegetables grown in your garden?

(127)

1 = Once a week or more
2 = Less than once per week
3 = Never (GO TO 236)
9 = DON'T KNOW (GO TO 236)

234. How often does (CHILD'S NAME) eat leafy green vegetables, (such as lettuce or spinach) grown your garden?

(128)

1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

235. How often does (CHILD'S NAME) eat root vegetabl (such as beets or turnips) grown in your garden

(129)

1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

236. How often does (CHILD'S NAME) eat vegetables grown elsewhere in th local area? (e.g. NEIGHBOR'S GARDEN OR LOCAL FARMERS MARKET)

(130)

1 = Once a week or more
2 = Less than once per week
3 = Never (GO TO 239)
9 = DON'T KNOW (GO TO 239)

237. How often does he/she eat leafy green vegetables, (s as lettuce or spinach) grown elsewhere in the area?

(131)

1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

238. How often does he/she eat root vegetables, (such as b or turnips) grown elsewhere in the area?

(132)

1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

239. Has SUBJECT ever been treated with traditional, folk or herbal medications?
(133)

1 = Yes
2 = No
9 = DON'T KNOW

If YES, what was the medicine called? _____

_____

END: This completes the questionnaire. Do you have any questions or comments about it?

_____

_____

_____

Thank you for your time.

PERSON ID _ _ _ _ - _ _ _ _

YOUNG PERSON QUESTIONNAIRE
AGES 6 - 14 YEARS OLD

HOUSEHOLD _ _ _ _

PERSON ID _ _ _ _ _ _ _ _ _ _

QUESTIONS ABOUT THE CHILD 6-14 YEARS OLD MUST BE ANSWERED BY THE PARENT OR LEGAL GUARDIAN OF THE CHILD.

Child's full/legal name _____

(001-004) HOUSE ID __ __ __ __

(005-012) PERSON ID __ __ __ __ - __ __ __ __

I need to ask a number of questions about (CHILD'S NAME).

301. Who is answering these questions?

(013)
1 = child's mother
2 = child's father
3 = child's grandparent
4 = child's other relative
5 = Other _____

302. How long has (SUBJECT'S NAME) been living in this home?

Years __ __ (014-015) Months __ __ (016-017)

IF LESS THAN 90 DAYS, OBTAIN PREVIOUS ADDRESS (12 MONTH PERIOD).

Address: ----------

---

303 What is (CHILD'S NAME) date of birth?

(018-023) (MO/DA/YR) __ __/__ __/__ __

ENTER 88 FOR REFUSED
ENTER 99 FOR DON'T KNOW

304. Is (NAME) a boy or girl?

(024)
1 = Male
2 = Female

305. Which of the following best describes HIS/HER racial background?

(025)
1 = White
2 = Black
3 = Asian or Pacific Islander
4 = American Indian/Alaska native
8 = REFUSED
9 = DON'T KNOW

306. Is he/she Hispanic or of Spanish origin or descent?

(026)
1 = Yes
2 = No
8 = REFUSED
9 = DON'T KNOW

307. What is the highest year of education (CHILD'S NAME) has comple

(027-029)

	(circle one)
No Schooling	000
Elementary School	001 002 003 004 005 006 007 008
High School (GED = 012)	009 010 011 012
REFUSED TO ANSWER	088
DON'T KNOW	099

IF CHIL IS 12 YEARS OR OLDER ASK 308 ON SMOKING, OTHERWISE, GO TO 309

308. Does (CHILD'S NAME) smoke or use tobacco products?

(030)

1 = Yes
2 = No (GO TO 309)
8 = REFUSED (GO TO 309)
9 = DON'T KNOW (GO TO 309)

Does he/she smoke/use TOBACCO PRODUCT?
(Circle responses)

			Yes	No	Don't know	IF YES, HOW MANY:
(031)	a.	Cigarettes	1	2	9	___ ___ Cigarettes per day, tot (032-033) (1 pack=20)
(034)	b.	Cigars	1	2	9	___ ___ Cigars per day, total (035-036)
(037)	c.	Pipes	1	2	9	___ ___ Pipe bowls per day, to (038-039)
(040)	d.	Smokeless tobacco	1	2	9	___ ___ Times per day, total (041-042)

309. In the last 90 days, where does (CHILD'S NAME) usually spend HIS/HER time each 24 hour period? (approximate number of hours)
(99 = DON'T KNOW)

	School	Babysitter (outside of home)	Day Care (commercial facility)	Other Location	Home	Total (24 h)
Monday	(043-044)	(045-046)	(047-048)	(049-050)	(051-052)	(053-054)
Tuesday	(055-056)	(057-058)	(059-060)	(061-062)	(063-064)	(065-066)
Wednesday	(067-068)	(069-070)	(071-072)	(073-074)	(075-076)	(077-078)
Thursday	(079-080)	(081-082)	(083-084)	(085-086)	(087-088)	(089-090)
Friday	(091-092)	(093-094)	(095-096)	(097-098)	(099-100)	(101-102)
Saturday	(103-104)	(105-106)	(107-108)	(109-110)	(111-112)	(113-114)
Sunday	(115-116)	(117-118)	(119-120)	(121-122)	(123-124)	(125-126)

310 How many hours a day does (CHILD'S NAME) spend sleeping?
(127) ___ ___ (99 = DON'T KNOW)

311. Does (CHILD'S NAME) play or spend time outdoors around the house or in the neighborhood?
(128)
1 = Yes
2 = No (GO TO QUESTION 317)
9 = DON'T KNOW (GO TO QUESTION 317)

312. If yes, then how many hours a day on the average does (CHILD'S NAME) play or spend time outdoors?

(129-130) ___ ___ Hours 99 = DON'T KNOW

PERSON ID _ _ _ _-_ _ _ _

313. Where does (CHILD'S NAME) usually play when outdoors around the house?

(131)

1 = Back yard
2 = Front yard
3 = Side yard
7 = Other (specify) _____
9 = DON'T KNOW

314. Where does (CHILD'S NAME) usually play outdoors (in the last 90 days) when he/she is not playing in your own home yard?

(132-133)

01 = Neighbor's yard
02 = Playground
03 = Near or around creek or ditch
04 = On or near tailings or slag piles
05 = On sidewalks or streets
06 = Park
07 = Only plays at home
08 = Other (SPECIFY) _____
99 = DON'T KNOW

315. Is the ground where (CHILD'S NAME) usually plays mainly grassy, concrete/asphalt, plain dirt or soil, just a sandbox, or some other stuff?

(134)

1 = Grassy
2 = Concrete/asphalt
3 = Dirt/soil
4 = Sandbox
7 = Other (SPECIFY) _____
9 = DON'T KNOW

316. Does (CHILD'S NAME) often take food or a drink with him/her outside to play?

(135)

1 = Yes
2 = No
9 = DON'T KNOW

317. Does (NAME) usually wash HIS/HER hands or face before eating?

(136)
1 = Yes
2 = No
9 = DON'T KNOW

318. Does (NAME) usually wash HIS/HER hands or face before going to sleep?

(137)
1 = Yes
2 = No
9 = DON'T KNOW

319. Does (NAME) usually wash HIS/HER hands or face after playing or working with dirt or sand?

(138)
1 = Yes
2 = No
9 = DON'T KNOW

320. Does (NAME) suck HIS/HER thumb or fingers?

(139)
1 = Yes
2 = No
9 = DON'T KNOW

321. Does (CHILD'S NAME) chew on HIS/HER fingernails?

(140)
1 = Yes
2 = No
9 = DON'T KNOW

322. Does (CHILD'S NAME) put things other than food in HIS/HER mouth?

(141)
1 = Yes
2 = No
9 = DON'T KNOW

IF YES, SPECIFY ----------

323. Sometimes children swallow things other than food. Would you say that (CHILD'S NAME) swallows things other than food:

(142)
1 = Does this a lot
2 = Just once in a while
3 = Almost never
4 = Never
9 = DON'T KNOW

IF YES, SPECIFY ----------

324. Does your household have a vegetable garden in your yard?

(143)

1 = Yes
2 = No (GO TO 329)
9 = DON'T KNOW (GO TO 329)

325. Has soil been hauled in and placed on your garden?

(144)

1 = Yes
2 = No
9 = DON'T KNOW

IF YES, SPECIFY FROM WHERE? ----------

326. How often does (CHILD'S NAME) eat vegetables grown in your garden?

(145)

1 = Once a week or more
2 = Less than once per week
3 = Never (GO TO 329)
9 = DON'T KNOW (GO TO 329)

327. How often does (CHILD'S NAME) eat leafy green vegetables, (such as lettuce or spinach) grown i your garden?

(146)

1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

328. How often does (CHILD'S NAME) eat root vegetables, (such as beets or turnips) grown i your garden?

(147)

1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

329. How often does (CHILD'S NAME) eat vegetables grown elsewhere in the local area? (e.g. NEIGHBOR'S GARDEN OR LOCAL FARMERS MARKET)

(148)

1 = Once a week or more
2 = Less than once per week
3 = Never (GO TO 332)
9 = DON'T KNOW (GO TO 332)

How often does he/she eat leafy green vegetables, (such as lettuce or spinach) grown elsewhere in the area?

(149)

1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

331. How often does he/she eat root vegetables, (such as beets or turnips) grown elsewhere in the area?

(150)

1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

332. Has SUBJECT ever been treated with traditional, folk or herbal medications?

(151)

1 = Yes
2 = No
9 = DON'T KNOW

IF YES, What was the medicine called? _____

_____

PERSON ID _ _ _ _-_ _ _ _

My last questions are about (CHILD'S NAME'S) activities.

333. In the last 90 day, has (CHILD'S NAME) participated in any of the following activities? (Circle all that apply.)

			Yes	No	D K
(152)	a.	Painted pictures with artists paints? (not children's paints)	1	2	9
(153)	b.	Painted, stained or refinished furniture?	1	2	9
(154)	c.	Painted the inside or outside of a home or building?	1	2	9
(155)	d.	Worked with stained glass?	1	2	9
(156)	e.	Cast lead into fishing sinkers, bullets or anything else?	1	2	9
(157)	f.	Worked with soldering in electronics?	1	2	9
(158)	g.	Worked on soldering pipes or sheets of metal?	1	2	9
(159)	h.	Repaired auto radiators?	1	2	9
(160)	i.	Worked on auto bodies or auto maintenance?	1	2	9
(161)	j.	Made pottery?	1	2	9
(162)	k.	Ridden a dirt bike, mountain bike, or ATV in the local area?	1	2	9
(163)	l.	Welded?	1	2	
(164)	m.	Visited indoor firearm target ranges?	1	2	9
(165)	n.	Cleaned or repaired firearms	1	2	

This completes the questionnaire. Do you have any questions or com about it?

_____

_____

Thank you for your time.

TEENAGE AND ADULT QUESTIONNAIRE
AGES 15 - 44 YEARS

QUESTIONS ABOUT THE YOUNG ADULT AGED 15-16 MUST BE ANSWERED WITH THE PARENT OR GUARDIAN PRESENT.

400. QUESTIONS FOR SELECTED PERSON AGE 15 - 44.

HOUSE ID __ __ __ __

PERSON ID __ __ __ __ - __ __ __ __

What is your full/legal name?

_____

(001-004) HOUSE ID __ __ __ __

(005-012) PERSON ID __ __ __ __ - __ __ __ __

40. WHO IS ANSWERING THESE QUESTIONS?
(013)
1 = self
2 = subject's mother
3 = subject's father
4 = subject's grandparent
5 = subject's other relative
6 = Other _____

401a. IF SELF IS ANSWERING, IS ANY OTHER FAMILY MEMBER PRESENT?
(014)
1 = yes
2 = no

402. How long have you (SUBJECT'S NAME) been living in this home?

Years __ __ (015-016) Months __ __ (017-118)

IF LESS THAN 90 DAYS, OBTAIN PREVIOUS ADDRESS.

Address: ----------

---

403. What is the your date of birth? __ __/__ __/__ __
(019-024) (MONTH / DAY / YEAR)
ENTER 88 = REFUSED
ENTER 99 = DON'T KNOW

404 SUBJECT'S GENDER
(circle one)
(025) 1 = Male 2 = Female

405. What is your race or ethnic group? (READ THE LIST)
(026)
1 = White
2 = Black
3 = Asian or Pacific Islander
4 = American Indian/Alaska native
8 = REFUSED
9 = DON'T KNOW

406. Are you Hispanic or of Spanish origin or descent?
(027)
1 = Yes
2 = No
8 = REFUSED
9 = DON'T KNOW

407 What is the highest year of education you have completed?
(028-030) (circle one)

No Schooling	000
Elementary School	001 002 003 004 005 006 007 008
High School (GED = 012)	009 010 011 012
Technical or Trade School	T13 T14
Junior or Community College	J13 J14
Four year College or University	013 014 015 016
Graduate School (or higher)	017
REFUSED TO ANSWER	088
DON'T KNOW	099

PERSON ID _ _ _ _-_ _ _ _

TOBACCO/ALCOHOL

The next questions concern tobacco and alcohol consumption.

408. Are you exposed to people smoking at your workplace in your [illegible] work area?

(031) 1 = yes
2 = no
8 = REFUSED TO ANSWER
9 = DON'T KNOW

409. Have you smoked at least 100 cigarettes during your entire life (1 PACK = 20 CIGARETTES)

(032) 1 = yes
2 = no (GO TO QUESTION 410)
8 = REFUSED TO ANSWER
9 = DON'T KNOW

409.1 Do you smoke cigarettes now?

(033) 1 = yes (GO TO QUESTION 409.1.1)
2 = no (GO TO QUESTION 409.2)
8 = REFUSED TO ANSWER (GO TO 409.2)
9 = DON'T KNOW

409.1.1 On the average, how many cigarettes a you now smoke?

(034-036) ___ ___ ___ (NOW GO TO QUESTION 409.3)

409.2 How long has it been since you smoked cigarettes?

(037-038) __ __ years
00 = under 1 year
88 = refused
99 = DON'T KNOW

409.3 On the average of the entire time you smoked, how cigarettes did you smoke per day?

(039-040) __ __ cigarettes per day
88 = REFUSED
99 = DON'T KNOW

409.4 About how old were you when you first started smok cigarettes regularly?

(041-042) __ __ years old
88 = REFUSED
99 = DON'T KNOW

409.5 For how many years WERE YOU/HAVE YOU BEEN a smoke including the time you may have stayed off cigaret

(043-044) __ __ years
88 = REFUSED
99 = DON'T KNOW

CIGARS

410. Have you smoked at least 50 cigars during your entire life?

(045)
1 = yes
2 = no (GO TO QUESTION 411)
8 = REFUSED TO ANSWER
9 = DON'T KNOW

410.1 Do you smoke cigars now?

(046)
1 = yes
2 = no (GO TO QUESTION 410.2)
8 = REFUSED TO ANSWER (GO TO 410.2)
9 = DON'T KNOW

410.1.1 On the average, how many cigars a week do you now smoke?

(047-048) ___ ___ (NOW GO TO QUESTION 410.3)

410.2 How long has it been since you smoked cigars?

(049-050) ___ ___ years
00 = under 1 year
88 = REFUSED
99 = DON'T KNOW

410.3 On the average of the entire time you smoked, how many cigars did you smoke per week?

(051-052) ___ ___ cigars per week
88 = REFUSED
99 = DON'T KNOW

410.4 About how old were you when you first started smoking cigars regularly?

(053-054) ___ ___ years old
88 = REFUSED
99 = DON'T KNOW

410.5 For how many years WERE YOU/HAVE YOU BEEN a cigar smoker, not including the time you may have stayed off cigars?

(055-056, ___ ___ years
88 = REFUSED
99 = DON'T KNOW

PERSON ID _ _ _ _-_ _ _ _

PIPES

411. Have you smoked at least 50 pipes during your entire li

(057)
1 = yes
2 = no (GO TO QUESTION 412)
8 = REFUSED TO ANSWER
9 = DON'T KNOW

411.1 Do you smoke pipes now?

(058)
1 = yes (GO TO QUESTION 411.1.1)
2 = no (GO TO QUESTION 411.2)
8 = REFUSED TO ANSWER (GO TO 411.2)
9 = DON'T KNOW

411.1.1 On the average, how many pipes do you now smoke per week?

(059-060) __ __ (NOW GO TO QUESTION 411.3)

411.2 How long has it been since you smoked pipes?

(061-062) __ __ years
00 = under 1 year
88 = REFUSED
99 = DON'T KNOW

411.3 On the average of the entire time you smoked, how pipes did you smoke per week?

(063-064) __ __ pipes per week
88 = REFUSED
99 = DON'T KNOW

411.4 About how old were you when you first started s pipes regularly?

(065-066) __ __ years old
88 = REFUSED
99 = DON'T KNOW

411.5 For how many years WERE YOU/HAVE YOU BEEN a pipe s not including the time you may have stayed off pip

(067-068) __ __ years
88 = REFUSED
99 = DON'T KNOW

CHEWING TOBACCO

412. Have you used chewing tobacco at least 20 or more times during your entire life?

(069)
1 = yes
2 = no (GO TO QUESTION 413)
8 = REFUSED TO ANSWER
9 = DON'T KNOW

412.1 Do you chew tobacco now?

(070)
1 = yes
2 = no (GO TO QUESTION 412.2)
8 = REFUSED TO ANSWER (GO TO 412.2)
9 = DON'T KNOW

412.1.1 On the average, how many plugs, twists, or pouches do you chew a week?

(071-072) __ __ (NOW GO TO QUESTION 412.3)

412.2 How long has it been since you chewed tobacco?

(073-074) __ __ years
00 = under 1 year
88 = REFUSED
99 = DON'T KNOW

412.3 On the average of the entire time you chewed tobacco, how many plugs/twists/or pouches did you chew a week?

(075-076) __ __ per week
88 = REFUSED
99 = DON'T KNOW

412.4 About how old were you when you first started chewing tobacco regularly?

(077-078) __ __ years old
88 = REFUSED
99 = DON'T KNOW

412.5 For how many years HAVE YOU/DID YOU chew tobacco, not including the time you may have stayed off chewing tobacco?

(079-080) __ __ years
88 = REFUSED
99 = DON'T KNOW

PERSON ID _ _ _ _-_ _ _ _

SNUFF

413. Have you used snuff at least 20 or more times during yo entire life?

(081) 1 = yes
2 = no (GO TO QUESTION 414)
8 = REFUSED TO ANSWER
9 = DON'T KNOW

413.1 Do you use snuff now?

(082) 1 = yes (GO TO QUESTION 413.1.1)
2 = no (GO TO QUESTION 413.2)
8 = REFUSED TO ANSWER (GO TO 413.2)
9 = DON'T KNOW

413.1.1 On the average, how many cans/tins/or of snuff do you use a week?

(083-084) __ __ (NOW GO TO QUESTION 413.3)

413.2 How long has it been since you used snuff?

(085-086) __ __ years
00 = under 1 year
88 = REFUSED
99 = DON'T KNOW

413.3 On the average of the entire time you used snuf how many cans/tins/or pouches did you use a wee

(087-088) __ __ per week
88 = REFUSED
99 = DON'T KNOW

413.4 About how old were you when you first starte snuff regularly?

(089-090) __ __ years old
88 = REFUSED
99 = DON'T KNOW

413.5 For how many years HAVE YOU/DID YOU use snuff, including the time you may have stayed off snu

(091-092) __ __ years
88 = REFUSED
99 = DON'T KNOW

ALCOHOL

Now I have a few questions on alcohol consumption.

414. Did you ever drink alcoholic beverages?

(C93)
1 = Yes
2 = No (GO TO QUESTION 415)
8 = REFUSED
9 = DON'T KNOW

414.1 Do you presently drink alcoholic beverages?

(C94)
1 = Yes (GO TO QUESTION 414.1.2)
2 = No
8 = REFUSED TO ANSWER (GO TO QUESTION 415)
9 = DON'T KNOW (GO TO QUESTION 415)

414.1.1 How old were you when you quit?

(C95-C96)
__ __
88 = REFUSED TO ANSWER
99 = DON'T KNOW

414.1.2 How old were you when you began drinking alcoholic beverages?

(C97-C98)
__ __
88 = REFUSED TO ANSWER
99 = DON'T KNOW

414.1.3 On the average, how many drinks a week do you have? (1 DRINK = 1 BEER, 1 SHOT LIQUOR OR MOONSHINE, 1 GLASS WINE OR WINE COOLER)

(C99-100)
__ __
88 = REFUSED TO ANSWER
99 = DON'T KNOW
LESS THAN 1/week = 00

PERSON ID _ _ _ _ _ _ _ _

415. Now I would like to know where you spend your time each 24 hour peri
between school, home, work, or some other location, in the last 9
(approximate number of hours; 99 = DON'T KNOW)

	School	Work	Other Location	Home	Total (24hr)
Monday	(101-102)	(103-104)	(105-106)	(107-108)	(109-110)
Tuesday	(111-112)	(113-114)	(115-116)	(117-118)	(119-120)
Wednesday	(121-122)	(123-124)	(125-126)	(127-128)	(129-130)
Thursday	(131-132)	(133-134)	(135-136)	(137-138)	(139-140)
Friday	(141-142)	(143-144)	(145-146)	(147-148)	(149-150)
Saturday	(151-152)	(153-154)	(155-156)	(157-158)	(159-160)
Sunday	(161-162)	(163-164)	(165-166)	(167-168)	(169-170)

The next set of questions are about activities and jobs you may have.

416. In the last 90 days have you worked as a miner or in a mining related job such as mine material handling or transportation?

(171)
1 = Yes
2 = No (GO TO 423)
9 = DON'T KNOW (GO TO 423)

417. What type of mine work did you do in the last 90 days? (Circle all that apply.)

			Yes	No	DON'T KNOW
(172)	a.	Underground	1	2	9
(173)	b.	Surface	1	2	9
(174)	c.	Milling	1	2	9
(175)	d.	Transportation/ handling	1	2	9
(176)	e.	Clerical/Admin.	1	2	9
(177)	f.	Smelter	1	2	9
(178)	g.	Other	1	2	9

IF OTHER, specify: _____

418. What type of mine did you work in the last 90 days? (Circle all that apply.)

			Yes	No	Don't know
(179)	a.	Lead	1	2	9
(180)	b.	Zinc	1	2	9
(181)	c.	Silver	1	2	9
(182)	d.	Molybdenum	1	2	9
(183)	e.	Coal	1	2	9
(184)	f.	Limestone	1	2	9
(185)	g.	Clay	1	2	9
(186)	h.	Other	1	2	9

IF OTHER, SPECIFY: _____

419. What is the name of the place where you work (have worked)?

_____

420. How long have you worked (did you work) there, in years and months?

___ ___ Years (187-188) ___ ___ Months (189-190)

421. Do (did) you change out of your work clothes and leave them at work?

(191)
1 = Always
2 = Sometimes
3 = Never
9 = DON'T KNOW

422. Do (did) you shower at work before coming home?

(192)
1 = Always
2 = Sometimes
3 = Never
9 = DON'T KNOW

PERSON ID _ _ _ _-_ _ _ _

423. In the last 90 days, have you done any of the following activities? (Circle all that apply)

			Yes	No	Don't know
(193)	a.	Painted pictures with artists paints? (not children's paints)	1	2	9
(194)	b.	Painted, stained or refinished furniture?	1	2	9
(195)	c.	Painted the inside or outside of a home or building?	1	2	9
(196)	d.	Worked with stained glass?	1	2	9
(197)	e.	Cast lead into fishing sinkers, bullets or anything else?	1	2	9
(198)	f.	Worked with soldering in electronics?	1	2	9
(199)	g.	Worked on soldering pipes or sheets of metal?	1	2	9
(200)	h.	Repaired radiators?	1	2	9
(201)	i.	Worked on auto bodies or auto maintenance?	1	2	9
(202)	j.	Worked at a sewage treatment plant?	1	2	9
(203)	k.	Made pottery?	1	2	9
(204)	l.	Ridden a dirt bike, mountain bike, or ATV in the local area?	1	2	9
(205)	m.	Welding?	1	2	9
(206)	n.	Visited indoor firearm target ranges?	1	2	9
(207)	o.	Cleaned or repaired firearms?	1	2	9
(208)	p.	Wire or cable cutting or splicing?	1	2	9
(209)	q.	Casting or smelting lead?	1	2	9
(210)	r.	Plastics manufacture?	1	2	9
(211)	s.	Battery manufacture?	1	2	9
(212)	t.	Pipe machining?	1	2	9
(213)	u.	Electroplating with lead solutions?	1	2	9
(214)	v.	Refining gasoline?	1	2	9

(215)	w. Paint, glaze, and ink manufacture?	1	2	9
(216)	x. Rubber manufacture?	1	2	9
(217)	y. Scrap metal recovery?	1	2	9
(218)	z1. Other lead related job or activity?	1	2	9
	SPECIFY_____			
(219)	z2. Other cadmium related job or activity	1	2	9
	SPECIFY_____			

424. Have you done any of the following activities in the last month?

		Yes	No
(220)	a. Painted a house or building inside or out?	1	2
(221)	b. Painted or refinished furniture?	1	2

OCCUPATIONS

425. Now I'd like to ask about your two most recent jobs, starting with the (Unemployed or retired or housewife should be entered as a job.)

a. What type of industry is/was this?
b. What is/was your job title and a description of what you do?
c. When did you work there?

	a. TYPE OF INDUSTRY	b. TITLE & DESCRIPTION	c. TIME FROM (MO/YR)	TO (MO/Y
425.1	_____ (222-225)	_____ (226-229)	_ _/_ _ (230-233)	_ _/_ _ (234-237
425.2	_____ (238-241)	_____ (242-245)	_ _/_ _ (246-249)	_ _/_ _ (250-253)

(254-257) 426. What is the job title you have had most of the time you have worked in the last 90 days?

_____
_ _ _ _

(258-261) 427. What is the job title you have had most of the time you have worked in the last year?

_____
_ _ _ _

428. Does your household have a garden in your yard? (VEGETABLE OR FLOWER)

(262)
1 = Yes
2 = No (GO TO 434)
9 = DON'T KNOW (GO TO 434)

429. IF YES, Do you frequently till, plant or work the garden yourself?

(263)
1 = Yes
2 = No
9 = DON'T KNOW

430. Has soil been hauled in and placed on your garden?

(264)
1 = Yes
2 = No
9 = DON'T KNOW
IF YES, Specify from where _____

431. How often do you eat vegetables grown in your garden?

(265)
1 = Once a week or more
2 = Less than once per week
3 = Never (GO TO 434)
9 = DON'T KNOW (GO TO 434)

432. How often do you eat leafy green vegetables, (such as lettuce or spinach) grown in your garden?

(266)
1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

433. How often do you eat root vegetables, (such as beets or turnips) grown in your garden?

(267)
1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

434. How often do you eat vegetables grown elsewhere in the local area (e.g. NEIGHBOR'S GARDEN OR LOCAL FARMER'S MARKET)

(268)
1 = Once a week or more
2 = Less than once per week
3 = Never (GO TO 437)
9 = DON'T KNOW (GO TO 437)

435. How often do you eat leafy green vegetables, (such as lettuce or spinach) grown elsewhere in the area?

(269)
1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

436. How often do you eat root vegetables, (such as beets or turnips) grown elsewhere in the area?

(270)
1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

437. Have you ever been treated with traditional, folk, or herbal medications?

(271)
1 = Yes
2 = No
9 = DON'T KNOW

IF YES, What was the medicine called? _____

_____

PERSON ID _ _ _ _ - _ _ _ _

MEN: GO TO END

FOR WOMEN ONLY:

Now I have a couple questions on pregnancy and birth control pills. I ask these questions because they can affect the results of the blood tests we will be doing.

438. Are you pregnant?
(272) 1 = Yes (GO TO END)
2 = No
7 = Not applicable (male subject)
8 = REFUSED
9 = DON'T KNOW

439. Are you taking birth control pills?
(273) 1 = Yes
2 = No
7 = Not applicable (male subject or 438 answered YES)
8 = REFUSED
9 = DON'T KNOW

END:

This completes the questionnaire. Do you have any questions or comments about it?

_____

_____

_____ _____

_____

Thank you for your time.

Appendix D—MRI (Midwest Research Institute) Report

MRI REPORT

Multistate Lead and Cadmium Exposure Study with the States of Missouri, Kansas, and Illinois

Summary Report

For Agency for Toxic Substances and Disease Registry (ATSDR)

Contract No. 205-90-0839
Work Authorization No. 1

MRI Project No. 9723-A

March 2, 1992

MIDWEST RESEARCH INSTITUTE 425 Volker Boulevard, Kansas City, MO 64110-2299 • (816) 753-7600

SECTION 1

EXECUTIVE SUMMARY

1.1 BACKGROUND

The Agency for Toxic Substances and Disease Registry (ATSDR) developed a multisite approach to examine the interdependence between environmental contaminant sources, human behavior, and socioeconomic factors that may influence blood lead levels in susceptible populations.

Three sites on the National Priority List (NPL) came to the attention of ATSDR as areas where residents require additional health evaluations. Lead and cadmium are the contaminants of specific concern. The NPL's sites included in this study are (1) Joplin, Jasper County, Missouri; (2) Cherokee County Subsite in Galena, Kansas; and (3) NL Industries/Taracorp Site in Granite City, Madison County, Illinois. The primary media and route for potential exposure at each of these sites are high soil concentrations of lead and cadmium.

Health officials in each of the three states represented agreed to participate in conducting exposure studies to assess the degree to which residents were being exposed. The similarity in study design for the three sites made it feasible to include the individual studies in a larger multisite study approach. During the months of November 1990 through March 1991, ATSDR met with representatives and officials from the three State Departments of Health who agreed to participate in the Multistate Study.

1.2 OBJECTIVES

ATSDR, through Contract No. 205-90-0839, assigned Midwest Research Institute (MRI) the responsibility to provide laboratory services and support the collection of biological data for the Multistate Study. MRI's objectives for the project were:

- To collect, process, store, and transport blood and urine specimens from study participants to the Centers for Disease Control/Center for Environmental Health and Injury Control (CDC/CEHIC) for analysis for lead, cadmium, free erythrocyte protoporphyrin (FEP), alanine-amino

pectidase (AAP), gamma-glutamyltransferase (GGT), *N*-acetyl β-glucosamindase (NAGA), creatinine, and several immunological indicators.

- To provide analysis services for routine blood and urine tests, using local hospitals and Roche Biomedical Laboratories (Roche) in Kansas City, Missouri.

- To implement a Quality Assurance/Quality Control (QA/QC) program to assess the quality of the data from the routine blood and urine tests and to provide comprehensive and traceable data to ATSDR.

1.3 SUMMARY OF RESULTS

MRI supplied qualified personnel to collect blood and urine specimens from 1,705 study participants at the three study sites and to process, store, and transport the specimens for the analytical tests shown in Tables 1 and 2. The sites, number of participants, and dates of collection were as follows:

Site	Number of participants	Dates of collection
Joplin, Missouri	701	July 16-August 27, 1991
Galena, Kansas	163	September 10-30, 1991
Granite City, Illinois	841	August 22-September 20, 1991

Summaries of the number of specimens collected for specific tests are shown in Tables 3 and 4. Control and replicate specimens were generated at the rates of 15% and 10%, respectively, of the number of participants for the routine blood and urine tests shown in Table 4. Table 5 is a summary of the number of specimens generated for each QA/QC specimen type.

1.4 ORGANIZATION OF REPORT

The remainder of this report provides detail on project organization (Section 2); preliminary activities (Section 3); collection, processing, storage, and transport of specimens (Section 4); analysis activities (Section 5); and collection, analysis, and QC results (Section 6). The Appendices contain the CDC/CEHIC laboratory protocol, examples of documentation forms, and detailed collection results and QC data for the control and replicate specimens.

Table 1. BLOOD SPECIMEN COLLECTION

Blood tests	Collection tube type	No. of tubes	Volume required	Special handling	Shipping instructions
Lead[a]	EDTA	b	0.5 mL	4°C	Overnight/batch
Cadmium[a]	EDTA	b	0.5 mL	4°C	Overnight/batch
FEP[a]	EDTA	b	0.5 mL	4°C	Overnight/batch
CBC[c]	EDTA	1	1 mL	8 h/on ice	Local/daily
Immunoglobulin[a]	Red top	d	—	Freeze	Overnight/batch
Biomedical tests[e]	Red top	d	3 mL	4°C	Overnight/batch
Immune panel[a]	Heparinized	1	1.5 mL	Control room temp.	Overnight/daily
Total volume			7.0 mL		

[a] Analysis by CDC/CEHIC.
[b] One tube was used to collect the blood for Pb, Cd, and FEP.
[c] Analysis by local hospital laboratories.
[d] One tube was used to collect the blood for the IgG and biomedical tests.
[e] Analysis by Roche Biomedical Laboratories.

Notes:

A. Tests listed by priority for collection and analysis.

B. Syringe and butterfly/vacutainer apparatus was used to collect specimens from children ages 6 mo through 6 yr old.

C. The immunoglobulin test was performed from a 0.5-mL aliquot of the serum collected for the biomedical tests.

Table 2. URINE SPECIMEN COLLECTION

Analyte	Specimen	Volume	Preparation
Cadmium[a]	On-site void	10 mL	HNO_3
GGT/AAP[a]	On-site void	10 mL	Glycerol
NAGA[a]	On-site void	5 mL	No preservative
Creatinine[a]	On-site void	5 mL	No preservative
Urinalysis[b]	On-site void	5 mL	No preservative

[a] Frozen immediately (-20°C), stored, and shipped with dry ice overnight. Analysis by CDC/CEHIC.
[b] Stored at 4°C. Analysis by local hospital laboratories.

SECTION 2

PROJECT ORGANIZATION

Midwest Research Institute (MRI) worked with ATSDR and the Principal Investigators (PIs) from each of the states to plan, coordinate, and conduct the Multistate Study. The overall project organization is shown in Figure 1.

As cited previously, MRI's responsibilities included collecting, processing, storing, and transporting blood and urine specimens to the various laboratories for specific chemical and biomedical analyses, implementing a QA/QC program that was initiated at the collection site, and providing comprehensive and traceable data to ATSDR.

Specific activities performed by MRI to achieve the objectives of the Multistate Study included:

- Providing qualified personnel to work at each study site to collect, process, store, and transport blood and urine specimens as specified in the Revised Work Plan. Phlebotomists and lab staff were recruited near the study sites to perform this work.
- Contracting with Roche Biomedical Laboratories (Roche) to perform the blood chemistry panel specified in the Revised Work Plan.
- Contracting with a hospital laboratory near each site to perform complete blood counts (CBC) and routine urinalyses (UA) for all specimens.
- Coordinating all collection activities with the Missouri, Kansas, and Illinois Departments of Health Principal Investigators (PIs).
- Applying QA/QC procedures to maintain specimen integrity, and providing control specimens and replicate analyses as required.
- Providing appropriate documentation to track all specimens (using a unique ID number) through collection, processing, storage, and transport.
- Transporting all specimens to CDC/CEHIC, Roche, and local hospital laboratories for analysis under specified storage conditions.

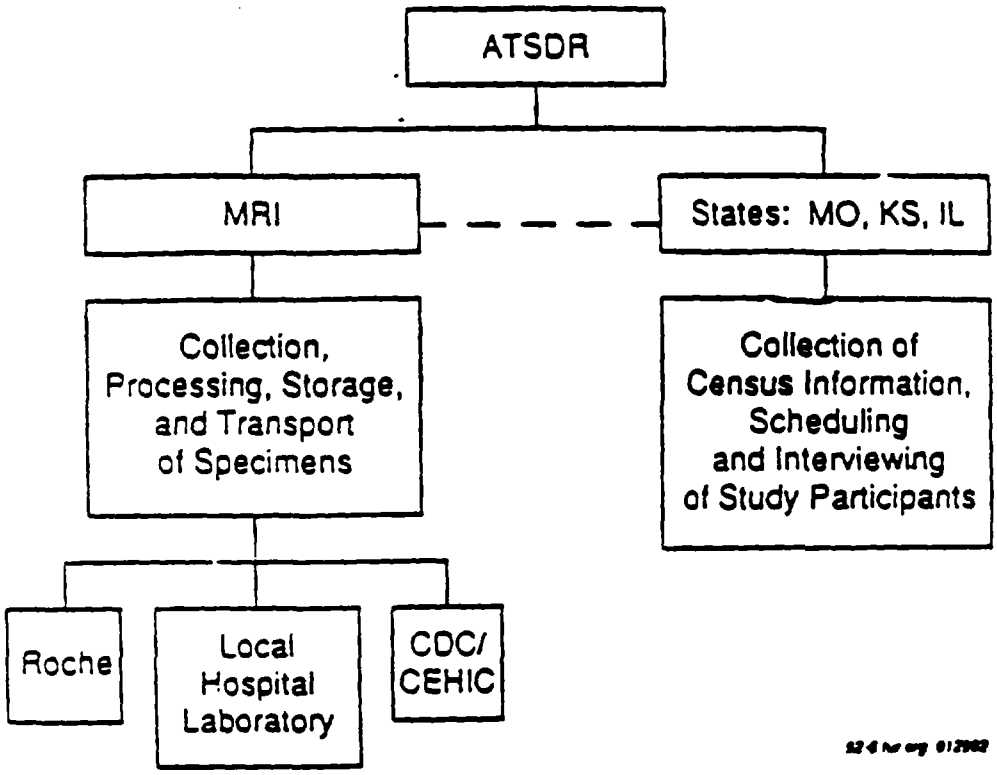


Figure 1. Overall project organization.

- Providing analysis results by unique ID number for each specimen to ATSDR for the routine blood and urine tests and biomedical tests. The test results provided by the local laboratories and Roche were reported to MRI, reviewed, compiled, and transferred by magnetic tape to ATSDR.

MRI's day-to-day project management included the following responsibilities:

- Daily contact with the on-site coordinator and PI.
- Receipt of copies of collection and shipping summaries.
- Receipt, review, and compilation of hard copy analysis results from Roche and local hospital laboratories.
- Evaluation of blind QC results received with each set of analysis results.
- Transcription of hard copy data onto a magnetic tape.
- Reporting status of the project to the ATSDR project officer in required weekly and monthly reports and as needed.

SECTION 3

PRELIMINARY ACTIVITIES

Several planning meetings were held with ATSDR, States, MRI, and CDC/CEHIC staff between November 1990 and initiation of the study, including a planning meeting in Atlanta in March 1991, which was attended by staff from all the agencies. These meetings were held to clarify the work and to define the responsibilities of all agencies involved in the Multistate Study. MRI prepared a work plan for the Multistate Study in response to a work assignment request from ATSDR dated April 8, 1991. MRI's work plan was reviewed by ATSDR and subsequently revised to address specific comments. MRI's work plan dated May 24, 1991 was followed throughout the Multistate Study. A laboratory protocol for collection, processing, storage, and transport of specimens was supplied by CDC/CEHIC and is included as Appendix A.

Planning meetings were also conducted by MRI with local hospitals, Roche, local labor resources, and couriers/shippers to arrange analysis services, labor, and transport of specimens for the Multistate Study. These planning meetings included prestudy site visits to evaluate collection facilities and shipping logistics. Preliminary trials were conducted immediately before collection dates to ensure that all personnel were properly trained.

Data management was planned in conjunction with the ATSDR Project Officer and Data Manager. A meeting was held at MRI on July 10, 1991, to discuss the data management requirements, and subsequent planning with a local transcription service followed. A test tape containing results from the CBC, UA, and blood chemistry tests was submitted to ATSDR on September 17, 1991, and was approved on September 30, 1991.

Additional details on the preliminary activities for each study site follow.

SECTION 4

COLLECTION, PROCESSING, STORAGE, AND TRANSPORT OF SPECIMENS

Specimens were collected, processed, stored, and transported according to the laboratory protocol supplied by CDC/CEHIC (Appendix A). Specific information regarding staff, facilities, supplies, scheduling, storage, and transport follows.

4.1 ON-SITE STAFF

Phlebotomy support was arranged through Roche for the Joplin, Missouri, and Galena, Kansas, studies. One phlebotomist worked through both studies, but backup staff was provided by Roche on occasion. College students and temporary help provided urine collection, processing of specimens, and on-site coordination for the Missouri and Kansas studies. The hospital staff at St. Elizabeth Medical Center provided phlebotomy service, urine collection, specimen processing, and on-site coordination for the Granite City, Illinois, study.

All staff were trained by MRI and CDC/CEHIC staff during the preliminary trials held at the sites prior to initiation of the collection. The CDC/CEHIC laboratory protocol (Appendix A), the MRI Revised Work Plan, and supporting documentation forms (Appendix B) were used in the training. Figure 4 shows the overall collection, processing, storage, and transport scheme which was used for the Multistate Study. All handling and packaging of specimens were performed in compliance with the following documents:

- Memorandum of Instructions for Packaging and Shipping of Biomedical Materials, October 24, 1988 (supplied by ATSDR).
- 42 *CFR* Part 72—Interstate shipment of Etiologic Agents.
- MMWR August 21, 1987—Recommendations for Prevention of HIV Transmission in Health-Care Settings.
- MMWR June 24, 1988—Universal Precautions for Prevention of Transmission of HIV Virus, Hepatitis B Virus, and Other Blood-borne Pathogens in Health-Care Settings.

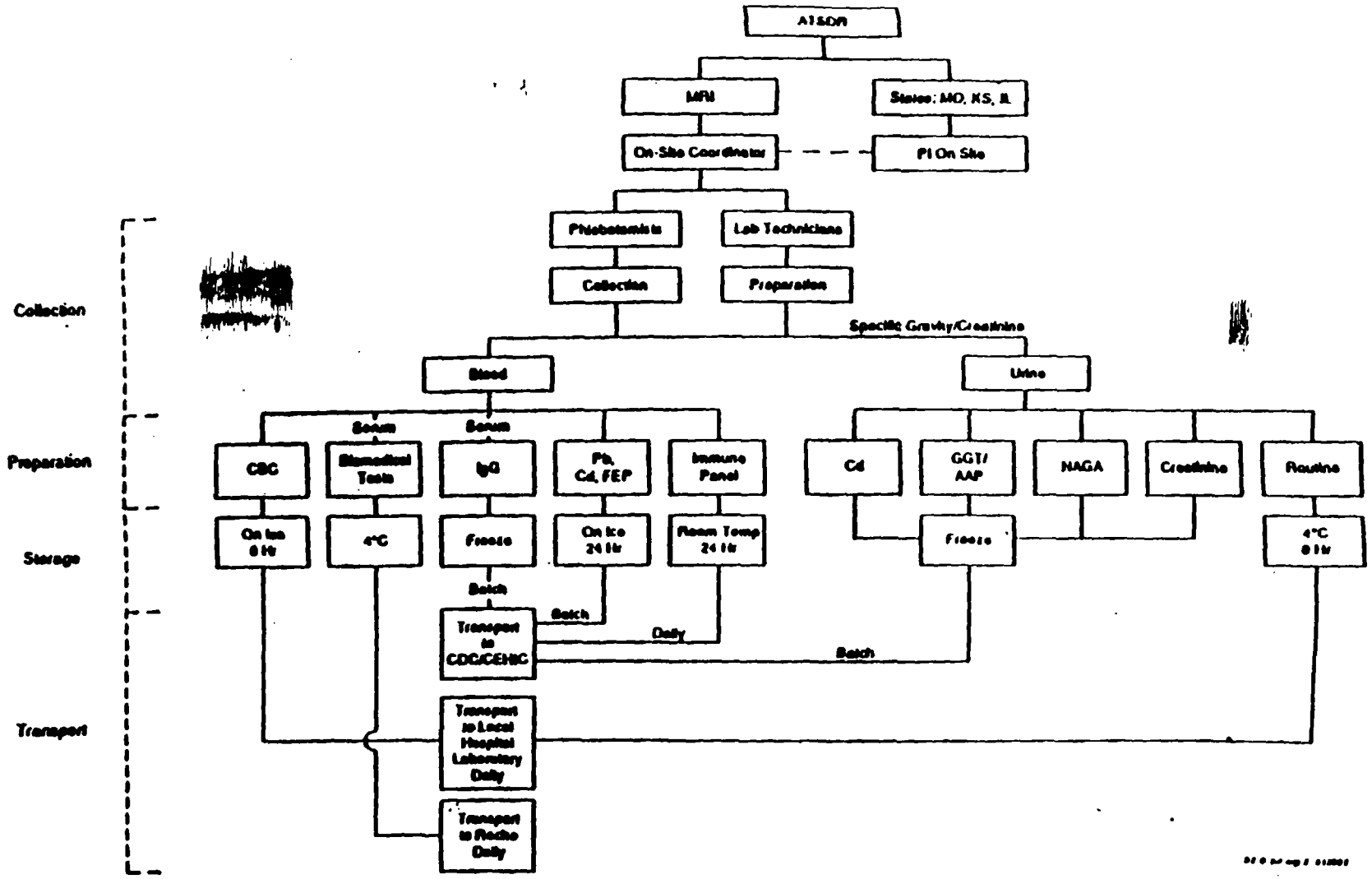


Figure 4. Collection, processing, storage, and transport of specimens.

All on-site personnel who were involved with collecting, processing, storing, or packing specimens for transport were instructed on the regulations and the correct means of handling and packaging the specimens. Copies of the above listed documents were available at each collection site. As a safety precaution, a solution of 5,000 ppm sodium hypochlorite (1:10 dilution of household bleach in water) was available at each collection site to decontaminate any spills that might have occurred.

Supervision of the staff was provided by the on-site coordinator hired by MRI, and was supported by technical advice provided by the PI on site and CDC/CEHIC staff by telephone.

4.2 COLLECTION FACILITIES

The collection facilities were selected by the States with several considerations in mind, including convenience to participants, privacy, availability of bathrooms, utilities, telephones, storage, safety, and cleanliness. Details regarding each collection facility follow.

4.2.1 Joplin, Missouri

Specimens from the study population were collected from July 16 through August 6 at the Jasper County Health Department. Blood collection and processing was performed in a partitioned area in an upstairs office. The urine specimens were collected and processed in a downstairs laundry area convenient to the restrooms and the waiting area. Since no fume hood facilities were available, urine specimens needing the addition of nitric acid were taken daily to a local university to perform that function. A room was available for storage of specimens and extra supplies. A phone was installed by the State, and copies of collection logs were made at a nearby library. No telefaxing service was available.

Collection activities were moved to the Neosho Auditorium on August 7 where specimens from the control population were collected through August 27. Blood collection and processing was performed in a stairwell area, and the urine specimens were collected and processed in a partitioned area convenient to the restrooms. No fume hood facility was available, so urine specimens needing the addition of nitric acid were taken to a nearby hospital pharmacy to perform that function. A closet was used for the storage of extra supplies. A telephone and copy machine were available for use as needed. No telefaxing service was available.

4.2.2 Galena, Kansas

The Baxter Memorial Hospital (non-operating) facility was used for the collection of specimens from both the study and control participants. Blood collection and

processing were performed in the hospital pharmacy. A patient room with a restroom was used for urine collection and processing. A fume hood was available in the pharmacy for the nitric acid addition to selected urines. There was sufficient space in the collection areas for storage of extra supplies. A telephone and copy machine were available for use as needed. No telefaxing service was available.

4.2.3 Granite City, Illinois

Specimens from the study and control populations were collected at St. Elizabeth Medical Center. A large room, which was convenient to restrooms and the waiting area, was set up for blood and urine processing. There was sufficient space in the collection area for storage of extra supplies. A telephone, copy machine, and telefax machine were available for use as needed.

4.3 COLLECTION SUPPLIES

Collection supplies for the Multistate Study were provided by CDC/CEHIC, MRI, and the States. Table 6 gives a summary of the supplies used and by whom they were provided.

4.4 SCHEDULING PARTICIPANTS

Scheduling participants for interviews and specimen collection was performed by staff from the individual States. Scheduling was adjusted based on the number of participants, the time of the first and/or last appointment, shipping restrictions, and the CDC/CEHIC work load. Generally, the days and hours of operation for each site were as follows.

Site	Hours of Operations
Joplin, MO	M-F, varied hours
Galena, KS	M,W—3 p.m. to 8 p.m.; T,Th—11 a.m. to 6 p.m.
Granite City, IL	M-F, 8 a.m. to 8 p.m.

These hours were adjusted as necessary based on the factors mentioned above. The schedules were given by the State's PI to MRI's on-site coordinator on a daily basis.

Table 6. SUMMARY OF COLLECTION SUPPLIES PROVIDED BY CDC/CEHIC,MRI, AND THE STATES[a]

Supplier	Supplies
CDC/CEHIC	Screened collection supplies (for Pb and Cd specimens) Containers for other specimens analyzed by CDC/CEHIC. Protocol, collection logs Specimen labels Shipping containers Band-Aids™, gauze
MRI	Serum separator and transfer tubes (through Roche) Centrifuge (through Roche) Urine tubes (through local hospitals) Slides for blood smears (through local hospitals) Facility equipment Paperwork Shipping supplies Slide mailers Juice, toys, candy, Band-Aids™
Missouri	Candy, toys
Kansas	None
Illinois	Juice, toys, McDonald's® certificates

[a] Some supplies were provided jointly by more than one agency participating in the study.

4.5 STORAGE OF SPECIMENS

Specimens were stored according to the conditions identified in Tables 1 and 2 and shown in Figure 4. Prior to transport, room temperature specimens were stored at ambient temperature, refrigerated specimens in a refrigerator, and frozen specimens in a freezer. During transport, room temperature was maintained in the insulated shipping container by enclosing unfrozen cold packs, and refrigeration and freezing was maintained by enclosing frozen cold packs and dry ice, respectively, in the insulated shipping containers.

4.6 TRANSPORT OF SPECIMENS

MRI arranged the transport of all specimens to local hospitals, Roche, and CDC/CEHIC. Specimens for CBC and UA were delivered to the local hospital laboratories at least twice a day by MRI's on-site staff. The blood chemistry specimens were transported to Roche in Kansas City by their courier (Missouri and Kansas) or Flexfleet courier (Illinois). The specimens collected for the immune panel were shipped daily to CDC/CEHIC. The remaining specimens (frozen blood serum and urine) were batched and shipped to CDC/CEHIC at least once a week.

Specimens going to CDC/CEHIC were transported by Flexfleet couriers to the nearest major airport (Missouri and Kansas—Tulsa, Oklahoma; Illinois—St. Louis, Missouri), flown to Atlanta by Delta Dash, and delivered to CDC/CEHIC by Dependable Courier. Shipments were scheduled for overnight service with delivery to CDC/CEHIC by 10 a.m. The only exception was Granite City, Illinois, where Federal Express was used on Fridays, with Saturday delivery by noon.

4.7 REDRAWS

A second blood specimen was collected and transported to CDC/CEHIC for analysis for those participants found to have elevated blood lead levels. The collection and transport was arranged by MRI, using the same phlebotomists hired for the studies.

For the Joplin, Missouri study, 12 blood specimens for lead analysis were collected from participants having blood levels > 15 µg/dL. Six of the specimens were drawn during the Galena, Kansas collection in September, 1991; four were drawn at the Jasper County Health Department and two at the Joplin Health Department on September 25, 1991, and November 22, 1991, respectively. For the Galena, Kansas, study, redraws for blood lead analysis were performed on December 23, 1991, for three participants with blood lead levels of > 15 µg/dL. The collection was performed in the participants' homes.

Forty-seven redraws were performed January 6-15, 1992, at St. Elizabeth Medical Center in Granite City, Illinois for those participants with blood lead levels of > 10 µg/dL.

All [redacted] blood lead specimens were refrigerated prior to and during shipment to CDC/CEHIC for analysis.

EX. D

177335.

The Effectiveness of Soil Removal on Lead Exposure in Granite City

April, 1996

R. Bornschein

University of Cincinnati

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1 Executive Summary

This report details the findings of a study of environmental lead levels in Granite City Illinois commissioned by the City and conducted by the University of Cincinnati. U.S. EPA has declared Granite City a Superfund site because of lead contamination allegedly stemming from the operation of the now defunct smelter located at the NL Taracorp plant. During 1993 and 1994, the Agency removed contaminated soil from the yards of 38 dwellings.

Granite City commissioned the University of Cincinnati study of environmental lead in the City to evaluate EPA's remedial approach. Specifically, the study was designed to determine if the removal of soil from residential yards would substantially reduce the risk of further lead exposure to the residents of Granite City. As part of that objective, the study investigated if the remedial action already taken by EPA had effectively reduced housedust lead levels. The study also searched for additional lead sources that may contaminate interior housedust, a medium thought to be especially responsible for lead exposure among children. Finally, the University of Cincinnati study investigated the accuracy of paint lead concentration values reported in a study conducted by the Illinois Department of Health (Illinois DOH). That study utilized a Gamma-Tech XRF device, rather than more recently developed XRF devices. The University of Cincinnati compared the results reported by Illinois DOH to results recorded by the recently developed SciTec XRF device.

To fully characterize environmental lead exposure in Granite City, the University of Cincinnati recorded the following information: 1) interior surface dust lead levels, 2) 30-day dustfall rates; 3) Interior entry mat dust lead loading levels; 4) Alley dust lead levels; 5) Exterior dust lead levels; and 6) soil lead levels. To evaluate the paint lead concentration results reported by Illinois DOH, the University of Cincinnati sampled paint lead levels using the SciTec XRF device.

The study results revealed two sources of lead contamination not considered by U.S. EPA in the Agency's formulation of a risk management strategy: lead-based residential paint, and street dust transported from the Taracorp site by either wind action or by trucks traveling from the site and through the city. Lead paint is a likely contamination source because the concentration of lead in paint is several orders of magnitude higher than the corresponding concentrations in either house dust or exterior soil; moreover, age and inadequate maintenance for many dwellings have caused lead-painted surfaces to

deteriorate and release lead paint to the environment. The fact that soil lead levels are substantially higher near dwelling "drip line" locations than soil lead levels near the street curb also points towards deteriorating lead paint as a likely candidate for lead contamination in soil. On going contamination of soil resulting from the transport of lead from the Taracorp site (by either wind action or by trucks traveling through the city from the Taracorp site) is also likely. Data detailing street dust lead levels reveal an inverse relationship with distance to the Taracorp site. Because the smelter has been inactive for over a decade, and because street dust lead stemming from the operation of the smelter would be eliminated relatively quickly (*e.g.*, by rain and street cleaning activities), it is likely that the currently observed street dust lead levels reflect current and on going contamination from the Taracorp site.

The study results also demonstrated that abatement of residential soil does not effectively reduce housedust lead levels and therefore is likely to have a minimal effect on lead exposure. In fact, interior housedust lead levels increased substantially at most of the dwellings evaluated. The study results also revealed that soil itself became recontaminated after the completion of abatement activities.

Finally, the evaluation of the Illinois DOH paint lead results using the SciTec device indicated that the DOH results were valid.

The results of the University of Cincinnati study call into question EPA's strategy of abating residential soil as a first (and perhaps only) step in the Agency's effort to reduce lead exposure in Granite City. First, the study demonstrated that there are at least two on going sources of soil contamination – deteriorating residential lead-based paint, and the continuing transport of lead from the Taracorp site. There is reason to believe that these lead sources would recontaminate abated soil. EPA's risk management recommendations are based on the Agency's use of its Integrated Exposure Uptake Biokinetic (IEUBK) model, which does not account for these sources of soil contamination. EPA's focus on soil removal alone is also questionable given that at other sites, the Agency has adopted a more holistic approach to addressing lead contamination. Second, the study results cast doubt on the efficacy of soil removal; even after soil is abated, housedust lead levels remain elevated. Third, the fact that soil becomes recontaminated after abatement confirms the hypothesis that other on going sources of lead contamination are active in Granite City and that EPA should address these sources before it considers abatement of residential soil. Finally, we note that the Illinois DOH paint lead level results are valid. Hence, the fact that Illinois DOH did not use the most up-to-date technology for this evaluation does not justify disregarding their findings.

2 Background

In the fall of 1994, the University of Cincinnati was asked by the Granite City City Council to assist the city in its evaluation of the effectiveness of soil remediation efforts currently under way on residential properties adjacent to the Taracorp Superfund site. Numerous studies and investigations have been conducted in this community by both the U.S. EPA, by ATSDR, and by outside investigators. These studies have revealed lead levels as high as several thousand µg/g in residential soils. A comprehensive blood lead level survey conducted by the Illinois Department of Health identified multiple sources and reservoirs of lead in the residential environment. Subsequent to the University of Cincinnati study conducted in the fall of 1994, Dr. Robert Bornschein, the study's lead investigator, suggested the collection of additional data. In seeking to extend the study, Dr. Bornschein stated that doing so would give his team an opportunity to increase the study sample size (since remediation of additional homes was planned) and to investigate the impact of soil recontamination over a longer period of time (two years, rather than one year). The City concurred and asked the University to continue its investigation. This report details the University's findings through the fall of 1995.

The U.S. EPA undertook soil removal on 21 properties in 1993 in an effort to address possible excessive lead exposure among residents living adjacent to the site. In the fall of 1994, the EPA remediated an additional 17 properties. However, these actions raised many questions within the community and the city administration about whether the cleanup was reducing lead exposure in any significant manner. The questions are outlined in the subsequent section.

3 Objectives

This section describes the objectives of the University of Cincinnati study of environmental lead in Granite City.

3.1 Determine if the Removal of Soil would Substantially Reduce the Risk of Further Lead Exposure to the Residents of Granite City.

The main question the University of Cincinnati study set out to investigate was whether removal of soil from residential yards in Granite City would substantially reduce lead exposure among the residents of this community. To answer this question, the University of Cincinnati assessed the impact of soil remediation on interior dust lead levels since ingestion of interior housedust is thought to be one of the main pathways by which children are exposed to lead present in soil (US Dept. of HUD, 1990; Bornschein *et al.*, 1986; Bornschein *et al.*, 1988).

This study evaluated the potential effectiveness of soil removal by measuring changes in housedust lead levels after remediation and by investigating three factors: 1) the importance of media other than soil as sources that contaminate interior housedust; 2) the short-term impact of soil removal on lead levels in key exposure media; and 3) the recontamination of remediated soils by various sources of lead in Granite City.

3.1.1 Identify Additional Lead Sources that may Contaminate Interior Housedust

Since the housing stock in Granite City is relatively old, lead-based pigment in both exterior and interior paint may directly contaminate interior dust. In such cases, removal of lead in exterior soil may not substantially affect interior dust lead levels. Since the huge lead slag piles generated during the operation of the lead smelter have not been removed, it is possible that trucks leaving the plant now occupying that site or trucks leaving the adjacent trucking company could track dust through the streets, and that this dust could directly contaminate interior housedust. Alternatively, wind could transport this source of lead into houses. Among the quantities surveyed by the study, the University of Cincinnati therefore measured the following: lead concentration of exterior (entry) dust sample; dust loading of exterior (entry) dust sample; lead concentration of the repeated exterior (entry) dust sample; lead concentration of the interior dust

sample; dust lead loading of the interior dust sample; lead concentration in the mat dust sample; lead concentration in paint chip samples; and street dust lead levels.

3.1.2 Determine the Short-Term Effectiveness of Soil Remediation on Lead Exposure as Reflected in Housedust Levels

The efficacy of soil removal can be evaluated by measuring lead exposure (*e.g.*, lead concentrations in various media) both before and after soil removal has been conducted. Such comparisons are limited since EPA has remediated soil in only a limited number of homes in Granite City. Nonetheless, comparing lead concentrations in various media provides some insight into this issue. It also permits the investigation of whether soil removal activities actually increase lead levels in various exposure media by disturbing lead and creating fugitive sources of lead contaminated dust. To address this issue, the study measured the following both before and after soil removal: lead concentrations (μg/g) in exterior dust, mat dust, and floor dust; lead loading (μg/m^2) in exterior dust.

3.1.3 Characterize the Potential Recontamination of Remediated Soil

The second factor affecting the efficacy of soil removal is the extent to which the new soil may become recontaminated. One potential source of recontamination at Granite City is exterior residential lead paint. The study also considered the possibility that the fugitive lead dust spread through town by trucks or transported from the Taracorp site by wind could recontaminate soil. To evaluate this issue, the study measured street dust lead concentrations, perimeter soil lead concentrations, and curb soil lead concentrations both before and after soil removal.

3.2 Deter[redacted]he Accuracy of Paint Lead Concentration Values Reported in the Illino[redacted]. of Public Health Study

Questions have been raised about the validity of the paint lead measurements reported in the Illinois Department of Health Granite City Study since Illinois DOH used an older generation Gamma-Tech XRF device to make these measurements. The University of Cincinnati study evaluated these measurements by comparing the Illinois DOH values to measurements made using a SciTec XRF measuring device. The SciTec model is a later generation XRF device than the Gamma Tech model,

although both the SciTec and Gamma Tech devices have been evaluated and approved for lead paint testing by the Department of Housing and Urban Development (HUD).

4 Study Protocol and Methodology

This section describes the protocol for the University of Cincinnati study of lead contamination in Granite City, Illinois. Section 4.1 describes sampling procedures for dust and soil, while Section 4.2 describes paint XRF sampling procedures. This section also details steps taken for QA/QC purposes.

4.1 Collection of Dust and Soil

This section describes the collection of interior surface dust, 30-day dustfall collection, collection of interior entry mat dust loading, alley dust sampling, exterior dust sampling, and soil collection.

4.1.1 Collection of Interior Surface Dust

Interior surface dust is collected by using a personal monitoring pump connected by Nalgene tubing to a three-piece air monitoring cassette with a 0.8 micron poly cellulose acetate filter. A collection nozzle is connected to the air monitoring cassette by means of a short piece of Nalgene tubing. The collection nozzle is a piece of acrylic plastic tubing crimped on one end to form an opening of approximately 1.3 by 0.1 cm. To facilitate the collection of interior dust samples, a template is used. The inside of the template measures 25 cm × 25 cm.

The interior dust sample will consist of a composite of at least three sub-samples taken from the following areas in the residence:

1. An area adjacent to the main entrance;
2. [illegible] or area in the room most utilized by the subject child;
3. [illegible] or area in the subject child's bedroom. (If there are no children residing in the house, we collect this part of the composite sample from the bedroom of an adult).

Additional sub-samples may be added to the composite sample. These sub-samples will be taken from bedrooms occupied by additional subject children (*i.e.*, children less than 72 months of age).

The main entry sample is collected by placing the template on a carpeted surface immediately inside of the entry door. The preferred sampling surface for interior dust is a carpeted surface. If carpeting is not present in [redacted]rea the most likely place to find an adequate surface dust loading is the area immediately adjacent to the main entry door.

The identification of sample sites from the most frequently occupied room and the child's bedroom is determined in part by the floor covering present in those rooms. If the floor is carpeted, an adequate sample can readily be collected from almost any pathway in the room. A pathway might consist of an area immediately inside of a doorway into the room, or an obvious pathway from one side of the room to the other. In rooms where there is no carpeting, the most likely place to find an adequate supply of surface dust is an area immediately adjacent to a wall. Very often, on floors with hard surfaces, dust will migrate to the edge of the room; therefore, that is the most likely place to collect the dust.

The dust sample is collected by placing the template on the identified sampling area. The pump is then turned on and a visual check is made to ensure that the flow rate is 2.5 liters per minute. The collection apparatus (acrylic nozzle connected to cassette) is held at about a 45 degree angle to the surface (floor) and moved from one side of the template area to the opposite. This sweeping motion in the same direction is repeated until the entire area has been "vacuumed" with the collection attachment (approximate time – 1 minute in each direction). The procedure is repeated in a direction 90 degrees from the initial direction. A third coverage of the area is then completed in the same direction as the initial coverage. The rate of movement from one side of the template to the other is approximately 1.5 to 2 seconds per stroke (the total time to sample the area within the template is approximately 3 minutes).

As each sub-sample is collected, its location is indicated on the floor plan that was completed earlier. Care i[redacted] to note the total number of areas sampled. At the completion of the sample collection, the [redacted]ette is removed from the collection device and the end plugs are replaced. The dwelling ID number and the sample number are written on the side of the cassette with permanent ink.

The FORM 05 Interior Dust Sampling-Residential worksheet is completed at the time the dust sample is collected. The XRF testing is conducted in the rooms where interior surface dust samples are collected (see Section 4.2).

4.1.2 Dustfall Collection – 30 Days

Dustfall samples are collected in polypropylene containers that have snap-on lids. They are "Tupperware™" type containers. The dustfall containers are cleaned in a nitric acid bath, sealed, and not opened until placed at the residence. The lid, appropriate labeled, is retained by the sampling crew in a sealed zip-loc bag until the sample is retrieved. The container is placed outside of the tested house (for example, on the porch area) at a level far enough above the floor level to be out of the reach of children. It is also located in a relatively inconspicuous spot so that no one will interfere with it; finally, the container is placed so as not to be exposed to rain and other elements. The required sampling time is 30 days.

4.1.3 Interior Entry Mat Dust Loading

One entry mat is placed inside of the tested house at the front door or back door, depending on which entrance is used most frequently by the residents. Prior to placement, the mat is vacuumed for 6 minutes with a Hoover Brush VacO with a beater bar. Initially, the mat must be vacuumed for approximately 6 minutes.

When placed at the residence, the mat is checked to ensure that it does not interfere with the opening and closing of the door. The residents are instructed not to clean the mat. The testing crew vacuums the mat using the Hoover vacuum with brush. Total testing time is 20 days. The mat is left in place for the residents to use after completion of the study.

4.1.4 Alley Dust

The fugitive dust samples from the alleys are taken from gravel using a brush or the vacuum without the brush attachment. Large pieces of rock and gravel are removed and discarded prior to collection of the sample. One sample is obtained behind each test house. The location of the sample is close to a walk, fence gate, or garage that provides access to the rear yard.

4.1.5 Exterior Dust

Two composite exterior dust samples are collected: an entry sample, and a street sample. The entry sample is a composite sample from two separate areas, if available. The two entry sub-samples are collected from the front and side or rear entrances to the residence. If an entry is never used, no sub-sample will be collected from that entrance.

The street composite sample consists of a sub-sample collected from the intersection of the driveway and the street curb and a sub-sample from the curb area closest to the sidewalk leading to the front entry of the residence. If there is no sidewalk leading from the street to the front door, the curb area to be sampled is the area immediately in front of the front entry to the residence, or alternatively, the curb area closest to the front door.

The entry dust sample is collected by first selecting an area within 6 feet of the entrance with the heaviest loading of dust near the door. The area with the heaviest loading is most commonly the intersection of the first porch step and the sidewalk. Once the heaviest loading has been identified, the template is placed over an area that includes that loading. The perimeter of a template (1 square foot, *i.e.*, a square area measuring 12 inches by 12 inches, or a rectangular area measuring 6 inches by 24 inches) is drawn on the surface using carpenter's chalk. The template is removed and the dust is loosened, if necessary, by means of a stiff bristled brush. Once the material is loosened, it is brushed into a pile within the defined area with a paint brush. This pile is then deposited in the appropriate sample bag, along with the brush, using a scoop. After the bulk of the material is collected in this fashion, a portable vacuum cleaner (Hoover vacuum with brush) is used to vacuum the area defined by the chalk lines.

The sample is collected by passing the vacuum head across the designated surface area from one side to the other at a rate of 3 to 4 seconds per pass. Repeated passes are made at the same rate until the entire area has been vacuumed once. A second collection is made over the same area in a direction 90 degrees to the initial direction. Again, each pass lasts from 3 to 4 seconds. A third collection is made in the same direction as the initial collection. Both sub-samples are collected in this fashion.

Once the surface dust is brushed into the sample collection bag, the interior of the vacuum cleaner (including the cleaner bowl and the motor assembly) is cleaned by utilizing several wet wipes. On a dry,

sunny day, spontaneous, natural evaporation removes the dampness remaining from wet wipe. On cool, cloudy days, paper towels may be used to dry the interior of the vacuum cleaner. Removing the moisture from the vacuum cleaner prevents dust from the next sample collection from adhering to the vacuum cleaner parts.

The final step in the collection of the exterior dust samples is the final check of the data entered on the sample collection sheets (FORM 08-Exterior Sampling-Residential). The monitoring team makes certain that all of the data has been entered onto the sheets. The vacuum and other equipment are then packed to be transported to the next sampling site.

4.1.6 Soil Collection

Soil samples are collected with a coring device. The device may be used in either of two ways. There is a "T" handle that can be attached to the top of the coring device that allows the operator to push the coring tool into the ground. The coring tool can be twisted as it is pushed into the ground to allow the cutting edge of the soil corer to cut through roots and packed earth. Alternatively, a hammer can be attached to the top of the coring tool. After the coring tool is placed on the ground where the sample is to be collected, the hammer is raided and allowed to fall while it is guided by the operator's hands.

1. At each residence occupied by a participating family, composite soil samples are collected from the four sides of the residence. Three sub-samples will be collected from each side where soil is present. The samples are collected at a distance of one (1) foot from the exterior wall of the residence. Spacing along a side of the residence may depend on the location of sidewalks, vegetation, or other obstacles. If there is a sidewalk along an entire side of a house, the sample is collected along the edge of the sidewalk. If a sidewalk, driveway, or patio is immediately adjacent to a house and extends more than 3 feet from the foundation, no sample is collected at that location.

2. [illegible]amples are collected from the curb area (the area between the street and sidewalk). [illegible] sub-samples are obtained to make one (1) composite soil sample.

3. Variation soil sample – From two residences, twelve (12) grab samples have been obtained from either the front or rear yard (depending on the shape and area of the tested yards). Each grab sample consists of two core samples collected along two parallel lines extending from the house property line. The two lines are located one foot apart and grab samples are collected approximately every 3 feet. The first grab sample is located one foot from the house.

The sampling tools are decontaminated between each type of soil sample and between tested yards by brushing and wet wipe cleaning using water and detergent solutions. Samples are placed in double 6 mil plastic bags. All samples are labeled with the dwelling ID number using waterproof, permanent ink.

4.1.7 Summary of QA/QC Precautions

A subset of houses in the sample were identified for QA/QC control purposes. At each of these dwellings, the following QA/QC protocol was executed:

- Dust collection (Section 4.1.5): One (1) wet wipe sample is obtained after each decontamination of the vacuum as a QA/QC sample. Duplicate samples are obtained for selected houses (10 samples were initially planned based on the assumption that 50 dwellings would be surveyed). The dwellings selected as "QC homes" are chosen randomly; at these dwellings, co-located samples of all types are obtained. The lead levels in these co-located samples can be compared to assess sampling reliability.

- Soil collection (Section 4.1.6): As noted in Section 4.1.6, the sampling tools are decontaminated between each type of soil sample and between tested yards by brushing and wet wipe cleaning using water and detergent solutions. At the designated QA/QC residences, one (1) wet wipe sample has been obtained after decontamination of the coring device for QA/QC purposes.

In addition to the above QA/QC procedures, the following components are sampled *via* a 60 second measurement for QA/QC purposes:

- Three components on the exterior of the house. Possible options include, but are not limited to: exterior wall or siding, exterior porch ceiling, porch railing, exterior door, exterior window casing or sill, *etc.*

- Two components in the most frequently used entry room or foyer, *i.e.*, the wall, and the trim with the greatest surface area in the room. Some possible options for the trim include but not limited to: door casing, window casing, baseboard, other decorative trim, *etc.*

- Two components in the room most utilized by young children in the house, *i.e.*, a wall and the trim with the greatest surface area.

- Two components from the child's bedroom, *i.e.*, a wall, and the trim with the greatest surface area. If no young children reside in the residence, an adult's bedroom will be selected.

A total of nine samples plus a quality control sample, if necessary, will be taken at each address.

The following general procedures also help to ensure the quality of the data:

1. The sampling points are documented by area maps, photograph, and video;
2. All samples are kept in 6 mil plastic bags or in glass jars; and
3. The samples are submitted with chain of custody forms to the University of Cincinnati for analysis.
4. The ID system is based on the site maps and house number.

4.2 XRF Sampling Protocol

Testing of paint has been performed using the SciTec XRF spectrum analyzer. The X-ray fluorescence spectrum analyzer used during the exposure assessment is manufactured by SciTec Corporation, 20000 Logston Boulevard, Suite 125, Richland, Washington, 99352. The radioactive source is licensed in Missouri (#RM-140).

The SciTec XRF spectrum analyzer is equipped with a Cobalt 57 radioactive source. This source has a half-life of 273 days. As time passes, the excitation, or rate of X-ray emission, from the Cobalt 57 source decreases. As the Cobalt 57 excitation source loses strength, the measurement time is automatically increased.

4.2.1 Method of Operation

The S[redacted]RF spectrum analyzer is capable of taking three types of measurements:

- 15-second screen with an uncertainty of ± 0.6 mg Pb/cm^2;
- 60-second test with an uncertainty of ± 0.3 mg Pb/cm^2; and
- 240-second confirmation with an uncertainty of ± 0.15 mg Pb/cm^2.

The uncertainty decreases as the quantity of radiation counts received by the spectrum analyzer increases. The actual time of these measurements varies with the strength of the radioactive source.

The inconclusive range for each type of measurement, relative to 1.0 mg lead per square cm, is presented in Table 4.2-1.

Table 4.2-1
XRF Measurement Ranges

Type of measurement	Inconclusive Range
screen (15 seconds) uncertainty ± 0.6 mg Pb/cm^2	0.4 to 1.6 Pb/cm^2
test (60 seconds) uncertainty ± 0.3 mg Pb/cm^2	0.7 to 1.3 mg Pb/cm^2
Confirmation (240 seconds) ± 0.15 mg Pb/cm^2;	0.85 to 1.15 mg Pb/cm^2

If a measurement fall within the inconclusive range, the true lead concentration may actually be above or below 1.0 mg Pb per square cm.

The information generated by the SciTec XRF spectrum analyzer is stored in the XRF's memory and later downloaded to disk. All data collected for this inspection, including the spectrum for each sample, is retained.

4.2.2 Quality Assurance / Quality Control

The QA/QC program for the XRF spectrum analyzer ensures that accurate data are collected and a focused risk assessment is performed. These goals are accomplished through instrument calibration and duplicate samples. Instrument calibration of the SciTec XRF spectrum analyzer is performed by both the manufacturer and the operator.

The XRF unity corrects each measurement for the particular substrate to which the paint is adhered. The manufacturer's calibration involves measurement of lead films of known concentration placed on many different types of building material substrates. The results of these tests are incorporated into a mathematical function that is a component of the XRF on-board computer's software.

The reference lead-based paint film used during the manufacturer's calibration is prepared by the National Institute of Standards and Technology (NIST) for HUD. Three lead concentrations are used: 0.6, 1.5, and 3.0 mg Pb per square cm.

In addition to the calibration performed by SciTec, the instrument will be calibrated daily by REACT against a lead painted calibration block. These calibrations are not accuracy checks, but rather checks to determine if the instrument is operating within the parameters set during manufacture. The calibration block, which is provided by SciTec, is coated with paint containing 1.1. mg Pb per square cm, and is measured by attaching it to the face of the XRF unit.

At the beginning of each lead paint inspection shift, a series of five test measurements on the calibration check standard will be made by REACT. If the average of these five test measurements does not fall within ± 0.7 mg Pb/cm^2 of the value reported by SciTec, another set of five readings will be taken. At this point, all ten measurements will be averaged and compared to the calibration block lead level of 1.1 mg Pb per square cm. If the averaged calibrations did not fall within 0.7 mg Pb/cm^2 of the true value, SciTec will be notified. The results of the start-up calibration will be plotted daily to determine if a trend representing bias or drift is present.

In addition to start-up calibration, the unit was checked against the standard every two hours. To assure legal defensibility and testing integrity, all calibration checks are documented and stored with the inspection data in REACTs archives.

While instrument calibration assures that the XRF is operating to manufacturer's parameters, duplicate samples establishes the accuracy of the data. Duplicate samples for 5% of the total data have been collected. The twentieth sample has been taken twice, and the results compared. The difference in value between the two samples in each pair and the duplicate QA/QC samples are documented.

QA/QC results appear in Appendix A to this report.

5 Study Results

5.1 Lead Exposure Risk Reduction Following Soil Removal

This section summarizes study results that address the objectives outlined in Section 3.1 of this report.

5.1.1 Alternative Lead Sources Contaminate Interior Housedust

Data collected in Granite City by the University of Cincinnati identify two sources, in addition to soil, that contaminate interior housedust: lead-based residential paint, and street dust transported from the Taracorp site by either wind action or by trucks traveling from the site. Both of these sources must be considered as potentially important because the lead concentrations in both residential paint and in housedust are so high, as indicated in Table 5-1. One of these sources – lead paint – has far higher lead concentrations than soil samples taken from Granite City.

Table 5-1[a]
Lead Concentrations in Perimeter Soil Lead, Residential Lead Paint, and in Street Dust, in Unremediated Houses

	Lead Concentration Statistics (µg/g)				
Medium	**N**	**Average**	**Minimum**	**Maximum**	**Std. Deviation**
Perimeter Soil	26	2,588	298	14,238	3,024
Street Dust	25	580	179	2,463	462
Paint	12	43,933	178	157,000	52,054

Note:

(a) [redacted]tistics are calculated from the unremediated houses in the 1994 University of Cincinnati data set.

Paint le[redacted]also be reported in terms of lead loading (mg lead per cm^2 paint). Much of the exterior residential lead paint measurements recorded in Granite City reveal loadings on the order of 10 to 30 mg of lead per cm^2 paint. That is, each square centimeter of exterior lead paint can contain on the order of tens of thousands of µg of lead. The complete data set from which the lead paint summary statistics in Table 5-1 have been calculated appears in Appendix B to this report.

Additional data collected from homes far from the Taracorp site (outside EPA's proposed area of remediation) further supports the hypothesis that exterior lead paint is a major source of lead contamination. The distance of these homes from the Taracorp site is sufficiently large to ensure that both past and current lead contamination from the site have had only a limited impact on soil lead concentrations. A comparison of soil lead levels near these houses to soil lead levels at the curb in front of these houses appears in Table 5-2.

Table 5-2[a]
Soil Lead Levels at the Drip line and at the Curb for Houses Far from the Taracorp Site

Location	Distance from site entrance (miles)	Soil lead concentration near house (μg/g)	Soil lead concentration near curb (μg/g)	Ratio of perimeter to curb
2129 Grand	0.58	1757	526	3.340304
2146 Delmar	0.56	2729	288	9.475694
2142 State	0.56	1879	571	3.290718
2158 State	0.56	400	420	0.952381
2124 Edison	0.54	1513	189	8.005291
2128 Edison	0.54	650	148	4.391892

Note:

(a) This table includes all the unremediated houses at least 0.5 miles from the site entrance in the 1994 University of Cincinnati data set.

The fact that soil lead concentrations near these dwellings are much higher than lead concentrations at the curb indicates paint on the dwellings may be contaminating nearby soil (alternatively, these elevated levels may reflect the impact of contaminated rain water running off the roofs of these dwellings).

Street dust lead concentrations are also very high in Granite City, suggesting that this medium may serve as an important interior dust contamination source if it is tracked into or blown into dwellings (see Appendix B, Table 2 – Lead Concentrations and loadings for street dust samples collected in August, 1995). Moreover, these concentrations tend to be inversely proportional to the distance from the Taracorp site. Table 5-3 summarizes the lead concentration measurements recorded in Granite City.

Table 5-3[a]
Street Dust Lead Concentrations and Loadings in Granite City and Distance to the Taracorp Site

Location	Distance from site entrance (miles)	Concentration of lead in street dust (μg/g)	Lead Loadings in Street Dust (μg / m²)
1429 Grand	0.3	443	1824
1436 Grand	0.3	1045	1,320
1431 Grand	0.3	665	168
1440 Grand	0.3	675	976
1438 Grand	0.3	1102	312
1437 Grand	0.3	416	184
1447 Grand	0.3	705	176
1415 Grand	0.32	565	1,104
1412 Grand	0.32	659	536
1418 Grand	0.32	334	736
1424 Grand	0.32	469	240
1413 Grand	0.32	608	6,560
1425 Grand	0.32	681	1,176
1417 Grand	0.32	606	NA
1441 Madison	0.32	NA	672
1400 State	0.32	556	66,000
1425 Madison	0.34	183	2,912
1439 Madison	0.34	216	1,536
1433 Madison	0.34	179	2,280
2030 Benton	0.44	2463	240
2124 Edison	0.54	320	536
2128 Edison	0.54	319	1,104
2146 Delmar	0.56	217	816
2142 State	0.56	521	992
2158 State	0.56	318	2,744
2129 Grand	0.58	228	3,080

Note:

(a) This table includes all of the unremediated houses in the 1994 University of Cincinnati data set.

Regressing these concentrations against distance yields a negative coefficient (a negative slope of 691 ppm lead in street [illegible] r mile from smelter), verifying that street dust lead concentrations decrease with distance from [illegible]acorp site and indicating that the site is a continuing source of lead exposure for Granite City residents.

The data collected in Granite City were used to construct a Pathway Exposure that describes the pathways by which lead travels from one medium to another. The Granite City Pathway Exposure Model appears in Figure 5-1. Each pathway described in the model is quantified by a correlation coefficient and

an associated p-value, which appears in parentheses. Similar path models have been used to quantify the influence of environmental lead sources on childhood blood lead levels, and many of these models have appeared in the peer-reviewed literature (Bornschein *et al.*, 1986; Bornschein *et al.*, 1988).

5.1.2 The Short-Term Effectiveness of Soil Remediation on Lead Exposure as Reflected by Housedust Levels

As noted in Section 3, ingestion of interior housedust is an important pathway by which children are exposed to lead. We therefore have investigated pre- and post- soil removal dust lead concentrations. As of this time, data are available for only a limited number of dwellings, making it not possible to conduct a conclusive statistical analysis of this issue. Instead, Table 5-4 summarizes the available data.

Table 5-4[a]
Pre- and Post- Soil Removal Interior Dust Lead Concentrations (µg/g)

Location	Pre-remediation (1994)	Post-remediation (1995)	Difference (post- minus pre-remediation)
1412 Grand St.	608	652	-44
1415 Grand St.	1070	303	767
1418 Grand St.	109	522	-413
1424 Grand St.	462	782	-320
1431 Grand St.	1094	959	135

Notes:

(a) These are the only houses for which pre- and post-remediation data are available in the 1994 and 1995 University of Cincinnati data sets.

Note that in the majority of cases, post-remediation dust lead concentrations are higher than pre-remediation concentrations. These findings may reflect the continuing contribution of interior paint to the interior dust lead levels. Several studies have demonstrated that interior dust lead is very difficult to remove.

5.1.3 Recontamination of Remediated Soil by Remaining, Non-Abated Lead Sources

The concentration of lead in exterior lead paint is much higher than typical lead concentrations in even unremediated soil in Granite City. Dust lead levels are also high. Table 5-3 in Section 5.1.1 summarizes some of the street dust lead concentration data collected as part of the University of Cincinnati

Study. We note that street dust lead concentrations are higher (500 to 1,000 μg/g) at locations near the Taracorp site. More disturbing is the very high lead loading (mg lead per square foot) in street dust. These levels are several orders of magnitude greater than permissible in interior housedust (0.1 mg / square foot).

Figure 5-2 illustrates the high levels of lead in exterior residential paint compared to residential soil. This Figure shows 2 vials: the left vial contains paint chips from Granite City, while the right vial contains soil from Granite City. Although the left vial contains only a few chips of paint and the right vial is virtually full of soil, the vials contain the same amount of lead. This comparison shows that a limited degree of lead paint contamination can substantially elevate the concentration of lead. Photographs of dwellings in Granite City (Figure 5-3) demonstrate that in many cases, exterior paint has deteriorated, making it available to recontaminate clean soil after remediation.

Finally, post-remediation soil lead concentration measurements recorded 1 year and 2 years after removal of contaminated soil indicate that many properties still have lead concentrations in composite soil samples that exceed 500 μg/g (for example, of the 38 perimeter soil samples, 9, or approximately 24%, had lead levels exceeding 500 μg/g when resampled after soil abatement; mid-yard lead levels were considerably lower, with 3, or approximately 8%, exceeding 500 μg/g when resampled). Hence, in the presence of elevated levels of lead in paint and the Taracorp pile, government sponsored remediation is proving ineffective in many cases in reaching its stated goal of residential soils of less than 500 μg/g. Table 5-5 summarizes the soil lead concentration results.

Table 5-5[a]
Post-Remediation Soil Lead Concentrations (μg/g):
1 year and 2 years after Soil Removal

	Time[b]	N	Mean	SD	Min	Max
Peri[illegible]oil	1 year	17	676	1,048	38	4,154
	2 years	21	339	823	46	3,845
Mid-yard Soil	1 year	17	194	436	23	1,770
	2 years	21	277	915	27	4,257

Notes:

(a) These statistics are calculated from the 1995 University of Cincinnati data set.

(b) The 1-year and 2-year houses are not the same houses. There are a total of 38 houses; 17 of these had been remediated 1 year ago, and 21 had been remediated 2 years ago.

5.2 The Illinois Department of Public Health Paint Lead Measurements are Valid

The Princeton Gamma-Tech XRF paint lead readings, which indicated markedly elevated levels of lead in paint, have been validated using the SciTec XRF device and by atomic absorption analysis of paint chips.

6 Discussion and Conclusions

6.1 Soil Removal in the Absence of Other Interventions that Address Other Lead Sources Does not Reduce Lead Exposure

EPA has justified its decision to address lead exposure in Granite City by removing contaminated residential soil on the basis of predictions made by the Agency's Integrated Exposure Uptake Biokinetic (IEUBK) model. For example, EPA states that "... the IEUBK model can be used at this [the NL Taracorp] site, with appropriate site-specific input parameters appearing not much different than standard model parameters" (Marcus, 1994, p 58). However, the IEUBK model, as used by EPA, assumes that 70% of the lead in interior housedust derives from soil tracked in from the outside (US EPA, 1994). As noted in Appendix C, empirical measurements of this transfer coefficient have yielded considerably lower values. Moreover, the model makes no allowances for lead sources that may continue to contaminate exterior soil. In other words, the assumptions underlying the model imply that soil is the main source of lead in interior housedust, and moreover, that removal of the lead in exterior soil will be permanent and that such removal will substantially decrease interior dust lead concentrations. Applying the model to the Granite City population suggests that soil removal will substantially decrease childhood lead exposure since the model assumes that children ingest between 85 and 135 mg of soil and interior housedust each day (US EPA, 1994). Both the University of Cincinnati Study at Granite City, and other studies, do not support EPA's plans to remove lead-contaminated residential soil before addressing other sources of lead contamination.

Section 5.1 documents three sets of findings from the University of Cincinnati study that cast doubt on the efficacy of soil removal as a means to reduce lead exposure in Granite City. Section 5.1.1 identifies two lead contamination sources – residential lead paint, and street dust apparently transported from the Taracorp site – appear to be important. In the case of residential paint, lead concentrations often far exceed the concentrations found in soil. The Path Model, which reflects the data collected in Granite City (see Figure 5-1), illustrates the importance of these sources and pathways. EPA's IEUBK model, in contrast, does not adequately characterize the flow of lead between various source pools, including sources contributing to lead in interior dust.

Dr. R. Kimbrough's study of Granite City (Kimbrough *et al.*, 1995) also suggests that paint, especially when it is in poor condition, is an important source of lead contamination. The results in the Kimbrough study [illegible]ed that "lead in paint together with the condition of the house were the main contributors to the dust lead variance (26%) with soil lead accounting for an additional 6%." In other words, residential lead paint is approximately four times more important than soil lead concentrations in explaining the variance in dust lead concentrations in Granite City.

Other studies also point to the potential importance of lead paint relative to lead in soil, especially when the lead concentration in that paint is high and the paint is in poor condition. For example, Don Ryan, Director of the Alliance to End Childhood Lead Poisoning wrote in a letter to EPA/ECAO (Ryan, 1994) that "[EPA's] three cities studies appear to confirm our belief that the most intensive exposures come from lead-based paint and interior dust and that the benefits of soil abatement as a stand-alone strategy are modest in most cases." In fact, as noted below, only in Boston did investigators observe statistically significant changes in blood lead levels after soil abatement was conducted (US EPA, 1995). However, soil lead concentrations were considerably higher in Boston – on the order of 2,000 μg/g (Aschengrau, 1994) – than they were in either Baltimore or Cincinnati. These findings suggest that soil remediation, if effective at all, is effective only when soil lead levels are substantially elevated.

Data from the University of Cincinnati study also indicate that lead transported from the Taracorp site continues to be an important contamination source. Street dust lead levels remain high more than a decade after lead smelting operations ceased at the Taracorp site (see Appendix B, Table B-2, page 6 – Lead Concentrations and loadings for street dust samples collected in August, 1995). Since streets are cleaned often (by either the city or by rain), the lead levels now observed cannot be the result of historic smelting operations. Two additional points should be noted. First, the lead loadings listed in Appendix B, page 6 are ext[illegible]-high. Note that the units reported are mg/m^2, so that the highest lead loadings reported are on[illegible]er of 5 g/m^2. Second, the data listed in Appendix B, page 6 reveal that the lead loadings adjacent to the Taracorp site are higher (average = 2,737 mg/m^2) than those that were measured at other locations (average = 1,168 mg/m^2), again supporting the hypothesis that the Taracorp site continues to act as a source of lead contamination for Granite City. The path model based on the University of Cincinnati data, along with data indicating that street dust lead levels decline with distance from the Taracorp site, further support the possibility that wind action or trucks traveling from the site spread contaminated dust, dust that is likely to originate within the site and is perhaps attributable to the lead slag

piles within the site. The importance of this source again indicates that remediation of residential soil alone will not address substantial contributors to environmental lead contamination in Granite City.

The second finding in Section 5.1 that casts doubt on the efficacy of soil removal on lead exposure is documented in Section 5.1.2. That section demonstrates that dust lead levels do not consistently decrease after remediation of soil; in some cases, dust lead levels increase. This finding may reflect the relative importance of other lead contamination sources (described above). Alternatively, it may reflect inadequate remediation practices in Granite City. For example, after removing soil from contaminated yards, abatement contractors do not always cover the abated area during the interval prior to replacing the removed soil with clean fill. This practice may disturb and uncover contaminated soil, making it more available to contaminate the surrounding environment as the result of wind action. In other cases, abatement contractors have failed to completely cover with plastic contaminated soil that is removed from yards to prevent it from being spread. These inadequate remediation practices may disturb and redistribute lead in the soil, contaminating both exterior and interior housedust.

The final finding in Section 5.1 casting doubt on the efficacy of soil removal is the potential for recontamination of soil after abatement (Section 5.1.3). Specifically, paint has much higher lead concentrations than does soil, and hence can potentially recontaminate clean soil. Street dust lead levels are also elevated. Second, empirical measurements of soil lead concentrations recorded during the first and second year after soil removal (Table 5-5) verify that soil lead concentrations remain elevated (more than 500 μg/g) in many yards.

The findings from the University of Cincinnati study support the claim that remediating soil prior to addressing other contamination sources will not effectively decrease lead exposure among the Granite City population. [illegible] conducted, soil remediation may increase lead exposure. First, as noted above, soil remediation can [illegible] dust lead concentrations by releasing lead from the soil. In addition, large-scale, highly visible remediation efforts might give the Granite City community a false sense of security, suggesting to them that the lead problem has been addressed, when in reality the situation persists. It is conceivable that some parents may relax their vigilance after remediation of yard soil, putting their children at even greater risk of exposure to lead in both external dust and interior housedust.

Remediation strategies that address multiple media at other sites confirm that focusing on soil alone at Granite City is ill-advised. Aschengrau *et al.* (1994) investigated the efficacy of soil abatement, along with soil, dust and paint abatement, as part of the EPA's "Three-City Study," carried out in the early 1990's. Although soil abatement alone decreased blood lead levels by 1 to 2 μg/dL in the Boston population, Aschengrau *et al.* noted that "Soil abatement was not effective among children with persistently elevated interior floor dust lead loading levels" (p 146) – a scenario comparable to Granite City. The EPA's integrated draft report for the Agency's Urban Soil Lead Abatement Project notes that abatement of soil will not result in a statistically significant decline in blood lead levels unless there is "(a) a notably elevated starting soil lead concentration (*e.g.*, in excess of 1,000 to 2,000 μg/g); [and] (b) a marked reduction of more than 1,000 μg/g in soil lead consequent to soil abatement..." (U.S. EPA, 1995, p 6-4). EPA also emphasizes the importance of addressing multiple sources of lead contamination. For example, the Agency states that, "The maximum reduction in lead exposure will not be achieved unless both paint and soil abatement are implemented' (p 6-11). The Agency adds that, "At a minimum, when implemented, both soil abatement and interior dust removal should be performed to be fully effective" (p 6-12).

EPA's proposed remediation plan for the Silver Bow Creek/Butte Area Site (US EPA Region VIII, 1994) also addressed the multi-media nature that often characterizes lead contamination. EPA's Preferred Response Action included the following tasks (p 4):

- "Cleanup interior and exterior lead paint by replacement, encapsulation, paint removal, and/or house siding as necessary."
- "Remove indoor dust contaminated with lead by cleaning: heating ducts, interior surfaces, and attics, and replacing: insulation, cloth furniture, and carpeting."
- "Continue blood-lead testing of young children, lead education and awareness activities"

Commenting on the Butte site for EPA, Griffin *et al.* (Griffin *et al.*, 1993) also point out the importance of addressing lead-based paint when attempting to reduce lead contaminated housedust. They state that, "The primary source of lead exposure appeared to be lead-contaminated housedust which was contributed to indirectly by soil lead and deteriorated lead-based paint."

6.2 Paint Lead Concentrations Reported by the Illinois Department of Public Health are Valid

Results from the University of Cincinnati study show that the Illinois Department of Public Health correctly identified the number of dwellings with elevated paint lead concentrations. Like the results of the Illinois Department of Public Health, sampling conducted using the SciTec XRF device revealed that only a small fraction of dwellings in Granite City have exteriors free of lead paint. The SciTec device identified only two houses out of 35 (6%) that were lead paint free. These results were further confirmed using wet chemical analysis of paint chip samples from dwellings in Granite City.

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Figure 5-2

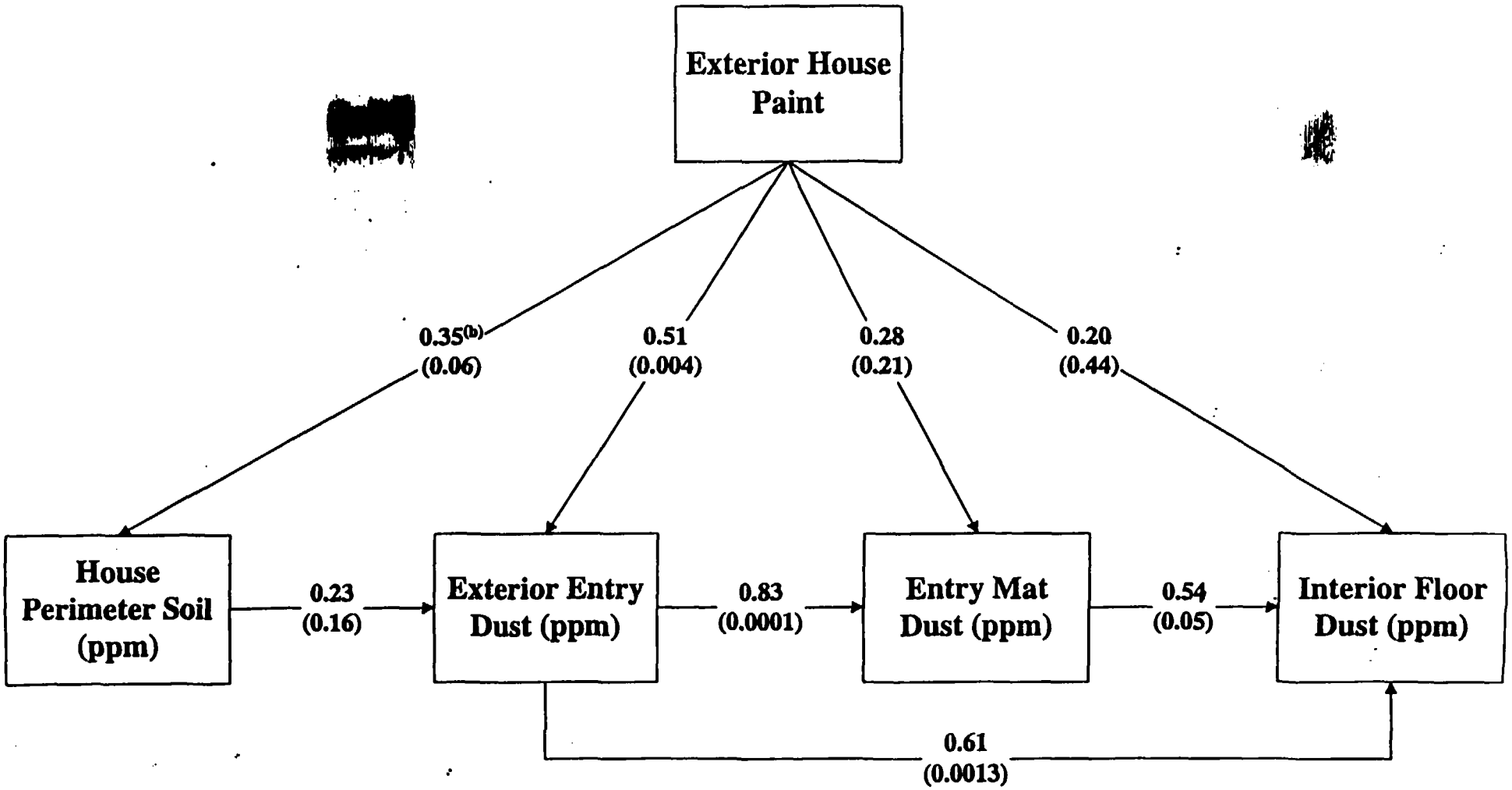
Illustration of relative concentrations of lead in soil and paint in Granite City

To be provided

Figure 3-1

Granite City Path Model[a]

N = 25 - 38



Notes:

(a) Based on 1995 data from the University of Cincinnati Study.
(b) Values are correlation coeficients; values in parantheses are p-values.

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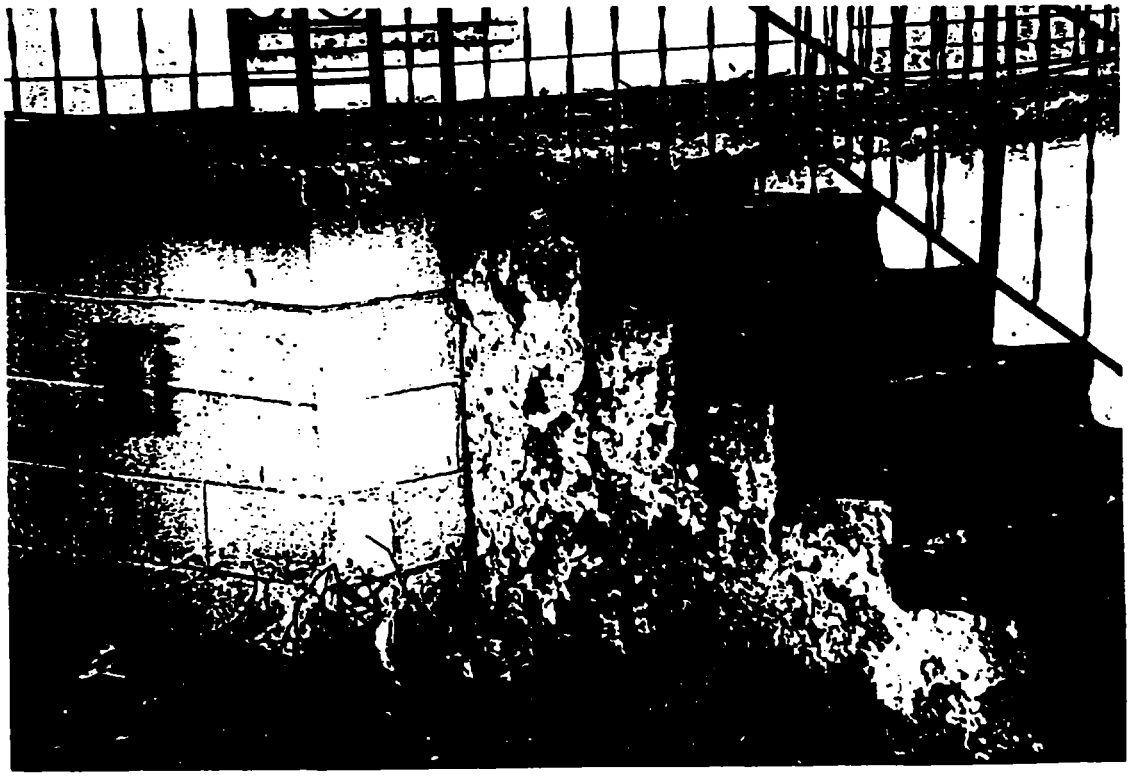
Figure 5-2

Illustration of relative concentrations of lead in soil and paint in Granite City

To be provided

Figure 5-3
Deteriorated Exterior Paint on Dwellings in Granite City

1412 Grand



1429 Grand

Figure 5-3 (Cont)
Deteriorated Exterior Paint on Dwellings in Granite City

1438 Grand

Appendix A
QA/QC Results

GRANITE CITY, ILLINOIS

ENVIRONMENTAL SAMPLES

FIELD AND LABORATORY QUALITY CONTROL RESULTS

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April 24, 1996

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Introduction

Granite City, Illinois Field and Laboratory Quality Control Results

The quality of sample collection and analysis can be monitored by evaluation specific quality control procedures implemented as a component of a project's sampling and analytical plans. In the Granite City, Illinois Lead Exposure Study various types of quality control measures were utilized to assess overall quality including the accuracy and precision of sampling and daily laboratory activities. The following report summarizes the results of the quality control data generated for the study samples. Attachment A contains listings of the actual Q.C. samples.

Soil

Soil samples were collected and shipped to the Hematology and Environmental (H&E) laboratories at the University of Cincinnati for analysis. Samples were dried and sieved to a particle size of <250 microns and analyzed by a laboratory XRF unit, the KEVEX Analyst 770 Delta Analyzer. Collection of co-located or duplicate samples was part of the study's field sampling design (Table 1). Variation in these values reflect all sources of variance, including environmental heterogeneity, sample collection, sample preparation (sieving, splitting, and weighing) and data analysis. In addition, field control samples were inserted into the study samples prior to delivery to the lab (Table 2).

Analysis by XRF is a non-destructive method. Two bench controls are run with every set of 14 samples analyzed. Limits of ± two standard deviations were established for these controls; and, if the concentration of one or more of the controls fell outside of the established limits, the entire run was reanalyzed. The limits for these control samples were:

LEAD (low)	162 - 192 ppm
LEAD (high)	1051 - 1151 ppm

Information on the controls analyzed within the runs of study samples is presented in Table 3

TABLE 1

SOIL Pb RESULTS FOR CO-LOCATED SAMPLES

INITIAL SAMPLE (PPM)	REPEAT SAMPLE (PPM)
28	31
31	31
60	29
71	88
80	62
342	276
670	575
767	1703

TABLE 2

FIELD (BLIND) Q.C. SAMPLES

		SOIL (ppm)	
	Target	303	1633
RESULTS:	N	5	5
	MEAN	296	1524
	S.D.	9.4	31
	%C.V.	3%	2%
	MINIMUM	286	1486
	MAXIMUM	310	1572
	RANGE	24	86

TABLE 3

SOIL Pb XRF
CALIBRATION CHECK SAMPLES

	ASSIGNED CONCENTRATION	
	177 ± 15 ppm	1101 ± 50 ppm
N	7	7
MEAN	173.3	1052.1
S.D.	4.3	50.3
% C.V.	2.5%	4.8%
MINIMUM	167	994
MAXIMUM	181	1107
RANGE	14	113

EXTERIOR MAT INTERIOR DUST AND DUST FALL

Dust samples were collected and then shipped to the University of Cincinnati H & E labs for analysis. Since almost all of the mat and exterior dust samples weighed less than 2 grams (the minimum sample weight required for XRF analysis), the samples were digested and analyzed by flame-atomic absorption spectroscopy (FAAS). Interior dust samples were obtained by using a micro vacuum (2L/min. personal air sampler) with a cassette attached to collect the sample. The sample was extracted from the cassette by rinsing with distilled deionized water, collecting the rinsate, and evaporating to dryness. This sample was then weighed, digested and analyzed by FAAS. Because of the additional steps in this process, reagent blanks and method samples were acceptable based upon quality control limits and laboratory criteria for acceptability.

Collection of co-located or duplicate samples was part of the study's field sampling design (Table 5). In addition, field control samples were inserted into the study sample stream prior to delivery to the lab (Table 6).

TABLE 4

DUST Pb LABORATORY QUALITY CONTROL SAMPLES

CONTROL AND KNOWN CONCENTRATION

	Regent Blank (µg)	Method Blank (µg)	NIST-E #1646 28±4 (ppm)	NIST-U #1648 6550±160 (ppm)	NIST-BRS #2704 161±34 (ppm)	R-HIGH (BULK) 2816±283 (ppm)	R-LOW (BULK) 488±67 (ppm)
N	31	5	11	20	15	4	5
MEAN	0.15	0.26	23.6	6136	150	2685	471
S.D.	0.17	0.36	2.6	207	3.4	75	28
%C.V.	114%	138%	11%	3%	2%	3%	6%
MINIMUM	<0.1	<0.1	20.3	5885	142	2618	440
MAXIMUM	0.4	0.9	30.8	6844	155	2770	517
RANGE	0.3	0.8	10.5	959	13	152	77

TABLE 5

DUST Pb RESULTS FOR CO-LOCATED SAMPLES

	INITIAL SAMPLE (ppm)	REPEAT SAMPLE (ppm)
INTERIOR DUST	303	264
	943	976
	959	863
EXTERIOR DUST	276	377
	2209	2329
	2479	1317

FIELD (BLIND) Q.C. SAMPLES INTERIOR DUST (ppm)		
TAR[illegible]		161
RESULTS:	N	4
	MEAN	142.8
	S.D.	10.7
	%C.V.	7%
	MINIMUM	132.7
	MAXIMUM	157.6
	RANGE	24.9

PAINT

Paint samples were collected and shipped to the UCH&E labs for analysis. In the lab, samples were ground, digested, and analyzed by FAAS. The method detection limit was 10 µg Pb. The sample runs consisted of blanks and NIST lead-based paint SRMS. All runs were acceptable and within laboratory quality control criteria. The results of the paint Q.C. are listed in Table 7.

TABLE 7

PAINT Pb LABORATORY QUALITY CONTROL SAMPLES

CONCENTRATION	Reagent Blank (µg)	Powdered Pb based Paint #1579A 119,950±310 (ppm)	CONTROL AND KNOWN Powdered Pb based Paint #2582 208.8±4.9 (ppm)
N	8	8	2
MEAN	<10*	119,854	219
S.D.	0	3885	55
%C.V	0	3%	25%
MINIMUM	<10	115,813	180
MAXIMUM	50	125,638	258
RANGE	-	9825	78

**Notes: all results <10, except one value = 50 ppm*

Attachment A

Data Listing for all Q.C. Samples

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Table 1	Soil
Table 2	Exterior Dust
Table 3	Interior Dust
Table 4	Dustfall Dust
Table 5	Entry Mat Dust
Table 6	Paint
Table 7	Co-located Samples

TABLE 1
Granite City Soil Q.C.

Reference LO	Reference HI
177 (ppm)	1101 (ppm)
167	1107
175	1105
174	1099
173	994
181	999
173	1034
170	1027

TABLE 2

Granite City Exterior Dust Q.C.

HI STD 2816 PPM	LO STD 488 PPM	NBSE 27.1 PPM	BRS 161 PPM	NBSU 6550 PPM	MH SOIL 5532 PPM	MM SOIL 1162 PPM	REAGENT BLANK	DUPLICATE	DUPLICATE	DUP. DIFF	% RECOVERY
2770.1	516.6	23.3	1.5	6066.7	5464.0	1173.0	<0.1	44.0	44.0	0.0	103.0
		22.	.7	6105.5	5534.0	1156.0	<0.1	61.0	61.0	0.0	102.
		22.7	.5	5885.0			<0.1	61.0	61.0	0.0	10
			149.5	6007.8			<0.1	50.0	50.0	0.0	105.0
			147.8	6105.5			<0.1	66.0	64.0	2.0	102.0
			149.4				<0.1	39.0	39.0	0.0	101.0
			153.0				<0.1	50.0	50.0	0.0	
			148.1				<0.1	30.0	30.0	0.0	
			151.1				<0.1	73.0	73.0	0.0	
							<0.1	46.0	46.0	0.0	
							0.1				
							<0.1				
							<0.1				
							<0.1				
							0.3				
							0.2				

TABLE 3

Granite City Interior Dust Q.C.

HI STD 2816 ppm	LO STD 488 ppm	NBSE 27.1 ppm	BRS 161 ppm	NBSU 6550 ppm	REAGENT BLANK	METHOD BLANK	DUPLICATE	DUPLICATE	DUP. DIFF.	% RECOVERY
2772.3	474.4	[illegible]	155.2	6277.2	0.4	<0.1	27.0	27.0	0.0	105.0
	440.0	[illegible]	151.9	6376.2	0.2	<0.1	26.0	25.0	1.0	[illegible]
		[illegible]		6162.0	<0.1	<0.1	27.0	27.0	0.0	[illegible]
		23.1		6844.1	<0.1	0.9	25.0	24.0	1.0	105.0
		22.2		6140.4	<0.1	<0.1	486.0	486.0	0.0	100.0
		22.4		5911.7	<0.1					100.0
		23.6			0.1					99.0
		20.3			<0.1					102.0
					0.1					

TABLE 4
Granite City Dustfall Q.C.

HI STD 2816 ppm	LO STD (488 ppm)	REAGENT BLANK	DUPLICATE	DUPLICATE	DUP. DIFF.	% RECOVERY
2626.5	460.1	[illegible]0.1	54	55	0	101
2617.8	466.1	[illegible]0.1				

TABLE 5
Granite City Entry Mat Q.C.

BRS 161 ppm	NBSU (6550 ppm)	REAGENT BLANK	DUPLICATE	DUPLICATE	DUP. DIFF.	% RECOVERY
147.9	6210.7	<0.1	36	36	0	103
142.0	6213.8	<0.1	39	39	0	103
146.6	6103.2	<0.1	53	53	0	101
146.7	6142.6	<0.1				

TABLE 6
Granite City Paint Q.C.

LO Pb PAINT 208.8 ppm	HI Pb PAINT 119,950 ppm	REAGENT BLANK	DUPLICATE	DUPLICATE 14000	DUP. DIFF.	% RECOVERY
180	116,689	<10	15200		400	101
250	119,221	<10	58000	58000	0	100
	117,272	<10	70	70	0	97
	115,813	<10	310	310	0	101
	123,853	<10	60	60	0	103
	125,638	<10	420	420	0	97
	123,534	<10				
	116,809	50*				
		<10				

TABLE 7
Granite City Co-Located Sample Results

SOIL	SAMPLE 1
	28
	31
	60
	71
	80
	342
	670
	767
EXTERIOR DUST	SAMPLE 1
	276
	2209
	2479
INTERIOR DUST	
	303
	943
	959

Attachment B

Analytical Methods

N. Preparation - Surface Dust Samples
O. Preparation - Dust Fall Samples
P. Nitric Digestion of Interior Dust & Dustfall Samples for Lead
Q. Nitric Digestion of Soil & Exterior Dust Samples for Lead
R. Nitric/Peroxide Extraction for Paint Samples
W. The Determination of Lead in Environmental Samples
EE. XRF Analysis of Soil and Exterior Dust for Lead

N. Preparation - Surface Dust Samples

Preparation for A[illegible]igestion

1. Fill in Lab # numbers for 27 beakers in lab notebook starting with the next # number after the last # number from the previous batch of completed samples.

2. Mark and date 27 100 ml beakers that have been previously washed, rinsed, acid soaked for 4 hours and rinsed in D.I. H_20 with the 27 numbers from the lab notebook for that run of samples.

3. Place beakers in drier oven for 1 hour.

4. While beakers are in drier oven, pick out random # numbers from the 27 in that run to be used for 2 High or Low standards.

   1 NBS-E or NBS-U standards
   1 reagent BLANK = RB
   1 method BLANK = MB

   The standards will have numbers on the cassettes. Write this number next to the lab number you have selected for that standard.

   Next to the number for reagent BLANK write RB.
   Next to the number for method BLANK write MB.

5. Next fill in sample # numbers next to your 22 remaining lab numbers along with Family I.D. # numbers.

6. Move beakers from drier oven to cooling box with tongs for 1 hour. While beakers are in cooling box, line up sample cassettes on lab bench top next to hoods.

7. About 6" behind cassettes lay down a line of overlapping Kimwipes and place your numbered beakers on them upside down after weighing.

8. [illegible] beakers are ready to come out of cooling box, cover top of lab cart with Kimwipes. [illegible]ate balance just before weighing.

9. [illegible]e 9 beakers from cooling box with tongs and place on the cart. Move carat to balance. Move beakers on to balance with tongs and record weight in log book. Be sure to match beaker number to lab number.

10. At this point you may remove the beakers from the balance by hand to the cart and bench top.

11. After 3 sets of 9 beakers have been weighed and placed upside down on clean Kimwipes next to sample cassettes. Double check to make sure numbered beakers are lined up in order to match numbers in log book.

12. Set up 27 watchglass covers on clean Kimwipes in front of cassettes. Fill 3 squirt bottles with D.I. H_20.

13. [redacted] first beakers and first sample cassette to area where sample transfer will occur.

14. Using spatula carefully, pry top off of cassette. Tap sample into beaker.

15. Rinse inside of cassette top into beaker using rinse bottle with D.I. H_20. Next rinse inside of cassette and pour rinsings into beaker. Then pry the next ring off and, starting with the inside top of the ring, rinse into beaker. Next rinse out the inside of the cassette again. Remove top filter with tweezers and rinse both sides into beaker starting from back to front, then front to back. Next remove support pad and rinse the same as was done with the top filter. Next rinse the inside bottom of cassette into beaker and discard cassette in trash can. By rinsing from back to front, you will wash more sample out of filter.

16. Move beakers to back of lab batch and cover with watchglass. Move on to next sample.

17. When you come to empty cassette (method BLANK) treat the same as sample. When you come to 50 ml beaker (reagent BLANK), move the numbered beaker to your rinsing spot and fill it with 40 to 50 mls of D.I. H_20 from your bottle. DO NOT rinse 50 ml beaker into numbered beakers. IT IS ONLY A MARKER.

18. After all samples have been rinsed into the numbered beakers move them to drier oven at 105° C for Pbk or 95° C for As digestion.

19. After all samples have been placed into the frier oven, allow them to remain there overnight.

20. The first thing the next day move all samples into cooling box for 1 hour using tongs.

21. Cut 27 pieces of parafilm about 9 ½ mm x 9 ½ mm and place them on Kimwipes next to balance.

22. After beakers have been in cooling box for 1 hour, calibrate balance and remove with tongs 9 samples at a time to lab cart with top covered with bench top paper.

    Remove watchglasses by hand without touching beakers, then place beakers on balance [redacted] tongs and record weights in lab notebook. Double check to be sure you place the [redacted]t next to the proper lab number. At this point you may handle the beakers.

    [redacted]ve from balance and cover the top with parafilm, pulling the parafilm snug but not to snug as it may shrink and tear later on. Expose the sample to air. Move on to next sample.

23. After all the samples have been weighted and covered with parafilm, place them in box with sample sheet. Write date the samples were processed.

24. Next go to lab notebook and subtract empty beaker weight from (beakers sample weight) and enter difference in lab book.

Samples are now ready to be submitted to the Lab technician (Rose) for digestion.

O. Preparation - Dust Fall Samples

Preparation for [redacted]Digestion

1. Record lab # numbers for 29 beakers into lab notebook starting with the next # number from the previous batch of completed samples.

2. Mark and date 29-100 ml and 29-250 ml beakers that have been previously washed, rinsed, acid soaked for 4 hours and rinsed in D.I. H_20 with the 29 numbers from the lab notebook for that run of samples. (Refer to procedure for cleaning glassware).

3. Place beakers in drier oven for 1 hour, "only 100 ml beakers."

4. While beakers are in drier oven, pick random # numbers from the 29 that run to be used for 2 High or Low standards.

   1 NBS-E or NBS-U standard

   1 reagent BLANK

   1 METHOD BLANK

   Next to the number for reagent BLANK write RB

   Next to the number for method BLANK write MB

5. Next fill in the sample # numbers next to your 24 remaining lab numbers along with Family I.D. # numbers and area/Cm^2 in log book.

   Move beakers from drier over to cooling box with tongs for 1 hour.

6. Use new plastic containers to make up 1 High of 1 Low standards 2 NBS-E or 2 NBS-U, to do this weight out 50 mg on weighing paper and transfer into container. You must mark the lid with type of standard, weight and lab #. Be sure to enter weight and lab in log book.

7. [redacted] mark sample containers with Lab # in order from your lab book. Next stack sample [redacted]er on lab bench with standards on blank in their proper order.

8. Using the lab notebook, march place samples and standards in order according to number. When you come to method BLANK, place on empty container in that space. When you come to the reagent blank, place a paper towel with Lab # and reagent blank written on it. Lay down a line of overlapping Kimwipes to place your number beakers on after weighing.

9. Cover the top of the lab cart with bench paper. Calibrate balance just before weighing.

10. Remove 9 beakers from the cooling box with tongs and place on the cart. Move cart to balance. move beakers on to balance with tongs and record weight in log book. Be sure to match beaker number to lab number.

11. At this point, you may remove the beakers from the balance by hand to place on the cart and bench top.

12. Dustfall samples are contained in plastic containers with lids.

13. Using clean forceps remove any obvious foreign objects from the dustfall container such as insect bodies, leaves, pins, etc.., and discard.

14. Using hot distilled/deionized water in a glass wash bottle, and by scraping with a rubber policeman, quantitatively transfer the dust fall samples by rinsing to a labeled, acid washed 250 ml beaker. Rinse the inside lid of the dustfall container also. If the dustfall container is very heavily loaded, an additional labeled 250 ml beaker may be used. When you come to reagent blank, fill beaker with 100 mls D.I. H_20 and cover.

15. Cover each sample with a watchglass supported by two glass hooks. Evaporate the dustfall rinsings to about 50 ml on a hot plate at about 200° C. If more than one beaker was used, amalgamate the rinsings.

16. Rinse the concentrate dustfall rinsings with hot distilled/deionized water and scrape into a tared, acid washed 100 ml beaker. Beaker tare weights will be taken on a calibrated 4-place analytical balance.

    BE SURE TO MATCH LAB # ON 250 ML BEAKER WITH THE SAME LAB 3 ON 100 ML BEAKER.

17. Transfer the covered sample beakers to a drying oven which has a maximum temperature of 105°C. Dry in the oven overnight.

18. Keep the samples covered. Place the samples in a desiccated cabinet to cool prior to weighing for one hour.

19. Obtain the gross weight of the dustfall sample plus beaker to obtain the total sample weight collected.

20. At this point, the samples should be covered with parafilm for storage prior to acid digestion.

P Nitric Digestion of Interior Dust & Dustfall Samples for Lead & Arsenic

1. The regents being used are 1M and 7M reagent nitric acid prepared with distilled deionized water.

1M = 64 ml HNO_3/1 liter D.D. H_2O (volumetric)

7M = 898 ml HNO_3/2 liter D.D. H_2O (volumetric)

Measure conc. acid in a graduated cylinder. Pour acid slowly into the volumetric half-filled with water, frequent swirling. Make up to volume.

Make up solution 1 day prior to use, to allow for cooling of acid, then bring back up to volume.

2. To each sample, add 25 ml of 7M HNO_3 using a repeater pipetter dispenser or acid buret. Wash down the sides of the beaker.

3. Cover each beaker with a ribbed watchglass, place samples on hot plate at 120° Centigrade for 2 hours. For arsenic samples stay at 100° Centigrade throughout procedure.

4. Remove the samples from the hot plate and cool in hood until they are at room temperature.

5. The entire filtration procedure should take place under the hood. Use a wash bottle filled with 1M HNO_3 for rinsing. Set up glass funnels over 100 ml pre-labeled beakers. In each funnel, place a folded whatman #54 filter paper. Before filtering, wet filter paper and rinse glassware with about 20-30 ml of 1M HNO_3. Discard waste rinse. To filter, decant the liquid from the sample first, then pour the solids onto the filter. Once this has drained, wash the beaker with 3 small (3 ml) portions of 1M HNO_3, adding each wash to the filter paper. Rinse the filter paper with 3 small (3 ml) portions of 1M HNO_3. After the filter paper is thoroughly drained it is discarded. Rinse the glass runnel with one small portion of 1M HNO_3.

6. Re-cover samples with watchglasses and place on a hot plate at 180° Centigrade to evaporate down to dryness. Remove samples just at dryness to avoid burning. For arsenic samples temp. is 100° Centigrade and can be left overnight to go down to dryness.

7. To re-dissolve lead, add - 3 ml of 1M HNO_3 (using Pasteur pipets), rinsing down sides of beakers.

8. [illegible]ver beakers with watchglasses and put on hot plate at 120° Centigrade for a few [illegible]s (5-10 min.) to mildly heat, some of the 3 ml may evaporate.

9. Cool the samples to room temperature. Pour the remaining sample into a 10 ml labeled centrifuge tube. Rinse the beaker 3 times with 1M HNO_3 from a Pasteur pipette. Each rinsette should be about 1 ml. Bring sample up to volume, shake thoroughly.

10. Samples are then submitted to the A.A.S. lab for determination of lead or arsenic. Samples are now 6.4% nitric acid.

Q. NITRIC DIGESTION OF SOIL & EXTERIOR DUST SAMPLES FOR LEAD AND ARSENIC

Preparation:

1. Oven dry samples overnight at 105° Centigrade.

2. Desiccate 1 hour till cool thoroughly mix before weighing.

3. Weight out 0.1 g (nearest milligram) into a pre-labeled, acid washed 100 ml beaker.

Digestion:

1. The reagents being used are 1M and 7M reagent nitric acid prepared with distilled deionized water.

   1M = 64 ml HNO_3/1 liter D.D. H_2O (volumetric)
   7M = 898 ml HNO_3/2 liter D.D. H_2O (volumetric)

   Measure conc. acid in a graduated cylinder. Pour acid slowly into a volumetric half-filled with water, frequently swirling. Make up to volume.

   Make up solution 1 day prior to use to allow for cooling of acid, then bring back up to volume.

2. To each sample, add 25 ml of 7M HNO_3 using a repeater pipette dispenser or acid buret. Wash down the sides of the beaker.

3. Cover each beaker with a ribbed watchglass, place samples on hot plate at 120° Centigrade for 2 hours. For Arsenic samples stay at 100° Centigrade throughout procedure.

4. Remove the samples from the hot plate and cool in hood until they are at room temperature.

5. The entire filtration procedure should take place under the hood. Use a wash bottle filled with 1M HNO_3 for rinsing. Set up glass funnels over 100 ml pre-labeled beakers. In each funnel, place a folded whatman #54 filter paper. Before filtering, wet filter paper and rinse glassware with about 20-30 ml of 1M HNO_3. Discard waste rinse. To filter, decant the liquid from the sample first, then pour the solids onto the filter. Once this has drained, wash the beaker with 3 small (3 ml) portions of 1M HNO_3. After the filter paper is thoroughly drained it is discarded. Rinse the glass funnel with one small portion of 1M HNO_3.

6. Re-cover samples with watchglasses and place on a hot plate at 180° Centigrade to evaporate down to dryness. Remove samples just at dryness to avoid burning. For

Arsenic samples temperature is 100° Centigrade and can be left overnight to go down to dryness.

7. [redacted]-dissolve lead, add 3 ml of 1M HNO_3 (using Pasteur pipets), rinsing down sides of [redacted]ers.

8. Re-cover beakers with watchglasses and put on hot plate at 120° Centigrade for a few minutes (5-10 min) to mildly heat, some of the 3 ml may evaporate.

9. Cool the samples to room temperature. Pour the remaining sample into a 10 ml labeled centrifuge tube. Rinse the beaker 3 times with 1M HNO_3 from a Pasteur pipette. Each rinse should be about 1 ml. Keep in mind the total volume is 10 ml. Bring sample up to volume, shake thoroughly.

10. Samples are then submitted to the A.A.S. lab for determination of lead or arsenic. Samples are now 6.4% nitric acid.

R. NITRIC/PEROXIDE EXTRACTION FOR PAINT SAMPLES

Preparation:

1. Oven dry samples overnight at 105° Centigrade.

2. Desiccate 1 hour till cool, thoroughly mix before weighing.

3. Weigh out 0.1 g (nearest milligram) into a pre-labeled, acid washed 100 ml beaker.

Digestion:

Should take place under the hood.

1. Add 3 ml concentrated HNO_3 and 1 ml 30% H_2O_2 cover with ribbed watchglass.

2. [redacted] on hot plate at 140° Centigrade until most of the acid has evaporated, remove from [redacted]nd allow to cool.

3. [redacted] ml concentrated HNO_3 and 1 ml 30% H_2O_2, take down to near dryness, remove from heat and cool.

4. Repeat step 3 one more time, remove samples near dryness and allow to cool.

5. Rinse watchglass and walls of beaker with 3 to 5 ml of 10% HNO_3. Allow the solution to evaporate gently to dryness, remove from heat and cool.

6. Add 1 ml concentrated HNO_3 to residue swirl sample to dissolve soluble species.

7. Next add 40-50 ml of Deionized/distilled water to 1 ml conc. acid solution. Swirl sample and place back onto hot plate for 1 hour to gently heat at 140° Centigrade. Remove and cool sample. The remainder of procedure will be finished using D.D. H_2O.

Filtration:

Should take place under the hood.

1. Set up glass over 100 ml prelabeled, acid washed beakers. In each funnel, place a folded Whatman #54 filter paper. Using wash bottle with D.D. H_2O wet filter paper and rinse glassware with about 20-30 ml of water. Discard waste rinse.

2. To filter, decant liquid from sample first, then pour the solids on top the filter. Once this has drained, wash beaker thoroughly with 3 rinsings, adding each rinse to filter paper. Rinse the filter paper 3 times also with H_2O. Once filter paper has thoroughly drained. It is discarded. Rinse glass funnel with small portion of H_2O.

3. Pour the sample from beaker into labeled 100 ml graduated cylinder, rinse beaker thoroughly. Bring sample up to 100 ml total volume, stopper cylinder and mix vigorously. Pour sample into prelabeled, acid washed 125 ml wide mouth Nalgene bottle.

4. Submit samples to A.A.S. lab for determination of lead. Samples are now 1% in nitric acid.

W. THE DETERMINATION OF LEAD IN ENVIRONMENTAL SAMPLES

Description

A 10 ml digested interior dust, dustfall, or handwipe sample is submitted for analysis. After direct analysis of the sample by flame atomic absorption spectrophotometry. All interior dust samples that show up found Pb levels of 9 µg or less will be set aside for a more precise analysis by MIBK extraction. The lead is dithioca[illegible] complex and is analyzed by using flame AA.

I. Analyti[illegible]cedure

A. Reagents

All chemicals are ACS Reagent Grade, or equivalent unless otherwise specified.

1. Ammonium Hydroxide

2. Concentrated Nitric Acid

3. Phenol Red Indicator Solution (0.04% w/v in water)

4. Aqueous Potassium Cyanide (10% w/v)

Caution: Avoid acid. Will form poisonous gas under acid conditions.

5. Aqueous Ammonium Pyrrolidine Dithiocarbamate (2% w/v). Prepare fresh daily.

6. Methyl Isobutyl Ketone

Saturate with water by shaking 250 ml of MIBK with 5 ml of water immediately prior to use.

7. Ammonium Citrate Buffer (pH = 8.4)

Place 1200 g of citric acid in a 4 liter beaker. Add 900 ml of water and 50 drops of phenol red indicator solution (see above). Add ammonium hydroxide until all the citric acid has dissolved and the solution has a definite pink color (pH = 8.4). Cool and adjust the final volume to 3000 ml.

B. Equipment

1. Perkin-Elmer Model 5000 Atomic Absorption Spectrophotometer, or equivalent.

2. A set of 50 ml volumetric flasks reserved for the chelation/extraction procedure.

II. <u>Direct Analysis Procedure</u>

1. Analyze digested 10 ml sample using flame AA by water aspiration.

2. Turn on the Perkin-Elmer Model 5000 (or 2380) Atomic Absorption Spectrophotometer and allow to warm up for 45 minutes prior to use.

3. Light to hollow cathode lamp. Adjust the wattage to that recommended on the lamp (*e.g.*, 10 watts). Allow to warm up for 15 minutes. If a electrodeless discharge lamp is being used, set the current (mA) to that recommended on the lamp and allow to warm up for 45 minutes.

4. [illegible]k up the wavelength (217.0 nm) for maximum light throughput (energy).

5. [illegible] following line pressures: air = 64.0 acetylene = 30.

6. Optimize the burner position for maximum absorbance while aspirating a 10 ppm solution of lead in 10% (v/v) nitric acid.

7. Start the stripchart (20 mm/min & 10 mv).

8. Activate AA/BG (background correction with Atomic Absorption).

9. Allow 15 min. to warm up.

10. When stable baseline has been achieved start analysis.

11. Use standard run order, aspirate standard blank, 1 ppm, 5 ppm, 7 ppm, 10 ppm , and [illegible]rd blank. Then aspirate 5 ppm NIST, 10 ppm and standard blank then aspirate 7 ppm and standard blank.

12. Start aspirating samples and allow enough time between to achieve baseline.

13. After every 10 samples aspirate one of the standards this should agree within 5$ of the previous response. If okay go ahead. If not respirate all the standards and reaspirate the 10 samples again and run 1 standard.

14. Any samples that respond over 9 ppm set aside for later dilution.

15. For every 25 samples there is one sample selected for duplication.

16. For every 20 samples there is one sample selected for recovery: (a) take 1 ml of 1 ppm of Pb standard and aspirate.

17. When all samples have been aspirated in standard run order. Aspirate 5 ppm NIST then aspirate all the standards again.

18. Samples that need dilution must be roughly determined using high standards and then diluted appropriately. a) then they can be analyzed using lower standards.

Calculations

1. Plot the measured peak height from the strip chart *vs.* the amount of lead added to each standard solution.

2. Measure the peak height in millimeters for each sample.

3. Translate the measured sample peak height into an equivalent number of micrograms by means of the calibration curve. This gives the amount of lead in the original sample (g/ml).

4. [illegible]ple ug/ml by initial volume (10 ml) to achieve µg found.

5. [illegible]erior dust samples that show µg found Pb levels of 9 µg or less will be set aside for [illegible] extraction.

6. All dustfall samples that show µg found Pb levels of 3 µg or less will be set aside for MIBK extraction.

7. Recoveries measured by (orig. sample + 1)/2 x 100% = Rec.%

III. Extraction Procedure

Once extracted the samples are stable for approximately 6 hours.

1. Transfer the measured pre-direct analyzed solution to a 50.0 ml volumetric flask with the [redacted] solution volume including rinsings not to exceed 25 ml.

2. Add 5.0 ml of the ammonium citrate buffer and 3 drops of 0.04% phenol red indicator solution.

3. Add ammonium hydroxide dropwide to adjust the pH to 8.2 (vivid pink from bright yellow, approximately 50 drops)

   NOTE: phenol red is pale pink at very acid pH as would be encountered initially. During pH adjustment, the sample will change from pink to bright yellow to vivid pink.

   CAUTION: THE SOLUTION MUST BE BASIC BEFORE PROCEEDING

EE. XRF ANALYSIS OF SOIL AND EXTERIOR DUST FOR LEAD AND ARSENIC

Sample Drying:

The soil sample in the bag is desegregated by crushing with gloved hand or with a stainless steel spoon. The entire sample is poured from the bag onto a 6" or 9" plastic plate, that has been labeled with corresponding lab number.

The plate is covered lightly with paper towels. Soil must be air dried until a constant weight is achieved (can be up to 5 days). All records of drying dates and weights are logged in a lab notebook.

Sample Sieving:

All sieving takes place under a hood with the exhaust fan operating.

Obta[redacted]n sieve pans, 2 mm sieve, and 250 µm sieve. Place the 2 mm sieve on one pan. Pour the entire dry [redacted]into the sieve. The entire sample should be passed through the sieve, using a stainless steel tool such as a spatula or spoon to desegregate particles.

The stones and other material larger than 2 mm may be discarded.

The fraction that passes the 2 mm sieve is now called the *fraction 1 & 2 and is stored in plastic bags.

The material in the sieve pan (Total Soil Fraction) is place in a pre-labeled glass storage jar, (Quorpak, 4 oz.) Stir the soil in the sieve pan well and remove an aliquot of the soil.

The remainder of the soil in the sieve pan is placed in the 250 um sieve on a second clean sieve pan. By gently desegregating the soil with a stainless steel tool such as a spatula or spoon, and by shaking the pan, work th[redacted] through the sieve until it appears that no more material is passing through. The portion that does not pass the 250 um sieve may be discarded. The soil inn the sieve pan is placed in a pre-labeled glass storage jar. This fraction will be identified as the "Urban Soil Fraction" (U).

Cleaning of Sieves:

Sieves are cleaned between samples by tapping on a hard surface, brushing out, and inspecting for remaining particles. Same "blinding" of the sieve is inevitable, as particles become lodged in the screen.

Drying Samples to Constant Weight:

The samples are weighed on a 2-place analytical balance and the weight recorded in a drying record notebook. Samples are considered at constant weight when 2 successive weighings have recorded less than 0.5g difference (less than -0.5%). Drying between weighings may be done with a minimum of 2 hours in a drying oven (max temperature 105°C) or a 24 hour air drying period.

Aliquoting Samples for Analysis:

Care should be taken to thoroughly mix the sample by tumbling and stirring before removing the aliquot for analysis.

XRF Analysis for Lead

Approximately 2g of loose sieved soil will be weighed and placed into labeled sample cups (Chemplex Industries, Inc., Cat. No. 1530), fitted with windows of ¼ mil thick X-ray polypropylene film (Chemplex Industries, Inc., Cast. No. 425).

The instrument configuration for the Kevex Delta Analyst Energy Dispersive X-ray Spectrometer is:

1. [redacted] Analyst 770 Excitation/Detection Subsystem:
   a. X-ray tube: Kevex high output rhodium anode
   b. Maximum power supply: Kevex 60 kv, 3.3 mA
   c. Detector/cryostat: Kevex Quantum - UTW lithium, drifted silicon. 165 eV FWHM resolution at 5.9 KeV

2. Kevex Delta Analyzer:

a. Computer mainframe: Digital Equipment Corp. PDP 11/73

b. Computer software: Kevex XRF Toolbox II, Version 4.14

c. Disk drives: Iomega Bernoulli box, dual drives, 20 MB

d. Pulse processor: Kevex 4460

e. Energy to digital converter: Kevex 5230

3. Operating conditions:

a. Excitation Mode: Mo secondary target with 4 mil thick Mo filter

b. Excitation conditions: 30 kV, 0.5 mA

c. Acquisition time: 200 livetime seconds

d. Shaping time constant: 7.5 microseconds

e. Sample chamber atmosphere: air

f. Detector collimator: Ta

4. Analytical conditions:

a. Escape peaks, and background are removed from all spectra

b. The intensity ratio, defined as the integral of counts in the Pb (LB) window divided by the integral of the counts in the MO (KA) Raleigh scatter window, are determined for each spectrum

c. The intensity ratios for the standards are used to determine a linear least squares calibration curve.

5. Calibration standards:

The following Cincinnati Soil and EMSL Las Vegas Standards used to produce two calibration cures. Sample concentration is determined using the calibration curve in which its intensity ratio falls. The two curves consist of concentration ranges of 11-4, 142 ppm and 4, 142-21, 867 ppm. The standards were analyzed by an SRF analysis done in the EMSL Las Vegas lab.

<u>ppm Pb</u>

11
40
175
423
752
1,040
2,446
4,142
13,885
21,867

6. Calibration check:

The 175 and 1, 040 ppm standards will be used as calibration checks.

XRF Analysis for Arsenic

Approximately 2g of loose sieved soil will be weighed and placed into labeled sample sups (Chemplex Industries, Inc., Cat. No. 1530), fitted with windows of ¼ mil thick X-ray polypropylene film (Chemplex Industries, Inc., Cat. No. 425)

The instrument configuration for the Kevex Delta Analyst Energy Dispersive X-ray Spectrometers is

1. Kevex Analyst 770 Excitation/Detection Subsystem:

END OF ATTACHMENT A

Appendix B
The complete Bornschein dataset

Table B-1
1994 University of Cincinnati Data Set

ST_NO	ST_NAME	TYPPROP	DFALLDAY	WTMATFIN	TOTWTMAT	MAT_DAY	DFALLGMS	XRFPB_P	XRFPB_C	XRFPB_X	XRFPB_Y	PAINTPPM
2030	BENTON	C	28	0.02	1.89	14	0.25	298	373	224	2463	.
2146	DELMAR	C	30	.	.	.	0.13	2729	288	1194	217	136342
2124	EDISON	C	32	9.43	17.8	27	0.05	1513	189	1746	320	6933
2128	EDISON	C	[illegible]	.	.	.	0.09	650	148	181	319	16344
1410	GRAND	PR	[illegible]	27.55	38.18	27	0.08	32	2159	218	55[illegible]	.
1412	GRAND	R	[illegible]	40.04	46.47	21	0.08	3635	2243	1076	6[illegible]	.
1413	GRAND	A	31	.	.	.	0.09	1215	2182	284	608	.
1415	GRAND	R	31	.	.	.	0.08	1089	1782	190	565	.
1417	GRAND	A	31	0.48	1.3	25	0.16	910	2371	845	606	.
1418	GRAND	R	31	9.55	12.73	21	0.09	2065	4840	3368	334	2928
1419	GRAND	PR	31	.	.	.	0.16	1312	3124	1094	776	27476
1424	GRAND	R	32	0.96	2.65	20	0.34	2852	2869	3253	469	23059
1425	GRAND	A	31	1.35	2.9	19	0.07	2210	1531	614	681	.
1429	GRAND	R	32	19.05	35.31	20	1.45	2330	2193	2350	443	.
1431	GRAND	R	36	14.37	18.25	36	2.63	1250	2247	1705	665	157000
1436	GRAND	R	36	7.73	5.89	36	0.11	938	2967	753	1045	.
1437	GRAND	A	32	4.74	7.79	27	0.07	14238	2240	1220	416	.
1438	GRAND	R	34	.	.	.	0.04	10373	1838	72496	1102	40496
1440	GRAND	R	.	5.87	13.12	20	.	2105	2281	1160	675	.
1442	GRAND	PR	.	.	.	.	.	34	213	.	569	.
1443	GRAND	PR	32	4.58	8	25	0.11	630	1133	1500	712	.
1447	GRAND	A	33	.	.	.	0.09	2780	3781	651	705	.
2129	GRAND	C	33	.	.	.	0.07	1757	526	1415	228	178
1413	MADISON	AR	19	.	.	.	0.09	30	190	773	171	41488
1415	MADISON	AR	19	.	.	.	0.04	28	90	511	164	.
1425	MADISON	R	32	6.05	12.77	27	0.14	1868	1420	2424	183	28549
1429	MADISON	PR	33	2.36	4.47	33	0.26	104	2351	1107	145	.
1433	MADISON	A	33	.	.	.	0.11	1359	1331	7635	179	56555
1439	MADISON	A	33	10.03	11.58	33	0.39	2333	1829	1210	216	2104
1441	MADISON	A	.	.	.	.	.	2715	226	.	.	.
1400	STATE	A	30	1.95	5.71	25	0.16	1787	2025	788	556	.
1406	STATE	AR	.	.	.	.	.	26	24	.	.	.
1408	STATE	PR	.	.	.	.	.	48	125	551	277	.
2142	STATE	C	31	0.56	2.39	21	0.03	1879	571	438	521	56713
2158	STATE	C	33	1.45	3.82	19	0.05	400	420	368	318	.

Table B-1
1994 University of Cincinnati Data Set

ST NO	ST NAME	PBPPM D	DFALLPPM	XRFPB Z	PBPPMMAT	FL AREA	TOTWT X	WT D	MAXINT P	MAXEXT P	PAINTPOS	ENT AREA	ST AREA
2030	BENTON	403	176	.	594	1250	30	285	0.3	0.2	0	2	2
2146	DELMAR	.	1920	55	.	.	147	.	.	44.3	87.5	2	2
2124	EDISON	1141	4011	95	1631	1875	228	84	27.1	9.4	44.4	2	2
2128	EDISON	.	326	192	.	.	21	.	.	1.1	0	2	2
1410	GRAND	480	6[illegible]	195	439	1875	24	144	0.5	1.8	11.1	2	2
1412	GRAND	608	6[illegible]	143	148	2550	122	11	3.6	10.1	66.7	2	2
1413	GRAND	.	622	253	.	.	30	.	.	1.7	33.3	2	2
1415	GRAND	1070	454	154	.	2500	22	290	0.7	18.1	22.2	2	2
1417	GRAND	890	908	309	596	1875	102	138	3	.	44.4	2	2
1418	GRAND	109	513	52	115	2500	385	82	39.2	38.6	55.6	2	2
1419	GRAND	4878	880	224	.	1875	126	460	1.8	17.3	37.5	2	2
1424	GRAND	462	2494	87	2355	2500	364	14	2.3	13.2	44.4	2	2
1425	GRAND	839	432	272	277	2500	67	27	6.2	31.9	23.1	2	2
1429	GRAND	6385	1141	444	1878	3125	285	295	0.5	28.3	11.1	2	2
1431	GRAND	1094	21	.	283	2500	192	1170	2.5	21.8	36.4	2	2
1436	GRAND	258	2091	59	648	1875	84	2000	5.5	9.1	55.6	2	2
1437	GRAND	2684	896	827	1378	1875	138	6000	3.3	1.7	33.3	2	2
1438	GRAND	.	4863	86	.	.	8250	.	.	17.1	50	2	2
1440	GRAND	442	.	105	364	2500	124	212	2.9	3.2	44.4	2	2
1442	GRAND	.	.	.	.	.	.	.	.	.	.	.	1
1443	GRAND	1462	974	299	396	1875	156	120	0.9	2.8	30	2	2
1447	GRAND	1155	1400	388	.	1875	67	625	12.6	6.2	44.4	2	2
2129	GRAND	.	376	202	.	.	165	.	0.1	14.6	22.2	2	2
1413	MADISON	.	64378	946	.	.	84	.	.	.	.	2	2
1415	MADISON	.	4060	102	.	.	56	.	.	8.9	75	2	2
1425	MADISON	655	2966	71	877	2500	343	100	5.5	18.9	44.4	2	2
1429	MADISON	.	859	104	3635	.	132	.	.	39.8	33.3	2	2
1433	MADISON	.	710	.	.	.	820	.	.	7.7	25	2	2
1439	MADISON	.	36990	98	8636	.	138	.	.	1.8	25	2	2
1441	MADISON	.	.	.	.	.	.	.	.	.	.	.	2
1400	STATE	551	527	428	546	1875	92	46	0.2	1.3	14.3	2	2
1406	STATE	377	.	.	.	2500	.	27	2.5	0.4	9.1	2	.
1408	STATE	638	.	340	.	2500	64	156	1.3	0	22.2	2	2
2142	STATE	403	540	415	589	1925	23	10	4.4	18.1	44.4	2	2
2158	STATE	365	634	399	471	1875	39	63	2	1.2	11.1	2	2

Table B-1
1994 University of Cincinnati Data Set

ST NO	ST NAME	ALL AREA	DFALLRAT	MATPB LD	PBLOAD D	PBLOAD X
2030	BENTON	.	382.64	50.24	2280	240
2146	DELMAR	1	.	.	.	1176
2124	EDISON	1	1098.76	33728.34	448	1824
[redacted]	EDISON	1	.	.	.	168
[redacted]	GRAND	1	283.47	26522.56	768	192
[redacted]	GRAND	1	192.91	16708.2	43.14	976
1413	GRAND	1	.	.	.	240
1415	GRAND	1	149.78	.	1160	176
1417	GRAND	1	736.99	677.55	736	816
1418	GRAND	1	189.39	3096.53	328	3080
1419	GRAND	1	723.48	.	2453.33	1008
1424	GRAND	1	3235.71	6693.07	56	2912
1425	GRAND	1	122.16	1165.34	108	536
1429	GRAND	1	5021.84	105914.1	944	2280
1431	GRAND	.	186.64	6688.58	4680	1536
1436	GRAND	1	1018.32	8238.44	10666.67	672
1437	GRAND	1	304.54	14323.75	32000	1104
1438	GRAND	1	.	.	.	66000
1440	GRAND	1	.	6325.61	848	992
1442	GRAND	.	.	.	.	.
1443	GRAND	1	518.81	4295.5	640	1248
1447	GRAND	1	619.82	.	3333.33	536
2129	GRAND	1	.	.	.	1320
1413	MADISON	1	.	.	.	672
1415	MADISON	1	.	.	.	448
1425	MADISON	1	1579.86	11635.48	400	2744
1429	MADISON	1	.	15392.02	.	1056
1433	MADISON	.	.	.	.	6560
1439	MADISON	1	.	155414.9	.	1104
1441	MADISON	1	.	.	.	.
1400	STATE	1	453.41	2521.62	245.33	736
1406	STATE	.	.	.	108	.
1408	STATE	1	.	.	624	512
2142	STATE	1	77.12	929.99	51.95	184
2158	STATE	1	152.82	2128.28	336	312

Table B-1
1994 University of Cincinnati Data Set

Notes	
ST_NO	Street number
ST_NAME	Street name
TYPPROP	Type of Property (PR = previously remediated, A = adjacent, AR = immediately after remediation, R = prior to remediation, C = control)
DFALLDAY	Days of dust fall accumulation
WTMATFIN	Weight of seived [redacted]ust (g)
TOTWTMAT	Weight of dust on [redacted]
MAT_DAY	Days of dust accu[redacted]n entry mat
DFALLGMS	Weight of dustfall (g)
XRFPB_P	Perimeter soil lead concentration (ppm)
XRFPB_C	Curb soil lead concentration (ppm)
XRFPB_X	Concentration of lead in exterior entry dust (ppm)
XRFPB_Y	Concentration of lead in street dust (ppm)
PAINTPPM	Paint lead concentration (ppm)
PBPPM_D	Concentration of lead in interior floor dust
DFALLPPM	Concentration of lead in dustfall container (ppm)
XRFPB_Z	Concentration of lead in alley dust (ppm)
PBPPMMAT	Concentration of lead in interior entry mat dust (ppm)
FL_AREA	Floor area sampled (cm2)
TOTWT_X	Entry dust weight
WT_D	Floor dust weight
MAXINT_P	Maximum interior lead paint loading (mg/cm2)
MAXEXT_P	Maximum exterior lead paint loading (mg/cm2)
PAINTPOS	% of painted surfaces tested positive for lead
DFALLRAT	Exterior dust fall lead loading per month (ug/m2/month)
MATPB_LD	Mat dust lead loading per month: transfer rate (ug/m2/month)
PBLOAD_D	Interior floor dust lead loading (ug/m2)
PBLOAD_X	Exterior dust lead loading (ug/m2)

Table B-2
1995 University of Cincinnati Data Set

Street #	Street	Area	Building	Family	Apartment	Perimeter soil lead (ug/g)		Curb soil lead (ug/g)	
	[redacted]					Initial	Repeated	Initial	Repeated
1630	CLEVELAND	G	0031	1	0000	109		2879	
1640	CLEVELAND	G	0032	1	0000	146		2738	
1642	CLEVELAND	G	0040	1	0000	667		3291	
1728	CLEVELAND	G	0025	1	0002	120		1074	
1621	DELMAR	G	0028	1	0000	222		3780	
1624	DELMAR	G	0042	1	0000	118		4695	
1628	DELMAR	G	0041	1	0000	66		3665	
1633	DELMAR	G	0024	1	0000	357		3433	
1635	DELMAR	G	0023	1	0000	1180		3420	
1636	DELMAR	G	0037	1	0000	46		2068	
1636	DELMAR	G	0038	1	REAR	74		2068	
1638	DELMAR	G	0039	1	0000	63		2647	
1640	DELMAR	G	0043	1	0000	82		2016	
1641	DELMAR	G	0015	1	0000	125		1448	
1627	EDISON	G	0026	1	0000	59		2261	
1643	EDISON	G	0022	1	0000	101		1817	
1401	GRAND	G	0033	1	0000	219		127	
1410	GRAND	G	0001	1	0000	56		1283	
1412	GRAND	G	0007	1	0000	222		29	
1415	GRAND	G	0020	1	0000	670	575	31	31
1418	GRAND	G	0008	1	0000	490		85	
1419	GRAND	G	0012	1	0000	654		60	
1422	GRAND	G	0034	1	0000	218		51	
1424	GRAND	G	0002	1	0000	38		64	
1429	GRAND	G	0036	1	0000	75		47	
1431	GRAND	G	0006	1	0000	767	1703	71	88
1436	GRAND	G	0011	1	0000	2158		71	
1438	GRAND	G	0010	1	0000	4154		2094	
1443	GRAND	G	0003	1	0000	3845		764	
1411	MADISON	G	0021	1	0000	84		68	
1413	MADISON	G	0017	1	0000	69		53	
1415	MADISON	G	0018	1	0000	681		76	
1419	MADISON	G	0030	1	0000	342	276	80	62
1423	MA[redacted]	G	0035	1	0000	48		844	
1425	MA[redacted]	G	0029	1	0000	82		1448	
1429	MA[redacted]	G	0013	1	0000	117		1754	
1406	STATE	G	0014	1	0000	42		135	
1408	STATE	G	0019	1	0000	47		158	

Table B-2
1995 University of Cincinnati Data Set

Street #	Street	Mid-yard soil lead (ug/g)		Exterior dust sample				Exterior dust sample, repeated	
		Initial	Repeated	Total weight (g)	Lead conc. (ug/g)	Dust loading (g/m2)	Dust lead loading (ug/m2)	Total weight (g)	Lead conc. (ug/g)
1630	CLEVELAND	142		2.47	2,493.70	13.29	33,149.82		
1640	CLEVELAND	92		0.33	1,329.50	0.89	1,180.63		
1642	CLEVELAND	88		4.27	931.10	22.98	21,397.56		
1728	CLEVELAND	51		1.30	824.30	7.00	5,767.25		
1621	DELMAR	354		7.03	1,566.20	18.92	29,628.70		
1624	DELMAR	42		18.69	122.20	100.59	12,291.94		
1628	DELMAR	100		4.50	1,090.60	24.22	26,413.02		
1633	DELMAR	70		1.51	5,495.50	5.42	29,773.71		
1635	DELMAR	689		2.99	1,408.90	16.09	22,672.08		
1636	DELMAR	68		0.96	1,315.80	5.17	6,798.31		
1636	DELMAR	47		6.31	1,566.70	33.96	53,205.35		
1638	DELMAR	44		0.65	1,002.80	3.50	3,508.07		
1640	DELMAR	28		3.64	3,080.80	19.59	60,353.85		
1641	DELMAR	116		11.11	669.20	59.79	40,013.83		
1627	EDISON	44		1.79	407.30	9.63	3,923.81		
1643	EDISON	43		1.57	1,403.00	8.45	11,854.89		
1401	GRAND	62		9.79	15,103.40	52.69	795,788.20		
1410	GRAND	27		16.94	326.70	91.17	29,785.34		
1412	GRAND	30		25.05	1,524.70	134.82	205,556.97		
1415	GRAND	28	31	9.44	276.20	50.81	14,032.52	3.49	376.50
1418	GRAND	35		3.76	1,747.40	20.24	35,360.65		
1419	GRAND	38		38.87	2,322.50	209.20	485,859.10		
1422	GRAND	30		3.70	30,555.60	19.91	608,460.82		
1424	GRAND	23		13.19	2,268.60	70.99	161,043.35		
1429	GRAND	88		23.93	1,987.60	128.79	255,983.38		
1431	GRAND	53	41	3.89	2,479.00	20.94	51,899.86	2.08	1,317.20
1436	GRAND	158		6.50	1,703.50	34.98	59,593.04		
1438	GRAND	1770		32.88	18,822.40	176.96	3,330,787.19		
1443	GRAND	4257		48.57	707.60	261.40	184,967.75		
1411	MADISON	30		0.72	7,819.30	3.88	30,299.85		
1413	MADISON	27		44.76	2,170.50	240.90	522,865.45		
1415	MADISON	32		3.01	2,057.80	16.20	33,335.71		
1419	MADISON	60	29	11.82	2,208.50	63.61	140,493.09	5.65	2,328.80
1423	MADISO	43		10.40	1,703.30	55.97	95,337.68		
1425	MADISO	140		49.83	803.50	268.18	215,484.90		
1429	MADISO	84		37.78	1,771.20	203.33	360,138.57		
1406	STATE	46		10.39	812.20	55.92	45,417.02		
1408	STATE	44		19.52	1,284.60	105.06	134,954.64		

Table B-2
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Street #	Street	Interior dust sample					Interior dust quality control sample		
		Total weight (g)	Lead (ug)	Lead conc. (ug/g)	Dust loading (g/m2)	Dust lead loading (ug/m2)	Total weight (g)	Lead (ug)	Lead con (ug/g)
1630	CLEVELAND								
1640	CLEVELAND								
1642	CLEVELAND	0.03	21.0	642.2	0.17	112.00			
1728	CLEVELAND	0.12	72.0	618.6	0.62	384.00			
1621	DELMAR	0.09	102.0	1,075.9	0.51	544.00			
1624	DELMAR	0.20	147.0	720.2	1.09	784.00			
1628	DELMAR	0.21	52.0	251.5	1.10	277.33			
1633	DELMAR	0.03	36.0	1,353.4	0.14	192.00			
1635	DELMAR	0.03	12.0	415.2	0.15	64.00			
1636	DELMAR	0.21	110.0	531.1	1.10	586.67			
1636	DELMAR	0.05	30.0	600.0	0.27	160.00			
1638	DELMAR	0.03	11.0	347.0	0.17	58.67			
1640	DELMAR	0.10	28.0	281.4	0.53	149.33			
1641	DELMAR	0.26	211.2	804.9	1.40	1,126.40			
1627	EDISON								
1643	EDISON	0.02	7.1	327.2	0.12	37.87			
1401	GRAND								
1410	GRAND	0.16	34.0	216.0	0.84	181.33			
1412	GRAND	0.17	108.0	651.8	2.65	1,728.00			
1415	GRAND	0.02	6.6	302.8	0.12	35.20	0.02	6.1	264.1
1418	GRAND	0.05	24.0	521.7	0.25	128.00			
1419	GRAND								
1422	GRAND	0.07	96.0	1,463.4	0.35	512.00			
1424	GRAND	0.03	23.0	782.3	0.16	122.67			
1429	GRAND								
1431	GRAND	0.04	35.0	958.9	0.19	186.67	0.1	82	863.2
1436	GRAND								
1438	GRAND								
1443	GRAND	0.02	10.0	448.4	0.12	53.33			
1411	MADISON								
1413	MADISON								
1415	MADISON	0.02	11.0	569.9	0.10	58.67			
1419	MADISON	0.02	15.0	943.4	0.08	80.00	0.03	29	976.4
1423	MADISON	[illegible]05	38.0	742.2	0.27	202.67			
1425	MADISON	[illegible]							
1429	MADISON	[illegible]							
1406	STATE	0.04	12.0	319.1	0.15	48.00			
1408	STATE								

Table B-2
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Street #	Street	Interior dust field blank			First paint chip sample			Second paint chip sample		
		[redacted]al weight (g)	Lead (ug)	Lead conc. (ug/g)	Total weight (g)	Lead (ug)	Lead conc. (ug/g)	Total weight (g)	Lead (ug)	Lead conc. (ug/g)
1630	CLEVELAND				0.07	830	12,029.0	0.30	180	599.4
1640	CLEVELAND				0.49	3,570	7,244.3	0.33	16,200	48,765.8
1642	CLEVELAND				0.46	8,400	18,300.7			
1728	CLEVELAND				0.19	570	3,048.1			
1621	DELMAR									
1624	DELMAR				0.47	47,000	99,808.9			
1628	DELMAR				0.44	50,000	114,547.5			
1633	DELMAR				0.71	53,100	74,453.2	0.10	10	96.1
1635	DELMAR									
1636	DELMAR				0.56	60	107.9			
1636	DELMAR									
1638	DELMAR									
1640	DELMAR									
1641	DELMAR									
1627	EDISON				0.37	39,750	106,797.4	0.88	10,500	11,900.7
1643	EDISON				0.12	250	2,061.0	0.77	840	1,093.6
1401	GRAND				0.68	76,950	113,848.2	0.39	184,500	471,987.7
1410	GRAND				0.03	30	1,052.6	0.19	250	1,319.3
1412	GRAND				0.18	13,500	74,750.8	0.13	1,040	8,106.0
1415	GRAND		0.10							
1418	GRAND				0.40	130,000	321,066.9			
1419	GRAND				0.25	8,400	33,898.3			
1422	GRAND				0.65	91,800	141,230.8	0.48	38,250	78,866.0
1424	GRAND				0.14	650	4,662.8			
1429	GRAND				0.50	79,650	160,617.1	1.70	30,600	18,032.9
1431	GRAND		0.10		0.57	4,500	7,865.8	0.28	43,200	154,617.0
1436	GRAND				0.31	1,560	4,987.2	0.44	310	701.4
1438	GRAND				0.80	136,000	169,049.1			
1443	GRAND									
1411	MADISON				1.02	5,310	5,207.4	1.02	32,400	31,827.1
1413	MADISON				0.50	69,600	140,350.9	0.85	58,500	68,670.0
1415	MADISON				0.14	330	2,370.7			
1419	MADISON		0.10		0.92	15,600	17,019.4			
1423	MADISON	[redacted]			0.28	10,500	37,661.4	0.59	15,600	26,231.7
1425	MADISON	[redacted]			0.48	68,250	143,081.8			
1429	MADISON	[redacted]			0.10	16,500	157,743.8	0.44	121,800	279,807.0
1406	STATE				0.40	210	529.4	0.11	110	959.9
1408	STATE				0.10	470	4,648.9	0.13	1,100	8,352.3

Table B-2
1995 University of Cincinnati Data Set

Street #	Street	Mat dust sample		Years after abatement	Soil lead conc. determined by EPA in 1991, 1992
		Total weight (g)	Lead conc. (ug/g)		Concentration expressed as ug/g
1630	CLEVELAND	3.08	429.1	2	2,120
1640	CLEVELAND	0.92	772.5	2	2,270
1642	CLEVELAND	2.11	508.0	2	1,220
1728	CLEVELAND	0.99	539.4	2	1,490
1621	DELMAR	0.60	784.3	2	
1624	DELMAR	1.56	790.7	2	1,460
1628	DELMAR	0.97	245.8	2	1,620
1633	DELMAR	0.36	171.3	2	2,260
1635	DELMAR	0.72	499.0	1	
1636	DELMAR	1.00	496.4	2	1,320
1636	DELMAR	1.50	377.9	2	
1638	DELMAR	0.29	474.1	2	1,300
1640	DELMAR	0.40	1,690.1	2	
1641	DELMAR	6.03	719.9	2	1,840
1627	EDISON			2	2,070
1643	EDISON	0.89	322.8	2	1,630
1401	GRAND			1	256
1410	GRAND	9.68	166.8	2	2,730
1412	GRAND	0.80	1,430.3	1	1,020
1415	GRAND	0.46	303.8	1	1,640
1418	GRAND	0.20	1,555.4	1	3,450
1419	GRAND			2	5,910
1422	GRAND	1.63	21,847.2	1	1,980
1424	GRAND	0.80	413.8	1	1,520
1429	GRAND			1	
1431	GRAND	1.92	1,643.8	1	
1436	GRAND			1	1,400
1438	GRAND	0.55	1,479.6	1	
1443	GRAND	1.29	728.1	2	1,970
1411	MADISON			1	
1413	MADISON	0.46	6,300.9	1	2,810
1415	MADISON	0.30	1,168.8	1	1,620
1419	MADISON	1.45	2,376.7	1	3,200
1423	ADISON	2.01	974.7	2	2,040
1425	ADISON			1	
1429	ADISON	1.44	834.1	2	1,920
1406	STATE	2.72	337.7	1	
1408	STATE			2	1,430

Table B-2
1995 University of Cincinnati Data Set

Lead Concentrations and loadings for street dust samples collected in August, 1995

Street #	Street Name	Conc. (ug/g)	Loading (mg/m2)	Location Adjacent to Taracorp Site
1600	State	498	1163	Yes
1600	Edison	1389	3721	Yes
1600	Delmar	2003	5733	Yes
1600	Cleveland	1738	2113	
1700	State	247	319	
1700	Edison	523	1553	
1700	Delmar	277	686	
1700	Cleveland	838	1614	Yes
1400	State	423	1625	Yes
1500	State	1210	2565	Yes
1400	Grand	286	825	
1500	Grand	592	2414	
1400	Madison	444	162	
1500	Madison	366	205	

Appendix C
EPA's Default Soil-to-Dust Transfer Coefficient of 70% is not Valid

The default assumption employed by EPA in its analysis of the potential benefits of soil remediation at Granite City is that interior housedust lead concentrations are equal to 70% of the concentration of lead in soil. That is, EPA assumes that the "soil-to-dust transfer coefficient" is 70%. This value is inconsistent with site-specific evidence collected by EPA. EPA found that the transfer coefficient value ranges from 0.29 for dwellings within 1/4 mile from the smelter to 0.55 ("distances to 3/8 mile") (Marcus, undated, p 63). For the entire community, EPA reported the soil-to-dust transfer coefficient to be 0.385. These values are consistent with the values reported in the literature.

Findings published in the literature also suggest that a transfer coefficient value of 70% is too high. Investigators have identified a wide range of plausible values for this coefficient. A structural equation model presented by EPA in the Agency's 1991 draft guidance for the IEUBK model (U.S. EPA, 1991, Figure B5-2) indicates the transfer coefficient is approximately 50%. Fergusson *et al.* (1986) used nine tracer elements to measure the extent to which exterior soil infiltrates homes and comprises interior housedust. The average ratio reported by this investigator was 0.44, suggesting a transfer coefficient of 44%. Moreover, in Fergusson's study, the results from the various tracers used were highly consistent, with a standard deviation of only 0.06. Fergusson and Kim (1991) reviewed a large number of earlier studies and compiled data based on 28 tracer elements (this review covered approximately 30 studies, including Fergusson *et al.* (1986)). Using values in the literature to estimate the concentration of these tracer elements in soil, and limiting attention to those tracers that were unlikely to be contaminated by interior house sources, Fergusson and Kim (1991) calculated that the ratio of the concentration of elements in housedust to the corresponding ratio of elements in soil was 0.33, corresponding to a transfer coefficient of 33%. Cal[illegible]nd Stanek (1992) concluded that the transfer coefficient was approximately 31%. Other studies [illegible]erature have used structural equation modeling techniques. However, because these models are non-linear, it is not possible to infer a unique transfer coefficient from their results. In contrast, EPA's default transfer coefficient value is 70%.

Finally, the pre-abatement and post-abatement data from Granite City casts doubt on EPA's assumption that interior dust lead concentrations fall by 70 µg/g for every 100 µg/g that exterior soil lead

concentrations are decreased. Recall that the data in Table 5-4 in the main body of this report shows that interior dust lead concentrations both increase and decrease following abatement of exterior soil.

EX. E

APPENDIX B

SELECTION OF A LEAD SOIL CLEAN-UP LEVEL FOR THE NL/TARACORP SUPERFUND SITE

Prepared by U.S. EPA, Region V

Several sets of comments to the Proposed Plan at the NL/Taracorp site have questioned U.S. EPA's decision regarding the selection of the lead in soil clean-up standards to be used at the site. This document is intended to respond to these comments by setting forth U.S. EPA rationale supporting this decision.

Lead poisoning in young children is one of the most prevalent and preventable childhood public health problems in the U.S. today (USDHHS, 1985). The Environmental Protection Agency's concern with the health hazards of lead is longstanding - The Clean Air Act of 1970 authorized the EPA to set National Ambient Air Quality Standards (NAAQS) for the regulation of air emissions of pollutants considered harmful to public health or welfare; lead was one of the six pollutants to be regulated. In 1974 under the regulatory requirements of the Safe Drinking Water Act, EPA Office of Drinking Water issue[redacted] National Interim Primary Drinking Water Regulations; again lead was [redacted] the 26 contaminants addressed. Since 1975, EPA has increasingly restricted automobile emissions; all new cars since 1975 have been equipped with catalytic converters. Because lead destroys the effectiveness of these converters, the use of unleaded gasoline has increased dramatically, with corresponding decreases in lead emissions from exhaust. EPA has moved to accelerate this progress by phasing out lead in gasoline during the 1980s.

Further reductions in the National Ambient Air Quality Standard for lead and the Maximum Concentration Level for lead in drinking water are expected in 1990. [redacted] overall effect of these control programs has been a major reduction in the amount of lead being released to the environment.

Lead released into the environment in the past from stationary sources such as factories, power plants and smelters and from mobile sources such as automobiles, buses and other forms of transportation remains a persistent problem. Deposition and precipitation have resulted in the accumulation of high concentrations of lead in the soil in areas where significant releases to the air have occurred. Thus, lead-contaminated soils and housedust have emerged as important contributors to blood lead concentrations in the general population.

The present action has provided a mechanism for the clean-up of the lead in the soil at the NL/Taracorp Superfund site in Granite City. A risk assessment has been prepared by O'Brien & Gere as part of the Remedial Investigation for the NL/Taracorp Superfund site (Remedial Investigation Report 1988). This health risk assessment has correctly identified children as the most sensitive subpopulation, noting that they are at particular risk to lead poisoning due to their greater lead absorption efficiency than adults and to [redacted] greater probability of exposure to environmental lead in soil through [redacted] or play activities, mouthing habits and through intentional ingestion of soil (pica). It further identifies two pathways for lead exposure to the resident population stemming from the Superfund site as being complete: " 1) the airborne route, with lead-bearing soil particulates and dusts transported from friable soils on the Taracorp site to offsite locations

for subsequent inhalation, and 2) the direct contact route, with exposed soil previously contaminated with lead from particulate fallout from smelting emissions in previous years providing a source for ingestion of lead residue. Pathways have been identified as complete based on contaminant existence, magnitude, environmental fate, toxicological impacts of components released from the site and transport to receptors. The assessment also acknowledges that "lead in its various environmental forms is able to combine with a variety of physiologically significant proteins in the body, with resultant effects on structure and function".

Because children are developing, they absorb and retain more lead than adults. Thus, even at very low levels of lead exposure, children can experience reduced I.Q. levels, impaired learning and language skills, loss of hearing, and reduced attention spans and poor classroom performance. At higher levels, lead can damage their brains and central nervous systems, interferring with both learning and physical growth. Needleman (1988) has provided a review of 110 publications documenting the health effects of lead in children. He summarized that at low blood lead levels, neurocognitive effects of lead expressed as diminished psychometric intelligence, attention deficits, conduct problems, alterations in the electroencephalogram, school failure and increased referral rates for special needs predominant. He emphasizes that careful epidemiologic studies, which have controlled for the important confounders, have set the level for these effects at 10-15 micrograms per deciliter lead in blood. Exposure to lead in men can cause increases in blood pressure. These health effects and their associated blood lead levels have been summarized by EPA and the Agency for Toxic Substances and Disease Registry (ATSDR), and are summarized in Table 1. Particularly

notable are the risks of lead to women of child-bearing age. They include fertility problems and miscarriages. In pregnant women, lead can cause impai[illegible]evelopment of the fetus, premature births and reduced birth weights. The data in Table 2 shows that miscarriages and reproductive effects, such as premature birth and low birth weight, may occur at blood lead levels as low as 10 micrograms per deciliters and possibly lower. It is this growing preponderance of literature that has prompted the National Centers for Disease Control (CDC) to consider the lowering of the blood lead level from 25 to 15 micrograms per deciliter to protect for the health effects seen at lower levels. It is also this same growing accumulation of evidence that has led EPA to reject the suggestion put forth by the contractors for NL Industries in their risk assessment that the proposed 15 micrograms per deciliter blood lead level can be considered as a threshold level for the adverse health effects of lead in children. This lack of ability to identify a threshold level for lead coupled with the understanding that Reference Dose (RfD) methodologies are basically route-specific and do not incorporate site-specific information has led EPA to withdraw the RfD for lead. The EPA Environmental Criteria and Assessment Office (ECAO) has suggested instead the use of an uptake/biokinetic modeling approach to develop health critera for lead (U.S.EPA 1989b).

Many considerations have gone into the documentation of a lead soil clean[illegible]vel for the NL/Taracorp Superfund site. The first was the inabi[illegible]o find a suitable basis on which to perform a risk assessment based on dose-response relationships given the withdrawal of the RfD for lead. The second was the EPA Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites (OSWER Directive # 9355.4-02, 1989). This directive sets forth an interim soil clean-up guideline for total lead in soil at 500 to

1,000 ppm. However, it also allows that "site-specific conditions may warrant the use of soil clean-up levels below 500 ppm or somewhat above the 1000 ppm level". This latter guidance was used to evaluate the conditions at the NL/Taracorp Superfund site.

A number of factors have influenced the setting of a lead soil clean-up level for the NL/Taracorp site.

1) The soil at the NL/Taracorp (Granite City) site has been documented as containing elevated levels of lead (Remedial Investigation Report 1988).

2) Smelter operations are known to result in the emission of small aerosol particles which stay airborne and travel over an extensive area (Steele 1989). Because the lead deposits at the NL site originated from air emissions from smeltring operations, the resulting discharge was as fine particles having a wide area of distribution and deposition. (This area has not been fully delineated and further soil testing will be needed to determine the extent of the area contaminated by lead emissions from the NL Industries operations.)

3) The small particles deposited in the soil can cling to skin, clothing and children's toys and can be transferred into the indoor environment as windborne dust or carried in on the shoes or clothing of residents or the fur of household pets.

4) The small lead particles have high bioavailability, due to their easy diss[illegible]n in the stomach and the chemical form of the lead salts.

[illegible]n low exposures to lead have been shown to have significant health effects on developing children, especially those under the age of six years.

6) Children who show tendencies toward frequent mouthing activities can ingest large amounts of soil and indoor dust and hence, large amounts of lead

(Calabrese 1989, Binder 1986). Those who are nutritionally compromised and/or exhibit pica might be at risk for severe health effects.

The area of Granite City most affected by the smelter emissions is highly residential and contains a significant number of young children - the subpopulation known to be the most sensitive to the toxic effects of lead.

8) Granite City and the surrounding area is highly industrialized and residents are likely to be exposed to a complex mixture of toxic substances in the air and in the soil, which may act to increase the toxic effects of lead in a synergistic manner. The assessment of health risks from chemical mixtures is of growing concern to EPA (FR 50 1985).

These factors indicate that there is a high possibility of adverse health effects in young children living in the Granite City areas impacted by the NL/Taracorp Superfund site. Accordingly, a soil lead clean-up level of 500 ppm was deemed necessary if this subpopulation is to be fully protected.

This lead soil clean-up level is consistent with the approach being taken for similiar contaminated sites in other countries, other Regions in the U.S, and is advocated by researchers examining lead toxicity in pediatric populations. In a report to the Ontario Minister of the Environment by their Lead in Soil Committee, the committee responded to the request that they review the available literature on lead in soil and recommend "scientifically defen[illegible] soil removal guidelines for lead-contaminated soil (OLSC Report 1987). [illegible] committee recommended that a 1000 ppm guideline level is appropriate for areas to which children do not have routine access, while a guideline level between 500 and 1000 ppm is appropriate for areas to which children do have routine access. The comments of the Royal Society of Canada were also included in the report. They recommended that for clean-up around

lead-processing or lead-using plants, soil lead levels of up to 500 micrograms per deciliter are acceptable for residential areas and for garden and allotments, while levels of up to 1000 ppm should be acceptable for parklands and other areas to which children have only intermittent access. Similiar conclusions have been reached in the U.S. regarding the soil clean-up at lead smelter sites; lead soil clean-up levels in such impacted residential areas in Regions I, II and VIII have recently been set at 200 t 500 ppm. These are also the conclusions being echoed by researchers in the field. Milar and Mushak (1982) warned that a definite health hazard exists to children when household dust levels exceed either 1000 ppm or 50 micrograms per square meter. Mielke et al. (1989) summarized the work of a number of researchers addressing the question of the safe lead concentration in soil to protect children from undue exposure with the conclusion that a rapid rise in population blood lead levels takes place when the lead content of soil increases from less than 100 ppm to 500-600 ppm. Dr. Mielke has stated in a personal communication that he believes the safe lead soil level in areas contaminated with fine lead particles to be between 200 qnd 250 ppm. A study by Shellshear et al. (1975) in New Zealand concluded that children exposed to more than 100 ppm lead in soil and who also exhibit pica are at major risk to lead exposure.

The site-specific conditions presented earlier led Region V to consider the use of a modeling approach to further evaluate the lead soil clean-up level proposed for this site. This approach is consistent with the recent comments received from NL Industries that the incorporation of the Biokinetic Model and other generic and site-specific data into the development of clean-up levels for lead are appropriate (NL Industries comment to the

public response, Exhibit A. The letter from Dr. Krablin, Manager for Environmental Projects, ARCO, included in Exhibit A defends the EPA Integrated Uptake/Biokinetic Model as having been "demonstrated to be a reliable analytical method to determine the relationship between environmental lead concentrations and blood lead concentrations for EPA lead rulemaking". The EPA Office of Research and Development has examined several other modeling approaches, including a lead soil matrix model proposed by the Society for Environmental Geochemistry and Health (SEGH) Task Force on Lead in Soil, and has indicated that the favored approach is the Biokinetic Model. Two recent technical support documents have been issued which present the rationale for this modeling approach for developing health criteria for lead (USEPA 1989b, USEPA 1989c). The Biokinetic Model provides a means for incorporating either site-specific or internationally consistent default assumption values regarding exposure scenarios and absorption efficiencies for lead uptake from various media into the exposure analysis to yield estimates of the relative contributions of air, dietary and soil lead to the total estimated lead uptake.

When site-specific data collected in Granite City and soil lead/dust lead levels of 500 ppm and 1,000 ppm were input into the Lead Uptake/ Biokinetic Model, the graphs presented in Figures 1 and 2 were obtained. Figure 1 uses the 500 ppm soil lead/dust lead level, soil ingestion rates of 0.10 [illegible] per day as suggested by O'Brien & Gere rather than the default Calabrese data, air lead levels taken from the Remedial Investigation Report, and default values as listed from the Users Guide for Lead: A PC Software Application of the Uptake/Biokinetic Model. No pica was considered; lead in paint was considered not to be available for ingestion (painted surfaces in

good condition). An U.S. average water lead level was included to account for the contribution from lead in plumbing. The model predicted the mean blood lead [redacted] for children under the age of six to be 8.37 micrograms per deciliter, with approximately 8.5 percent of the children predicted to attain blood lead levels greater than 15 micrograms per deciliter. When a soil lead/dust lead level of 1,000 ppm was substituted into the model, approximately 34 percent of the children were predicted to have blood lead levels greater than 15 micrograms per deciliter. This would put 34% of the Granite City children above a level which may represent a risk of adverse health effects. It is notable that the model shows that for most ages, the soil/dust lead intake is greater than 29 micrograms per day while the lead intakes from air and water are nonsignificant. The model also shows that the 500 ppm soil clean-up level appears to be appropriate because further reductions in food lead levels are anticipated due to the removal of lead-containing soils, to education of residents on ways to reduce lead intake in children provided by the U.S. EPA and IEPA, and to the possible impact of reductions in allowable releases of lead to the air and in the water expected from changes to the National Ambient Air Quality Standard and the National Primary Drinking Water Regulations later this year.

In conclusion, EPA Region V has set a 500 ppm lead soil clean-up level [redacted] NL/Taracorp Superfund site. It is the best professional judge[redacted] the staff that this level represents the minimum soil clean-up level which can be expected to protect the most sensitive Granite City residents, children under the age of six years.

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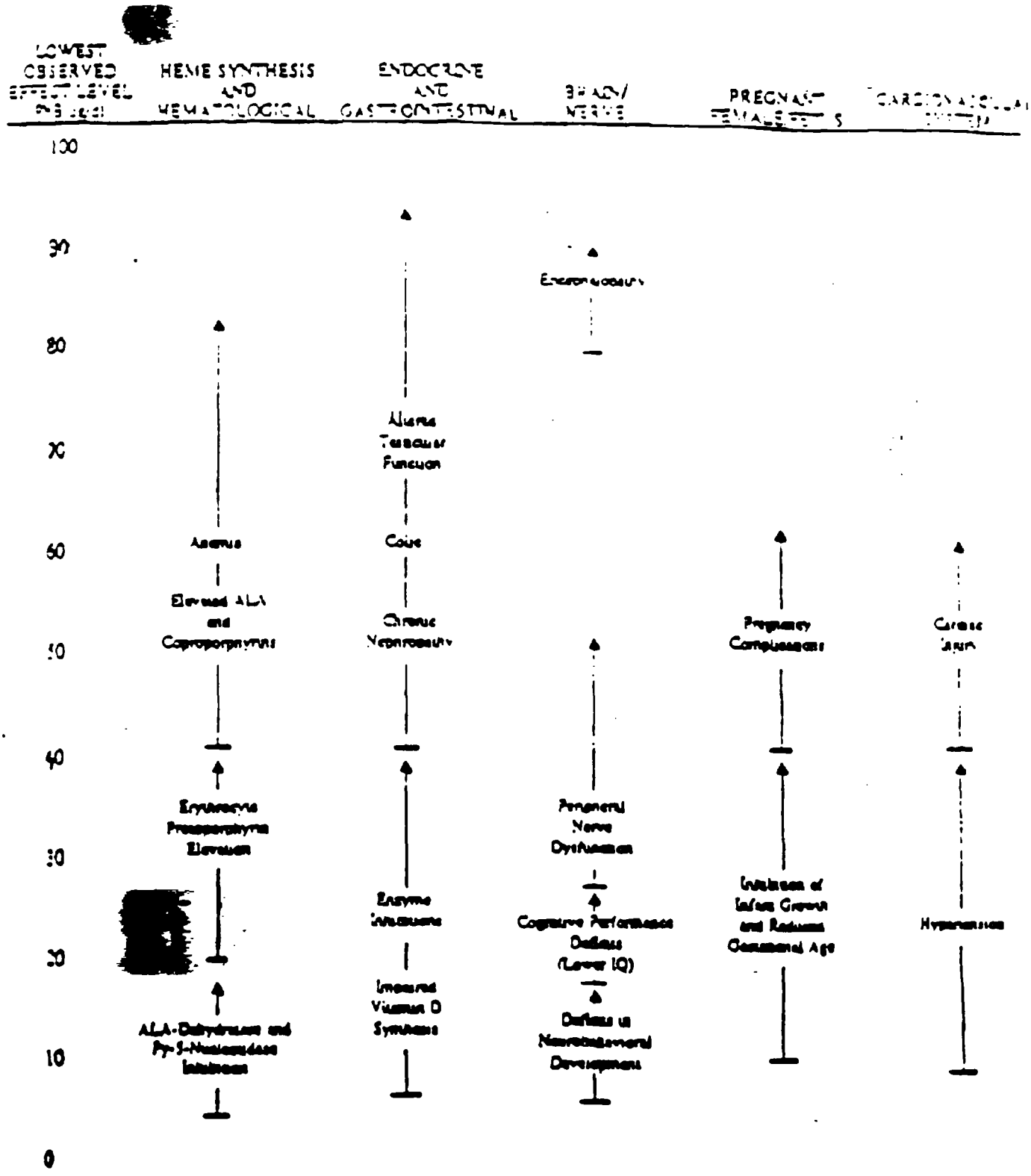
TABLE 1

Summary of Lowest Observed Effect Levels For Lead-induced Health Effects in Children and Adults



Adapted from U.S. EPA (1986a) with modifications according to ATSDR (1988a)

E004880

TABLE 2

SUMMARY OF RECENT STUDIES ON THE ASSOCIATION OF PRENATAL LEAD EXPOSURE WITH SELECTED FETAL OUTCOMES[1]

Reference	N	Pb [illegible] Source	Average ug/dl	Gestational Age	Birth Weight
Ernhart et al. (1985a, 1986)	185	maternal/del.	6.5	0	0
	162	cord	5.3	0	0
Bellinger et al. (1984)	215	cord	6.5	+	-[a]
Needleman et al. (1984)	4354	cord	6.5	0	0
Bornschein et al. (1989)	222	maternal/pre	7.0	0	-[a]
Dietrich et al. (1989)	185	maternal/pre	8.3	-*	-*
Wolf et al. (1987)	182	infant/post-natal	10.3		-*
McMichael et al. (1986)	749	maternal/del.	11.0	-*	+
		cord	10.0	-*	+
Moore et al. (1982)	236	maternal/del	14.0 g.m.	-*	0
		cord	12.0 g.m.	-*	0
Rothenberg et al. (1989)	51	maternal/pre	15.0		
		maternal/del	15.4	0	-*
		cord	13.8		
Graziano et al. (1989)	907	maternal (prospect.)	17.1 g.m.		0
	639	maternal (retrosp.)	15.9 g.m.	0[b]	
Ward et al. (1987)	100	placental Pb	2.35 pg/g	-	-*

Symbols: 0, no evident relationship; +, positive relationship; -, negative relationship; *, statistically significant at $p<0.05$; g.m., geometric mean.

[a] Birth weight showed no relationship, but the trend in percentage of small-for-gestational-age infants was nearly statistically significant at $p<0.05$.

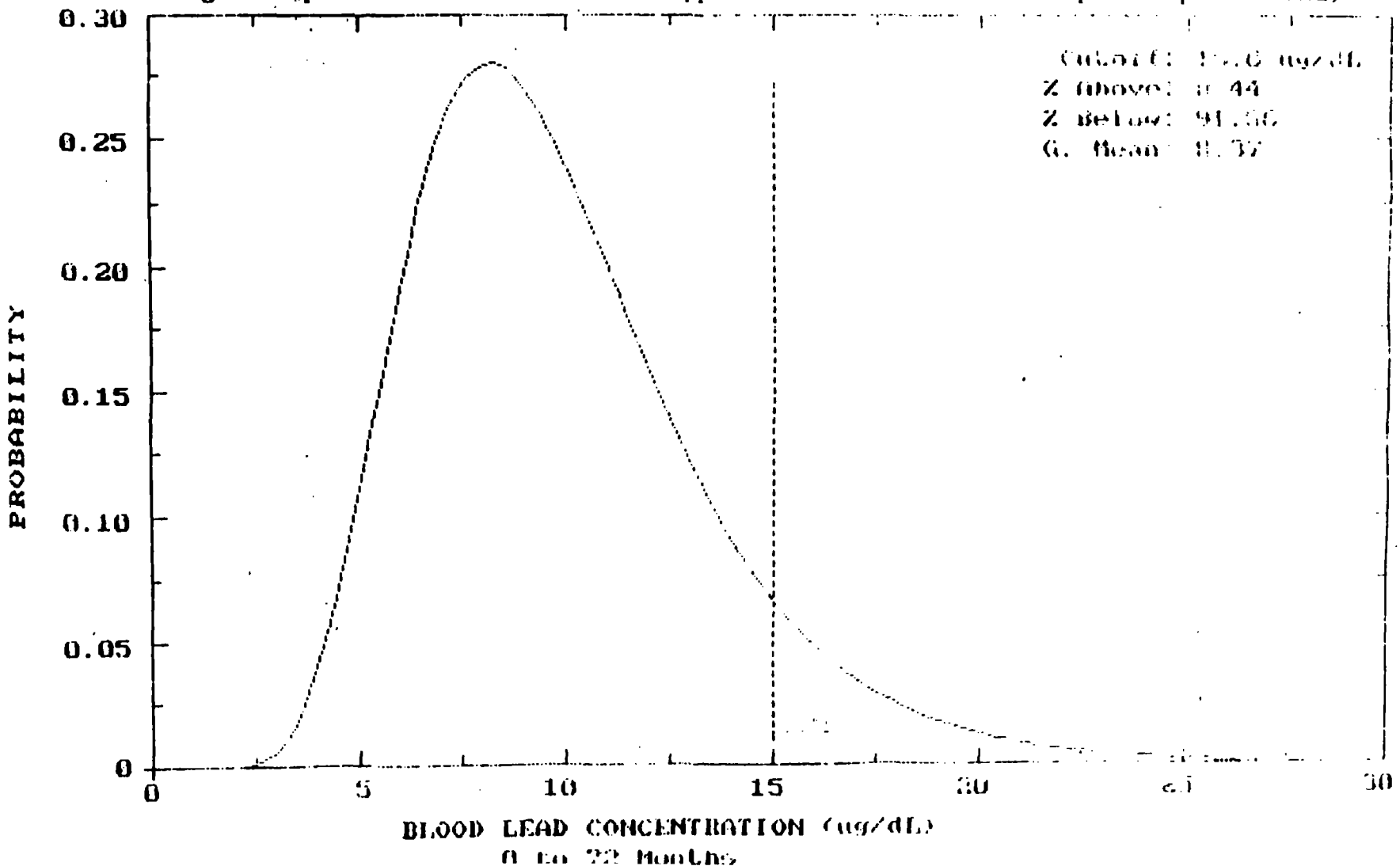
[b] Rate of spontaneous abortions.

[1] From: U.S. EPA 1989a.

E004881

Figure 1

Integrated Uptake/Biokinetic Model (500 ppm soil/dust Pb + NL/Taracorp site-specific data)



E004882

Air Concentration: 0.260 ug/m3

Diet: DEFAULT

Drinking Water: 8.88 ug/L DEFAULT

Soil & House Dust: Values entered by user.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	500.0	500.0
1-2	500.0	500.0
2-3	500.0	500.0
3-4	500.0	500.0
4-5	500.0	500.0
5-6	500.0	500.0
6-7	500.0	500.0

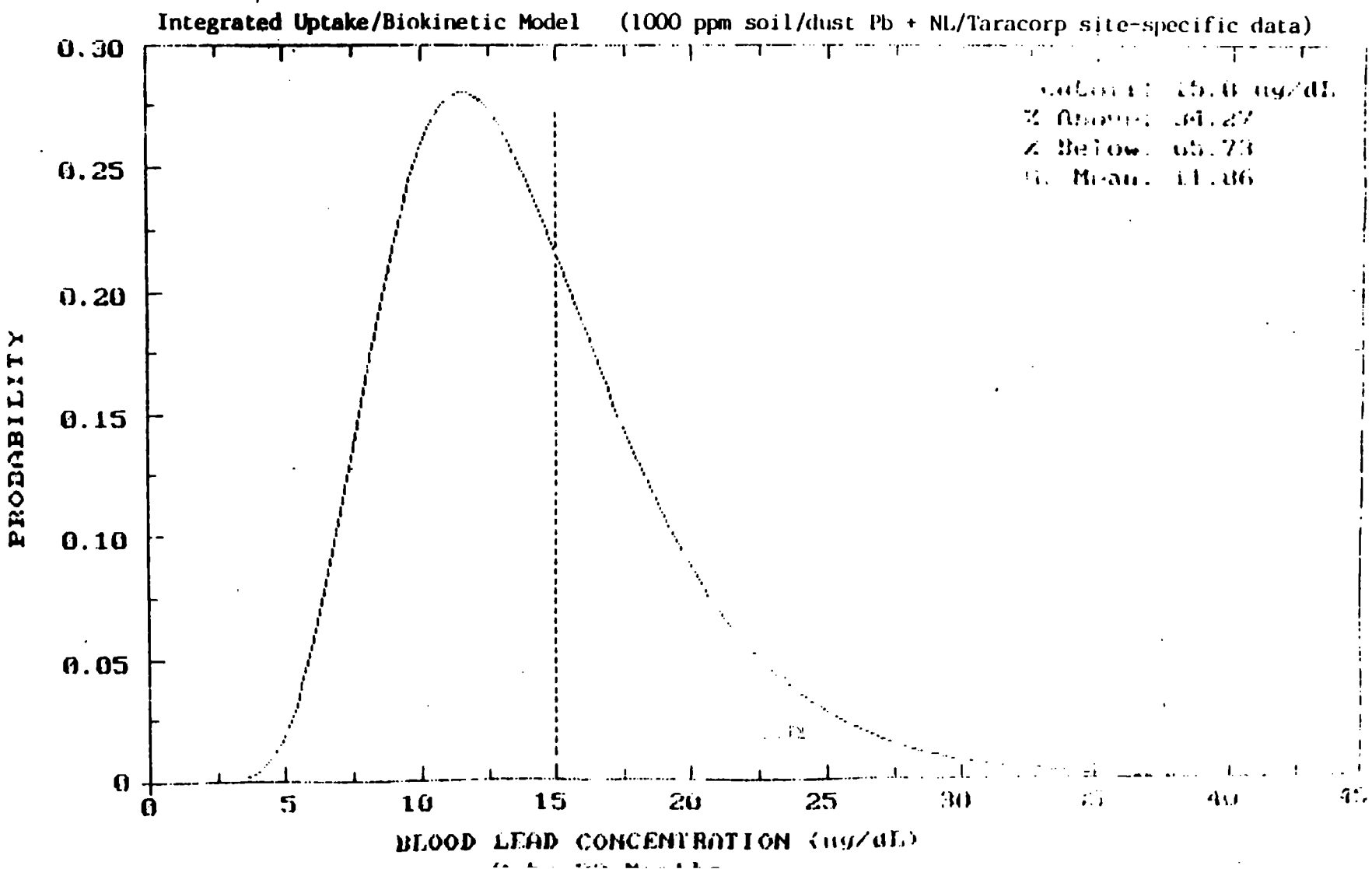
Additional Dust Sources: None DEFAULT

Paint Intake: 0.00 ug/day DEFAULT

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	5.13	15.73	3.75
1-2:	7.50	30.42	14.99
2-3:	8.78	32.04	14.99
3-4:	9.22	32.24	14.98
4-5:	9.66	32.54	14.97
5-6:	9.83	33.57	14.96
6-7:	10.01	35.08	14.95

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Upt. (ug/da
0.5-1:	10.93	0.89	0.00	0.16
1-2:	12.96	2.22	0.00	0.25
2-3:	14.33	2.31	0.00	0.41
3-4:	14.49	2.35	0.00	0.41
4-5:	[illegible].71	2.44	0.00	0.41
5-6:	[illegible].45	2.58	0.00	0.57
6-7:	[illegible].94	2.62	0.00	0.57

Figure 2



E004884

Air Concentration: 0.250 ug/m3

Diet: DEFAULT

Drinking Water: 8.88 ug/L DEFAULT

Soil & House Dust: Values entered by user.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	1000.0	1000.0
1-2	1000.0	1000.0
2-3	1000.0	1000.0
3-4	1000.0	1000.0
4-5	1000.0	1000.0
5-6	1000.0	1000.0
6-7	1000.0	1000.0

Additional Dust Sources: None DEFAULT

Paint Intake: 0.00 ug/day DEFAULT

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	6.21	19.48	7.50
1-2:	10.68	45.33	29.90
2-3:	12.88	46.88	29.83
3-4:	13.47	46.98	29.73
4-5:	14.07	47.16	29.60
5-6:	14.20	48.04	29.44
6-7:	14.27	49.38	29.24

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Upta (ug/day
0.5-1:	10.93	0.89	0.00	0.16
1-2:	12.96	2.22	0.00	0.25
2-3:	14.33	2.31	0.00	0.41
3-4:	14.49	2.35	0.00	0.41
4-5:	14.71	2.44	0.00	0.41
5-6:	15.45	2.58	0.00	0.57
6-7:	16.94	2.62	0.00	0.57

function.

9. VALUES of DEFAULT PARAMETERS

The values of the default parameters which can be changed by the user are as follows:

Air Data: Air Concentration: 0.20 µg Pb/m³
Lung Absorption: 31.5%
Vary Air Conc by Year: NO
Ventilation Rate
Age 0-1: 2.0 m³/day
1-2: 3.0 m³/day
2-3: 5.0 m³/day
3-4: 5.0 m³/day
4-5: 5.0 m³/day
5-6: 7.0 m³/day
6-7: 7.0 m³/day

Water Data: Water Concentration: 8.88 µg/L
Use Alternate Values: NO
Water Consumption
Age 0-1: 0.20 L/day
1-2: 0.50 L/day
2-3: 0.52 L/day
3-4: 0.53 L/day
4-5: 0.55 L/day
5-6: 0.58 L/day
6-7: 0.59 L/day

Diet Data: Use Alternate Values: NO
Diet Intake
Age 0-1: 21.86 µg Pb/day
1-2: 25.94 µg Pb/day
2-3: 28.71 µg Pb/day
3-4: 29.05 µg Pb/day
4-5: 29.53 µg Pb/day
5-6: 31.10 µg Pb/day
6-7: 34.26 µg Pb/day

Soil & Dust Data: Use Alternate Dust Values: NO
Calculated
Amount Ingested Daily
Age 0-1: 0.005 g/day
1-2: 0.050 g/day
2-3: 0.200 g/day
3-4: 0.200 g/day
4-5: 0.050 g/day
5-6: 0.050 g/day
6-7: 0.050 g/day

$\bar{x}_{0-7} = 0.086$ g/day } Use: 0.100 g age 9mo

Paint Data: Amount Ingested Daily: 0.0 µg Pb/day (all ages)

Graph Values: GSD: 1.42
Cutoff: 10 µg Pb/dL

E004886

ADDENDUM

The following additions and corrections should be made to Appendix B: Selection of a Lead Soil Clean-up Level for the NL/Taracorp Superfund Site.

1) Sixth page, last line. 500 micrograms per deciliter should read 500 ppm.

2) Eighth page, line 11. Reference 1989c should be 1989a.

3) Ninth page, line 9. Text should read: It is notable that at a lead in soil level of 500 ppm, the model shows that for most ages the soil/dust lead intake is approximately 15 micrograms per day. At a lead soil level of 1000 ppm, the soil/dust lead intake is greater than 29 micrograms per day, accounting for approximately 63 percent of the total daily intake. At both soil lead levels, the intakes from air and water are nonsignificant.

EX. P

176912

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

SEP 11 1990

REPLY TO ATTENTION OF: 5CS-TUB-3

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Mr. Dennis Reis
Sidley & Austin
One First National Plaza
Suite 5400
Chicago, IL 60603

Dear Mr. Reis:

On September 4, 1990, the U.S. EPA Office of Regional Counsel received an offer from the NL Industries/Taracorp Steering Committee to perform the remedial design and remedial action at the NL Industries/Taracorp Superfund Site (NL Site) in Granite City, Illinois. The offer is dated August 31, 1990. The purpose of this letter is to inform the PRP committee that the offer received by U.S. EPA does not constitute a "good faith" offer as that term is defined in the special notice letter U.S. EPA sent to members of the committee.

A good faith offer must not be significantly different from U.S. EPA's Record of Decision (ROD). The ROD specifies that the cleanup of the NL Site must include a soil-lead cleanup of no more than 500 parts per million (ppm) lead in soil. The primary reason the committee's offer does not form the basis for formal negotiations is the offer's failure to accept the 500 ppm cleanup standard.

The committee's offer contains an extensive discussion of the appropriate cleanup standards at the NL Site. The discussion indicates a number of misconceptions regarding the cleanup standard and how it was chosen. The remainder of this letter will briefly list some [illegible]hese differences.

1. The [illegible]ttee's proposal to reconsider the 500 ppm cleanup standard [illegible]es the primary site specific reasons U.S. EPA selected the cleanup standard. To reiterate our previous comments on this matter, the soil at the NL Site is documented as containing elevated levels of lead. The lead is the result of smelter emissions. Smelter operations in Granite City resulted in the emission of small, highly bioavailable lead particles. Low exposures to this form of lead have been shown to have significant health effects on children. The industrial nature of Granite City may make children especially sensitive to the toxic effects of these particles due to the synergistic interaction of lead with

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other toxic substances. The zone of contamination at the NL Site is a residential area, provides unrestricted access to the many children who visit and live in the contaminated area, and leaves the population vulnerable to a number of exposure paths. Appendix B of the ROD contains a more detailed discussion of these and other reasons for U.S. EPA's selection of the cleanup standard.

2. The Committee has misunderstood EPA's use of the Integrated Uptake/Biokinetic Model (the "biokinetic model") in the Record of Decision for the NL Site. Comments in the public response of NL Industries suggested that the EPA Integrated Uptake/Biokinetic Model has been "demonstrated to be a reliable analytical method to determine the relationship between environmental lead concentrations and blood lead concentrations for EPA lead rulemaking." EPA has stated that the Biokinetic Model has not yet been approved for use in setting cleanup levels at Superfund sites. EPA did not rely on use of the biokinetic model in its selection of cleanup standards at the NL Site. However, EPA did consider and discussed the biokinetic model in the NL ROD and determined that even a liberal interpretation of the model supported the selected cleanup standard. The choices of default parameters used in the model were those suggested by the commenters. U.S. EPA did not necessarily agree with the validity of those assumptions. An example is the use of the 15 ug/dl level for lead in blood in U.S. EPA's application of the model. This number was used at the commenters' request, but is actually 50% higher than acceptable. A more commonly accepted -- and better -- standard is 10 ug/dl of lead in the blood of children. It is noteworthy that the application of the commenters' suggested parameters in the model demonstrated that the selected cleanup level of 500 ppm lead in soil is at the <u>high</u> end of any acceptable range.

3. It is evident from the committee's comments on the Integrated Uptake/Biokinetic Model that the committee is aware of the extensive review U.S. EPA has made of this model. We appreciate the committee's critique of the model and suggest that general comments on the use of the model be addressed to Chris DeRosa at U.S. EPA's Office of Health and Environmental Assessment in Cincinnati. Region V has not been involved in the development of this model.

4. The basis of the committee's present criticism of the biokinetic model was not presented during the public comment period. Nevertheless, the information presented by the committee does not support the need to alter the response action. The environmental consultants hired by the committee appear to rely on a lead study conducted in Midvale, Utah, to support their criticism of U.S. EPA's use of the biokinetic model in Granite City. The Midvale study was not available at the time of the ROD. Nevertheless, the study contains flaws which prohibit its use by Region V. One example of the flaws in the Midvale study is the

data set. The contractors for the Midvale study chose to edit the data in such manner so as to discard data of children with the highest levels of lead in their blood. Such an approach is, at best, questionable.

For further response to the committee's suggestion that a blood-lead study should be utilized to determine the remedy at the NL Site, the committee should refer to section 2.2.2 "Biological Monitoring as a Measure of Exposure and Effects" in Toxicological Profile for LEAD, U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, ATSDR/TP-88/17, June, 1990. In examining the measurement of lead in blood as a method of exposure, ATSDR notes that

> "The half-life of lead in human blood is 28 to 36 days; thus, levels of lead in blood reflect relatively recent exposure compared with levels of lead in teeth [or bone], which continue to accumulate lead over time. Because lead cycles between the blood and bone, a single blood lead determination cannot distinguish between exposure to a given level for an extended period of time from a previous exposure to a high level that would result in the same blood level due to recycling from bone."

The ATSDR report further notes that the development of a technique using X-ray fluorescence to determine lead in bone may prove to be a valuable indicator of the body burden of lead. It is U.S. EPA's position, however, that the NL Site presents an imminent and substantial endangerment which requires prompt action.

5. Another inherent flaw in the committee's proposal is a fundamental misunderstanding of the biokinetic model, its use and its purposes. The model is designed to predict blood-lead levels which occur in individuals and utilizes a number of parameters, including soil-lead levels, in its predictions. The model, however, is not designed to do a reverse regression; it can not be used to determine appropriate levels of lead in soil based on blood-levels found in children at a particular time. This, however, is exactly what is proposed by your committee. In fact, the backward step-wise multiple regression programs that the committee has proposed to use do not exist in an acceptable form, if at all. U.S. EPA is engaged in a number of ongoing research programs which may generate the data required to develop the relationships between environmental lead sources and blood lead levels. Such data is incomplete at present, but suggests that these relationships may not be linear. For these reasons, the use of such a multiple regression program is not an EPA approved methodology.

In summary, the fundamental difference between the committee's offer and a good faith offer is the acceptance of the cleanup standards expressed in the ROD. The committee appears to propose that the ultimate cleanup of the site be dictated by the blood-lead levels of children in the area. U.S. EPA strongly believes that a blood study simply can not drive the remedy at a lead site. Blood lead levels merely provide a snap shot of an individual's exposure to lead. The levels are transient, will change from time to time, and are not a reliable means of determining an individual's actual exposure to lead.

U.S. EPA requests that all further contact in matters related to the NL Site be directed to Steven Siegel of our Office of Regional Counsel. Please contact Mr. Siegel if you or your committee believes there is a basis for any further discussions based upon a good faith offer.

Sincerely,

Norman R. Niedergang
Acting Associate Division Director
Office of Superfund

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

SEP 14 1990

REPLY TO ATTENTION OF: 5CS-TUB-3

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Ms. Janet Smith
NL Industries, Inc.
Office of General Counsel
445 Park Avenue
New York, New York 10022

Dear Ms. Smith:

On August 31, 1990, U.S. EPA received an offer from NL Industries, Inc. to commence negotiations for the remedial design and remedial action of the NL Industries/Taracorp Superfund Site in Granite City, Illinois (the "NL Site"). The purpose of this letter is to inform you that the offer presented by NL Industries is not a "good faith" offer as that term is defined in the special notice letter of June 25, 1990, which U.S. EPA sent to NL.

A good faith offer must not be significantly different from U.S. EPA's Record of Decision (ROD). The ROD specifies that the cleanup of the NL Site must include a soil-lead cleanup of no more than 500 parts per million (ppm) lead in soil. The primary reason NL's offer does not form the basis for formal negotiations is the offer's failure to accept the 500 ppm cleanup standard.

Please direct all future contacts between NL and the United States related to this matter to Steven Siegel of our Office of Regional Counsel. Please be advised, however, that additional meetings with NL for the purpose of achieving a negotiated settlement of this matter are not warranted so long as NL refuses to accept the cleanup standard expressed in the Record of Decision.

Sincerely,

Norman R. Niedergang
Acting Associate Division Director
Office of Superfund

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

SEP 14 1990

REPLY TO ATTENTION OF: 5CS-TUB-3

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Mr. Dennis Reis
Sidley & Austin
One First National Plaza
Suite 5400
Chicago, IL 60603

Dear Mr. Reis:

On September 4, 1990, the U.S. EPA Office of Regional Counsel received an offer from the NL Industries/Taracorp Steering Committee to perform the remedial design and remedial action at the NL Industries/Taracorp Superfund Site (NL Site) in Granite City, Illinois. The offer is dated August 31, 1990. The purpose of this letter is to inform the PRP committee that the offer received by U.S. EPA does not constitute a "good faith" offer as that term is defined in the special notice letter U.S. EPA sent to members of the committee.

A good faith offer must not be significantly different from U.S. EPA's Record of Decision (ROD). The ROD specifies that the cleanup of the NL Site must include a soil-lead cleanup of no more than 500 parts per million (ppm) lead in soil. The primary reason the committee's offer does not form the basis for formal negotiations is the offer's failure to accept the 500 ppm cleanup standard.

The committee's offer contains an extensive discussion of the appropriate cleanup standards at the NL Site. The discussion indicates a num[illegible] misconceptions regarding the cleanup standard and how it was [illegible]n. The remainder of this letter will briefly list some of th[illegible]ifferences.

1. The committee's proposal to reconsider the 500 ppm cleanup standard ignores the primary site specific reasons U.S. EPA selected the cleanup standard. To reiterate our previous comments on this matter, the soil at the NL Site is documented as containing elevated levels of lead. The lead is the result of smelter emissions. Smelter operations in Granite City resulted in the emission of small, highly bioavailable lead particles. Low exposures to this form of lead have been shown to have significant health effects on children. The industrial nature of Granite City may make children especially sensitive to the toxic effects of these particles due to the synergistic interaction of lead with

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other toxic substances. The zone of contamination at the NL Site is a residential area, provides unrestricted access to the many children who visit and live in the contaminated area, and leaves the population vulnerable to a number of exposure paths. Appendix B of the ROD contains a more detailed discussion of these and other reasons for U.S. EPA's selection of the cleanup standard.

2. The Committee has misunderstood EPA's use of the Integrated Uptake/Biokinetic Model (the "biokinetic model") in the Record of Decision for the NL Site. Comments in the public response of NL Industries suggested that the EPA Integrated Uptake/Biokinetic Model has been "demonstrated to be a reliable analytical method to determine the relationship between environmental lead concentrations and blood lead concentrations for EPA lead rulemaking." EPA has stated that the Biokinetic Model has not yet been approved for use in setting cleanup levels at Superfund sites. EPA did not rely on use of the biokinetic model in its selection of cleanup standards at the NL Site. However, EPA did consider and discussed the biokinetic model in the NL ROD and determined that even a liberal interpretation of the model supported the selected cleanup standard. The choices of default parameters used in the model were those suggested by the commenters. U.S. EPA did not necessarily agree with the validity of those assumptions. An example is the use of the 15 ug/dl level for lead in blood in U.S. EPA's application of the model. This number was used at the commenters' request, but is actually 50% higher than acceptable. A more commonly accepted -- and better -- standard is 10 ug/dl of lead in the blood of children. It is noteworthy that the application of the commenters' suggested parameters in the model demonstrated that the selected cleanup level of 500 ppm lead in soil is at the <u>high</u> end of any acceptable range.

3. It is evident from the committee's comments on the Integrated Uptake/Biokinetic Model that the committee is aware of the extensive review U.S. EPA has made of this model. We appreciate the committee's critique of the model and suggest that general comments on the use of the model be addressed to Chris DeRosa at U.S. EPA's Office of Health and Environmental Assessment in Cincinnati. Region V has not been involved in the development of this model.

4. The basis of the committee's present criticism of the biokinetic model was not presented during the public comment period. Nevertheless, the information presented by the committee does not support the need to alter the response action. The environmental consultants hired by the committee appear to rely on a lead study conducted in Midvale, Utah, to support their criticism of U.S. EPA's use of the biokinetic model in Granite City. The Midvale study was not available at the time of the ROD. Nevertheless, the study contains flaws which prohibit its use by Region V. One example of the flaws in the Midvale study is the

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data set. The contractors for the Midvale study chose to edit the data in such a manner so as to discard data of children with the highest levels of lead in their blood. Such an approach is, at best, questionable.

For further response to the committee's suggestion that a blood-lead study should be utilized to determine the remedy at the NL Site, the committee should refer to section 2.2.2 "Biological Monitoring as a Measure of Exposure and Effects" in Toxicological Profile for LEAD, U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, ATSDR/TP-88/17, June, 1990. In examining the measurement of lead in blood as a method of exposure, ATSDR notes that

> "The half-life of lead in human blood is 28 to 36 days; thus, levels of lead in blood reflect relatively recent exposure compared with levels of lead in teeth (or bone), which continue to accumulate lead over time. Because lead cycles between the blood and bone, a single blood lead determination cannot distinguish between exposure to a given level for an extended period of time from a previous exposure to a high level that would result in the same blood level due to recycling from bone."

The ATSDR report further notes that the development of a technique using X-ray fluorescence to determine lead in bone may prove to be a valuable indicator of the body burden of lead. It is U.S. EPA's position, however, that the NL Site presents an imminent and substantial endangerment which requires prompt action.

5. Another inherent flaw in the committee's proposal is a fundamental misunderstanding of the biokinetic model, its use and its purposes. The model is designed to predict blood-lead levels which occur in individuals and utilizes a number of parameters, including soil lead levels, in its predictions. The model, however, is not designed to do a reverse regression; it can not be used to determine appropriate levels of lead in soil based on blood-levels found in children at a particular time. This, however, is exactly what is proposed by your committee. In fact, the backward step-wise multiple regression programs that the committee has proposed to use do not exist in an acceptable form, if at all. U.S. EPA is engaged in a number of ongoing research programs which may generate the data required to develop the relationships between environmental lead sources and blood lead levels. Such data is incomplete at present, but suggests that these relationships may not be linear. For these reasons, the use of such a multiple regression program is not an EPA approved methodology.

In summary, [redacted] fundamental difference between the committee's offer and a good faith offer is the acceptance of the cleanup standards expressed in the ROD. The committee appears to propose that the ultimate cleanup of the site be dictated by the blood-lead levels of children in the area. U.S. EPA strongly believes that a blood study simply can not drive the remedy at a lead site. Blood lead levels merely provide a snap shot of an individual's exposure to lead. The levels are transient, will change from time to time, and are not a reliable means of determining an individual's actual exposure to lead.

U.S. EPA requests that all further contact in matters related to the NL Site be directed to Steven Siegel of our Office of Regional Counsel. Please contact Mr. Siegel if you or your committee believes there is a basis for any further discussions based upon a good faith offer.

Sincerely,

Norman R. Niedergang
Acting Associate Division Director
Office of Superfund

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

SEP 2 5 1990

REPLY TO ATTENTION OF: 5CS-TUB-3

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Mr. George M. von Stamwitz, Esq.
Armstrong, Teasdale, Schlafly, Davis & Dicus
One Metropolitan Square, Suite 2600
St. Louis, Missouri 63102-2740

Dear Mr. von Stamwitz:

U.S. EPA is in receipt of an offer dated August 31, 1990, from St. Louis Lead Recyclers ("SLLR") to commence negotiations for the remedial design and remedial action of the NL Industries/Taracorp Superfund Site in Granite City, Illinois (the "NL Site"). The purpose of this letter is to inform you that the offer presented by SLLR is not a "good faith" offer as that term is defined in the special notice letter of June 25, 1990, which U.S. EPA sent to SLLR.

A good faith offer must not be significantly different from U.S. EPA's Record of Decision (ROD). The ROD provides for the entire cleanup of the NL Site. SLLR's offer addresses only a small portion of the selected remedy for the NL site and appears to base its offer on the assertion that SLLR's involvement at the NL Site is clearly divisible from other potentially responsible parties. U.S. EPA [redacted]rees with this assertion. We also note that SLLR's offer app[redacted]to be an attempt to reduce SLLR's existing statutory obligatio[redacted]

Please direct all future contacts between SLLR and the United States related to this matter to Steven Siegel at our Office of Regional Counsel.

Sincerely,

Norman R. Niedergang
Acting Associate Division Director
Office of Superfund

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

DEC 24 1990

REPLY TO ATTENTION OF: 5CS-TUB-3

Mr. Daniel J. Bicknell
Environmental Activities Staff
General Motors Corporation
General Motors Technical Center
30400 Mound Road
Warren, Michigan 48090-9015

Dear Mr. Bicknell:

This letter is in response to our December 7, 1990 meeting and your December 13, 1990 correspondence proposing that generators at the NL Industries/Taracorp Site perform 35% of the cleanup of the Site. As you are aware, U.S. EPA issued special notices to the generators represented by your committee on June 25, 1990, pursuant to Section 122 of CERCLA. The negotiation period closed after 60 days when no good faith offer was received to undertake the remedy. As an initial matter, then, your proposal, was made only after U.S. EPA issued a unilateral administrative order pursuant to section 106 of CERCLA. Such late proposals are not favored, and U.S. EPA is under no obligation to consider a proposal in these circumstances.

Having said this, I believe that some elements of your proposal are worthy of serious consideration by U.S. EPA. I would be able to recommend pursuing settlement discussions for a limited time provided that I receive agreement from your committee on certain key points as follows:

1. Th[illegible]erators who sign the proposed settlement will be responsible [illegible]mplementing 35% of the remedy. This share will not be reneg[illegible]ed based any role NL Industries may have played as a generator. In addition, the generators will agree to perform remedial design.

2. The December 13, 1990 letter is silent on the subject of reopener clauses. Any settlement acceptable to EPA must include standard reopeners in the event that there is remedy failure and, additionally, if the U.S. Government determines that recovery of 65% of the remedy costs from the owner/operator (NL Industries) is not feasible. This later point will require further discussions, obviously.

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3. Past costs will be paid by the generators as part of the settlement (past costs are estimated not to exceed $300,000).

4. A negotiated settlement must be consistant with the remedy selected in the Record of Decision. A remedy based on tilling is a dilution remedy which is inconsistant with the record of decision and is not an appropriate subject for negotiations at this time.

Your letter of December 13 raises several additional points which are addressed as follows:

1. The Committee requests that the settlement contain provisions making it clear that the generators have assented to the percentages for settlement purposes only. I do not object to such provisions.

2. The generators wish to retain the right to sue NL for contribution. A negotiated consent decree will not preclude the generators from any rights to sue NL they otherwise may have. EPA, of course, would not be foreclosed from reaching a negotiated agreement with NL.

3. Your letter states that EPA has indicated it is willing to exclude specific units of work from the generators' assigned share. While this is accurate, your letter indicates that home interior inspections was mentioned as an area which may be excluded. EPA has not indicated that home interior inspections is an appropriate category to exclude from the generators share of work.

Several other issues were not mentioned in the December 13 correspondence will also warrant further discussion. Mark Hester indicated in a telephone conversation a willingness to allow the Remedial Design to be included in the generators' share of work in addition to the 35% share of the remedial action, if U.S. EPA agreed not to include a cost for the Other Contingency Measures when calculating the generators 35%. Questions for further discussion include 1) what adjustments will be made on the 35% share after the RD cost estimates are approved and 2) the method and sharing of contributions by generators who did not receive the Order.

I wish to emphasize that this letter should not be regarded as an "offer" by U.S. EPA. Any settlement will require review by Regional management and Headquarters. As mentioned above, I will recommend further discussions on these points if I receive the Committee's conceptual agreement on each of the issues outlined above by January 4, 1990. Please call me at (312) 353-1129 to discuss any of these issues at your earliest convenience.

Sincerely,

Steven Siegel
Assistant Regional Counsel

cc: Brad Bradly
Allen Held
Mark Hester
Stuart Williams

EX. H

59TH OPINION of Level 1 printed in FULL format.

UNITED STATES OF AMERICA, Plaintiff, v. OLIN CORPORATION, Defendant.

CIVIL ACTION NO. 95-0526-BH-S

U[redacted] STATES DISTRICT COURT FOR THE SOUTHERN DISTRICT OF ALABAMA, SOUTHERN DIVISION

1996 U.S. Dist. LEXIS 6996

May 20, 1996, Decided
May 20, 1996, FILED

DISPOSITION: [*1] Motion DENIED. Action DISMISSED with prejudice.

COUNSEL: For USA, acting at request of the Administrator of the United States Environmental Protection Agency (EPA), plaintiff: Eugene A. Seidel, Esq., U. S. Attorney's Office, Mobile, AL. Kathy Urbach, Assistant Regional Counsel, Environmental Protection Agency, Atlanta, GA. Robert A. Kaplan, Environmental Enforcement Section, U. S. Dept. of Justice, Washington, DC. Cheryl L. Smout, U. S. Dept. of Justice, Environmental Enforcement Section, Washington, DC. Robert R. Homiak, U. S. Dept. of Justice, Environmental Enforcement Section, Environment & Natural Resources Div., Washington, DC.

For OLIN CORPORATION, defendant: T. Bruce McGowin, Esq., Mobile, AL. Caine O'Rear, III, Esq., Mobile, AL. Arthur A. Rheingold, Chief Counsel, Olin Corporation, Stamford, CT. Michael W. Steinberg, Morgan, Lewis & Bockius LLP, Washington, DC. Alex S. Karlin, Morgan, Lewis & Bockius LLP, Washington, DC.

JUDGES: W B Hand, SENIOR DISTRICT JUDGE. Mag. Judge William H. Steele

OPINIONBY: W B Hand

OPINION: ORDER

The United States filed this action under the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA"), 42 U.S.C. §§ 9601, et seq., [*2] against defendant Olin Corporation ("Olin"), a Virginia corporation which owns and operates a chemical plant in McIntosh, Alabama, in southwest Wa[redacted]ton County, approximately 25 miles east of the Mississippi state line [redacted] miles north of the Gulf of Mexico. With the complaint, the parties fil[redacted]roposed consent degree. This court requested the parties to brief certa[redacted]tutory and constitutional issues relating to CERCLA. For the reasons stated below, this court has determined that rather than signing the consent decree, it must dismiss the action both because 1) Congress did not clearly express its intent that the liability provision of CERCLA be retroactive, as required by Landgraf v. USI Film Products, U.S. , 114 S. Ct. 1483, 128 L. Ed. 2d 229 (1994) and 2) the application of CERCLA, at least on the facts of this case, violates the Commerce Clause as interpreted in United States v. Lopez, 514 U.S. , 115 S. Ct. 1624, 131 L. Ed. 2d 626 (1995).

I. THE COMPLAINT AND PROPOSED CONSENT DECREE

LEXIS·NEXIS A member of the Reed Elsevier plc group LEXIS·NEXIS A member of the Reed Elsevier plc group LEXIS·NEXIS A member of the Reed Elsevier plc group

A. The Olin Property in the Complaint

In its co[redacted]nt, the Justice Department alleges that the Olin plant site in McIntosh, co[redacted]ing [*3] 1,500 acres, contains two actionable sites. This action conce[redacted]nly the first of two sites at the Olin property. "Site 1" n1 includes 20 acres on the southern edge of the property, on which an active chemical-production facility operates. This site contains a number of "solid waste-management units," both active and inactive, many of which have been closed and treated for the removal of hazardous substances. n2 To the north and northwest of the active chemical production facility are undeveloped tracts of land. To the west of the facility is a brine-well field. Four thousand feet east of the main plant area is a steep bluff which defines the edge of Site 2, n3 the natural basin. n4

- - - - - - - - - - - - - - - - - - -Footnotes- - - - - - - - - - - - - - - - - - -

n1 The government labels Sites 1 and 2 as the "first operable unit" ("OUI") and the "second operable unit" ("OU2"), respectively. Site 1 includes all of the land except for the approximately sixty two acres designated as Site 2. See n.3.

n2 Remedial-Investigation Report at 1-5.

n3 Site 2 consists of approximately 62 acres which form a natural basin lying east of the plant, surrounded by wetlands, and adjacent to the Tombigbee River. The government alleges that Olin (at the time known as Olin Mathieson) directed surface runoff containing hazardous substances into Site 2, which discharges into the Tombigbee River (the Tombigbee joins with the Alabama River to form the Mobile River, which flows into Mobile Bay and then the Gulf of Mexico). However, the costs which the federal Environmental Protection Agency ("EPA") claims it has incurred and will incur for cleanup in Site 2, and any injunctions it may seek regarding this effort at Site 2, are not part of this action. The government plans to file a separate action regarding Site 2. See Complaint at p. 3, P 8. [*4]

n4 EPA Record of Decision at 5.

- - - - - - - - - - - - - - - - - - -End Footnotes- - - - - - - - - - - - - - - - - - -

The government alleges that in 1952 Olin Mathieson began operating a mercury-cell chloralkali plant on Site 1 which generated and released wastewater containing [redacted] into Site 2 until 1974. This plant ceased operating in 1982. n5 In 1955, [redacted]e 1, Olin Mathieson built a "crop-protection-chemicals" plant which disch[redacted]wastewater into Site 2 until 1974. This plant also ceased operating in [redacted]. n6 As a result of the operation of these two plants (1950's - late 1982), mercury and chloroform, which are alleged to be hazardous substances under 42 U.S.C. § 9601(14), were released into Site 1.

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n5 EPA Record of Decision at 8.

n6 Id. at 10.

- - - - - - - - - - - - - - - - - - -End Footnotes- - - - - - - - - - - - - - - - - - -

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Most of the alleged contamination resulting from the operation of these two plants occurred prior to the effective date of CERCLA, December 11, 1980. n7 However, to [redacted]xtent that both of these plants also operated after CERCLA's enactment, [redacted] i.e., from December 11, 1980, until late 1982, and to the extent that [redacted]eat of continuing releases at and from Site 1 continues, as the government a[redacted]es, n8 the government also seeks to recover CERCLA cleanup costs from Olin for post-enactment conduct.

- - - - - - - - - - - - - - - - - - - -Footnotes- - - - - - - - - - - - - - - - - - - -

n7 42 U.S.C. § 9601(22).

n8 Complaint, P 18.

- - - - - - - - - - - - - - - - - - - -End Footnotes- - - - - - - - - - - - - - - - - - - -

In 1978, the company (whose name changed that year to Olin Corporation) built a diaphragm-cell caustic-soda/chlorine plant which it currently operates. There is no allegation in the complaint that the operation of this plant has any connection with the contaminants found on Site 1.

The Environmental Protection Agency ("EPA") listed the Olin plant site on the "national priorities list" in September 1984. Cf. 42 U.S.C. § 9605; 40 C.F.R. Part 300.

The complaint indicates that Olin conducted a "remedial investigation" of Site 1, completed in July 1993, and then a "feasibility study" of proposed responses to contamination at Site 1, completed in February 1994. In December 1994, the EPA executed its [*6] "record of decision" based on the remedial investigation and the feasibility study. The record of decision provides a remedy for the contamination of the alluvial aquifer which the agency contends is consistent with CERCLA and the national contingency plan.

For present purposes, the court accepts the allegations of the complaint as true and notes, in fairness, that Olin's answer admits many, while denying some, of them. For example, the defendant admits that there have been releases in the past, but denies that there is any threat of future release of hazardous substances. The defendant also denies any imminent and substantial danger to the public health or welfare, or the environment, because of actual or threatened releases from Site 1.

B. The P[redacted]d Consent Decree and Remedial-Investigation Report

With the [redacted]int, the Justice department filed a proposed consent decree, n9 which both parties had signed. The government published notice thereof in the Federal Register to afford the public opportunity for comment. 603 Fed. Reg. 36309, 36309-10 (1995). When the government received no comment within 30 days, the parties jointly moved for the court to enter the consent decree. [*7] See 42 U.S.C. § 9622(d)(2).

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n9 Attached to the consent decree are two appendices. Appendix A is the record of decision. Appendix B is a statement of work for Olin for Site 1.

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The consent decree runs to 71 pages. It makes the defendant, its officers, directors, and anyone else associated with the defendant, liable for everything even remotely associated with the clean-up of Site 1, including insuring the automobiles the government uses in fulfilling and supervising the consent decree.

Although the EPA estimates the present value of the cost of compliance to Olin at $ 10,339,000, n10 the EPA has an almost unconstrained right to amend the consent decree. Of course, the defendant may appeal, but the defendant must direct the appeal to the EPA. The propriety of such procedures is beyond the scope of this inquiry, yet defense counsel has acknowledged that the consent decree gives the EPA carte blanche over the company treasury.

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n10 EPA Record of Decision at 39.

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[*8]

Olin has committed itself to performing the actions which the consent decree specifically requires, regardless of whether the court approves of the decree; n11 however, it has sought to do so under the supervision of the Alabama Department of Environmental Management ("ADEM") rather than under the EPA. n12 The ADEM has sought the same. Twice in May 1994, the ADEM's director wrote to the EPA to request that the EPA allow the ADEM to implement the record of decision for Site 1 under the Resource Conservation and Recovery Act, 42 U.S.C. §§ 6901 et seq., and the Alabama Hazardous Waste Management and Minimization Act, Ala. Code §§ 22-30-1 et sec., rather than CERCLA. In December 1994, the EPA's regional administrator in Atlanta, Georgia, wrote the ADEM director to convey the EPA's belief that it would be "premature at this time to defer" to the ADEM. The regional administrator stated that accepting the state's proposal would require modifying a permit under the Resource Conservation and Recovery Act, which would "add this additional layer of involvement and federal resources to the already complex situation." He further asserted that "continued implementation under CERCLA insures [*9] consistency and decreases the potential for conflict." n13 Be that as it may, consistency and the decreased potential for conflict are not necessarily synonymous with constitutionality.

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n11 Def.'s Mem. of Law at 2.

n12 Tr. of Hr'g at 20.

n13 Def.'s Mem. of Law at App. A.

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Four days after rejecting the ADEM's request, the EPA issued its record of decision, the major portions of which require Olin to (1) pump and treat additional ground water, (2) upgrade and extend the existing caps over closed portions of Site 1, (3) increase monitoring of ground water, and (4) establish

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certain institutional controls. n14

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n14 EPA R[illegible] of Decision at Unnumbered Page 2.

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When the court inquired at oral argument why the defendant negotiated a settlement and entered into this "consent" decree, counsel for the defendant responded that it was [*10] "a pragmatic business judgment." It believed that "the fastest and most expedient way to get the work performed would be to simply go along with what the EPA sought here." n15 Olin wanted to complete the work and went along despite reservations about its legality n16 and despite the government's rigid dictation of the terms and conditions it would accept. n17

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n15 Tr. of Hr'g at 20.

n16 Id.

n17 This is not an action in which anyone is trying to avoid a responsibility to the environment; Olin has agreed to perform the proposed remedial actions called for in the consent decree. The fact that Olin, despite its reservations about the fairness and even legality of the proposed consent decree, originally went along with the EPA is a vivid testament to the powerlessness felt by this citizen when forced to comply with various directives ordered by our administrative state.

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In addition to the consent decree, the government filed n18 a remedial-investigation report, prepared by Woodward-Clyde Consultants [*11] of Baton Rouge, Louisiana, in July 1993. The report documents remedial-investigation activities under an amended work plan and was completed under EPA supervision and ultimately with EPA approval. The objectives of the remedial investigation were (1) to investigate the nature, lateral extent, and vertical extent of contamination in order to ascertain the types, concentrations, and distributions of waste in all potentially affected media, such as the [illegible]roundwater, soil, surface water, and sediment; (2) to determine th[illegible]ntial of the wastes to migrate beyond Site 1 and Site 2; and (3) to asses[illegible] current and potential risk to public health, welfare, and the environment. [illegible]hortly after the government filed the remedial-investigation report, the parties jointly informed the court that they neither needed nor desired further discovery in this action. n20

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n18 Tab 15.

n19 Remedial-Investigation Report at 1-3.

n20 See tab 16, p.2.

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According [illegible] the remedial-investigation report, any contaminants [*12] still at Site [illegible] affect groundwater there mostly by migrating through the alluvial aqu[illegible] This aquifer lies atop a miocene aquifer. n21 The remedial-investigation report indicates that there is little or no migration between the aquifers. The potential does exist for minimal migration along the casing of an enormous well on Site 1; e.g., if the well were to develop a leak in the casing and/or a rupture in the annular seal. If so, the potential concentration of contaminants not only would be localized around the well, but also negligible because the amount of water removed by this well is so great.

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n21 "Constituents are not expected to be present in the Miocene Aquifer beyond the lateral extent of hydrolic control of these active water supply wells. No migration towards the boundaries of OU-1 is anticipated as long as pumping of these wells continues at the current rates." Remedial-Investigation Report at 5-57.

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Wells established around the site to contain any outward flow of contaminants monitor the alluvial [*13] aquifer. Nothing shows that the alluvial aquifer carries water across any state lines or into any river or other transportation source that would take it across any state lines, nor is there any indication of transport of contaminants through the air across state lines. n22

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n22 At hearing, the government could only point to contaminants at Site 2 which potentially traveled across state lines. See Tr. of Hr'g. at 9-10, 16-17.

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Indeed, the record reflects that any contamination at Site 1 is of such minimal proportions as not to constitute any hazard to the public. As stated in the EPA Record of Decision:

The risk assessment indicates that only risks associated with potential future on-site resi[illegible] exposures to contaminated groundwater and surface soils would not be with[illegible]s acceptable risk range. The chemicals of concern would pose unacceptabl[illegible] if the on-site groundwater were used as a source of potable water or if [illegible]en living on the site were exposed to contaminated surface [*14] soils. Future use of this site as a residential area is considered unlikely and thus the proposed remedial goals are directed at protecting the groundwater for its maximum beneficial use. n23

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n23 EPA Record of Decision at 23 (emphasis added).

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C. REVIEW OF THE CONSENT DECREE

Notwithsta[redacted] the initial willingness of the defendant to enter into a "consent" de[redacted] this court has a duty to examine a consent decree not only to determine wh[redacted] its factual and legal determinations are reasonable, but also to ensure that the decree does not violate the Constitution, a federal statute, or the controlling jurisprudence. E.g., Howard v. McLucas, 871 F.2d 1000, 1008 (11th Cir.) (citing United States v. City of Miami, 664 F.2d 435, 441 (5th Cir. 1981) (Rubin, J., concurring); Cotton v. Hinton, 559 F.2d 1326, 1330-31 (5th Cir. 1977)), cert. denied, 493 U.S. 1002, 110 S. Ct. 560, 107 L. Ed. 2d 555 (1989). The court, therefore, has made two requests for briefs, the first of which directed [*15] the parties to brief whether CERCLA, as applied in this case, is consistent with the Supreme Court's view of the Commerce Clause as recently explained in United States v. Lopez, 514 U.S. , 115 S. Ct. 1624, 131 L. Ed. 2d 626 (1995). While both parties have responded to this issue, the defendant has also raised the issue of CERCLA's retroactivity. The defendant contends that Congress did not intend for CERCLA to be retroactive and that if it did, CERCLA violates the Due Process Clause and unconstitutionally delegates legislative power to the EPA. As a result of further direction from the court by order of December 29, 1995, the Justice Department has responded to the defendant's claims concerning retroactivity.

A frequently reaffirmed principle dictates that a court avoid deciding a constitutional issue if a case can be disposed of on non-constitutional grounds. See, e.g., Ashwander v. TVA, 297 U.S. 288, 347, 56 S. Ct. 466, 483, 80 L. Ed. 688, 711 (1936) (Brandeis, J., concurring). Therefore, before considering the several constitutional issues, this court first addresses the statutory question of whether Congress intended to make CERCLA retroactive.

II. CERCLA [*16] and Retroactivity

Although the retroactivity of CERCLA has been the subject of holdings in other circuits, the issue has not been squarely addressed by the Eleventh Circuit. In dicta, a panel of the Eleventh Circuit recently referred to CERCLA as being retroactive. Virginia Properties Inc. v. Home Ins. Co., 74 F.3d 1131, 1132 (11th Cir., 1996). The issue of retroactivity, however, was not before at court. n24 In another CERCLA case before this court recently, the parties failed to raise the issue of CERCLA's retroactivity, see Redwing Carriers, Inc. v. Saraland Apartments., LTD, 875 F. Supp. 1545 (1995); in its decision, however, this court refused to apply certain regulations retroactively. 875 F. Supp. at 1565 ("Since [redacted] is no such clear intent in FIFRA, see, e.g., 7 U.S.C. Secs. 136a(a), 13[redacted]), 1361, the court declines to apply registration cancellation retroactive[redacted]

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n24 Another reference to the retroactivity of CERCLA appears in an appendix to a 11th Circuit case, which is actually in a Georgia Supreme Court case appended to the per curiam opinion on a state contract issue. See Claussen v. Aetna Casualty, 888 F.2d 747, 751 (11th Cir. 1989).

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Of those federal decisions which have directly addressed the issue of CERCLA's retroactivity, n25 none have declined to apply CERCLA on retroactivity grounds. Nev[illegible]less, all of those cases were decided before the Supreme Court's deci[illegible]in Landgraf v. USI Film Prods., U.S. , 114 S. Ct. 1483 (1994), on w[illegible] the defendant rests its argument against retroactivity. n26

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n25 United States v. Monsanto Co., 858 F.2d 160 (4th Cir. 1988); United States v. Northeastern Pharmaceutical & Chemical Co., 810 F.2d 726 (8th Cir. 1986; HRW Systems v. Washington Gas, 823 F. Supp. 318 (D. Md. 1993); City of Philadelphia v. Stepan Chemical, 748 F. Supp. 283 (E.D. Pa. 1990); Kelley v. Solvent Co., 714 F. Supp. 1439 (W.D. Mich. 1989); O'Neil v. Picillo, 682 F. Supp. 706 (D. R.I. 1988); United States v. Hooker Chemical and Plastics, 680 F. Supp. 546 (W.D. N.Y. 1988); United States v. Dickerson, 640 F. Supp. 448 (D. Md. 1986); United States v. Ottati and Goss, Inc., 630 F. Supp. 1361 (D. N.H. 1985); Town of Boonton v. Drew Chemical, 621 F. Supp. 663 (D. NJ. 1985); United States v. Conservation Chemical Co., 619 F. Supp. 162 (W.D. Mo. 1985); United States v. Shell Oil, 605 F. Supp. 1064 (D. Colo. 1985); Jones v. Inmont, 584 F. Supp. 1425 (S.D. Ohio 1984); United States v. South Carolina Recycling Disposal Co., 653 F. Supp. 984 (D.S.C. 1984); United States v. Northeastern Pharmaceutical & Chemical Co., 579 F. Supp. 823 (W.D. Mo. 1984); United States v. Price, 577 F. Supp. 1103 (D. N.J. 1983); Ohio v. Georgeoff, 562 F. Supp. 1300 (N.D. Oh. 1983); United States v. Wade, 546 F. Supp. 785 (E.D. Penn. 1982); Cf. Aetna Cas. & Sur. Co., Inc. v. Pintlar Corp., 948 F.2d 1507 (9th Cir. 1991); O'Neil v. Picillo, 883 F.2d 176 (1st. Cir. 1989); In the Matter of Penn Central, 944 F.2d 164 (3rd. Cir. 1991); United States v. Kramer, 757 F. Supp. 397 (D.N.J. 1991). [*18]

n26 The defendant cites and seems to summarize an article entitled, "A Public Policy Essay: Superfund Retroactivity Revisited," by George Clemon Freeman, Jr., published in the American Bar Association's Business Lawyer, vol. 50 at 663 (Feb., 1995) (hereinafter, "Freeman.") The author, a practicing attorney, who was a member of the Superfund Section 301(e) Study Group, a congressional advisory committee on the Act, and who has participated in litigation on the retroactivity issue, see United States v. Northeastern Pharmaceutical & Chemical Co., 810 F.2d 726 (8th Cir. 1986), argues that neither the text nor legislative history demonstrate that Congress intended CERCLA to be retroactive. He has previously made this argument. See Id. notes 16 - 18, and accompanying text. The author contends:

If the question were before a federal court today in a case of first impression, Superfund's [illegible]ity provision, section 107(a), could not meet the test of statutory c[illegible]tion set forth in Justice Stevens' majority opinion in Landgraf. N[illegible] the text of the statute not its legislative history could sustain retroactive application. Nor could section 107(a) meet the more restrictive test of Justice Scalia's concurrence, which looked only at the text of the statute.

"Freeman" at 664-665 (footnotes omitted)

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[*19]

A.

The Justice Department has responded somewhat cavalierly to the issue of CERCLA's retroactivity, contending the matter is "well settled" and unaffected

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by Landgraf:

Every court t[illegible]e CERCLA retroactivity challenges has rejected the arguments advanced her[illegible]deed, courts have uniformly held that (1) Congress clearly and unequivocall[illegible]ended retroactive application of CERCLA and; (2) such a liability sc[illegible]is rationally related to a legitimate governmental interest. The Supreme Court's decision in Landgraf v. USI Film Prods., 128 L. Ed. 2d 229, 114 S. Ct. 1483 (1994) announces no new constitutional rules, and in no way impacts this case law.

See Pl's Mem. on the Retroactivity of CERCLA and Due Process Issues, p. 2. To begin with, Justice errs in claiming that the lower federal courts have "uniformly held that (1) Congress clearly and unequivocally intended retroactive application of CERCLA." In fact, not all the courts which have applied CERCLA to pre-enactment conduct have agreed that it is retroactive, n27 and those which have actually analyzed the retroactivity issue have differed on whether Congress was acting "clearly and unequivocally." [*20] n28 More importantly, Justice's observation that Landgraf "announces no new constitutional rules" fails to assist this court with what is a significant non-constitutional decision. n29 Written against the backdrop of several constitutional issues, the Landgraf holding addresses a rule of statutory construction. Justice cannot credibly contend that "the result in Landgraf is unremarkable." n30

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n27 See United States v. South Carolina Recycling & Disposal, Inc., 653 F. Supp. 984 (D.S.C. 1984) aff'd in part and vac. in part sub nom. United States v. Monsanto Co., 858 F.2d 160 (4th Cir. 1988); Cf. United States v. Diamond Shamrock Corp., [1982] 12 Envtl. L. Rep. (Envtl. L. Inst.) 20, 819 (N.D. Ohio May 29, 1981); United States v. Price, 523 F. Supp. 1055 (D.N.J. 1981), aff'd, 688 F.2d 204 (3d Cir. 1982). South Carolina Recycling concluded that the act was not "retroactive," but applied CERCLA on the theory that because the previous disposal continued to cause or threatened to cause releases after the Act's effective date.

n28 See notes 31-34, infra.

n29 See n. 38, infra. [*21]

n30 "Pl's Mem. on the Retroactivity of CERCLA and Due Process Issues" at 4.

- - - - - - [illegible] - - - - - - - - -End Footnotes- - - - - - - - - - - - - - - - - -

It is un[illegible]dable that Justice would attempt to dismiss Landgraf so casually. n31 Landgraf certainly demolishes the interpretive premises o n which prior cases had concluded CERCLA is retroactive. Landgraf does so in the course of attempting to clarify confusion regarding the interpretive rules applicable to retroactivity:

Our precedents on retroactivity left doubts about what default rule would apply in the absence of congressional guidance, and suggested that some provisions might apply to cases arising before enactment while others might not. Compare Bowen v. Georgetown Univ. Hospital, 488 U.S. 204, 109 S. Ct. 468, 102 L. Ed. 2d 493 (1988) with Bradley v. Richmond School Bd., 416 U.S. 696, 94 S. Ct. 2006, 40 L. Ed. 2d 476 (1974).

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Landgraf, 114 S. Ct. at 1495. In reaffirming the traditional presumption against retroactive [illegible]ation, Landgraf disapproves language in Bradley which had appeared to [illegible]se that traditional presumption.

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n31 See e.g. Ohio v. Georgeoff, 562 F. Supp. 1300, 1311 (N.D. Ohio, 1983) ("The Court is unable to declare that the statute evidences the 'imperative character' required to overcome the presumption against retroactivity").

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[*22]

Bradley allowed an award of attorneys' fees for work done prior to the effective date of the statute providing for attorneys' fees. The Supreme Court stated it was doing so "on the principle that a court is to apply the law in effect at the time it renders its decision, unless doing so would result in manifest injustice or there is a statutory direction or legislative history to the contrary." 416 U.S. at 711, 94 S. Ct. at 2016. The applicability of this language was severely limited by Landgraf:

Although the language suggests a categorical presumption in favor of application of all new rules of law, we now make it clear that Bradley did not alter the well-settled presumption against application of the class of new statutes that would have genuinely "retroactive" effect.

Landgraf, 114 S. Ct. at 1503 (emphasis in the original).

An early and influential case finding CERCLA retroactive, Ohio v. Georgeoff, 562 F. Supp. 1300 (N.D. Ohio, 1983), did exactly what Landgraf disapproves. Georgeoff began quite appropriately by "initially determining the standard to be applied in determining whether a statute should be applied retroactively." [*23] 562 F. Supp. at 1306. While it acknowledged an "historical[] . . . presumption favoring a prospective only application of a statute", n32 the court otherwise approved of n33 and seemed to apply a presumption in favor of retroactivity. The premises for the decision in Georgeoff were disapproved in and are no longer tenable after Landgraf. As a result, Georgeoff and the cases which rely on its analysis, -- and which do not do their own analysis -- cannot be considered persuasive.

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n32 562 F. Supp. at 1306.

n33 In footnotes, the court explained its view of the presumption:

Since the principal basis for the presumption against retroactivity is the threat of raising a constitutional issue, the reduction of that constitutional issue must necessarily reduce the need to interpret CERCLA to avoid raising that constitutional issue. The weight of the presumption therefore being reduced, a more lenient approach in reviewing claims that the presumption has been over-ridden may be appropriate. 562 F. Supp. at 1306, n.7. (emphasis added)

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. . . .

After Thorpe [redacted]radley, the presumption against retroactivity has arguably been changed [redacted]presumption in favor of retroactivity. That presumption can only be over-[redacted]n where there is a clear legislative directive to limit the statute to a prospective application or the change in law would cause manifest injustice to the party adversely affected. Id. at 1307, n.9. (emphasis added).

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[*24]

Besides Georgeoff, only two other cases actually do analyze the issue of retroactivity; the rest of the cases basically rely on one or more of these three cases and other cases which cite these cases. Those other two cases which do their own analyses are United States v. Shell Oil, Co., 605 F. Supp. 1064 (D. Colo., 1985) and United States v. Northeastern Pharmaceutical & Chemical Co., Inc., 810 F.2d 726 (8th Cir., 1986), both of which also cite Georgeoff with approval. See 605 F. Supp. at 1072 and 810 F.2d at 733. Unlike Georgeoff, neither case explains how it is applying the presumption against retroactivity; but like Georgeoff, both cases demonstrate little regard for the presumption. Following an analysis unlike that of Landgraf n34 and after quoting Georgeoff, Id. at 1072, Shell Oil concludes that CERCLA is "unavoidably retroactive." Id. at 1073. It does so on the basis of CERCLA's "general purpose and scheme." n35 Under Landgraf, however, the fact "that retroactive application of a new statute would vindicate its purpose more fully . . . . is not sufficient to rebut the presumption against retroactivity." 114 S. Ct. at 1507-8. [*25] Other than its discussion of "general purpose and scheme," Shell Oil does not explain precisely what overrides the presumption against retroactivity. n36 As for Northeastern, on which Justice relies, the case treats the presumption itself rather lightly, devotes only one sentence to the statutory language, relies on Shell Oil and Georgeoff among other cases, and offers one paragraph about the "statutory scheme." n37

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n34 "Before turning to a close analysis of specific statutory provisions and their accompanying legislative history, I will review the general purpose and scheme of CERCLA," 605 F. Supp. at 1069.

n35 See n[redacted]pra.

n36 Addit[redacted]y, both Shell Oil and Northeastern also rely upon an argument disapproved [redacted]andgraf. Specifically, these two cases argue that the affirmative preclusion of recovery for damages occurring before CERCLA's enactment in § 107(f), the natural resource liability section, indicates congressional intent for the other liability sections to operate retroactively. See Shell Oil, 605 F. Supp. at 1076 and Northeastern, 810 F.2d at 736. Noting that, "it would be surprising for Congress to have chosen to resolve [the retroactivity issue] through negative inference," the Landgraf Court found a remarkably similar argument to be unpersuasive. 114 S. Ct. at 1493-1494. [*26]

n37 The courts' discussion is as follows with reference to the presumption itself emphasized:

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The district court correctly found Congress intended CERCLA to apply retroactively. Id. at 839. We acknowledge there is a presumption against the retroactive application of the statutes. See United States v. Security Industrial Bank, 459 U.S. 70, 79, 103 S. Ct. 407, 413, 74 L. Ed. 2d 235 (1982). We hold, however, that CERCLA § 302(a), 42 U.S.C. § 9652(a), is "merely a standard 'effective date' provision that indicated the date when an action can first be brought and when the time begins to run for issuing regulations and doing other future acts mandated by the statute." United States v. Shell Oil Co., 605 F. Supp. 1064, 1075 (D. Colo. 1985); cf. Von Allmen v. Connecticut Teachers Retirement Board, 613 F.2d 356, 359-60 (2d Cir. 1979) (veterans statute).

Although CERCLA does not expressly provide for retroactivity, it is manifestly clear that Congress intended CERCLA to have retroactive effect. The language used in the key liability provision, CERCLA § 107, 42 U.S.C. § 9607, refers to actions and conditions in the past tense: "any person who at the time of disposal of any hazardous substances owned or operated," CERCLA § 107(a)(2), 42 U.S.C. § 9607(a)(2), "any person who . . . arranged with a transporter for a transport for disposal," CERCLA § 107(a)(3), 42 U.S.C. § 9607(a)(3), and "any person who . . . accepted any hazardous substances for transport to . . . sites selected by such person," CERCLA § 107(a)(4), 42 U.S.C. § 9607(a)(4). See, e.g., United States v. Conservation Chemical Co., 619 F. Supp. 162, 220 (W.D. Mo. 1985); United States v. Shell Oil Co., 605 F. Supp. at 1069-73; United States v. South Carolina Recycling & Disposal, Inc., 20 Env't Rep. Cases (BNA) 1753, 1760-62 (D. S.C. 1984) (The court in United States v. South Carolina Recycling & Disposal, Inc., 20 Env't Rep. Cases (BNA) 1753, 1760 (D. S.C. 1984), noted CERCLA does not apply "retroactively" because it does not impose liability for past conduct; rather, CERCLA imposes liability upon those parties responsible for causing certain conditions, that is, the release or threatened release or hazardous substances, that are the present or future results of their past actions.); United States v. A & F Materials Co., 578 F. Supp. at 1259; United States v. Price, 577 F. Supp. 1103, 1111-12 (D. N.J. 1983); Ohio ex rel. Brown v. Georgeoff, 562 F. Supp. 1300, 1312 (N.D. Ohio 1983); United States v. Outboard Marine Corp., 556 F. Supp. 54, 57 (N.D. Ill. 1982); United States v. Reilly Tar & Chemical Corp., 546 F. Supp. 1100, 1113-14 (D. Minn. 1982); see generally Developments in the Law -- Toxic Waste Litigation, 99 Harv. L. Rev. 1498 (1986) (Developments).

Further, the statutory scheme itself is overwhelmingly remedial and retroactive. CERCLA authorizes the EPA to force responsible parties to clean up inactive or abandoned hazardous substance sites, CERCLA § 106, 42 U.S.C. § 9606, and authorizes federal, state and local governments and private parties to clean up such sites and then seek recovery of their response costs from responsible parties, CERCLA § 104, 107, 42 U.S.C. §§ 9604, 9607. In order to be effective, CERCLA must reach past conduct. CERCLA's backward-looking focus is confirmed by the legislative history. See generally, H.R.Rep. No. 1016, 96th Cong., 2d Sess., reprinted in 1980 U.S. Code Cong. & Ad. News 6119 (CERCLA House Report). Congress intended CERCLA "to initiate and establish a comprehensive response and financing mechanism to abate and control the vast problems associated with abandoned and inactive hazardous waste disposal sites." Id. at 22, 1980 U.S. Code Cong. & Ad. News at 6125.
810 F.2d at 732-33 (emphasis added).

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It is understandable that, prior to Landgraf, lower federal courts would have tended to minimize the importance of the presumption against retroactivity given some Supreme [redacted]t precedents. Landgraf reflects the different views on the Court about [redacted]er some of its precedents, in particular Bradley v. Richmond School Bd., [redacted]l.S. 696, 94 S. Ct. 2006, 40 L. Ed. 2d 476 (1969) and a case on which it rel[redacted] Thorpe v. Housing Authority of Durham, 393 U.S. 268, 89 S. Ct. 518, 21 L. Ed. 2d 474 (1969), have been consistent with other Supreme Court precedents. The dissenting opinion in Landgraf remarks on the majority's "eagerness to resolve the 'apparent tension' . . . between Bradley v. Richmond School Bd. . . . and Bowen v. Georgetown University Hospital", 114 S. Ct. at 1508 (Blackmun, J., dissenting) (citations omitted) . The concurring opinion simply says that Bradley and Thorpe "invented an utterly new and erroneous rule." Id. at 1523 (Scalia, J., concurring). On the one hand, the majority "begin[s] by noting that there is no tension between the holdings in Bradley and Bowen." Id. at 149 (emphasis in the original). Later, however, [*28] the majority isolates and limits the troublesome language in Bradley, quoted above, which created the confusion about the strength of the presumption against retroactivity. Whether Bradley actually is or is not at odds with pre and post-precedent need not concern this court. It suffices to recognize that, contrary to the assertion by Justice, Landgraf does at least clarify the analysis of retroactivity and, therefore, does "impact this case." n38

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n38 See also Leonard Charles Presberg, The Civil Rights Act of 1991, Retroactivity, and Continuing Violations, 28 U. Richmond L. Rev. 1363, (1994) ("Prior to Landgraf, the Court had utilized two conflicting presumptions regarding the retroactivity of civil legislation."); Nelson Lund, Retroactivity, Institutional Incentives, and the Politics of Civil Rights, 1995 Pub. Int. L. Rev. 87 (1995); Duncan B. Hollis, Employment Discrimination Law, Statutory Retroactivity, 36 B.C. L. Rev. 373, 385 (1995) ("Beyond the scope of § 1981 cases, however, Rivers, in conjunction with Landgraf, does much to resolve the confusion surrounding what test a court should apply when a case implicates a statute enacted after the violative conduct occurred").

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B.

The major[redacted]pinion in Landgraf sets forth an analysis which, as here summarized, [redacted]res a court 1) to determine a) whether Congress has expressly stated the [redacted]s reach and b) if not, whether the text and legislative history hav[redacted]rly prescribed" Congress' intent to apply the provision retroactively; 2) if not, to determine whether the provision actually has "retroactive effect on the party or parties in the litigation;" and 3) if so, to apply the traditional presumption against retroactivity -- absent a clear congressional intent to the contrary.

The majority opinion's approach breaks down as follows:

1) In the last sentence of Part II of the opinion, the majority says: "Our first question, then, is whether the statutory text...manifests an intent that the 1991 Act should be applied to cases that arose and went to trial before its enactment." 114 S. Ct. at 1492. What follows in Part III of the opinion, 114

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S. Ct. at 1493-96, is an analysis of the arguments based on the text and legislative history. At the end of this section, the majority determines: "in the absence o[redacted] kind of unambiguous directive found in Sec. 15 of the 1990 bill [which e[redacted]itly [*30] provided for retroactivity], we must look elsewhere for[redacted]ance on whether Sec. 102 applies to this case." 114 S. Ct. at 1496.

2) Part IV of the opinion, 114 S. Ct. at 1496-1505, discusses the presumption against retroactivity. The majority notes the "'apparent tension'" between the different canons of construction found in Bradley as opposed to other Supreme Court precedents. Id. at 1496. The Court concludes this section with the following framework for analysis:

When a case implicates a federal statute enacted after the events in suit, the court's first task is to determine whether Congress has expressly prescribed the statutes' reach. If Congress has done so, of course, there is no need to resort to judicial default rules. When, however, the statute contains no such express command, the court must determine whether the new statute would have retroactive effect, i.e., whether it would impair rights a party possessed when he acted, increase a party's liability for past conduct, or impose new duties with respect to transactions already completed. If the statute would operate retroactively, our traditional presumption teaches that it does not govern absent [*31] clear congressional intent favoring such a result.

Id. at 1505. (emphasis added).

3) In Part V of the opinion, 128 L. Ed. 2d 229, 1994 U.S. LEXIS 3292 *71, 114 S. Ct. 1483, 1505-1508, the majority "ask[s] whether, given the absence of guiding instructions from Congress, Sec. 102 of the Civil Rights Act of 1991 is the type of provision that should govern cases arising before its enactment." 114 S. Ct. at 1505. They find the new damages remedy to have a retroactive effect and conclude it "is the kind of provision that does not apply to events antedating its enactment in the absence of clear congressional intent," 114 at 1506. The section proceeds without reconsidering its earlier discussion of congressional intent -- other than to reject as insufficient to overcome the presumption against retroactivity the argument that "retroactive application of a new statute would vindicate its purpose more fully" 114 S. Ct. at 1507 (footnote omitted) -- to conclude that they "have found no clear evidence of congressional intent that Sec. 102 of the Civil Rights Act of 1991 should apply to cases arising before its enactment." 114 S. Ct. at 1508.

In the fr[redacted]k of analysis as quoted above in 2), the first step involves only a deter[redacted]on [*32] of whether Congress has made an express statement concerning r[redacted]ivity; other evidence of "clear congressional intent" is left to step three. In the opinion itself, however, the Court considers both express and other evidence of congressional intent in the first step. As reflected from the quotes from Parts II and III of the opinion, see 1), the Court does not clearly differentiate between express language and other clear language of intent from the statute or legislative history. While it does not seem to matter whether the discussion of intent is confined to step one or divided between step one and step three, the analysis here follows what Landgraf in fact does.

1. Has Congress expressed its intent on CERCLA retroactivity?

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CERCLA contains no language explicitly stating it is retroactive. n39 Under language in some Supreme Court opinions, that failure would be fatal for retroactivit[redacted]ited States v. Heth, 7 U.S. 399, 3 Cranch 399, 414, 2 L. Ed. 479 (1806). [redacted]ing, J.) ("It [is] unreasonable in my opinion, to give the law a constructi[redacted]ich would have such a retrospective effect, unless it contained express words to that purpose.") While Landgraf [*33] demonstrates a preference for express language regarding retroactivity n40 and seems to warn Congress about the danger of not being explicit, n41 its discussion of other (i.e., non-express) statutory language and legislative history establishes that these should be considered in determining congressional intent.

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n39 As Justice and the other parties in Georgeoff agreed, "there are no unequivocal statements in the [CERCLA] statute indicating a Congressional intent to make it apply retroactively." 562 F. Supp. at 1309.

n40 See discussion in B., supra and n. 41, infra.

n41 Although the passage of the, 1990 bill may indicate that a majority of the 1991 Congress also favored retroactive application, even the will of the majority does not become law unless it follows the path charted in Article I, § 7, cl. 2 of the Constitution. See INS v. Chadha, 462 U.S. 919, 946-951, 103 S. Ct. 2764, 2781-2784, 77 L. Ed. 2d 317 (1983).

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a) Non-Express Statutory Language.

In resolving retroactivity [*34] issues, Landgraf instructs that the answer may vary among provisions within an act. 114 S. Ct. at 1494 and 1505. Accordingly, the analysis focuses on the particular provisions of CERCLA, at issue in the complaint, Sections 106(a) n42 and 107(a). n43 Under Section 106(a) the government seeks injunctive relief in the first claim of the complaint. Although injunctive relief is ordinarily prospective, when it requires a party to spend funds related to actions taken prior to CERCLA's enactment, such relief is nevertheless retroactive. See Georgeoff 562 F. Supp. at 1303-05. Thus to the extent that the government's claims under 106(a) and 107(a) relate to actions taken prior to the effective date of CERCLA, they involve the issue of retroactivity.

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n42 Sect[redacted](a) of CERCLA, 42 U.S.C. § 9606(a), provides in pertinent part:

In addition to any other action taken by a State or local government, when the President determines that there may be an imminent and substantial endangerment to the public health or welfare or the environment because of an actual or threatened release of a hazardous substance from a facility, he may require the Attorney General of the United States to secure such relief as may be necessary to abate such danger or threat, and the district court of the United States in the district in which the threat occurs shall have jurisdiction to grant such relief as the public interest and the equities of the case may require.
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n43 Section 107(a) of CERCLA, 42 U.S.C. § 96007(a), provides, in pertinent part:

(1) the owne[illegible] operator of a vessel or a facility; [and]

(2) any pers[illegible]o at the time of disposal of any hazardous substance owned or operated any facility at which such hazardous substances were disposed of ...

shall be liable for --

(A) all costs of removal or remedial action incurred by the United States Government ... not inconsistent with the national contingency plan ....

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The Justice Department devotes little attention to statutory language as evidence of congressional intent. To the extent it does, Justice's brief relies on Northeastern's observation that "the language used in the key liability provision, CERCLA § 107 ... refers to actions and conditions in the past tense." Northeastern, 810 F.2d at 733. Georgeoff, after a more extensive analysis, finds the use of the past tense not dispositive. n44 Even while finding other terms supportive of retroactivity, Georgeoff states that the statutory provisions are insufficient to overcome the presumption [*36] of retroactivity.

Despite these statutory arguments, the Court is unable to declare that the statute evidences the "imperative character" required to overcome the presumption against retroactivity. Regardless, these provisions provide some evidence that Congress intended CERCLA to apply retroactively. The Court, therefore, will consider these statutory terms as indicia, but not dispositive indicia, of a Congressional intent to allow retroactive application of CERCLA.

562 F. Supp. at 1311. Shell Oil agrees with Georgeoff. n45 Georgeoff's and Shell Oil's conclusion that the statutory language in CERCLA is not sufficient to establish retroactivity is persuasive. Although Northeastern arguably n46 reaches a contrary conclusion, it does so without conducting nearly as extensive an analysis as done in Georgeoff. This court concludes, therefore, that the language of section 107 provides "no clear evidence of Congressional intent," as required by Landgraf, that CERCLA's liability provisions be given retroactive effect.

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n44 See [illegible]lly 562 F. Supp. at 1309 - 11. "It will be unnecessary to construe the word 'accepted' to apply to pre-enactment conduct to give it effect. 'Accepted' may apply to pre-enactment conduct, but the Statute does not require such an application." Id. at 1310. [*37]

n45 "I find and conclude that congressional intent to either impose or withhold liability for response costs incurred before CERCLA cannot be divined from the verb tenses in § 107(a)." 605 F. Supp. at 1073.

n46 Despite the language cited in n. 37, supra, Northeastern goes on to follow the Shell Oil analysis and cites approvingly that court's finding that congressional intent to impose liability for pre-enactment response costs

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cannot be divined from the verb tenses in § 107(a). See 810 F.2d at 735.

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Section 10[illegible]tains no language indicating congressional intent to authorize relief that is retroactive. n47 If anything, the language suggests the very argument, later made by Justice, that CERCLA liability is not "retroactive." The pertinent language of § 106 borrows from law on the abatement of nuisance; it refers to "an imminent and substantial endangerment to the public health or welfare or the environment" and provides "such relief as may be necessary to abate such danger or threat." n48 Georgeoff records Justice's unsuccessful attempt to argue that, although it reaches [*38] pre-enactment conduct, legislation designed to alleviate a continuing public nuisance does not act retroactively." 562 F. Supp. at 1304. United States v. So. Carolina Recycling and Disposal Inc., 653 F. Supp. 984 (D. S.C., 1984), on the other hand, adopts that argument. n49 As discussed below, Landgraf now precludes such attempts to avoid the issue of retroactivity. The fact that in the early cases Justice thought it necessary to argue, at least in the alternative, that CERCLA is not retroactive certainly indicates Justice's initial concern that courts might not find a clear congressional intent that CERCLA be applied "retroactively."

- -Footnotes- -

n47 See 106(a) quoted in n. 42, supra.

n48 Id.

n49 "Although liability under CERCLA is premised in part upon conduct which occurred prior to CERCLA's enactment in 1980 this court does not consider CERCLA 'retroactive' in the constitutional sense as applied to the facts of this case." 653 F. Supp. 984, 996.

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b) Legislative History.

CERCLA itself has [*39] almost no legislative history.

Although Congress had worked on "Superfund" cleanup of toxic and hazardous waste bills, and on parallel oil spill bills for over three years, the actual bill which b[illegible] Public Law No. 96-510 had virtually no legislative history at all, becaus[illegible] bill which became law was hurriedly put together by a bipartisan [illegible]ship group of Senators--with some assistance of their House counterpart[illegible]oduced and passed by the Senate in lieu of all pending measures on the subject. It was then placed before the House, in the form of a Senate amendment of the earlier House bill. It was considered on December 3, 1980, in the closing days of the lame duck session of an outgoing Congress. It was considered and passed, after very limited debate, under a suspension of the rules, in a situation which allowed for no amendments. Faced with a complicated bill on a take-it-or-leave-it basis, the House took it, groaning all the way.

Frank P. Grad, Treatise on Environmental Law Sec. 4A.02[2][a], at 4A-51 (1994). (footnote omitted) (Hereinafter, "Grad") (emphasis added).

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The unusual lack of legislative history, as reflected by the failure even to produce [*40] a House--Senate Conference Report, is attributable to "the delicate nature of the compromise" which led to passage, according to the Preface to the Congressional Research Service Legislative History. n50 Much of what passes for legislative history of CERCLA, therefore, comes from "bills introduced which contributed to some extent to the final act." n51

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n50 "A Legislative History of the Comprehensive Environmental Response Compensation, and Liability Act of 1980 (Superfund), public Law 96-51Q." Comm. on Environment and Public Works, U.S. Senate, 97th Cong., 2d Sess. Vol. 1 at VII.

n51 Grad at 4A-51.

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In Landgraf, the Supreme Court does consider a prior bill as part of its review of the legislative history. The Court places some weight on the fact that a bill vetoed in the previous year had explicitly provided for retroactivity. The legislative history considered in Landgraf comes not from committee reports, but from the language of the prior bill itself. The fact that the later enacted legislation [*41] had no such provision prompts the Court to infer: "it seems likely that one of the compromises that made it possible to enact the 1991 version was an agreement not to include the kind of explicit retroactivity command found in the 1990 bill," 114 S. Ct. at 1495 (emphasis in the original).

As acknowledged in Georgeoff, "the precise issue of retroactivity...was not addressed in Congressional debates," 562 F. Supp. at 1311, including debate on prior bills. Id. Under Landgraf, that fact would seem to be nearly fatal to any attempt to overcome the presumption against retroactivity.

The Justice Department attempts to distinguish CERCLA from the civil rights statute considered in Landgraf because no bill prior to CERCLA explicitly provided for retroactivity. See "Pl's Mem. on Retroactivity" at 4-5. That fact, however, does not strengthen the case for retroactivity. It only means that what Justice and other courts have labeled the legislative history of CERCLA may not be as clear as was the legislative history of the Civil Rights Act considered in Landgraf. It still remains for Justice to demonstrate that the legislative history does contain clear intent of CERCLA's [*42] retroactivity. In attempting to do so, Justice contends that the "history, as analyzed by the courts, demonstrates unequivocally that Congress was concerned about past, pre-enactment [illegible] of disposal." "Pl's Mem" at 8.

The argument of Justice, relying as it does on past cases, fails to overcome the presumption against retroactivity because those prior cases do not follow the analysis of Landgraf and because they find clarity in legislative history which does not exist. Many of the past cases are unclear about two things which are distinguished in Landgraf: congressional intent and retroactive effect. As discussed below, Landgraf struggles with the term "retroactive." The majority excludes certain statutes from the presumption against retroactivity, n52 specifically procedural and jurisdictional statutes. See 114 S. Ct. at 1501-02. Approving of Justice Story's discussion in Society for Propagation of the Gospel v. Wheeler, 2 Gall. 105, 22 F. Cas. 756 (No. 12,156) (CCDNH 1814), the

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majority says:

A statute do[redacted] operate "retroactively" merely because it is applied in a case arising [redacted] conduct antedating the statute's enactment . . .
114 S. Ct. a[redacted]9.
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In other words, the fact that legislation might have retroactive effect does not necessarily mean that Congress clearly intended that it be so applied.

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n52 "Even absent specific legislative authorization, application of new statutes passed after the events in suit is unquestionably proper in many situations." 114 S. Ct. at 1501.

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In searching the legislative history, some courts have placed weight on sources that have little no value. As two commentators write: "the available reports pertaining to prior versions of the legislation are of little value in interpreting the statute -- CERLCA, as enacted, differed significantly from previous proposals." Allan J. Topol and Rebecca Snow, Superfund Law and Procedure § 1.1. at 5 (St. Paul, West; 1992).

The most that can be said from the legislative history is that Congress left many questions, including retroactivity, as open ones to be decided later. Like Landgraf, the circumstances surrounding passage of CERCLA strongly suggest that the failure expressly [*44] to prescribe the reach of the statute was deliberate on Congress' part.

It would have been a simple matter for Congress to have included a provision within the Act providing that liability would be imposed retroactively. Given the undoubted Congressional awareness of an existing problem, this omission takes on special importance. There can be no question that Congress was aware that the issue of retroactivity could arise. Yet, Congress failed to make this statement.

Georgeoff. 562 F. Supp. at 1309.

The polit[redacted]ircumstances suggest why there was little actual legislative history and [redacted]ngress left many issues deliberately ambiguous. n53

In 1980, CE[redacted]erged from the lame duck session of Congress after President Carter had been defeated and former Governor Reagan had yet to assume the presidency. Its language was derived mainly from S. 1480, 99th Cong., 2d Sess. (1980), a bill that had been reported from the Senate Committee on Environment and Public Works but that had little hope for passage in its complete form. A group of approximately 25 to 30 senators, with assistance from House members and the outgoing Administration (at one point including [*45] President Carter himself), and crafted new legislative language to paper over policy disputes on which there was no consensus. Because many such disputes remained after these negotiators finished their deliberations, floor debate in the Senate often contain rival explanations of the same provisions of CERCLA.

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Alfred R. Light, CERCLA Law and Procedure Compendium (BNA; Washington, D.C., 1992) at 1-1.

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n53 As Se[redacted] Randolph stated in part in explaining the liability provisions of the Compromise:

The liability regime [Sec. 109] in this substitute contains some changes in language from that in the bill reported by the Committee on Environment and Public Works. The changes were made in recognition of the difficulty in prescribing in statutory terms liability standards which will be applicable in individual cases. The changes do not reflect a rejection of the standards in the earlier bill.

Unless otherwise provided in this act, the standard of liability is intended to be the same as that provided in section 311 of the Federal Water Pollution Control Act (33 U.S.C. 1321). I understand this to be a standard of strict liability.

It is intended that issues of liability not resolved by this act, if any, shall be governed by traditional and evolving principles of common law. An example is joint and several liability, Any reference to these terms has been deleted, and the liability of joint tortfeasors will be determined under common or previous statutory law.

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[*46]

The circumstances explain why Congress decided not to decide many issues, leaving them for others -- the EPA and the courts--to decide. The fact that CERCLA includes a legislative veto, see 42 U.S.C. § 9655, since determined to be unconstitutional, see INS. v. Chadha, 462 U.S. 919, 103 S. Ct. 2764, 77 L. Ed. 2d 317 (1983), suggests that members of Congress may not have been as concerned as they should have been about a number of issues, including retroactivity, because they assumed incorrectly that Congress has the power to "fix it" later without concern about a presidential veto. Whatever the reasons, the legislative history lacks the clear congressional intent to make CERCLA liability retroactive.

Given th[redacted] language--express or otherwise--and the legislative history--br[redacted]nd narrowly understood--fail to demonstrate a clear congression[redacted]nt for retroactivity, Landgraf requires that the presumption against retroactivity be applied if the statute is one to which that presumption applies.

2. Does CERCLA Have Retroactive Effect?

Landgraf does not simply ask: is the statute retroactive? Framing the question that way, as have a number of the lower federal [*47] courts, reduces the analysis to a matter of labeling rather than distinguishing between the effect of the statute and the intent of Congress as does Landgraf. n54 A few of the early cases manipulate the label "retroactive" apparently as a way of avoiding the issues of congressional intent and constitutionality. Thus United

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States v. South Carolina Recycling Disposal Co., 653 F. Supp. 984 (D.S.C., 1984), aff'd in part and vac. in part sub nom. United States v. Monsanto Co., 858 F.2d 160 (4th Cir., 1988), cert. denied, 490 U.S. 1106, 104 L. Ed. 2d 1019, 109 S. Ct. 31[illegible]989), concludes that considering pre-enactment conduct does not make CERC[illegible]ability "retroactive" because the statute actually imposes liability fo[illegible] post enactment releases or threatened releases. Although the Justice Department now contends that CERCLA is clearly retroactive, early cases reflect that Justice made the argument that CERCLA is not retroactive. See e.g., Georgeoff 562 F. Supp. at 1304. n55

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n54 114 S. Ct. at 1499.
Rather, the court must ask whether the new provision attaches new legal consequences to events completed before its enactment. The conclusion that a particular rule operates "retroactively" comes at the end of a process of judgment concerning the nature and extent of the change in the law and the degree of connection between the operation of the new rule and a relevant past event.
[*48]

n55 562 F. Supp. at 1304 (emphasis added).

The Court next turns to a consideration of Justice's position. Under the liability provisions of CERCLA, 42 U.S.C. § 9607(a), a "release or threatened release" of hazardous wastes is required to trigger liability. Justice argues that the release at the Dump is a continuing release of hazardous waste triggering liability at any time before the wastes' removal. Because the waste has yet to be removed, BFI has engaged in conduct taking place after the enactment of CERLCA. Imposition of liability, therefore, would not be retroactive because at least some of the facts giving rise to the liability are based on events taking place after the enactment of CERCLA.

In support of this argument, Justice cites a number of cases which it argues hold that legislation designed to alleviate a continuing public nuisance does not act retroactively. Samuels v. McCurdy, 267 U.S. 188, 45 S. Ct. 264, 69 L. Ed. 568 (1924); Chicago & Alton Railroad Company v. Tranbarger, 238 U.S. 67, 35 S. Ct. 678, 59 L. Ed. 1204 (1914); City of Bakersfield v. Miller, 64 Cal. 2d 93, 410 P.2d 393, 48 Cal. Rptr. 889 (1966); People of Illinois v. Jones, 329 Ill. App. 503, 69 N.E.2d 522 (4th Dist. 1946).

- - - - - - [illegible] - - - - - - - - -End Footnotes- - - - - - - - - - - - - - - - - - -
[*49]

Under the Landgraf's analysis, CERCLA liability certainly has "retroactive effect" because as applied in this and many other cases it easily falls within the explanatory language of that term. That is to say, the Justice Department's attempt in this case to impose liability under § 107(a) largely on actions occurring prior to the statute's effective date "would impair rights a party possessed when he acted, increase a party's liability for past conduct, or impose new duties with respect to transactions already completed." 114 S.C. at 1505. What Landgraf said about compensatory damages can be said about the financial liabilities under CERCLA for pre-enactment conduct: "the new damages remedy in Sec. 102, we conclude, is the kind of provision that does not apply to events antedating its enactment in the absence of clear congressional intent."

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114 S. Ct. at 1506.

3. Should the Presumption Against Retroactivity be Applied?

In the third step of the analysis, Landgraf asks "whether, given the absence of guiding instruction from Congress, the [particular section of the act] is the type of provision that should govern cases arising before its enactment. The Court does [*50] not ask generally whether the act is retroactive, but focuses on the particular section. The opinion then distinguishes between a procedural provision of that section (jury trial right) which would "presumably apply to cases ... regardless of when the underlying conduct occurred," n56 and its punitive and compensatory damages provisions. Recognizing that "retrospective imposition of punitive damages would raise a serious constitutional question", Id. at 1505, the Court avoids that constitutional question by interpreting the punitive damages provision not to be retroactive. n57 The provision "authorizing recovery of compensatory damages is not easily classified," id., according to the Court, because the conduct itself was already unlawful--only the remedy was new--and also because compensatory damages are not punitive. Despite these differences, Landgraf applies the presumption against retroactivity even to the compensatory damages provision.

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n56 In Landgraf, the right to a jury trial does not apply retroactively, despite the fact that it is a procedural provision, because this right is attached to the punitive and compensatory damages provisions, to which the presumption against retroactivity applies. See 114 S. Ct. at 1505. [*51]

n57 114 S. Ct. at 1506. "Before we entertained that [constitutional] question, we would have to be confronted with a statute that explicitly authorized punitive damages for pre-enactment conduct. The Civil Rights Act of 1991 contains no such explicit command."

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The CERCLA provision, § 107(a), as applied in this case falls somewhere between the punitive damage and the compensatory damage provisions considered in Landgraf. In this case, punitive damages are not sought. Nevertheless, § 106 does provide for fines for failure to comply with an executive branch abatement order; such fines are clearly punitive. Section 107(c)(3) also authorizes punitive, treble damages. The EPA uses the threat of punitive damages as a negotiating [illegible] n58 Given the very real threat of punitive damages, CERCLA retroactivity [illegible] very nearly the same "ex post facto" danger referred to in Landgraf. 114 S. Ct. at 1505-06. According to Landgraf, a provision for punitive damages should not be construed as retroactive unless the language forces that conclusion because the court must then confront substantial [*52] constitutional questions which follow.

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n58 The EPA's use of punitive damages is laid out in its "Superfund Enforcement Strategy and Implementation Plan," as reprinted in Alfred R. Light, CERCLA Law and Procedure Compendium at III-6:
As authorized under sections 106 and 107, the government will pursue cases involving treble damages and penalties for violations of unilateral and

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consent orders. Taking such actions is important for establishing a credible deterrent. These actions are available against persons who fail without sufficient c[redacted]to comply with orders.

[redacted]

- - - - - - [redacted] - - - - - - - - -End Footnotes- - - - - - - - - - - - - - - - - -

Regardless of the threat of punitive damages, retroactive CERCLA liability is more egregious than the compensatory relief which the Court refused to apply retroactively in Landgraf. In the instant and many other cases, liability under CERCLA would require compensation for actions which when taken violated no federal or state law. At least as to the compensatory damages remedy sought in Landgraf, it could be said that retroactivity [*53] involved no new legal standard concerning the conduct itself. n59 Nevertheless, even on the compensatory damages issue Landgraf says, "it is the kind of provision that does not apply in the absence of clear congressional intent." Certainly, under Landgraf principles, CERCLA liability is the kind that does not apply retroactivity without clear congressional intent.

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n59 See 114 S. Ct. at 1506:
It does not make unlawful conduct that was lawful when it occurred; as we have noted, supra, at 1490-1491, § 102 only reaches discriminatory conduct already prohibited by Title VII. Concerns about a lack of fair notice are further muted by the fact that such discrimination was in many cases (although not this one) already subject to monetary liability in the form of backpay. Nor could anyone seriously contend that the compensatory damages provisions smack of a "retributive" or other suspect legislative purpose. Section 102 reflects Congress' desire to afford victims of discrimination more complete redress for violations of rules established more than a generation ago in the Civil Rights Act of 1964. As least with respect to its compensatory damages provisions, then § 102 is not in a category in which objections to retroactive application on grounds of fairness have their greatest force.

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[*54]

As discussed above, pre-Landgraf cases addressing CERCLA retroactivity are unreliable. Among these cases, Justice places particular reliance on Northeastern[redacted]h characterizes CERCLA as "overwhelmingly remedial and retroactive[redacted]as having a "backward focus." Such labels only confuse the issue as e[redacted]d by Landgraf. Legislation cannot be remedial if the conduct being "remedied" was lawful at the time of its occurrence. As discussed above, determining that a statute has "retroactive effect" is only part of the analysis; by itself, it does not indicate Congress' intent. Northeastern's statement about CERCLA having a "backward focus," is no more dispositive than a similar characterization of the compensatory damage provision discussed in Landgraf.

Unlike certain other forms of relief, compensatory damages are quintessentially backward-looking. Compensatory damages may be intended less to sanction wrongdoers than to make victims whole, but they do so by a mechanism that affects the liabilities of defendants. They do not "compensate" by

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distributing funds from the public coffers, but by requiring particular employers to pay for harms they caused. [*55] The introduction of a right to compensatory [redacted]ges is also the type of legal change that would have an impact on private p[redacted]s' planning.

114 S. Ct. at 1506. (emphasis added in first sentence only). Landgraf insists that in no case "in which Congress had not clearly spoken, have we read a statute substantially increasing the monetary liability of a private party to apply to conduct occurring before the statute's enactment." 114 S. Ct. at 1507. Liability under CERCLA certainly must be in accord with this principle. The fact that "retroactive application of [this] statute would vindicate its purpose more fully", as in Landgraf, "is not sufficient to rebut the presumption against retroactivity." Id. at 1507-08.

Only one sentence in Landgraf, if taken in isolation, lends any support at all to Justice's position. Near the end of the opinion, Landgraf says: "Section 102 is plainly not the sort of provision that must be understood to operate retroactively because a contrary reading would render it ineffective." Id. at 1508 (emphasis in original). Justice's argument boils down to a claim that CERCLA must be read to be retroactive.

Without any doubt, [*56] in CERCLA Congress is addressing an existing situation as well as future problems. In this respect, CERCLA certainly has a "backward focus." It does not follow, however, that the liability provision "must be understood to operate retroactively because a contrary reading would render it ineffective." Early on, the Justice Department itself argued, at least in the alternative, that CERCLA's liability provision need not be interpreted to be retroactive. See Georgeoff at 1304-1306. Quickly, however, that argument failed, but ultimately became unnecessary as courts approved of applying CERCLA retroactively. Citing certain "main policy objectives underlying CERCLA . . . and the need for a liberal interpretation of the Statute, the courts have expanded the scope of CERCLA liability well beyond anything that Congress itself could have envisioned." Allan J. Topol and Rebecca Snow, 1 Superfund Law and Procedure, § 1.1 at 6 (West Pub.; St. Paul, Minn. 1992).

Justice confuses what it, the EPA, and a number of courts consider desirable with what it can be said Congress clearly intended. Insofar as pre-enactment releases are concerned, the purpose of CERCLA can be covered through the Superfund. [*57] The EPA, however, has chosen to recover as much as possible from private parties, n60 no doubt in part due to Congress' failure to provide sufficient r[redacted]es to pay for cleaning all the sites, even as the need was thought to b[redacted]980. See Georgeoff 562 F. Supp. at 1312-13. While Georgeoff takes the la[redacted]funding as an indication of congressional intent to make CERCLA retro[redacted]; Id. at 1313, lack of funding does not render the operation of the statute itself ineffective in the sense used in Landgraf.

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n60 See "Superfund Enforcement Strategy and Implementation Plan" (Sept. 26, 1989) reprinted in Alfred R. Light, CERCLA Law and Procedure Conpendium (BNA, Washington, D.C., 1992) at III-2.
EPA will consider private party responses as the preferred approach for the majority of Superfund sites. At the same time, EPA will retain the maximum amount of leverage to use the Fund at specific sites where negotiations are unsuccessful. The goal of the government is to negotiate an agreement for 100%

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of response costs.

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[*58]

Landgraf mentions accepted means such as certain taxes and zoning regulations by which governments "impose burdens on past conduct." 114 S. Ct. at 1499, n. 24. n61 Such means, if not otherwise unconstitutional, allow legislators to "remedy" past conduct. Legislators can address environmental damage; however, under the "Takings Clause," n62 "confiscatory regulations ... cannot be newly legislated or decreed (without compensation), but must inhere in the title itself, in the restriction that background principles of the State's law of property and nuisance already place upon land ownership." Lucas v. So. Carolina Coastal Covn., 505 U.S. 1003, 1029, 112 S. Ct. 2886, 120 L. Ed. 2d 798 (1992). As Landgraf observes, the "Takings Clause" is one of several constitutional provisions which incorporate the anti-retroactivity provisions. 114 S. Ct. at 1497. Of course, agencies and officials at all levels of government generally would wish to induce or compel particular parties to pay for government initiatives rather than having to impose a general tax. However, the general presumption against retroactivity and particular constitutional provisions are designed to limit, and in some [*59] instances to prevent, governments from doing so.

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n61 See also 114 S. Ct. at 1506. ("They do not 'compensate' by distributing funds from public coffers, but by requiring particular employers to pay for harms caused.")

n62 U.S. Constitution, Amendment V.

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Ironically, the EPA has resisted the retroactivity principle when it would have worked in favor of private parties. Under Section 106(b)(2)(A), added in 1986 by Superfund Amendments and Reauthorization Act ("SARA"), private parties can seek certain reimbursement from the Superfund. n63 The EPA has "adopted the position that orders issued before the passage of SARA do not provide the petitioner with a right to reimbursement against the Fund." 2 Superfund Law and Procedure supra § 11.1 at 272 (footnote omitted). Courts have generally agreed with the EP[redacted]tion. See cases cited in id., n. 7-10.

- - - - - [redacted] - - - - - - - - - -Footnotes- - - - - - - - - - - - - - - - - - -

n63 Section 106(b)(2)(A) provides that "any person who receives and complies with the liens of any [Section 106(a) order] may, within 60 days after completion of the required action, petition the President for reimbursement from the Fund for the reasonable costs of such action, plus interest."

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[*60]

Nothing presented in the Justice Department brief or pre-Landgraf cases concerning the statutory language of CERCLA or its legislative history

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demonstrates that Section 107(a) (and/or Section 106(a) as related to it in this case) is "the sort of provision that must be understood to operate retroactively because a co[illegible]y reading would render it ineffective." 114 S. Ct. at 1508. Accordingly, [illegible] court holds that Section 107(a), a Section 106(a) as linked to it in this c[illegible]re not retroactive.

III. CONSTITUTIONAL ISSUES

The holding that Sections 106(a) and 107(a) cannot be given retroactive effect resolves much, but not all, of this case. Moreover, because of the court's statutory interpretation holding, the court need not rule on the due process constitutional issue, which applies only to pre-enactment conduct. The complaint, however, covers conduct which, while largely occurring prior to the effective date of CERCLA in 1980, includes some post-enactment conduct. n64 As the defendant mentions in its brief, the provisions of the consent decree respond "mostly with respect to waste disposal activities that preceded the enactment of CERCLA in 1980" (emphasis added). [*61] After briefly addressing one constitutional issue which has been mooted by the court's holding on pre-enactment conduct, the court considers more fully those constitutional issues which are not limited to pre-enactment conduct.

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n64 See Complaint P's 12 and 18.

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A. Retroactivity and Due Process

Landgraf recognizes the due process and other constitutional concerns lurking in the background of the interpretive issue of whether Congress intended retroactive application. See 114 S. Ct. at 1497-98. Such constitutional considerations seem to have contributed to the Court's confirmation of the presumption against retroactivity. Yet, with the possible exception of a punitive damages provision, the Court seems to accept that Congress has the constitutional power to give a statute retroactive effect if it clearly intends to do so. Landgraf, 114 S. Ct. at 1499 ("Since the early days of this Court, we have declined to give retroactive effect to statutes burdening private rights unless Congress [*62] has made its intent clear." (emphasis added)). Given the court's statutory interpretation of CERCLA, there is no need to reach the constitution[illegible]lidity of retroactive application of CERCLA under the due process clau[illegible]

B. Delega[illegible]f Legislative Power

The defendant contends that CERCLA unconstitutionally "delegates to EPA the basic policy decisions" with "no 'intelligible standard' to guide EPA's decisions about which contaminated sites pose significant risks and how much money should be spent to reduce or eliminate such risks." Def.'s Mem. of Law in Resp. to Ct.'s Ord. of Sept. 19, 1995 at 20-21. This constitutional challenge attacks CERCLA as generally administered by the EPA. This broader challenge based on the non-delegation doctrine has not been mooted by the holding that CERCLA liability cannot be applied retroactively.

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The EPA's decision to apply CERCLA retroactively against private parties represents one example of what the defendant contends is the unauthorized exercise of [redacted]lative power. One way of understanding the decision in Landgraf is to view i[redacted]applying a specific rule of non-delegation, namely that Congress ca[redacted]eave such a basic legislative [*63] decision as a statute's possible retroactivity to the executive and judicial branches. Both the presumption against retroactivity and the non-delegation doctrine derive from the more fundamental doctrine of separation of powers. Thus, Landgraf cites INS v. Chadha, 462 U.S. 919, 103 S. Ct. 2764, 77 L. Ed. 2d 317 (1983), in support of the proposition that "even the will of the majority does not become law unless it follows the path charted in Article I, § 7, cl. 2 of the Constitution." 114 S. Ct. at 1496. Landgraf could also have cited Chadha as to what is "essentially legislative", namely Congressional "action that [has] the purpose and effect of altering the legal rights, duties, and relations of persons." 462 U.S. at 952.

Chadha, which is the first modern case to declare a congressional statute unconstitutional on clear separation-of-powers grounds, illustrates the relationship between the general doctrine and particular constitutional provisions. Chadha declares the one-house legislative veto void because it violates the bicameralism and the presentment clauses. Following Chadha, a line of separation-of-powers cases raise various issues, including [*64] delegation of powers and removal from office. See Metro. Washington Airports Author. v. Citizens for the Abatement of Aircraft Noise, Inc., 501 U.S. 252, 111 S. Ct. 2298, 115 L. Ed. 2d 236 (1991) (invalidating a provision in a federal statute approving an agreement for the transfer of two Washington-area airports from the U.S. Department of Transportation to an "Airports Authority," which created a "Board of Review" consisting of nine members of Congress because it violated separation of powers either by allowing members of Congress to exercise executive power or by allowing members of Congress to enact legislation without complying with the bicameralism and presentment requirements of the Constitution.); Mistretta v. United States, 488 U.S. 361, 109 S. Ct. 647, 102 L. Ed. 2d 714 (1989) (finding no separation-of-powers violation in a statute establishing the United States Sentencing Commission as "an independent commission in the judicial branch of the United States" with removal by the President of commission members; Morrison v. Olson, 487 U.S. 654, 108 S. Ct. 2597, 101 L. Ed. 2d 569 (1988) (finding no separation -of- powers violation in a statute providing for the appointment [*65] of "Independent Counsel" by a panel of Article III judges and removal only for cause by the Attorney General.); Bowsher v. Synar, 478 U.S. 714, 106 S. Ct. 3181, 92 L. Ed. 2d 583 (1984) (holding that the provision in the Balanced Budget and Emergency Deficit Control Act [redacted] executive power to the Comptroller General, who was removable by Congress, [redacted]tes separation of powers).

In Chadh[redacted]issent worried that the Court's decision threatened the "modern administrative state." See 462 U.S. at 984-89. As the post-Chadha cases summarized above reflect, the Court has not consistently pursued a rigorous separation-of-powers approach. n65 Consequently, the modern administrative state has not been much disturbed by the line of cases cited above. A rigorous separation-of-powers approach, which would include a stricter non-delegation doctrine, would greatly curtail the rule-making authority of administrative agencies, n66 including the EPA. n67 By itself, however, a broad non-delegation constitutional challenge to CERCLA cannot currently succeed. Under present Supreme Court jurisprudence, "there is no significant 'anti-delegation' principle which restricts the exercise of [*66] the commerce power." John E. Nowak and Ronald D. Rotunda, Constitutional Law (St. Paul, West; 1995) at 156.

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n65 It is [redacted]h mentioning that the two cases in which the Court fails to find a viola[redacted]of separation of powers, Morrison and Mistretta, involve statutes which give powers to the judiciary.

n66 Professor Bernard Schwartz has written about a first draft of the Bowsher opinion which would have cast doubt on the constitutionality of independent agencies:

since it virtually would have placed the Supreme Court imprimatur upon the claim that independent agencies are unconstitutional.

. . . .

. . . The years before Bowsher had seen a revival of the claim that the independent agencies were unconstitutional because, though they exercised "executed power," they were not subject to presidential control. The argument against the agencies received the support of the Reagan Department of Justice. . . .

n67 The activities of the EPA under CERCLA include a double delegation. First, Congress has delegated to the President. Sec. 106. Then the President has delegated to EPA. (Executive Order 12580 of January 3, 1987).

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[*67]

A year ago, of course, it could have been said that almost nothing restricts Congress' exercise of the commerce power. In the interim, the jurisprudence has become unsettled due to the Supreme Court's decision in United States v. Lopez, 514 U.S. , 115 S. Ct. 1624, 131 L. Ed. 2d 626 (1995), which, for the first time in more than fifty years, struck down a congressional statute which regulates non-state activity n68 on grounds that it exceeded Congress' power under the Commerce Clause. Some of the concerns raised by the defendant under the non-delegation doctrine overlap with the issues in Lopez, to which this court now turns.

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n68 Nati[redacted]eague of Cities v. Usery, 426 U.S. 833, 96 S. Ct. 2465, 49 L. Ed. 2d 245 [redacted], overruled by Garcia v. San Antonio Metro Transit Auth. 469 U.S. 528, 1[redacted]ct. 1005, 83 L. Ed. 2d 1016 (1985), invalidated provisions in the Fair Labor Standards Act applicable to state and local governments as exceeding Congress' power under the Commerce Clause.

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[*68]

C. The Commerce Clause

The Supreme Court's interpretation of the Commerce Clause has expanded greatly over the better part of the last two centuries. In one pre-Lopez case, a federal district court described the expansion of that clause as follows:

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To be within the ambit of the Commerce Clause, an activity originally had to be commerce that moved across state lines. With time, courts began to hold that the commerce need only affect movement across state lines. Finally, courts dropped the commerce requirement and applied the Clause to any activity that affects movement across state lines. The sole remaining limitations on Congress's power under the Commerce Clause is the requirement that the effect on commerce be substantial.

Michigan Protection & Advocacy Service v. Babin, 799 F. Supp. 695, 735 (E.D. Mich. 1992), aff'd, 18 F.3d 337 (6th Cir. 1994).

Since the 1930's the Supreme Court has found very little in the Constitution that limits Congress' power to justify legislation under the Commerce Clause. Prior to United States v. Lopez, 514 U.S. , 114 S. Ct. 1624 (1995), the only unsettled area appeared to involve the ability of Congress [*69] to regulate states themselves. In National League of Cities v. Usery, 426 U.S. 833, 49 L. Ed. 2d 245, 96 S. Ct. 2465 (1976) the Court held that the Commerce Clause did not give Congress power to regulate "the state as a state." n69 A few years later, the Court overturned National League of Cities by its decision in Garcia v. San Antonio 469 U.S. 528, 83 L. Ed. 2d 1016, 105 S. Ct. 1005 (1985), holding that the sovereignty of the states does not limit Congress' power under the Commerce Clause. n70 Then, somewhat inconsistently, the Court decided in United States v. New York, 505 U.S. 144, 112 S. Ct. 2408, 120 L. Ed. 2d 120 (1992), that the Constitution does not give Congress power to "Commandeer the legislative procedure of the states by directly compelling them to enact and enforce a federal regulatory program." Id. at 2428 (quotation omitted). While the holding in New York did not rest on the Tenth Amendment, the Court noted that "the Tenth Amendment confirms that the power of the Federal Government is subject to limits that may, in a given instance, reserve power to the states." Id. at 2418. The application of the federalism principles found in New York [*70] has remained somewhat uncertain as reflected in recent federal circuit cases ruling on the Brady Bill. n71 At the same time, however, the Court has recently reaffirmed the traditional principles of state sovereignty in a case from this circuit, Seminole Tribe of Fla. v. Florida, U.S. , 116 S. Ct. 1114, 134 L. Ed. 2d. 252 (1996), which rejected the principle that Congress' Commerce Clause power could be used to overrule a state's sovereign immunity. n72

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n69 The particular issue involved the application of the Fair Labor Standards Act to state and local government.

n70 Again the particular issue involved the Fair Labor Standards Act.

n71 Contrast Koog v. United States, 79 F.3d 452 (5th Cir., 1996) (holding the Brady Act exceeds Congress' power per New York v. United States, insofar as it requires local law enforcement official to administer the Act) with Mack v United States, 66 F.3d 1025 (9th Cir. 1995) (upholding the Brady Act against a challenge under New York v. United States).

n72 The particular case involved the Indian Commerce Clause, but the case overruled Pennsylvania v. Union Gas Co., 491 U.S. 1, 109 S. Ct. 2273, 105 L. Ed. 2d 1 (1988), which involved the general Commerce Clause.

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[*71]

United St[redacted]v. Lopez did not involve federal regulation of a state itself. Rather, the federal gun statute at issue attempted to exercise police power over matters historically falling within the jurisdiction of local government. In declaring Congress had exceeded its powers under the Commerce Clause in regulating non-state action, the Court seemed to open up many questions. The dissenting Justices warned that "the Court's holding threatens legal uncertainty in an area of law that, until [Lopez], seemed reasonably well settled." Id. at 514 U.S. , 115 S. Ct. at 1664 (Breyer, J., dissenting). The dissenters were clearly concerned that changes which occurred in landmark cases in the late 1930's and early 40's could be overturned. Id. at 514 U.S. , 115 S. Ct. at 1665.

Despite the potential for uncertainty, the majority focused on the Constitution's limits on federal power. They emphasized that the Constitution does not grant Congress "a plenary police power that would authorize enactment of every type of legislation." Id. at , 115 S. Ct. at 1633. While a few of its cases had "taken long steps" towards granting such "a general police [*72] power of the sort retained by the states," the Court declined to follow some of the very broad language which seemed to allow Congress to do virtually anything under the Commerce Clause. Id. at , 115 S. Ct. at 1634.

Any application of Lopez must begin with its reassertion that the Constitution's enumeration of powers limits federal power, that such enumeration "[does] not presuppose something not enumerated." Id. at , 115 S. Ct. at 1634 (citing Gibbons v. Ogden, 22 U.S. (9 Wheat.) at 195, 6 L. Ed. 23 (1824)).

Since this country's inception, the division of powers between the state and federal governments has been a constant source of friction. Indeed, that conflict was considered an important institutional protection for liberty. n73 Moreover, federal courts have been considered essential to preserving the federal state balance. n74 Thus, in performing its duty to elucidate the meaning of the Constitution in such a way as to reconcile prior case law with the meaning of the Constitution itself, n75 the federal courts play an important part in maintaining federalism.

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n73 See [redacted]lly The Federalist No.39. [*73]

n74 See [redacted]he Federalist No. 44, at 233 (James Madison) (George W. Carey and James McClellan eds., 1990)
(If it be asked what is to be the consequence, in case the Congress shall misconstrue this part of the Constitution, and exercise powers not warranted by its true meaning? I answer the same as if they should misconstrue or enlarge any other power vested in them, as if the general power had been reduced to particulars, and any one of these were to be violated; the same in short, as if the State Legislatures should violate their respective constitutional authorities. In the first instance, the success of the usurpation will depend on the executive and judiciary departments, which are to expound and give effect to the legislative acts; and in the last resort, a remedy must be obtained by the people, who can by the election of more faithful representatives, annul the

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acts of the usurpers.);

See also McCu[redacted]h v. Maryland 17 U.S. (4 Wheat.) 316, 423, 4 L. Ed. 579 (1819) (Marshall, C[redacted]("Should Congress, under the pretext of executing its powers, pass laws fo[redacted] accomplishment of objects not entrusted to the government, it would become [redacted]painful duty of this tribunal, should a case requiring such a decision come before it, to say that such an act was not the law of the land.); The Federalist No. 78, at 404 (Alexander Hamilton) (George W. Carey and James McClellan eds., 1990) (referring to the courts as "the bulwarks of a limited constitution against legislative encroachments."). [*74]

n75 "The ultimate touchstone of constitutionality is the Constitution itself and not what we have said about it." Graves v. O'Keefe, 306 U.S. 466, 491-492, 59 S. Ct. 595, 603-604, 83 L. Ed. 927 (1939) (Frankfurter, J., concurring). But see Cooper v. Aaron 358 U.S. 1, 18, 78 S. Ct. 1401, 3 L. Ed. 2d 5 (1958) (per curiam) (dictum) (characterizing decisions of the Supreme Court as "the supreme law of the land"); see also Addresses and Papers of Charles Evans Hughes 133, 139 (1908) (speech to the Elmira Chamber of Commerce (May 3, 1907)) ("The Constitution is what the judges say it is.).

See also Justice Thomas' concurrence: "Although I join the majority, I write separately to observe that our case law has drifted far from the original understanding of the Commerce Clause. In a future case, we ought to temper our Commerce Clause jurisprudence in a manner that both makes sense of our more recent case law and is more faithful to the original understanding of that Clause." Id. at 514 U.S. , 115 S. Ct. at 1642. In short, as the majority in Lopez implicitly recognized, it is our jurisprudence that must be squared with the constitution, not the other way around.

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[*75]

Accordingly, this court applies the principle of enumerated powers discussed in Lopez to the question of CERCLA'S constitutionality. In so doing, this court finds that, when measured against the "ultimate touchstone of constitutionality," Graves v. O'Keefe, 306 U.S. 466, 491-492, 59 S. Ct. 595, 603-604, 83 L. Ed. 927 (1939) (Frankfurter, J., concurring), the application of CERCLA to this case exceeds the power given Congress under the Commerce Clause.

1. The Constitutional Text and Its Original Interpretation

As stated [redacted]pez:

We start [redacted]irst principles. The Constitution creates a Federal Government of enumerated powers. See U.S. Const., Art. I, § 8. As James Madison wrote, "the powers delegated by the proposed Constitution to the federal government are few and defined. Those which are to remain in the State governments are numerous and indefinite." The Federalist No. 45, pp. 292-293 (C. Rossiter ed. 1961). This constitutionally mandated division of authority "was adopted by the Framers to ensure protection of our fundamental liberties." Gregory v. Ashcroft, 501 U.S. 452, 458, 111 S. Ct. 2395, 2400, 115 L. Ed. 2d 410 (1991) (internal quotation [*76] marks omitted). "Just as the separation and independence of the coordinate branches of the Federal Government serves to prevent the accumulation of excessive power in any one branch, a healthy balance of power between the States and the Federal Government will reduce the risk of tyranny and abuse

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from either front." Ibid.

Lopez, 514 U[redacted]t , 115 S. Ct. at 1626 (opinion of Rehnquist, C.J.); see also Id. 514 [redacted] at , 115 S. Ct. at 1638 (Kennedy, J., concurring) ("It was the insight [redacted]e Framers that freedom was enhanced by the creation of two governments, not one").

Perhaps, "it is easy to lose sight of all this in a day when Congress appropriates trillion-dollar budgets and regulates myriad aspects of economic and social life. Nevertheless, there are occasions on which we are reminded of this fundamental postulate of our constitutional order." United States v. Lopez, 2 F.3d 1342, 1345 (5th Cir. 1993), aff'd, 514 U.S. , 115 S. Ct. 1624, 131 L. Ed. 2d 626 (1995).

a. Enumerated Powers and the Necessary and Proper Clause

The Constitution enumerated the powers of Congress in Article I, Section 8, which begins: "The Congress [*77] shall have the Power To . . . ." Then, in the following eighteen clauses, the text listed the powers given to Congress, including the Commerce Clause and the Necessary and Proper Clause.

From the beginning, the import of the necessary and proper clause was controversial. In the administration of George Washington, Secretary of State Thomas Jefferson argued for a narrow or strict interpretation of the enumerated powers. n76 His views reflected those of the anti-Federalists who had opposed the Constitution, in large measure from fear of the necessary and proper clause. They desired a provision like the one in the Articles of Confederation which had limited the powers of the government to those "expressly" delegated by the states. The anti-Federalists lost this argument, even when they got the Tenth Amendment as part of the Bill of Rights, as this amendment failed to use the term "expressly. n77" In opposition to Jefferson, Alexander Hamilton -- following the Federalist -- argued for a broader interpretation of the enumerated powers, but nevertheless one within the structural constraints of the Constitution. As Hamilton had written in The Federalist, no one was proposing an all-powerful [*78] government; only a more powerful central government than that of the Articles of Confederation. n78

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n76 See Carl B. Swisher, American Constitutional Development at 72-73, Riverside P[redacted]1943).

n77 The [redacted]mendment states, "The powers not delegated to the United States by th[redacted]titution, nor prohibited by it to the States, are reserved to the States respectively, or to the people.

n78 See generally, The Federalist Nos. 23-36.

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The views of Hamilton and The Federalist found their way into the Marshall Court, which is hardly surprising since the Court was dominated by Federalists. The same basic Federalist viewpoint which created the text of the Constitution also interpreted that text. Moreover, Chief Justice Marshall's opinions coincided with The Federalist without ever citing those essays. n79

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Apparently, Marshall's point was to derive meaning directly from the text and structure of the Constitution rather than to rely on a secondary source.

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n79 See J[illegible]ove, "Early Uses of The Federalist" in Saving the Revolution (C. Kessler, ed.) (N.Y., 1987) at 240 ("his jurisprudence and its Hamiltonian strains were independent expressions of a set of principles and beliefs that both men had long shared ... In fact, Marshall rarely made use of The Federalist in his opinions.") (footnotes omitted)

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[*79]

Marshall's opinion in McCulloch v. Maryland, 17 U.S. (4 Wheat.) 316, 4 L. Ed. 579 (1819) is often referred to as giving a broad interpretation of the necessary and proper clause. In fact, McCulloch demonstrated that the necessary and proper clause is unnecessary. That is to say, McCulloch first explained how a proper interpretation of the enumerated powers supports Congress' power to create the Bank of the United States. n80 The fact that Congress did not have the power generally to create corporations (and still does not attempt to exercise such a power) did not mean it lacked the power to create a particular corporation as a means to the exercise of one or more of its clearly enumerated powers.

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n80 McCulloch v. Maryland, 17 U.S. (4 Wheat.) at 407-408.

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The necessary and proper clause in no way expanded the enumerated powers of Congress; n81 it simply left no doubt that Congress has the fullness of those powers actually granted in the Constitution. McCulloch, therefore, followed the explanation [*80] of the necessary and proper clause as provided in The Federalist, namely that it is merely "declaratory of a truth, which would have resulted by necessary and unavoidable implication from the very act of constituting a Federal Government, and vesting it with certain specified powers." The Federalist No. 33, at 159 (George W. Carey and James McClellan eds., 1990) (arguing further that "the constitutional operation of the intended government would be precisely the same, if [the Necessary and Proper Clause and the Supremac[illegible]se] were entirely obliterated, as if they were repeated in every artic[illegible] See also The Federalist No. 44, at 232 (George W. Carey and James McCle[illegible]s., 1990) ("No axiom is more clearly established in law, or in reason, than that wherever the end is required, the means are authorized; wherever a general power to do a thing is given, every particular power necessary for doing it, is included.") (emphasis added). Echoing this reading of the text, McCulloch v. Maryland stated, "it may with great reason be contended, that a government, entrusted with such ample powers, on the due execution of which the happiness and prosperity of [*81] the nation so vitally depends, must also be entrusted with ample means for their execution." (emphasis added) 17 U.S. (4 Wheat.) 316, 408, 4 L. Ed. 579 (1819).

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n81 "The doctrine that Congress may provide for regulation of activities not themselves interstate commerce, but merely 'affecting' such commerce, rests on the premise that in certain fact situations the Federal government may find that regulation of purely local and intrastate commerce is 'necessary and proper' to prevent injury to interstate commerce." Polish National Alliance of the United States of North America v. National Labor Relations Board, (Black J., concurring) 322 U.S. 643, 652, 64 S. Ct. 1196, 88 L. Ed. 1509 (1944).

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In McCulloch, Marshall discussed the relationship between ends and means as applied to the necessary and proper clause: "Let the end be legitimate, let it be within the scope of the constitution, and all means which are appropriate, which are plainly adapted to that end, which are not prohibited, but consist of the letter and spirit [*82] of the constitution, are constitutional." McCulloch, 17 U.S. at 421. According to Chief Justice Marshall, McCulloch represented no augmentation of the enumerated powers. Writing in defense of the opinion under the pseudonym "A Friend of the Constitution," Marshall insisted that McCulloch "does not contain the most distant illusion to any extension by construction of the powers of congress. Its sole object is to remind us that a constitution cannot possibly enumerate the means by which the powers of government are to be carried into execution." n82 McCulloch's statement that we must remember that it is a constitution we are interpreting was not a justification for departing from the text, but an indication of how to interpret the text, i.e., not narrowly like a statute. n83 Thus, Marshall stated that a Constitution does not "partake of a prolixity of a legal code." McCulloch, 17 U.S. at 407.

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n82 G. Gunther, ed., John Marshall's Defense of McCulloch v. Maryland 185.

n83 See discussion of McCulloch by Justice Story in II Commentaries on The Constitution, §§ 1263-70 (Cambridge; MA, 1858) (3rd ed.) at 149-161.

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[*83]

The necessary and proper clause is like the Tenth Amendment in that both declare what the structure of the Constitution already provides. As Chief Justice Marshall and The Federalist say, the necessary and proper clause merely declares that powers given to the federal government are given in their fullness. This clause does not mean -- as anti-Federalists feared -- that Congress can create other powers not listed by invoking the necessary and proper clause. Accordingly, the Tenth Amendment reflects the attempt to quiet what Federalists at the time considered to be unfounded fears. Thus, "the Tenth Amendment does not independently provide a substantive limitation on the powers of the United States. Instead the Tenth Amendment simply makes plain that the federal government possesses only the powers that have been given to it by the Constitution--and no more." Koog v. United States, 79 F.3d at 455, (5th Cir., 1996).

b. Marshall's Interpretation of the Commerce Clause

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The power referred to as "the Commerce Clause", Article I, Section 8 provides: "The Congress shall have Power ... To regulate Commerce with foreign Nations, and among the several States, and with the Indian [*84] Tribes." U.S. Const. Art. I, § 8, cl. 3. "Even to speak of 'the Commerce Clause,' perhaps obscures the actual scope of that clause because Congress did not have authority to regulate all commerce; Congress could only regulate Commerce with foreign Nations, and among the several States, and with the Indian' Tribes.'" Lopez, 514 U.S. at , n. 2, 115 S. Ct. at 1644 n. 2 (Thomas, J., concurring).

Five years after McCulloch, Chief Justice Marshall wrote Gibbons v. Ogden, 22 U.S. (9 Wheat.) 1, 6 L. Ed. 23 (1824) which is the classic analysis of the text of the Commerce Clause in its fullness. n84 He addressed the three questions which naturally follow from the language of the "power to regulate commerce among the several states." He discussed: 1) whether the subject of the congressional legislation is commerce; 2) whether the commerce affects other states; and 3) whether the legislation regulates the commerce. n85 Neither the text nor Gibbons use the term "interstate." As to the phrase "among the several states," Gibbons asks whether the commerce affects other states, not whether some activity affects interstate commerce. The text and Gibbons ask whether [*85] the federal legislation regulates the commerce, not some activity which affects interstate commerce. n86

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n84 The language of the clause differs in its choice of prepositions to precede "foreign Nations," i.e.. "with," and States, i.e., "among". The import of the difference becomes readily apparent by using the preposition "among" to precede "foreign Nations." The power to regulate commerce "among" is a superintending power which Congress possesses vis-a-vis the states, but obviously not vis-a-vis foreign nations.

n85 22 U.S. 1, 9 Wheat. (22 U.S.) 1, 189-197, 6 L. Ed. 23 (1824).

[The] words are, "Congress shall have power to regulate commerce with foreign nations, and among the several states, and with the Indian tribes."

The subject to be regulated is commerce; and... [to] ascertain the extent of the power, it becomes necessary to settle the meaning of the word. The counsel for the appellee would limit it to traffic, to buying and selling, or the interchange of commodities, and do not admit that it comprehends navigation. This would restrict a general term, applicable to many objects, to one of its significations. Commerce, undoubtedly, is traffic, but is something more; it is intercourse. It describes the commercial intercourse between nations, and parts of nations, in all its branches, and is regulated by prescribing rules for carrying on that intercourse...

....

To what commerce does this power extend? The constitution informs us, to commerce "with foreign nations, and among the several states, and with the Indian tribes.

It has [been] universally admitted that these words comprehend every species of commercial intercourse between the United States and foreign nations. No sort of trade can be carried on between this country and any other, to which this

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power does not extend...

[The] sub[illegible]to which the power is next applied, is to commerce "among the several stat[illegible]The word "among" means intermingled with. A thing which is among others [illegible]intermingled with them. Commerce among the states cannot stop at the external [illegible]ndary line of each state, but may be introduced into the interior.

It is not intended to say that these words comprehend that commerce which is completely internal, which is carried on between man and man in a state, or between different parts of the same state, and which does not extend to or affect other states. Such a power would be inconvenient, and is certainly unnecessary.

Comprehensive as the word "among" is, it may very properly be restricted to that commerce which concerns more states than one. The phrase is not one which would probably have been selected to indicate the completely interior traffic of a state, because it is not an apt phrase for that purpose; and the enumeration of the particular classes of commerce to which the power was to be extended, would not have been made, had the intention been to extend the power to every description. The enumeration presupposes something not enumerated; and that something, if we regard the language or the subject of the sentence, must be the exclusively internal commerce of a state. The genius and character of the whole government seem to be, that its action is to be applied to all the external concerns of the nation, and to those internal concerns which affect the states generally; but not to those which are completely within a particular state, which do not affect other states, and with which it is not necessary to interfere, for the purpose of executing some of the general powers of the government. The completely internal commerce of a state, then, may be considered as reserved for the state itself.

....

[We] are now arrived at the inquiry -- What is this power?

It is the power to regulate; that is, to prescribe the rule by which commerce is to be governed. This power, like all others vested in Congress, is complete in itself, may be exercised to its utmost extent, and acknowledges no limitations, other than are prescribed in the constitution... [If], as has always been understood, the sovereignty of Congress, though limited to specified objects, is [illegible]y as to those objects, the power over commerce with foreign nations, an[illegible]g the several States, is vested in Congress as absolutely as it would be in [illegible]le government, having in its constitution the same restriction[illegible]e exercise of the power as are found in the constitution of the United States.
[*86]

n86 Justice Thomas makes a different critique of the Court's jurisprudence. He says that the "substantially affects" language so broadens Congress's power that much of Art. 1, Sec. 8 becomes "surplusage." (Thomas, J., concurring).

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2. Deconstruction of the Constitutional Text

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The shift in focus from the text itself to a distinction between interstate and intrastate commerce came later. Lopez did not discuss specifically this transformati[illegible]he several opinions mentioned in Lopez, however, did relate that the exp[illegible] use of the Commerce Clause began with the Interstate Commerce Act of 1887, [illegible]115 S. Ct. at 1627, and that in reviewing congressional legislation, the Court had borrowed, inappropriately as Chief Justice Rehnquist noted, from its negative or dormant Commerce Clause jurisprudence which pertained to state legislation. Id.

a. The Influence of the Dormant Commerce Clause

As is generally recognized, the early dormant commerce clause cases divided federal and state powers in analytical or categorical terms. In Cooley v. Bd. of Wardens of the Port of [*87] Philadelphia, 53 U.S. 299, 12 HOW 299, 13 L. Ed. 996 (1851), the Court drew a distinction between those things subject to national regulation and those subject to local regulation. n87 Such an approach, unlike that of Marshall, n88 was bound to fail. Under this analysis, the Court decided whether the object of regulation was or was not local. If it was "local", the Court allowed the state to regulate it; if national, states could not regulate it. Whatever merit this approach may have to analysis of state regulatory power, n89 its application to federal statutes inappropriately limited Congress. That is to say, the Court declared in some cases that Congress could not regulate things that the Court declared were "local." The Court ignored the possibility that something might be local, in the sense that a state could regulate it, without being beyond Congress' reach. This approach, epitomized later by Hammer v. Dagenhart, 247 U.S. 251, 38 S. Ct. 529, 62 L. Ed. 1101 (1918), failed to acknowledge that both the state and federal governments might regulate the same commerce because even though it was "local" in a certain sense it was also affecting other states.

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n87 12 HOW at 319-320. [*88]

n88 Although the Marshall Court did not address many Commerce Clause Cases, either active or dormant, it did address both. The Court decided Willson v. The Black Bird Creek Marsh Co., 27 U.S. 245, 7 L. Ed. 412 (1829) and Brown v. Md., 25 U.S. 419, 6 L. Ed. 678 (1827).

n89 Whether the Constitution contains a "dormant" Commerce Clause is not an issue in thi[illegible]. See Justice Scalia's argument that the Constitution does not contain a d[illegible] commerce clause in Tyler Pipe Industries v. Washington, 483 U.S. 232, 1[illegible]t. 2810, 97 L. Ed. 2d 199 (1987) (Scalia, J., concurring).

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The faulty framework of analysis adapted from the dormant Commerce Clause then got mixed in with the confusion between regulating commerce and exercising police powers -- a distinction critical to Lopez. Beginning in the late 19th century a dialectual process occurred between the Court and Congress that expanded Congress' power. n90 The process began when Congress attempted to prohibit transmission by mail or importation of lottery tickets. When this failed, Congress also prohibited [*89] the transportation of lottery tickets across state lines in the 1895 Lottery Act. n91 In Champion v. Ames n92 (upholding the constitutionality of the Lottery Act), the Supreme Court

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divided over the question whether regulating the movement of lottery tickets was within congressional power or within the police power of the states. In upholding th[redacted]hibition, the majority noted that it considered the purpose of the Act pert[redacted] to the constitutional question. The Court recognized a general police powe[redacted]ongress to eliminate evils which threaten the general welfare. n93

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n90 Much of this historical overview summarizes part of an article by John S. Baker, Jr., "Nationalizing Criminal Law: Does Organized Crime Make It Necessary or Proper?", 16 Rutgers L.Rev. 495, 521-531 (1985).

n91 Act of March 2, 1895, ch. 191, 28 Stat. 963.

n92 188 U.S. 321, 23 S. Ct. 321, 47 L. Ed. 492 (1903).

n93 Id. at 355-57.

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The dissent in Champion contended, inter alia, that the prohibition [*90] was not within the necessary and proper power of Congress because, while the "purpose" of the Act was the suppression of lotteries, the exercise of a general police power by the Congress conflicted with the powers reserved to the states under the Tenth Amendment. n94 In fact, the Act neither interfered with the police powers of any state nor represented a general, national police power. As the dissent itself noted, the Act did not prevent lotteries in states which chose to legalize them. n95 What the Act did was to prevent a seller of lottery tickets in a state where lotteries were legal from sending those lottery tickets into other states where lotteries were illegal. As a result of a previous Supreme Court decision, n96 a state on its own authority could not prohibit items from being mailed into or otherwise transported into its jurisdiction. Thus, regardless of the congressional motive or the broad dicta in the Champion opinion, the Lottery Act regulated a matter (cross-border movement of certain commerce) which the Court's interpretation of the dormant Commerce Clause had placed beyond the power of the states. n97 Champion exemplified Congress' use of the prohibiting technique [*91] to regulate, indeed to prevent, the flow of certain commerce across state lines. n98

- - - - - - [redacted] - - - - - - - - - -Footnotes- - - - - - - - - - - - - - - - - - -

n94 Id. [redacted] (Fuller, C.J., dissenting).

n95 Id. at 357.

n96 In Leisy v. Hardin, 135 U.S. 100, 10 S. Ct. 681, 34 L. Ed. 128 (1890), the Court had prohibited states from blocking shipments of liquor into the state.

n97 Id.

n98 The sale of lottery tickets in Louisiana was local as long as restricted to the state. Once they moved across state lines, they affected other states. Congress at the time, but not the Court, understood this difference.

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While the [redacted]ent in Champion incorrectly argued that Congress' "purpose" made the sta[redacted]y prohibition improper, the majority also erred when it suggested that Congress had the power to prohibit because of its worthy purpose. The Court should have held that Congress has the power to prohibit the movement of commerce across state lines regardless of purpose. n99 Had this been made clear, the Court might not have later struck down the [*92] child labor laws in Hammer v. Dagenhart n100 based on what the majority considered to be an improper purpose. After Champion, however, the power to prohibit seemed to turn on the purpose. n101 Indeed, members of Congress read Champion as positing a national police power premised upon purpose. n102

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n99 See United States v. Darby, 312 U.S. 100, 115, 61 S. Ct. 451, 85 L. Ed. 609 (1941) (upholding Fair Labor Standards Act of 1938).

n100 247 U.S. 251, 38 S. Ct. 529, 62 L. Ed. 2d 1101 (1918).

n101 Congress' purpose in passing the statute is one thing; the statute's inclusion of the word "purpose" as an element in the proof of the offense is another. Mann Act § 2, quoted supra note 128. As for Congress, its purpose in the sense of its motive for passing the legislation might or might not have been accurately incorporated into the purpose of the statute as evidenced by its language. Thus, although the legislative history of a statute such as the Mann Act may have reflected Congress's limited purpose, i.e., to stop the systematic enticement and interstate transportation of women for purposes of prostitution, proponents of the Act emphasized that its provisions did not reach prostitution or immorality "per se," but only interstate and international "white slave trade." H.R. Rep. No. 47, supra note 129, at 1-2, 9-11; E. Levi, An Introduction to Legal Reasoning 36-38 (1949).

The interpretation of the statutory language may not be limited to the legislative purpose. Thus, in Caminetti v. United States, 242 U.S. 470, 37 S. Ct. 192, 61 L. Ed. 442 (1917), the Supreme Court found that the statute reflected much broader purposes. The actual language of the statute was not as limited as the legislative history would indicate, but extended to single incidents of transportation for "any immoral purpose." In Caminetti Justice McKenna dis[redacted] because he thought the Court's construction of the Act went beyond the [redacted]es intended by Congress. Yet, previously, in Hoke v. United States, 227 [redacted]308, 33 S. Ct. 281, 57 L. Ed. 523 (1913) he wrote the opinion upholding th[redacted]r Act against a Commerce Clause challenge. Had Justice McKenna paid more attention to the statute itself in Hoke, he would have seen that its language went well beyond the congressional purposes. As an element of the offense, the word "purpose" required the prosecution to prove the defendant had a certain criminal intent. Congress' purpose in putting the word "purpose into the statute was clear; it appeared to provide a Commerce Clause justification for purporting to prohibit the transportation of persons within the country. The effect of regulating persons based on their purposes, i.e., motive or intent, however, was to create a "true" crime rather than a regulatory offense. [*93]

n102 Thus, Congress thought purpose provided the constitutional justification for passage of the Mann (White Slave) Act. White-Slave Traffic (Mann) Act, ch.

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395, § 2, 36 Stat. 825 (1910). After quoting from Champion, the House Committee Report concluded:

Certainly, [redacted]he case of lotteries there is nothing harmful in the mere transportati[redacted] the pieces of paper. The injury resulted from the connection which existe[redacted]ween those tickets and the entire scheme of the lottery. It was the purpose for which the tickets were used which made them an instrument of injury to the public. H.R. Rep. No. 47, 61st Cong., 2d Sess. 4-5 (1909).

In Hoke v. United States, 227 U.S. 308, 57 L. Ed. 523, 33 S. Ct. 281 (1913), the Court analogized the aims of the Mann Act to those of the Lottery Act and the Pure Food and Drug Act. Ch. 3915, 35 Stat. 768 (1906). The Mann Act, however, differed from both because it did not actually prohibit anything or anyone from crossing state lines. Although purporting to prohibit transportation, it could not do so because it regulated persons rather than things. The Court dismissed such differences, contending that "the substance of the congressional power is the same, only the manner of its exercise must be accommodated to the difference in its objects." 227 U.S. at 323. The Court considered the similarity of purpose sufficient to uphold the Mann Act under the Commerce Clause. Id at 322-23. Nevertheless, the difference in means were significant. In the Food and Drug Act, like the Lottery Act, Congress had provided for seizure of the offending articles when shipped across state lines even though the misbranded food itself was not illegal when prepared. Pure Food and Drug Act, ch. 3915, § 10, 34 Stat. 768, 771 (1906). The Mann Act did not prohibit transportation of impure or immoral things. It punished a male who had certain immoral or criminal purposes (a criminal mental element), as the object of transporting a woman across state lines.

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[*94]

Having facilitated the transformation of Congress' regulatory power into an implied national police power, the Court later cut back on Congress' clearly constitutional powers. In Hammer v. Dagenhart, the Court invalidated the congressional prohibition of the interstate transportation of goods made using child labor. The decision departed from Champion and other cases in that it denied Congress the power to prohibit the shipment of certain goods across state lines. The Court, however, was consistent with prior cases in the sense that, as in Champion and other cases, the decision turned on congressional purpose. n103

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n103 The [redacted] distinguished the approved congressional purposes discussed in Champion, H[redacted]e and Hoke from the economic purpose behind the child-labor legislation. Id. at 270-72. Not only was legislation based on Congress' economic purposes more clearly constitutional than that based on moral purposes, but as Justice Holmes observed, See 247 U.S. at 280 (Holmes, J. dissenting) the moral purposes prompting the childlabor legislation were certainly no less worthy than those supporting earlier congressional legislation based on Congress' economic purposes upheld by the Court. In both Hammer v. Dagenhart, 247 U.S. at 276 ("We have neither authority nor disposition to question the motives of Congress in enacting this legislation.") voiding congressional legislation and in Champion, upholding congressional legislation, the Court took the same position, namely that the extension of national power -- whether regulatory or police -- turned on the Court's approval of Congress' purpose.

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[*95]

Even Fr[redacted] Roosevelt's Justice Department viewed Champion and other "police po[redacted]cases in one category, set apart from the regulation of commerce. n104 The Roosevelt administration initially avoided the prohibiting commerce technique in favor of other forms of regulation based on the "affecting commerce" and "in commerce" rationales. After the Supreme Court made its famous 1937 course correction in N.L.R.B. v. Jones & Laughlin Steel, 301 U.S. 1, 57 S. Ct. 615, 81 L. Ed. 893 (1937), Congress employed both the commerce-prohibiting technique and direct regulation based on the "affecting commerce" rationale when it enacted the 1938 Fair Labor Standards Act (FLSA). In United States v. Darby, n105 which upheld the Act and overruled Hammer v. Dagenhart, the Court approved both the prohibiting technique and direct regulation based on the "affecting commerce" rationale. Although not regulating a true crime, the FLSA made its regulations of economic relationships enforceable by criminal sanctions. The combination in Darby of a regulatory offense, the prohibiting technique, and the affecting commerce rationale later resulted n106 in the commingling of two lines [*96] of cases -- the exercising police power cases and the regulating economic activity cases -- once thought to be separate.

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n104 See n. 111, infra.

n105 312 U.S. 100, 61 S. Ct. 451, 85 L. Ed. 609 (1941).

n106 See Perez v. United States, 402 U.S. 146, 28 L. Ed. 2d 686, 91 S. Ct. 1357 (1971).

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The coincidence in Darby of the prohibiting technique, which requires no rationale, and the "affecting commerce" rationale, which supports various techniques, did not immediately result in the expansion of federal criminal law. Although it interpreted the "affecting commerce" rationale expansively in economic matters, the Court generally took a much more restrictive view in criminal cases prior to 1970 when it decided Perez v. United States, 402 U.S. 146, 91 S. Ct. 1357, 28 L. Ed. 2d 686 (1971). In Perez, various strands from the cases under the Commerce Clause met and merged into an expansive view of Congress' [redacted] to create criminal law. The Court upheld application of a federal "l[redacted]ark" statute to [*97] local acts without any showing of an interstat[redacted] or effect. n107 The Court considered it sufficient that the activity was part of a class of activities which Congress had targeted as having affected commerce through organized crime. Id. at 154-56. The Court thought Darby to be "particularly relevant . . . because it involved a criminal prosecution." n108 However, Darby and the cases which built on it and were cited in Perez -- Wickard v. Filburn 317 U.S. 111, 63 S. Ct. 82, 87 L. Ed. 122 (1942), and the public accommodations cases, Atlanta Motel v. United States 379 U.S. 241, 85 S. Ct. 348, 13 L. Ed. 2d 258 (1964), and Katzenbach v. McClung 379 U.S. 294 85 S. Ct. 377, 13 L. Ed. 2d 290 (1964), -- were not criminal cases, even though indictments for regulatory offenses may have been involved.

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n107 402 [redacted] 146, 154-157, 91 S. Ct. 1357, 28 L. Ed. 2d 686

n108 Id [redacted] 52-53.

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b. United States v. Lopez

As observed above, n109 the majority in Lopez recognized the uncertainty unleashed upon the lower courts [*98] left to reconcile that case with other Commerce Clause cases. In reopening debate on issues once thought foreclosed, the majority opinion in Lopez walks a fine line between two different views expressed by justices who, while joining the opinion, also write concurring opinions. Two of the justices "counsel[] great restraint," 115 S. Ct. at 1634 (Kennedy, J., concurring), but one justice would "reconsider our 'substantial effects' test with an eye toward constructing a standard that reflects the text and history of the Commerce Clause without totally rejecting our more recent Commerce Clause jurisprudence." Id. at 1642-43 (Thomas, J., concurring). While the Court's opinion may represent a moderate position among the justices in the majority, the dissenters consider the decision "radical." Id. at 1651 (Stevens, J., dissenting) ("I also agree with JUSTICE SOUTER's exposition of the radical character of the Court's holding.")

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n109 See p. 50, supra.

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In one Eleventh Circuit case applying Lopez, [*99] that court concluded that, under the Commerce Clause, Congress possesses the power to enact the Freedom of Access to Clinic Entrances Act of 1994, Pub. L. No. 103-259, 1098 Stat. 694 (1994) (codified at 18 U.S.C. § 248). See Cheffer v. Reno, 55 F.3d 1517 (11th Cir. 1995). The Eleventh Circuit found support for Congress' conclusion that the "access act regulates activity which 'substantially affects' interstate commerce." 55 F.3d at 1520. In upholding the Access Act, it was not necessary to go beyond a very narrow reading of Lopez. That is to say, Cheffer involved a criminal statute, like the gun statute in Lopez; but unlike the gun statute, C[redacted]s had made findings that the activity regulated by the Access Act "subst[redacted]ly affects interstate commerce." The court accepted those findings [redacted]uasive.

The Justice Department narrowly views Lopez as applying only to the facts of the Gun Free Schools Act. n110 Only wishful thinking, however, can lead to the conclusion that the holding of Lopez is applicable only to schools or guns-in-schools cases. Lopez could have chosen a narrower approach. Lopez could have narrowly limited its holding to federal [*100] criminal statutes under the Commerce Clause that involve no "substantial effect" on interstate commerce. It did not do so. Had Lopez taken such an approach, Cheffer need not have been decided any differently. More importantly, such a narrowed approach would not have opened to debate the fundamental turn taken in the late 1930s jurisprudence under the Commerce Clause, which the dissenters took pains to defend. As previously noted, until Perez v. United States in 1971, the Supreme Court did

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not actually confront the application of the post-1937 Commerce Clause jurisprudence to federal criminal statutes. Before and even since, the Court has tended towa[redacted]rrow construction of federal criminal statutes, thereby avoiding constitutio[redacted]ssues of federalism. See e.g., United States v. Bass, 404 U.S. 336, 92 S. [redacted]15, 30 L. Ed. 2d 488 (1971). Lopez could have, but did not, reach the [redacted] it did by disapproving Perez without thereby calling into question anything else about Commerce Clause jurisprudence from 1937 to 1971. n111

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n110 See Tr. of Hr'g at 4.

n111 A prominent "New Deal" advocate, Robert Stern, has written about Perez as being unrelated to the interpretation of the Commerce Clause put forth to justify 1930's economic legislation: "Even a lawyer who fought for a realistic interpretation which would recognize that in commercial matters the United States was one nation finds himself surprised at where we are now -- and at how readily the recent expansion is accepted." Robert Stern, The Commerce Clause Revisited: The Federalization of Intrastate Crime, 15 Ariz. L. Rev. 271, 284 (1973).

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[*101]

Instead, Lopez relies on Perez to categorize Commerce Clause cases as being divided into three: "First, Congress may regulate the use of the channels of interstate commerce. . . . Second, Congress is empowered to regulate and protect the instrumentalities of interstate commerce, or persons or things in interstate commerce, even though the threat may come only from intrastate activities. ... Finally, Congress' commerce authority includes the power to regulate those activities having a substantial relationship to interstate commerce." Id. at 1629-30 (citations omitted). Like Lopez, see Id. at 1629-30, this particular case involves only the third of these categories.

In discussing the third category, the Court repeatedly refers not simply to regulating activities which have a substantial effect on interstate commerce but to "regulating economic activity" which has a substantial effect on interstate commerce.

Section 922(q) is a criminal statute that by its terms has nothing to do with "commerce" [redacted]y sort of economic enterprise, however broadly one might define those ter[redacted]tion 922(q) is not an essential part of a larger regulation of economic [redacted]y, [*102] in which the regulatory scheme could be undercut unless the intrastate activities that arise out of or are connected with a commercial transaction, which viewed in the aggregate, substantially affects interstate commerce. Lopez, 514 U.S. , 115 S. Ct. at 1630.

In requiring that the object of the regulation, which "substantially affects" interstate commerce, must itself be "economic activity," (i.e., commerce) rather than merely "activities," the Court is being more faithful to Chief Justice Marshall's explanation in Gibbons v. Ogden. See text accompanying n.83.

Lopez also discusses and refutes the reasoning advanced by the government for justifying Congressional action in that case. The court found the government's

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"cost of crime" and "national productivity" rationales to be incorrect, because, under such reasoning, Congress could regulate any activity that might lead to violent cri[redacted] any activity affecting the economic productivity of individual citizens, "[redacted]dless of how tenuously [these activities] relate to interstate commerce." [redacted], 131 L. Ed. 2d 626, 514 U.S. , 115 S. Ct. 1624. By demonstrat[redacted]ow the inherent logic of [*103] certain rationales fails to place any meaningful limits on congressional authority, Lopez requires that there be a genuine causal connection between the regulated activity and interstate commerce. In so doing, the Court is being more faithful to Chief Justice Marshall's ends/means analysis in McCulloch. See n. 81 and accompanying text. In other words, the assumption that the regulation of any activity which has a substantial effect on interstate commerce is automatically "necessary and proper" is not appropriate under Lopez. Thus, the Lopez majority criticizes the dissent for their willingness to gloss over the tenuous connection between gun possession at a school and interstate commerce. As Chief Justice Rehnquist notes, "depending upon the level of generality, any activity can be looked upon as commercial." Lopez, 514 U.S. , 115 S. Ct. at 1633 (Rehnquist, C.J.). Such reasoning, "lacks any real limits," id., and would lead to the acceptance of a general police power at the federal level. Id. at 1634. See also Northern Securities Co. v. United States, 193 U.S. 197, 402-403, 24 S. Ct. 436, 48 L. Ed. 679 (1904) ("Commerce depends upon population, [*104] but Congress could not, on that ground, undertake to regulate marriage and divorce. If the act before us is to be carried out according to what seems to be the logic of the argument for the government . . . I can see no part of the conduct of life with which, on similar principles, Congress might not interfere"). n112

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n112 Accord Maryland V. Wirtz, 392 U.S. 183, 204-205, 88 S. Ct. 2017, 20 L. Ed. 2d 1020 (1968) (Douglas, J., dissenting). Noting that state government itself is an enterprise that has a substantial effect on interstate commerce, the Justice Douglas stated that the logic of the case would lead to the conclusion that "the National Government could devour the essentials of state sovereignty, though that sovereignty is attested to by the Tenth Amendment." Id at 205. See also A.L.A. Schechter Poultry Corporation v. United States, 295 U.S. 495, 554, 55 S. Ct. 837, 79 L. Ed. 1570 (1935)

There is a view of causation that would obliterate the distinction between what is national and what is local in the activities of commerce. Motion in the outer rim is communicated perceptibly, though minutely, to recording instruments at the centre. A society such as ours "is an elastic medium which transmits all tremors th[redacted] its territory; the only question is of their size." Per Learned Hand, J., [redacted] court below. The law is not indifferent to considerations of degree. Ac[redacted]es local in their immediacy do not become interstate and national [redacted] of distant repercussions.

(Cardozo J., concurring); Polish National Alliance of the United States of North America V. National Labor Relations Board, 322 U.S. 643, 650, 64 S. Ct. 1196, 88 L. Ed. 1509 (1944).

The interpenetrations of modern society have not wiped out state lines. It is not for us to make inroads upon our federal system either by indifference to its maintenance or excessive regard for the unifying forces of modern technology. Scholastic reasoning may prove that no activity is isolated within the boundaries of a single state, but that cannot justify the absorption of legislative power over every activity.

(Frankfurter, J.).

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[*105]

Finally, [redacted] above discussion is devoted to what Lopez says; however, that case is al[redacted]eworthy for what it fails to say. The ease with which the Supreme Cou[redacted]ight have upheld the Gun-Free Schools Act of 1990 is striking. This point was not lost on the dissenting justices. The Court might have held that guns are articles of commerce that can be used to restrain commerce. 514 U.S. at , 115 S. Ct. at 1651 (Stevens, J., dissenting). It did not. The Court could have aggregated "the effect of all guns possessed in or near schools[.]" Id. at , 115 S. Ct. at 1658 (Breyer, J., dissenting) (citing Wickard, 317 U.S. at 127-28, 63 S. Ct. at 89-90); see id. at , 115 S. Ct. at 1651 (Stevens, J., dissenting). It did not do this either. The Court also might have considered whether Congress could have had a rational basis for concluding that the "regulated activity sufficiently affected interstate commerce." n113 Id. at , 115 S. Ct. at 1658 (Breyer, J., dissenting). Again, the court would have none of this. n114 See Lopez at , 115 S. Ct. at 1630-34.

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n113 While the majority in Lopez does not utilize the rational basis test, it does mention it, albeit in the context of warning against granting Congress too much deference in deciding the extent of its authority under the Commerce Clause. See Lopez, 131 L. Ed. 2d 626, 115 S. Ct. 1624, n. 2 ("Simply because Congress may conclude that a particular activity substantially affects interstate commerce, does not necessarily make it so.") (quoting Hodel, 452 U.S. at 311) (Rehnquist, J., concurring in judgment); ("Whether particular operations affect interstate commerce sufficiently to come under the constitutional power of the Congress to regulate them is ultimately a judicial rather than a legislative question, and can be settled finally only be this Court.") (quoting Heart of Atlanta Motel, 379 U.S. at 273) (Black, J., concurring)." See also n. 72, supra. [*106]

n114 In addition, the majority might have asked, but did not, whether Congress could have found that gun violence around schools creates a commercial problem, Lopez at , 115 S. Ct. at 1659 (Breyer, J., dissenting), or perhaps a serious economic threat to "consequently inadequately educated workers who must endure low paying jobs" and to communities and businesses that might otherwise gain from a well-educated work force. Id. at , 115 S. Ct. at 1661 (Breyer, J., dissenting).

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3. App[redacted]n of Lopez to CERCLA.

Thus Lopez requires 1) that the statute itself regulate economic activity, which activity "substantially affects" interstate commerce. Id. at 1630; and 2) that the statute include a "jurisdictional element which would ensure, through case-by-case inquiry, that the [statute] in question affects interstate commerce." Id. at 1631. In applying Lopez to this case, the court finds it doubtful that the object of regulation in this case is "economic activity," i.e., "commerce," as that term is used in Lopez. It is true that at one [*107] point the defendant operated two plants, which are the focus of this litigation, and that these plants were surely engaged in "economic activity." These two plants, however, no longer operate and have not since 1982, long

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before this litigation was initiated.

Arguably, this case might be somewhat different if the government were attempting to regulate a functioning facility. Although, the complaint includes an allegation about threatened releases, the fact remains that this suit seeks clean-up of [illegible] property. While environmental degradation generally may have an effect on interstate commerce, it is not clear to this court that the degradation at issue in this case is necessarily "economic activity" or that it has a "substantial effect" on interstate commerce. It is clear to this court that the law regulating real property has been traditionally a local matter falling under the police power of the states. n115

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n115 See e.g., United States v. Little Lake Misere Land Co., 412 U.S. 580, 591, 93 S. Ct. 2389, 37 L. Ed. 2d 187 (1973) ("Even when federal general law was in its heyday, an exception was carved out for local laws of real property.") (Burger, C.J.); Davies Warehouse Co. v. Bowles, 321 U.S. 144, 155, 64 S. Ct. 474, 480, 88 L. Ed. 635 (1944) ("The great body of law in this country which controls acquisition, transmission, and transfer of property, and defines the rights of its owners in relation to the state or to private parties, is found in the statutes and decisions of the state.") Hawaii Housing Authority v. Midkiff, 467 U.S. 229, 241-242, 104 S. Ct. 2321, 81 L. Ed. 2d 186 (1984) ("Regulation of [land] oligopoly and the evils associated with it is a classic exercise of the State's police powers.")

It is also worth mentioning that Congress agrees that reduction, control, and the prevention of pollution, and the collection and disposal of solid waste, are all the primary responsibility of state and local governments. See e.g., 42 U.S.C. § 7401(a)(3) (Clean Air Act); 42 U.S.C. § 6901(a)(4) (Resource Conservation and Recovery Act); 33 U.S.C. § 1251(b) (Federal Water Pollution and Control Act).

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[*108]

Given that Lopez does not limit its holding to criminal cases, n116 the government must demonstrate that its use of CERCLA is limited to the regulation of economic activity, i.e., commerce, which "substantially affects" interstate commerce. Congress (or the Executive on behalf of Congress) may regulate economic activity which falls within the local police power, but it cannot exercise a [illegible]al police power. It appears to this court that CERCLA generally represents [illegible]ample of the kind of national police power rejected by Lopez. It is not ne[illegible] however, for this court to reach such a conclusion, because -- at least in this case -- the application of CERCLA fails to meet the second criteria of Lopez.

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n116 See text accompanying n. 111.

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Even if the application of CERCLA to the facts of this case does generally meet the first test of regulating intrastate economic activity which

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substantially affects interstate commerce, it must also be shown that the statute has a jurisdictional [*109] element which would ensure, through case-by-case inquiry, that the [statute] in question affects interstate commerce." S. Ct. at 1631. Nothing in the statute provides for such a case-by-case inquiry. Nevertheless, assuming it had such a provision, the particular inquiry in this case clearly demonstrates that the activity in question has virtually no effect on interstate commerce. As demonstrated in the remedial investigative report, any contaminants still at Site 1 affect groundwater mostly by migrating through the locally-contained alluvial aquifer. This aquifer lies atop a miocene aquifer. The remedial-investigation report indicates there is little or no migration between the two aquifers, and there is no evidence that contaminants at Site 1 travel across state lines.

Accordingly, this court holds that EPA's attempt in this case to apply CERCLA liability against the defendant would exceed the power of Congress under the Commerce Clause.

VII. CONCLUSION

For the reasons set forth above, the federal government has no constitutional authority to do what it proposes at Site 1. The court therefore has no authority to sign or enter the proposed consent decree and hereby [*110] DENIES the motion n117 to do so.

- -Footnotes- -

n117 Tab 3.

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Because the court has reached this conclusion, there is no conceivable remedy to which the plaintiff would be entitled to under the complaint. This action is therefore DISMISSED with prejudice.

SO ORDERED this 20th day of May 1996.

W B Hand

SENIOR DISTRICT JUDGE

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EX. G

Attachment 4

STATISTICAL ANALYSES OF DATA FROM THE MADISON COUNTY LEAD STUDY AND IMPLICATIONS FOR REMEDIATION OF LEAD-CONTAMINATED SOIL

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EXECUTIVE SUMMARY

The purpose of this report is to provide an independent interpretation of the data and reports generated as part of an epidemiologic study of childhood lead exposure in the Madison County, Illinois conducted in 1991.

Children and pregnant women are the human subpopulations most susceptible to the effects of lead. Identification of the major sources of environmental lead exposure for children with elevated blood lead concentrations became the primary focus of the epidemiologic study of childhood lead exposure in the Madison County, Illinois study[1] conducted in 1991 as directed by the Agency for Toxic Substances and Disease Registry (ATSDR). (While the study was directed by the ATSDR, it was primarily carried out by the Illinois Department of Public Health (IDPH) through its contractor, Institute for Evaluating Health Risks (IEHR), as is discussed more specifically below [2]).

Childhood blood lead depends on many factors. The most important factors must necessarily be related to some environmental sources of lead, since lead is not created in the child's body, but must be brought into the body by exposure to lead occurring outside of the body. Typically, lead is carried in some medium of exposure. The ingestion media most usually encountered by children include food, drinking water, and non-food media such as soil, household dust, and chips or flakes of

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[1]While the identification of the major sources of environmental lead exposure for children with elevated blood lead concentrations became the primary focus of the epidemiologic study of childhood lead exposure in the Madison County, Illinois study by the authors of the report describing the study (IDPH/IEHR 1994), this purpose was not clearly articulated by ATSDR when the study began. (For example, one of the stated purposes of the study was to determine the level of environmental lead and cadmium found in target areas and compare them with levels of contamination observed in comparable non-target areas.) Therefore, the study methodologies were not suitably designed to be able to make firm conclusions about the major sources of environmental lead exposure for children or to provide an adequate basis for comparison with many other studies of blood lead and environmental lead. Even given these shortcomings, the data available from the blood study can be analyzed and lend support to retaining the 500 ppm residential soil lead cleanup level.

[2]U.S. EPA participated by providing contractor assistance as guided by IDPH and ATSDR.

lead-based paint. Most lead experts agree that household dust is a very important medium for childhood lead exposure, and is likely the primary exposure pathway for lead in soil and for lead in interior lead-based paint. Also, ingestion of exterior dust from soil is a direct exposure pathway to soil lead that may be nearly as important as the indirect pathway from soil through household dust. All of the lead in the child's body has come from current or historic intake from these media, from other media such as inhalation of airborne particles, or from exposure in utero to lead in the mother's blood.

Many other factors may modify the blood lead concentration in a child who is exposed to environmental lead. The most important modifiers affect the amount of lead consumed in different media, such as the amount of fine soil and dust particles that the child eats during normal play activity. Some of the modifying factors for lead intake (See Section 3.1 of this report) can sometimes be estimated, but in epidemiology studies such as that carried out in Madison County, the modifying factors are only inferred from family characteristics such as parental education or income, from ethnicity or race, or from other child characteristics such as age or sex. The Madison County study collected data on a large number of potential modifying factors, but it is important to remember that the modifying factors must necessarily have a secondary role compared to the measurable components of lead in the child's environment.

The study was directed by the ATSDR in 1991 and carried out by the IDPH, primarily via its contractor, IEHR, and U.S. EPA (as guided by [redacted] and ATSDR). Analyses of the data were presented in a draft report by IEHR and IDPH (February 1994), hereafter described as the IEHR/IDPH report, and by ATSDR in a separate report (May 1994) with a more cursory analysis. U.S. EPA provided a critical review of these analyses (Marcus et al., May 1994), but it did not provide an analysis of the data since it did not yet have access to the data. The preliminary report of the reexamination of these data (Marcus 1994) was submitted as

part of the Administrative Record Update as part of U.S. EPA's proposed plan and public comment period for the residential soil cleanup l[illegible] in October, 1994. U.S. EPA requested access to the data from IDPH (through a request by the U.S. Department of Justice). Data on blood lead, environmental lead, and family interviews for 490 children in Madison County, Illinois, were provided to U.S. EPA by the IEHR, IDPH's contractor, in late 1994. The data were sent to U.S. EPA on diskette in ASCII format. U.S. EPA converted these data into a SYSTAT (Wilkinson 1992) data file used in analyses reported here were performed. Additional analyses required creation of SAS (SAS 1990) data sets. The data set was incomplete in some important ways, as described below.

In this report, U.S. EPA performs reanalyses of the data. The purposes of the for U.S. EPA's reanalyses are:

1. To assess the results described in the IEHR/IDPH report (1994) for use in evaluating childhood lead exposure in Madison County;
2. To extend these analyses so as to obtain relevant site-specific inferences about environmental pathways for childhood lead exposure for Madison County children, with particular emphasis on those locations nearest the former NL/Taracorp Lead smelter at the NL/Taracorp Superfund Site;
3. To provide site-specific information about relevant parameters in the EPA Integrated Exposure, Uptake, and Biokinetic Model for Lead (IEUBK Model) which was used by U.S. [illegible] in certain risk evaluations of child blood lead risk[illegible].
4. To e[illegible]te U.S. EPA's proposed soil remediation level of 500 ppm using this recent information.

The IEHR/IDPH report evaluates some of the relationships among child blood lead, environmental lead, other environmental factors affecting blood lead, sociodemographic factors, and individual child-specific behavioral factors. Many of the relationships are characterized by bivariate correlation

coefficients, or by related quantities such as the multiple correlation coefficient for the multiple regression analyses (the only multivariate procedure considered in the IEHR/IDPH analyses). The analyses in the IEHR/IDPH report provides an inadequate description of child lead exposure in Madison County. As shown herein, the analyses are so incomplete as to give a misleading impression of childhood lead exposure. U.S. EPA's analyses will provide a more balanced view of child lead exposure in Madison County, clarifying the important but distinctly different roles of lead in soil, in deteriorating lead-based paint, and in household dust, with emphasis on resolving issues that may affect decisions about remediation of lead sources near the NL/Taracorp lead smelter and elsewhere in Madison County. U.S. EPA has established the following:

1. There are some areas in the Madison County study that clearly show an excessive number of cases of children with elevated blood lead concentrations. The number of cases is elevated by comparison with other parts of Madison County, and elevated by comparison with current EPA guidelines. These cases are concentrated near the NL/Taracorp lead smelter and in a few more remote locations. These suggest localized, site-specific sources of lead exposure.

2. There are some serious inadequacies in the design of the study that complicate the analysis and interpretation of the data, particularly with the possibility of confounding of some environmental and demographic factors. However, the potential problems are not so serious as to prevent far more detailed and complete conclusions than were reached in the IEHR/IDPH report.

3. The IEHR/IDPH report failed to consider certain non-standard features of the soil sampling and dust sampling and reporting protocols that complicate the use of these data for inferences about environmental lead sources. In particular, the reported dust lead concentrations used for analyses in the Madison County study were mathematical averages of fine dust particles (which can be picked up on the child's hands and

ingested), and large particles including lead paint chips that are much less likely to be ingested during normal hand-mouth activity. This differs from dust lead measurements used in most earlier studies, and is likely to bias the estimated effects of dust and paint on blood lead. U.S. EPA's analyses suggest that most dust lead concentrations above 1000 ppm reported in the Madison County Study are likely to be biased above the values that would have been obtained using only fine dust particles, thereby overstating the role of lead paint on dust lead and on blood lead.

4. Average soil lead concentration is nearly inversely proportional to distance from the NL/Taracorp lead smelter (See Figure 5), with a few isolated locations far from the previous active NL/Taracorp lead smelter that also have high soil lead. Many of these spots are believed to be in Eagle Park Acres or in Venice Township, where waste pile material containing lead battery casing chips was used as fill or for repairing city streets and alleys. Exterior lead paint played a much smaller role in soil lead concentrations than did distance from the NL/Taracorp lead smelter.

5. Most of the lead in house dust near the NL/Taracorp lead smelter is likely to have come from lead in soil. In most homes near the smelter, soil lead is more likely to be the major source of lead in house dust than lead in interior paint. Interior lead-based paint is likely to be a more important source of lead in house dust than is soil lead only in some homes at a great distance from the NL/Taracorp lead smelter (ring 7 or at least 3/4 mile where there are no other known sources of lead.

6. [redacted] lead inside the house depends mainly on soil lead from the yard and on deteriorating lead paint inside the house, modified somewhat by overall building condition. The effects of soil lead and lead paint on blood lead are therefore primarily indirect effects, in which these lead sources contribute lead to house dust, a medium that is more accessible to the child.

7. The hierarchical regression method used in the IEHR/IDPH

report to identify significant lead sources was seriously biased. A more appropriate application of the hierarchical regression method in section 4 herein shows that lead in soil is a more significant predictor of elevated blood lead than is lead paint, but that inclusion of dust lead loading in the model can explain about as much of the variance in blood lead as all of the modifying factors combined. Soil lead is not strongly confounded with other significant predictors of dust lead loading, including building condition, age, race, parental education and income, child's outdoor play, lead in drinking water, and recent refinishing or remodelling. This allows estimation of both the direct effect of soil lead on blood lead, and the indirect effect of soil lead through the dust lead pathway. While the most important predictors of blood lead were dust lead loading and child age, soil lead had a smaller statistically significant effect on blood lead over and above the effect of dust lead.

The overall effect of soil lead on blood is very clear, as shown in Tables E-1 and E-2. Table E-1 shows the percentage of children in the Madison County Lead Study who had blood lead concentrations of 10 ug/dl or greater, which is a level of concern for increased potential of health risks. The level of concern is defined by blood lead levels at which most individuals in a population of children are not expected to have health effects of major consequence. The level of concern is not a threshold level below which all individual children are free of lead-induced health effects. The blood lead level of concern expresses scientific judgements about health effects of lead exposure in form that is useful in evaluating public health implications of various actual or hypothetical levels of lead exposure, and is not meant to imply the biological effects do not occur at lower levels of exposure.

The percentage of children with elevated blood lead levels whose yard soil lead concentration is less than 250 ppm is only 6 percent (i.e., 10/162 children). The percentage is much larger for children with residential soil lead concentrations of 250 to

499 ppm (20% or 33/169 children); 500 to 999 ppm (21/104 children or 20%); and 1000 ppm or greater (12/39 children or 31 percent).

8. African American children in the Madison County Study have on average about 1.2 ug/dl higher blood lead than other children of the same age, everything else being equal. It is possible that race/ethnicity represents a surrogate measure for locations south and southwest of the NL/Taracorp lead smelter, or some other unknown covariates.

9. Soil lead is a significant predictor of blood lead in any appropriate linear or additive model specification, which is biologically and physically more realistic than the log-log model in the IEHR/IDPH report.

TABLE E-1. Percentage of Children with Blood Lead of 10 ug/dl or Greater in Madison County Lead Study

Soil [redacted] (ppm)	Number of Children	Percent
0 - 249	10/162	6
250 - 499	33/169	20
500 - 999	21/104	20
1000 +	12/39	31
Unknown	2/16	-
Total	78/490	16

Blood lead concentrations of 20 ug/dl or greater are sufficiently high to warrant individual immediate intervention. These also show a very clear relationship to soil lead, with a marked increase at soil lead concentrations of 500 ppm or greater (6.7 to 7.7 %), compared to only 1.9 % of children living on yards with soil lead less than 250 ppm.

TABLE E-2. Percentage of Children with Blood Lead of 20 ug/dl or Greater in Madison County Lead Study

Soil Lead (ppm)	Number of Children	Percent
0 - 249	3/162	1.9
2[redacted]99	5/169	3.0
500 - 999	7/104	6.7
1000 +	3/39	7.7
Unknown	0/16	-
Total	18/490	3.7

10. Visual observation and analyses of Madison County data show the following:

(A) Significant transport of lead from soil to household dust;

(B) Bare areas on soil in many yards, and significant amount of child outdoor play activity, especially in neighborhoods closest to the NL/Taracorp smelter;

(C) Quantitative relationship of soil lead with the NL/Taracorp smelter, implying that soil derived from historical deposition of airborne particles from the secondary lead smelter and related smelter wastes are likely to have bioavailability and other properties similar to particles derived from smelter air emissions in other communities; and,

(D) Quantitative strong relationship of blood lead to lead in household dust, and indirectly to lead in soil through the soil-to-dust-to-child pathway.

11. Lead particles emitted from smelters often have high concentrations of relatively soluble species, such as lead oxides and lead sulfates. Lead in soil and house dust derived from smelter emissions are therefore more likely to consist of small particles of relatively bioavailable species of lead. Since the analyses in this report point strongly towards the NL/Taracorp smelter as the source of most of the lead in soil and house dust in most of the housing located in the rings closest to the smelter, the lead particles encountered by children residing there are likely to be highly bioavailable, and the standard assumptions about bioavailability used in the IEUBK model are consistent with site-specific observations and analyses. 11. Site-specific conditions at the NL/Taracorp lead site are therefore very close to those found at sites for which the IEUBK model was calibrated and for which the default parameters are appropriate.

12. When data from the Madison County Lead Study were used

as a basis for evaluating the predictiveness of the IEUBK model, systematic deviations were noted when the reported dust lead concentrations were used as input variables. These deviations were largely eliminated when dust lead concentration was estimated using the IEUBK model default method, dust lead concentration = 0.7 soil lead concentration + 10 ppm. This is consistent with the results of the regression models and the environmental pathway models, which found some indication that dust lead concentrations above about 1000 ppm may be inflated by inclusion of large paint chips on the floors or window sills that are probably not accessible to the child.

13. Using default input parameters in the IEUBK model, and allowing for differences in the soil lead contribution to dust lead within the range of values estimated at various parts of the site, target levels for soil remediation are in the range of 350 to 480 ppm. Inclusion of lead paint lowers these levels substantially (i.e., 115 to 350 ppm).

ASSESSMENT OF DATA FROM THE MADISON COUNTY LEAD STUDY AND IMPLICATIONS FOR REMEDIATION OF LEAD-CONTAMINATED SOIL

1 INTRODUCTION

Children and pregnant women are the human subpopulations most susceptible to the effects of lead. Childhood blood lead levels depend on many factors. The most important factors must necessarily be related to some environmental sources of lead, since lead is not created in the child's body, but must be brought into the body by exposure to lead occurring outside of the body.

Typically, lead is carried in some medium of exposure. The ingestion media most usually encountered by children include food, drinking water, and non-food media such as soil, household dust, and chips or flakes of lead-based paint. Lead inhaled from the air used to be an important exposure medium, but with the phaseout of leaded gasoline in the 1970's and 1980's, inhaling of lead in air is now a relatively minor pathway of exposure unless the child lives near active primary or secondary smelters or lead battery processing plants, or some similar specific sources. Rare cases of lead poisoning from other sources, such as certain ethnic medicines, foods, or cosmetics, may also occur. Finally, lead is readily transferred during pregnancy from the mother to the fetus, and after birth may be transferred from the nursing mother to her infant through the mother's milk, so that some part of the m[illegible]'s environmental lead exposure is transferred to the newborn [illegible]. Thus, all of the lead in the child's body has come from someplace outside. Identification of the major sources of environmental lead exposure for children with elevated blood lead concentrations is the primary challenge in the epidemiologic study of childhood lead exposure in the Madison County study.

Many other factors may modify the blood lead concentration in

a child who is exposed to environmental lead. The most important modifiers affect the amount of lead consumed in different media. For example, some children may consume a great deal of tap water early in the day, either as drinking water or as water used to make up the child's formula; other children, in other households, may drink much less tap water, so that the concentration of lead in the tap water is not the only factor that affects the amount of lead taken in by the child from tap water, and two children exposed to exactly the same concentration of lead in their drinking water may have different concentrations of blood lead attributable to tap water.

The situation encountered in the Madison County study is that children may be exposed to elevated levels of lead in several media encountered in their homes, including lead in household dust, in yard soil, and in lead-painted walls and trim inside and outside the house. The amount of time that the one child spends playing in the yard outside the house, on the floor, or at some other non-home location can differ greatly from the activity pattern of another child, and the amount of surface soil or dust that the child picks up on his or her hands and transfers to the mouth during normal play activity also depends on parental awareness, hygiene habits and other factors. However, even if the child consumes large quantities of media such as water, dust, soil, or paint, there is no lead exposure unless there is lead in the media.

Some of the modifying factors for lead intake (See Section 3.1 of this report) can sometimes be observed, but in many epidemiological studies such as that carried out in Madison County, the modifying factors are only inferred from family characteristics such as parental education or income, from ethnicity or race, or from other child characteristics such as age or sex. The Madison County study collected data on a large number of potential modifying factors, but it is important to remember that the modifying factors must necessarily have a secondary role compared to the measurable components of lead

exposure.

The study was directed by the ATSDR in 1991 and carried out by the IDPH primarily via its contractor, IEHR, and U.S. EPA (as guided by IDPH and ATSDR). Analyses of the data were presented in a draft report by IEHR and IDPH (February 1994), hereafter described as the IEHR/IDPH report, and by ATSDR in a separate report (May 1994) with a more cursory analysis. U.S. EPA provided a critical review of these analyses (Marcus et al., May 1994), but it did not provide an analysis of the data since it did not yet have access to the data. The preliminary report of the reexamination of these data (Marcus 1994) was submitted as part of the Administrative Record Update as part of U.S. EPA's proposed plan and public comment period for the residential soil cleanup level in October, 1994. U.S. EPA requested access to the data from IDPH (through a request by the U.S. Department of Justice). Data on blood lead, environmental lead, and family interviews for 490 children in Madison County, Illinois, were provided to U.S. EPA by the IEHR, IDPH's contractor, in late 1994. The data were sent to U.S. EPA on diskette in ASCII format. U.S. EPA converted these data into a SYSTAT (Wilkinson 1992) data file used in analyses reported here were performed. Additional analyses required creation of SAS (SAS 1990) data sets. The data set was incomplete in some important ways, as described below. In this report, U.S. EPA performs reanalyses of the data. The purposes of the for U.S. EPA's reanalyses are:

1. To assess the results described in the IEHR/IDPH report (199[illegible]r use in evaluating childhood lead exposure in Madi[illegible]ounty;

2. To ex[illegible] these analyses so as to obtain relevant site-specific inferences about environmental pathways for childhood lead exposure for Madison County children, with particular emphasis on those locations nearest the NL/Taracorp smelter;

3. To provide site-specific information about relevant parameters in the EPA Integrated Exposure, Uptake, and Biokinetic Model for Lead (IEUBK Model) which predicts the

distribution of blood lead concentrations expected in children of a specific age who all have the same specific set of environmental lead exposure concentrations—equivalently, the risk of incurring different blood lead concentrations for any child with such exposure;

4. To evaluate U.S. EPA's proposed soil remediation level of 500 ppm using this recent information.

This report provides the technical basis for the inferences made in U.S. EPA's preliminary report of results. The U.S. Environmental Protection Agency will describe the methods used in the analyses, a complete set of results, and the basis for U.S. EPA's conclusions. This report is divided into the following sections. Section 2 provides a detailed narrative for the simple graphical and tabular presentations given in the preliminary report (U.S. Environmental Protection Agency, October, 1994). Section 3 evaluates potential problems of confounding, and describes several approaches to assess the extent of confounding in the Madison County study and to alleviate the problem where it exists. In particular, the role of hierarchical regression modelling is discussed.

Section 4 describes the results of several approaches to deriving statistical relationships among child blood lead and a host of demographic, behavioral, and environmental factors that may contribute to blood lead. The regression modelling approaches in Section 4 also help to identify important variables for subsequent analyses. One approach parallels the log-log regression methods used in the IEHR/IDPH report, but enlarges the approach to a wider range of possible factors contributing to child blood lead. The second approach is similar to earlier EPA analyses and is useful in evaluating exposure pathways assumed in the IEUBK model.

During the course of these analyses, it became obvious that several extremely high dust lead concentrations had an undue influence on the nature of the regression analyses. Subsequent investigation showed that many of the dust lead concentrations reported in the study consisted of mathematical averages of dust

lead concentrations in fine particles and dust lead concentrations in larger debris, including lead paint chips that may have [illegible]ously biased the reported concentrations. Consequently, it was necessary to perform subsequent analyses with and without these extremely high dust lead values in order to evaluate the sensitivity of the results to inclusion of data that differed substantially from data used in other studies. The regression models also provide a basis for assessing the relative importance of exterior lead-based paint and distance from the NL/Taracorp smelter as contributing sources of lead in soil, and the relative importance of soil lead, interior lead-based paint, and exterior building condition as contributing sources of lead in household dust.

Section 5 reports the results of analyses in which an explicit causal model is assumed for environmental lead pathways, particularly from paint to soil and house dust. These results are also described graphically and in tables, with a minimum of technical details. The technical details are given in Appendix B. The use of the analyses in providing input to the IEUBK model is described in Section 6. Section 7 evaluates the adequacy of the IEUBK model for estimating blood levels for children in the Madison County blood study. Sections 6 and 7 present the basis for a soil lead cleanup level. Section 8 describes the soil lead results when input values for the IEUBK Model from Section 3.1 are used, and describes the reevaluation of the soil lead cleanup level for the NL/Taracorp Superfund Site.

The main body of the text of this report describes the results [illegible] analyses with little technical detail. Some readers [illegible]ish to review these technical details, so that a much more extensive mathematical presentation of the results is given in the Technical Appendices.

2 DESCRIPTIVE STATISTICAL ANALYSES

2.1 Simple Statistical Summaries

The U[illegible] Environmental Protection Agency's analyses are all related to assessing the risk of elevated blood lead that exposure to lead from diverse sources poses to children in Madison County, with particular attention to the former NL/Taracorp lead smelter at the NL/Taracorp Superfund Site in Granite City, Illinois and environs. It is generally recognized that there are other potential sources of lead in Madison County to which children may be exposed, such as waste pile material used for street repairing in Venice, battery casings and waste pile material used as fill in Eagle Park Acres, and deteriorating lead-based paint on older housing throughout the community. In all of these, there is an important component of location relative to the NL/Taracorp lead smelter. The data provided to U.S. EPA only contain a single spatial component, rings of so-called "DISTANCE", which is the approximate distance of the household from the NL/Taracorp smelter or center of the site, in units of about 1/8 mile. This is shown in Map 1. The U.S. Environmental Protection Agency has therefore reported the mean or geometric mean values of the variables in the data set in each ring. The number of children with blood leads (NC) and number of households (NH) with children is also reported. Each of the other variables is either a household or family measurement (coded H) or an individual child measurement (denoted C). The uncertainty associated with each mean is either the standard error (denoted s.e.) or percentage relative standard error (denoted [illegible]e.). These are shown in Table 1 through Table 5, and gra[illegible]ly in Figure 1 through Figure 18. Standard errors are shown with each mean or percentage, and relative or geometric standard errors with each mean geometric mean in these figures.

2.2 Blood Lead

Table 1 shows that the percentage of children with elevated blood lead concentration, defined as blood lead of 10 ug/dl or

greater, tends to decrease with increasing distance from the NL/Taracorp smelter. There are small deviations from this rule, consistent with random deviations expected in small to moderate sized groups of children, except for distance ring 9, where 5 of 22 children have blood leads of 10 ug/dl or higher. This small deviation may correspond to exposure to other sources of lead, such as battery casing debris, in remote neighborhoods in Venice Township or in Eagle Park Acres or other unincorporated parts of Madison County. The percentage of children whose blood lead concentrations are 15 ug/dl or greater are particularly concentrated near the NL smelter, at rings 1, 2, and 3 on Map 1. The percentage of children with blood lead concentrations of at least 20 ug/dl are also concentrated in rings 2 and 3, lower in rings 4, 5, and 6. In view of the small number of children in ring 1, it is not surprising that no child with blood lead at least 20 ug/dl is found in ring 1 (n is approximately 9). This is shown in Figures 1, 2, and 3 respectively. Figure 4 and Table 1 show that the geometric mean blood lead concentration decreases with increasing distance from the NL/Taracorp smelter, in general. Some figures (such as Figures 19-21) are plotted on a natural logarithm scale (base e, not base 10), since the distribution of blood lead concentration and most other variables used in U.S. EPA analyses are not normally distributed, but have a substantial amount of skewness towards high values.

2.3 Environmental Lead

2.3.1 Lead in Residential Soil and in House Dust

Environmental lead concentrations also show a striking relation with distance, as shown in Table 2 and in Figures 5 through soil lead concentration shows a very consistent decrease with increasing distance from the NL/Taracorp smelter, except for 2 households in ring 10. The reader should note that the standard errors are relatively small, compared to those in most other indices, showing that the relationship between soil lead and distance is relatively well defined. Table 2 and Figure 6 show a very similar relationship between distance and dust lead

concentration, again excepting ring 10. Table 2 and Figure 7 also show a very similar relationship between distance and dust lead loading, with larger variability than dust lead concentration, but with greater consistency including ring 10. Mean blood lead concentration, soil lead concentration, house dust lead concentration, and house dust lead loading show very similar patterns of decreasing concentration with increasing distance from the NL /Taracorp lead smelter, on average.

2.3.2 Lead-Based Paint

Other environmental indices are not shown in the Tables, but in Figures 8 through 11. Loadings of deteriorating lead paint inside and outside the house show little or no relationship to distance from the NL /Taracorp. This suggests that deteriorating lead-based paint is not the most important direct environmental factor in childhood blood lead in Madison County, and is much less important than soil lead and dust lead. This is not to say that paint lead may not be a significant indirect source of childhood lead exposure. Deteriorating interior lead-based paint may be a significant contributor to household dust along with lead in soil. Deteriorating exterior lead-based paint may be a significant contributor to lead in soil along with proximity to the smelter but the soil lead measurements in the Madison County Study found only a slight contribution of exterior lead paint to lead in soil away from the dripline. This will be shown in subsequent analyses. Figure 8 shows that the interior lead paint hazard index has only a weak relationship to distance from the Taracorp smelter. This interior lead paint cannot explain [illegible] of the blood lead variability in the data set. Lead paint hazard index was measured in the data set by the product of the paint condition (from 0 to 10 on a scale of increasing deterioration) times the lead paint loading measured by X-ray fluorescence (XRF) analyzer. Figure 9 shows that exterior lead paint hazard has even less average relationship to distance. There is in fact a strong relationship between environmental lead

and lead-based paint, but this is visible after the dominant effect of distance from the NL/Taracorp smelter is removed, using more sophisticated statistical methods.

2.3.3 Lead in Drinking Water

Figure 10 shows that the household tap water lead concentration is highest in the housing closest to the NL/Taracorp smelter, but otherwise show little relationship to distance. Thus, lead in tap water may be a contributing source of child blood lead and is, in some analyses, but is not the primary factor.

2.4 Modifying Factors for Lead Exposure: Household Environment, Demographics, and Individual Child Behavior

The relationship between blood lead and environmental lead is affected by demographic and behavioral variables. While a child could not acquire an elevated blood lead concentration without ingesting or inhaling environmental lead from some medium, contact with and exposure to that medium, and the amount of intake from the medium depend strongly on social and behavioral aspects of the environment. Most of the variability in child blood lead concentrations can be attributed to inter-individual differences in lead exposure, absorption, and biokinetics. For example, poor nutrition may cause an increase in lead absorption, or possibly even an increase in lead intake. Even in the same environment, some children will ingest little lead from soil or dust, or will absorb little of what they ingest, while others will in[illegible] and absorb a much larger quantity. This does not mean th[illegible]e amount of lead in the environment is unimportant, since a[illegible]-all studies have found a strong relationship between some components of environmental lead and blood lead in children. It does mean that the modifying effects of socio-demographic conditions that affect exposure, individual behaviors, and individual absorption and biokinetic elimination of lead must be included in a mathematical model in order to interpret the data.

2.5 Household Environment

2.5.1 Dust in the Household

Total dust loading shows almost no relationship to distance from the NL/Taracorp smelter, on average, so that increased dustiness of homes cannot explain the higher household dust lead loadings found near the NL/Taracorp smelter. As will be shown later, total dust loading is an extremely important predictor of dust lead loading, but it is the higher concentration of lead in household dust or soil that accounts for higher dust lead loadings near the NL/Taracorp lead smelter. Figure 11 shows somewhat higher dust loadings in rings 2 and 10, although there is a great deal of uncertainty associated with the geometric means from such a small number of households.

The reader should note at this point that there is an exact mathematical relationship between dust lead concentration, dust lead loading, and dust loading. Dust lead concentration is measured in micrograms of lead per gram of dust. Dust lead loading is measured in micrograms of lead per square meter of surface. Total dust loading is measured in units of milligrams of dust per square meter of surface. Thus, in the IDPH data set,

(Dust lead concentration) * (Dust loading) / (Dust lead loading) = 1000.

This implies an exact linear relationship when logarithms are taken on both sides of this equation. The terms "log" or "ln" are used interchangeably in this report to mean the natural or base (e) logarithm. The above equation is equivalent to:

- log(Dust lead concentration) + log(Dust loading) - log(Dust lead loading) = log(1000)

This is useful in providing a benchmark for the reader to

interpret the concept of 'collinearity' discussed below. Household dust loading is correlated with many other socio-demographic variables, but plays a very important role in household environmental lead exposure.

2.5.2 Housing Age

Table 3 shows some of the demographic characteristics that U.S. EPA has found useful in interpreting the Madison County lead study. There is a clear gradient from older housing near the NL/Taracorp smelter to newer housing farther away. U.S. EPA has assigned the midpoint of each decade in order to calculate a mean as shown in Table 3, and a nominal value of 1905 to all pre-1910 housing. Housing age is clearly a surrogate for historical exposure to smelter emissions and soil deposition, for increased likelihood of encountering lead-based solder in plumbing materials or lead alloy pipes and fixtures. Older houses are also much more likely to have deteriorating lead-based paint. U.S. EPA did not use housing age in subsequent analyses because it was unknown for over 30% of the households in the study.

2.5.3 Condition of the Building Exterior

Condition of the building also turned out to be a useful predictor, both for blood lead (as a socio-demographic surrogate) and for environmental lead. This was coded 1 for least deteriorated buildings, 3 for very deteriorated buildings, and 2 for moderately deteriorated buildings. Subsequent analyses showed that building condition was about as predictive treated as a metric numeric variable as it was when coded into three classes. That the mean building condition is shown in Table 3 and in Figure 12, and shows a steady improvement in building condition from ring 2 outward. This variable was used in many analyses, even though it was missing for about 20 percent of all households in the study, and is denoted BLDGCOND in some of U.S. EPA's tables. Missing values were imputed in the IEHR/IDPH report using the overall mean building condition value of 1.389;

this variable is denoted BLDCONIM in some of U.S. EPA's tables. Since building condition shows a good relationship with distance, U.S. EPA also tested a scheme in which missing values where imputed by using the average value for the ring shown in Table 3, for example assigning 2.00 to missing values of building condition for ring 2, 1.63 for ring 3, 1.50 for ring 4 and so on. This scheme proved to be much more predictive than using the grand mean of 1.389, and is denoted BLDGCIMP.

2.5.4 Use of Home Air Conditioners

Air conditioning is both an indicator of economic status and a physical device that may reduce the amount of airborne dust particles and resuspended exterior dust from surface soil entering the house through the windows and doors. However, the pattern with distance shown in Table 3 is not exactly parallel to that of other variables. Although selected in other analyses, this variable did not prove as highly predictive of child blood lead as was suggested in earlier analyses.

2.6 Demographic Factors

2.6.1 Parental Education

Parental education is often the most significant component of indicators of socio-economic status (denoted SES in other studies). This was characterized numerically by the number of years of education completed. Some coding conventions were necessary, such as 12 years for completion of a GED, 13 or 14 years for attendance at technical schools or junior colleges, and 17 years for a nominal value for any graduate or professional schools. EPA found that parental education could predict blood lead better if the parents' actual educational level was specified and used as a predictor rather than simple dichotomies such as coding "less than high school" vs. "high school graduate or above". Table 3 and Figure 13 show that mean number of years increases steadily with increasing distance from the NL/Taracorp smelter, from a minimum at ring 2. In later analyses, parental

education was a good predictor of childhood blood lead levels. It is important to note that the correlation between education and dust lead was not strongly correlated, and that education was an impor[illegible] covariate of blood lead, but not a strong confounder for environmental lead in dust or soil.

2.6.2 Parental/household Income

Household income was reported in inexact groups, intervals of $5,000, in order to improve the confidentiality of the study. U.S. EPA used the midpoint of each interval as a numeric covariate, for example, $2500 for the group reporting 0 to $5000 per year. Even though parental education was much more predictive as a sociodemographic factor, the logarithm of household income was an additional statistically significant predictor of blood lead. The incidence of children with elevated blood lead was lower in higher income households even after statistical adjustment for environmental lead indicators, suggesting that the effect of environmental lead was not completely confounded with socioeconomic factors.

2.6.3 Home Ownership

Home ownership shows a clear increase with increasing distance from ring 2 outward, as shown in Table 3 and Figure 14. This variable also proved less predictive than other socio-demographic variables, but was included in preliminary assessments.

2.6.4 [illegible] and Ethnicity

Rac[illegible] ethnicity are among the most important demographic variabl[illegible] this data set. Many other studies have found higher blood lead concentrations in children from certain racial or ethnic sub-populations, even when adjusted for similar levels of environmental lead and other socio-demographic variables (Stark et al. 1982; Weitzmann et al. 1993). This study coded racial sub-groups as 1 = White, 2 = African American, 3 = Asian or

Pacific islander, 4 = American Indian or Alaska native (Q. 205). Because of the small number of children in categories 3 or 4, these were sometimes combined with category 2 = African American into a new "Non-white" group. In other analyses, another variable was created by coding category 2 as 1, and combining categories 1, 3, and 4 and coded them as 0. Interview questions also identified Hispanic ethnicity (Q. 206) but these data were not provided to us. As shown in Table 3 and Figure 15, non-white households are located differentially from ring 6 outward to ring 9. U.S. EPA suspects that the majority of these are located in the communities of Madison and Venice, but no data were provided to U.S. EPA that would allow confirmation of the community in which the non-white households were located. Additional analyses for these more highly impacted subgroups may be useful.

The IEHR/IDPH report has found no apparent difference in race/ethnicity relative to childhood blood lead levels. However, a more detailed statistical analysis carried out by U.S. EPA shows that race/ethnicity does appear to have a significant effect in childhood blood lead levels in Madison County. The analyses in the IEHR/IDPH report may have obscured this finding, since simple comparisons of blood lead concentrations among white and non-white residents of Madison County ignore the fact that the majority of non-white residents lived at distances at which there were typically lower soil and dust lead concentrations.

2.6.5 Number of Pre-School Children in the Household

Some previous studies have suggested that households with multiple pre-school age children may allow greater childhood lead exposure resulting in elevated blood lead concentrations (Stark et al. 1982). Table 3 and Figure 16 show that there is some tendency towards larger numbers of children in households closer to the NL/Taracorp smelter, but the tendency is not striking and proved to be less predictive than other socio-demographic covariates. However, from the point of view of community risk assessment, it is important to note that households with several

pre-school children may be differentially located in certain areas of the community. In some inner-city neighborhoods in the Urban Lead Abatement Demonstration Projects in Baltimore, Boston, and Cincinnati, larger houses and larger apartments in old housing were preferred by families with multiple children. In view of the rapid turnover of rental housing in these communities, the number of lead-exposed children over some period of time may be larger than can be estimated from a simple cross-sectional study such as the Madison County study.

2.6.6 Cigarette Smoking

One of the household characteristics studied in detail was the number of cigarettes smoked per day by the adult who was interviewed (questionnaire item 409, especially Q. 409.3). While some household dust lead may come from cigarette smoke particles, it is also possible that cigarette smoking is a surrogate for other family characteristics that affect childhood exposure to dust and soil. Further study of this relationship would be interesting. Table 3 clearly shows a gradient of smoking from a maximum at ring 2 and a marked tendency to decrease with increasing distance from the NL/Taracorp lead smelter. However, this variable was usually not predictive of blood lead when other sociodemographic variable were included in the model.

2.7 Individual Child Variables, Including Age and Behavior

2.7.1 Age Distribution

Table 4 shows the age distribution as a function of distance from the Taracorp smelter, and the mean age of children in each ring. The age distribution is shown in Figure 17. Note that there seems to be relatively little dependence of age on distance, so that the inclusion of age in a model for blood lead is not expected to confound the relationship of blood lead with environmental lead in subsequent analyses.

2.7.2 Time Spent in Various Activities

Data were available on individual child activities, including the number of hours per week spent at home, the number of hours per day spent playing outside the house, the number of hours per day spent playing on the floor, and the number of hours per day spent sleeping. The first three of these are shown in Table 5, and the mean number of hours spent playing outside shown in Figure 18 as a function of distance from the NL/Taracorp smelter. There is also a systematic decrease in outdoor play with increasing distance from the NL/Taracorp lead smelter. This analysis suggests that soil exposure is likely to be greater for children living in rings 1 to 3, which are close to the NL/Taracorp smelter.

2.7.3 Mouthing of Non-Food Objects

Individual child behavior is important in understanding why children with similar soil lead levels can have very different blood lead concentrations. However, the relevant behavior is not easily captured on a questionnaire. Some useful information may be obtained from items on the mouthing of non-food objects, and on whether the child eats paint chips. These items are coded 1 = "Does this a lot", 2 = "Just once in a while", 3 = "Almost never", 4 = "Never". U.S. EPA has provisionally recoded these into a consumption frequency scale that may be more useful as a numeric predictor of surface soil or dust intake. U.S. EPA recoding is: "Never" = 0 (times per month), "Almost never" = 1 (time per month), "Just once in a while" = 3 (times per month), "Does this a lot" = 10 (times per month). The mean values are shown in Table 5.

2.8 Correlations and Relationships Among Variables

Many multivariate modelling approaches are based on associations among variables. The methods used in many textbooks, are based on simple Pearson correlation coefficients among the numeric variables. U.S. EPA will emphasize this approach in this report. Categorization of variables is often

not needed, since it involves some loss of information. Some categorical variables of particular interest, however, include health-based responses such as whether a blood lead concentration exceeds some criterion such as 10, 15, or 20 ug/dl. Another categorization of interest is whether a soil lead concentration exceed some action-based criterion such as 500 or 1000 ppm.

2.8.1 Correlation Coefficients

Based on preliminary assessments, the list of variables used in U.S. EPA's analyses was reduced to a manageable set of 31 variables. They may be characterized as follows, using variable names in U.S. EPA's analyses and some recoding for clarity:

• Response variable LOGPBB = natural logarithm of blood lead;

Location LOGDIST = natural logarithm of distance from NL/Taracorp smelter, in rings of about 1/8 mile, coded 1 to 10;

Environmental lead variables:
•LOGPBD = natural logarithm of dust lead concentration;
•LOGPBDL = natural logarithm of dust lead loading;
•LOGPBS = natural logarithm of soil lead concentration;
•LOGPBW = natural logarithm of water lead concentration;
•LOGXRFMN = natural logarithm of average lead paint loading measured by XRF, plus 1;
•LOGCXI = natural logarithm of interior lead paint loading times paint condition, plus 1;
•LOGCXO = natural logarithm of exterior lead paint loading times paint condition, plus 1;
•REFIN = refinishing or paint removal done within last year (0 = no, 1 = yes);

Demographic and household variables:
•AIRCOND = air conditioner used (0 = no, 1 = yes);
•BLDCONIM = building condition, with imputation (1, 2, or 3 if

not missing; 1.389 if
missing);
•CIGSDAY = number of cigarettes smoked per day;
•EDUCY[redacted] educational attainment, in years;
•INCOME = total household income, coded 0 to 9 in intervals of $5000;
•LOGDSTLD = natural logarithm of total dust loading;
•LOGYRS = natural logarithm of time at residence, in years;
•NONWHITE = parents Afro-American, Asian, Pacific Islander or Native American (0 if
no, 1 if yes);
•NUMSMOKE = number of smokers in household;
•RENT_OWN = rental housing (0 if no, 1 if yes);
•USEDSLAG = slag used as fill on property (0 = no, 1 = yes);

Individual child variables:
•AGE = child's age in years;
•AGE2SQR = (age - 2 years), squared;
•FOLK_MED = folk medicine used (0 = no, 1 = yes);
•HRS_HOME = hours spent at home, per week;
•MOUTHFR = mouthing frequency, coded 0, 1, 3, or 10 for never, almost never, once in a
while, a lot;
•OUTPLHRS = hours spent playing outside, per day;
•PAINTFR = frequency of eating paint, coded 0, 1, 3, or 10 for never, almost never, once
in a while, a lot;
•PLAY[redacted] hours spent playing on floor;
•SEX [redacted]d's sex (0= male, 1 = female);
•SUCK[redacted] child sucks thumb (0 = no, 1 = yes);

The correlations involve both household and environmental factors on a household unit level, and individual child factors. U.S. EPA therefore calculated the correlation matrix from the complete child data set, which implicitly weights each household

or environmental correlation by the number of children in that household. In U.S. EPA opinion, from a risk assessment perspective, this is an appropriate weighting. Correlations calculated from the household-level data set show little difference, however. The results are shown in the Technical Appendix, Tables A1, A2, and A3. Table A1 shows the simple pairwise Pearson correlation coefficients, Table A2 the number of pairs of children from whom non-missing data were available, and Table A-3 the statistical significance or P-value of the correlation.

Any single pairwise correlation coefficient is difficult to interpret by itself because the variables are highly inter-correlated, and a multivariate approach must be used in order to determine overall patterns of association. Any attempt to interpret individual pairwise correlation coefficient is likely to mislead or confuse the reader who is trying to draw some causal conclusions from these data. Section 3 sets out some basic principles and develops modelling strategies for interpreting these data.

It may be useful to the reader to visualize the strength of the statistical associations described by the pairwise correlation coefficients. We have done this in Figures 19 and 20, which are presented as "scatter plot matrices" (Wilkinson 1992) in order to emphasize the multivariate nature of the data. Figure 19 shows the bivariate scatter plot matrix for the logarithm of blood lead and the logarithms of the four most predictive environmental lead variables in the order of their decreasing predictiveness with blood lead. The plots are shown in "standardized values" or Z-scores so that all figures are shown on about the same scale. Since the correlation coefficient between any two variables (say, X and Y) is the same whatever the order of the variables (X and Y or Y and X), we have reduced the visual clutter by showing only half of the correlation scatter plots; the other half are simply the mirror images of those shown. The correlation of a variable with itself would be plotted

as a straight line, and always is a perfect linear correlation of 1.0 (the maximum possible). The bivariate correlation (denoted r) between log(blood lead) and log(dust lead loading) is fairly strong, [redacted] 0.429. There is a great deal of scatter in the plot, since child blood lead depends on many factors other than dust lead, but there is also a strong and highly significant positive relationship. The relationship between log(blood lead) and log(dust lead concentration) is weaker but still very significant, r = 0.314. The direct correlation between log(blood lead and log(soil lead) is weaker yet, r = 0.254, but still just significant. The direct pairwise correlation between log(blood lead) and log(1 + lead paint hazard index) is weakest of all, r = 0.170, and not very significant. This particular transformation was chosen because the lead paint hazard index for houses with no interior lead paint is 0, which does not have a finite logarithm.

The strongest linear correlation coefficient in Figure 19 is that between log(dust lead loading) and log(dust lead concentration), r = 0.824, which is not surprising since there is an exact linear mathematical relationship between them,

- log(dust lead loading) = log(dust lead concentration) + log(total dust loading) - log(1000).

The variability in this scatter plot is attributable to differences in total dust loading among households. The correlations between log(dust lead loading) and log(soil lead concentration) or log(1 + interior lead paint hazard index) is weaker, [redacted] still statistically significant.

The [redacted] almost an equally strong correlation between log(du[redacted]d concentration) and log(soil lead concentration) or log(1 + interior lead paint hazard index), respectively r = 0.438 and r = 0.433. This is consistent with a causal model in which both soil lead and interior lead paint are significant sources of lead in house dust.

The panels in Figure 19 show that these log-transformed lead

variables are found in roughly elliptical clouds of data points, with a few straggling values or "outliers" in each plot. This suggests that standard multivariate statistical methods based on an assumed underlying multivariate normal distribution will be adequate for most analyses, but that some attention must be given to outlying values. This concern was not discussed in the IEHR/IDPH report.

Figure 20 shows the correlations and scatter plots for the five lead variables with the five most likely covariate confounders of the relationship between blood lead and environmental lead: log(total dust loading), imputed building condition, decade in which the residence was built, household income, and parental education. The one really strong relationship in Figure 20 is that between log(dust lead loading) and log(total dust loading), which reflects an underlying exactly linear mathematical relationship in which variability is due only to differences in log(dust lead concentration). While higher levels of soil lead and lead paint are found in older houses closer to the NL/Taracorp lead smelter, the correlations of housing age with blood lead and dust lead are much weaker. This shows that the actual dust lead loading as an index of lead exposure is a better predictor of blood lead than is housing age, since it includes information about both the amount of lead in dust and the amount of dust on the floors of the child's residence. The logarithm of total dust loading is therefore correlated moderately well with log(blood lead) because it is a component of log(dust lead loading), but log(total dust loading) is virtually uncorrelated with log(dust lead concentration), log(soil lead concentration), and log(1 + interior lead paint hazard index). The amount of dust on the floor appears to be a very appropriate index for relating socioeconomic variables and housing condition to child blood lead, but dust loading is not strongly confounded with environmental lead variables, so that it is feasible to evaluate the separate effects of different lead sources on childhood lead exposure.

Finally, the importance -- and difficulty -- of showing data in more than two dimensions is illustrated in Figure 21. In this three-dimensional display we illustrate the most important relationships among blood lead, dust lead loading, and soil lead. Much of the variability in log(blood lead) is attributable to differences in dust lead loading, with a smaller but not insignificant increase in blood lead associated with differences in soil lead, over and above those differences attributable to dust lead loading. All of the statistical analyses described in Sections 4, 5, and 6 elaborate these ideas. A multiple linear regression model for log(blood lead) vs. Log(dust lead loading) and log(soil lead) is a mathematical procedure for producing a simple approximate description of the relationship. The mathematical relationship is sketched by the shaded plane that cuts close to most of the blood lead data points, with a few values further away because of inter-individual differences not attributable to the measured quantity of lead in residential soil and dust. The significant effect of dust lead loading is shown by the steep slope of the plane on the log(blood lead) vs. Log(dust lead loading) plane projection. The smaller effect of soil lead is shown by the flatter slope on the log(blood lead) vs. Log(soil lead) plane projection, which is also statistically significant because of the large number of children in the study.

2.8.2 Bivariate Tables for Percentage of Children with Elevated Blood Lead

Grouping of continuous variables such as blood lead or soil lead into categories is usually not necessary and may cost some information. However, sometimes it is easier to understand a relationship by looking at grouped data, especially where the groups are determined by generally recognized public health criteria (such as blood lead), or by regulatory or administrative guidelines such as the range of soil lead remediation levels of 500 to 1000 ppm in the U.S. EPA's former soil lead directive. An

example of this is given in Table 6a, which shows the percentage of children with elevated blood lead concentrations (10 ug/dl or greater) for four ranges of soil lead (0-249, 250-499, 500-999, and 100[illegible]pm) and three ranges of dust lead concentration, low (0 to 249 ppm), medium (250 to 749 ppm), and high (750+ ppm). The soil cut points reflect the remediation range for lead suggested in U.S. EPA's former soil lead directive (500 to 1000 ppm) as well as a low or baseline range for urban areas (less than 250 ppm). The dust cut points were chosen to provide sufficiently large numbers in each group or cell in the table, but other cut points were evaluated and showed similar trends.

Table 6a shows that when dust lead levels are low, soil lead concentrations show little relationship to blood lead in this data set, probably reflecting that the common soil-to-dust pathway has been controlled to some extent. However, when dust lead levels are in the "medium" range, there is a clear gradient from the percentage at low soil lead (13.5 percent with elevated blood lead) to medium soil lead (23 and 21 percent elevated blood lead) to high soil lead (30 percent above 1000 ppm soil lead). When lead concentrations in house dust are high, the gradient with soil lead is very steep, from 6.7 percent children at low soil lead (< 250 ppm) to 26 percent having elevated blood lead when exposed to soil lead of 500 to 1000 ppm, and 31 percent above 1000 ppm. The increased gradient of blood lead with increasing dust lead is most noticeable in the soil lead category of 500 to 999 ppm, which supports the usual interpretation that soil lead is largely transferred to humans via house dust. This is les[illegible]r in the other groups, but due to small or moderate number[illegible]hildren in most cells (numbers shown in parentheses), Table [illegible]uld not be over-interpreted.

Similar results are shown in Table 6b for blood lead concentrations of 15 ug/dl or above, and in Table 6c for blood lead concentrations of 20 ug/dl or above. In Table 6b, where dust lead concentrations are sufficiently high to suggest that the indirect exposure pathway from soil through house dust may

actually exist for these households, there is a clear increase of elevated blood lead percentages at soil leads of 500 ppm or greater. In Table 6c, the occurrence of highly elevated blood lead concentrations of 20 ug/dl or greater is substantial when soil lead is 500 ppm or greater, but typically only when elevated dust lead concentrations (750 ppm or greater) occur for the indirect exposure pathway.

Table 7 presents a similar display for ranges of dust lead loading and interior lead paint hazard. The lead paint hazard index CXRFIAV is the average of the product of lead paint XRF loading and paint condition number over a number of surfaces inside the housing unit. The ranges of soil lead and lead paint index were chosen to produce sufficiently large numbers of children in each cell in the table. It is clear that there is little evidence of a gradient of the percentage of elevated blood lead with lead paint under most circumstances, whereas there is a clear increase of blood lead with dust lead loading when the lead paint hazard index is either low (< 0.5 mg Pb /sq.cm.) or high (> 5 mg Pb /sq.cm.). The soil lead relationship is flat at medium ranges of the lead paint hazard index (1.5 to 5 mg / sq.cm.).

Certain other anomalies exist in Tables 6a-6c and Table 7, such as the rather high percentage of elevated blood lead for moderate levels of soil lead (250 to 499 ppm) at all ranges of dust lead. It is clear that other factors must be invoked to explain such anomalies in the form of a multivariate relationship. The remainder of this report develops these relationships.

3 CONFOUNDING OF VARIABLES AND IMPLICATIONS FOR MULTIVARIATE STATISTICAL MODELLING

The issue of confounding came up in several contexts: (1) in the draft IEHR/IDPH report of Feb. 1994, and in a subsequent commentary and response by Dr. Maurice LeVois of July 21, 1994 (received by U.S. EPA on January 6, 1995), as a justification for

not attempting to include both soil lead and dust lead as predictors of blood lead; (2) as a justification for attributing as much [redacted]he variation of blood lead as possible to behavioral and socio[redacted]ographic factors, and to environmental factors other than lead. In this section, U.S. EPA will discuss several of the most import aspects of confounding as they affect the Madison County Study:

3.1 Identification of Potential Confounding

Confounding is a potential problem in an epidemiological study. Well-designed studies can minimize the occurrence of confounding. However, even in an observational study with inadequate epidemiological design such as the Madison County study, a post-study analysis of the data finds little evidence that the relationships among blood lead, soil lead, paint lead, and sociodemographic factors are so severely confounded as to preclude quantitative analysis. The effects of soil lead, dust lead, paint lead, sociodemographic and behavioral factors can be estimated separately without excessive loss of information efficiency.

"Confounding" is a term that is widely used in epidemiology and other observational sciences. Confounding occurs when some third variable or factor is related both to the outcome or response being studied—in this case, childhood blood lead—and to the nominal cause of the outcome, such as lead in soil. As noted in U.S. EPA's "Preliminary Assessment" of October 1994, several factors appear to match the decline in mean blood lead with increas[redacted]istance from the NL/Taracorp smelter, including decrea[redacted]oil lead and dust lead, decreasing housing age and deterioration, increasing parental education and income. These are potential confounding factors.

The most certain way to avoid confounding is to prevent it from happening by designing the study so that possible confounded relationships in the lead-exposed group have at least one corresponding control group without the hypothetical confounding.

In the case of the Madison County study, that would have required identifying a similar community in which there is a gradient of factors such as age of housing, building condition, lead-based paint, ethnicity, income and education with increasing distance from a centrally-located industrial facility, but with no lead-emitting sources that cause elevated levels of lead in soil. There may be many communities of about the same size with substantial points of similarity that may fit this description. The nearby community of Pontoon Beach, Illinois (discussed in the IEHR/IDPH report) may not have been an adequate control group, but it appears that little effort was made to identify any other appropriate community. The design of the IDPH study therefore precluded an easy solution to the confounding problem.

The IEHR/IDPH report and the response by Dr. LeVois then attempt to justify exclusion of related exposure variables from statistical analyses such as multiple regression. This is not, properly, an example of confounding, since soil lead, paint, dust lead concentration, and dust lead loading are simply steps on a causal pathway from source terms (soil, paint) through an intermediate medium (dust) to the child. The existence of this pathway as an important pathway, usually the most important exposure pathway for most children, has been established using a variety of scientific approaches (see discussion below in Technical Appendix A), and has not been disputed by scientific experts. Use of different components of an exposure pathway is discussed in standard epidemiology texts, such as *Modern Epidemiology* by K. Rothman (1986). However, neither the IEHR/IDPH report nor Dr. LeVois's response appear to have quantitatively evaluated the extent of the "confounding" they claim exists in the Madison County Study.

Confounding is a potential problem in this study. Is the problem real? The U.S. Environmental Protection Agency has evaluated quantitatively the amount of confounding, to the extent that it can be defined internally from the data in the study, in the attached Technical Appendix. There are several methods for

assessing the consequences of confounding on inferences about relationships between blood lead and other factors. In multiple linear regression models such as used in the IEHR/IDPH report and in some U.S. EPA's analyses, one technical consequence of confounding is a high degree of collinearity among the predictor variables in the relationship. An example of a perfectly collinear relationship is that between the logarithms of dust lead concentration, dust lead loading, and total dust loading. That relationship is given by:

- log(dust lead loading) = log(dust lead concentration) + log(total dust loading) - log(1000)

where the factor of 1000 arises from combining dust lead loading measured in units of ug Pb/sq.m. and dust lead concentration in units of ug Pb/g dust with dust loading in units of mg dust/sq.m. The amount of collinearity and the components of a collinear relationship are easily identified by a principal components analysis of the correlation matrix of predictor variables (D. Belsley, E. Kuh, and R. Welsch, *Regression Diagnostics*, 1981). In fact, almost any statistical software package that is currently available, including SAS and SYSTAT as used by U.S. EPA and by the writers of the IEHR/IDPH report, contains a great variety of regression diagnostic indicators of collinearity. The authors of the IEHR/IDPH reports and subsequent reports must have not used these diagnostics. The collinearity diagnostics among the 30 most plausible predictors have shown that collinearity as a serious problem only occurs under four conditions:

1. When the logarithms of dust lead loading, dust lead concentration, and total dust loading are all used in a regression model, there is a perfect collinearity as shown above;

2. The shifted logarithm of the variable CXRFIAV, the mean of the product of paint condition and XRF lead loading on interior surfaces, is highly correlated with the logarithm of

the mean XRF, and using both in a regression model causes a loss of information efficiency;

3. AGE [redacted]ighly correlated with AGE squared, and using both in a mo[redacted]is less desirable than using other variables for age effects; and

4. there is a fairly strong correlation between soil lead and distance from the NL/Taracorp lead smelter, with the geometric mean soil lead within each distance ring being nearly inversely proportional to the distance of the ring from the NL/Taracorp smelter. This last result may be written in the form

• soil lead = (constant) / (distance from NL)

or, taking logarithms on both sides of this equation

• log(soil lead) = log(constant) - log(distance)

which is a fairly strong collinearity. The value of the constant is estimated as about 1300 ppm. If these combinations are avoided, then there are no severe collinearities and the effects of most other predictors or covariates can be estimated separately in joint regressions with only a modest degree of variance inflation.

Household covariates are responsible for part of the variation in blood lead, and including demographic covariates such as race or ethnicity, parental education or home ownership in a model will generally reduce the unexplained variance in blood lead. These variables are not so highly correlated with soil le[redacted]owever, and are therefore weak confounders of the relatio[redacted]

Alm[redacted]l statistical modelling procedures in statistical packages currently available can generate the estimates of the correlations among the regression coefficients. The linear regression models can generate exact correlation coefficients even for small samples. Large-sample correlation coefficients among the regression coefficients were calculated for nonlinear

regression models, linear and nonlinear structural equation models o[illegible]uation systems; with sample sizes of 360 to 450 childre[illegible]m the analyses, these correlation coefficients are valid. [illegible]odels U.S. EPA tested, the correlations of the blood lead regression coefficient estimates were not close to 1 in magnitude even when ostensibly correlated covariates such as log(dust lead loading) and log(soil lead) were both used as predictors of log(blood lead). Similarly low values of the correlation of regression coefficients for most other factors were found, as noted above. Therefore, the regression coefficients for different predictive factors have only a modest degree of overlap, and the statistical models are generally capable of sorting out the effects of different factors. The only consistent exception appeared to involve soil lead and distance from the NL/Taracorp lead smelter; including one of these variables generally left the other variable statistically non-significant. Even when dust lead loading was used in the regression models as a predictor for blood lead, the soil lead coefficient was statistically significant or marginally significant in all of the models described below.

Apart from the four conditions to be avoided in models, labelled (i)-(iv) above, no other serious collinearity was noted. However, there was a moderate degree of collinearity combining the logarithms of soil lead concentration , distance, and the number of cigarettes smoked per day in the household. The latter variable is likely to be a surrogate for other sociodemographic factors. Exterior lead paint and building condition also played a smaller [illegible] in this component. As U.S. EPA noted earlier, exterio[illegible]d paint and distance from the NL/Taracorp smelter are good pr[illegible]rs of soil lead. When soil lead is used as a predictor for dust lead, there is little additional information that distance can give about dust lead since soil lead and distance are fairly strongly correlated.

In a non-technical sense, there is only a slight to moderate amount of confounding that can modify the relationship between

soil lead and blood lead. For example, there is only relatively modest confounding with dust lead. Within each distance or ring, there is some variation in soil lead concentrations. However, for any soil lead concentration, there are housing units with both lower and higher dust lead concentrations and children with both lower and higher blood leads. Therefore, the interfering effects of dust lead differences (using dust lead as the closest environmental predictor of blood lead on the indirect exposure pathway from soil lead to blood lead) can be minimized. Likewise, sociodemographic factors or building condition are not strongly related to both blood lead and soil lead.

Finally, U.S. EPA notes that there is one additional test of potential confounding effects, and in many applications R.M. Mickey and S. Greenland ("The Impact of Confounder Selection Criteria on Effect Estimation", *American Journal of Epidemiology*, Vol. 129, No. 1, 1989, pp. 125 to 137) have shown that this method is one of the best tests (although not foolproof). The method is to carry out the analyses with and without the potential confounding factor included in the model, and to determine whether or not the estimated effect sizes are substantially different. The IEHR/IDPH report carried out a somewhat similar method in the "hierarchical analysis" whose results were shown in Table 11 of their report, but as U.S. EPA will show in the next section, their approach is incomplete and highly misleading.

In summary, extensive diagnostic analyses of a variety of statistical models find that confounding is a worrisome but not insurmountable problem in estimating separate effects of lead in soil, dust and paint. Careful analyses of the Madison County data should adequately characterize the typical contributions of lead in paint to soil, the contributions of leads in soil and paint to lead in household dust, and the separate contributions of soil lead and dust lead to blood lead.

3.2 Hierarchical Tests of Environmental Lead Variables

The IEHR/IDPH report argues that soil lead is an inadequate predictor of blood lead, since adding soil lead to other predictors in a linear regression model increases the coefficient of determination or squared multiple correlation (denoted R-squared) by only 3%. They further argued that it was not appropriate to also include dust lead in the model since dust lead and soil lead are confounded as predictors of blood lead. The U.S. Environmental Protection Agency's analyses have found the following results:

1. Using the same base model as in the IEHR/IDPH report, inclusion of soil lead in a linear regression model greatly reduces the statistical significance of modifying factors such as building condition, with soil lead being the most important or second most important predictor of blood lead in the models;

2. When lead paint is tested in the same way as soil lead, lead paint makes a completely insignificant contribution to blood lead, so that applying the same fallacious approach as used in the IEHR/IDPH report would completely dismiss lead paint as a factor in child blood lead;

3. The use of imputed building condition as done in the IEHR/IDPH report provides the least predictive baseline model for hierarchical models among several approaches to the problem of missing values of exterior building condition;

4. The use of dust lead loading nearly doubles the amount of variance in log(blood lead) that is predicted by the regression model, but soil lead makes an additional statistically significant contribution to blood lead over and above that of dust lead, without substantially changing the estimated effect of dust lead, which suggests that confounding of soil lead or dust lead effects on blood lead is moderate but not excessive; and

5. The estimated effects of dust lead are somewhat exaggerated because of the high influence of a few houses with extremely elevated dust lead concentrations (greater than about 8,000 to 10,000 ppm—see next section), but similar estimates are obtained even when the data set is restricted to dust lead concentrations below 1000 ppm.

In order to explain these ideas, some use of mathematical expressions will be helpful. The baseline model used in the "hierarchical analysis" in the IEHR/IDPH report may be written in the form:

- baseline log(blood lead) = B0 + BW log(water lead) + BXI log(CXRFIAV+1) + BXO log(CXRFOAV) + BCOND * BLDCONIM + BREF * REFINISH

where

- CXRFIAV = average product of interior lead paint XRF and interior surface condition,
- CXRFOAV = average product of exterior lead paint XRF and exterior surface condition,
- BLDCONIM = exterior building condition (1,2, or 3) if not missing, 1.389 if missing,
- REFINISH = 1 if recent paint refinishing or remodelling, 0 otherwise.

B0, BW, BXI, BXO, BCOND, BREF are regression coefficients to be fitted to data.

The hierarchical model in the IEHR/IDPH report is given by:

- log(blood lead) = baseline model + BS * log(soil lead).

In order to evaluate this model, U.S. EPA carried out several additional tests. These included: (1) also using only observed building condition as a predictor, or building condition in which missing values were imputed by the mean condition in the distance ring; (2) also truncating the data set to dust lead concentrations less than 3,000 or 1,000 ppm; and (3) also testing dust lead concentration and dust lead loading as predictors, with models:

- log(blood lead) = baseline model + BDC log(dust lead concentration)
- log(blood lead) = baseline model + BDL log(dust lead loading)

and

- log(blood lead) = baseline model + BDL log(dust lead loading) + BS log(soil lead).

The results are shown in Tables 8a-8d, omitting results for dust lead concentration. Dust lead concentration was more predictive than soil lead, but less predictive than dust lead loading.

Predictiveness of a multiple regression model will here be characterized by the squared multiple correlation coefficient, denoted R-squared. Other measures such as the "adjusted" R-square may also be used, but the unadjusted R-square has the most direct interpretation as the fraction of variance in log(blood lead) that is attributable to the linear predictor variables.

The least predictive baseline model was the one used in the IEHR/IDPH report (R-square between 0.029 and 0.051), whereas the baseline models using only observed building condition with no imputation (N = 387) were about as predictive (R-square from 0.098 to 0.128) as the models with building condition imputed by distance (N = 441, R-square from 0.104 to 0.133). The U.S. Environmental Protection Agency next observes that including soil lead increased R-square by only about 0.03 to 0.04 over the baseline model, as noted in the IEHR/IDPH report. However, including dust lead loading nearly doubled R-square, increasing R-square by about 0.08 to 0.14. Thus, dust lead loading is by far the most important environmental lead predictor of blood lead.

The U.S. EPA finally notes that the regression coefficients in the model with both dust lead loading and soil lead are somewhat different than in the models that included either dust lead alone or soil lead alone, but that all coefficients were

statistically significant and had the correct sign for a causal relation[illegible]. When dust lead was included in the model, the soil lead re[illegible]ion coefficient was roughly halved, although still statisti[illegible]ly significant or marginally significant (one-tailed P < 0.10). The regression coefficient for log(dust lead loading) decreased slightly when soil lead was included in the model, but remained highly significant. While this demonstrates that there is some degree of confounding between soil lead and dust lead, the estimated effect of dust lead is largely insensitive to the inclusion of soil lead. The fact that the estimated soil lead effect is greatly reduced by including dust lead in the model strongly suggests that dust lead is the "proximate" predictor on the pathway from soil lead to blood lead. Of course, this has been established in many other studies.

A noteworthy fallacy exists in the use of the particular hierarchical regression model in the IEHR/IDPH report which is that both soil lead and interior lead-based paint are significant predictors of dust lead. Forcing interior lead paint (CXRFIAV) into the model before testing soil lead or dust lead has already biased the conclusions, since part of the predictive power of dust lead on blood lead has already been stolen (so to speak) by lead paint. Likewise, since exterior lead paint is a significant component of soil lead, forcing exterior lead paint into the model before soil lead is included has already biased the results towards a lower estimate of the effect of soil lead on blood lead, even if there were no other confounding factors. This can be demonstrated by comparing the "sub-baseline" model

- log([illegible]lead) = B0 + BW log(water lead) + BCOND (building condi[illegible]) + BREF (REFINISH)

with the baseline model, as shown in Table 9. Neither the sub-baseline nor the baseline model is very predictive (R-squared for sub-baseline models range from 0.033 to 0.125), but the predictiveness of the sub-baseline model is improved much more by

the inclusion of soil lead (increases in R-squared range from 0.024 to [illegible]59) than by the inclusion of both interior and exterior [illegible]d-based paint (increases in R-squared range from -0.002 to 0.018). Dust lead loading produces an even larger effect than soil lead (increases in R-squared range from 0.09 to 0.18). By the same reasoning as used in the IEHR/IDPH report, lead paint should be a much less important source of blood lead than is soil lead. In reality, soil lead and lead paint are the most important primary sources of environmental lead, acting mainly through the indirect dust exposure pathway. While U.S. EPA does not completely endorse the use of hierarchical regression models to evaluate potential confounding effects, it is clear that the IEHR/IDPH report derived incorrect conclusions about the relative importance of blood lead sources from a biased and inadequate application of this approach, and that almost any reasonable alternative approach would quickly have shown the relative importance of dust lead as the "proximate" predictor for soil lead and lead paint.

The same conclusions apply even when a much better baseline model is used. Based on other studies such as those reviewed in the Air Lead Criteria Document (U.S. Environmental Protection Agency, 1986), U.S. EPA has added child age and race as additional factors in the better baseline model. Age has a nonlinear effect on blood lead. Rather than use a parametric model for which there is no theoretical basis, U.S. EPA has converted age into a set of categorical variables. The reference group is children < 12 months of age who probably have very little [illegible]exposure, and whose dust exposure is largely limited to post[illegible]nth crawling behavior. The other categories are coded as binary variables with AGE1 = 1 if the child is 12 to 23 months of age, AGE2 = 1 if age 24 to 35 months, AGE3 = 1 if age 36 to 47 months, AGE4P =1 if age 48 months or older, and = 0 otherwise for each age indicator. The age groups at 1, 2, and 3 years have significantly higher blood lead concentrations. The U.S. EPA has used BLACK as an indicator for Afro-American racial

status in the family interview, since this is by far the largest ethnic o[illegible]cial subpopulation in the study. The non-BLACK group is prima[illegible] white, with only 9 Asian, Pacific Islander, or Native American children in the sample. African-American children had significantly higher blood leads (at least 30 percent higher) in all of the models, everything else being equal.

The results are shown in Tables 10a-10c and Table 11. The new baseline model has a much larger R-square, about 0.21. Adding soil lead still increases R-square by only 0.03 to 0.05, but including dust lead increases R-square by about 0.08 to 0.12. Including soil lead in the model reduces the dust lead loading regression coefficient slightly, from about 0.14 to about 0.12, and including dust lead in the model reduces the estimated soil lead regression coefficient from about 0.18 to about 0.10. In spite of the confounding shown by the decrease of the soil lead regression coefficient when dust lead is included in the models, the soil lead coefficients are statistically significant until the data set is truncated at dust lead concentrations of 1000 ppm. Even with restriction of the data to 1000 ppm dust lead, the soil lead coefficient remains marginally significant in spite of losing many cases with high soil lead concentrations from the restricted data set. Dust lead and child age are the most significant predictors of blood lead in all of these models, and lead paint is always an insignificant direct predictor of blood.

3.3 [illegible]ounding May Be Introduced by Non-standard Soil and [illegible] Sampling Protocols

There may be some concerns about the soil and dust sampling protocols that need to be examined. Many other environmental lead studies U.S. EPA has examined include drip-line or house perimeter samples among the soil samples that are composited to obtain a single soil lead concentration that characterizes the yard. The Madison County study used composites of 10 soil

sampling locations within a residential yard. No soil samples were taken within the dripline of the housing unit. It is therefore possible that higher soil lead concentrations would have been obtained had the sampling been done so as to include some dripline samples, since dripline samples are more likely to be contaminated by exterior lead-based paint than soils further away from the house. This may explain the low (albeit statistically significant) relationship between exterior lead paint and yard soil. This suggests that lead paint makes a minor contribution to mid-yard soil, but may present a distorted estimate of the risk to a child who resides there, since the child will generally have access to contaminated yard soil within the dripline.

There may be a converse problem with the dust samples. Many other environmental lead studies included residential dust samples collected by vacuum from floor areas. The dust samples are composited and sieved to obtain a single house dust lead concentration (and dust lead loading) that characterizes the child's exposure to fine dust particles that can adhere to the child's hands, and may contaminate the child's food during preparation and consumption. The Madison County study used composite dust samples that were much larger than other studies, typically 3 to 5 g for Madison County residences, and may therefore have required sampling at locations within a residence that would not have been included in other studies. Dust samples collected in the Madison County may have included components collected on window sills or in other locations where one might expect to encounter large paint chips, and even though these paint chips would have been removed during the laboratory analysis, the dust lead concentrations in the fine dust particles and in the larger debris were recomposited mathematically. There may then be some additional confounding between dust lead and interior lead-based paint based on this mathematical recompositing.

3.4 Components In a Causal Pathway Can Give the Appearance of Confounding

The [redacted]arance of confounding may arise from the use of both soil le[redacted]nd dust lead as predictors for blood lead, since they are components on a common causal pathway from soil lead to blood lead. Inferring causality from empirical evidence is a basic issue in all of the observational sciences, not least of all in epidemiology. The causal relationships relating blood lead to environmental lead have been very clearly established by other scientific techniques. Longitudinal studies provide an excellent experimental basis for concluding that changes in soil lead and dust lead concentrations in the environment can produce changes in child blood lead. Reductions in environmental lead exposure leading to reductions in child blood lead may include dust removal (Charney et al. 1983) or combined soil and dust removal (Weitzmann et al. 1993; Aschengrau et al. 1994), where cause [redacted] (change in environmental lead) clearly precedes effect (greater reduction in blood lead occurs in soil removal group than in control group). Mass balance calculations, and source identification using stable lead isotope methods, also demonstrate that there is a causal pathway among environmental variables, with exterior lead paint and deposition of airborne lead contributing to lead in soil, and with lead in soil, interior lead-based paint, and deposition of airborne particles contributing to lead in household dust. Thus, lead in soil can contribute to child blood directly, when the child ingests surface soil or exterior dust particles, and indirectly, when the child i[redacted] household dust to which soil has contributed some lead. [redacted]lead cannot be considered merely a confounding factor in asse[redacted] the relationship between blood lead and soil lead.

A standard epidemiology text (K. Rothman, *Modern Epidemiology*, 1986, p. 94) is quite clear on this point: "A confounding variable must not be an intermediate step in the causal pathway between exposure and disease [elevated blood lead in this case]. This criterion requires information outside the

data. The investigator must decide whether the causal mechanism that mi[redacted]follow from exposure to disease would include the potenti[redacted] confounding factor as an intermediate step. If so, the var[redacted] is not a confounder."

The use of the "hierarchical regression model" in the IEHR/IDPH report (Table 11 of that report) without assessing the role of dust lead is therefore an extremely serious conceptual error in drawing valid scientific inferences from the IDPH Madison County study. The U.S. EPA finds that both dust lead and soil lead play a role in childhood lead exposure, but not the same role. Hierarchical regression models can be applied in circumstances where there is a clear separation between the extra variable being tested, and the variables that have already been used in the preceding model as predictors of blood lead. A correct application of hierarchical regression modelling is given in EPA's Air Quality Criteria for Lead, 1986. A mathematical model for predicting child blood lead was developed based on the National Health and Nutrition Examination Survey (NHANES II) for the 1976 to 1980 period. It was then shown that, after all other terms had been included in the model, reductions in blood lead during this period of time could be well predicted using the corresponding changes in leaded gasoline. It was also shown that this conclusion was not confounded with changes in other variables over time, including the amount of lead used in lead-soldered food cans. Preliminary analyses showed that the leaded gasoline time series shared relatively little variance with other predictors so that it was appropriate to test leaded gasoline after a[redacted]iminary model had been developed using other variabl[redacted]The application of hierarchical modelling to estimate the eff[redacted] soil lead on blood lead Madison County study in the IEHR/IDPH report is clearly different from this, since their analysis excludes the "proximate" predictor, dust lead. Several more appropriate methods are available, as was demonstrated in Section 3.2 of this report.

4 REGRESSION MODELS FOR EVALUATING RELATIONSHIPS AMONG BLOOD LEAD, DUST LEAD, PAINT LEAD, SOIL LEAD, AND DISTANCE FROM THE NL/TARACORP LEAD SMELTER

4.1 Introduction

Because of the complex interrelationships among the variables in the Madison County study, simple bivariate models and bivariate correlation coefficients cannot sort out the relative contributions of several covarying factors. Several multivariate procedures were used in U.S. EPA's analyses, including linear and nonlinear regression models, as well as structural equation models (abbreviated SEM) described in Section 5. Sections 4.2 and 4.3 assess the relationships among lead in several environmental media, with particular reference to location of the child's residence relative to the NL/Taracorp lead smelter. Section 4.3 describes several regression approaches for relating blood lead to environmental lead.

4.2 The Relationship of Blood Lead and Environmental Lead to Distance From the Smelter

The U.S. EPA focussed on the relationship of blood lead, dust lead, and soil lead as a function of distance from the NL/Taracorp smelter because distance is the only information in the data set provided to U.S. EPA that is specifically relevant to the location of most of the proposed soil remediation. The IDPH study covered most of Madison County, a much larger area than Granite City. In fact, there is no way of identifying which children in the IDPH data set provided to U.S. EPA actually live in Granite City, or in Madison, or in Venice, or in Eagle Park Acres. These children may have lead exposure sources causing elevated blood lead concentrations, but the sources are quantitatively different in different locations, and will almost certainly require different remedial strategies depending on the properties of the primary lead sources. The remedial approaches may depend on whether the most important source of exposure is soil near the NL/Taracorp lead smelter, or battery casings and

other waste material from the pile at isolated locations further away fr[redacted]he NL/Taracorp lead smelter, such as Venice or Eagle Park Ac[redacted]

From this point of view, the IEHR report on the IDPH study is not useful since it is not related to any specific part of Madison County, much less to identifiable sources of exposure. The U.S. EPA's reanalyses attempt to adjust for these serious omissions of the IEHR/IDPH report, but U.S. EPA has not been given the data that will allow U.S. EPA to reanalyze the study in the way that is most relevant to remediation.

There are statements in the IEHR/IDPH report implying that the study area has an overall incidence of elevated blood lead that is not remarkably high compared to other urban areas. This argument is based on fallacious reasoning. Statistical dilution (as practiced in the IEHR/IDPH report) is not the solution to lead pollution. There is a clear indication that the incidence of elevated blood lead concentrations is much higher near the NL/Taracorp lead smelter. The U.S. EPA's May 23 memo, based on the map in Figure 1 of the IEHR/IDPH report, shows a much higher incidence of elevated blood lead near the NL/Taracorp smelter and in the "downwind" direction, about 26 percent of households with at least one child with elevated blood lead as opposed to 13 percent in the urbanized areas farther from the NL/Taracorp smelter, and 7 percent of households in a less urbanized area. EPA has not been given access to the data that would allow U.S. EPA to count the number of children with elevated blood lead in each area. The data that were sent to U.S. EPA showed a very defini[redacted]dient of elevated blood leads with distance from the NL/Tar[redacted]lead smelter, with the highest percentage of children within rings 4 or 5 (distance of about 1/2 to 5/8 mile from the NL/Taracorp lead smelter). There clearly are childhood lead exposure problems that are localized in the area near the NL/Taracorp lead smelter. Averaging the lead exposure areas with the rest of Madison County conceals the existence of localized high lead exposures near the NL/Taracorp lead smelter.

The U.S. EPA has also evaluated the role of location (as measured by distance from NL) as a potential confounding factor. At any given location (ring or group of adjacent rings surrounding the NL/Taracorp lead smelter), there are some houses with higher levels and some with lower levels of almost any other measured variable in the study: dust lead, paint lead, parental education and income. Of all the variables in the study, none is seriously confounded with distance from the NL/Taracorp lead smelter except for soil lead concentration. The range of soil lead concentrations in any ring is relatively small, so that soil lead and distance are relatively highly correlated with each other. The average soil lead in each ring is very nearly inversely proportional to the distance of the ring from the smelter. In this regard, the soil lead distribution around the NL/Taracorp lead smelter looks very similar to every other lead smelter community U.S. EPA has studied. This does not by itself prove that the smelter was the primary source of the lead in soil. However, the Illinois EPA report of 1983 (IEPA, 1983) demonstrates a combination of soil lead concentration isopleths with elevated air lead concentrations observed near the NL/Taracorp lead smelter when the smelter was operating in the 1970's and early 1980's that leaves little doubt that much of the soil lead was deposited from airborne particles emitted by the smelter, and possibly to a much lesser extent by other nearby particle sources. Since elevated concentrations of lead are highly persistent in undisturbed soils, current high levels of soil lead largely reflect these historic deposits.

How[illegible] U.S. EPA has analyzed the relationship between soil lead a[illegible] only other plausible source of elevated lead concen[illegible]on in residential yard soils, deteriorating exterior lead-based paint. The U.S. EPA found that there was a consistent contribution of exterior lead-based paint to soil that was approximately the same at any distance from the NL/Taracorp lead smelter. Similar results were obtained by several different analytical methods (linear and non-linear regression, structural

equations modelling). The condition of the building was used as a covari[illegible]in many of the analyses, as were other sociodem[illegible]phic variables, and their interactions were tested. When the [illegible]timated contribution of exterior-lead-based paint and building condition were subtracted from the observed soil lead concentration, there remained a large positive fraction of soil lead at most residences that was not explained by lead paint or by building condition. This component could be reasonably attributed to historical deposition of airborne particles emitted by the smelter and dust particles blown off the NL/Taracorp lead smelter. Neither the building condition nor the background term were ever statistically significant. The best-fitting model (smallest residual variance) was a very simple linear model, fitted in log form:

Soil lead concentration = (1333 / distance) + 7.79 CXRFOAV, where distance = ring number 1 through 10, and where CXRFOAV [illegible] the average of the exterior XRF lead paint loading times the [illegible] exterior paint condition. Since CXRFOAV never exceeded 62.3, and was usually much smaller, the typical exterior lead paint contribution to lead in residential yard soil was always less than 500 ppm, usually much less. The remaining term, which depended on the inverse of the distance from the NL/Taracorp lead smelter, was dominant near the NL/Taracorp lead smelter. Estimates of a non-zero intercept or background soil lead concentration were either very small or negative, and was so insignificant that the goodness of fit of the model was reduced negligibly by omitting the background term. There was little evidenc[illegible] confounding between distance and exterior paint. The U.S. E[illegible]cludes that most of the lead in soil near the NL/Taracorp lead smelter must be attributed to some processes by which lead is transported from the smelter to the surrounding yards. This implies that much of lead in soil near the NL/Taracorp lead smelter will have properties similar to those of other former smelter communities U.S. EPA has studied: high bioavailability and ready transport from surface soil into the

household dust.

There are some relatively high soil lead concentrations far away from the NL/Taracorp lead smelter, attributable to lead paint or other sources such as use of waste materials for fill or for street repair. These locations cannot be confirmed since IDPH has not provided U.S. EPA with any information about the location of these residences. It is likely that these few exceptional cases (4 out of 351 units) are found in places such as Venice Township or Eagle Park Acres.

4.3 Sources of Lead In Household Dust

Most lead experts agree that household dust is a very important medium for childhood lead exposure, and is likely the primary exposure pathway for lead in soil and for lead in interior lead-based paint. Ingestion of exterior dust from soil is a direct exposure pathway to soil lead that may be nearly as important as the indirect pathway from soil through household dust. Direct ingestion of large flakes or chips of deteriorating interior lead paint can have catastrophic consequences when it occurs, but it would appear that ingestion of large paint chips is a highly unusual circumstance in Granite City. Most children are likely to obtain most of their interior lead paint intake from ingestion of fine particles adhering to the child's hands during normal activities on floor, carpets, or furniture contaminated by lead dusts, with paint as only one of the lesser sources contributing to house dust, compared to track-in of soil and deposition of airborne particles.

There have been many assertions that most of the lead in household dust is attributable to interior lead paint. The U.S. EPA's analyses point in a very different direction. In fact, even Table 12 in the IEHR/IDPH report, for all its faults, finds that lead in soil and lead in paint make contributions that are nearly equal in statistical significance. The U.S. EPA analyses suggest that the estimated contribution of soil to dust is greater near than NL/Taracorp lead smelter than is the estimated

contribution of interior lead-based paint because the soil lead concentrations near the smelter are very high compared to soil lead concentrations, whereas the interior lead paint hazard index near the site is only moderately higher than it is farther away. This will be demonstrated quantitatively using multiple regression methods.

The U.S. EPA has analyzed the relationship between dust lead and the only other plausible source of elevated lead concentration in household dusts, deteriorating interior lead-based paint. The U.S. EPA found that there was a consistent contribution of interior lead-based paint to dust that was approximately the same at any distance from the NL/Taracorp lead smelter. Similar results were obtained by several different analytical methods (linear and non-linear regression, structural equations modelling). The condition of the building was used as a covariate in many of the analyses, as were other sociodemographic variables, and their interactions were tested. When the estimated contribution of interior-lead-based paint and building condition were subtracted from the observed dust lead concentration, there remained a large positive fraction of dust lead at most residences that was not explained by lead paint or by building condition. This component could be reasonably attributed to lead in yard soil that was transported into the house. The yard soil contained lead from the smelter or waste pile, along with some exterior lead paint particles. Both soil lead and deteriorating interior lead paint were highly significant predictors of dust lead concentration. The building condition was a statistically significant predictor of household dust in most of the models U.S. EPA tested, but much less significant than the soil or paint "source" terms. The background term was positive but not statistically significant in most models U.S. EPA tested. The best-fitting model (smallest residual variance) was a very simple linear model, fitted in log form:

- Dust lead concentration = (0.385 Soil lead) + 94.5 CXRFIAV + (82.7 [illegible] lding condition)

where building condition was coded 1 through 3, and where CXRFIAV is the average of the interior XRF lead paint loading times the interior paint condition. Since CXRFIAV never exceeded 39.4, and was usually much smaller, the lead paint contribution to household dust was often small, but sometimes large. The U.S. EPA also tested distance from the NL/Taracorp lead smelter as a covariate. When distance was included in the model, distance had a statistically insignificant effect on dust lead, apart from its relationship to physically meaningful source terms such as soil lead and interior paint lead, and to building condition as a modifier of effect. In fact, interactions of building condition with soil lead or with distance were also not statistically significant. Interactions of building condition and interior lead paint with distance were marginally significant in some models The U.S. EPA tested.

The U.S. EPA used the prediction equation for lead in household dust to estimate the fraction of dust that was attributable to soil at each house:

- Soil fraction = (0.385 Soil lead) / (Predicted dust lead concentration)
- Paint fraction = (94.5 CXRFIAV) /(Predicted dust lead concentration)

Soil [illegible] is the dominant contributor to lead in household dust in the [illegible] closest to the NL/Taracorp lead smelter. The estimated contribution of soil lead to household dust lead is generally much larger than the paint contribution in rings 1 through 4 or 5, and on average comparable further away from the NL/Taracorp lead smelter. If most of the lead in house dust near the former smelter is derived from lead in soil, and lead in soil near the NL/Taracorp lead smelter was derived from historic

smelter emissions, then much of lead in dust near the NL/Taracorp smelter [illegible]ld also have properties similar to those of other former s[illegible]er communities U.S. EPA has studied: high bioavai[illegible]ity and ready transport from household surfaces into the child's mouth.

One way to visualize the relative importance of lead in soil is shown in Figure 22. The estimated contribution of soil lead to household dust lead is generally much larger than the paint contribution in rings 1 through 4 or 5, and on average comparable further away from the NL/Taracorp lead smelter.

Here, the percentage of housing units for which the estimated soil lead fraction of house dust lead is greater than the estimated paint lead fraction of house dust lead is plotted. Note that this decreases from a maximum near the NL/Taracorp lead smelter at ring 1 to a minimum at ring 9, but is greater than 50 percent from rings 1 through 8. (See Map 1 for locations). In other words, lead from soil appears to make a greater contribution to household dust lead than does interior lead paint in the majority of houses within about one mile of the NL/Taracorp lead smelter.

4.4 Specification of Regression Models For Blood Lead

The statistical models that are most easily fitted using linear regression programs are linear in log-transformed variables:

Model 1:

log(blood lead) = constant + a log(soil lead) + b [illegible]dust lead loading) + etc

Unfortunately, when used to predict blood lead concentrations, this model is intrinsically multiplicative and nonlinear, implying that the predicted blood concentration is:

- blood lead = exp (constant) (soil lead)^a (dust lead loading)^b

exp (etc.).

Since lead uptake from the environment is believed to be nearly linear at low to moderate intake rates or exposure concentrations, a more plausible biological model is an additive model:

Model 2:

blood lead = constant + A (soil lead) + B (dust lead loading) + etc.

For statistical purposes, Model 2 is best fitted in log-transformed form which is intrinsically nonlinear in the regression parameters A and B. The parameters A and B are slope factors of the form ug/dl blood lead per ug/g soil lead or per ug/g dust lead, whereas the parameters a and b are dimensionless "elasticities" of the form of percent change in blood lead per 1 percent change in soil lead or dust lead respectively. The logarithmic form of Model 2 for statistical estimation is:

- log(blood lead) = log(constant + A (soil lead) + B (dust lead loading) + etc.).

These parameters can be estimated using standard iteratively reweighted least squares programs for nonlinear regression. These methods have been discussed in (U.S. Environmental Protection Agency 1986, 1989a; Angle et al. 1984).

4.5 Stepwise Models for the Logarithm of Blood Lead (Model 1)

Results of fitting Model 1 using a variety of stepwise modelling approaches is shown in Table 12. Values of R-squared of about 0.37 for the logarithm of blood lead can be achieved with any of several parsimonious models, including models with both log(soil lead) and log(dust lead loading) or log(dust lead concentration) as statistically significant predictors.

Results in Table 12 are characterized by the partial regressi[illegible]oefficient b between the variable and log(blood lead), a[illegible]y the significance level P of the coefficient (two-tailed; half as large when one-tailed tests are appropriate). The lead paint variables LOGCXI and LOGCXO were never retained in stepwise models that included dust lead. This is not to deny that deteriorating lead-based paint is not a potential source of lead exposure, but rather to emphasize that dust lead, as loading or concentration, are almost always better predictors. In the sense of a causal pathway model, U.S. EPA may infer that dust lead is a more proximate source/pathway of childhood lead exposure than is lead-based paint.

In the forward stepwise selection model that excluded DISTANCE as a predictor, the logarithm of the mean of all XRF measurements, LOGXRFMN, was marginally significant (P = 0.049[illegible]). While water lead concentration was well down on the list of suspected major sources, there was a detectable statistically significant relationship between log(blood lead) and LOGPBW (P between 0.00180 and 0.0127, b between 0.0460 and 0.0561), and between log(blood lead) and REFINISH (P between 0.00107 and 0.00386, b between 0.147 and 0.178)in all of the stepwise models shown here. While building condition was included in all three of these models, with P between 0.0158 and 0.0417, it was not ever as highly significant as suggested in the IDPH report, once the set of predictor variables to be tested included the confounders and covariates identified in Sections 3 and 4. Total dust loading in the house was not selected as a predictor in any of the[illegible]dels, nor in most of the models shown in Table 12. Parent[illegible]cation remained a significant and relatively stable predictor of blood lead, P between 0.0119 and 0.0184, and with a stable regression coefficient b between -0.0387 and -0.0424. The number of cigarettes smoked per day was well correlated with distance, but on an individual child basis was only marginally predictive of blood lead in different children, P between 0.0459 and 0.1217. Renter vs. homeowner status was included in two of

three models but with P between 0.1862 and 0.2248, and should probably [redacted] omitted from the models. The relationship between log(blo[redacted]ad) and age is not linear, and in this model is better described as a convex downward quadratic function with a maximum between 1 and 2 or 3 years of age. The number of hours a child spends at home was included in the stepwise models but was not significant by usual standards, P between 0.1199 and 0.1249. On the other hand the number of hours per day that the child spends outside of the house playing was always one of the most significant predictors in these models, $P < 0.00016$. Gender was only selected in one model, and was not a statistically significant predictor.

In summary, linear models for log(blood lead) always included dust lead as a highly significant predictor, usually selecting log(dust lead loading) as a better predictor than log (dust lead concentration) and thus excluding log (total dust loading) as a significant predictor. The logarithm of soil lead, of average lead-based paint, or of deteriorating interior or exterior lead-based paint, were rarely or never selected for inclusion in models, suggesting that these variables are less proximate predictors of blood lead, in general only playing a role insofar as they contribute lead to household dust and thence to the child by hand-to-mouth contact with surface soil or dust. Soil and paint are therefore largely indirect sources, using house dust as a pathway. Although U.S. EPA believes that this modelling approach has less biological plausibility or interpretability than the linear model (Model 2) described in Section 4.2, this is the me[redacted]hat was adopted in the IDPH report. A reasonably direct[redacted]el specification search would have clearly exposed these relationships, and in fact the IDPH report clearly identifies household dust lead as the most important and significant predictor of blood lead. The IEHR/IDPH report did not examine the role of soil lead as a major source of dust lead, and therefore an important indirect source of lead in blood.

4.6 Linear Models for Blood Lead fitted in Log Form (Model 2)

The relationship between blood lead and lead intake is somewhat nonlinear (Chamberlain 1984, Marcus and Cohen 1988), but only at levels corresponding to soil and dust lead concentrations well in excess of 1000 ug/g. Therefore, a reasonable approximation to the relationship can be obtained by fitting a linear model, in log-transformed form. The low-dose linearity is also predicted by almost any biokinetic model of lead uptake and distribution in the body, hence has a theoretical as well as an empirical basis. The empirical regression coefficients derived in this way can be compared with earlier studies (U.S. Environmental Protection Agency 1986, 1989a). The same general approach to identifying confounders and selecting predictor variables was applied to this problem as well, but the form of the relationship fitted to the data is intrinsically nonlinear in the parameters. There is no stepwise variable selection method in the nonlinear regression procedures in some commonly used statistical packages (SYSTAT, SAS, BMDP), so U.S. EPA used SYSTAT's PROC NONLIN (Wilkinson 1992) on one model at a time. Three models are shown in Table 13. The simplest model is provided to show that child age, residential soil lead and dust lead can only predict about 16 percent of the variability in LOGblood lead, as measured by R-squared. Substantial increases were obtained in the following way. The U.S. EPA first added a set of household, demographic, and behavioral variables to the model as in Section 4. This increased R-squared to 31 percent. Note that even the baseline model has used age as a categorical variable with five categories: <1 year of age, 1 year, 2 years, 3 years and 4 to 6 years. The third model reports the results of specification searches in which interaction terms between age category, soil lead, and dust are reported.

Results are shown in Table 13. Even in the simple model, both dust lead loading and soil lead are statistically significant predictors of child blood lead. Blood lead is highest at age 2 years, although baseline blood lead ages 1 to 3

years are somewhat similar. The soil lead regression coefficient of 1.73 [illegible]dl per 1000 ppm soil lead is very similar to the typical [illegible]ue cited in the EPA Air Lead Criteria document (U.S. Environmental Protection Agency, 1986) of 2.2 ug/dl per 1000 ppm. The dust lead coefficient in earlier work was derived for dust lead concentration, not lead loading. In the second model in Table 13, a number of important demographic and behavioral variables was included. The variables that were significant predictors of blood lead included house dust loading, refinishing or remodelling within the last year, building condition, nonwhite race, parental education, and time spent outdoors. The number of cigarettes smoked per day and the number of hours per week spent at home were not significant and were dropped from the last model in Table 13.

The last model in Table 13 includes the possibility that there may be different soil lead and dust lead loading regression coefficients at different ages. The predictor variables that capture this effect are the interaction variables or products of soil lead (PBS) with each age category < 1 year, 1 to 6 years, and the products of dust lead loading with ages 0, 1, 2, 3, 4 to 6 (denoted PBDL AGE0 etc.). Preliminary tests found that the soil lead coefficients were very similar, and not significantly different among different ages beyond infancy. The soil lead coefficient, adjusted for dust lead loading, is 1.87 ug/dl blood lead per 1000 ppm soil lead, which is even closer to the usual estimate of 2.2 ug/dl per 1000 ppm soil lead at some other urban and lead smelter sites (U.S. Environmental Protection Agency 1986, [illegible]). The estimated dust lead loading coefficient was not ca[illegible]ted in these publications, but is here estimated as a decreasing function of age, from 1.77 ug/dl per 1000 ug Pb/sq.m surface area at ages < 12 months, 0.66 ug/dl per 1000 ug/sq.m. at age 1 year, 0.48 ug/dl per 1000 ug/sq.m. at age 2 years, 0.29 ug/dl per 1000 ug/sq.m at age 3 years. Unfortunately standard error estimates were not estimable using the SYSTAT NONLIN procedure due to a nearly singular Hessian matrix for calculating

asymptotic errors. Other methods, such as the bootstrap (Efron and Tibs[illegible]ni 1992), may be used.

5 CAUSAL MODELS OF ENVIRONMENTAL LEAD PATHWAYS

5.1 Causal Pathway Modelling

Rothman (1986) emphasizes that confounding is not appropriate to describe the use of several predictor variables that are indicators of various steps in a pathway model from the nominal causal agent to the response. There is abundant physical evidence that residential soil lead in the yard of a pre-school child contributes to child blood lead. This includes similarities in patterns of stable lead isotopes, calculations of mass balance of lead in environmental media, and—most importantly—when soil lead is removed under conditions in which there is little or no recontamination of household dust from other exterior sources, then there is a significant reduction of child blood lead for children residing there.

The stable lead isotope studies are described by Wesolowski et al. (1983) based on older housing in Oakland, California. Some studies in Boston children described by Rabinowitz (1987). Isotope ratios have been used in some source identification studies (Rabinowitz 1974).

Some mass balance considerations are described by Marcus and Elias (1994), who estimated that a typical house with lead in paint and soil has roughly 1 kg Pb on interior surfaces, 4 kg Pb in paint on exterior surfaces, and 8 kg Pb in the yard, but less than o[illegible]m of lead in household floor dust. While dust moves in and [illegible]f houses, time scales for dust transport may range from 2 to 10 months (Marcus 1993) so that the direction of causality is clear: Soil and paint may contaminate dust, whereas dust in the house has little effect on soil lead in the yard, with the possible exception of improperly conducted lead paint abatement.

The most important evidence is directly experimental.

Removal of soil at Kellogg, Idaho, has resulted in a reduction of child blood lead exceeding 50 percent (Ian Von Lindern, personal communication, October 28, 1994). The Boston Urban Soil Lead Abatement Demonstration Project resulted in a 15 percent reduction in blood lead in the first year (Weitzmann et al. 1993), with a continuing comparable decline in the next year (Aschengrau et al. 1994).

The U.S. EPA therefore proceeds with modelling the pathways by which soil lead contributes to lead in house dust and to child blood lead. Several models were developed and tested. Models that have been in the research literature for a decade (Bornschein et al. 1985) suggest that the following system of equations is appropriate:

Model 1:

log(blood lead) = a + b log(soil lead) + c log(dust lead loading) + other covariates

- log(dust lead loading) = log(dust lead concentration) + log(total dust loading) - log(1000)
- log(dust lead concentration) = f + d log(soil lead) + e (Deteriorated interior lead paint) + other covariates
- log(soil lead) = g + h (Deteriorated exterior lead paint) + other covariates

The parameters a, b, ..., h are estimated from the data. The U.S. EPA has developed a complementary approach based on a linear model:

Model 2:

blood lead = A + B (soil lead)+ C (dust lead loading) + other covariates

- dust lead loading = (dust lead concentration) * (total dust loading) / 1000

- dust lead concentration = D + E (soil lead concentration) + F (Deteriorated interior lead paint) + other covariates
- soil lead concentration = G + H (Deteriorated exterior lead paint) + Q / (DISTANCE) + other covariates

The parameters A, B, ..., Q and other parameters must also be estimated from the data. Some technical details are discussed in Appendix B.

5.2 Structural Models for the Logarithm of Blood Lead, Dust Lead, and Soil Lead: Model 1

Models were fitted using the structural equations modelling program EQS (Bentler 1994). This program was selected because it allows a very flexible set of parameter and model specifications, except that models must be linear in variables. The general form of the structural model is shown in Figure 23. The best fitting parsimonious model using LOGPBB, LOGPBDL, LOGPBD, and LOGPBS as state variables is shown in Figure 23, and results tabulated in Table 14. The regression coefficients shown in Table 14 are "elasticities". For example, the direct regression coefficient of LOGPBB on LOGPBS is 0.072, which means that a 1% change in soil lead was associated with a change of 0.072 % in blood lead. Standard errors of elasticities are shown in Table 14. Statistical significance is shown on Figure 23 and subsequently by the two-tailed statistical significance of the pathway regression coefficient. Because multiple comparisons and multiple models have been evaluated before this model was selected, the more stringent criteria may be necessary in order to guarantee groupwise significance of the coefficients (Leamer 1978). Figure 23 and Table 14 show the following results. Soil lead and dust lead loading are significant predictors of blood lead. Dust lead loading and water lead are highly significant predictors, as are building condition and several demographic variables including nonwhite race, cigarette smoking, time spent playing outside, and time spent at home. Neither interior nor

exterior lead-based paint deteriorating paint are direct predictors of blood lead, but deteriorating exterior lead paint is a highly significant contributor to soil lead. Deteriorating interior lead-based paint is a highly significant predictor of dust lead concentration, which is of course a highly significant predictor of dust lead loading. Soil lead concentration is also a predictor of dust lead concentration and dust lead loading. The most significant predictor of soil lead is distance from the NL/Taracorp lead smelter site, and the elasticity of -1.00 suggests that approximating soil lead (absent its paint lead component) as the inversely proportional to distance from the NL/Taracorp lead smelter would accurately characterize the relationship. This was used to define inverse distance as the appropriate distance metric for the linear model in Section 5.3. There is therefore some indication that soil lead is a significant predictor of blood lead, both by direct and indirect pathways, with the major component of soil lead close to the NL/Taracorp lead smelter not being derived from lead-based paint.

5.3 Linear Models for Blood Lead, Dust Lead, and Soil Lead: Model 2

Models were fitted using the simultaneous equations modelling program SAS PROC MODEL (SAS 1993). This SAS program was particularly useful for fitting nonlinear equations that arose after logarithmic transformation of the linear equations. The general form of the linear structural model is shown in Figure 24 and results tabulated in Table 15. The regression coefficients shown in Table 15 are slope estimates in appropriate physical units: ug/dl for blood lead vs 1000 ppm = 1 mg/g for dust lead or soil lead concentration, ug/dl for blood lead vs. 1000 ug/sq.m = 1 mg/sq.m for dust lead loading, and so on. For example, the coefficient 5.47 between dust lead loading and blood lead means that the coefficient is 5.47 ug/dl per 1 mg/sq.m. lead in dust. Standard errors of coefficients are shown in Table 18. Statistical significance is shown on Figure 24 using the same

notation as Figure 23. Sensitivity of the results was tested by truncati[illegible]f the data set, with relatively little difference in results [illegible]een the two cases shown in Table 15, truncation at dust lea[illegible] of 1,500 ppm and 10,000 ppm.

Figure 24 and Table 15 show the following results:

1. Dust lead loading is a highly significant predictor of blood lead, more predictive than dust lead concentration and much more predictive than soil lead;

2. Several demographic and individual behavioral variables were significant predictors of blood lead, including parental education, identification as Afro-American race, time spent playing outside, and recent refinishing or remodeling of painted surfaces. Time spent at home was marginally significant, time playing on the floor and cigarette smoking were non-significant, and dropped from the final model;

3. Building condition was a highly significant predictor of dust loading, but also a significant predictor of blo[illegible] lead;

4. Water lead was a marginally significant predictor of blood lead;

5. Neither interior nor exterior lead paint hazard index are direct predictors of blood lead;

6. Total dust loading is significantly correlated with some demographic and house variables such as building condition, cigarette smoking, and Afro-American race identification, although the latter is probably a surrogate for community location within Madison County (not provided to EPA);

7. Soil lead concentration and interior lead paint hazard index are highly significant predictors of dust lead [illegible]ntration;

8. [illegible]iorating exterior lead paint is a highly [illegible]stically significant contributor to soil lead, but a much smaller and much less significant contributor than inverse distance to the NL/Taracorp lead smelter; and

9. Two different methods for parameter estimation were used, with somewhat different quantitative results, but showing nearly the same pattern of significant pathway relationships.

The results of fitting Model 2 again confirm that soil lead is a significant predictor of blood lead, by an indirect pathway through house dust lead loading, with the major component of soil lead contributed to the NL/Taracorp lead smelter not being derived from lead-based paint.

6 SUMMARY AND CONCLUSIONS: SITE-SPECIFIC PROPERTIES FOR RISK ASSESSMENT

The NL/Taracorp site appears to have properties that are characteristic of other recently inactive lead smelter sites. The areas closest to the NL/Taracorp lead smelter have soil and dust lead concentrations that are highest and fitting to airborne particulates from smelter emissions. These particles are generally easily transported from exterior soil into household dust, and are likely to be small, soluble, and highly bioavailable.

These analyses, plus observation of Granite City neighborhoods closest to the NL/Taracorp lead smelter, show that:

1. There are many young children in the community;
2. Children often play outdoors for much of the day;
3. Residential yards often contain large bare areas without grass cover;
4. Adjacent yards are often not fenced and are readily accessible to young children; and
5. The residential areas are surrounded by industrial areas and by transportation routes that contribute to the total environmental impact on these children.

Therefore, the IEUBK model can be used at this site, with appropriate site-specific input parameters appearing not much different than standard model parameters.

7 EVALUATION OF THE ADEQUACY OF THE IEUBK MODEL FOR PREDICTING

BLOOD LEAD CONCENTRATIONS IN MADISON COUNTY

The computer model known as the Integrated Exposure Uptake Biokinetic (IEUBK) Model for lead in children, version 0.99d, is designed to predict the distribution of blood lead concentrations for children exposed to a specific set of concentrations of lead in the environment and to allow estimation of a protective residential lead soil level. The EPA IEUBK lead Model has been extensively documented in a Guidance Manual, a Technical Support Document on the model parameters and equations. Preliminary validation studies (1994) and more detailed validations have established a wide range of usefulness for the model. The model is based on five broad kinds of scientific evidence:
(1) community epidemiology studies of children at former lead smelter sites and mining sites, and in urban areas;
(2) occupational and community epidemiology studies in human adults; (3) clinical and medical studies of human children and adults; (4) animal toxicology studies, with particular emphasis on species with some specific physiological or anatomical similarity to humans; (5) mechanistic studies on biological or physical processes, such as the rate of dissolution of lead particles.

A number of assessments were done to evaluate the suitability of the IEUBK Model for estimating the distribution of blood lead concentrations in Madison County children. In spite of U.S. EPA's reservations about the adequacy of the study design, U.S. EPA provisionally accepted the data from the Madison County Lead Study as adequate for these assessments. The IEUBK Model was used in batch mode with soil lead, dust lead, and water lead concentrations as input variables, along with the child's age when the study was done in 1991. The basis for model evaluation was comparisons of observed blood lead with predicted geometric mean blood lead. The overall community distribution of observed and predicted blood lead was in reasonable agreement (Figure 31) except for the upper tail of the distribution, where a number of blood lead concentrations were over-estimated by the IEUBK model.

After considerable investigation, EPA determined the differences between observed and predicted blood lead concentrations were far more closely correlated with the dust lead concentration than with any other variables in the data set, including lead in soil and in paint. Further investigation identified the probable cause as the inclusion of large particles with paint chips in the reported dust lead concentrations, with the consequent increase of reported dust lead concentration for most such occurrences since the lead concentration in a chip of lead-based paint would almost surely exceed 0.5 percent lead (5,000 ppm). The U.S. EPA therefore evaluated several alternative model specifications.

The standard alternative to use of measured dust lead concentration in the IEUBK Model is to assume that the dust lead concentration can be calculated as a mixture from other sources with known concentrations. The most important component of the alternative dust model is the assumed contribution of yard soil to house dust, amounting to 70 percent of the soil lead concentration. The U.S. EPA also added a nominal air lead deposition contribution of 10 ppm. Using the IEUBK Model in batch mode with estimated rather than observed dust lead produced a much better fitting blood lead concentration distribution for Madison County children.

Comparisons of goodness of fit are shown in Figure 25. Figure 25 shows a more compelling argument for use of the estimated dust lead concentration rather than the observed concentration. The observed dust lead concentration was divided up into a range of values [redacted] to 249, 250 to 499, 500 to 749, 750 to 999, 1000 to 1499, [redacted] to 1999, 2000 to 2999, 3000 to 9999, and 10,000+ ppm lead in house dust.

The difference between observed and predicted blood lead averaged less than 2 ug/dl only up to about 750 ppm reported dust lead, then grew larger and larger. On the other hand, the average difference between observed and predicted blood lead was less than 2.4 ug/dl for reported dust lead concentrations up to

10,000 ppm, and the difference above 10,000 ppm was only 10 ug/dl instead [illegible]0 ug/dl. Therefore, within the range of values to be used in [illegible] estimation, the estimated dust lead concentration using th[illegible]tandard assumption provides a much better description of the observed distribution of blood lead concentration than does the use of the reported dust lead concentration. While these analyses confirm the usefulness of the standard assumption (70 percent contribution of soil lead to house dust lead concentration) for risk estimation purposes, additional investigations were performed to assess the apparent lack of predictiveness of the reported dust lead concentrations.

The sources of any deviations between observed and predicted blood lead concentrations should always be investigated, with clear emphasis on study protocols and analytical methods that may account for non-standard input data. As an example of a possible artifact that could affect observed blood lead concentrations, any area with substantial public awareness of a major lead hazard is likely to have some households (probably those nearest the NL/Taracorp lead smelter) that are aware of the hazard, so that the children and their caretakers may make considerable efforts to avoid lead exposure. There was no way to identify any such artifact in the Madison County Lead Study, whether or not it existed.

On the other hand, there was clear evidence of a potential biasing factor in the method for reporting dust lead concentrations. The U.S. EPA believes that the physical evidence of some inflation of dust leads, along with statistical compari[illegible]f the use of observed (i.e., reported) and estimated dust l[illegible]how clearly the estimated dust lead is preferable.

Furth[illegible]ssessment of the relationships among dust lead concentration in small particles and lead concentration in larger paint chips is continuing. Some of the lead concentrations in the small dust particles were also extremely high, well in excess of 10,000 ppm, suggesting that the biasing effect may not be merely the inclusion of large paint chips in the reported dust

lead concentration. A plausible explanation is that the attempt to collect extremely large samples of dust (3 to 5 g per house) may have required collection of samples from locations that do not reflect the current lead transport kinetics and sources for household dust. Typical floor dust samples in the U.S. EPA Urban Soil Lead Abatement Demonstration Project in Baltimore, Boston, and Cincinnati required only 100 to 300 mg of dust, less than one tenth of the quantity defined in the Madison County Protocol. The only way to obtain such a large dust sample in many homes is to collect samples from "historic reservoirs" of lead contamination, for example behind refrigerators or on window sills. Even fine particles from such obscure locations are likely to contain artificially high concentrations of lead from ground-up lead paint particles from which the child is not currently exposed. If the children had actually been exposed to these very high lead concentrations from ground-up paint chips, there would have been even more observed cases of elevated blood lead. At this time, there is no way by which existing data from the Madison County Lead Study can be used to resolve the uncertainty about the relevance of the dust sampling protocol to actual child exposure.

Note in particular that this evaluation did not require any post hoc calibration or backfitting of IEUBK model parameters to match the data.

Other studies validating the use of the IEUBK model have found that the model provides a very good description of the blood lead distribution at a number of sites, including sites similar to the NL/Tara site (K. Hogan, U.S. Environmental Protection Agency, draft memo, Sept. 7, 1995). In fact, one of the validation studies where the prediction was particularly good was done using data from the Madison County Study.

8 SOIL LEAD CLEANUP LEVELS USING THE IEUBK MODEL

Site-specific parameters were based on U.S. EPA's judgement and analysis that the NL/Taracorp site had many points of similarity to the calibration site, Midvale, and that it is appropriate to assume no mitigating factors that may reduce childhood exposure to dust and soil. The standard model parameters with an assumed soil-to-dust coefficient of 70 percent provided a very good fit to the blood lead data, in terms of geometric mean blood lead, percentiles of the blood lead distribution, and reasonable correlation between observed and predicted blood lead.

Sensitivity analyses were based on a range of values for the contribution of lead-contaminated soil to household dust. The default assumption, that the concentration of soil-derived lead in house dust is 0.70 of the soil lead concentration, was judged to be appropriate, and also provided a very good fit to the child blood lead data from the Madison County study. Alternative values in the sensitivity analyses were based on statistical analyses from study data: 0.29 (distances up to 1/4 mile), 0.385 (all data, as discussed in Section 4), and 0.55 (distances to 3/8 mile). The higher dust/soil coefficients of 0.70 and 0.55 are more appropriate for risk assessment, more realistic for properties of the site, and provide a good fit to the data.

Remediation goals for soil abatement were calculated from the IEUBK Model so as to generate not more than 5 percent of children of ages 6 to 84 months with blood lead 10 ug/dl or greater. The calculated soil lead concentrations depended on the assumptions one made about soil to dust transport, but otherwise assumed only default parameters. The soil remediation levels ranged from 350 ppm (soil-to-dust coefficient = 0.70) to 480 ppm (soil-to-dust coefficient of 0.29). This suggests a range of soil lead cleanup values of 350 to 500 ppm. The results are shown in Table 16.

Additional sensitivity analyses were done to assess the effect of lead-based paint on soil lead cleanup levels. As noted in the IEUBK Lead Model Guidance Manual (U.S. Environmental Protection

Agency, 1994), there is very little basis for estimating the "typical intake of lead from lead-based paint. The Guidance Manual suggests that ingestion of a one-square-inch paint chip may correspond to an intake of about 400 ug Pb. We have assumed that there is some age dependence on paint ingestion that is roughly proportional to the ingestion rate of soil and dust, and have therefore assumed daily intake rates of lead from lead-based paint of 240, 400, 400, 400, 300, 270, and 240 ug Pb per day at ages < 1 year, 1 year, 2 years, 3 years, 4 years, 5 years, and 6 years respectively. However, to start with conservative assumptions about the absorption of lead from lead-based paint, we assumed absorption rates of only 1 percent and 2 percent respectively. This may be reasonable, if paint chips are only partially dissolved in the stomach, or if the lead is contained in some relatively insoluble pigment such as lead chromate. The exact input parameters used in all of the models are presented as IEUBK lead model parameter input files in Appendix D.

Table 17 shows that over the range of soil-to-dust transfer coefficients observed from the Madison County Lead Study, and including the standard assumption of 70 percent that gave the adequate blood lead predictions discussed in Section 7, soil lead cleanup levels are greatly reduced by even a modest intake of lead-based paint, from 230 to 350 ppm if only 1 percent of the lead in the paint is absorbed, and from 115 to 170 ppm if 2 percent is absorbed. These calculations assumed that paint chips are consumed regularly. The IEUBK Model does not presently offer any options to assess the effects of infrequent or sporadic intake of paint chips.

In summary, the use of a range of conditions specific to the NL/Taracorp site has identified a range of soil lead remediation levels that should achieve the specified goal: not more than 5 percent of the children exposed to any specific level can be expected to have a blood lead concentration of at least 10 ug/dl. The upper end of this range, using a site-specific soil-to-dust coefficient, is approximately 500 ppm.

TABLE 1. CHILD BLOOD LEAD AS A FUNCTION OF DISTANCE

Distance	[redacted]	Blood Lead GM	rse (%)	GSD	Percent 10 + ug/dl	Percent 15 + ug/dl	Percent 20 + ug/dl
1	9	8.98	(14)	1.501	33.33	11.11	0.00
2	13	6.46	(18)	1.790	23.08	15.38	7.69
3	63	7.77	(9)	2.015	23.81	19.05	12.70
4	98	6.04	(7)	1.879	19.39	5.10	4.08
5	118	5.69	(6)	1.924	18.64	5.93	3.39
6	81	4.86	(7)	1.835	7.41	2.47	1.24
7	25	5.19	(12)	1.725	12.00	8.00	0.00
8	47	4.44	(8)	1.657	2.13	0.00	0.00
9	22	4.18	(22)	2.584	22.73	0.00	0.00
10	3	3.41	(76)	2.673	0.00	0.00	0.00
Missing	11	4.00	(29)	2.338	9.09	9.09	0.00

GM = Geometric mean blood lead; rse = relative standard error; GSD = geometric standard deviation, and percentage of children with elevated blood lead concentrations, as a function of approximate distance from the NL/Taracorp Lead Smelter at the NL/Taracorp Superfund Site

[redacted]

TABLE 2. SOIL LEAD AND DUST LEAD AS A FUNCTION OF DISTANCE

Distance	Soil Lead, ppm			Dust Lead, ppm			Dust Lead Loading	
	NH	GM	rse	NH	GM	rse	GM	rse
1	6	1501	(17)	6	1410	(38)	0.914	(28)
2	8	1201	(7)	8	611	(51)	0.397	(106)
3	38	541	(10)	39	600	(24)	0.269	(29)
4	66	352	(8)	62	422	(15)	0.239	(20)
5	84	379	(8)	83	409	(13)	0.212	(18)
6	55	251	(7)	55	359	(18)	0.158	(23)
7	19	251	(17)	19	389	(31)	0.159	(35)
8	35	222	(11)	35	326	(16)	0.130	(21)
9	18	180	(17)	18	222	(31)	0.139	(52)
10	2	481	(282)	2	566	(195)	0.143	(238)
Missing	7	73	(50)	7	97	(34)	0.017	(64)

Geometric means (GM) of soil and dust lead concentrations, number N of households, relative standard errors (rse) in percent, as a function of the approximate distance from the NL/Taracorp lead smelter at the NL/Taracorp Superfund Site. Distance is measured in intervals of approximately 1/8 mile.

TABLE 3. HOUSEHOLD DEMOGRAPHIC CHARACTERISTICS AS A FUNCTION OF DISTANCE

Distance	NH	Mean Year Built	Mean Cigs./ Day	Mean Education	Mean Bldg. Cond.	Pct. Non-White	Pct. Renters	Pct. Air Cond.	Mean No. Child.
1	6	1908	16.8	12.5	1.25	11.1	50.0	33.3	1.50
2	8	1926	37.2	11.7	2.00	15.4	62.5	11.1	1.44
3	38	1926	25.0	12.1	1.63	4.8	65.0	17.5	1.58
4	66	1937	25.6	12.5	1.50	13.3	50.8	19.4	1.46
5	84	1935	19.8	12.3	1.40	18.3	50.6	13.4	1.34
6	55	1935	11.2	12.7	1.20	34.6	54.5	10.5	1.42
7	19	1937	14.3	13.0	1.21	28.0	26.3	10.5	1.25
8	35	1936	9.2	12.9	1.06	30.4	28.6	2.8	1.31
9	18	1940	8.1	12.8	1.18	31.8	31.2	0.0	1.22
10	2	1950	5.0	14.0	1.00	0.0	50.0	0.0	1.50
Missing	7	1939	16.4	14.0	1.00	0.0	16.7	0.0	1.38

Numerical characteristics of households as a function of distance the NL/Taracorp lead smelter at the NL/Taracorp Superfund Site, where distance is measured in intervals of about 1/8 mile. Results reported as mean or percent of households.

TABLE 4. AGE DISTRIBUTION OF CHILDREN AS A FUNCTION OF DISTANCE

Distance	[redacted]NC	Age					
		<1 year	1 year	2 years	3 years	4 to 6 years	Mean Age
1	9	0.0	11.1	22.2	22.2	44.4	3.93
2	13	0.0	23.1	0.0	15.4	61.5	4.12
3	63	12.7	15.9	17.5	14.3	39.7	3.22
4	98	8.2	14.3	17.4	18.4	41.8	3.45
5	118	10.2	16.9	21.2	18.6	33.1	3.27
6	81	12.3	13.6	19.8	13.6	40.7	3.44
7	25	8.0	12.0	12.0	4.0	64.0	3.92
8	47	10.6	19.1	27.7	8.5	34.0	3.22
9	22	13.6	4.5	22.7	22.7	36.4	3.49
10	3	0.0	0.0	66.7	0.0	33.3	3.60
Missing	11	9.1	18.2	45.5	9.1	18.2	2.47

Percent of children in different age groups as a function of approximate distance from the NL/Taracorp lead smelter at the NL/Taracorp Superfund site, where distance is measured in intervals of about 1/8 mile.

[redacted]

TABLE 5. BEHAVIORAL CHARACTERISTICS AS A FUNCTION OF DISTANCE

Distance	N	Mean Outside Hours	Mean Floor Hours	Mean Mouthing Score
1	9	3.67	4.22	2.33
2	13	3.23	7.69	2.62
3	63	3.87	5.95	2.32
4	98	3.17	6.62	2.26
5	118	2.92	6.28	2.34
6	81	2.57	5.16	2.31
7	25	2.40	5.96	2.60
8	47	2.60	6.04	2.21
9	22	2.09	5.62	2.64
10	3	1.33	3.67	1.67
Missing	11	3.55	7.36	2.46

Mean of individual behavioral characteristics as a function of distance from the NL/Taracorp lead smelter at the NL/Taracorp Superfund site, in intervals of about 1/8 mile.

TABLE 6. PERCENTAGE OF ELEVATED BLOOD LEAD DEPENDS ON BOTH SOIL LEAD AND DUST LEAD CONCENTRATIONS.

TABLE 6A: BLOOD LEAD AT LEAST 10 μg/dl

		Soil Lead			
		0-249	250-499	500-999	1000+
Dust	0-249	3.7 (4/104)	17.2 (11/64)	7.1 (1/14)	33.3 (1/3)
Lead	250-749	13.5 (5/37)	23.2 (13/56)	20.7 (12/58)	30.0 (3/10)
	750 +	6.7 (1/15)	17.8 (8/45)	25.8 (8/31)	30.8 (8/26)

TABLE 6B: BLOOD LEAD AT LEAST 15 μg/dl

		Soil Lead			
		0-249	250-499	500-999	1000+
Dust	0-249	1.0 (1/104)	4.7 (3/64)	0 (0/14)	0 (0/3)
Lead	250-749	5.4 (2/37)	7.1 (4/56)	10.3 (6/58)	10.0 (1/10)
	750+	6.7 (1/15)	4.4 (2/45)	16.1 (5/31)	19.2 (5/26)

TABLE 6C: BLOOD LEAD AT LEAST 20 μg/dl

		Soil Lead			
		0-249	250-499	500-999	1000+
Dust	0-249	0 (0/104)	3.1 (2/64)	0 (0/14)	0 (0/3)
Lead	250-749	5.4 (2/37)	0 (0/56)	3.4 (2/58)	0 (0/10)
	750+	6.7 (1/15)	4.4 (2/45)	16.1 (5/31)	11.5 (3/26)

TABLE 7. PERCENTAGE OF ELEVATED BLOOD LEAD INCREASES WITH DUST LEAD LOADING, BUT IS NEARLY INDEPENDENT OF INTERIOR LEAD PAINT HAZARD INDEX

TABLE 7A: BLOOD LEAD AT LEAST 10 μg/dL DUST LEAD LOADING, μg/m²

Interior		0-249		250-499		500-999		1000+	
Lead Paint	<0.5	5	(7/134)	26	(9/34)	38	(3/80)	29	(2/7)
Hazard Index	0.5-4.9	10	(11/107)	24	(11/46)	19	(5/26)	36	(15/42)
μg/cm²	5+	5	(1/21)	14	(1/7)	38	(3/8)	38	(8/21)

TABLE 7B: BLOOD LEAD AT LEAST 15 μg/dL DUST LEAD LOADING, μg/m²

Interior		0-249		250-499		500-999		1000+	
Lead Paint	<0.5	0	(0/139)	8.8	(3/34)	25	(2/8)	29	(2/7)
Hazard Index	0.5-4.9	3.7	(4/107)	6.5	(3/46)	7.7	(2/26)	17	(7/42)
μg/cm²	5+	4.8	(1/21)	0	(0/7)	0	(0/8)	29	(6/21)

TABLE 7C: BLOOD LEAD AT LEAST 20 μg/dL DUST LEAD LOADING, μg/m²

Interior		0-249		250-499		500-999		1000+	
Lead Paint	<0.5	0	(0/139)	2.9	(1/34)	12.5	(1/8)	29	(2/7)
Hazard Index	0.5-4.9	1.9	(2/107)	0	(0/46)	3.8	(1/26)	9.5	(4/42)
mg/cm²	5+	4.8	(1/21)	0	(0/7)	0	(0/8)	24	(5/21)

TABLE 8. SENSITIVITY OF LINEAR REGRESSION MODEL FOR LOG, BLOOD LEAD TO MODEL SPECIFICATION USING BASELINE AND HIERARCHICAL MODELS

TABLE 8A: COEFFICIENT OF DETERMINATION R^2

Data Subset	[redacted] All			Dust Lead Conc. < 3000 ppm			Dust Lead Con[redacted] < 1000 ppm		
Building	BLDCONIM	BLDGCOND	BLDGCIMP	BLDCONIM	BLDGCOND	BLDGCIMP	BLDCONIM	BLDGCOND	BLDGCIMP
Condition Model	Grand Mean	No Impute	Distance Mean	Grand Mean	No Impute	Distance Mean	Grand Mean	No Impute	Distance Mean
Regression Model									
Baseline	0.051	0.128	0.133	0.041	0.098	0.105	0.029	0.109	0.104
+ Soil Lead	0.091	0.168	0.161	0.080	0.146	0.133	0.067	0.157	0.133
+ Dust Pb Load	0.197	0.215	0.228	0.156	0.183	0.189	0.171	0.208	0.201
+ Soil + Dust	0.209	0.233	0.238	0.169	0.205	0.200	0.182	0.229	0.212

TABLE 8B: LOG DUST LEAD LOADING REGRESSION COEFFICIENT

Regression Model									
Base	-	-	-	-	-	-	-	-	-
+ Dust PbL	0.176	0.139	0.148	0.174	0.150	0.153	0.199	0.170	0.172
+ Soil + Dust	0.164	0.125	0.129	0.158	0.131	0.139	0.186	0.151	0.160

TABLE 8C: LOG SOIL LEAD REGRESSION COEFFICIENT

Regression Model									
Base	-	-	-	-	-	-	-	-	-
+ Soil Pb	0.191	0.190	0.158	0.185	0.201	0.284	0.182	0.201	0.157
+ Soil + Dust	0.098	0.123	0.092	0.105	0.134	0.096	0.091	0.127	0.088

TABLE 8D: BUILDING CONDITION REGRESSION COEFFICIENT

Regression Model									
Base	0.141	0.329	0.348	0.124	0.305	0.321	0.124	0.334	0.337
+ Soil Pb	0.081	0.288	0.311	0.068	0.264	0.284	0.071	0.293	0.305
+ Dust PbL	0.101	0.225	0.231	0.104	0.236	0.243	0.090	0.229	0.228
+ Soil + Dust	0.066	0.207	0.215	0.068	0.215	0.224	0.059	0.213	0.215

TABLE 9. SENSITIVITY OF LINEAR REGRESSION MODEL FOR LOG, BLOOD LEAD TO MODEL SPECIFICATION USING 'SUB-BASELINE' AND HIERARCHICAL MODELS

TABLE 9A: COEFFICIENT OF DETERMINATION R^2

Data Subset	All			Dust Lead Conc. < 3000 ppm			Dust Lead Conc. < 1000 ppm		
Building	BLDCONIM	BLDGCOND	BLDGCIMP	BLDCONIM	BLDGCOND	BLDGCIMP	BLDCONIM	BLDGCOND	BLDGCIMP
Condition Model	Grand (Mean)	(No Impute)	(Distance Mean)	Grand (Mean)	(No Impute)	(Distance Mean)	Grand (Mean)	(No Impute)	(Distance Mean)
Regression Model									
Sub-Base	0.033	0.122	0.125	0.036	0.098	0.102	0.027	0.109	0.102
+ Lead Paint	0.051	0.128	0.133	0.041	0.098	0.105	0.029	0.111	0.104
+ Soil Lead	0.092	0.169	0.161	0.084	0.146	0.133	0.065	0.155	0.126
+ Soil + Dust	0.210	0.228	0.236	0.169	0.195	0.195	0.173	0.215	0.197

TABLE 9B: LOG SOIL LEAD REGRESSION COEFFICIENT

Regression Model									
Sub-Base	-	-	-	-	-	-	-	-	-
+ Soil Lead	0.210	0.195	0.165	0.185	0.192	0.153	0.168	0.185	0.134
+ Soil + Dust	0.077	0.109	0.072	0.078	0.114	0.070	0.059	0.103	0.054

TABLE 10. SENSITIVITY OF LINEAR REGRESSION MODEL FOR LOG, BLOOD LEAD TO MODEL SPECIFICATION USING NEW BASELINE AND HIERARCHICAL MODELS

TABLE 10A: COEFFICIENT OF DETERMINATION R^2

Data Subset	All	Dust Lead < 10,000 ppm	Dust Lead < 3,000 ppm	Dust Lead < 2,000 ppm	Dust Lead < 1,000 ppm
Regression Model					
New Base	0.214	0.198	0.197	0.209	0.220
+ Lead Paint	0.224	0.202	0.199	0.210	0.218
+ Soil Pb	0.264	0.242	0.245	0.253	0.255
+ Dust PbC	0.279	0.242	0.242	0.248	0.249
+ Paint + Soil	0.262	0.240	0.243	0.250	0.257
+ Dust PbL	0.318	0.285	0.283	0.288	0.293
+ Paint + Dust	0.318	0.285	0.284	0.288	0.297
+ Soil + Dust	0.333	0.299	0.299	0.302	0.305

TABLE 10B: LOG DUST LEAD LOADING REGRESSION COEFFICIENT

Model					
New Base	-	-	-	-	-
+ Dust PbL	0.142	0.139	0.143	0.142	0.142
+ Paint + Dust	0.144	0.142	0.147	0.147	0.150
+ Soil + Dust	0.124	0.119	0.120	0.120	0.124

TABLE 10C: LOG SOIL LEAD REGRESSION COEFFICIENT

Model					
New Base	-	-	-	-	-
+ Soil Pb	0.195	0.180	0.189	0.179	0.160
+ Paint + Soil	0.181	0.173	01.88	0.180	0.175
+ Dust + Soil	0.104	0.099	0.109	0.103	0.090

TABLE 11. STEPWISE REGRESSION MODEL WITH STRONG AND WEAK CONFOUNDERS OF THE RELATIONSHIP BETWEEN LOG BLOOD LEAD AND [redacted] SOIL LEAD, AND COVARIATES OF LOG BLOOD LEAD

Model [redacted]	Forward		Backward		Force First 3		Drop 6 Worst	
R-squared	0.353		0.353		0.353		0.379	
Variable	B	P	B	P	B	P	B	P
LOGPBDL	0.129	0.000	---	---	0.124	0.000	0.114	0.001
LOGDSTLD	---	---	0.139	0.000	0.016	0.703	---	---
BLDCONIM	0.105	0.040	0.103	0.048	0.103	0.048	0.088	0.091
LOGPBD	---	---	0.124	0.000	---	---	0.026	0.540
AIRCOND	---	---	---	---	---	---	---	---
LOGDIST	-0.226	0.001	-0.230	0.001	-0.230	0.001	0.243	0.001
LOGPBS	---	---	---	---	---	---	---	---
CIGSDAY	0.001	0.236	0.001	0.244	0.001	0.244	0.002	0.096
RENT_OWN	0.073	0.200	0.073	0.198	0.073	0.198	0.099	0.091
LOGCXI	---	---	---	---	---	---	---	---
NUMSMOKE	---	---	---	---	---	---	---	---
EDUCYRS	-0.042	0.012	-0.042	0.011	-0.042	0.011	-0.029	0.085
INCOME	---	---	---	---	---	---	---	---
NONWHITE	0.277	0.000	0.270	0.000	0.270	0.000	0.274	0.000
LOGXRFMN	---	---	---	---	---	---	-0.015	0.338
OUTPLHRS	0.050	0.000	0.049	0.000	0.049	0.000	0.051	0.000
AGE2SQR	-0.024	0.000	-0.024	0.000	-0.024	0.000	-0.024	0.000
REFINISI[redacted]	0.203	0.000	0.204	0.000	0.204	0.000	0.172	0.002
HRS_HO[redacted]	---	---	---	---	---	---	0.002	0.149
SEX	---	---	---	---	---	---	-0.067	0.216

TABLE 12. REGRESSION MODELS FOR LOGARITHM OF BLOOD LEAD. LINEAR IN LOG ENVIRONMENTAL LEAD.

Model	Forward Step		Forward-Drop Dist.		Backward-Drop Dist.	
R-squared	0.369		0.363		0.372	
S-squared	0.2834		0.2918		0.2886	
N	413		422		416	
VARIABLE	B	P	B	P	B	P
LOGPBDL	0.126	0.00000	0.140	0.00000	0.120	0.00000
LOGPBD	—	—	—	—	—	—
LOGPBS	—	—	0.097	0.0124	0.071	0.0622
LOGCXI	—	—	—	—	—	—
LOGCXO	—	—	—	—	—	—
LOGXRFMN	—	—	0.0304	0.0496	—	—
LOGPBW	0.0460	0.0127	0.0561	0.00180	0.0545	0.00254
REFINISH	0.178	0.00107	0.147	0.00699	0.160	0.00386
LOGDSTLD	—	—	—	—	—	—
LOGDIST	-0.215	0.00227	—	—	—	—
AIRCOND	—	—	—	—	—	—
BLDCONIM	0.106	0.0417	0.111	0.0280	0.127	0.0158
CIGSDAY	0.00190	0.1217	0.00243	0.0459	0.00239	0.0513
EDUCYRS	-0.0424	0.0119	-0.0387	0.0184	-0.0400	0.0152
LOGINCOM	—	—	—	—	—	—
NONWHITE	0.281	0.00007	0.301	0.00002	0.288	0.00006
NUMSMOKE	—	—	—	—	—	—
RENT_OWN	0.0688	0.2248	—	—	0.0771	0.1862
AGE	0.158	0.0327	—	—	0.184	0.0188
AGE-squa[illegible]	-0.0317	0.00230	-0.0096	0.00008	-0.0328	0.00209
EATPNTE[illegible]	—	—	—	—	—	—
HRS_HOME	0.00184	0.1247	0.00186	0.1199	0.00182	0.1229
MOUTHFR	—	—	—	—	0.0149	0.0914
OUTPLHRS	0.0483	0.00013	0.0574	0.00000	0.0486	0.00015
PLAYFLR	—	—	—	—	—	—
SEX	—	—	—	—	-0.0748	0.1662

TABLE 13. REGRESSION MODELS FOR BLOOD LEAD. LOGARITHM OF LINEAR MODEL FITTED.

Model	Minimal Environment		Minimal Environment + House, Child Confounders		Environment, Age Inter., + House, Child Confounders	
R-squared	0.161		0.314		0.335	
S-squared	0.3868		0.3070		0.3041	
N	463		441		441	
VARIABLE	B	STD.ERR.	B	STD.ERR.	B	STD.ERR.
PBDL	0.557	0.056	0.267	0.027	—	NE—
PBS	1.729	0.473	1.519	0.417	—	NE—
AGE 0	3.07	0.38	2.84	1.67	3.76	NE—
AGE 1	5.30	0.59	4.64	1.87	5.22	NE—
AGE 2	5.52	0.54	4.25	1.85	4.82	NE—
AGE 3	5.10	0.57	3.80	1.87	4.42	NE—
AGES 4-6	3.86	0.41	2.84	1.80	3.56	NE—
PBDL AGE 0	—	—	—	—	1.767	NE—
PBDL AGE 1	—	—	—	—	0.660	NE—
PBDL AGE 2	—	—	—	—	0.482	NE—
PBDL AGE 3	—	—	—	—	0.289	NE—
PBDL AGE4+	—	—	—	—	0.002	NE—
PBS AGE 0	—	—	—	—	-0.149	NE—
PBS AGE 1	—	—	—	—	1.72	NE—
DUST LOAD	—	—	0.847	0.263	0.832	NE—
REFINISH	—	—	0.666	0.271	0.677	NE—
BLDG.COND	—	—	0.893	0.329	0.907	NE—
CIGS/DAY	—	—	0.00110	0.00605	—	—
NONWHITE	—	—	1.176	0.394	1.18	NE—
EDUC.YRS	—	—	-0.1625	0.0768	-0.1909	NE—
HRS_HOME	—	—	0.00210	0.00555	—	—
OUTPLHRS	—	—	0.2116	0.0720	0.2044	NE—

TABLE 15. STRUCTURAL EQUATION MODEL FOR BLOOD LEAD AND ENVIRONMENTAL LEAD: REGRESSION PARAMETERS OF MODEL 2.

Response Variable	[redacted]dictor [redacted]iable	Method	Full Inf. Max. Likelihood				Gen. Method Moments			
		Dust Lead Cutoff	< 10,000		< 1,500		< 10,000		[redacted]500	
		Units	Est.	S.E.	Est.	S.E.	Est.	S.E.	[redacted]	S.E.
Soil Lead Conc.	Distance Ring	μg/g per 1/ring	1304	55	1269	58	1092	40	1067	39
	Ext. Lead Paint XRF* Condition	μg/g per mg/cm²	7.9	1.1	8.3	1.2	11.0	1.4	12.4	1.5
Dust Lead Conc.	Intercept	μg/g	1	28	56	26	0	forced	0	forced
	Soil Lead Conc.	μg/g per μg/g	0.874	0.127	0.638	0.098	0.880	0.053	0.934	0.051
	Int. Lead Paint XRF* Condition	μg/g per mg/cm²	58.3	10.6	24.0	6.5	53.6	12.9	26.9	9.3

TABLE 16. SENSITIVITY ANALYSIS FOR SOIL LEAD CLEANUP LEVEL, WITHOUT LEAD PAINT

Soil-to-Dust [illegible]ficient	Soil Lead Concentration, ppm
0.20	520
0.29	480
0.385 (all data)	440
0.55	390
0.70	350

TABLE 17. SENSITIVITY ANALYSES FOR SOIL LEAD CLEANUP LEVEL, WITH LEAD PAINT ADDED

	Soil Lead Concentration, ppm	
Soil-to-Dust Coefficient	Paint Absorption 1%	2%
0.29	320	160
0.385 (all data)	290	150
0.55	260	130
0.70	230	115

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increasing distance from the NL/Taracorp lead smelter. Bars show one standard error of percentage estimate.

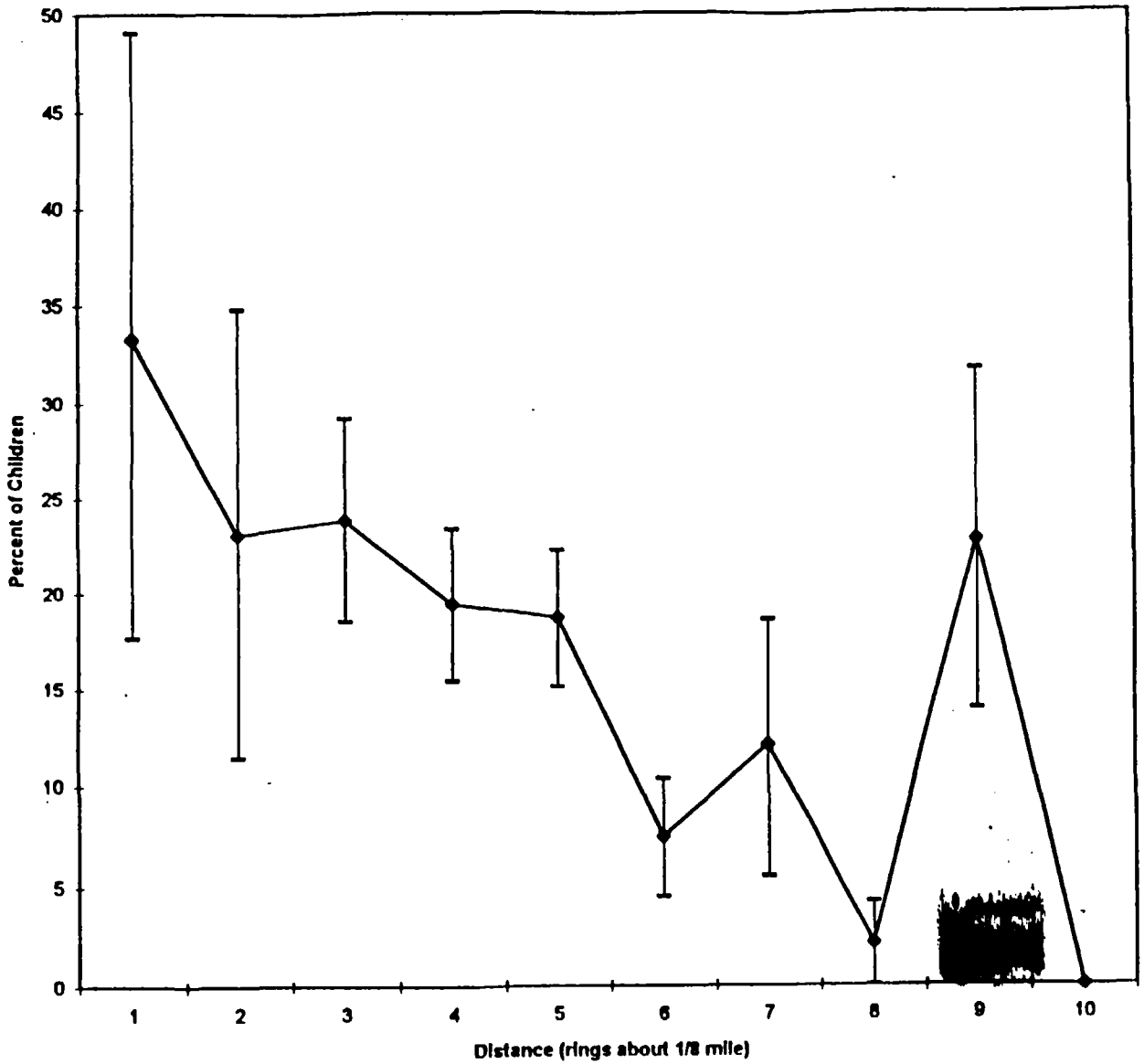


Figure 2. Percentage of children with very elevated blood lead (15 ug/dl or above) decreases with increasing distance from the NL/Taracorp lead smelter. Bars show one standard error of percentage estimate.

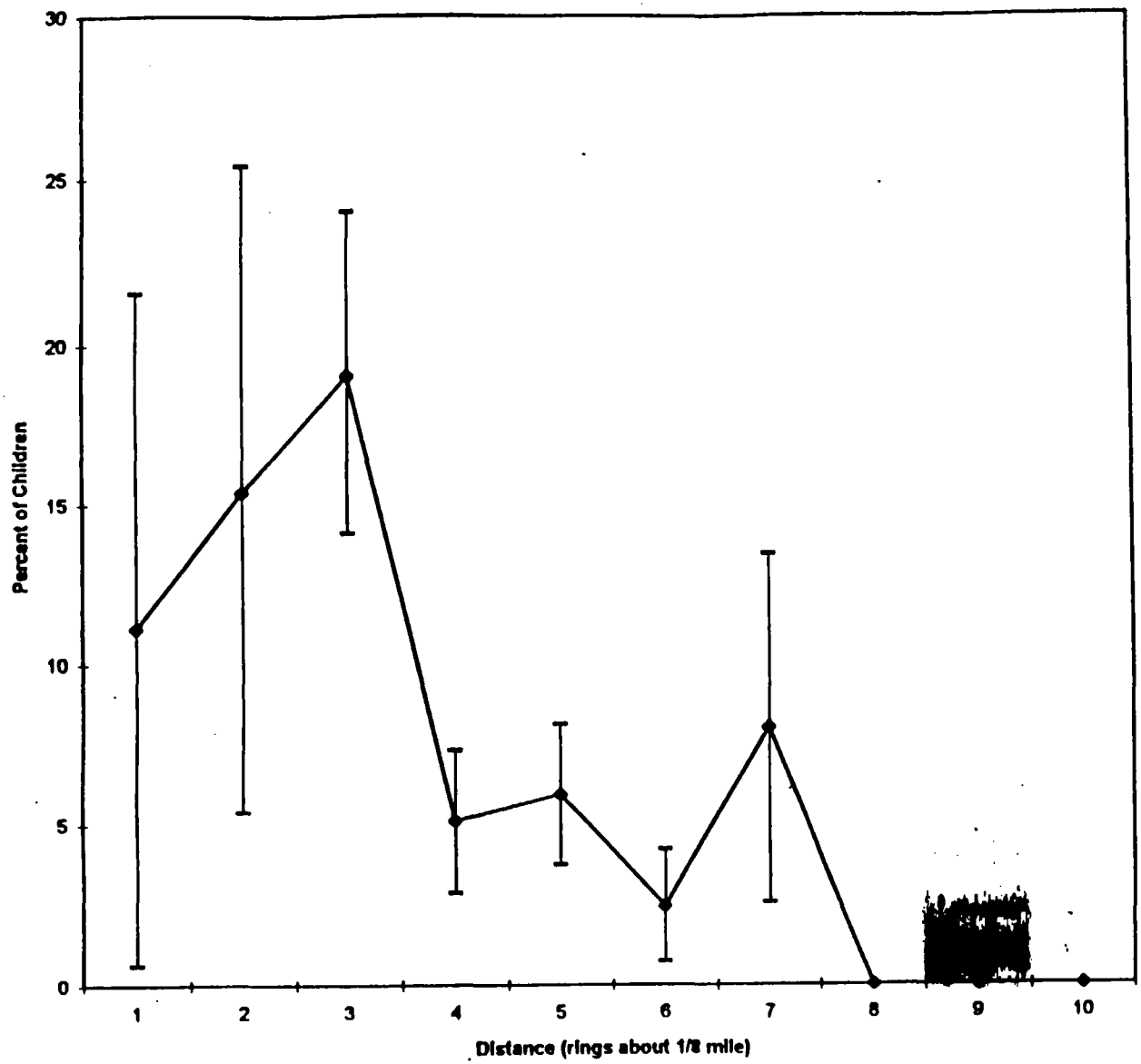
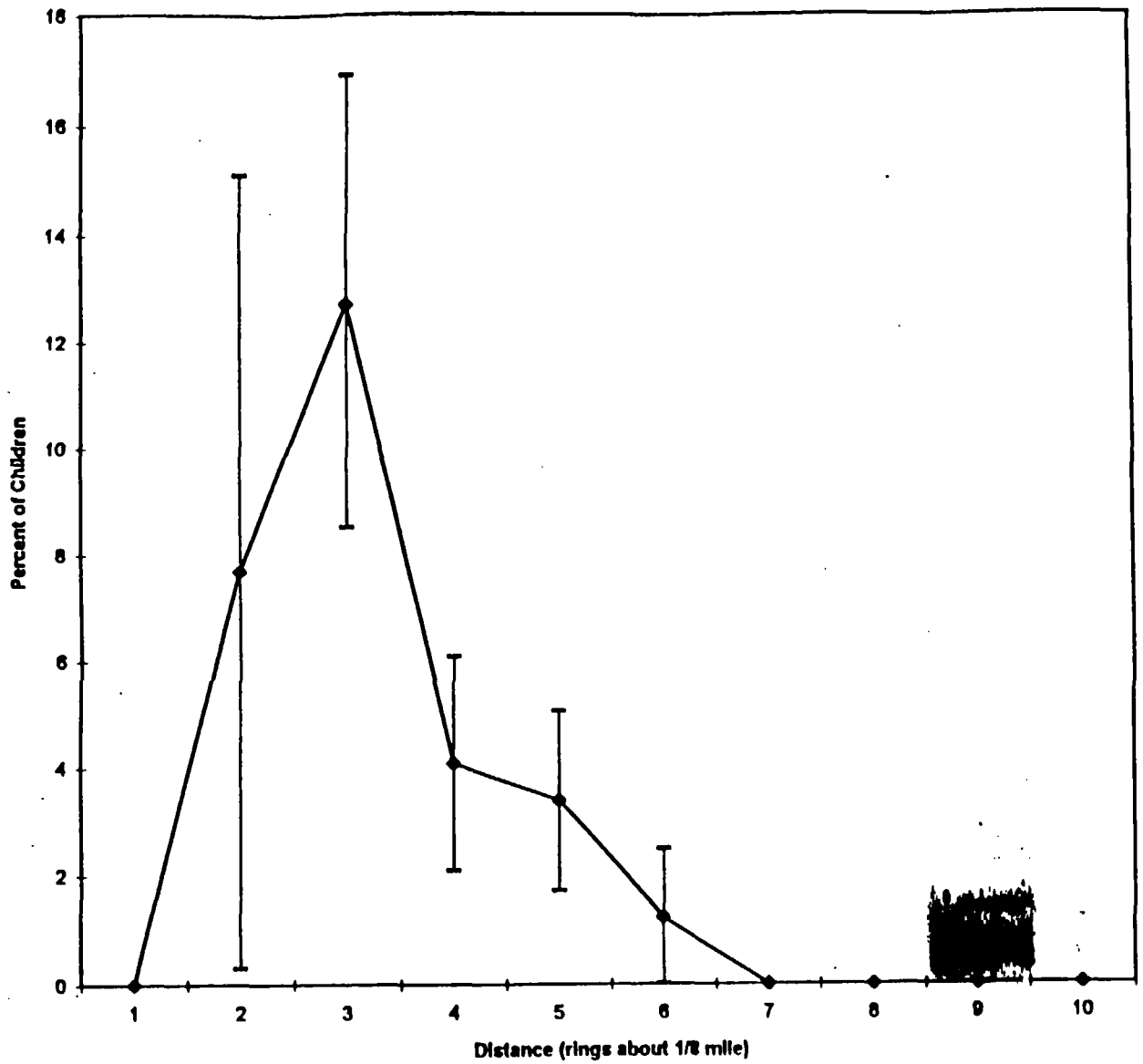
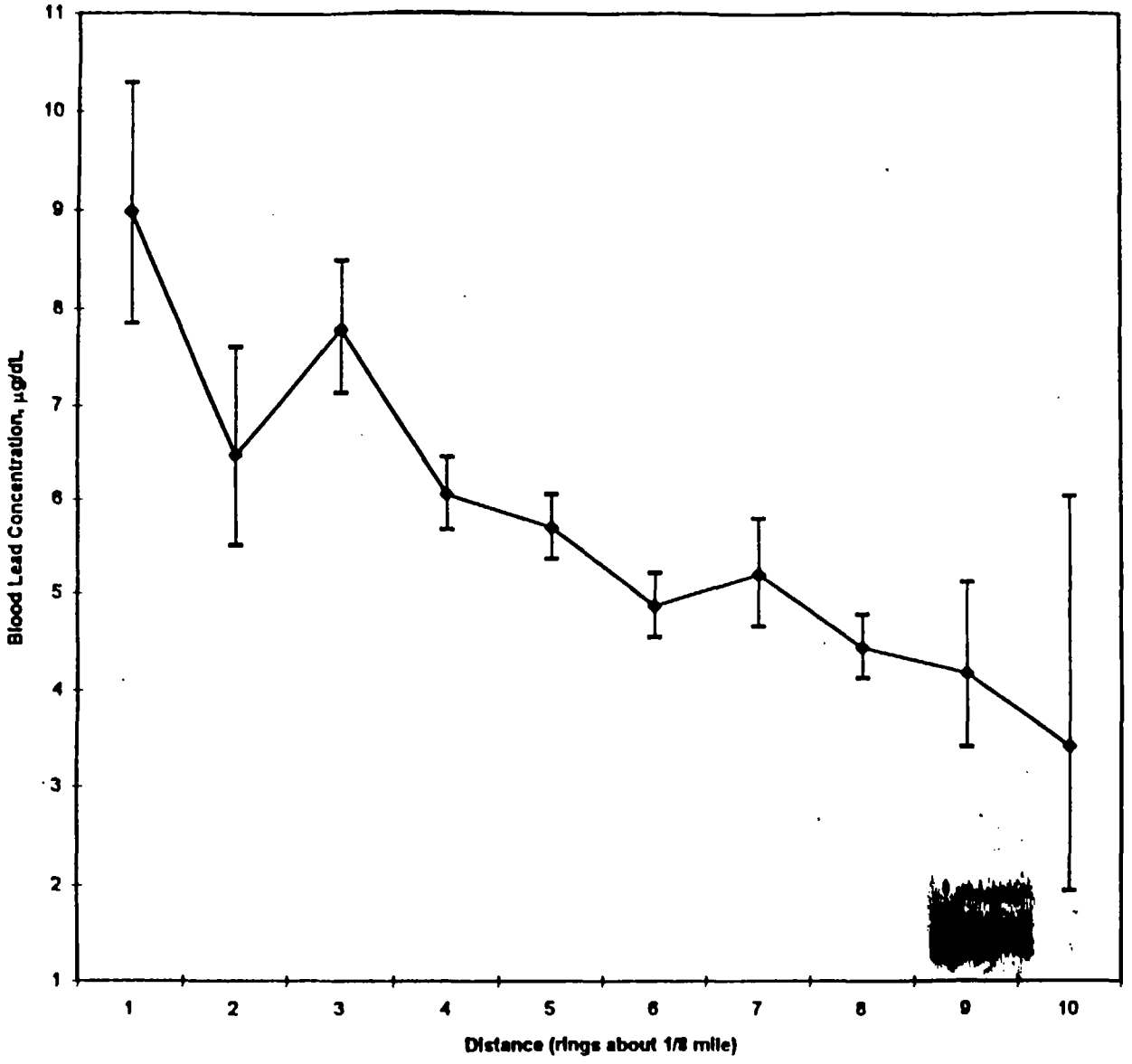


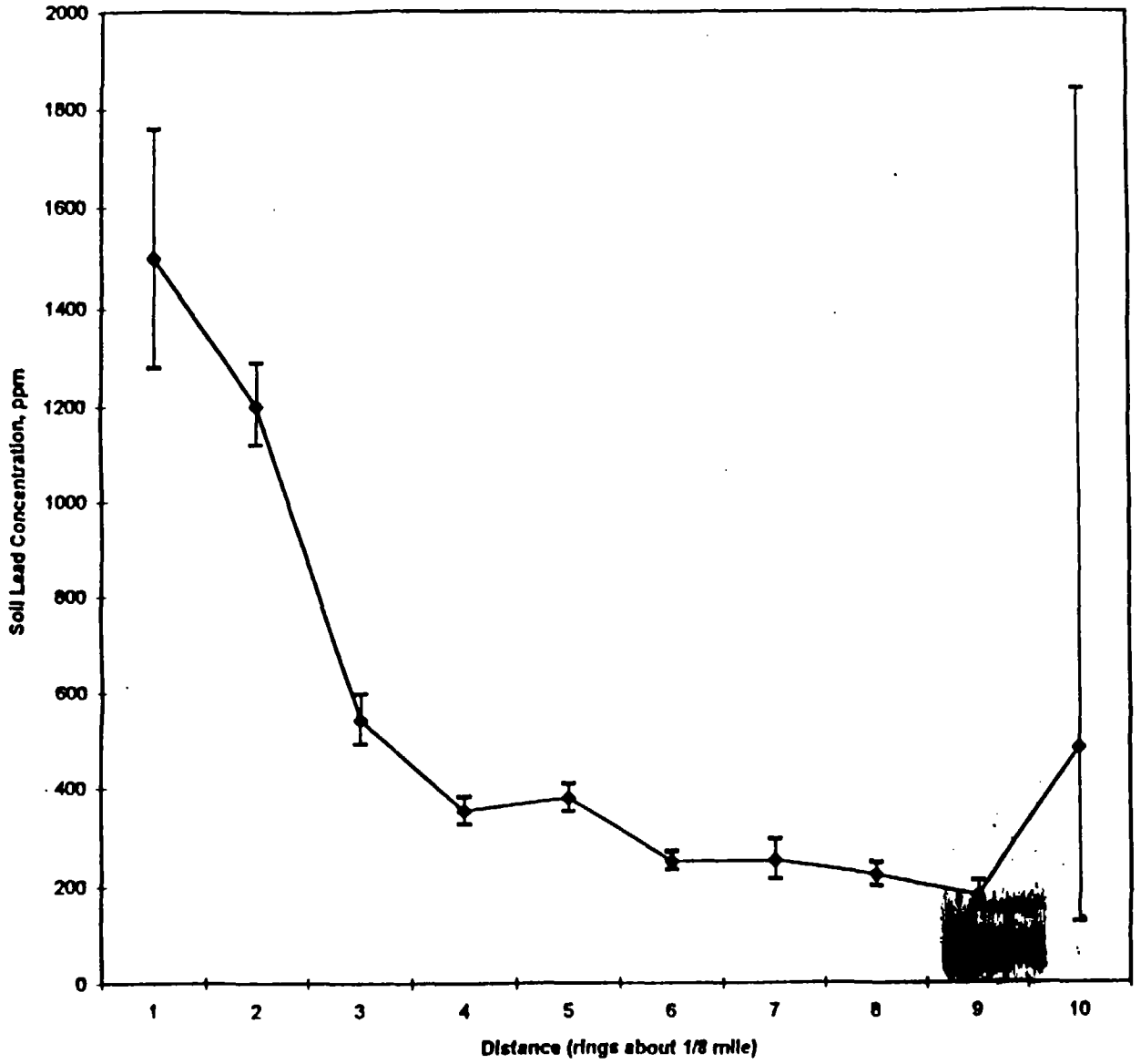
Figure 5. Percentage of children with blood lead sufficiently high to require [illegible] intervention (20 ug/dl or above) decreases with increasing distance from the NL/Taracorp lead smelter, beyond ring 3. Bars show one standard error of percentage estimate.



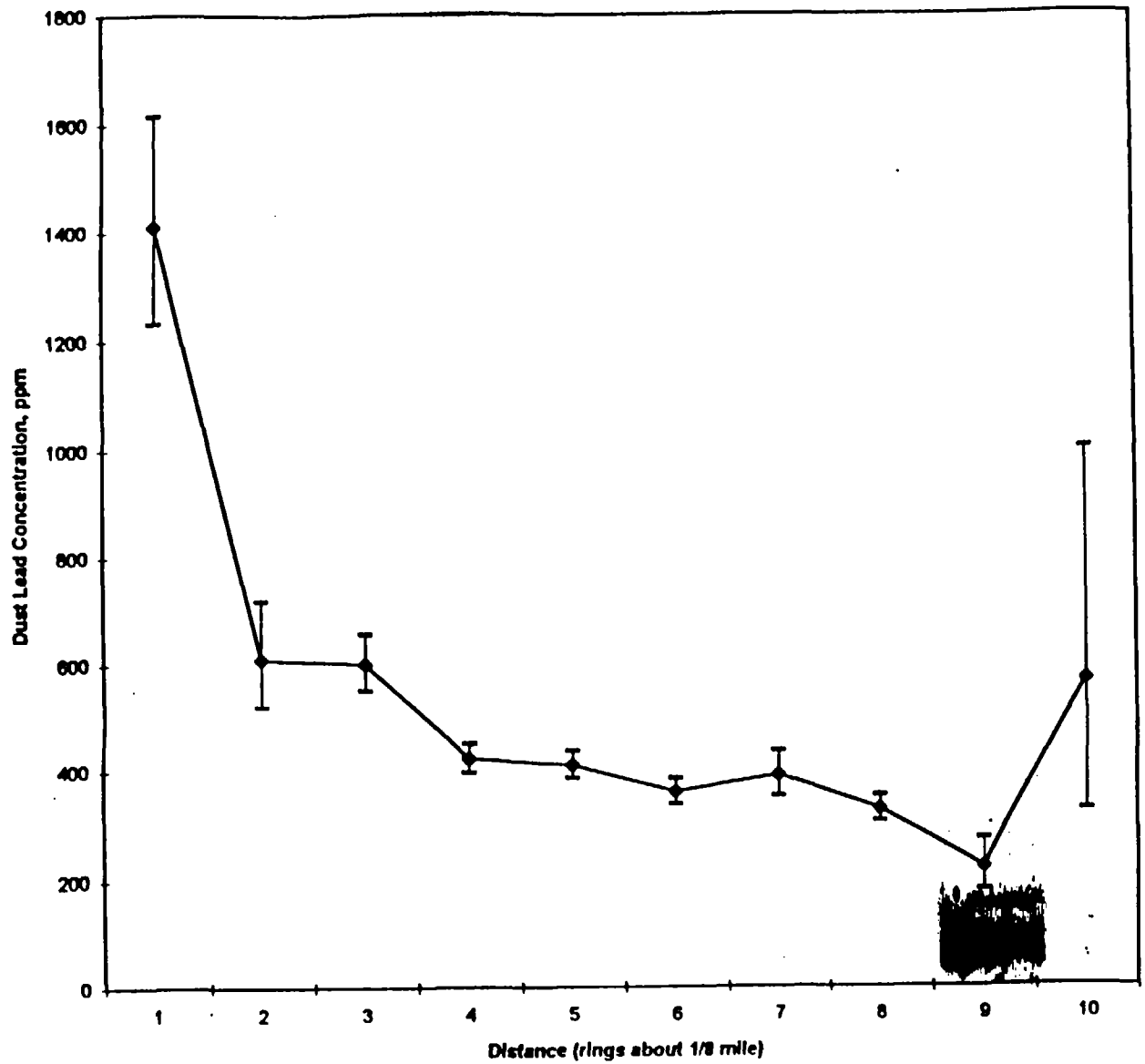
increasing distance from the NL/Taracorp lead smelter. Bars show one geometric or relative standard error of geometric mean.



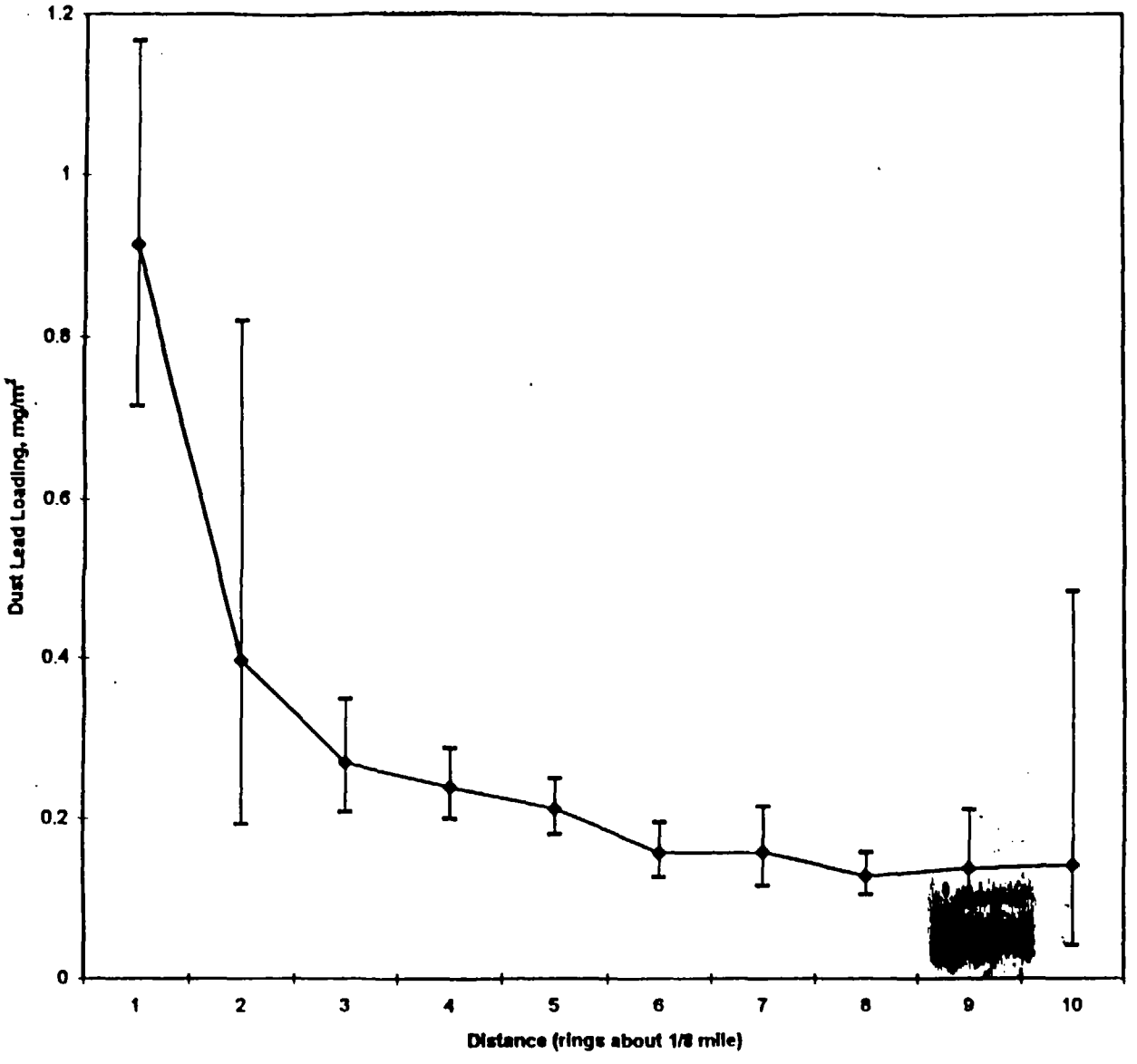
decreases with increasing distance from the NL/Taracorp lead smelter. Bars show one geometric or relative standard error of geometric mean.



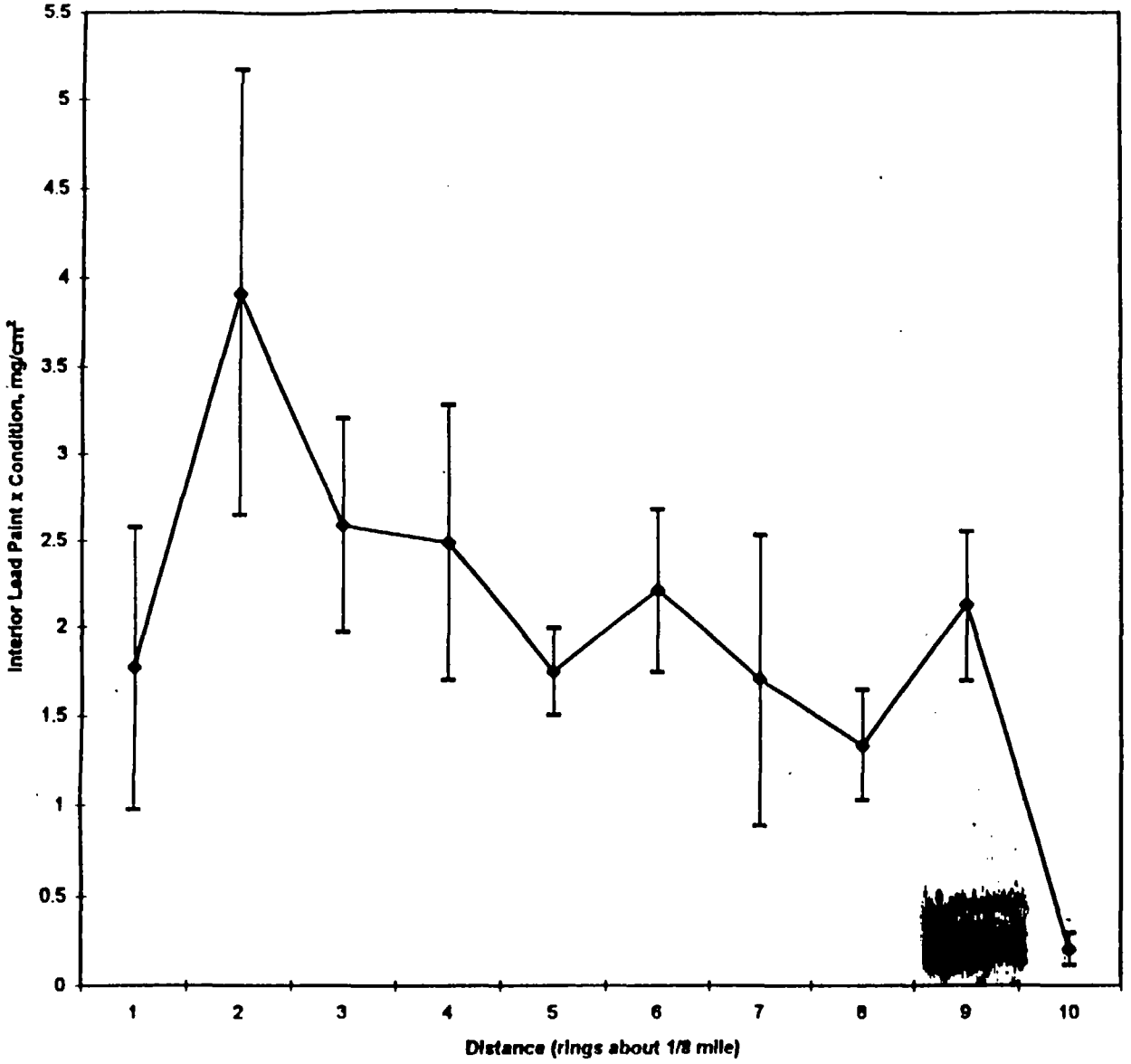
decreases with increasing distance from the NL/Taracorp lead smelter. Bars show one geometric or relative standard error of geometric mean.



with increasing distance from the NL/Taracorp lead smelter. Bars show one geometric or relative standard error of geometric mean.



condition) in residences of Madison County children decreases slightly with increasing distance from the NL/Taracorp lead smelter. Bars show one standard error of mean.



condition) in residences of Madison County children shows little relationship with increasing distance from the NL/Taracorp lead smelter. Bars show one standard error of mean.

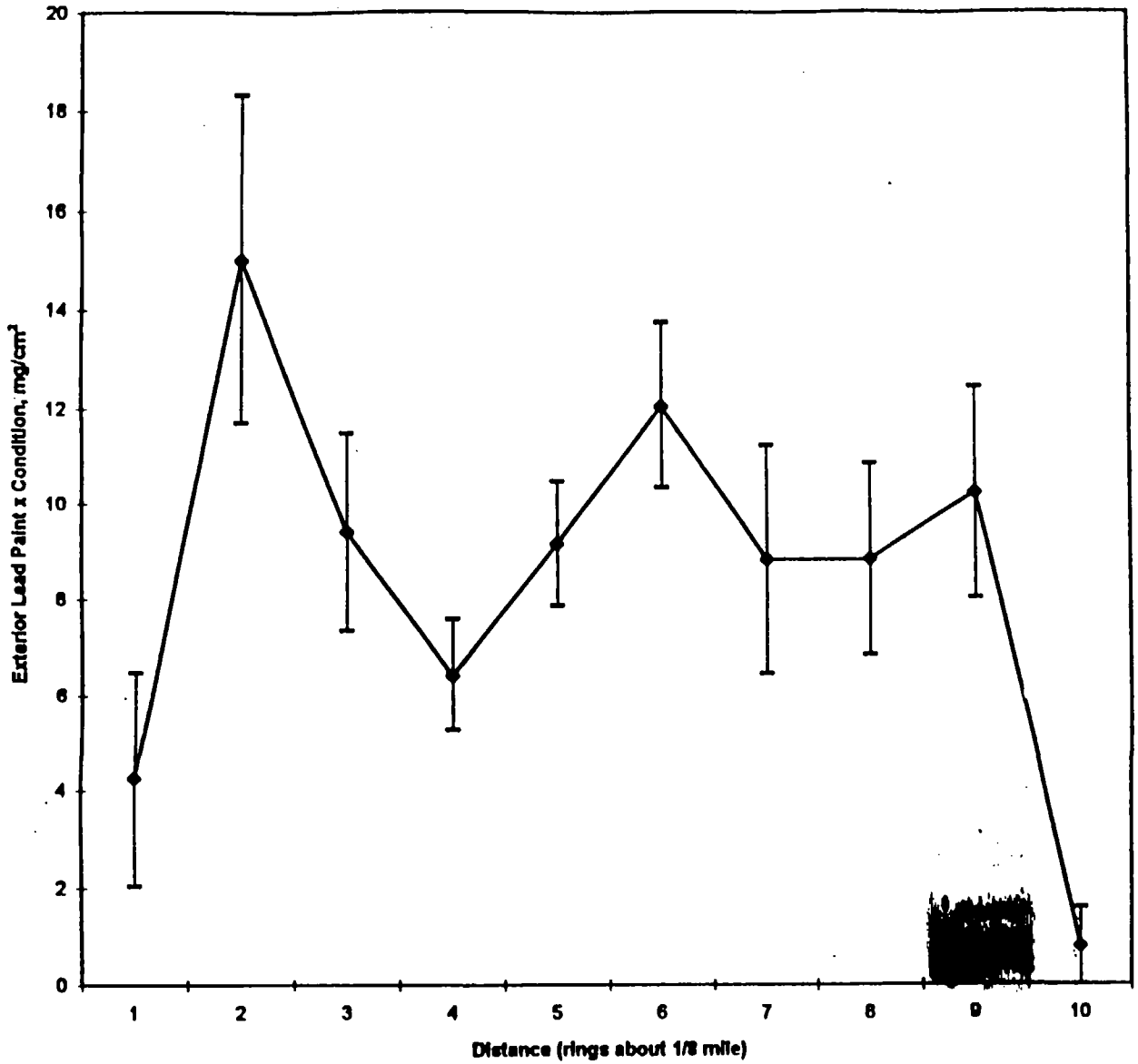
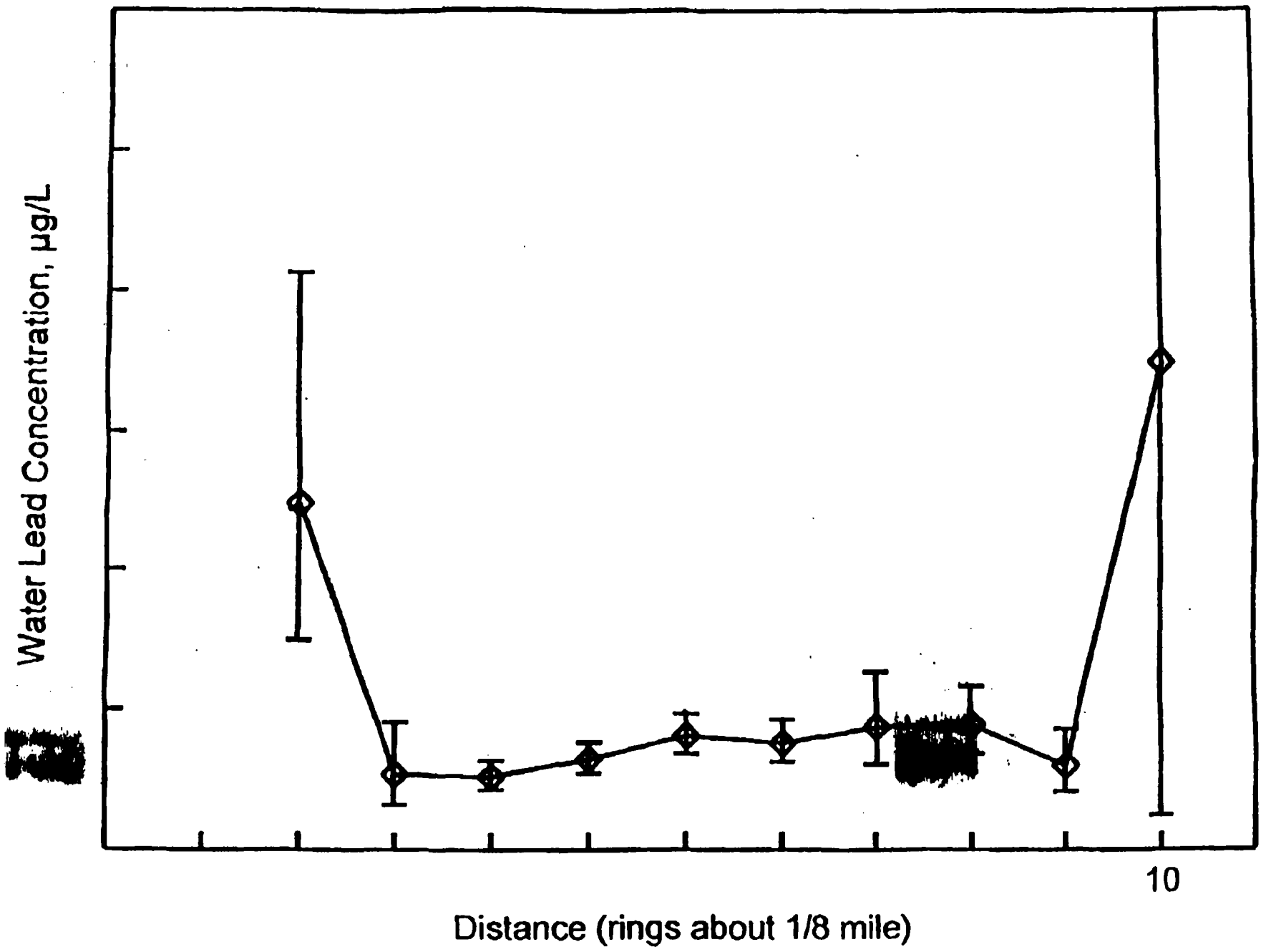
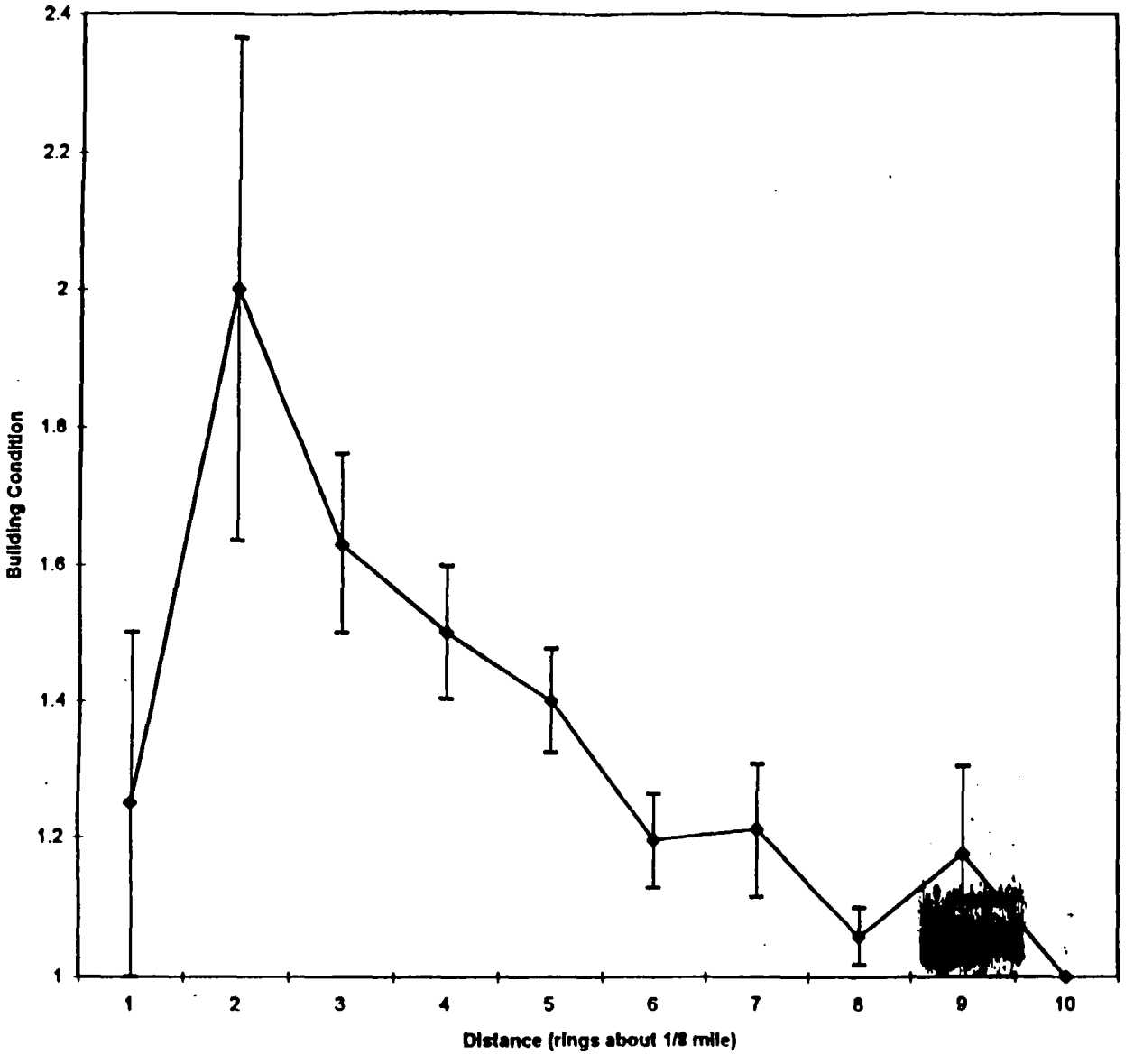


Figure 10. Geometric mean water concentration in residences of Madison County children shows little relation to increasing distance from the NL/Taracorp lead smelter, beyond ring 1. Bars show one geometric or relative standard error of geometric mean.



with increasing distance from the NL/Taracorp lead smelter. Bars show one standard error of mean.



shows a very slight decrease with increasing distance from the NL/Taracorp lead smelter. Bars show one geometric or relative standard error of geometric mean.

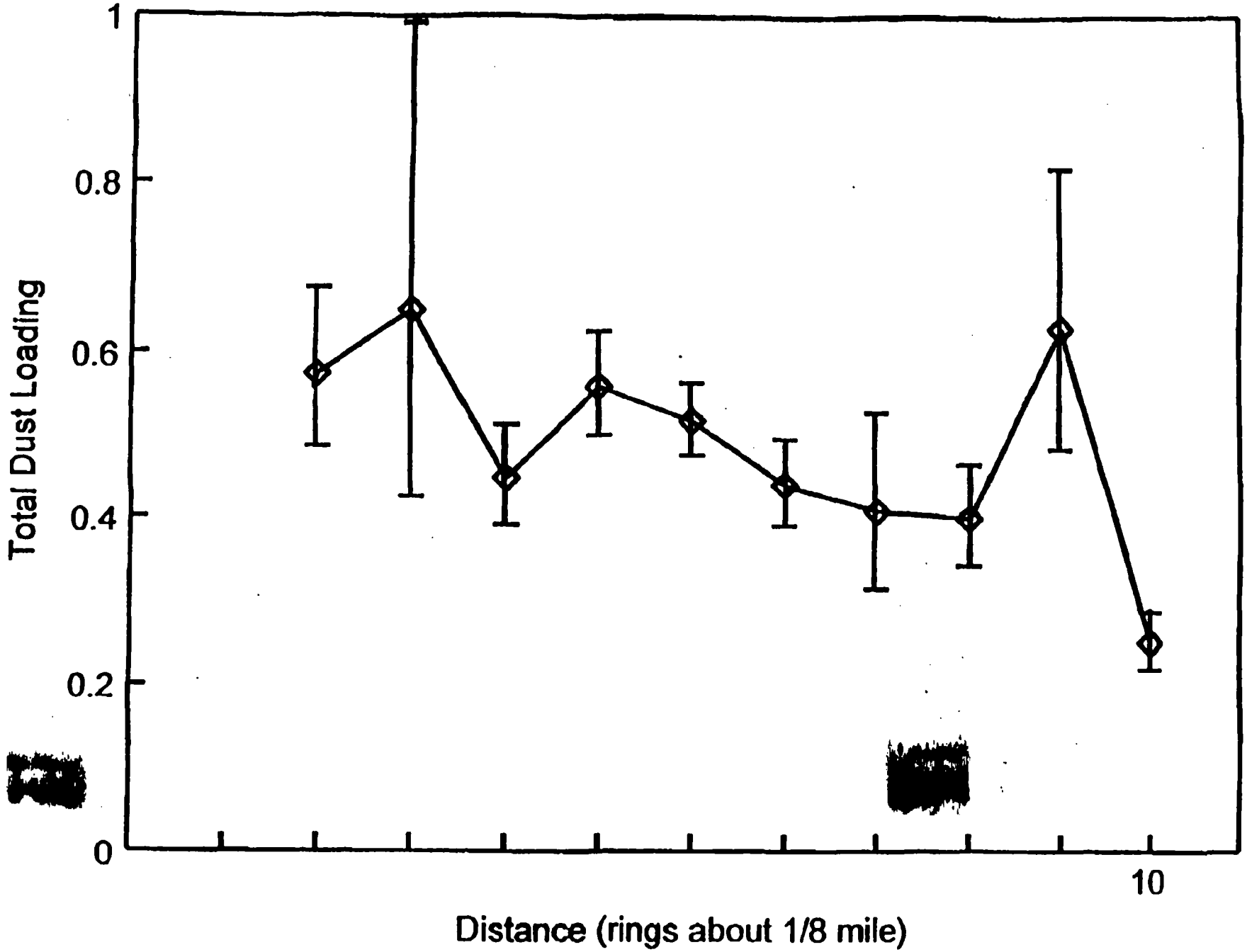


Figure 12. Mean exterior building condition of residences [illegible] with increasing distance from the NL/Taracorp lead smelter. Bars show one standard error of mean.

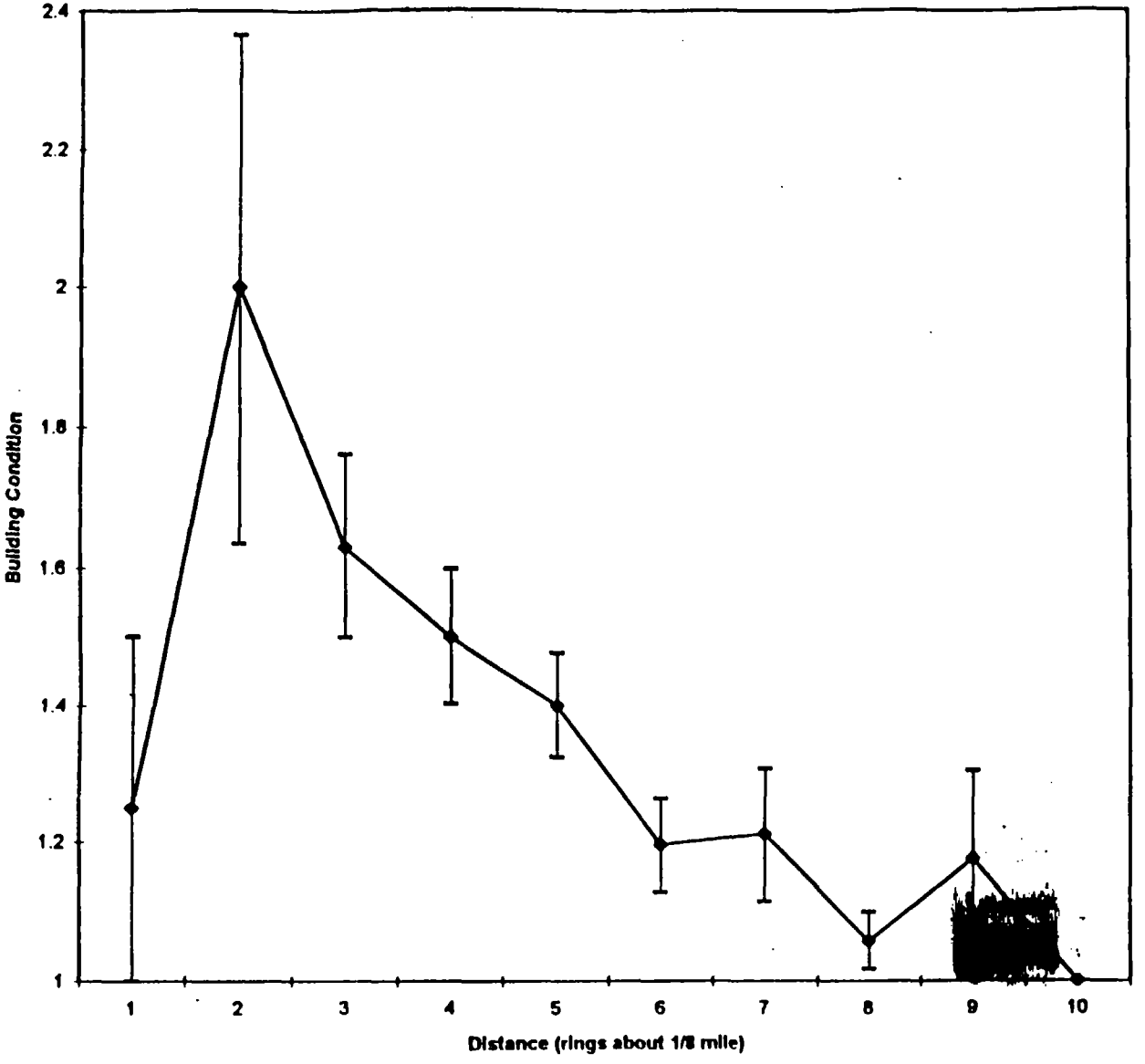
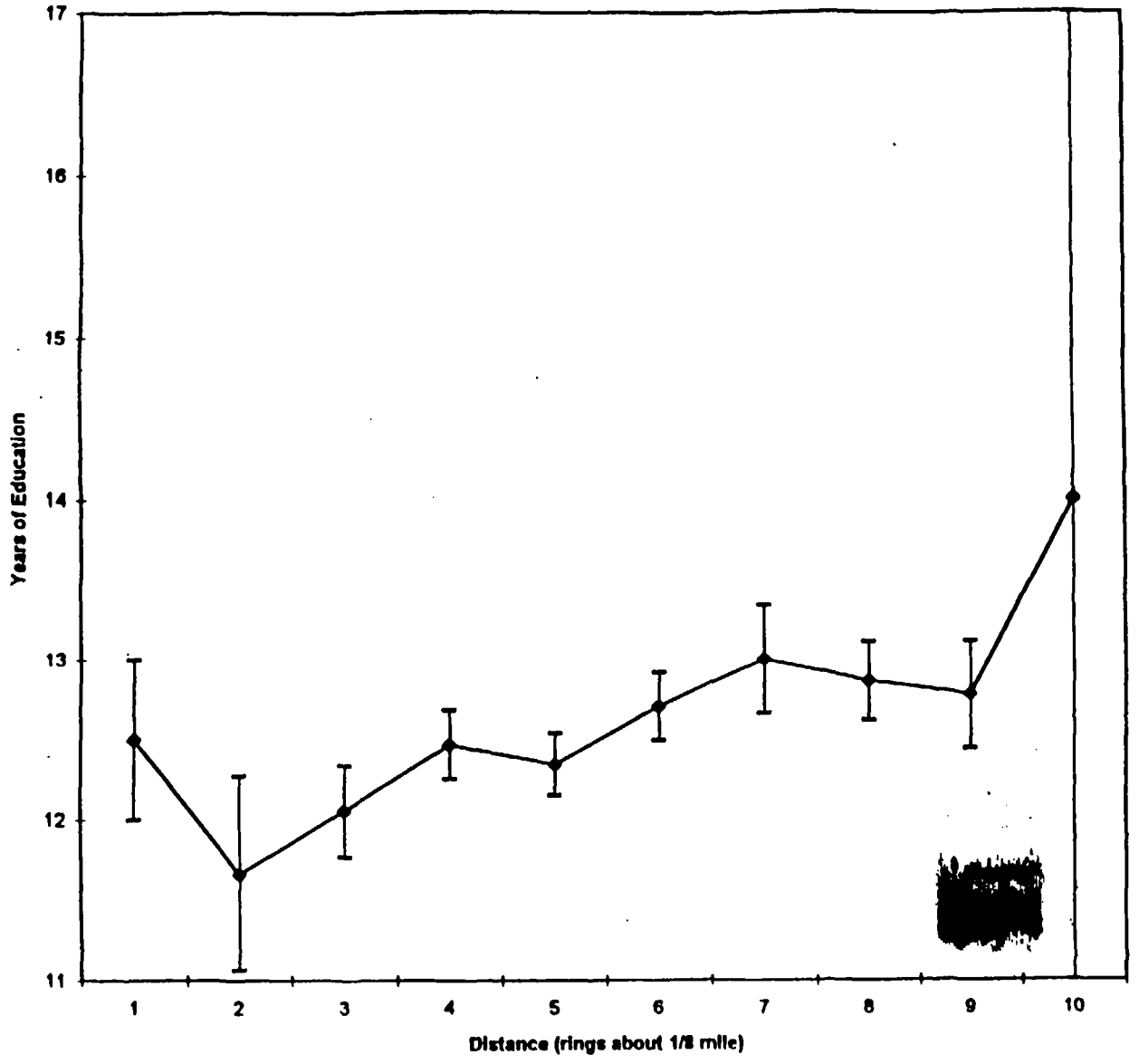


Figure 13. Mean years of education of parents of Madison County children increases with increasing distance from the NL/Taracorp lead smelter. Bars show one standard error of mean.



distance from the NL/Taracorp lead smelter beyond ring 6. Bars show one standard error of percentage estimate.

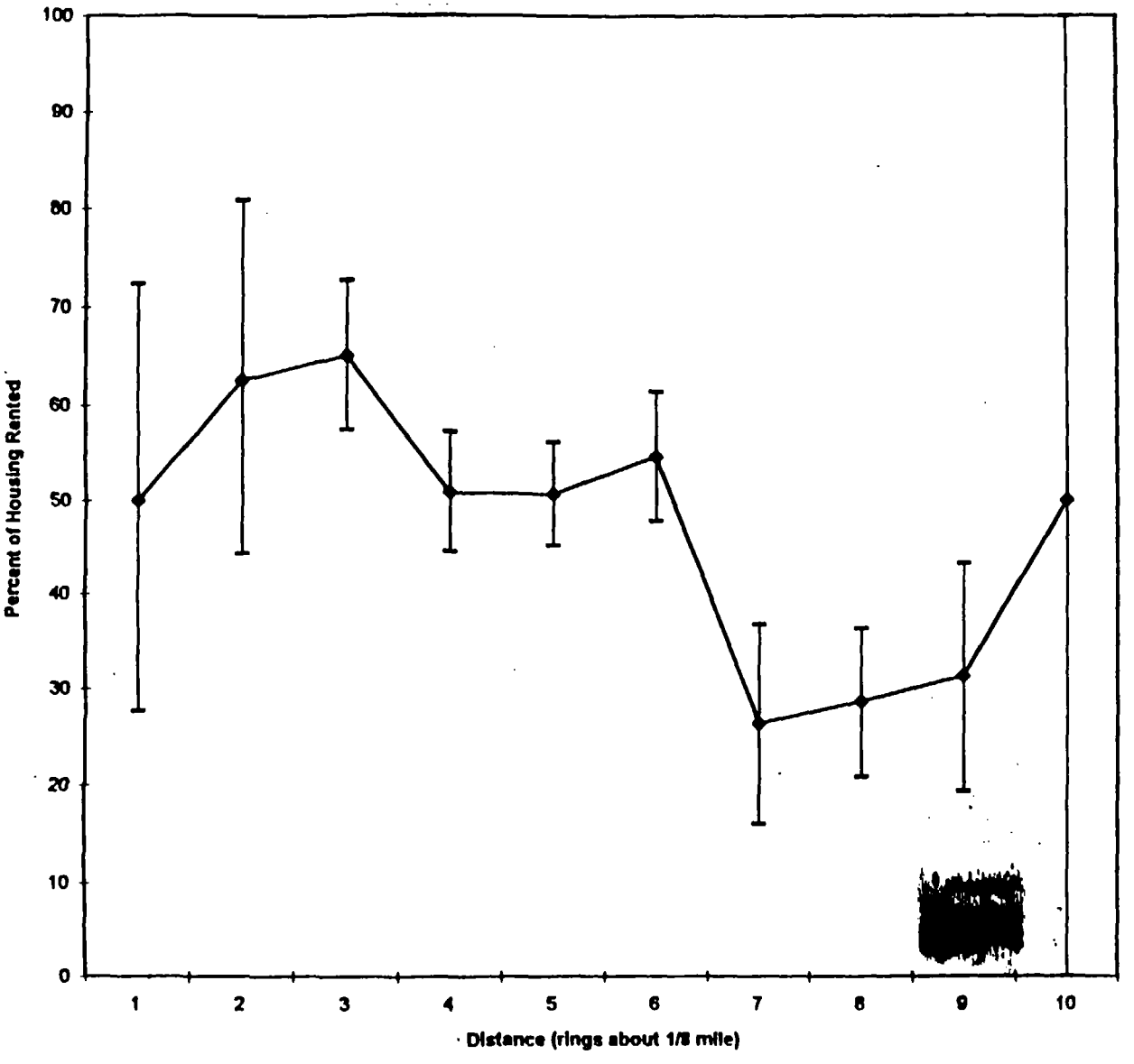
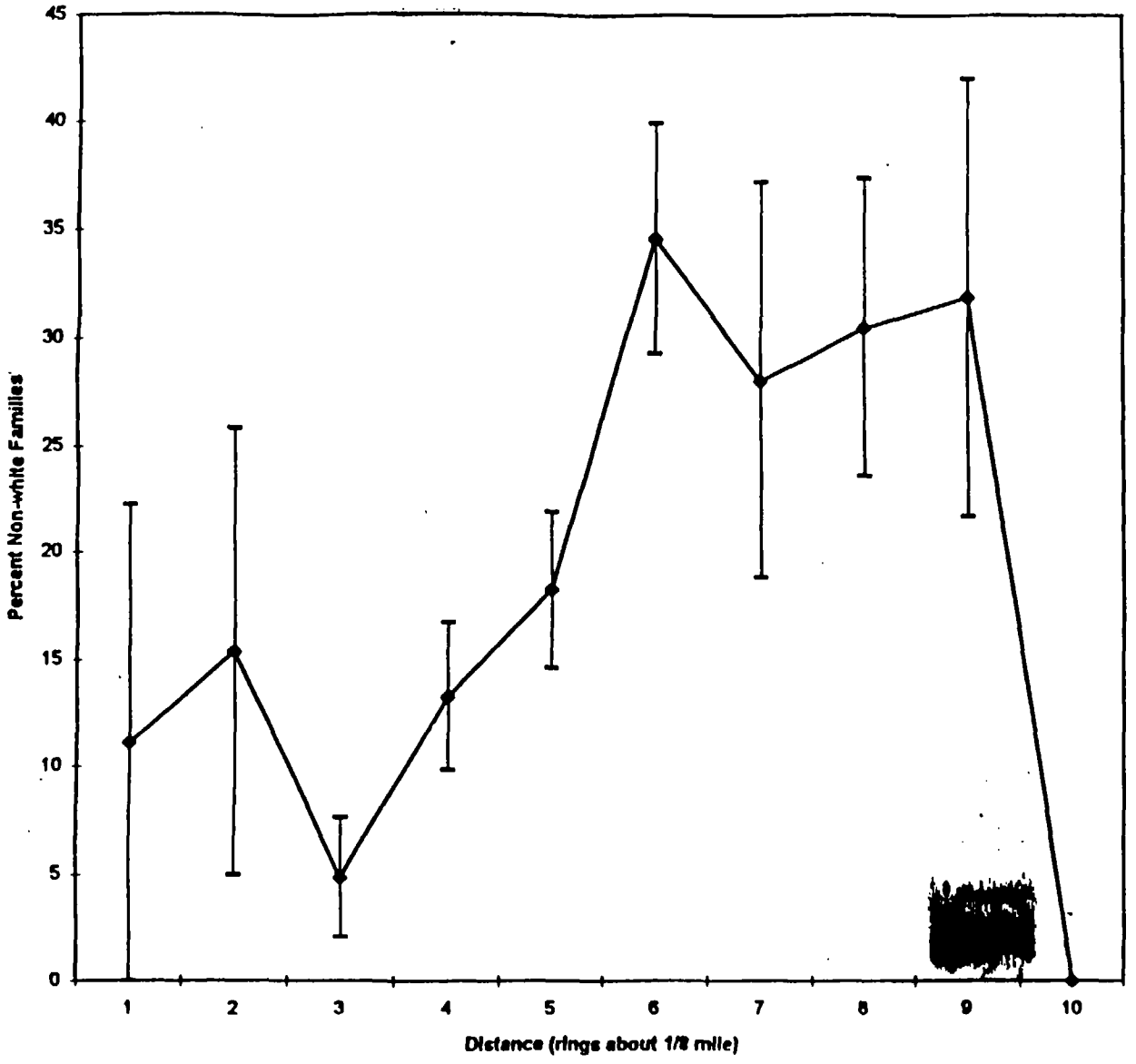
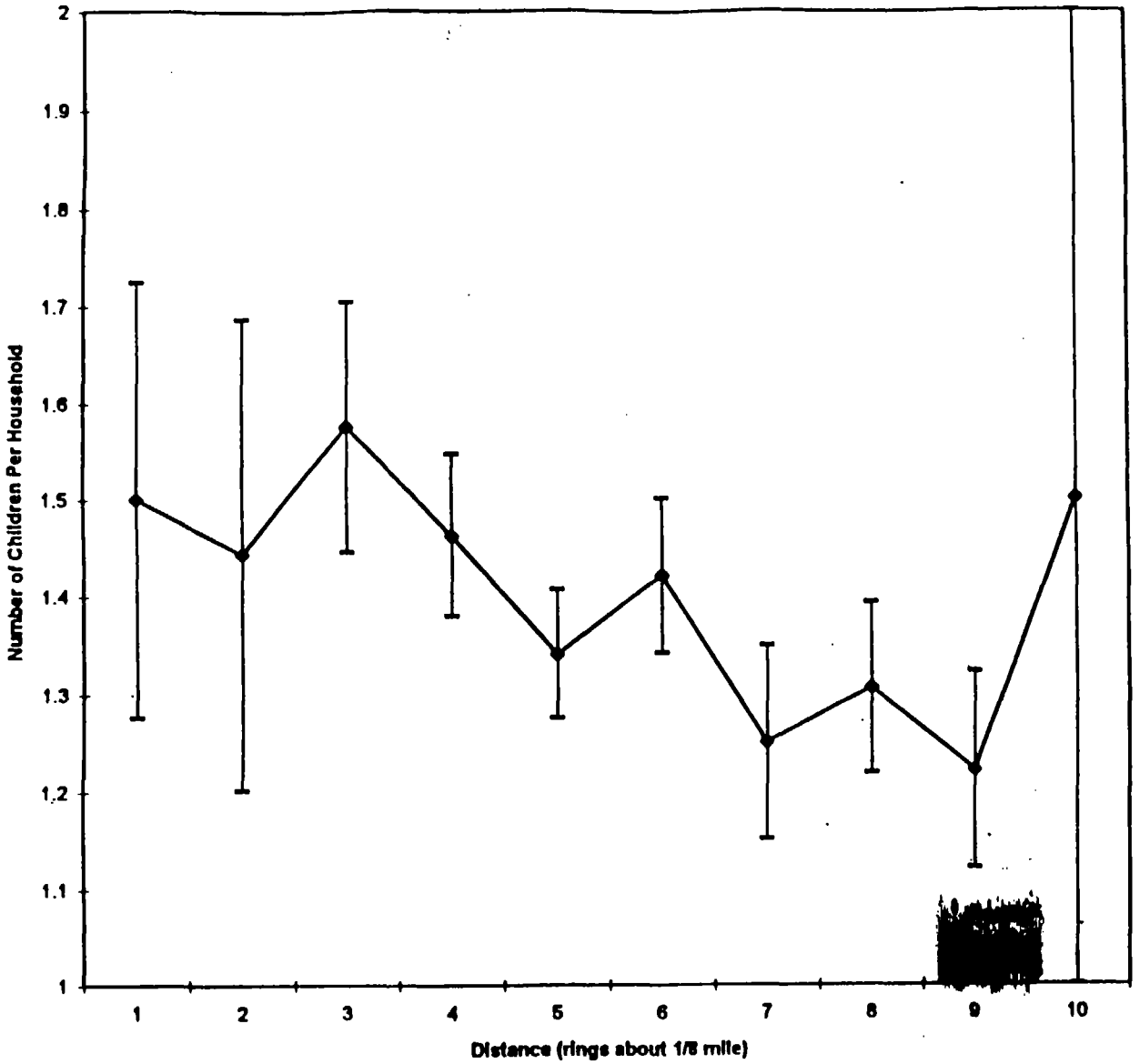


Figure 15. Percent of non-white Madison County children increases with increasing distance from the NL/Taracorp lead smelter. Bars show one standard error of percentage estimate.



children decreases with increasing distance from the NL Paracorp lead shelter. Bars show one standard error of mean.



percentage estimate.

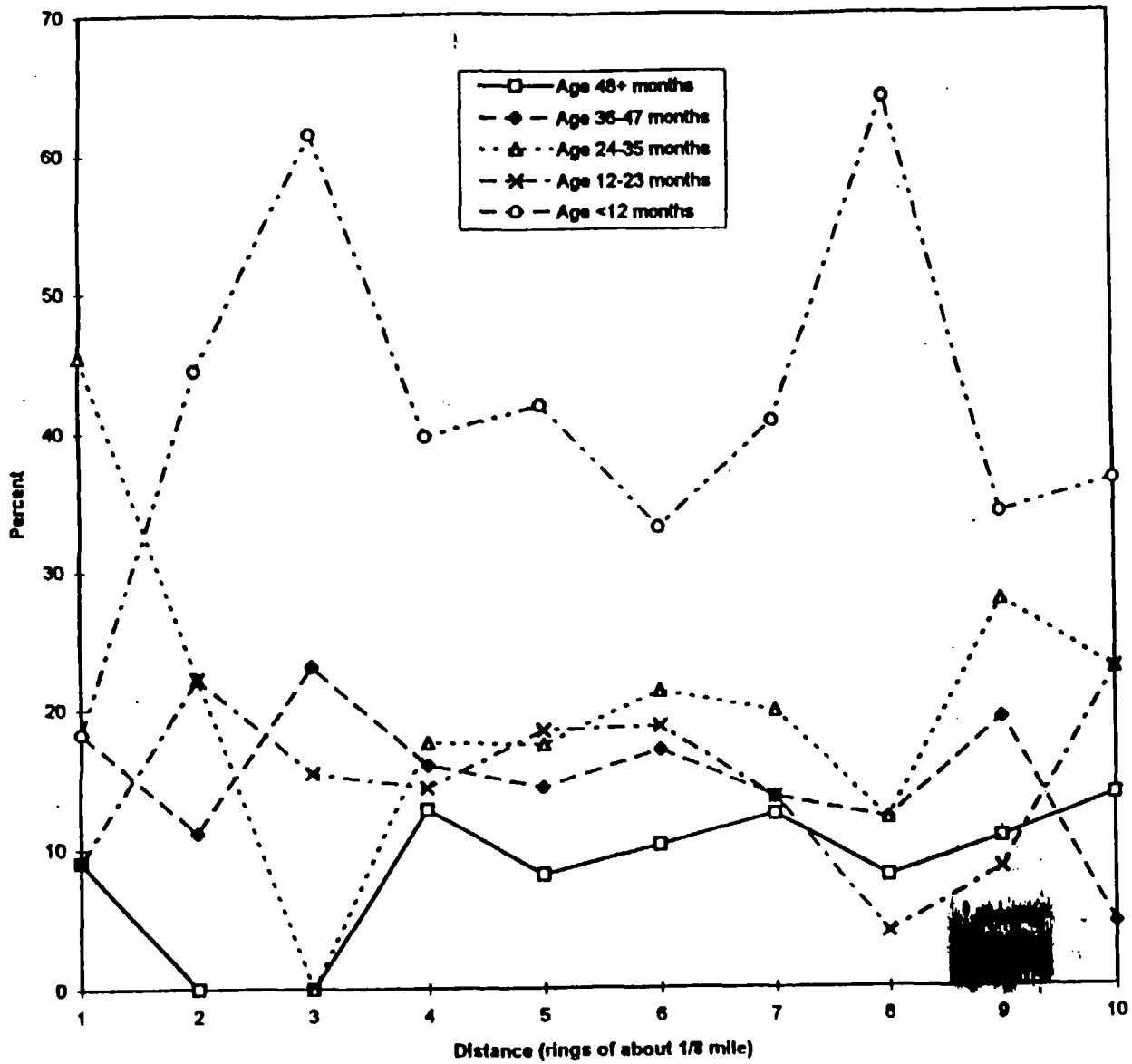
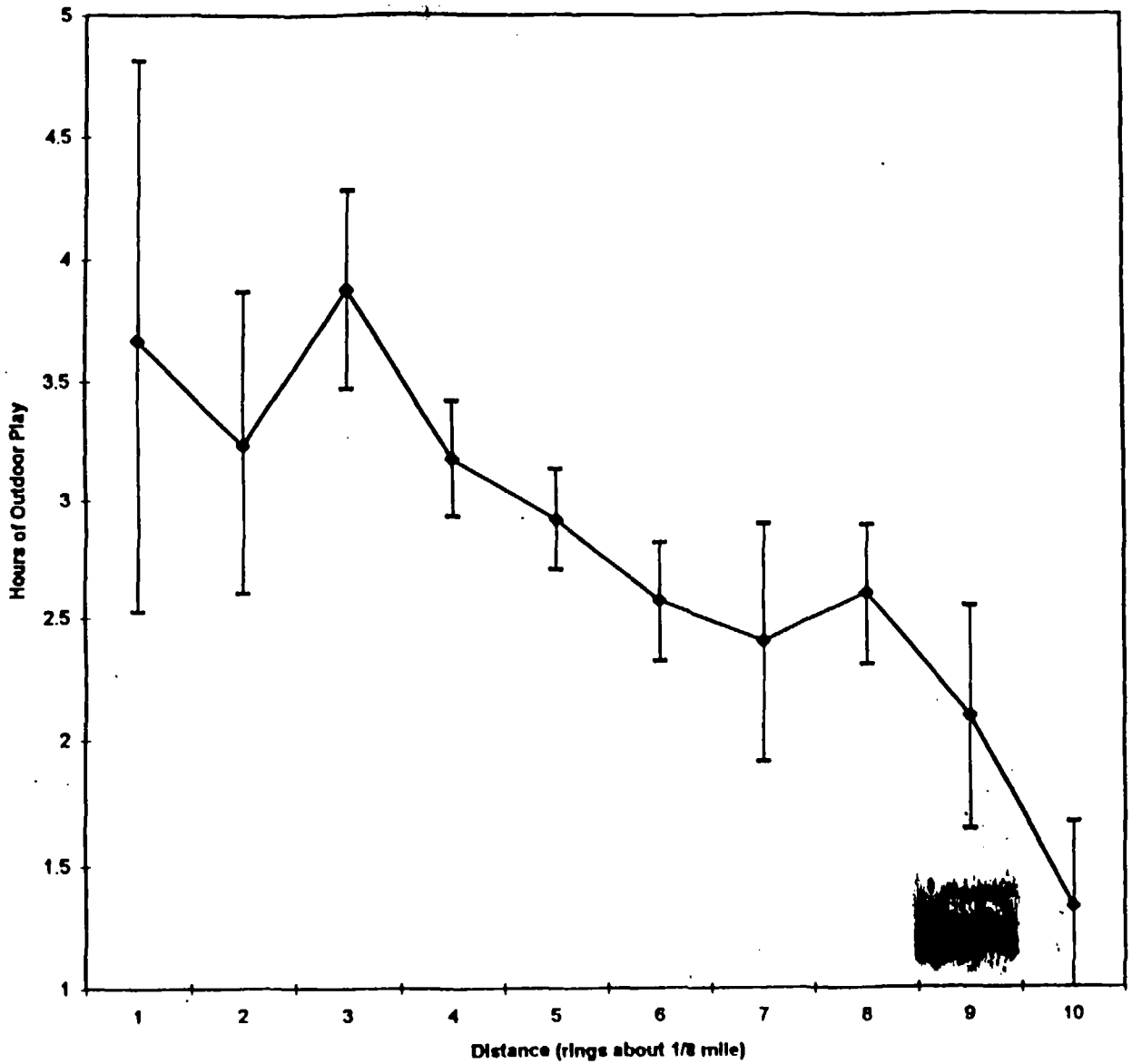


Figure 18. Mean hours of outdoor play per day of Madison County children decreases with increasing distance from the NL/Taracorp lead smelter. Bars show one standard error of mean.



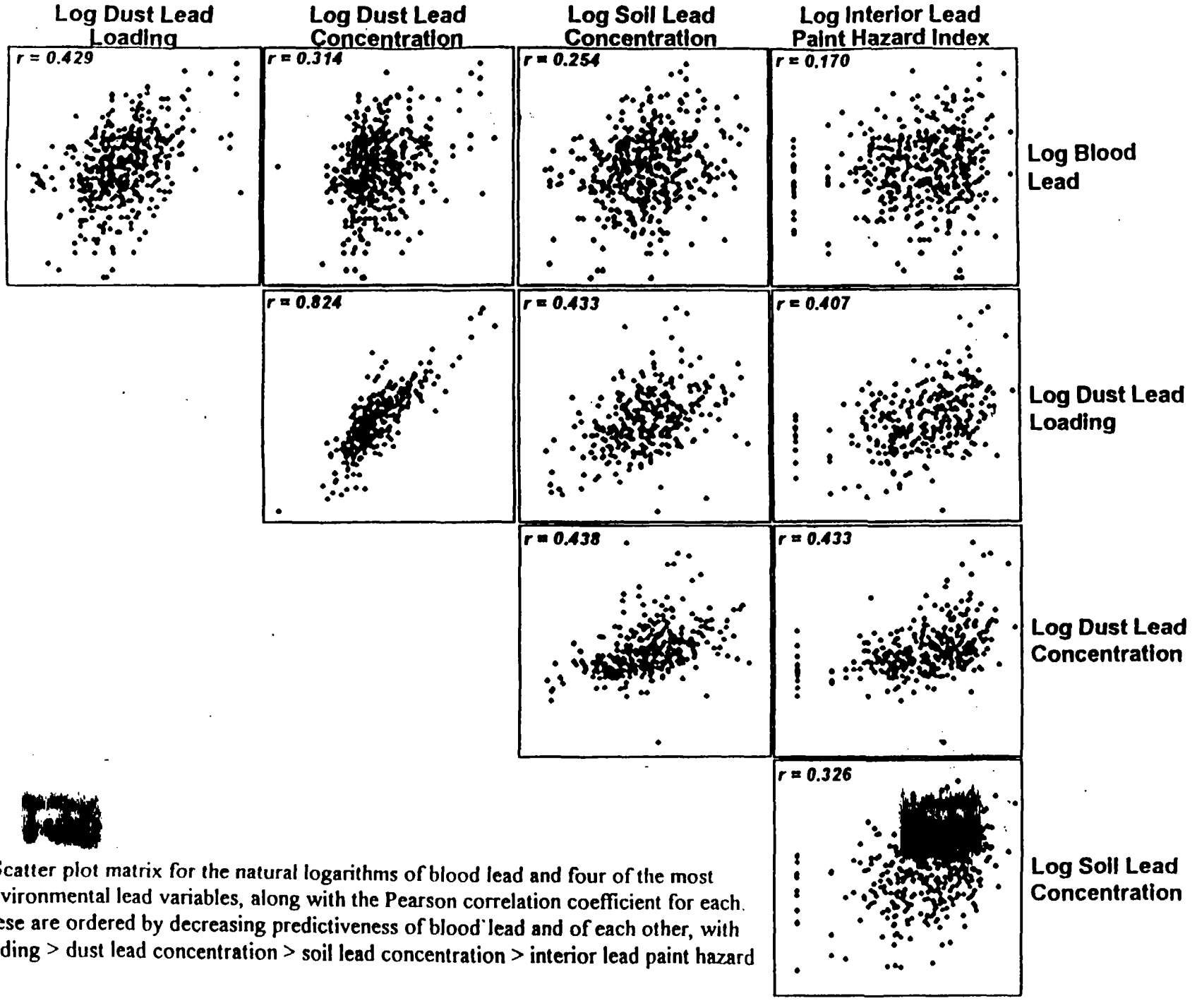


Figure 19. Scatter plot matrix for the natural logarithms of blood lead and four of the most important environmental lead variables, along with the Pearson correlation coefficient for each. Note that these are ordered by decreasing predictiveness of blood lead and of each other, with dust lead loading > dust lead concentration > soil lead concentration > interior lead paint hazard index.

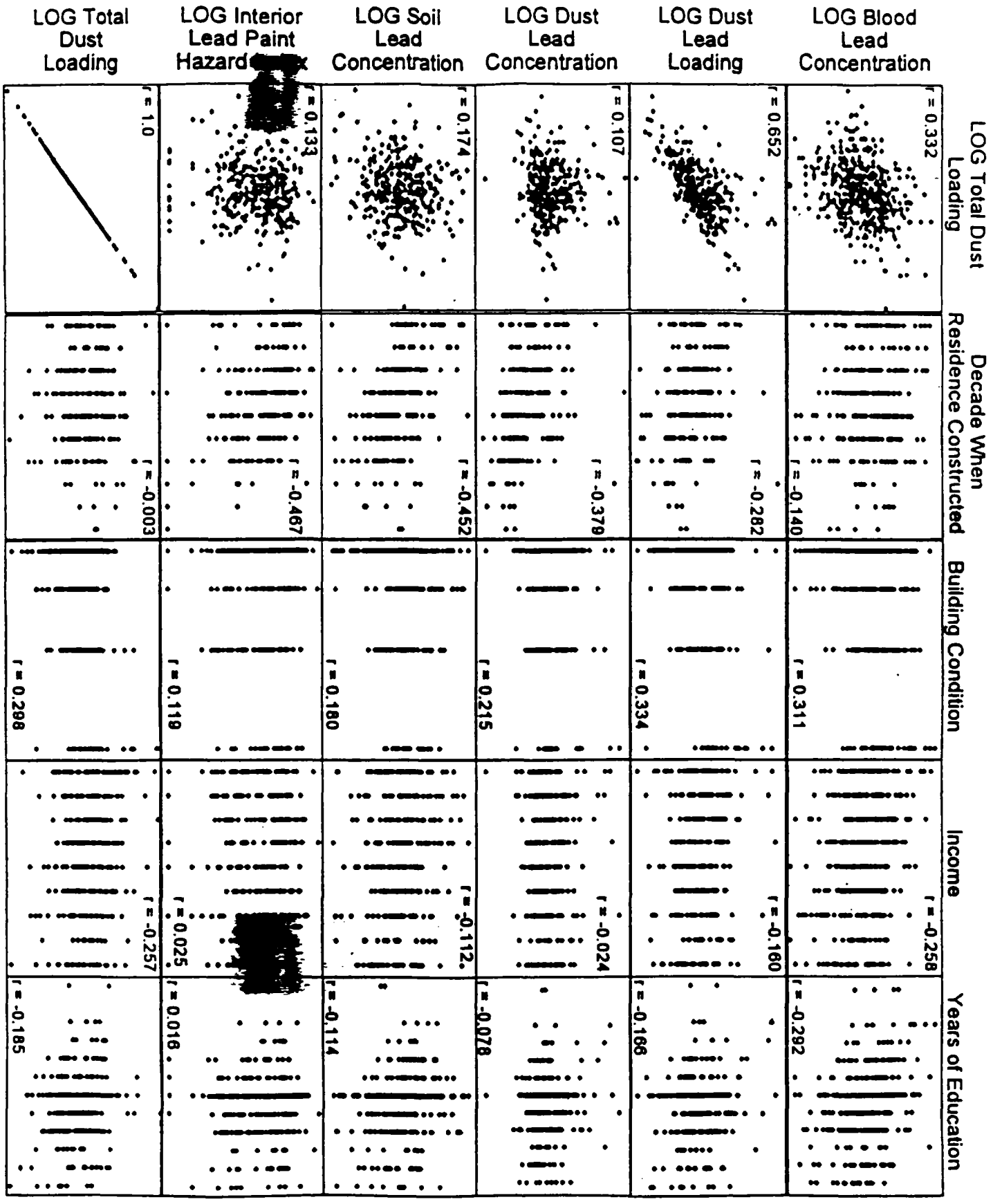


Figure 20. Scatter plot matrix for cross-correlation of the natural logarithms of blood lead, four of the environmental lead variables (dust lead loading, dust lead concentration, soil lead concentration, and interior lead paint hazard index) and total dust loading vs. three environmental factors (total dust loading, housing age, exterior building condition) and two sociodemographic factors (household income and education). The Pearson correlation coefficient for is shown for

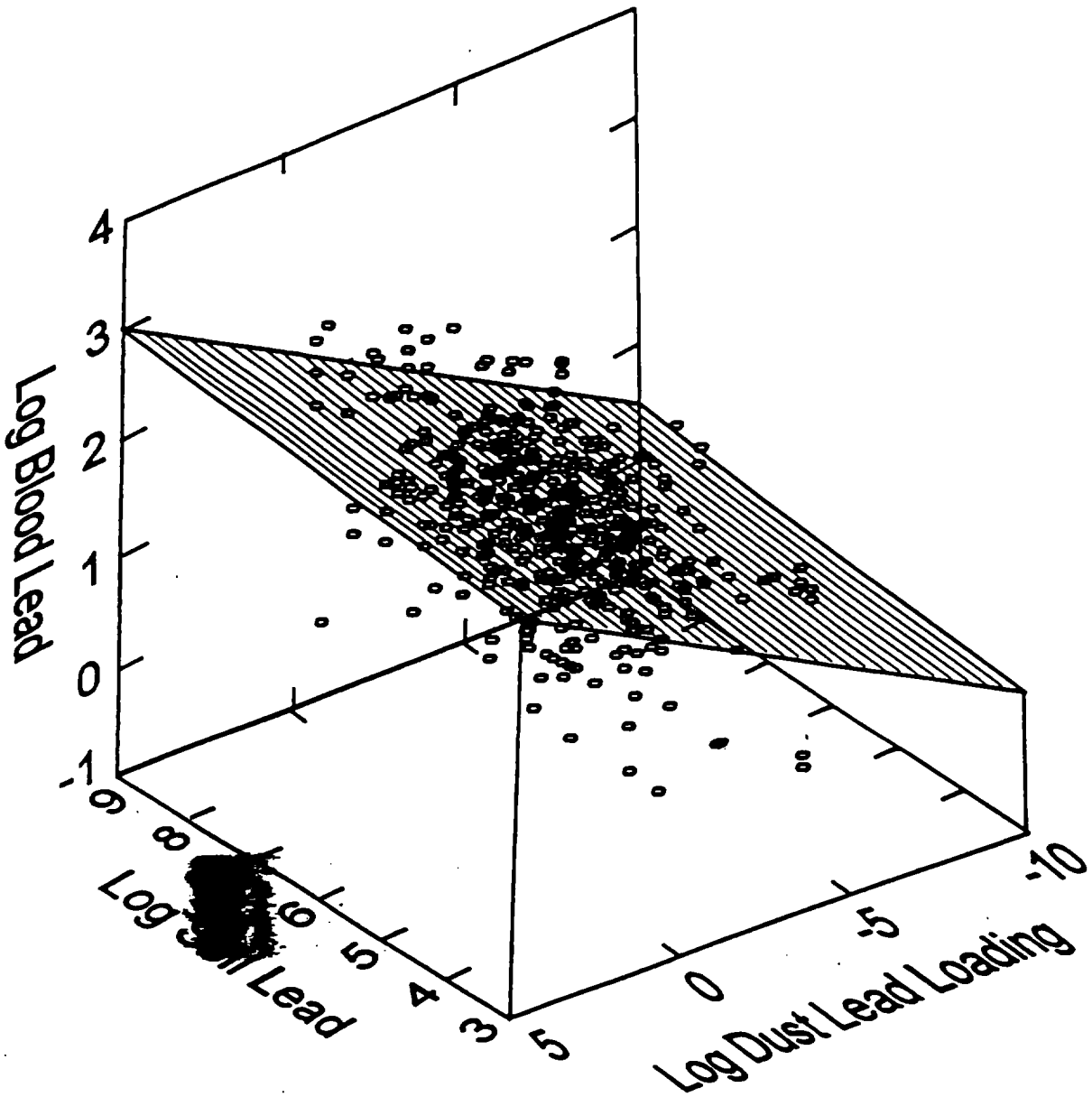
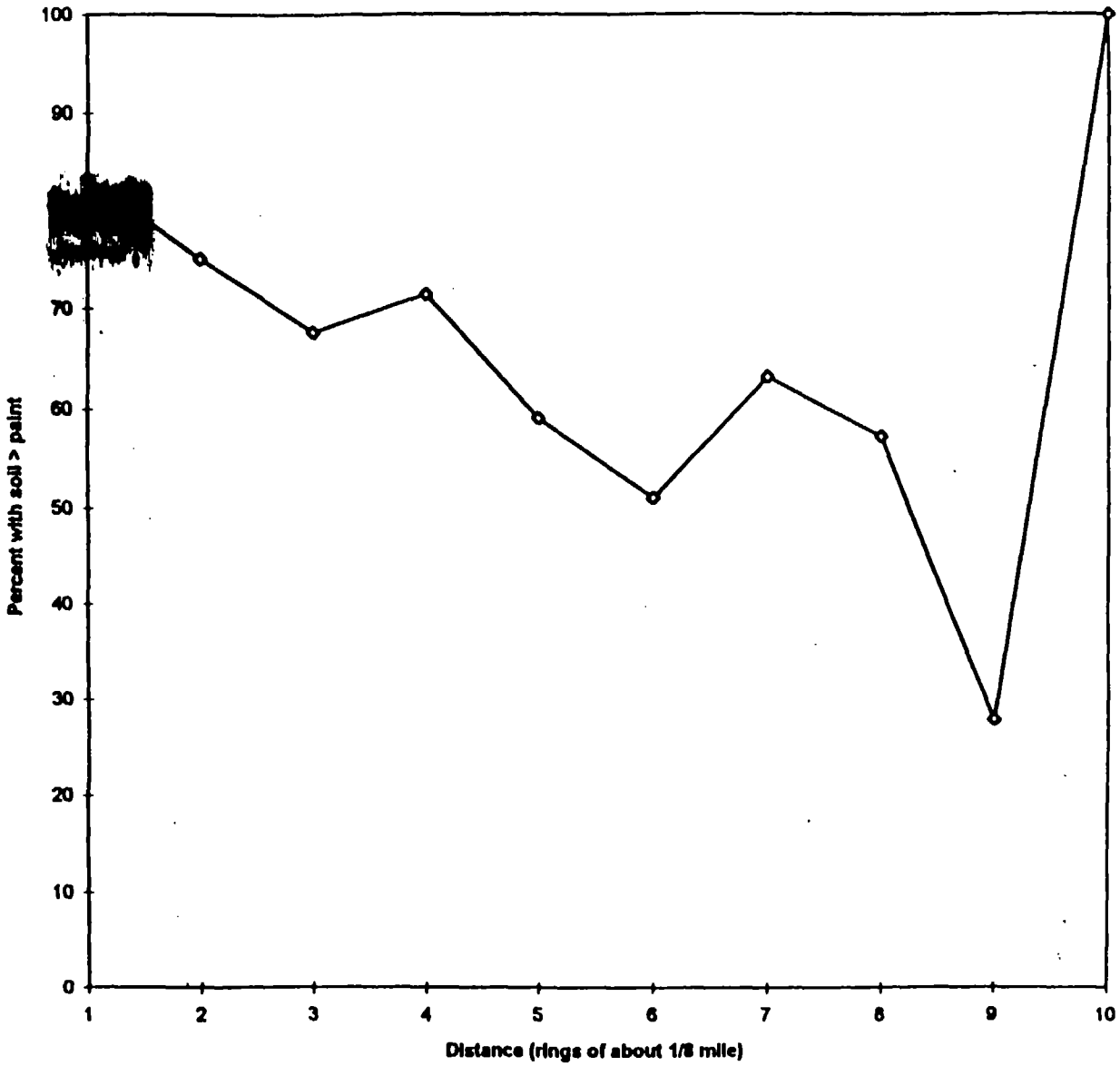


Figure 21. Scatter plot for natural logarithm of blood lead, dust lead loading, and soil lead is shown in a three-dimensional representation. The multiple regression relationship of log(blood lead) on log(dust lead loading) and log(soil lead) is shown as a shaded plane surface. Note that most data points lie close to the plane, and that there is a relatively large effect of dust lead loading. There is also a slight effect of soil lead on blod lead, shown as a small positive slant of the multiple regression surface projected on the log(blood lead) vs. log(soil lead) plane.

Figure 22. Percentage of households in which the estimated contribution of soil lead to household dust exceeds the estimated contribution of deteriorating lead-based paint decreases with increasing distance from the NL/Taracorp site, but still exceeds 50 percent up to ring 8.



TECHNICAL APPENDIX A

Bivariate Correlations and Relationships Among the Data

Based on preliminary assessments, the list of variables used in U.S. EPA's analyses was reduced to a manageable set of 31 variables. They may be characterized as follows, using variable names in U.S. EPA's analyses and some recoding for clarity:

Response variable LOGPBB = natural logarithm of blood lead;

Location LOGDIST = natural logarithm of distance from NL/Taracorp lead smelter, in rings of about 1/8 mile, coded 1 to 10;

Environmental lead variables

LOGPBD = natural logarithm of dust lead concentration;

LOGPBDL = natural logarithm of dust lead loading;

LOGPBS = natural logarithm of soil lead concentration;

LOGPBW = natural logarithm of water lead concentration;

LOGXRFMN = natural logarithm of average lead paint loading measured by XRF, plus 1;

LOGCXI = natural logarithm of interior lead paint loading times paint condition, plus 1;

LOGCXO = natural logarithm of exterior lead paint loading times paint condition, plus 1;

REFINISH = refinishing or paint removal done within last year (0 = no, 1 = yes);

Demographic and household variables

AIRCOND = air conditioner used (0 = no, 1 = yes);

BLDCONIM = building condition, with imputation (1, 2, or 3 if not missing; 1.389 if missing);

CIGSDAY = number of cigarettes smoked per day;

EDUCYRS = educational attainment, in years;

INCOME = total household income, coded 0 to 9 in intervals of $5000;

LOGDSTLD = natural logarithm of total dust loading;

LOGYRS = natural logarithm of time at residence, in years;

NONWHITE = parents Afro-American, Asian, Pacific Islander or Native American (0 if no, 1 if yes);

NUMSMOK[redacted] number of smokers in household;

RENT_OWN = rental housing (0 if no, 1 if yes);

USEDSLAG = slag used as fill on property (0 = no, 1 = yes);

Individual child variables

AGE = child's age in years;

AGE2SQR = (age - 2 years), squared;

FOLK_MED = folk medicine used (0 = no, 1 = yes);

HRS_HOME = hours spent at home, per week;

MOUTHFR = mouthing frequency, coded 0, 1, 3, or 10 for never, almost never, once in a while, a lot;

OUTPLHRS = hours spent playing outside, per day;

PAINTFR = frequency of eating paint, coded 0, 1, 3, or 10 for never, almost never, once in a while, a lot;

PLAYFLR = hours spent playing on floor;

SEX = child's sex (0= male, 1 = female);

SUCKTHUM = child sucks thumb (0 = no, 1 = yes);

The correlations involve both household and environmental factors on a household unit level, and individual child factors. U.S. EPA therefore calculated the correlation matrix from the complete child data set, which implicitly weights each household or environmental correlation [redacted] number of children in that household. In U.S. EPA's opinion, from a risk assessment [redacted]ctive, this is an appropriate weighting. Correlations calculated from the household-level data set show little difference, however. The results are shown in the Appendix. Tables A-1, A-2 and A-3. Table A-1 shows the Pearson bivariate correlation coefficients, in a triangular matrix format to avoid clutter. Since the correlation between variables X and Y is the same as the correlation between variables Y and X, any entry not found by looking for X in the row list and Y in the column list can be found at Y in the row list and X in the column list. A correlation coefficient of 1 means a perfect positive linear

relationship exists, $Y = a + bX$, where b is a positive number. A correlation coefficient of -1 means that [redacted]fect linear relationship exists, where b is a negative number. A correlation c[redacted]ient of 0 means that there is no linear relationship between the variables, on average. Table A-2 gives the number of pairs of measurements in which both variables are not missing, so that the correlation coefficient is calculated using only those pairs. Note that there are many missing values, but that the pattern shifts depending on which pairs of variables are being considered. The statistical significance (denoted P) of each correlation coefficient is given in Table A-3. Note that because of the large sample size, even relatively small correlation coefficients of about 0.1 are statistically significant by conventional criteria ($P < 0.05$).

[redacted]

TABLE A1. PEARSON CORRELATION MATRIX FOR 31 VARIABLES IN MADISON COUNTY LEAD STUDY

	Response	Location	Environmental		
	LOGPBB	LOGDIST	LOGPBD	LOGPBDL	LOGPBS
Response Variable					
LOGPBB	1.000				
Location Variable					
LOGDIST	-0.257	1.000			
Environmental Variables					
LOGPBD	0.307	-0.243	1.000		
LOGPBDL	0.425	-0.219	0.824	1.000	
LOGPBS	0.249	-0.522	0.440	0.433	1.000
LOGPBW	0.084	-0.005	0.023	0.011	0.086
LOGXRFMN	0.105	-0.066	0.393	0.381	0.295
LOGCXI	0.163	-0.011	0.432	0.405	0.337
LOGCXO	0.077	0.048	0.360	0.301	0.278
REFINISH	0.114	0.038	0.085	0.056	0.065
Household and Demographic Variables					
AIRCOND	-0.267	0.189	-0.196	-0.272	-0.149
BLDCONIM	0.311	-0.266	0.215	0.334	0.180
CIGSDAY	0.229	-0.269	0.108	0.150	0.168
EDUCYRS	-0.292	0.148	-0.078	-0.166	-0.114
INCOME	-0.258	0.170	-0.024	-0.160	-0.112
LOGDSTLD	0.332	-0.051	0.107	0.652	0.174
LOGYRS	-0.082	0.039	-0.013	-0.016	-0.102
NONWHITE	0.107	0.180	-0.204	-0.069	-0.183
NUMSMOKE	0.161	-0.226	0.095	0.141	0.158
RENT OWN	0.222	-0.117	0.114	0.180	0.198
USEDSLAG	-0.004	0.054	-0.038	-0.003	-0.093
Individual and Behavioral Variables					
AGE	-0.039	-0.040	0.053	0.069	0.062
AGE2SQR	-0.120	-0.037	0.046	0.049	0.064
FOLK MED	-0.018	-0.052	-0.019	-0.041	0.044
HRS HOME	0.109	-0.056	0.008	0.079	-0.010
MOUTHFR	0.030	-0.033	0.011	0.013	0.019
OUTPLHRS	0.229	-0.167	0.010	0.078	0.081
EATPNTFR	0.049	-0.049	0.058	0.025	0.016
PLAYFLR	0.052	-0.038	0.067	0.056	0.049
SEX	-0.097	0.095	-0.061	-0.076	-0.085
SUCKTHUM	0.069	-0.152	-0.027	0.011	0.069

TABLE A1 (cont'd). PEARSON CORRELATION MATRIX FOR 31 VARIABLES IN MADISON COUNTY LEAD STUDY

	Environmental Variables				
	LOGPBW	LOGXRFMN	LOGCXI	LOGCXO	REFINISH
Environmental Variables					
LOGPBW	1.000				
LOGXRFMN	0.022	1.000			
LOGCXI	0.038	0.917	1.000		
LOGCXO	-0.016	0.333	0.477	1.000	
REFINISH	0.084	0.072	0.173	0.013	1.000
Household and Demographic Variables					
AIRCOND	0.059	-0.032	-0.083	-0.069	0.104
BLDCONIM	0.041	0.058	0.119	0.172	-0.139
CIGSDAY	-0.173	0.009	0.002	0.111	0.030
EDUCYRS	0.105	0.005	0.016	0.019	0.029
INCOME	-0.018	0.007	0.025	0.086	0.059
LOGDSTLD	-0.007	0.146	0.133	0.042	-0.015
LOGYRS	0.014	0.018	0.055	0.027	-0.008
NONWHITE	-0.053	-0.059	-0.065	-0.215	-0.097
NUMSMOKE	-0.023	0.060	0.027	0.067	0.056
RENT OWN	0.028	-0.064	-0.001	0.041	-0.018
USEDSLAG	-0.010	0.050	0.016	0.039	0.000
Individual and Behavioral Variables					
AGE	0.060	0.039	0.047	0.076	0.044
AGE2SQR	0.033	0.050	0.030	0.054	0.045
FOLK MED	0.026	-0.020	-0.030	-0.063	0.033
HRS HOME	-0.128	0.057	0.019	-0.012	0.054
MOUTHFR	-0.041	0.000	0.037	0.034	0.089
OUTPLHRS	-0.016	0.016	0.045	-0.003	0.054
EATPNTFR	0.057	0.022	0.013	-0.043	0.054
PLAYFLR	-0.031	0.013	0.046	0.093	0.005
SEX	0.037	-0.052	-0.074	-0.058	-0.040
SUCKTHUM	0.009	0.022	-0.017	-0.032	-0.012

	Household and Demographic Variables				
	AIRCOND	BLDCONIM	CIGSDAY	EDUCYRS	INCOME
Household and Demographic Variables					
AIRCOND	1.000				
BLDCONIM	-0.243	1.000			
CIGSDAY	-0.241	0.235	1.000		
EDUCYRS	0.375	-0.335	-0.339	1.000	

TABLE A1 (cont'd). PEARSON CORRELATION MATRIX FOR 31 VARIABLES IN MADISON COUNTY LEAD STUDY

	AIRCOND	BLDCONIM	CIGSDAY	EDUCYRS	INCOME
Household and Demographic Variables					
INCOME	0.250	-0.272	-0.201	0.357	1.000
LOGDSTLD	-0.215	0.298	0.117	-0.185	-0.257
LOGYRS	0.123	-0.064	-0.045	0.144	0.247
NONWHITE	-0.116	-0.106	-0.190	-0.114	-0.283
NUMSMOKE	-0.048	0.265	0.547	-0.223	-0.165
RENT OWN	-0.150	0.253	0.124	-0.273	-0.519
USEDSLAG	-0.072	0.024	-0.049	-0.070	-0.140
Individual and Behavioral Variables					
AGE	0.020	-0.001	0.061	-0.006	0.014
AGE2SQR	0.031	-0.020	0.013	-0.004	0.025
FOLK MED	-0.053	-0.034	0.032	0.000	0.048
HRS HOME	-0.053	0.029	0.073	-0.086	-0.136
MOUTHFR	-0.026	0.039	-0.019	0.037	-0.054
OUTPLHRS	-0.113	0.134	0.277	-0.115	-0.033
EATPNTFR	-0.050	-0.001	0.004	-0.041	-0.085
PLAYFLR	0.051	0.059	0.062	-0.003	-0.006
SEX	0.073	-0.024	-0.081	0.058	-0.020
SUCKTHUM	-0.049	0.083	0.080	-0.095	-0.089

	LOGDSTLD	LOGYRS	NONWHITE	NUMSMOKE	RENT OWN
LOGDSTLD	1.000				
LOGYRS	-0.010	1.000			
NONWHITE	0.155	-0.101	1.000		
NUMSMOKE	0.117	-0.008	-0.122	1.000	
RENT OWN	0.167	-0.372	0.177	0.171	1.000
USEDSLAG	0.046	-0.103	0.004	0.014	0.192
AGE	0.053	0.370	-0.021	0.028	-0.049
AGE2SQR	0.026	0.245	-0.026	0.016	-0.064
FOLK MED	-0.048	0.033	-0.142	-0.106	-0.103
HRS HOME	0.124	-0.083	-0.010	0.019	0.035
MOUTHFR	0.008	-0.270	-0.105	0.003	0.010
OUTPLHRS	0.124	0.224	-0.062	0.212	-0.004
EATPNTFR	-0.033	-0.030	-0.004	-0.009	0.046
PLAYFLR	0.001	-0.112	-0.146	0.100	0.081
SEX	-0.046	-0.034	0.057	-0.031	0.118
SUCKTHUM	0.053	0.080	0.067	0.039	0.050

TABLE A1 (cont'd). PEARSON CORRELATION MATRIX FOR 31 VARIABLES IN MADISON COUNTY LEAD STUDY

	Individual and Behavioral Variables				
	USEDSLAG	AGE	AGE2SQR	FOLK MED	HRS HOME
USEDSLAG	1.000				
Individual and Behavioral Variables					
AGE	-0.017	1.000			
AGE2SQR	-0.029	0.875	1.000		
FOLK_MED	-0.032	-0.002	-0.000	1.000	
HRS_HOME	0.036	-0.184	-0.159	-0.016	1.000
MOUTHFR	0.031	-0.496	-0.346	-0.065	0.064
OUTPLHRS	-0.031	0.420	0.285	0.011	-0.010
EATPNTFR	-0.054	-0.048	-0.049	0.005	-0.008
PLAYFLR	-0.055	-0.275	-0.282	0.050	0.201
SEX	0.060	-0.045	-0.051	-0.039	0.006
SUCKTHUM	-0.033	0.219	0.149	0.056	-0.064

	Individual and Behavioral Variables				
	MOUTHFR	OUTPLHRS	EATPNTFR	PLAYFLR	SEX
Individual and Behavioral Variables					
MOUTHFR	1.000				
OUTPLHRS	-0.197	1.000			
EATPNTFR	0.111	-0.036	1.000		
PLAYFLR	0.148	-0.170	0.063	1.000	
SEX	0.042	-0.071	-0.056	-0.069	1.000
SUCKTHUM	-0.190	0.131	0.027	-0.032	-0.079

	SUCKTHUM
SUCKTHUM	1.000

TABLE A2. FREQUENCY TABLE OF THE NUMBER OF NON-MISSING PAIRED OBSERVATIONS IN [redacted] CORRELATION MATRIX FOR THE MADISON COUNTY ENVIRONMENTAL LEAD STUDY.

	LOGPBB	LOGDIST	LOGPBD	LOGPBDL	LOGPBS
LOGPBB	490				
LOGDIST	479	479			
LOGPBD	470	460	470		
LOGPBDL	466	456	466	466	
LOGPBS	474	464	467	463	474
LOGPBW	470	460	463	459	467
LOGXRFMN	457	448	456	454	454
LOGCXI	471	461	470	466	468
LOGCXO	480	474	462	458	466
REFINISH	473	463	455	451	458
AIRCOND	489	479	470	466	474
BLDCONIM	490	479	470	466	474
CIGSDAY	482	472	464	462	468
EDUCYRS	487	477	468	464	472
INCOME	475	465	456	452	460
LOGDSTLD	466	456	466	466	463
LOGYRS	488	477	469	465	473
NONWHITE	485	474	465	461	469
NUMSMOKE	487	477	468	464	472
RENT OWN	472	463	453	449	457
USEDSLAG	467	458	449	445	453
AGE	490	479	470	466	474
AGE2SQR	490	479	470	466	474
FOLK MED	484	473	464	460	468
HRS HOME	490	479	470	466	474
MOUTHFR	487	476	467	463	471
OUTPLHRS	490	479	470	466	474
EATPNTFR	486	475	466	462	470
PLAYFLR	487	476	468	464	472
SEX	490	479	470	466	474
SUCKTHUM	490	479	470	466	474

	LOGPBW	LOGXRFMN	LOGCXI	LOGCXO	REFINISH
LOGPBW	470				
LOGXRFMN	450	457			
LOGCXI	464	457	471		
LOGCXO	462	449	463	480	
REFINISH	454	441	455	465	473
AIRCOND	470	457	471	480	473
BLDCONIM	470	457	471	480	473
CIGSDAY	464	453	465	473	467

TABLE A2 (cont'd). FREQUENCY TABLE OF THE NUMBER OF NON-MISSING PAIRED OBSERVATIONS IN THE CORRELATION MATRIX FOR THE MADISON COUNTY ENVIRONMENTAL LEAD STUDY.

	LOGPBW	LOGXRFMN	LOGCXI	LOGCXO	REFINISH
EDUCYRS	468	455	469	478	471
INCOME	456	443	457	466	459
LOGDSTLD	459	454	466	458	451
LOGYRS	469	456	470	478	471
NONWHITE	468	452	466	475	468
NUMSMOKE	468	455	469	478	471
RENT OWN	453	440	454	463	458
USEDSLAG	449	436	450	460	454
AGE	470	457	471	480	473
AGE2SQR	470	457	471	480	473
FOLK MED	464	451	465	474	467
HRS HOME	470	457	471	480	473
MOUTHFR	467	454	468	477	470
OUTPLHRS	470	457	471	480	473
EATPNTFR	467	453	467	476	469
PLAYFLR	468	455	469	478	470
SEX	470	457	471	480	473
SUCKTHUM	470	457	471	480	473

	AIRCOND	BLDCONIM	CIGSDAY	EDUCYRS	INCOME
AIRCOND	489				
BLDCONIM	489	490			
CIGSDAY	482	482	482		
EDUCYRS	487	487	480	487	
INCOME	475	475	468	473	475
LOGDSTLD	466	466	462	464	452
LOGYRS	487	488	480	485	473
NONWHITE	484	485	477	482	470
NUMSMOKE	487	487	480	485	475
RENT OWN	472	472	465	470	458
USEDSLAG	467	467	460	465	453
AGE	489	490	482	487	475
AGE2SQR	489	490	482	487	475
FOLK MED	483	484	476	481	470
HRS HOME	489	490	482	487	475
MOUTHFR	486	487	479	484	472
OUTPLHRS	489	490	482	487	475
EATPNTFR	485	486	478	483	471
PLAYFLR	486	487	479	484	473
SEX	489	490	482	487	475
SUCKTHUM	489	490	482	487	475

TABLE A2 (cont'd). FREQUENCY TABLE OF THE NUMBER OF NON-MISSING PAIRED OBSERVATIONS IN THE CORRELATION MATRIX FOR THE MADISON COUNTY ENVIRONMENTAL LEAD STUDY.

	LOGDSTLD	LOGYRS	NONWHITE	NUMSMOKE	RENT OWN
LOGDSTLD	466				
LOGYRS	465	488			
NONWHITE	461	483	485		
NUMSMOKE	464	485	482	487	
RENT OWN	449	470	467	470	472
USEDSLAG	445	465	462	465	452
AGE	466	488	485	487	472
AGE2SQR	466	488	485	487	472
FOLK MED	460	482	479	482	466
HRS HOME	466	488	485	487	472
MOUTHFR	463	485	482	484	469
OUTPLHRS	466	488	485	487	472
EATPNTFR	462	484	481	483	468
PLAYFLR	464	485	482	484	469
SEX	466	488	485	487	472
SUCKTHUM	466	488	485	487	472

	USEDSLAG	AGE	AGE2SQR	FOLK MED	HRS HOME
USEDSLAG	467				
AGE	467	490			
AGE2SQR	467	490	490		
FOLK MED	461	484	484	484	
HRS HOME	467	490	490	484	490
MOUTHFR	464	487	487	481	487
OUTPLHRS	467	490	490	484	490
EATPNTFR	463	486	486	480	486
PLAYFLR	465	487	487	481	487
SEX	467	490	490	484	490
SUCKTHUM	467	490	490	484	490

	MOUTHFR	OUTPLHRS	EATPNTFR	PLAYFLR	SEX
MOUTHFR	487				
OUTPLHRS	487	490			
EATPNTFR	484	486	486		
PLAYFLR	484	487	483	487	
SEX	487	490	486	487	490
SUCKTHUM	487	490	486	487	490

	SUCKTHUM
SUCKTHUM	490

TABLE A3. MATRIX OF SIGNIFICANCE LEVELS (PROBABILITIES) FOR VARIABLES IN THE MADISON COUNTY ENVIRONMENTAL LEAD STUDY

	LOGPBB	LOGDIST	LOGPBD	LOGPBDL	LOGPBS
Response Variable					
LOGPBB	0.000				
Location Variable					
LOGDIST	0.000	0.000			
Environmental Variables					
LOGPBD	0.000	0.000	0.000		
LOGPBDL	0.000	0.000	0.000	0.000	
LOGPBS	0.000	0.000	0.000	0.000	0.000
LOGPBW	0.069	0.915	0.615	0.807	0.064
LOGXRFMN	0.024	0.162	0.000	0.000	0.000
LOGCXI	0.000	0.816	0.000	0.000	0.000
LOGCXO	0.092	0.301	0.000	0.000	0.000
REFINISH	0.013	0.412	0.070	0.239	0.165
Household and Demographic Variables					
AIRCOND	0.000	0.000	0.000	0.000	0.001
BLDCONIM	0.000	0.000	0.000	0.000	0.000
CIGSDAY	0.000	0.000	0.020	0.001	0.000
EDUCYRS	0.000	0.001	0.093	0.000	0.013
INCOME	0.000	0.000	0.613	0.001	0.017
LOGDSTLD	0.000	0.276	0.021	0.000	0.000
LOGYRS	0.070	0.392	0.778	0.727	0.026
NONWHITE	0.019	0.000	0.000	0.142	0.000
NUMSMOKE	0.000	0.000	0.039	0.002	0.001
RENT OWN	0.000	0.012	0.015	0.000	0.000
USEDSLAG	0.932	0.244	0.421	0.952	0.047
Individual and Behavioral Variables					
AGE	0.384	0.378	0.252	0.135	0.176
AGE2SQR	0.008	0.423	0.325	0.291	0.165
FOLK MED	0.691	0.262	0.685	0.375	0.340
HRS HOME	0.016	0.223	0.863	0.087	0.834
MOUTHFR	0.512	0.472	0.807	0.781	0.674
OUTPLHRS	0.000	0.000	0.829	0.091	0.079
EATPNTFR	0.279	0.289	0.212	0.589	0.726
PLAYFLR	0.256	0.403	0.145	0.226	0.293
SEX	0.032	0.038	0.187	0.102	0.064
SUCKTHUM	0.127	0.001	0.565	0.815	0.134

TABLE A3 (cont'd). MATRIX OF SIGNIFICANCE LEVELS (PROBABILITIES) FOR VARIABLES IN THE [redacted]ADISON COUNTY ENVIRONMENTAL LEAD STUDY

[redacted]	LOGPBW	LOGXRFMN	LOGCXI	LOGCXO	REFINISH
Environmental [redacted]bles					
LOGPBW	0.000				
LOGXRFMN	0.642	0.000			
LOGCXI	0.411	0.000	0.000		
LOGCXO	0.732	0.000	0.000	0.000	
REFINISH	0.073	0.134	0.000	0.784	0.000
Household and Demographic Variables					
AIRCOND	0.205	0.495	0.073	0.130	0.024
BLDCONIM	0.372	0.218	0.010	0.000	0.003
CIGSDAY	0.000	0.851	0.962	0.015	0.522
EDUCYRS	0.023	0.921	0.734	0.684	0.535
INCOME	0.698	0.883	0.599	0.064	0.207
LOGDSTLD	0.884	0.002	0.004	0.365	0.757
LOGYRS	0.755	0.694	0.233	0.562	0.860
NONWHITE	0.255	0.209	0.160	0.000	0.037
NUMSMOKE	0.616	0.201	0.565	0.144	0.226
RENT OWN	0.551	0.177	0.978	0.374	0.700
USEDSLAG	0.839	0.302	0.743	0.400	1.000
Individual and Behavioral Variables					
AGE	0.191	0.411	0.305	0.098	0.337
AGE2SQR	0.476	0.286	0.511	0.236	0.332
FOLK MED	0.581	0.665	0.525	0.169	0.481
HRS HOME	0.006	0.227	0.679	0.789	0.243
MOUTHFR	0.378	1.000	0.423	0.456	0.054
OUTPLHRS	0.730	0.731	0.335	0.956	0.243
EATPNTFR	0.221	0.634	0.782	0.352	0.239
PLAYFLR	0.501	0.785	0.317	0.043	0.919
SEX	0.419	0.269	0.110	0.207	0.381
SUCKTHUM [redacted]	0.851	0.632	0.709	0.484	0.801

[redacted]	AIRCOND	BLDCONIM	CIGSDAY	EDUCYRS	INCOME
Household and Demographic Variables					
AIRCOND	0.000				
BLDCONIM	0.000	0.000			
CIGSDAY	0.000	0.000	0.000		
EDUCYRS	0.000	0.000	0.000	0.000	
INCOME	0.000	0.000	0.000	0.000	0.000
LOGDSTLD	0.000	0.000	0.012	0.000	0.000

TABLE A3 (cont'd). MATRIX OF SIGNIFICANCE LEVELS (PROBABILITIES) FOR VARIABLES IN THE MADISON COUNTY ENVIRONMENTAL LEAD STUDY

	AIRCOND	BLDCONIM	CIGSDAY	EDUCYRS	INCOME
LOGYRS	0.007	0.158	0.329	0.001	0.000
NONWHITE	0.011	0.020	0.000	0.012	0.000
NUMSMOKE	0.290	0.000	0.000	0.000	0.000
RENT OWN	0.001	0.000	0.008	0.000	0.000
USEDSLAG	0.122	0.610	0.293	0.130	0.003
Individual and Behavioral Variables					
AGE	0.654	0.983	0.183	0.892	0.753
AGE2SQR	0.494	0.655	0.773	0.934	0.582
FOLK MED	0.245	0.453	0.485	0.994	0.300
HRS HOME	0.240	0.518	0.111	0.057	0.003
MOUTHFR	0.566	0.394	0.682	0.417	0.243
OUTPLHRS	0.013	0.003	0.000	0.011	0.470
EATPNTFR	0.267	0.985	0.928	0.364	0.064
PLAYFLR	0.260	0.192	0.175	0.947	0.888
SEX	0.108	0.597	0.077	0.205	0.664
SUCKTHUM	0.282	0.066	0.079	0.037	0.054

	LOGDSTLD	LOGYRS	NONWHITE	NUMSMOKE	RENT OWN
Household and Demographic Variables					
LOGDSTLD	0.000				
LOGYRS	0.822	0.000			
NONWHITE	0.001	0.026	0.000		
NUMSMOKE	0.011	0.852	0.007	0.000	
RENT OWN	0.000	0.000	0.000	0.000	0.000
USEDSLAG	0.329	0.026	0.929	0.756	0.000
Individual and Behavioral Variables					
AGE	0.256	0.000	0.650	0.536	0.289
AGE2SQR	0.569	0.000	0.568	0.719	0.163
FOLK MED	0.308	0.465	0.002	0.020	0.026
HRS HOME	0.007	0.066	0.820	0.680	0.442
MOUTHFR	0.856	0.000	0.022	0.942	0.833
OUTPLHRS	0.007	0.000	0.170	0.000	0.937
EATPNTFR	0.479	0.508	0.926	0.839	0.324
PLAYFLR	0.979	0.014	0.001	0.027	0.081
SEX	0.323	0.453	0.213	0.489	0.010
SUCKTHUM	0.249	0.078	0.139	0.393	0.276

TABLE A3 (cont'd). MATRIX OF SIGNIFICANCE LEVELS (PROBABILITIES) FOR VARIABLES IN THE MADISON COUNTY ENVIRONMENTAL LEAD STUDY

	USEDSLAG	AGE	AGE2SQR	FOLK MED	HRS HOME
USEDSLAG	0.000				
AGE	0.711	0.000			
AGE2SQR	0.526	0.000	0.000		
FOLK MED	0.487	0.972	0.996	0.000	
HRS HOME	0.435	0.000	0.000	0.718	0.000
MOUTHFR	0.509	0.000	0.000	0.156	0.159
OUTPLHRS	0.499	0.000	0.000	0.818	0.830
EATPNTFR	0.246	0.290	0.282	0.905	0.869
PLAYFLR	0.240	0.000	0.000	0.272	0.000
SEX	0.197	0.322	0.263	0.387	0.898
SUCKTHUM	0.472	0.000	0.001	0.222	0.158

	MOUTHFR	OUTPLHRS	EATPNTFR	PLAYFLR	SEX
MOUTHFR	0.000				
OUTPLHRS	0.000	0.000			
EATPNTFR	0.014	0.428	0.000		
PLAYFLR	0.001	0.000	0.164	0.000	
SEX	0.351	0.115	0.217	0.127	0.000
SUCKTHUM	0.000	0.004	0.556	0.476	0.082

	SUCKTHUM
SUCKTHUM	0.000

TECHNICAL APPENDIX B

Confounding: Identification, Analysis, Remedies

1. Identification of Confounding

According to Stellman (1987), confounding is the "cause of great angst among epidemiologists". This term refers to the incorrect assignment of a response (such as elevated blood lead concentration) to a given agent when in fact a third variable (the confounder) is responsible. A confounder must therefore be correlated with the effect or response variable, and must also be so strongly correlated with the nominal causal agent as to mask its effect on the response. It is also important that the confounder is not an intermediate step in the causal path between exposure and response or outcome (Rothman 1986). This last requirement turns out to be the critical issue in modelling lead exposure for Madison County children. However (Stellman 1987, p. 165), writes that "Rarely, however, does confounding itself, especially from unidentified sources, live up to its reputation by introducing seriously spurious associations." U.S. EPA's first goal is to identify whether confounding is a possibility in these data.

A more serious concern is "overcontrol", which occurs when a large number of non-pollution variables are used in a statistical model in order to explain the observed response with anything except the nominal causal agent. This can be done unconsciously, when an investigator who has little understanding of the substantive issues in environmental exposure to a pollutant throws in every variable that has been measured, including all possible demographic and behavioral variables and their combinations and interactions, hoping that the truth will come out at the end of a complicated multivariate analysis. Whether done deliberately or not, the consequence of an unguided search for predictive relationships is to obscure true relationships with environmental pollutants. Unfortunately, the uninformed use of sophisticated computer programs, such as those for stepwise regression modelling, makes it easy to carry out an unguided search. U.S. EPA's second goal in this section is to devise strategies for modelling the relationship of environmental lead to blood lead.

Identification of potential confounding in linear regression models (which will be used exclusively here, as in the IDPH report, but with two alternative specifications) is easily

between soil lead and dust lead as to prevent estimation of separate contributions to blood lead.

It is [redacted] to recall here that Rothman (1986) excludes from confounding those variables that characterize a causal pathway relationship between the nominal causal agent and the response. Precisely this situation exists for soil lead, dust lead, and child blood lead, with the confounder (dust lead) occupying an intermediate place between soil lead and blood lead. This is discussed further in Section 6.

[redacted]

TABLE B-1. CONFOUNDERS AND COVARIATES OF THE RELATIONSHIP BETWEEN LOG BLOOD LEAD AND LOG SOIL LEAD

TABLE B-1A. STRONG CONFOUNDERS

VARIABLE	CORREL. LOGPBB	P	RANK OF CORREL.	CORREL. LOGPBS	P	RANK OF CORREL.
LOGPBDL	0.425	0.000	1	0.433	0.000	3
LOGDSTLD	0.332	0.000	2	0.174	0.000	10
BLDCONIM	0.311	0.000	3	0.180	0.000	9
LOGPBD	0.307	0.000	4	0.440	0.000	2
AIRCOND	-0.267	0.000	6	-0.149	0.001	13
LOGDIST	-0.257	0.000	8	-0.522	0.000	1
LOGPBS	0.249	0.000	9	1.000	---	---
CIGSDAY	0.229	0.000	10	0.168	0.000	11
RENT OWN	0.222	0.000	12	0.198	0.000	7
LOGCXI	0.163	0.000	13	0.337	0.000	4
NUMSMOKE	0.161	0.000	14	0.158	0.001	12

TABLE B-1B. WEAK CONFOUNDERS

VARIABLE	CORREL. LOGPBB	P	RANK OF CORREL.	CORREL. LOGPBS	P	RANK OF CORREL.
EDUCYRS	-0.292	0.000	5	-0.114	0.013	14
INCOME	-0.258	0.000	7	-0.112	0.017	15
NONWHITE	0.107	0.019	18	-0.183	0.000	8
LOGXRFMN	0.105	0.024	19	0.295	0.000	5

TABLE B1-C. COVARIATES OF LOG BLOOD LEAD

VARIABLE	CORREL. LOGPBB	P	RANK OF CORREL.	CORREL. LOGPBS	P	RANK OF CORREL.
OUTPLHRS	0.229	0.000	11	0.081	0.079	19
AGE2SQR	-0.120	0.008	15	0.064	0.165	21
REFINISH	0.114	0.013	16	0.065	0.165	20
HRS HOME	0.109	0.016	17	-0.010	0.834	22
SEX	-0.097	0.032	20	-0.085	0.064	18

BLE B1-D. COVARIATES OF LOG SOIL LEAD

VARIABLE	CORREL. LOGPBB	P	RANK OF CORREL.	CORREL. LOGPBS	P	RANK OF CORREL.
LOGCXO	0.077	0.092	22	0.278	0.000	6
LOGYRS	-0.082	0.070	21	-0.102	0.026	16
USEDSLAG	-0.004	0.932	23	0.093	0.047	17

TABLE B-2. LATENT ROOTS (EIGENVALUES) OF PREDICTOR VARIABLE PRINCIPAL COMPONENTS

[redacted]K	1	2	3	4	5
	4.002	3.025	2.656	1.779	1.435
RANK	6	7	8	9	10
	1.404	1.317	1.155	1.131	1.041
RANK	11	12	13	14	15
	1.004	0.931	0.913	0.881	0.829
RANK	16	17	18	19	20
	0.799	0.732	0.680	0.633	0.588
RANK	21	22	23	24	25
	0.567	0.524	0.465	0.414	0.350
RANK	26	27	28	29	30
	0.308	0.282	0.087	0.067	0.0000001

[redacted]

ATTACHMENT 4

STATISTICAL ANALYSES OF DATA FROM THE MADISON COUNTY LEAD STUDY AND IMPLICATIONS FOR REMEDIATION OF LEAD-CONTAMINATED SOIL

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TECHNICAL APPENDIX C

IEUB[redacted]RAMETER SAVE FILES FOR MODEL SENSITIVITY RUNS

GCFI2900.sv3[redacted]

soil-to-dust co[redacted]nt = 0.29

Lead paint chip absorption = 0 percent

0.100 2.0 32.0 1.0
0.100 3.0 32.0 2.0
0.100 5.0 32.0 3.0
0.100 5.0 32.0 4.0
0.100 5.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 0 0 30.0
5.53 50.0
5.78 50.0
6.49 50.0
6.24 50.0
6.01 50.0
6.34 50.0
7.00 50.0
0 0.000 0.000 0.000 0.000
0.0 0.0 0.0 0.0
0.20 50.0
0.50 50.0
0.52 50.0
0.53 50.0
0.55 50.0
0.58 50.0
0.59 50.0
0 4.00 1.00 4.00 10.00
50.0 15.0
0.0 0.0 0.085 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135[redacted]0.0
0.0 0.0 0.135[redacted]0.0
0.0 0.0 0.100[redacted]0.0
0.0 0.0 0.090 30.0 30.0
0.0 0.0 0.085 30.0 30.0
0 0 0
45.0 0.29 100.0 200.0 200.0
1200.0 200.0 200.0 200.0 1200.0
0.0 0.0 0.0 0.0 0.0
0.00 30.0
0.00 30.0

0.00 30.0
0.00 30.0
0.00 30.0
0.00 30.0
0.00 30.0
1.600000 10.000000
0.100 0.333
20.000 0.333
10.000 0.333
10.000 0.333
10.000 0.333
1.000 0.333
100.000 0.333
0.750 0.333
0.750 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
1.00 1.00 1.00 1.00 1.00
0.30 0.30 0.50 0.00 0.50
0.20 0.20 0.20 0.20 0.20
1.0 1.0 1.0 1.0 1.0
9.0 1.0 6.0 0.060 0.200 0.060
1.0 1.0 1.0 1.0
9.00 9.00 2.0 0.0
10.0 10.0 10.0 50.0
0.020 200.0 1000.0 0.10
0.00 0.00 30.0 0

GCFI3800.sv3
soil-to-dust coefficient = 0.385
Lead paint ch[illegible]orption = 0 percent

0.100 2.0 32[illegible]
0.100 3.0 32.0 2.0
0.100 5.0 32.0 3.0
0.100 5.0 32.0 4.0
0.100 5.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 7.0 32.0 4.0

0.100 0 0 30.0
5.53 50.0
5.78 50.0
6.49 50.0
6.24 50.0
6.01 50.0
6.34 50.0
7.00 50.0
0 0.000 0.000 0.000 0.000
0.0 0.0 0.0 0.0
0.20 50.0
0.50 50.0
0.52 50.0
0.53 50.0
0.55 50.0
0.58 50.0
0.59 50.0
0 4.00 1.00 4.00 10.00
50.0 15.0
0.0 0.0 0.085 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.100 30.0 30.0
0.0 0.0 0.090 30.0 30.0
0.0 0.0 0.085 30.0 30.0
0 0 0
45.0 0.38 100.0 200.0 200.0
1200.0 200.0 200.0 200.0 1200.0
0.0 0.0 0.0 0.0 0.0
0.00 30.0
0.00 30.0
0.00 30.0
0.00 30.0
0.00 30.0
0.00 30.0
0.00 30.0
1.600000 10.[illegible]
0.100 0.333
20.000 0.333
10.000 0.333
10.000 0.333
10.000 0.333
1.000 0.333

100.000 0.333
0.750 0.333
0.750 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
1.00 1.00 1.00 1.00 1.00
0.30 0.30 0.50 0.00 0.50
0.20 0.20 0.20 0.20 0.20
1.0 1.0 1.0 1.0 1.0
9.0 1.0 6.0 0.060 0.200 0.060
1.0 1.0 1.0 1.0
9.00 9.00 2.0 0.0
10.0 10.0 10.0 50.0
0.020 200.0 1000.0 0.10
0.00 0.00 30.0 0

GCFI5500.sv3
soil-to-dust coefficient = 0.55
Lead paint chip absorption = 0 percent

0.100 2.0 32.0 1.0
0.100 3.0 32.0 2.0
0.100 5.0 32.0 3.0
0.100 5.0 32.0 4.0
0.100 5.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 0 0 30.0
5.53 50.0
5.78 50.0
6.49 50.0
6.24 50.0
6.01 50.0
6.34 50.0
7.00 50.0
0 0.000 0.000 0.000 0.000
0.0 0.0 0.0 0.0

0.20 50.0
0.50 50.0
0.52 50.0
0.53 50.0
0.55 50.0
0.58 50.0
0.59 50.0
0 4.00 1.00 4.00 10.00
50.0 15.0
0.0 0.0 0.085 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.100 30.0 30.0
0.0 0.0 0.090 30.0 30.0
0.0 0.0 0.085 30.0 30.0
0 0 0
45.0 0.55 100.0 200.0 200.0
1200.0 200.0 200.0 200.0 1200.0
0.0 0.0 0.0 0.0 0.0
0.00 30.0
0.00 30.0
0.00 30.0
0.00 30.0
0.00 30.0
0.00 30.0
0.00 30.0
1.600000 10.000000
0.100 0.333
20.000 0.333
10.000 0.333
10.000 0.333
10.000 0.333
1.000 0.333
100.000 0.333
0.750 0.333
0.750 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
1.00 1.00 1.00 1.00 1.00

0.30 0.30 0.50 0.00 0.50
0.20 0.20 0.20 0.20 0.20
1.0 1.0 1.0 1.0
9.0 1.0 6.0 0.0 200 0.060
1.0 1.0 1.0 1.0
9.00 9.00 2.0 0.0
10.0 10.0 10.0 50.0
0.020 200.0 1000.0 0.10
0.00 0.00 30.0 0

GCFI7000.sv3
soil-to-dust coefficient = 0.70
Lead paint chip absorption = 0 percent

0.100 2.0 32.0 1.0
0.100 3.0 32.0 2.0
0.100 5.0 32.0 3.0
0.100 5.0 32.0 4.0
0.100 5.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 0 0 30.0
5.53 50.0
5.78 50.0
6.49 50.0
6.24 50.0
6.01 50.0
6.34 50.0
7.00 50.0
0 0.000 0.000 0.000 0.000
0.0 0.0 0.0 0.0
0.20 50.0
0.50 50.0
0.52 50.0
0.53 50.0
0.55 50.0
0.58 50.0
0.59 50.0
0 4.00 1.00 4.00 10.00
50.0 15.0
0.0 0.0 0.085 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0

0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.100 30.0 30.0
0.0 0.0 0.090 [redacted] 30.0
0.0 0.0 0.085 [redacted] 30.0
0 0 0 [redacted]
45.0 0.70 100.0 200.0 200.0
1200.0 200.0 200.0 200.0 1200.0
0.0 0.0 0.0 0.0 0.0
0.00 30.0
0.00 30.0
0.00 30.0
0.00 30.0
0.00 30.0
0.00 30.0
0.00 30.0
1.600000 10.000000
0.100 0.333
20.000 0.333
10.000 0.333
10.000 0.333
10.000 0.333
1.000 0.333
100.000 0.333
0.750 0.333
0.750 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
1.00 1.00 1.00 1.00 1.00
0.30 0.30 0.50 0.00 0.50
0.20 0.20 0.20 0.20 0.20
1.0 1.0 1.0 1.0 1.0
9.0 1.0 6.0 0 [redacted] 200 0.060
1.0 1.0 1.0 1 [redacted]
9.00 9.00 2.0 [redacted]
10.0 10.0 10.0 50.0
0.020 200.0 1000.0 0.10
0.00 0.00 30.0 0

GCFI2901.sv3

soil-to-dust coefficient = 0.29
Lead paint chip absorption = 1 percent

0.100 2.0 32.0 [redacted]
0.100 3.0 32.0 [redacted]
0.100 5.0 32.0 3.0
0.100 5.0 32.0 4.0
0.100 5.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 0 0 30.0
5.53 50.0
5.78 50.0
6.49 50.0
6.24 50.0
6.01 50.0
6.34 50.0
7.00 50.0
0 0.000 0.000 0.000 0.000
0.0 0.0 0.0 0.0
0.20 50.0
0.50 50.0
0.52 50.0
0.53 50.0
0.55 50.0
0.58 50.0
0.59 50.0
0 4.00 1.00 4.00 10.00
50.0 15.0
0.0 0.0 0.085 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.100 30.0 30.0
0.0 0.0 0.090 30.0 30.0
0.0 0.0 0.085 [redacted] 0.0
0 0 0 [redacted]
45.0 0.29 10[redacted]0 200.0
1200.0 200.0 200.0 200.0 1200.0
0.0 0.0 0.0 0.0 0.0
240.00 30.0
400.00 30.0
400.00 30.0
400.00 30.0

300.00 30.0
270.00 30.0
240.00 30.0
1.600000 10.6[illegible]0
0.100 0.333 [illegible]
20.000 0.333
10.000 0.333
10.000 0.333
10.000 0.333
1.000 0.333
100.000 0.333
0.750 0.333
0.750 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
1.00 1.00 1.00 1.00 1.00
0.30 0.30 0.50 0.01 0.50
0.20 0.20 0.20 0.20 0.20
1.0 1.0 1.0 1.0 1.0
9.0 1.0 6.0 0.060 0.200 0.060
1.0 1.0 1.0 1.0
9.00 9.00 2.0 0.0
10.0 10.0 10.0 50.0
0.020 200.0 1000.0 0.10
0.00 0.00 30.0 0

GCFI3801.sv3
soil-to-dust coefficient = 0.385
Lead paint chip absorption = 1 percent

0.100 2.0 32.[illegible]
0.100 3.0 32.[illegible]
0.100 5.0 32.0 3.0
0.100 5.0 32.0 4.0
0.100 5.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 0 0 30.0

5.53 50.0
5.78 50.0
6.49 50.0
6.24 50.0
6.01 50.0
6.34 50.0
7.00 50.0
0 0.000 0.000 0.000 0.000
0.0 0.0 0.0 0.0
0.20 50.0
0.50 50.0
0.52 50.0
0.53 50.0
0.55 50.0
0.58 50.0
0.59 50.0
0 4.00 1.00 4.00 10.00
50.0 15.0
0.0 0.0 0.085 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.100 30.0 30.0
0.0 0.0 0.090 30.0 30.0
0.0 0.0 0.085 30.0 30.0
0 0 0
45.0 0.38 100.0 200.0 200.0
1200.0 200.0 200.0 200.0 1200.0
0.0 0.0 0.0 0.0 0.0
240.00 30.0
400.00 30.0
400.00 30.0
400.00 30.0
300.00 30.0
270.00 30.0
240.00 30.0
1.600000 10.6
0.100 0.333
20.000 0.333
10.000 0.333
10.000 0.333
10.000 0.333
1.000 0.333
100.000 0.333

0.750 0.333
0.750 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
1.00 1.00 1.00 1.00 1.00
0.30 0.30 0.50 0.01 0.50
0.20 0.20 0.20 0.20 0.20
1.0 1.0 1.0 1.0 1.0
9.0 1.0 6.0 0.060 0.200 0.060
1.0 1.0 1.0 1.0
9.00 9.00 2.0 0.0
10.0 10.0 10.0 50.0
0.020 200.0 1000.0 0.10
0.00 0.00 30.0 0

GCFI5501.sv3
soil-to-dust coefficient = 0.55
Lead paint chip absorption = 1 percent

0.100 2.0 32.0 1.0
0.100 3.0 32.0 2.0
0.100 5.0 32.0 3.0
0.100 5.0 32.0 4.0
0.100 5.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 0 0 30.0
5.53 50.0
5.78 50.0
6.49 50.0
6.24 50.0
6.01 50.0
6.34 50.0
7.00 50.0
0 0.000 0.000 0.000 0.000
0.0 0.0 0.0 0.0
0.20 50.0
0.50 50.0

0.52 50.0
0.53 50.0
0.55 50.0
0.58 50.0
0.59 50.0
0 4.00 1.00 4.00 10.00
50.0 15.0
0.0 0.0 0.085 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.100 30.0 30.0
0.0 0.0 0.090 30.0 30.0
0.0 0.0 0.085 30.0 30.0
0 0 0
45.0 0.55 100.0 200.0 200.0
1200.0 200.0 200.0 200.0 1200.0
0.0 0.0 0.0 0.0 0.0
240.00 30.0
400.00 30.0
400.00 30.0
400.00 30.0
300.00 30.0
270.00 30.0
240.00 30.0
1.600000 10.000000
0.100 0.333
20.000 0.333
10.000 0.333
10.000 0.333
10.000 0.333
1.000 0.333
100.000 0.333
0.750 0.333
0.750 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
1.00 1.00 1.00 1.00 1.00
0.30 0.30 0.50 0.01 0.50
0.20 0.20 0.20 0.20 0.20

1.0 1.0 1.0 1.0 1.0
9.0 1.0 6.0 0.060 0.200 0.060
1.0 1.0 1.0 1.0[illegible]
9.00 9.00 2.0 [illegible]
10.0 10.0 10.0[illegible]
0.020 200.0 1000.0 0.10
0.00 0.00 30.0 0

GCFI7001.sv3
soil-to-dust coefficient = 0.70
Lead paint chip absorption = 1 percent

0.100 2.0 32.0 1.0
0.100 3.0 32.0 2.0
0.100 5.0 32.0 3.0
0.100 5.0 32.0 4.0
0.100 5.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 0 0 30.0
5.53 50.0
5.78 50.0
6.49 50.0
6.24 50.0
6.01 50.0
6.34 50.0
7.00 50.0
0 0.000 0.000 0.000 0.000
0.0 0.0 0.0 0.0
0.20 50.0
0.50 50.0
0.52 50.0
0.53 50.0
0.55 50.0
0.58 50.0
0.59 50.0
0 4.00 1.00 4[illegible]00
50.0 15.0
0.0 0.0 0.085 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.100 30.0 30.0

0.0 0.0 0.090 30.0 30.0
0.0 0.0 0.085 30.0 30.0
0 0 0
45.0 0.70 100[illegible].0 200.0
1200.0 200.0 [illegible] 200.0 1200.0
0.0 0.0 0.0 0.0 0.0
240.00 30.0
400.00 30.0
400.00 30.0
400.00 30.0
300.00 30.0
270.00 30.0
240.00 30.0
1.600000 10.000000
0.100 0.333
20.000 0.333
10.000 0.333
10.000 0.333
10.000 0.333
1.000 0.333
100.000 0.333
0.750 0.333
0.750 0.333
0.000 0.333

GCFI2902.sv3
soil-to-dust coefficient = 0.29
Lead paint chip absorption = 2 percent

0.100 2.0 32.0 1.0
0.100 3.0 32.0 2.0
0.100 5.0 32.0 3.0
0.100 5.0 32.0 4.0
0.100 5.0 32.0 4.0
0.100 7.0 32[illegible]
0.100 7.0 32[illegible]
0.100 0 0 30[illegible]
5.53 50.0
5.78 50.0
6.49 50.0
6.24 50.0
6.01 50.0
6.34 50.0

7.00 50.0
0 0.000 0.000 0.000 0.000
0.0 0.0 0.0 0.0
0.20 50.0
0.50 50.0
0.52 50.0
0.53 50.0
0.55 50.0
0.58 50.0
0.59 50.0
0 4.00 1.00 4.00 10.00
50.0 15.0
0.0 0.0 0.085 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.100 30.0 30.0
0.0 0.0 0.090 30.0 30.0
0.0 0.0 0.085 30.0 30.0
0 0 0
45.0 0.29 100.0 200.0 200.0
1200.0 200.0 200.0 200.0 1200.0
0.0 0.0 0.0 0.0 0.0
240.00 30.0
400.00 30.0
400.00 30.0
400.00 30.0
300.00 30.0
270.00 30.0
240.00 30.0
1.600000 10.000000
0.100 0.333
20.000 0.333
10.000 0.333
10.000 0.333
10.000 0.333
1.000 0.333
100.000 0.333
0.750 0.333
0.750 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333

0.000 0.333
0.000 0.333
1.00 1.00 1.00 [illegible] 1.00
0.30 0.30 0.50 [illegible] 0.50
0.20 0.20 0.20 [illegible] 0.20
1.0 1.0 1.0 1.0 1.0
9.0 1.0 6.0 0.060 0.200 0.060
1.0 1.0 1.0 1.0
9.00 9.00 2.0 0.0
10.0 10.0 10.0 50.0
0.020 200.0 1000.0 0.10
0.00 0.00 30.0 0

GCFI3802.sv3
soil-to-dust coefficient = 0.385
Lead paint chip absorption = 2 percent

0.100 2.0 32.0 1.0
0.100 3.0 32.0 2.0
0.100 5.0 32.0 3.0
0.100 5.0 32.0 4.0
0.100 5.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 0 0 30.0
5.53 50.0
5.78 50.0
6.49 50.0
6.24 50.0
6.01 50.0
6.34 50.0
7.00 50.0
0 0.000 0.000 0.000 0.000
0.0 0.0 0.0 0.0
0.20 50.0
0.50 50.0
0.52 50.0
0.53 50.0
0.55 50.0
0.58 50.0
0.59 50.0
0 4.00 1.00 4.00 10.00
50.0 15.0
0.0 0.0 0.085 30.0 30.0

0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 [redacted] 30.0
0.0 0.0 0.100 [redacted] 30.0
0.0 0.0 0.090 [redacted] 30.0
0.0 0.0 0.085 30.0 30.0
0 0 0
45.0 0.38 100.0 200.0 200.0
1200.0 200.0 200.0 200.0 1200.0
0.0 0.0 0.0 0.0 0.0
240.00 30.0
400.00 30.0
400.00 30.0
400.00 30.0
300.00 30.0
270.00 30.0
240.00 30.0
1.600000 10.000000
0.100 0.333
20.000 0.333
10.000 0.333
10.000 0.333
10.000 0.333
1.000 0.333
100.000 0.333
0.750 0.333
0.750 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
1.00 1.00 1.00 1.00 1.00
0.30 0.30 0.50 0.02 0.50
0.20 0.20 0.2 [redacted] 0.20
1.0 1.0 1.0 1 [redacted]
9.0 1.0 6.0 6 [redacted] 200 0.060
1.0 1.0 1.0 1.0
9.00 9.00 2.0 0.0
10.0 10.0 10.0 50.0
0.020 200.0 1000.0 0.10
0.00 0.00 30.0 0

GCFI5502.sv3
soil-to-dust coefficient = 0.55
Lead paint chi[redacted]rption = 2 percent

0.100 2.0 32.0 [redacted]
0.100 3.0 32.0 2.0
0.100 5.0 32.0 3.0
0.100 5.0 32.0 4.0
0.100 5.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 0 0 30.0
5.53 50.0
5.78 50.0
6.49 50.0
6.24 50.0
6.01 50.0
6.34 50.0
7.00 50.0
0 0.000 0.000 0.000 0.000
0.0 0.0 0.0 0.0
0.20 50:0
0.50 50.0
0.52 50.0
0.53 50.0
0.55 50.0
0.58 50.0
0.59 50.0
0 4.00 1.00 4.00 10.00
50.0 15.0
0.0 0.0 0.085 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.100 [redacted] 30.0
0.0 0.0 0.090 [redacted] 30.0
0.0 0.0 0.085 [redacted] 30.0
0 0 0 [redacted]
45.0 0.55 100.0 200.0 200.0
1200.0 200.0 200.0 200.0 1200.0
0.0 0.0 0.0 0.0 0.0
240.00 30.0
400.00 30.0
400.00 30.0

400.00 30.0
300.00 30.0
270.00 30.0
240.00 30.0
1.600000 10.000000
0.100 0.333
20.000 0.333
10.000 0.333
10.000 0.333
10.000 0.333
1.000 0.333
100.000 0.333
0.750 0.333
0.750 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
1.00 1.00 1.00 1.00 1.00
0.30 0.30 0.50 0.02 0.50
0.20 0.20 0.20 0.20 0.20
1.0 1.0 1.0 1.0 1.0
9.0 1.0 6.0 0.060 0.200 0.060
1.0 1.0 1.0 1.0
9.00 9.00 2.0 0.0
10.0 10.0 10.0 50.0
0.020 200.0 1000.0 0.10
0.00 0.00 30.0 0

GCFI7002.sv3
soil-to-dust coefficient = 0.70
Lead paint chip absorption = 2 percent

0.100 2.0 32.0 [illegible]
0.100 3.0 32.0 [illegible]
0.100 5.0 32.0 5.0
0.100 5.0 32.0 4.0
0.100 5.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 7.0 32.0 4.0
0.100 0 0 30.0
5.53 50.0

5.78 50.0
6.49 50.0
6.24 50.0
6.01 50.0
6.34 50.0
7.00 50.0
0 0.000 0.000 0.000 0.000
0.0 0.0 0.0 0.0
0.20 50.0
0.50 50.0
0.52 50.0
0.53 50.0
0.55 50.0
0.58 50.0
0.59 50.0
0 4.00 1.00 4.00 10.00
50.0 15.0
0.0 0.0 0.085 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.135 30.0 30.0
0.0 0.0 0.100 30.0 30.0
0.0 0.0 0.090 30.0 30.0
0.0 0.0 0.085 30.0 30.0
0 0 0
45.0 0.70 100.0 200.0 200.0
1200.0 200.0 200.0 200.0 1200.0
0.0 0.0 0.0 0.0 0.0
240.00 30.0
400.00 30.0
400.00 30.0
400.00 30.0
300.00 30.0
270.00 30.0
240.00 30.0
1.600000 10.0000
0.100 0.333
20.000 0.333
10.000 0.333
10.000 0.333
10.000 0.333
1.000 0.333
100.000 0.333
0.750 0.333

0.750 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
0.000 0.333
1.00 1.00 1.00 1.00 1.00
0.30 0.30 0.50 0.02 0.50
0.20 0.20 0.20 0.20 0.20
1.0 1.0 1.0 1.0 1.0
9.0 1.0 6.0 0.060 0.200 0.060
1.0 1.0 1.0 1.0
9.00 9.00 2.0 0.0
10.0 10.0 10.0 50.0
0.020 200.0 1000.0 0.10
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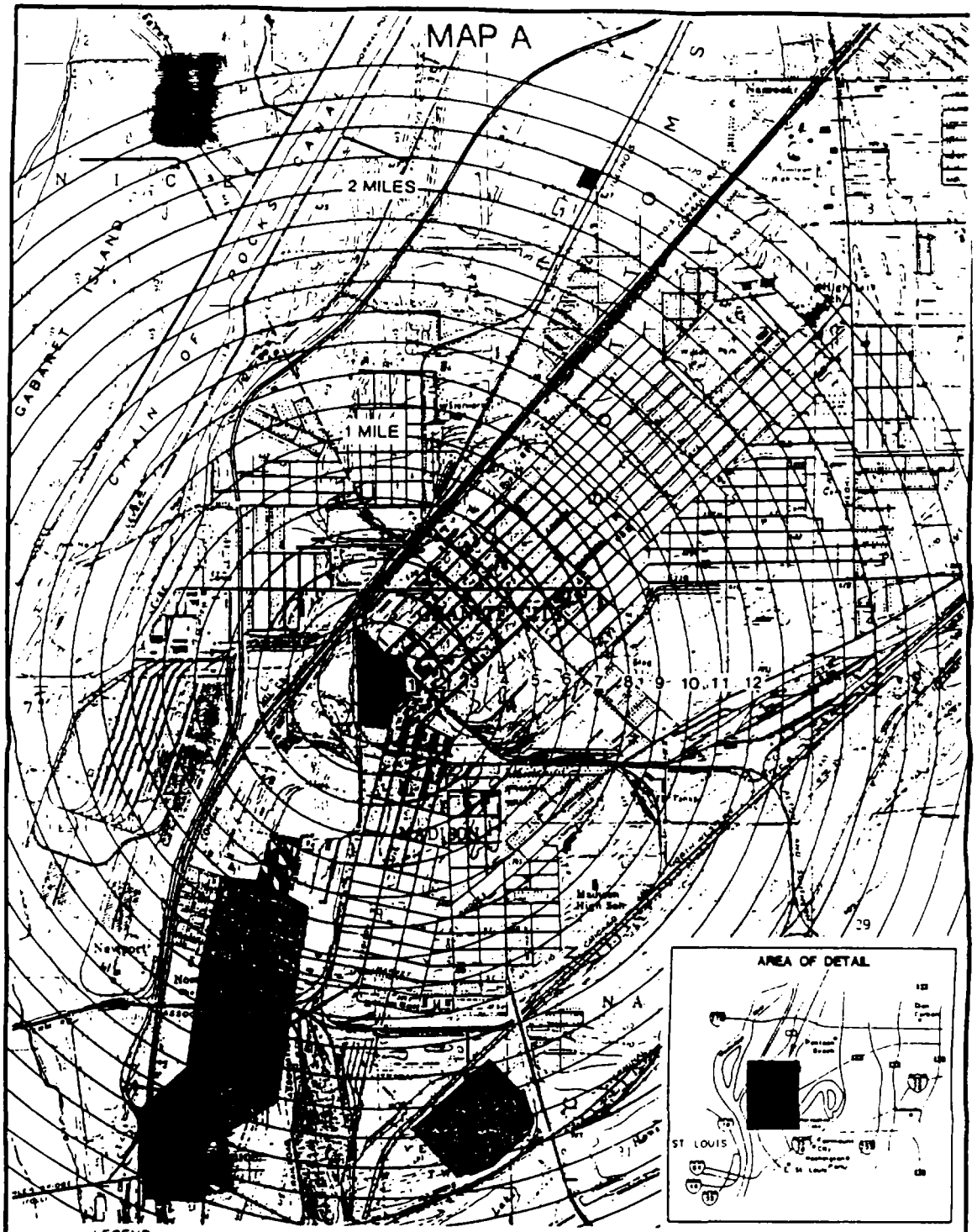

LEGEND

- REMOTE FILL AREAS
- INDUSTRIAL AREAS
- RESIDENTIAL AREAS
- 1. NUMERALS DENOTE RING NUMBERS

SPACING BETWEEN CIRCLES IS 1/8 OF A MILE

0 2000 4000
SCALE FEET

NOTE: Drawing taken from U.S.G.S. – Granite City, IL-MO and Monks Mound, IL Quadrangles dated 1982 & 1974.

NL/TARACORP SUPERFUND SITE SUPPLEMENTAL INVESTIGATION	PROJECT NO C3M11Q
Woodward-Clyde Consultants	
DRN BY kdw 7/23/93 DSGN BY CHKD BY	Site Plan South FIG NO 1-2

EX. H

59TH OPINION of Level 1 printed in FULL format.

UNITED STATES OF AMERICA, Plaintiff, v. OLIN CORPORATION, Defendant.

CIVIL ACTION NO. 95-0526-BH-S

U[redacted] STATES DISTRICT COURT FOR THE SOUTHERN DISTRICT OF ALABAMA, SOUTHERN DIVISION

1996 U.S. Dist. LEXIS 6996

May 20, 1996, Decided
May 20, 1996, FILED

DISPOSITION: [*1] Motion DENIED. Action DISMISSED with prejudice.

COUNSEL: For USA, acting at request of the Administrator of the United States Environmental Protection Agency (EPA), plaintiff: Eugene A. Seidel, Esq., U. S. Attorney's Office, Mobile, AL. Kathy Urbach, Assistant Regional Counsel, Environmental Protection Agency, Atlanta, GA. Robert A. Kaplan, Environmental Enforcement Section, U. S. Dept. of Justice, Washington, DC. Cheryl L. Smout, U. S. Dept. of Justice, Environmental Enforcement Section, Washington, DC. Robert R. Homiak, U. S. Dept. of Justice, Environmental Enforcement Section, Environment & Natural Resources Div., Washington, DC.

For OLIN CORPORATION, defendant: T. Bruce McGowin, Esq., Mobile, AL. Caine O'Rear, III, Esq., Mobile, AL. Arthur A. Rheingold, Chief Counsel, Olin Corporation, Stamford, CT. Michael W. Steinberg, Morgan, Lewis & Bockius LLP, Washington, DC. Alex S. Karlin, Morgan, Lewis & Bockius LLP, Washington, DC.

JUDGES: W B Hand, SENIOR DISTRICT JUDGE. Mag. Judge William H. Steele

OPINIONBY: W B Hand

OPINION: ORDER

The United States filed this action under the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA"), 42 U.S.C. §§ 9601, et seq., [*2] against defendant Olin Corporation ("Olin"), a Virginia corporation which owns and operates a chemical plant in McIntosh, Alabama, in southwest Wa[redacted]ton County, approximately 25 miles east of the Mississippi state line [redacted] miles north of the Gulf of Mexico. With the complaint, the parties fil[redacted]roposed consent degree. This court requested the parties to brief certa[redacted]utory and constitutional issues relating to CERCLA. For the reasons stated below, this court has determined that rather than signing the consent decree, it must dismiss the action both because 1) Congress did not clearly express its intent that the liability provision of CERCLA be retroactive, as required by Landgraf v. USI Film Products, U.S. , 114 S. Ct. 1483, 128 L. Ed. 2d 229 (1994) and 2) the application of CERCLA, at least on the facts of this case, violates the Commerce Clause as interpreted in United States v. Lopez, 514 U.S. , 115 S. Ct. 1624, 131 L. Ed. 2d 626 (1995).

I. THE COMPLAINT AND PROPOSED CONSENT DECREE

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A. The Olin Property in the Complaint

In its co[redacted]nt, the Justice Department alleges that the Olin plant site in McIntosh, co[redacted]ing [*3] 1,500 acres, contains two actionable sites. This action conce[redacted]nly the first of two sites at the Olin property. "Site 1" n1 includes 20 acres on the southern edge of the property, on which an active chemical-production facility operates. This site contains a number of "solid waste-management units," both active and inactive, many of which have been closed and treated for the removal of hazardous substances. n2 To the north and northwest of the active chemical production facility are undeveloped tracts of land. To the west of the facility is a brine-well field. Four thousand feet east of the main plant area is a steep bluff which defines the edge of Site 2, n3 the natural basin. n4

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n1 The government labels Sites 1 and 2 as the "first operable unit" ("OUI") and the "second operable unit" ("OU2"), respectively. Site 1 includes all of the land except for the approximately sixty two acres designated as Site 2. See n.3.

n2 Remedial-Investigation Report at 1-5.

n3 Site 2 consists of approximately 62 acres which form a natural basin lying east of the plant, surrounded by wetlands, and adjacent to the Tombigbee River. The government alleges that Olin (at the time known as Olin Mathieson) directed surface runoff containing hazardous substances into Site 2, which discharges into the Tombigbee River (the Tombigbee joins with the Alabama River to form the Mobile River, which flows into Mobile Bay and then the Gulf of Mexico). However, the costs which the federal Environmental Protection Agency ("EPA") claims it has incurred and will incur for cleanup in Site 2, and any injunctions it may seek regarding this effort at Site 2, are not part of this action. The government plans to file a separate action regarding Site 2. See Complaint at p. 3, P 8. [*4]

n4 EPA Record of Decision at 5.

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The government alleges that in 1952 Olin Mathieson began operating a mercury-cell chloralkali plant on Site 1 which generated and released wastewater containing [redacted] into Site 2 until 1974. This plant ceased operating in 1982. n5 In 1955, [redacted]e 1, Olin Mathieson built a "crop-protection-chemicals" plant which disch[redacted]astewater into Site 2 until 1974. This plant also ceased operating in [redacted]. n6 As a result of the operation of these two plants (1950's - late 1982), mercury and chloroform, which are alleged to be hazardous substances under 42 U.S.C. § 9601(14), were released into Site 1.

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n5 EPA Record of Decision at 8.

n6 Id. at 10.

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Most of the alleged contamination resulting from the operation of these two plants occurred prior to the effective date of CERCLA, December 11, 1980. n7 However, to [redacted]xtent that both of these plants also operated after CERCLA's enactment, [redacted] i.e., from December 11, 1980, until late 1982, and to the extent that [redacted]eat of continuing releases at and from Site 1 continues, as the government a[redacted]es, n8 the government also seeks to recover CERCLA cleanup costs from Olin for post-enactment conduct.

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n7 42 U.S.C. § 9601(22).

n8 Complaint, P 18.

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In 1978, the company (whose name changed that year to Olin Corporation) built a diaphragm-cell caustic-soda/chlorine plant which it currently operates. There is no allegation in the complaint that the operation of this plant has any connection with the contaminants found on Site 1.

The Environmental Protection Agency ("EPA") listed the Olin plant site on the "national priorities list" in September 1984. Cf. 42 U.S.C. § 9605; 40 C.F.R. Part 300.

The complaint indicates that Olin conducted a "remedial investigation" of Site 1, completed in July 1993, and then a "feasibility study" of proposed responses to contamination at Site 1, completed in February 1994. In December 1994, the EPA executed its [*6] "record of decision" based on the remedial investigation and the feasibility study. The record of decision provides a remedy for the contamination of the alluvial aquifer which the agency contends is consistent with CERCLA and the national contingency plan.

For present purposes, the court accepts the allegations of the complaint as true and notes, in fairness, that Olin's answer admits many, while denying some, of them. For example, the defendant admits that there have been releases in the past, but denies that there is any threat of future release of hazardous substances. The defendant also denies any imminent and substantial danger to the public health or welfare, or the environment, because of actual or threatened releases from Site 1.

B. The P[redacted]d Consent Decree and Remedial-Investigation Report

With the [redacted]int, the Justice department filed a proposed consent decree, n9 which both parties had signed. The government published notice thereof in the Federal Register to afford the public opportunity for comment. 603 Fed. Reg. 36309, 36309-10 (1995). When the government received no comment within 30 days, the parties jointly moved for the court to enter the consent decree. [*7] See 42 U.S.C. § 9622(d)(2).

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n9 Attached to the consent decree are two appendices. Appendix A is the record of decision. Appendix B is a statement of work for Olin for Site 1.

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The consent decree runs to 71 pages. It makes the defendant, its officers, directors, and anyone else associated with the defendant, liable for everything even remotely associated with the clean-up of Site 1, including insuring the automobiles the government uses in fulfilling and supervising the consent decree.

Although the EPA estimates the present value of the cost of compliance to Olin at $ 10,339,000, n10 the EPA has an almost unconstrained right to amend the consent decree. Of course, the defendant may appeal, but the defendant must direct the appeal to the EPA. The propriety of such procedures is beyond the scope of this inquiry, yet defense counsel has acknowledged that the consent decree gives the EPA carte blanche over the company treasury.

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n10 EPA Record of Decision at 39.

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[*8]

Olin has committed itself to performing the actions which the consent decree specifically requires, regardless of whether the court approves of the decree; n11 however, it has sought to do so under the supervision of the Alabama Department of Environmental Management ("ADEM") rather than under the EPA. n12 The ADEM has sought the same. Twice in May 1994, the ADEM's director wrote to the EPA to request that the EPA allow the ADEM to implement the record of decision for Site 1 under the Resource Conservation and Recovery Act, 42 U.S.C. §§ 6901 et seq., and the Alabama Hazardous Waste Management and Minimization Act, Ala. Code §§ 22-30-1 et sec., rather than CERCLA. In December 1994, the EPA's regional administrator in Atlanta, Georgia, wrote the ADEM director to convey the EPA's belief that it would be "premature at this time to defer" to the ADEM. The regional administrator stated that accepting the state's proposal would require modifying a permit under the Resource Conservation and Recovery Act, which would "add this additional layer of involvement and federal resources to the already complex situation." He further asserted that "continued implementation under CERCLA insures [*9] consistency and decreases the potential for conflict." n13 Be that as it may, consistency and the decreased potential for conflict are not necessarily synonymous with constitutionality.

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n11 Def.'s Mem. of Law at 2.

n12 Tr. of Hr'g at 20.

n13 Def.'s Mem. of Law at App. A.

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Four days after rejecting the ADEM's request, the EPA issued its record of decision, the major portions of which require Olin to (1) pump and treat additional ground water, (2) upgrade and extend the existing caps over closed portions of Site 1, (3) increase monitoring of ground water, and (4) establish

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certain institutional controls. n14

- -Footnotes- -

n14 EPA R[illegible] of Decision at Unnumbered Page 2.

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When the court inquired at oral argument why the defendant negotiated a settlement and entered into this "consent" decree, counsel for the defendant responded that it was [*10] "a pragmatic business judgment." It believed that "the fastest and most expedient way to get the work performed would be to simply go along with what the EPA sought here." n15 Olin wanted to complete the work and went along despite reservations about its legality n16 and despite the government's rigid dictation of the terms and conditions it would accept. n17

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n15 Tr. of Hr'g at 20.

n16 Id.

n17 This is not an action in which anyone is trying to avoid a responsibility to the environment; Olin has agreed to perform the proposed remedial actions called for in the consent decree. The fact that Olin, despite its reservations about the fairness and even legality of the proposed consent decree, originally went along with the EPA is a vivid testament to the powerlessness felt by this citizen when forced to comply with various directives ordered by our administrative state.

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In addition to the consent decree, the government filed n18 a remedial-investigation report, prepared by Woodward-Clyde Consultants [*11] of Baton Rouge, Louisiana, in July 1993. The report documents remedial-investigation activities under an amended work plan and was completed under EPA supervision and ultimately with EPA approval. The objectives of the remedial investigation were (1) to investigate the nature, lateral extent, and vertical extent of contamination in order to ascertain the types, concentrations, and distributions of waste in all potentially affected media, such as the [illegible]roundwater, soil, surface water, and sediment; (2) to determine th[illegible]ntial of the wastes to migrate beyond Site 1 and Site 2; and (3) to asse[illegible] current and potential risk to public health, welfare, and the environment. [illegible]hortly after the government filed the remedial-investigation report, the parties jointly informed the court that they neither needed nor desired further discovery in this action. n20

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n18 Tab 15.

n19 Remedial-Investigation Report at 1-3.

n20 See tab 16, p.2.

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According [illegible]e remedial-investigation report, any contaminants [*12] still at Site [illegible]ffect groundwater there mostly by migrating through the alluvial aqu[illegible] This aquifer lies atop a miocene aquifer. n21 The remedial-inv[illegible]ation report indicates that there is little or no migration between the aquifers. The potential does exist for minimal migration along the casing of an enormous well on Site 1; e.g., if the well were to develop a leak in the casing and/or a rupture in the annular seal. If so, the potential concentration of contaminants not only would be localized around the well, but also negligible because the amount of water removed by this well is so great.

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n21 "Constituents are not expected to be present in the Miocene Aquifer beyond the lateral extent of hydrolic control of these active water supply wells. No migration towards the boundaries of OU-1 is anticipated as long as pumping of these wells continues at the current rates." Remedial-Investigation Report at 5-57.

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Wells established around the site to contain any outward flow of contaminants monitor the alluvial [*13] aquifer. Nothing shows that the alluvial aquifer carries water across any state lines or into any river or other transportation source that would take it across any state lines, nor is there any indication of transport of contaminants through the air across state lines. n22

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n22 At hearing, the government could only point to contaminants at Site 2 which potentially traveled across state lines. See Tr. of Hr'g. at 9-10, 16-17.

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Indeed, the record reflects that any contamination at Site 1 is of such minimal proportions as not to constitute any hazard to the public. As stated in the EPA Record of Decision:

The risk assessment indicates that only risks associated with potential future on-site resi[illegible] exposures to contaminated groundwater and surface soils would not be with[illegible]s acceptable risk range. The chemicals of concern would pose unacceptabl[illegible] if the on-site groundwater were used as a source of potable water or if [illegible]en living on the site were exposed to contaminated surface [*14] soils. Future use of this site as a residential area is considered unlikely and thus the proposed remedial goals are directed at protecting the groundwater for its maximum beneficial use. n23

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n23 EPA Record of Decision at 23 (emphasis added).

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C. REVIEW OF THE CONSENT DECREE

Notwithsta[redacted] the initial willingness of the defendant to enter into a "consent" de[redacted] this court has a duty to examine a consent decree not only to determine wh[redacted] its factual and legal determinations are reasonable, but also to ensure that the decree does not violate the Constitution, a federal statute, or the controlling jurisprudence. E.g., Howard v. McLucas, 871 F.2d 1000, 1008 (11th Cir.) (citing United States v. City of Miami, 664 F.2d 435, 441 (5th Cir. 1981) (Rubin, J., concurring); Cotton v. Hinton, 559 F.2d 1326, 1330-31 (5th Cir. 1977)), cert. denied, 493 U.S. 1002, 110 S. Ct. 560, 107 L. Ed. 2d 555 (1989). The court, therefore, has made two requests for briefs, the first of which directed [*15] the parties to brief whether CERCLA, as applied in this case, is consistent with the Supreme Court's view of the Commerce Clause as recently explained in United States v. Lopez, 514 U.S. , 115 S. Ct. 1624, 131 L. Ed. 2d 626 (1995). While both parties have responded to this issue, the defendant has also raised the issue of CERCLA's retroactivity. The defendant contends that Congress did not intend for CERCLA to be retroactive and that if it did, CERCLA violates the Due Process Clause and unconstitutionally delegates legislative power to the EPA. As a result of further direction from the court by order of December 29, 1995, the Justice Department has responded to the defendant's claims concerning retroactivity.

A frequently reaffirmed principle dictates that a court avoid deciding a constitutional issue if a case can be disposed of on non-constitutional grounds. See, e.g., Ashwander v. TVA, 297 U.S. 288, 347, 56 S. Ct. 466, 483, 80 L. Ed. 688, 711 (1936) (Brandeis, J., concurring). Therefore, before considering the several constitutional issues, this court first addresses the statutory question of whether Congress intended to make CERCLA retroactive.

II. CERCLA [*16] and Retroactivity

Although the retroactivity of CERCLA has been the subject of holdings in other circuits, the issue has not been squarely addressed by the Eleventh Circuit. In dicta, a panel of the Eleventh Circuit recently referred to CERCLA as being retroactive. Virginia Properties Inc. v. Home Ins. Co., 74 F.3d 1131, 1132 (11th Cir., 1996). The issue of retroactivity, however, was not before at court. n24 In another CERCLA case before this court recently, the parties failed to raise the issue of CERCLA's retroactivity, see Redwing Carriers, Inc. v. Saraland Apartments., LTD, 875 F. Supp. 1545 (1995); in its decision, however, this court refused to apply certain regulations retroactively. 875 F. Supp. at 1565 ("Since [redacted] is no such clear intent in FIFRA, see, e.g., 7 U.S.C. Secs. 136a(a), 13[redacted]), 1361, the court declines to apply registration cancellation retroactive[redacted]

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n24 Another reference to the retroactivity of CERCLA appears in an appendix to a 11th Circuit case, which is actually in a Georgia Supreme Court case appended to the per curiam opinion on a state contract issue. See Claussen v. Aetna Casualty, 888 F.2d 747, 751 (11th Cir. 1989).

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[*17]

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Of those federal decisions which have directly addressed the issue of CERCLA's retroactivity, n25 none have declined to apply CERCLA on retroactivity grounds. Nev[redacted]less, all of those cases were decided before the Supreme Court's deci[redacted]in Landgraf v. USI Film Prods., U.S. , 114 S. Ct. 1483 (1994), on w[redacted]the defendant rests its argument against retroactivity. n26

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n25 United States v. Monsanto Co., 858 F.2d 160 (4th Cir. 1988); United States v. Northeastern Pharmaceutical & Chemical Co., 810 F.2d 726 (8th Cir. 1986; HRW Systems v. Washington Gas, 823 F. Supp. 318 (D. Md. 1993); City of Philadelphia v. Stepan Chemical, 748 F. Supp. 283 (E.D. Pa. 1990); Kelley v. Solvent Co., 714 F. Supp. 1439 (W.D. Mich. 1989); O'Neil v. Picillo, 682 F. Supp. 706 (D. R.I. 1988); United States v. Hooker Chemical and Plastics, 680 F. Supp. 546 (W.D. N.Y. 1988); United States v. Dickerson, 640 F. Supp. 448 (D. Md. 1986); United States v. Ottati and Goss, Inc., 630 F. Supp. 1361 (D. N.H. 1985); Town of Boonton v. Drew Chemical, 621 F. Supp. 663 (D. NJ. 1985); United States v. Conservation Chemical Co., 619 F. Supp. 162 (W.D. Mo. 1985); United States v. Shell Oil, 605 F. Supp. 1064 (D. Colo. 1985); Jones v. Inmont, 584 F. Supp. 1425 (S.D. Ohio 1984); United States v. South Carolina Recycling Disposal Co., 653 F. Supp. 984 (D.S.C. 1984); United States v. Northeastern Pharmaceutical & Chemical Co., 579 F. Supp. 823 (W.D. Mo. 1984); United States v. Price, 577 F. Supp. 1103 (D. N.J. 1983); Ohio v. Georgeoff, 562 F. Supp. 1300 (N.D. Oh. 1983); United States v. Wade, 546 F. Supp. 785 (E.D. Penn. 1982); Cf. Aetna Cas. & Sur. Co., Inc. v. Pintlar Corp., 948 F.2d 1507 (9th Cir. 1991); O'Neil v. Picillo, 883 F.2d 176 (1st. Cir. 1989); In the Matter of Penn Central, 944 F.2d 164 (3rd. Cir. 1991); United States v. Kramer, 757 F. Supp. 397 (D.N.J. 1991). [*18]

n26 The defendant cites and seems to summarize an article entitled, "A Public Policy Essay: Superfund Retroactivity Revisited," by George Clemon Freeman, Jr., published in the American Bar Association's Business Lawyer, vol. 50 at 663 (Feb., 1995) (hereinafter, "Freeman.") The author, a practicing attorney, who was a member of the Superfund Section 301(e) Study Group, a congressional advisory committee on the Act, and who has participated in litigation on the retroactivity issue, see United States v. Northeastern Pharmaceutical & Chemical Co., 810 F.2d 726 (8th Cir. 1986), argues that neither the text nor legislative history demonstrate that Congress intended CERCLA to be retroactive. He has previously made this argument. See Id. notes 16 - 18, and accompanying text. The author contends:

If the question were before a federal court today in a case of first impression, Superfund's [redacted]ity provision, section 107(a), could not meet the test of statutory c[redacted]tion set forth in Justice Stevens' majority opinion in Landgraf. N[redacted]the text of the statute not its legislative history could sustain retroactive application. Nor could section 107(a) meet the more restrictive test of Justice Scalia's concurrence, which looked only at the text of the statute.

"Freeman" at 664-665 (footnotes omitted)

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[*19]

A.

The Justice Department has responded somewhat cavalierly to the issue of CERCLA's retroactivity, contending the matter is "well settled" and unaffected

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by Landgraf:

Every court t[illegible]e CERCLA retroactivity challenges has rejected the arguments advanced her[illegible]deed, courts have uniformly held that (1) Congress clearly and unequivocall[illegible]ended retroactive application of CERCLA and; (2) such a liability sc[illegible]is rationally related to a legitimate governmental interest. The Supreme Court's decision in Landgraf v. USI Film Prods., 128 L. Ed. 2d 229, 114 S. Ct. 1483 (1994) announces no new constitutional rules, and in no way impacts this case law.

See Pl's Mem. on the Retroactivity of CERCLA and Due Process Issues, p. 2. To begin with, Justice errs in claiming that the lower federal courts have "uniformly held that (1) Congress clearly and unequivocally intended retroactive application of CERCLA." In fact, not all the courts which have applied CERCLA to pre-enactment conduct have agreed that it is retroactive, n27 and those which have actually analyzed the retroactivity issue have differed on whether Congress was acting "clearly and unequivocally." [*20] n28 More importantly, Justice's observation that Landgraf "announces no new constitutional rules" fails to assist this court with what is a significant non-constitutional decision. n29 Written against the backdrop of several constitutional issues, the Landgraf holding addresses a rule of statutory construction. Justice cannot credibly contend that "the result in Landgraf is unremarkable." n30

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n27 See United States v. South Carolina Recycling & Disposal, Inc., 653 F. Supp. 984 (D.S.C. 1984) aff'd in part and vac. in part sub nom. United States v. Monsanto Co., 858 F.2d 160 (4th Cir. 1988); Cf. United States v. Diamond Shamrock Corp., [1982] 12 Envtl. L. Rep. (Envtl. L. Inst.) 20, 819 (N.D. Ohio May 29, 1981); United States v. Price, 523 F. Supp. 1055 (D.N.J. 1981), aff'd, 688 F.2d 204 (3d Cir. 1982). South Carolina Recycling concluded that the act was not "retroactive," but applied CERCLA on the theory that because the previous disposal continued to cause or threatened to cause releases after the Act's effective date.

n28 See notes 31-34, infra.

n29 See n. 38, infra. [*21]

n30 "Pl's Mem. on the Retroactivity of CERCLA and Due Process Issues" at 4.

- - - - - - [illegible] - - - - - - - - -End Footnotes- - - - - - - - - - - - - - - - - -

It is un[illegible]dable that Justice would attempt to dismiss Landgraf so casually. n31 Landgraf certainly demolishes the interpretive premises o n which prior cases had concluded CERCLA is retroactive. Landgraf does so in the course of attempting to clarify confusion regarding the interpretive rules applicable to retroactivity:

Our precedents on retroactivity left doubts about what default rule would apply in the absence of congressional guidance, and suggested that some provisions might apply to cases arising before enactment while others might not. Compare Bowen v. Georgetown Univ. Hospital, 488 U.S. 204, 109 S. Ct. 468, 102 L. Ed. 2d 493 (1988) with Bradley v. Richmond School Bd., 416 U.S. 696, 94 S. Ct. 2006, 40 L. Ed. 2d 476 (1974).

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Landgraf, 114 S. Ct. at 1495. In reaffirming the traditional presumption against retroactive [illegible]ation, Landgraf disapproves language in Bradley which had appeared to [illegible]e that traditional presumption.

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n31 See e.g. Ohio v. Georgeoff, 562 F. Supp. 1300, 1311 (N.D. Ohio, 1983) ("The Court is unable to declare that the statute evidences the 'imperative character' required to overcome the presumption against retroactivity").

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[*22]

Bradley allowed an award of attorneys' fees for work done prior to the effective date of the statute providing for attorneys' fees. The Supreme Court stated it was doing so "on the principle that a court is to apply the law in effect at the time it renders its decision, unless doing so would result in manifest injustice or there is a statutory direction or legislative history to the contrary." 416 U.S. at 711, 94 S. Ct. at 2016. The applicability of this language was severely limited by Landgraf:

Although the language suggests a categorical presumption in favor of application of all new rules of law, we now make it clear that Bradley did not alter the well-settled presumption against application of the class of new statutes that would have genuinely "retroactive" effect.

Landgraf, 114 S. Ct. at 1503 (emphasis in the original).

An early and influential case finding CERCLA retroactive, Ohio v. Georgeoff, 562 F. Supp. 1300 (N.D. Ohio, 1983), did exactly what Landgraf disapproves. Georgeoff began quite appropriately by "initially determining the standard to be applied in determining whether a statute should be applied retroactively." [*23] 562 F. Supp. at 1306. While it acknowledged an "historical[] . . . presumption favoring a prospective only application of a statute", n32 the court otherwise approved of n33 and seemed to apply a presumption in favor of retroactivity. The premises for the decision in Georgeoff were disapproved in and are no longer tenable after Landgraf. As a result, Georgeoff and the cases which rely on its analysis, -- and which do not do their own analysis -- cannot be considered persuasive.

- - - - - - [illegible] - - - - - - - - -Footnotes- - - - - - - - - - - - - - - - - - -

n32 562 [illegible]. at 1306.

n33 In footnotes, the court explained its view of the presumption:

Since the principal basis for the presumption against retroactivity is the threat of raising a constitutional issue, the reduction of that constitutional issue must necessarily reduce the need to interpret CERCLA to avoid raising that constitutional issue. The weight of the presumption therefore being reduced, a more lenient approach in reviewing claims that the presumption has been over-ridden may be appropriate. 562 F. Supp. at 1306, n.7. (emphasis added)

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. . . .

After Thorpe [redacted]adley, the presumption against retroactivity has arguably been changed [redacted]presumption in favor of retroactivity. That presumption can only be over-[redacted]n where there is a clear legislative directive to limit the statute to a prospective application or the change in law would cause manifest injustice to the party adversely affected. Id. at 1307, n.9. (emphasis added).

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[*24]

Besides Georgeoff, only two other cases actually do analyze the issue of retroactivity; the rest of the cases basically rely on one or more of these three cases and other cases which cite these cases. Those other two cases which do their own analyses are United States v. Shell Oil, Co., 605 F. Supp. 1064 (D. Colo., 1985) and United States v. Northeastern Pharmaceutical & Chemical Co., Inc., 810 F.2d 726 (8th Cir., 1986), both of which also cite Georgeoff with approval. See 605 F. Supp. at 1072 and 810 F.2d at 733. Unlike Georgeoff, neither case explains how it is applying the presumption against retroactivity; but like Georgeoff, both cases demonstrate little regard for the presumption. Following an analysis unlike that of Landgraf n34 and after quoting Georgeoff, Id. at 1072, Shell Oil concludes that CERCLA is "unavoidably retroactive." Id. at 1073. It does so on the basis of CERCLA's "general purpose and scheme." n35 Under Landgraf, however, the fact "that retroactive application of a new statute would vindicate its purpose more fully . . . . is not sufficient to rebut the presumption against retroactivity." 114 S. Ct. at 1507-8. [*25] Other than its discussion of "general purpose and scheme," Shell Oil does not explain precisely what overrides the presumption against retroactivity. n36 As for Northeastern, on which Justice relies, the case treats the presumption itself rather lightly, devotes only one sentence to the statutory language, relies on Shell Oil and Georgeoff among other cases, and offers one paragraph about the "statutory scheme." n37

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n34 "Before turning to a close analysis of specific statutory provisions and their accompanying legislative history, I will review the general purpose and scheme of CERCLA," 605 F. Supp. at 1069.

n35 See n[redacted]pra.

n36 Addit[redacted]y, both Shell Oil and Northeastern also rely upon an argument disapproved [redacted]andgraf. Specifically, these two cases argue that the affirmative preclusion of recovery for damages occurring before CERCLA's enactment in § 107(f), the natural resource liability section, indicates congressional intent for the other liability sections to operate retroactively. See Shell Oil, 605 F. Supp. at 1076 and Northeastern, 810 F.2d at 736. Noting that, "it would be surprising for Congress to have chosen to resolve [the retroactivity issue] through negative inference," the Landgraf Court found a remarkably similar argument to be unpersuasive. 114 S. Ct. at 1493-1494. [*26]

n37 The courts' discussion is as follows with reference to the presumption itself emphasized:

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The district court correctly found Congress intended CERCLA to apply retroactively. Id. at 839. We acknowledge there is a presumption against the retroactive application of the statutes. See United States v. Security Industrial Bank, 459 U.S. 70, 79, 103 S. Ct. 407, 413, 74 L. Ed. 2d 235 (1982). We hold, however, that CERCLA § 302(a), 42 U.S.C. § 9652(a), is "merely a standard 'effective date' provision that indicated the date when an action can first be brought and when the time begins to run for issuing regulations and doing other future acts mandated by the statute." United States v. Shell Oil Co., 605 F. Supp. 1064, 1075 (D. Colo. 1985); cf. Von Allmen v. Connecticut Teachers Retirement Board, 613 F.2d 356, 359-60 (2d Cir. 1979) (veterans statute).

Although CERCLA does not expressly provide for retroactivity, it is manifestly clear that Congress intended CERCLA to have retroactive effect. The language used in the key liability provision, CERCLA § 107, 42 U.S.C. § 9607, refers to actions and conditions in the past tense: "any person who at the time of disposal of any hazardous substances owned or operated," CERCLA § 107(a)(2), 42 U.S.C. § 9607(a)(2), "any person who . . . arranged with a transporter for a transport for disposal," CERCLA § 107(a)(3), 42 U.S.C. § 9607(a)(3), and "any person who . . . accepted any hazardous substances for transport to . . . sites selected by such person," CERCLA § 107(a)(4), 42 U.S.C. § 9607(a)(4). See, e.g., United States v. Conservation Chemical Co., 619 F. Supp. 162, 220 (W.D. Mo. 1985); United States v. Shell Oil Co., 605 F. Supp. at 1069-73; United States v. South Carolina Recycling & Disposal, Inc., 20 Env't Rep. Cases (BNA) 1753, 1760-62 (D. S.C. 1984) (The court in United States v. South Carolina Recycling & Disposal, Inc., 20 Env't Rep. Cases (BNA) 1753, 1760 (D. S.C. 1984), noted CERCLA does not apply "retroactively" because it does not impose liability for past conduct; rather, CERCLA imposes liability upon those parties responsible for causing certain conditions, that is, the release or threatened release or hazardous substances, that are the present or future results of their past actions.); United States v. A & F Materials Co., 578 F. Supp. at 1259; United States v. Price, 577 F. Supp. 1103, 1111-12 (D. N.J. 1983); Ohio ex rel. Brown v. Georgeoff, 562 F. Supp. 1300, 1312 (N.D. Ohio 1983); United States v. Outboard Marine Corp., 556 F. Supp. 54, 57 (N.D. Ill. 1982); United States v. Reilly Tar & Chemical Corp., 546 F. Supp. 1100, 1113-14 (D. Minn. 1982); see generally Developments in the Law -- Toxic Waste Litigation, 99 Harv. L. Rev. 1498 (1986) (Developments).

Further, the statutory scheme itself is overwhelmingly remedial and retroactive. CERCLA authorizes the EPA to force responsible parties to clean up inactive or abandoned hazardous substance sites, CERCLA § 106, 42 U.S.C. § 9606, and authorizes federal, state and local governments and private parties to clean up such sites and then seek recovery of their response costs from responsible parties, CERCLA § 104, 107, 42 U.S.C. §§ 9604, 9607. In order to be effective, CERCLA must reach past conduct. CERCLA's backward-looking focus is confirmed by the legislative history. See generally, H.R.Rep. No. 1016, 96th Cong., 2d Sess., reprinted in 1980 U.S. Code Cong. & Ad. News 6119 (CERCLA House Report). Congress intended CERCLA "to initiate and establish a comprehensive response and financing mechanism to abate and control the vast problems associated with abandoned and inactive hazardous waste disposal sites." Id. at 22, 1980 U.S. Code Cong. & Ad. News at 6125.
810 F.2d at 732-33 (emphasis added).

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[*27]

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It is understandable that, prior to Landgraf, lower federal courts would have tended to minimize the importance of the presumption against retroactivity given some Supreme [redacted] precedents. Landgraf reflects the different views on the Court about [redacted] some of its precedents, in particular Bradley v. Richmond School Bd., [redacted] S. 696, 94 S. Ct. 2006, 40 L. Ed. 2d 476 (1969) and a case on which it rel[redacted] Thorpe v. Housing Authority of Durham, 393 U.S. 268, 89 S. Ct. 518, 21 L. Ed. 2d 474 (1969), have been consistent with other Supreme Court precedents. The dissenting opinion in Landgraf remarks on the majority's "eagerness to resolve the 'apparent tension' . . . between Bradley v. Richmond School Bd. . . . and Bowen v. Georgetown University Hospital", 114 S. Ct. at 1508 (Blackmun, J., dissenting) (citations omitted) . The concurring opinion simply says that Bradley and Thorpe "invented an utterly new and erroneous rule." Id. at 1523 (Scalia, J., concurring). On the one hand, the majority "begin[s] by noting that there is no tension between the holdings in Bradley and Bowen." Id. at 149 (emphasis in the original). Later, however, [*28] the majority isolates and limits the troublesome language in Bradley, quoted above, which created the confusion about the strength of the presumption against retroactivity. Whether Bradley actually is or is not at odds with pre and post-precedent need not concern this court. It suffices to recognize that, contrary to the assertion by Justice, Landgraf does at least clarify the analysis of retroactivity and, therefore, does "impact this case." n38

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n38 See also Leonard Charles Presberg, The Civil Rights Act of 1991, Retroactivity, and Continuing Violations, 28 U. Richmond L. Rev. 1363, (1994) ("Prior to Landgraf, the Court had utilized two conflicting presumptions regarding the retroactivity of civil legislation."); Nelson Lund, Retroactivity, Institutional Incentives, and the Politics of Civil Rights, 1995 Pub. Int. L. Rev. 87 (1995); Duncan B. Hollis, Employment Discrimination Law, Statutory Retroactivity, 36 B.C. L. Rev. 373, 385 (1995) ("Beyond the scope of § 1981 cases, however, Rivers, in conjunction with Landgraf, does much to resolve the confusion surrounding what test a court should apply when a case implicates a statute enacted after the violative conduct occurred").

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[*29]

B.

The majo[redacted]pinion in Landgraf sets forth an analysis which, as here summarized, [redacted]res a court 1) to determine a) whether Congress has expressly stated the [redacted]s reach and b) if not, whether the text and legislative history hav[redacted]rly prescribed" Congress' intent to apply the provision retroactively; 2) if not, to determine whether the provision actually has "retroactive effect on the party or parties in the litigation;" and 3) if so, to apply the traditional presumption against retroactivity -- absent a clear congressional intent to the contrary.

The majority opinion's approach breaks down as follows:

1) In the last sentence of Part II of the opinion, the majority says: "Our first question, then, is whether the statutory text...manifests an intent that the 1991 Act should be applied to cases that arose and went to trial before its enactment." 114 S. Ct. at 1492. What follows in Part III of the opinion, 114

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S. Ct. at 1493-96, is an analysis of the arguments based on the text and legislative history. At the end of this section, the majority determines: "in the absence of [redacted] kind of unambiguous directive found in Sec. 15 of the 1990 bill [which e[redacted]itly [*30] provided for retroactivity], we must look elsewhere for [redacted]ance on whether Sec. 102 applies to this case." 114 S. Ct. at 1496.

2) Part IV of the opinion, 114 S. Ct. at 1496-1505, discusses the presumption against retroactivity. The majority notes the "'apparent tension'" between the different canons of construction found in Bradley as opposed to other Supreme Court precedents. Id. at 1496. The Court concludes this section with the following framework for analysis:

When a case implicates a federal statute enacted after the events in suit, the court's first task is to determine whether Congress has expressly prescribed the statutes' reach. If Congress has done so, of course, there is no need to resort to judicial default rules. When, however, the statute contains no such express command, the court must determine whether the new statute would have retroactive effect, i.e., whether it would impair rights a party possessed when he acted, increase a party's liability for past conduct, or impose new duties with respect to transactions already completed. If the statute would operate retroactively, our traditional presumption teaches that it does not govern absent [*31] clear congressional intent favoring such a result.

Id. at 1505. (emphasis added).

3) In Part V of the opinion, 128 L. Ed. 2d 229, 1994 U.S. LEXIS 3292 *71, 114 S. Ct. 1483, 1505-1508, the majority "ask[s] whether, given the absence of guiding instructions from Congress, Sec. 102 of the Civil Rights Act of 1991 is the type of provision that should govern cases arising before its enactment." 114 S. Ct. at 1505. They find the new damages remedy to have a retroactive effect and conclude it "is the kind of provision that does not apply to events antedating its enactment in the absence of clear congressional intent," 114 at 1506. The section proceeds without reconsidering its earlier discussion of congressional intent -- other than to reject as insufficient to overcome the presumption against retroactivity the argument that "retroactive application of a new statute would vindicate its purpose more fully" 114 S. Ct. at 1507 (footnote omitted) -- to conclude that they "have found no clear evidence of congressional intent that Sec. 102 of the Civil Rights Act of 1991 should apply to cases arising before its enactment." 114 S. Ct. at 1508.

In the fr[redacted]k of analysis as quoted above in 2), the first step involves only a deter[redacted]on [*32] of whether Congress has made an express statement concerning r[redacted]ivity; other evidence of "clear congressional intent" is left to step three. In the opinion itself, however, the Court considers both express and other evidence of congressional intent in the first step. As reflected from the quotes from Parts II and III of the opinion, see 1), the Court does not clearly differentiate between express language and other clear language of intent from the statute or legislative history. While it does not seem to matter whether the discussion of intent is confined to step one or divided between step one and step three, the analysis here follows what Landgraf in fact does.

1. Has Congress expressed its intent on CERCLA retroactivity?

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CERCLA contains no language explicitly stating it is retroactive. n39 Under language in some Supreme Court opinions, that failure would be fatal for retroactivit[redacted]ited States v. Heth, 7 U.S. 399, 3 Cranch 399, 414, 2 L. Ed. 479 (1806). [redacted]ing, J.) ("It [is] unreasonable in my opinion, to give the law a constructi[redacted]ich would have such a retrospective effect, unless it contained express words to that purpose.") While Landgraf [*33] demonstrates a preference for express language regarding retroactivity n40 and seems to warn Congress about the danger of not being explicit, n41 its discussion of other (i.e., non-express) statutory language and legislative history establishes that these should be considered in determining congressional intent.

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n39 As Justice and the other parties in Georgeoff agreed, "there are no unequivocal statements in the [CERCLA] statute indicating a Congressional intent to make it apply retroactively." 562 F. Supp. at 1309.

n40 See discussion in B., supra and n. 41, infra.

n41 Although the passage of the, 1990 bill may indicate that a majority of the 1991 Congress also favored retroactive application, even the will of the majority does not become law unless it follows the path charted in Article I, § 7, cl. 2 of the Constitution. See INS v. Chadha, 462 U.S. 919, 946-951, 103 S. Ct. 2764, 2781-2784, 77 L. Ed. 2d 317 (1983).

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a) Non-Express Statutory Language.

In resolving retroactivity [*34] issues, Landgraf instructs that the answer may vary among provisions within an act. 114 S. Ct. at 1494 and 1505. Accordingly, the analysis focuses on the particular provisions of CERCLA, at issue in the complaint, Sections 106(a) n42 and 107(a). n43 Under Section 106(a) the government seeks injunctive relief in the first claim of the complaint. Although injunctive relief is ordinarily prospective, when it requires a party to spend funds related to actions taken prior to CERCLA's enactment, such relief is nevertheless retroactive. See Georgeoff 562 F. Supp. at 1303-05. Thus to the extent that the government's claims under 106(a) and 107(a) relate to actions taken prior to the effective date of CERCLA, they involve the issue of retroactivity.

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n42 Sect[redacted](a) of CERCLA, 42 U.S.C. § 9606(a), provides in pertinent part:

In addition to any other action taken by a State or local government, when the President determines that there may be an imminent and substantial endangerment to the public health or welfare or the environment because of an actual or threatened release of a hazardous substance from a facility, he may require the Attorney General of the United States to secure such relief as may be necessary to abate such danger or threat, and the district court of the United States in the district in which the threat occurs shall have jurisdiction to grant such relief as the public interest and the equities of the case may require.
[*35]

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n43 Section 107(a) of CERCLA, 42 U.S.C. § 96007(a), provides, in pertinent part:

(1) the owne[redacted] operator of a vessel or a facility; [and]

(2) any pers[redacted]o at the time of disposal of any hazardous substance owned or operated any facility at which such hazardous substances were disposed of ...

shall be liable for --

(A) all costs of removal or remedial action incurred by the United States Government ... not inconsistent with the national contingency plan ....

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The Justice Department devotes little attention to statutory language as evidence of congressional intent. To the extent it does, Justice's brief relies on Northeastern's observation that "the language used in the key liability provision, CERCLA § 107 ... refers to actions and conditions in the past tense." Northeastern, 810 F.2d at 733. Georgeoff, after a more extensive analysis, finds the use of the past tense not dispositive. n44 Even while finding other terms supportive of retroactivity, Georgeoff states that the statutory provisions are insufficient to overcome the presumption [*36] of retroactivity.

Despite these statutory arguments, the Court is unable to declare that the statute evidences the "imperative character" required to overcome the presumption against retroactivity. Regardless, these provisions provide some evidence that Congress intended CERCLA to apply retroactively. The Court, therefore, will consider these statutory terms as indicia, but not dispositive indicia, of a Congressional intent to allow retroactive application of CERCLA.

562 F. Supp. at 1311. Shell Oil agrees with Georgeoff. n45 Georgeoff's and Shell Oil's conclusion that the statutory language in CERCLA is not sufficient to establish retroactivity is persuasive. Although Northeastern arguably n46 reaches a contrary conclusion, it does so without conducting nearly as extensive an analysis as done in Georgeoff. This court concludes, therefore, that the language of section 107 provides "no clear evidence of Congressional intent," as required by Landgraf, that CERCLA's liability provisions be given retroactive effect.

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n44 See [redacted]lly 562 F. Supp. at 1309 - 11. "It will be unnecessary to construe the word 'accepted' to apply to pre-enactment conduct to give it effect. 'Accepted' may apply to pre-enactment conduct, but the Statute does not require such an application." Id. at 1310. [*37]

n45 "I find and conclude that congressional intent to either impose or withhold liability for response costs incurred before CERCLA cannot be divined from the verb tenses in § 107(a)." 605 F. Supp. at 1073.

n46 Despite the language cited in n. 37, supra, Northeastern goes on to follow the Shell Oil analysis and cites approvingly that court's finding that congressional intent to impose liability for pre-enactment response costs

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cannot be divined from the verb tenses in § 107(a). See 810 F.2d at 735.

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Section 10[illegible]tains no language indicating congressional intent to authorize relief that is retroactive. n47 If anything, the language suggests the very argument, later made by Justice, that CERCLA liability is not "retroactive." The pertinent language of § 106 borrows from law on the abatement of nuisance; it refers to "an imminent and substantial endangerment to the public health or welfare or the environment" and provides "such relief as may be necessary to abate such danger or threat." n48 Georgeoff records Justice's unsuccessful attempt to argue that, although it reaches [*38] pre-enactment conduct, legislation designed to alleviate a continuing public nuisance does not act retroactively." 562 F. Supp. at 1304. United States v. So. Carolina Recycling and Disposal Inc., 653 F. Supp. 984 (D. S.C., 1984), on the other hand, adopts that argument. n49 As discussed below, Landgraf now precludes such attempts to avoid the issue of retroactivity. The fact that in the early cases Justice thought it necessary to argue, at least in the alternative, that CERCLA is not retroactive certainly indicates Justice's initial concern that courts might not find a clear congressional intent that CERCLA be applied "retroactively."

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n47 See 106(a) quoted in n. 42, supra.

n48 Id.

n49 "Although liability under CERCLA is premised in part upon conduct which occurred prior to CERCLA's enactment in 1980 this court does not consider CERCLA 'retroactive' in the constitutional sense as applied to the facts of this case." 653 F. Supp. 984, 996.

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b) Legislative History.

CERCLA itself has [*39] almost no legislative history.

Although Congress had worked on "Superfund" cleanup of toxic and hazardous waste bills, and on parallel oil spill bills for over three years, the actual bill which b[illegible] Public Law No. 96-510 had virtually no legislative history at all, becaus[illegible]ill which became law was hurriedly put together by a bipartisan [illegible]hip group of Senators--with some assistance of their House counterpart[illegible]oduced and passed by the Senate in lieu of all pending measures on the subject. It was then placed before the House, in the form of a Senate amendment of the earlier House bill. It was considered on December 3, 1980, in the closing days of the lame duck session of an outgoing Congress. It was considered and passed, after very limited debate, under a suspension of the rules, in a situation which allowed for no amendments. Faced with a complicated bill on a take-it-or-leave-it basis, the House took it, groaning all the way.

Frank P. Grad, Treatise on Environmental Law Sec. 4A.02[2][a], at 4A-51 (1994). (footnote omitted) (Hereinafter, "Grad") (emphasis added).

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The unusual lack of legislative history, as reflected by the failure even to produce [*40] a House--Senate Conference Report, is attributable to "the delicate nat[illegible]f the compromise" which led to passage, according to the Preface to t[illegible]ngressional Research Service Legislative History. n50 Much of what passes [illegible]egislative history of CERCLA, therefore, comes from "bills introduced w[illegible] contributed to some extent to the final act." n51

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n50 "A Legislative History of the Comprehensive Environmental Response Compensation, and Liability Act of 1980 (Superfund), public Law 96-51Q." Comm. on Environment and Public Works, U.S. Senate, 97th Cong., 2d Sess. Vol. 1 at VII.

n51 Grad at 4A-51.

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In Landgraf, the Supreme Court does consider a prior bill as part of its review of the legislative history. The Court places some weight on the fact that a bill vetoed in the previous year had explicitly provided for retroactivity. The legislative history considered in Landgraf comes not from committee reports, but from the language of the prior bill itself. The fact that the later enacted legislation [*41] had no such provision prompts the Court to infer: "it seems likely that one of the compromises that made it possible to enact the 1991 version was an agreement not to include the kind of explicit retroactivity command found in the 1990 bill," 114 S. Ct. at 1495 (emphasis in the original).

As acknowledged in Georgeoff, "the precise issue of retroactivity...was not addressed in Congressional debates," 562 F. Supp. at 1311, including debate on prior bills. Id. Under Landgraf, that fact would seem to be nearly fatal to any attempt to overcome the presumption against retroactivity.

The Justice Department attempts to distinguish CERCLA from the civil rights statute considered in Landgraf because no bill prior to CERCLA explicitly provided for retroactivity. See "Pl's Mem. on Retroactivity" at 4-5. That fact, however, does not strengthen the case for retroactivity. It only means that what Justice and other courts have labeled the legislative history of CERCLA may not be as clear as was the legislative history of the Civil Rights Act considered in Landgraf. It still remains for Justice to demonstrate that the legislative history does [illegible]ain clear intent of CERCLA's [*42] retroactivity. In attempting [illegible]so, Justice contends that the "history, as analyzed by the courts, dem[illegible]tes unequivocally that Congress was concerned about past, pre-enactm[illegible] of disposal." "Pl's Mem" at 8.

The argument of Justice, relying as it does on past cases, fails to overcome the presumption against retroactivity because those prior cases do not follow the analysis of Landgraf and because they find clarity in legislative history which does not exist. Many of the past cases are unclear about two things which are distinguished in Landgraf: congressional intent and retroactive effect. As discussed below, Landgraf struggles with the term "retroactive." The majority excludes certain statutes from the presumption against retroactivity, n52 specifically procedural and jurisdictional statutes. See 114 S. Ct. at 1501-02. Approving of Justice Story's discussion in Society for Propagation of the Gospel v. Wheeler, 2 Gall. 105, 22 F. Cas. 756 (No. 12,156) (CCDNH 1814), the

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majority says:

A statute doe[redacted] operate "retroactively" merely because it is applied in a case arising [redacted] conduct antedating the statute's enactment . . .
114 S. Ct. a[redacted]9.
[*43]

In other words, the fact that legislation might have retroactive effect does not necessarily mean that Congress clearly intended that it be so applied.

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n52 "Even absent specific legislative authorization, application of new statutes passed after the events in suit is unquestionably proper in many situations." 114 S. Ct. at 1501.

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In searching the legislative history, some courts have placed weight on sources that have little no value. As two commentators write: "the available reports pertaining to prior versions of the legislation are of little value in interpreting the statute -- CERLCA, as enacted, differed significantly from previous proposals." Allan J. Topol and Rebecca Snow, Superfund Law and Procedure § 1.1. at 5 (St. Paul, West; 1992).

The most that can be said from the legislative history is that Congress left many questions, including retroactivity, as open ones to be decided later. Like Landgraf, the circumstances surrounding passage of CERCLA strongly suggest that the failure expressly [*44] to prescribe the reach of the statute was deliberate on Congress' part.

It would have been a simple matter for Congress to have included a provision within the Act providing that liability would be imposed retroactively. Given the undoubted Congressional awareness of an existing problem, this omission takes on special importance. There can be no question that Congress was aware that the issue of retroactivity could arise. Yet, Congress failed to make this statement.

Georgeoff. 562 F. Supp. at 1309.

The polit[redacted]circumstances suggest why there was little actual legislative history and [redacted]ngress left many issues deliberately ambiguous. n53

In 1980, CE[redacted]erged from the lame duck session of Congress after President Carter had been defeated and former Governor Reagan had yet to assume the presidency. Its language was derived mainly from S. 1480, 99th Cong., 2d Sess. (1980), a bill that had been reported from the Senate Committee on Environment and Public Works but that had little hope for passage in its complete form. A group of approximately 25 to 30 senators, with assistance from House members and the outgoing Administration (at one point including [*45] President Carter himself), and crafted new legislative language to paper over policy disputes on which there was no consensus. Because many such disputes remained after these negotiators finished their deliberations, floor debate in the Senate often contain rival explanations of the same provisions of CERCLA.

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Alfred R. Light, CERCLA Law and Procedure Compendium (BNA; Washington, D.C., 1992) at 1-1.

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n53 As Se[redacted] Randolph stated in part in explaining the liability provisions of the Compromise:

The liability regime [Sec. 109] in this substitute contains some changes in language from that in the bill reported by the Committee on Environment and Public Works. The changes were made in recognition of the difficulty in prescribing in statutory terms liability standards which will be applicable in individual cases. The changes do not reflect a rejection of the standards in the earlier bill.

Unless otherwise provided in this act, the standard of liability is intended to be the same as that provided in section 311 of the Federal Water Pollution Control Act (33 U.S.C. 1321). I understand this to be a standard of strict liability.

It is intended that issues of liability not resolved by this act, if any, shall be governed by traditional and evolving principles of common law. An example is joint and several liability, Any reference to these terms has been deleted, and the liability of joint tortfeasors will be determined under common or previous statutory law.

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[*46]

The circumstances explain why Congress decided not to decide many issues, leaving them for others -- the EPA and the courts--to decide. The fact that CERCLA includes a legislative veto, see 42 U.S.C. § 9655, since determined to be unconstitutional, see INS. v. Chadha, 462 U.S. 919, 103 S. Ct. 2764, 77 L. Ed. 2d 317 (1983), suggests that members of Congress may not have been as concerned as they should have been about a number of issues, including retroactivity, because they assumed incorrectly that Congress has the power to "fix it" later without concern about a presidential veto. Whatever the reasons, the legislative history lacks the clear congressional intent to make CERCLA liability retroactive.

Given th[redacted] language--express or otherwise--and the legislative history--br[redacted]nd narrowly understood--fail to demonstrate a clear congression[redacted]nt for retroactivity, Landgraf requires that the presumption against retro[redacted]ity be applied if the statute is one to which that presumption applies.

2. Does CERCLA Have Retroactive Effect?

Landgraf does not simply ask: is the statute retroactive? Framing the question that way, as have a number of the lower federal [*47] courts, reduces the analysis to a matter of labeling rather than distinguishing between the effect of the statute and the intent of Congress as does Landgraf. n54 A few of the early cases manipulate the label "retroactive" apparently as a way of avoiding the issues of congressional intent and constitutionality. Thus United

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States v. South Carolina Recycling Disposal Co., 653 F. Supp. 984 (D.S.C., 1984), aff'd in part and vac. in part sub nom. United States v. Monsanto Co., 858 F.2d 160 [illegible] Cir., 1988), cert. denied, 490 U.S. 1106, 104 L. Ed. 2d 1019, 109 S. Ct. 3[illegible] 989), concludes that considering pre-enactment conduct does not make CER[illegible] liability "retroactive" because the statute actually imposes liability fo[illegible] post enactment releases or threatened releases. Although the Justice Department now contends that CERCLA is clearly retroactive, early cases reflect that Justice made the argument that CERCLA is not retroactive. See e.g., Georgeoff 562 F. Supp. at 1304. n55

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n54 114 S. Ct. at 1499.
Rather, the court must ask whether the new provision attaches new legal consequences to events completed before its enactment. The conclusion that a particular rule operates "retroactively" comes at the end of a process of judgment concerning the nature and extent of the change in the law and the degree of connection between the operation of the new rule and a relevant past event.
[*48]

n55 562 F. Supp. at 1304 (emphasis added).

The Court next turns to a consideration of Justice's position. Under the liability provisions of CERCLA, 42 U.S.C. § 9607(a), a "release or threatened release" of hazardous wastes is required to trigger liability. Justice argues that the release at the Dump is a continuing release of hazardous waste triggering liability at any time before the wastes' removal. Because the waste has yet to be removed, BFI has engaged in conduct taking place after the enactment of CERLCA. Imposition of liability, therefore, would not be retroactive because at least some of the facts giving rise to the liability are based on events taking place after the enactment of CERCLA.

In support of this argument, Justice cites a number of cases which it argues hold that legislation designed to alleviate a continuing public nuisance does not act retroactively. Samuels v. McCurdy, 267 U.S. 188, 45 S. Ct. 264, 69 L. Ed. 568 (1924); Chicago & Alton Railroad Company v. Tranbarger, 238 U.S. 67, 35 S. Ct. 678, 59 L. Ed. 1204 (1914); City of Bakersfield v. Miller, 64 Cal. 2d 93, 410 P.2d 393, 48 Cal. Rptr. 889 (1966); People of Illinois v. Jones, 329 Ill. App. 503, 69 N.E.2d 522 (4th Dist. 1946).

- - - - - - [illegible] - - - - - - - -End Footnotes- - - - - - - - - - - - - - - - - - -
[*49]

Under the Landgraf's analysis, CERCLA liability certainly has "retroactive effect" because as applied in this and many other cases it easily falls within the explanatory language of that term. That is to say, the Justice Department's attempt in this case to impose liability under § 107(a) largely on actions occurring prior to the statute's effective date "would impair rights a party possessed when he acted, increase a party's liability for past conduct, or impose new duties with respect to transactions already completed." 114 S.C. at 1505. What Landgraf said about compensatory damages can be said about the financial liabilities under CERCLA for pre-enactment conduct: "the new damages remedy in Sec. 102, we conclude, is the kind of provision that does not apply to events antedating its enactment in the absence of clear congressional intent."

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114 S. Ct. at 1506.

3. Should [redacted]esumption Against Retroactivity be Applied?

In the thi[redacted]ep of the analysis, Landgraf asks "whether, given the absence of guiding instruction from Congress, the [particular section of the act] is the type of provision that should govern cases arising before its enactment. The Court does [*50] not ask generally whether the act is retroactive, but focuses on the particular section. The opinion then distinguishes between a procedural provision of that section (jury trial right) which would "presumably apply to cases ... regardless of when the underlying conduct occurred," n56 and its punitive and compensatory damages provisions. Recognizing that "retrospective imposition of punitive damages would raise a serious constitutional question", Id. at 1505, the Court avoids that constitutional question by interpreting the punitive damages provision not to be retroactive. n57 The provision "authorizing recovery of compensatory damages is not easily classified," id., according to the Court, because the conduct itself was already unlawful--only the remedy was new--and also because compensatory damages are not punitive. Despite these differences, Landgraf applies the presumption against retroactivity even to the compensatory damages provision.

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n56 In Landgraf, the right to a jury trial does not apply retroactively, despite the fact that it is a procedural provision, because this right is attached to the punitive and compensatory damages provisions, to which the presumption against retroactivity applies. See 114 S. Ct. at 1505. [*51]

n57 114 S. Ct. at 1506. "Before we entertained that [constitutional] question, we would have to be confronted with a statute that explicitly authorized punitive damages for pre-enactment conduct. The Civil Rights Act of 1991 contains no such explicit command."

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The CERCLA provision, § 107(a), as applied in this case falls somewhere between the punitive damage and the compensatory damage provisions considered in Landgraf. In this case, punitive damages are not sought. Nevertheless, § 106 does provide for fines for failure to comply with an executive branch abatement order; such fines are clearly punitive. Section 107(c)(3) also authorizes punitive, tr[redacted]amages. The EPA uses the threat of punitive damages as a negotiating [redacted]n58 Given the very real threat of punitive damages, CERCLA retroactivit[redacted] very nearly the same "ex post facto" danger referred to in Landgraf. 11[redacted]. at 1505-06. According to Landgraf, a provision for punitive damages should not be construed as retroactive unless the language forces that conclusion because the court must then confront substantial [*52] constitutional questions which follow.

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n58 The EPA's use of punitive damages is laid out in its "Superfund Enforcement Strategy and Implementation Plan," as reprinted in Alfred R. Light, CERCLA Law and Procedure Compendium at III-6:
As authorized under sections 106 and 107, the government will pursue cases involving treble damages and penalties for violations of unilateral and

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consent orders. Taking such actions is important for establishing a credible deterrent. These actions are available against persons who fail without sufficient c[redacted]to comply with orders.

- - - - - - [redacted] - - - - - - - - -End Footnotes- - - - - - - - - - - - - - - - - -

Regardless of the threat of punitive damages, retroactive CERCLA liability is more egregious than the compensatory relief which the Court refused to apply retroactively in Landgraf. In the instant and many other cases, liability under CERCLA would require compensation for actions which when taken violated no federal or state law. At least as to the compensatory damages remedy sought in Landgraf, it could be said that retroactivity [*53] involved no new legal standard concerning the conduct itself. n59 Nevertheless, even on the compensatory damages issue Landgraf says, "it is the kind of provision that does not apply in the absence of clear congressional intent." Certainly, under Landgraf principles, CERCLA liability is the kind that does not apply retroactivity without clear congressional intent.

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n59 See 114 S. Ct. at 1506:
It does not make unlawful conduct that was lawful when it occurred; as we have noted, supra, at 1490-1491, § 102 only reaches discriminatory conduct already prohibited by Title VII. Concerns about a lack of fair notice are further muted by the fact that such discrimination was in many cases (although not this one) already subject to monetary liability in the form of backpay. Nor could anyone seriously contend that the compensatory damages provisions smack of a "retributive" or other suspect legislative purpose. Section 102 reflects Congress' desire to afford victims of discrimination more complete redress for violations of rules established more than a generation ago in the Civil Rights Act of 1964. As least with respect to its compensatory damages provisions, then § 102 is not in a category in which objections to retroactive application on grounds of fairness have their greatest force.

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[*54]

As discussed above, pre-Landgraf cases addressing CERCLA retroactivity are unreliable. Among these cases, Justice places particular reliance on Northeastern[redacted]h characterizes CERCLA as "overwhelmingly remedial and retroactive[redacted]as having a "backward focus." Such labels only confuse the issue as ex[redacted]d by Landgraf. Legislation cannot be remedial if the conduct being "remedied" was lawful at the time of its occurrence. As discussed above, determining that a statute has "retroactive effect" is only part of the analysis; by itself, it does not indicate Congress' intent. Northeastern's statement about CERCLA having a "backward focus," is no more dispositive than a similar characterization of the compensatory damage provision discussed in Landgraf.

Unlike certain other forms of relief, compensatory damages are quintessentially backward-looking. Compensatory damages may be intended less to sanction wrongdoers than to make victims whole, but they do so by a mechanism that affects the liabilities of defendants. They do not "compensate" by

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distributing funds from the public coffers, but by requiring particular employers to pay for harms they caused. [*55] The introduction of a right to compensatory [illegible]ges is also the type of legal change that would have an impact on private p[illegible]s' planning.

114 S. Ct. at 1506. (emphasis added in first sentence only). Landgraf insists that in no case "in which Congress had not clearly spoken, have we read a statute substantially increasing the monetary liability of a private party to apply to conduct occurring before the statute's enactment." 114 S. Ct. at 1507. Liability under CERCLA certainly must be in accord with this principle. The fact that "retroactive application of [this] statute would vindicate its purpose more fully", as in Landgraf, "is not sufficient to rebut the presumption against retroactivity." Id. at 1507-08.

Only one sentence in Landgraf, if taken in isolation, lends any support at all to Justice's position. Near the end of the opinion, Landgraf says: "Section 102 is plainly not the sort of provision that must be understood to operate retroactively because a contrary reading would render it ineffective." Id. at 1508 (emphasis in original). Justice's argument boils down to a claim that CERCLA must be read to be retroactive.

Without any doubt, [*56] in CERCLA Congress is addressing an existing situation as well as future problems. In this respect, CERCLA certainly has a "backward focus." It does not follow, however, that the liability provision "must be understood to operate retroactively because a contrary reading would render it ineffective." Early on, the Justice Department itself argued, at least in the alternative, that CERCLA's liability provision need not be interpreted to be retroactive. See Georgeoff at 1304-1306. Quickly, however, that argument failed, but ultimately became unnecessary as courts approved of applying CERCLA retroactively. Citing certain "main policy objectives underlying CERCLA . . . and the need for a liberal interpretation of the Statute, the courts have expanded the scope of CERCLA liability well beyond anything that Congress itself could have envisioned." Allan J. Topol and Rebecca Snow, 1 Superfund Law and Procedure, § 1.1 at 6 (West Pub.; St. Paul, Minn. 1992).

Justice confuses what it, the EPA, and a number of courts consider desirable with what it can be said Congress clearly intended. Insofar as pre-enactment releases are concerned, the purpose of CERCLA can be covered through the Superfund. [*57] The EPA, however, has chosen to recover as much as possible from private parties, n60 no doubt in part due to Congress' failure to provide sufficient r[illegible]es to pay for cleaning all the sites, even as the need was thought to b[illegible]980. See Georgeoff 562 F. Supp. at 1312-13. While Georgeoff takes the la[illegible]funding as an indication of congressional intent to make CERCLA retro[illegible]; Id. at 1313, lack of funding does not render the operation of the statute itself ineffective in the sense used in Landgraf.

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n60 See "Superfund Enforcement Strategy and Implementation Plan" (Sept. 26, 1989) reprinted in Alfred R. Light, CERCLA Law and Procedure Conpendium (BNA, Washington, D.C., 1992) at III-2.
EPA will consider private party responses as the preferred approach for the majority of Superfund sites. At the same time, EPA will retain the maximum amount of leverage to use the Fund at specific sites where negotiations are unsuccessful. The goal of the government is to negotiate an agreement for 100%

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of response costs.

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[*58]

Landgraf mentions accepted means such as certain taxes and zoning regulations by which governments "impose burdens on past conduct." 114 S. Ct. at 1499, n. 24. n61 Such means, if not otherwise unconstitutional, allow legislators to "remedy" past conduct. Legislators can address environmental damage; however, under the "Takings Clause," n62 "confiscatory regulations ... cannot be newly legislated or decreed (without compensation), but must inhere in the title itself, in the restriction that background principles of the State's law of property and nuisance already place upon land ownership." Lucas v. So. Carolina Coastal Covn., 505 U.S. 1003, 1029, 112 S. Ct. 2886, 120 L. Ed. 2d 798 (1992). As Landgraf observes, the "Takings Clause" is one of several constitutional provisions which incorporate the anti-retroactivity provisions. 114 S. Ct. at 1497. Of course, agencies and officials at all levels of government generally would wish to induce or compel particular parties to pay for government initiatives rather than having to impose a general tax. However, the general presumption against retroactivity and particular constitutional provisions are designed to limit, and in some [*59] instances to prevent, governments from doing so.

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n61 See also 114 S. Ct. at 1506. ("They do not 'compensate' by distributing funds from public coffers, but by requiring particular employers to pay for harms caused.")

n62 U.S. Constitution, Amendment V.

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Ironically, the EPA has resisted the retroactivity principle when it would have worked in favor of private parties. Under Section 106(b)(2)(A), added in 1986 by Superfund Amendments and Reauthorization Act ("SARA"), private parties can seek certain reimbursement from the Superfund. n63 The EPA has "adopted the position that orders issued before the passage of SARA do not provide the petitioner with a right to reimbursement against the Fund." 2 Superfund Law and Procedure supra § 11.1 at 272 (footnote omitted). Courts have generally agreed with the EPA [illegible]tion. See cases cited in id., n. 7-10.

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n63 Section 106(b)(2)(A) provides that "any person who receives and complies with the liens of any [Section 106(a) order] may, within 60 days after completion of the required action, petition the President for reimbursement from the Fund for the reasonable costs of such action, plus interest."

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[*60]

Nothing presented in the Justice Department brief or pre-Landgraf cases concerning the statutory language of CERCLA or its legislative history

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demonstrates that Section 107(a) (and/or Section 106(a) as related to it in this case) is "the sort of provision that must be understood to operate retroactively because a co[illegible]y reading would render it ineffective." 114 S. Ct. at 1508. Accordingly, [illegible] court holds that Section 107(a), a Section 106(a) as linked to it in this c[illegible]re not retroactive.

III. CONSTITUTIONAL ISSUES

The holding that Sections 106(a) and 107(a) cannot be given retroactive effect resolves much, but not all, of this case. Moreover, because of the court's statutory interpretation holding, the court need not rule on the due process constitutional issue, which applies only to pre-enactment conduct. The complaint, however, covers conduct which, while largely occurring prior to the effective date of CERCLA in 1980, includes some post-enactment conduct. n64 As the defendant mentions in its brief, the provisions of the consent decree respond "mostly with respect to waste disposal activities that preceded the enactment of CERCLA in 1980" (emphasis added). [*61] After briefly addressing one constitutional issue which has been mooted by the court's holding on pre-enactment conduct, the court considers more fully those constitutional issues which are not limited to pre-enactment conduct.

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n64 See Complaint P's 12 and 18.

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A. Retroactivity and Due Process

Landgraf recognizes the due process and other constitutional concerns lurking in the background of the interpretive issue of whether Congress intended retroactive application. See 114 S. Ct. at 1497-98. Such constitutional considerations seem to have contributed to the Court's confirmation of the presumption against retroactivity. Yet, with the possible exception of a punitive damages provision, the Court seems to accept that Congress has the constitutional power to give a statute retroactive effect if it clearly intends to do so. Landgraf, 114 S. Ct. at 1499 ("Since the early days of this Court, we have declined to give retroactive effect to statutes burdening private rights unless Congress [*62] has made its intent clear." (emphasis added)). Given the court's statutory interpretation of CERCLA, there is no need to reach the constitution[illegible]idity of retroactive application of CERCLA under the due process cla[illegible].

B. Deleg[illegible]f Legislative Power

The defendant contends that CERCLA unconstitutionally "delegates to EPA the basic policy decisions" with "no 'intelligible standard' to guide EPA's decisions about which contaminated sites pose significant risks and how much money should be spent to reduce or eliminate such risks." Def.'s Mem. of Law in Resp. to Ct.'s Ord. of Sept. 19, 1995 at 20-21. This constitutional challenge attacks CERCLA as generally administered by the EPA. This broader challenge based on the non-delegation doctrine has not been mooted by the holding that CERCLA liability cannot be applied retroactively.

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The EPA's decision to apply CERCLA retroactively against private parties represents one example of what the defendant contends is the unauthorized exercise of [redacted]lative power. One way of understanding the decision in Landgraf is to view i[redacted]applying a specific rule of non-delegation, namely that Congress ca[redacted]eave such a basic legislative [*63] decision as a statute's possible retroactivity to the executive and judicial branches. Both the presumption against retroactivity and the non-delegation doctrine derive from the more fundamental doctrine of separation of powers. Thus, Landgraf cites INS v. Chadha, 462 U.S. 919, 103 S. Ct. 2764, 77 L. Ed. 2d 317 (1983), in support of the proposition that "even the will of the majority does not become law unless it follows the path charted in Article I, § 7, cl. 2 of the Constitution." 114 S. Ct. at 1496. Landgraf could also have cited Chadha as to what is "essentially legislative", namely Congressional "action that [has] the purpose and effect of altering the legal rights, duties, and relations of persons." 462 U.S. at 952.

Chadha, which is the first modern case to declare a congressional statute unconstitutional on clear separation-of-powers grounds, illustrates the relationship between the general doctrine and particular constitutional provisions. Chadha declares the one-house legislative veto void because it violates the bicameralism and the presentment clauses. Following Chadha, a line of separation-of-powers cases raise various issues, including [*64] delegation of powers and removal from office. See Metro. Washington Airports Author. v. Citizens for the Abatement of Aircraft Noise, Inc., 501 U.S. 252, 111 S. Ct. 2298, 115 L. Ed. 2d 236 (1991) (invalidating a provision in a federal statute approving an agreement for the transfer of two Washington-area airports from the U.S. Department of Transportation to an "Airports Authority," which created a "Board of Review" consisting of nine members of Congress because it violated separation of powers either by allowing members of Congress to exercise executive power or by allowing members of Congress to enact legislation without complying with the bicameralism and presentment requirements of the Constitution.); Mistretta v. United States, 488 U.S. 361, 109 S. Ct. 647, 102 L. Ed. 2d 714 (1989) (finding no separation-of-powers violation in a statute establishing the United States Sentencing Commission as "an independent commission in the judicial branch of the United States" with removal by the President of commission members; Morrison v. Olson, 487 U.S. 654, 108 S. Ct. 2597, 101 L. Ed. 2d 569 (1988) (finding no separation -of- powers violation in a statute providing for the appointment [*65] of "Independent Counsel" by a panel of Article III judges and removal only for cause by the Attorney General.); Bowsher v. Synar, 478 U.S. 714, 106 S. Ct. 3181, 92 L. Ed. 2d 583 (1984) (holding that the provision in the Balanced Budget and Emergency Deficit Control Act [redacted] executive power to the Comptroller General, who was removable by Congress, [redacted]tes separation of powers).

In Chadh[redacted]issent worried that the Court's decision threatened the "modern administrative state." See 462 U.S. at 984-89. As the post-Chadha cases summarized above reflect, the Court has not consistently pursued a rigorous separation-of-powers approach. n65 Consequently, the modern administrative state has not been much disturbed by the line of cases cited above. A rigorous separation-of-powers approach, which would include a stricter non-delegation doctrine, would greatly curtail the rule-making authority of administrative agencies, n66 including the EPA. n67 By itself, however, a broad non-delegation constitutional challenge to CERCLA cannot currently succeed. Under present Supreme Court jurisprudence, "there is no significant 'anti-delegation' principle which restricts the exercise of [*66] the commerce power." John E. Nowak and Ronald D. Rotunda, Constitutional Law (St. Paul, West; 1995) at 156.

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n65 It is [redacted]h mentioning that the two cases in which the Court fails to find a viola[redacted]of separation of powers, Morrison and Mistretta, involve statutes which give powers to the judiciary.

n66 Professor Bernard Schwartz has written about a first draft of the Bowsher opinion which would have cast doubt on the constitutionality of independent agencies:

since it virtually would have placed the Supreme Court imprimatur upon the claim that independent agencies are unconstitutional.

. . . .

. . . The years before Bowsher had seen a revival of the claim that the independent agencies were unconstitutional because, though they exercised "executed power," they were not subject to presidential control. The argument against the agencies received the support of the Reagan Department of Justice. . . .

n67 The activities of the EPA under CERCLA include a double delegation. First, Congress has delegated to the President. Sec. 106. Then the President has delegated to EPA. (Executive Order 12580 of January 3, 1987).

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[*67]

A year ago, of course, it could have been said that almost nothing restricts Congress' exercise of the commerce power. In the interim, the jurisprudence has become unsettled due to the Supreme Court's decision in United States v. Lopez, 514 U.S. , 115 S. Ct. 1624, 131 L. Ed. 2d 626 (1995), which, for the first time in more than fifty years, struck down a congressional statute which regulates non-state activity n68 on grounds that it exceeded Congress' power under the Commerce Clause. Some of the concerns raised by the defendant under the non-delegation doctrine overlap with the issues in Lopez, to which this court now turns.

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n68 Nati[redacted]eague of Cities v. Usery, 426 U.S. 833, 96 S. Ct. 2465, 49 L. Ed. 2d 245 [redacted] overruled by Garcia v. San Antonio Metro Transit Auth. 469 U.S. 528, 1[redacted]ct. 1005, 83 L. Ed. 2d 1016 (1985), invalidated provisions in the Fair Labor Standards Act applicable to state and local governments as exceeding Congress' power under the Commerce Clause.

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[*68]

C. The Commerce Clause

The Supreme Court's interpretation of the Commerce Clause has expanded greatly over the better part of the last two centuries. In one pre-Lopez case, a federal district court described the expansion of that clause as follows:

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To be within the ambit of the Commerce Clause, an activity originally had to be commerce that moved across state lines. With time, courts began to hold that the commerce need only affect movement across state lines. Finally, courts dropped the commerce requirement and applied the Clause to any activity that affects movement across state lines. The sole remaining limitations on Congress's power under the Commerce Clause is the requirement that the effect on commerce be substantial.

Michigan Protection & Advocacy Service v. Babin, 799 F. Supp. 695, 735 (E.D. Mich. 1992), aff'd, 18 F.3d 337 (6th Cir. 1994).

Since the 1930's the Supreme Court has found very little in the Constitution that limits Congress' power to justify legislation under the Commerce Clause. Prior to United States v. Lopez, 514 U.S. , 114 S. Ct. 1624 (1995), the only unsettled area appeared to involve the ability of Congress [*69] to regulate states themselves. In National League of Cities v. Usery, 426 U.S. 833, 49 L. Ed. 2d 245, 96 S. Ct. 2465 (1976) the Court held that the Commerce Clause did not give Congress power to regulate "the state as a state." n69 A few years later, the Court overturned National League of Cities by its decision in Garcia v. San Antonio 469 U.S. 528, 83 L. Ed. 2d 1016, 105 S. Ct. 1005 (1985), holding that the sovereignty of the states does not limit Congress' power under the Commerce Clause. n70 Then, somewhat inconsistently, the Court decided in United States v. New York, 505 U.S. 144, 112 S. Ct. 2408, 120 L. Ed. 2d 120 (1992), that the Constitution does not give Congress power to "Commandeer the legislative procedure of the states by directly compelling them to enact and enforce a federal regulatory program." Id. at 2428 (quotation omitted). While the holding in New York did not rest on the Tenth Amendment, the Court noted that "the Tenth Amendment confirms that the power of the Federal Government is subject to limits that may, in a given instance, reserve power to the states." Id. at 2418. The application of the federalism principles found in New York [*70] has remained somewhat uncertain as reflected in recent federal circuit cases ruling on the Brady Bill. n71 At the same time, however, the Court has recently reaffirmed the traditional principles of state sovereignty in a case from this circuit, Seminole Tribe of Fla. v. Florida, U.S. , 116 S. Ct. 1114, 134 L. Ed. 2d. 252 (1996), which rejected the principle that Congress' Commerce Clause power could be used to overrule a state's sovereign immunity. n72

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n69 The particular issue involved the application of the Fair Labor Standards Act to state and local government.

n70 Again the particular issue involved the Fair Labor Standards Act.

n71 Contrast Koog v. United States, 79 F.3d 452 (5th Cir., 1996) (holding the Brady Act exceeds Congress' power per New York v. United States, insofar as it requires local law enforcement official to administer the Act) with Mack v United States, 66 F.3d 1025 (9th Cir. 1995) (upholding the Brady Act against a challenge under New York v. United States).

n72 The particular case involved the Indian Commerce Clause, but the case overruled Pennsylvania v. Union Gas Co., 491 U.S. 1, 109 S. Ct. 2273, 105 L. Ed. 2d 1 (1988), which involved the general Commerce Clause.

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[*71]

United St[redacted]v. Lopez did not involve federal regulation of a state itself. Rather, the federal gun statute at issue attempted to exercise police power over matters historically falling within the jurisdiction of local government. In declaring Congress had exceeded its powers under the Commerce Clause in regulating non-state action, the Court seemed to open up many questions. The dissenting Justices warned that "the Court's holding threatens legal uncertainty in an area of law that, until [Lopez], seemed reasonably well settled." Id. at 514 U.S. , 115 S. Ct. at 1664 (Breyer, J., dissenting). The dissenters were clearly concerned that changes which occurred in landmark cases in the late 1930's and early 40's could be overturned. Id. at 514 U.S. , 115 S. Ct. at 1665.

Despite the potential for uncertainty, the majority focused on the Constitution's limits on federal power. They emphasized that the Constitution does not grant Congress "a plenary police power that would authorize enactment of every type of legislation." Id. at , 115 S. Ct. at 1633. While a few of its cases had "taken long steps" towards granting such "a general police [*72] power of the sort retained by the states," the Court declined to follow some of the very broad language which seemed to allow Congress to do virtually anything under the Commerce Clause. Id. at , 115 S. Ct. at 1634.

Any application of Lopez must begin with its reassertion that the Constitution's enumeration of powers limits federal power, that such enumeration "[does] not presuppose something not enumerated." Id. at , 115 S. Ct. at 1634 (citing Gibbons v. Ogden, 22 U.S. (9 Wheat.) at 195, 6 L. Ed. 23 (1824)).

Since this country's inception, the division of powers between the state and federal governments has been a constant source of friction. Indeed, that conflict was considered an important institutional protection for liberty. n73 Moreover, federal courts have been considered essential to preserving the federal state balance. n74 Thus, in performing its duty to elucidate the meaning of the Constitution in such a way as to reconcile prior case law with the meaning of the Constitution itself, n75 the federal courts play an important part in maintaining federalism.

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n73 See [redacted]lly The Federalist No.39. [*73]

n74 See [redacted]he Federalist No. 44, at 233 (James Madison) (George W. Carey and James McClellan eds., 1990)
(If it be asked what is to be the consequence, in case the Congress shall misconstrue this part of the Constitution, and exercise powers not warranted by its true meaning? I answer the same as if they should misconstrue or enlarge any other power vested in them, as if the general power had been reduced to particulars, and any one of these were to be violated; the same in short, as if the State Legislatures should violate their respective constitutional authorities. In the first instance, the success of the usurpation will depend on the executive and judiciary departments, which are to expound and give effect to the legislative acts; and in the last resort, a remedy must be obtained by the people, who can by the election of more faithful representatives, annul the

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acts of the usurpers.);

See also McCu[redacted] v. Maryland 17 U.S. (4 Wheat.) 316, 423, 4 L. Ed. 579 (1819) (Marshall, C[redacted] ("Should Congress, under the pretext of executing its powers, pass laws fo[redacted] accomplishment of objects not entrusted to the government, it would become[redacted] painful duty of this tribunal, should a case requiring such a decision come before it, to say that such an act was not the law of the land.); The Federalist No. 78, at 404 (Alexander Hamilton) (George W. Carey and James McClellan eds., 1990) (referring to the courts as "the bulwarks of a limited constitution against legislative encroachments."). [*74]

n75 "The ultimate touchstone of constitutionality is the Constitution itself and not what we have said about it." Graves v. O'Keefe, 306 U.S. 466, 491-492, 59 S. Ct. 595, 603-604, 83 L. Ed. 927 (1939) (Frankfurter, J., concurring). But see Cooper v. Aaron 358 U.S. 1, 18, 78 S. Ct. 1401, 3 L. Ed. 2d 5 (1958) (per curiam) (dictum) (characterizing decisions of the Supreme Court as "the supreme law of the land"); see also Addresses and Papers of Charles Evans Hughes 133, 139 (1908) (speech to the Elmira Chamber of Commerce (May 3, 1907)) ("The Constitution is what the judges say it is.).

See also Justice Thomas' concurrence: "Although I join the majority, I write separately to observe that our case law has drifted far from the original understanding of the Commerce Clause. In a future case, we ought to temper our Commerce Clause jurisprudence in a manner that both makes sense of our more recent case law and is more faithful to the original understanding of that Clause." Id. at 514 U.S. , 115 S. Ct. at 1642. In short, as the majority in Lopez implicitly recognized, it is our jurisprudence that must be squared with the constitution, not the other way around.

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Accordingly, this court applies the principle of enumerated powers discussed in Lopez to the question of CERCLA'S constitutionality. In so doing, this court finds that, when measured against the "ultimate touchstone of constitutionality," Graves v. O'Keefe, 306 U.S. 466, 491-492, 59 S. Ct. 595, 603-604, 83 L. Ed. 927 (1939) (Frankfurter, J., concurring), the application of CERCLA to this case exceeds the power given Congress under the Commerce Clause.

1. The Constitutional Text and Its Original Interpretation

As stated [redacted]pez:

We start [redacted]irst principles. The Constitution creates a Federal Government of enumerated powers. See U.S. Const., Art. I, § 8. As James Madison wrote, "the powers delegated by the proposed Constitution to the federal government are few and defined. Those which are to remain in the State governments are numerous and indefinite." The Federalist No. 45, pp. 292-293 (C. Rossiter ed. 1961). This constitutionally mandated division of authority "was adopted by the Framers to ensure protection of our fundamental liberties." Gregory v. Ashcroft, 501 U.S. 452, 458, 111 S. Ct. 2395, 2400, 115 L. Ed. 2d 410 (1991) (internal quotation [*76] marks omitted). "Just as the separation and independence of the coordinate branches of the Federal Government serves to prevent the accumulation of excessive power in any one branch, a healthy balance of power between the States and the Federal Government will reduce the risk of tyranny and abuse

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from either front." Ibid.

Lopez, 514 U[redacted]t , 115 S. Ct. at 1626 (opinion of Rehnquist, C.J.); see also Id. 514[redacted] at , 115 S. Ct. at 1638 (Kennedy, J., concurring) ("It was the insight [redacted]e Framers that freedom was enhanced by the creation of two governments, not one").

Perhaps, "it is easy to lose sight of all this in a day when Congress appropriates trillion-dollar budgets and regulates myriad aspects of economic and social life. Nevertheless, there are occasions on which we are reminded of this fundamental postulate of our constitutional order." United States v. Lopez, 2 F.3d 1342, 1345 (5th Cir. 1993), aff'd, 514 U.S. , 115 S. Ct. 1624, 131 L. Ed. 2d 626 (1995).

a. Enumerated Powers and the Necessary and Proper Clause

The Constitution enumerated the powers of Congress in Article I, Section 8, which begins: "The Congress [*77] shall have the Power To . . . ." Then, in the following eighteen clauses, the text listed the powers given to Congress, including the Commerce Clause and the Necessary and Proper Clause.

From the beginning, the import of the necessary and proper clause was controversial. In the administration of George Washington, Secretary of State Thomas Jefferson argued for a narrow or strict interpretation of the enumerated powers. n76 His views reflected those of the anti-Federalists who had opposed the Constitution, in large measure from fear of the necessary and proper clause. They desired a provision like the one in the Articles of Confederation which had limited the powers of the government to those "expressly" delegated by the states. The anti-Federalists lost this argument, even when they got the Tenth Amendment as part of the Bill of Rights, as this amendment failed to use the term "expressly. n77" In opposition to Jefferson, Alexander Hamilton -- following the Federalist -- argued for a broader interpretation of the enumerated powers, but nevertheless one within the structural constraints of the Constitution. As Hamilton had written in The Federalist, no one was proposing an all-powerful [*78] government; only a more powerful central government than that of the Articles of Confederation. n78

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n76 See Carl B. Swisher, American Constitutional Development at 72-73, Riverside P[redacted]1943).

n77 The [redacted]mendment states, "The powers not delegated to the United States by th[redacted]titution, nor prohibited by it to the States, are reserved to the States respectively, or to the people.

n78 See generally, The Federalist Nos. 23-36.

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The views of Hamilton and The Federalist found their way into the Marshall Court, which is hardly surprising since the Court was dominated by Federalists. The same basic Federalist viewpoint which created the text of the Constitution also interpreted that text. Moreover, Chief Justice Marshall's opinions coincided with The Federalist without ever citing those essays. n79

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Apparently, Marshall's point was to derive meaning directly from the text and structure of the Constitution rather than to rely on a secondary source.

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n79 See J[illegible]ve, "Early Uses of The Federalist" in Saving the Revolution (C. Kessler, ed.) (N.Y., 1987) at 240 ("his jurisprudence and its Hamiltonian strains were independent expressions of a set of principles and beliefs that both men had long shared ... In fact, Marshall rarely made use of The Federalist in his opinions.") (footnotes omitted)

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[*79]

Marshall's opinion in McCulloch v. Maryland, 17 U.S. (4 Wheat.) 316, 4 L. Ed. 579 (1819) is often referred to as giving a broad interpretation of the necessary and proper clause. In fact, McCulloch demonstrated that the necessary and proper clause is unnecessary. That is to say, McCulloch first explained how a proper interpretation of the enumerated powers supports Congress' power to create the Bank of the United States. n80 The fact that Congress did not have the power generally to create corporations (and still does not attempt to exercise such a power) did not mean it lacked the power to create a particular corporation as a means to the exercise of one or more of its clearly enumerated powers.

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n80 McCulloch v. Maryland, 17 U.S. (4 Wheat.) at 407-408.

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The necessary and proper clause in no way expanded the enumerated powers of Congress; n81 it simply left no doubt that Congress has the fullness of those powers actually granted in the Constitution. McCulloch, therefore, followed the explanation [*80] of the necessary and proper clause as provided in The Federalist, namely that it is merely "declaratory of a truth, which would have resulted by necessary and unavoidable implication from the very act of constituting a Federal Government, and vesting it with certain specified powers." The Federalist No. 33, at 159 (George W. Carey and James McClellan eds., 1990) (arguing further that "the constitutional operation of the intended government would be precisely the same, if [the Necessary and Proper Clause and the Supremac[illegible]se] were entirely obliterated, as if they were repeated in every artic[illegible] See also The Federalist No. 44, at 232 (George W. Carey and James McCle[illegible]s., 1990) ("No axiom is more clearly established in law, or in reason, than that wherever the end is required, the means are authorized; wherever a general power to do a thing is given, every particular power necessary for doing it, is included.") (emphasis added). Echoing this reading of the text, McCulloch v. Maryland stated, "it may with great reason be contended, that a government, entrusted with such ample powers, on the due execution of which the happiness and prosperity of [*81] the nation so vitally depends, must also be entrusted with ample means for their execution." (emphasis added) 17 U.S. (4 Wheat.) 316, 408, 4 L. Ed. 579 (1819).

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n81 "The doctrine that Congress may provide for regulation of activities not themselves interstate commerce, but merely 'affecting' such commerce, rests on the premise [illegible]in certain fact situations the Federal government may find that regulation o[illegible]ly local and intrastate commerce is 'necessary and proper' to prevent inju[illegible] interstate commerce." Polish National Alliance of the United States of No[illegible]merica v. National Labor Relations Board, (Black J., concurring) 322 U.S. 643, 652, 64 S. Ct. 1196, 88 L. Ed. 1509 (1944).

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In McCulloch, Marshall discussed the relationship between ends and means as applied to the necessary and proper clause: "Let the end be legitimate, let it be within the scope of the constitution, and all means which are appropriate, which are plainly adapted to that end, which are not prohibited, but consist of the letter and spirit [*82] of the constitution, are constitutional." McCulloch, 17 U.S. at 421. According to Chief Justice Marshall, McCulloch represented no augmentation of the enumerated powers. Writing in defense of the opinion under the pseudonym "A Friend of the Constitution," Marshall insisted that McCulloch "does not contain the most distant illusion to any extension by construction of the powers of congress. Its sole object is to remind us that a constitution cannot possibly enumerate the means by which the powers of government are to be carried into execution." n82 McCulloch's statement that we must remember that it is a constitution we are interpreting was not a justification for departing from the text, but an indication of how to interpret the text, i.e., not narrowly like a statute. n83 Thus, Marshall stated that a Constitution does not "partake of a prolixity of a legal code." McCulloch, 17 U.S. at 407.

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n82 G. Gunther, ed., John Marshall's Defense of McCulloch v. Maryland 185.

n83 See discussion of McCulloch by Justice Story in II Commentaries on The Constitution, §§ 1263-70 (Cambridge; MA, 1858) (3rd ed.) at 149-161.

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[*83]

The necessary and proper clause is like the Tenth Amendment in that both declare what the structure of the Constitution already provides. As Chief Justice Mars[illegible] and The Federalist say, the necessary and proper clause merely declares th[illegible] powers given to the federal government are given in their fullness. T[illegible]se does not mean -- as anti-Federalists feared -- that Congress ca[illegible] other powers not listed by invoking the necessary and proper clause. Accordingly, the Tenth Amendment reflects the attempt to quiet what Federalists at the time considered to be unfounded fears. Thus, "the Tenth Amendment does not independently provide a substantive limitation on the powers of the United States. Instead the Tenth Amendment simply makes plain that the federal government possesses only the powers that have been given to it by the Constitution--and no more." Koog v. United States, 79 F.3d at 455, (5th Cir., 1996).

b. Marshall's Interpretation of the Commerce Clause

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The power referred to as "the Commerce Clause", Article I, Section 8 provides: "The Congress shall have Power ... To regulate Commerce with foreign Nations, and among the several States, and with the Indian [*84] Tribes." U.S. Const. Art. I, § 8, cl. 3. "Even to speak of 'the Commerce Clause,' perhaps obscures the federal scope of that clause because Congress did not have authority to regulate all commerce; Congress could only regulate Commerce with foreign Nations, and among the several States, and with the Indian' Tribes.'" Lopez, 514 U.S. at , n. 2, 115 S. Ct. at 1644 n. 2 (Thomas, J., concurring).

Five years after McCulloch, Chief Justice Marshall wrote Gibbons v. Ogden, 22 U.S. (9 Wheat.) 1, 6 L. Ed. 23 (1824) which is the classic analysis of the text of the Commerce Clause in its fullness. n84 He addressed the three questions which naturally follow from the language of the "power to regulate commerce among the several states." He discussed: 1) whether the subject of the congressional legislation is commerce; 2) whether the commerce affects other states; and 3) whether the legislation regulates the commerce. n85 Neither the text nor Gibbons use the term "interstate." As to the phrase "among the several states," Gibbons asks whether the commerce affects other states, not whether some activity affects interstate commerce. The text and Gibbons ask whether [*85] the federal legislation regulates the commerce, not some activity which affects interstate commerce. n86

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n84 The language of the clause differs in its choice of prepositions to precede "foreign Nations," i.e.. "with," and States, i.e., "among". The import of the difference becomes readily apparent by using the preposition "among" to precede "foreign Nations." The power to regulate commerce "among" is a superintending power which Congress possesses vis-a-vis the states, but obviously not vis-a-vis foreign nations.

n85 22 U.S. 1, 9 Wheat. (22 U.S.) 1, 189-197, 6 L. Ed. 23 (1824).

[The] words are, "Congress shall have power to regulate commerce with foreign nations, and among the several states, and with the Indian tribes."

The subject to be regulated is commerce; and... [to] ascertain the extent of the power, it becomes necessary to settle the meaning of the word. The counsel for the appellee would limit it to traffic, to buying and selling, or the interchange of commodities, and do not admit that it comprehends navigation. This would restrict a general term, applicable to many objects, to one of its significations. Commerce, undoubtedly, is traffic, but is something more; it is intercourse. It describes the commercial intercourse between nations, and parts of nations, in all its branches, and is regulated by prescribing rules for carrying on that intercourse...

....

To what commerce does this power extend? The constitution informs us, to commerce "with foreign nations, and among the several states, and with the Indian tribes.

It has [been] universally admitted that these words comprehend every species of commercial intercourse between the United States and foreign nations. No sort of trade can be carried on between this country and any other, to which this

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power does not extend...

[The] sub[redacted]to which the power is next applied, is to commerce "among the several stat[redacted]The word "among" means intermingled with. A thing which is among others[redacted]intermingled with them. Commerce among the states cannot stop at the external[redacted]ndary line of each state, but may be introduced into the interior.

It is not intended to say that these words comprehend that commerce which is completely internal, which is carried on between man and man in a state, or between different parts of the same state, and which does not extend to or affect other states. Such a power would be inconvenient, and is certainly unnecessary.

Comprehensive as the word "among" is, it may very properly be restricted to that commerce which concerns more states than one. The phrase is not one which would probably have been selected to indicate the completely interior traffic of a state, because it is not an apt phrase for that purpose; and the enumeration of the particular classes of commerce to which the power was to be extended, would not have been made, had the intention been to extend the power to every description. The enumeration presupposes something not enumerated; and that something, if we regard the language or the subject of the sentence, must be the exclusively internal commerce of a state. The genius and character of the whole government seem to be, that its action is to be applied to all the external concerns of the nation, and to those internal concerns which affect the states generally; but not to those which are completely within a particular state, which do not affect other states, and with which it is not necessary to interfere, for the purpose of executing some of the general powers of the government. The completely internal commerce of a state, then, may be considered as reserved for the state itself.

....

[We] are now arrived at the inquiry -- What is this power?

It is the power to regulate; that is, to prescribe the rule by which commerce is to be governed. This power, like all others vested in Congress, is complete in itself, may be exercised to its utmost extent, and acknowledges no limitations, other than are prescribed in the constitution... [If], as has always been understood, the sovereignty of Congress, though limited to specified objects, is [redacted]y as to those objects, the power over commerce with foreign nations, an[redacted]g the several States, is vested in Congress as absolutely as it would be in[redacted]le government, having in its constitution the same restriction[redacted]n exercise of the power as are found in the constitution of the United States.
[*86]

n86 Justice Thomas makes a different critique of the Court's jurisprudence. He says that the "substantially affects" language so broadens Congress's power that much of Art. 1, Sec. 8 becomes "surplusage." (Thomas, J., concurring).

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2. Deconstruction of the Constitutional Text

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The shift in focus from the text itself to a distinction between interstate and intrastate commerce came later. Lopez did not discuss specifically this transformati[redacted]e several opinions mentioned in Lopez, however, did relate that the exp[redacted] use of the Commerce Clause began with the Interstate Commerce Act of 1887, [redacted]115 S. Ct. at 1627, and that in reviewing congressional legislation, the Court had borrowed, inappropriately as Chief Justice Rehnquist noted, from its negative or dormant Commerce Clause jurisprudence which pertained to state legislation. Id.

a. The Influence of the Dormant Commerce Clause

As is generally recognized, the early dormant commerce clause cases divided federal and state powers in analytical or categorical terms. In Cooley v. Bd. of Wardens of the Port of [*87] Philadelphia, 53 U.S. 299, 12 HOW 299, 13 L. Ed. 996 (1851), the Court drew a distinction between those things subject to national regulation and those subject to local regulation. n87 Such an approach, unlike that of Marshall, n88 was bound to fail. Under this analysis, the Court decided whether the object of regulation was or was not local. If it was "local", the Court allowed the state to regulate it; if national, states could not regulate it. Whatever merit this approach may have to analysis of state regulatory power, n89 its application to federal statutes inappropriately limited Congress. That is to say, the Court declared in some cases that Congress could not regulate things that the Court declared were "local." The Court ignored the possibility that something might be local, in the sense that a state could regulate it, without being beyond Congress' reach. This approach, epitomized later by Hammer v. Dagenhart, 247 U.S. 251, 38 S. Ct. 529, 62 L. Ed. 1101 (1918), failed to acknowledge that both the state and federal governments might regulate the same commerce because even though it was "local" in a certain sense it was also affecting other states.

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n87 12 HOW at 319-320. [*88]

n88 Although the Marshall Court did not address many Commerce Clause Cases, either active or dormant, it did address both. The Court decided Willson v. The Black Bird Creek Marsh Co., 27 U.S. 245, 7 L. Ed. 412 (1829) and Brown v. Md., 25 U.S. 419, 6 L. Ed. 678 (1827).

n89 Whether the Constitution contains a "dormant" Commerce Clause is not an issue in thi[redacted]. See Justice Scalia's argument that the Constitution does not contain a d[redacted] commerce clause in Tyler Pipe Industries v. Washington, 483 U.S. 232, 1[redacted]t. 2810, 97 L. Ed. 2d 199 (1987) (Scalia, J., concurring).

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The faulty framework of analysis adapted from the dormant Commerce Clause then got mixed in with the confusion between regulating commerce and exercising police powers -- a distinction critical to Lopez. Beginning in the late 19th century a dialectual process occurred between the Court and Congress that expanded Congress' power. n90 The process began when Congress attempted to prohibit transmission by mail or importation of lottery tickets. When this failed, Congress also prohibited [*89] the transportation of lottery tickets across state lines in the 1895 Lottery Act. n91 In Champion v. Ames n92 (upholding the constitutionality of the Lottery Act), the Supreme Court

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divided over the question whether regulating the movement of lottery tickets was within congressional power or within the police power of the states. In upholding th[redacted]hibition, the majority noted that it considered the purpose of the Act pert[redacted] to the constitutional question. The Court recognized a general police powe[redacted]ongress to eliminate evils which threaten the general welfare. n93

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n90 Much of this historical overview summarizes part of an article by John S. Baker, Jr., "Nationalizing Criminal Law: Does Organized Crime Make It Necessary or Proper?", 16 Rutgers L.Rev. 495, 521-531 (1985).

n91 Act of March 2, 1895, ch. 191, 28 Stat. 963.

n92 188 U.S. 321, 23 S. Ct. 321, 47 L. Ed. 492 (1903).

n93 Id. at 355-57.

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The dissent in Champion contended, inter alia, that the prohibition [*90] was not within the necessary and proper power of Congress because, while the "purpose" of the Act was the suppression of lotteries, the exercise of a general police power by the Congress conflicted with the powers reserved to the states under the Tenth Amendment. n94 In fact, the Act neither interfered with the police powers of any state nor represented a general, national police power. As the dissent itself noted, the Act did not prevent lotteries in states which chose to legalize them. n95 What the Act did was to prevent a seller of lottery tickets in a state where lotteries were legal from sending those lottery tickets into other states where lotteries were illegal. As a result of a previous Supreme Court decision, n96 a state on its own authority could not prohibit items from being mailed into or otherwise transported into its jurisdiction. Thus, regardless of the congressional motive or the broad dicta in the Champion opinion, the Lottery Act regulated a matter (cross-border movement of certain commerce) which the Court's interpretation of the dormant Commerce Clause had placed beyond the power of the states. n97 Champion exemplified Congress' use of the prohibiting technique [*91] to regulate, indeed to prevent, the flow of certain commerce across state lines. n98

- - - - - - [redacted] - - - - - - - - - -Footnotes- - - - - - - - - - - - - - - - - - -

n94 Id. [redacted] (Fuller, C.J., dissenting).

n95 Id. at 357.

n96 In Leisy v. Hardin, 135 U.S. 100, 10 S. Ct. 681, 34 L. Ed. 128 (1890), the Court had prohibited states from blocking shipments of liquor into the state.

n97 Id.

n98 The sale of lottery tickets in Louisiana was local as long as restricted to the state. Once they moved across state lines, they affected other states. Congress at the time, but not the Court, understood this difference.

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While the [redacted]ent in Champion incorrectly argued that Congress' "purpose" made the sta[redacted]y prohibition improper, the majority also erred when it suggested that Congress had the power to prohibit because of its worthy purpose. The Court should have held that Congress has the power to prohibit the movement of commerce across state lines regardless of purpose. n99 Had this been made clear, the Court might not have later struck down the [*92] child labor laws in Hammer v. Dagenhart n100 based on what the majority considered to be an improper purpose. After Champion, however, the power to prohibit seemed to turn on the purpose. n101 Indeed, members of Congress read Champion as positing a national police power premised upon purpose. n102

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n99 See United States v. Darby, 312 U.S. 100, 115, 61 S. Ct. 451, 85 L. Ed. 609 (1941) (upholding Fair Labor Standards Act of 1938).

n100 247 U.S. 251, 38 S. Ct. 529, 62 L. Ed. 2d 1101 (1918).

n101 Congress' purpose in passing the statute is one thing; the statute's inclusion of the word "purpose" as an element in the proof of the offense is another. Mann Act § 2, quoted supra note 128. As for Congress, its purpose in the sense of its motive for passing the legislation might or might not have been accurately incorporated into the purpose of the statute as evidenced by its language. Thus, although the legislative history of a statute such as the Mann Act may have reflected Congress's limited purpose, i.e., to stop the systematic enticement and interstate transportation of women for purposes of prostitution, proponents of the Act emphasized that its provisions did not reach prostitution or immorality "per se," but only interstate and international "white slave trade." H.R. Rep. No. 47, supra note 129, at 1-2, 9-11; E. Levi, An Introduction to Legal Reasoning 36-38 (1949).

The interpretation of the statutory language may not be limited to the legislative purpose. Thus, in Caminetti v. United States, 242 U.S. 470, 37 S. Ct. 192, 61 L. Ed. 442 (1917), the Supreme Court found that the statute reflected much broader purposes. The actual language of the statute was not as limited as the legislative history would indicate, but extended to single incidents of transportation for "any immoral purpose." In Caminetti Justice McKenna dis[redacted] because he thought the Court's construction of the Act went beyond the [redacted]es intended by Congress. Yet, previously, in Hoke v. United States, 227 [redacted]08, 33 S. Ct. 281, 57 L. Ed. 523 (1913) he wrote the opinion upholding th[redacted] Act against a Commerce Clause challenge. Had Justice McKenna paid more attention to the statute itself in Hoke, he would have seen that its language went well beyond the congressional purposes. As an element of the offense, the word "purpose" required the prosecution to prove the defendant had a certain criminal intent. Congress' purpose in putting the word "purpose into the statute was clear; it appeared to provide a Commerce Clause justification for purporting to prohibit the transportation of persons within the country. The effect of regulating persons based on their purposes, i.e., motive or intent, however, was to create a "true" crime rather than a regulatory offense. [*93]

n102 Thus, Congress thought purpose provided the constitutional justification for passage of the Mann (White Slave) Act. White-Slave Traffic (Mann) Act, ch.

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395, § 2, 36 Stat. 825 (1910). After quoting from Champion, the House Committee Report concluded:

Certainly, [illegible]he case of lotteries there is nothing harmful in the mere transportati[illegible] the pieces of paper. The injury resulted from the connection which existe[illegible]ween those tickets and the entire scheme of the lottery. It was the purpose for which the tickets were used which made them an instrument of injury to the public. H.R. Rep. No. 47, 61st Cong., 2d Sess. 4-5 (1909).

In Hoke v. United States, 227 U.S. 308, 57 L. Ed. 523, 33 S. Ct. 281 (1913), the Court analogized the aims of the Mann Act to those of the Lottery Act and the Pure Food and Drug Act. Ch. 3915, 35 Stat. 768 (1906). The Mann Act, however, differed from both because it did not actually prohibit anything or anyone from crossing state lines. Although purporting to prohibit transportation, it could not do so because it regulated persons rather than things. The Court dismissed such differences, contending that "the substance of the congressional power is the same, only the manner of its exercise must be accommodated to the difference in its objects." 227 U.S. at 323. The Court considered the similarity of purpose sufficient to uphold the Mann Act under the Commerce Clause. Id at 322-23. Nevertheless, the difference in means were significant. In the Food and Drug Act, like the Lottery Act, Congress had provided for seizure of the offending articles when shipped across state lines even though the misbranded food itself was not illegal when prepared. Pure Food and Drug Act, ch. 3915, § 10, 34 Stat. 768, 771 (1906). The Mann Act did not prohibit transportation of impure or immoral things. It punished a male who had certain immoral or criminal purposes (a criminal mental element), as the object of transporting a woman across state lines.

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[*94]

Having facilitated the transformation of Congress' regulatory power into an implied national police power, the Court later cut back on Congress' clearly constitutional powers. In Hammer v. Dagenhart, the Court invalidated the congressional prohibition of the interstate transportation of goods made using child labor. The decision departed from Champion and other cases in that it denied Congress the power to prohibit the shipment of certain goods across state lines. The Court, however, was consistent with prior cases in the sense that, as in Champion and other cases, the decision turned on congressional purpose. n103

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n103 The [illegible] distinguished the approved congressional purposes discussed in Champion, H[illegible]e and Hoke from the economic purpose behind the child-labor legislation. Id. at 270-72. Not only was legislation based on Congress' economic purposes more clearly constitutional than that based on moral purposes, but as Justice Holmes observed, See 247 U.S. at 280 (Holmes, J. dissenting) the moral purposes prompting the childlabor legislation were certainly no less worthy than those supporting earlier congressional legislation based on Congress' economic purposes upheld by the Court. In both Hammer v. Dagenhart, 247 U.S. at 276 ("We have neither authority nor disposition to question the motives of Congress in enacting this legislation.") voiding congressional legislation and in Champion, upholding congressional legislation, the Court took the same position, namely that the extension of national power -- whether regulatory or police -- turned on the Court's approval of Congress' purpose.

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[*95]

Even Fr[redacted]n Roosevelt's Justice Department viewed Champion and other "police po[redacted]cases in one category, set apart from the regulation of commerce. n104 The Roosevelt administration initially avoided the prohibiting commerce technique in favor of other forms of regulation based on the "affecting commerce" and "in commerce" rationales. After the Supreme Court made its famous 1937 course correction in N.L.R.B. v. Jones & Laughlin Steel, 301 U.S. 1, 57 S. Ct. 615, 81 L. Ed. 893 (1937), Congress employed both the commerce-prohibiting technique and direct regulation based on the "affecting commerce" rationale when it enacted the 1938 Fair Labor Standards Act (FLSA). In United States v. Darby, n105 which upheld the Act and overruled Hammer v. Dagenhart, the Court approved both the prohibiting technique and direct regulation based on the "affecting commerce" rationale. Although not regulating a true crime, the FLSA made its regulations of economic relationships enforceable by criminal sanctions. The combination in Darby of a regulatory offense, the prohibiting technique, and the affecting commerce rationale later resulted n106 in the commingling of two lines [*96] of cases -- the exercising police power cases and the regulating economic activity cases -- once thought to be separate.

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n104 See n. 111, infra.

n105 312 U.S. 100, 61 S. Ct. 451, 85 L. Ed. 609 (1941).

n106 See Perez v. United States, 402 U.S. 146, 28 L. Ed. 2d 686, 91 S. Ct. 1357 (1971).

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The coincidence in Darby of the prohibiting technique, which requires no rationale, and the "affecting commerce" rationale, which supports various techniques, did not immediately result in the expansion of federal criminal law. Although it interpreted the "affecting commerce" rationale expansively in economic matters, the Court generally took a much more restrictive view in criminal cases prior to 1970 when it decided Perez v. United States, 402 U.S. 146, 91 S. Ct. 1357, 28 L. Ed. 2d 686 (1971). In Perez, various strands from the cases under the Commerce Clause met and merged into an expansive view of Congress' [redacted] to create criminal law. The Court upheld application of a federal "l[redacted]ark" statute to [*97] local acts without any showing of an interstat[redacted] or effect. n107 The Court considered it sufficient that the activity was part of a class of activities which Congress had targeted as having affected commerce through organized crime. Id. at 154-56. The Court thought Darby to be "particularly relevant . . . because it involved a criminal prosecution." n108 However, Darby and the cases which built on it and were cited in Perez -- Wickard v. Filburn 317 U.S. 111, 63 S. Ct. 82, 87 L. Ed. 122 (1942), and the public accommodations cases, Atlanta Motel v. United States 379 U.S. 241, 85 S. Ct. 348, 13 L. Ed. 2d 258 (1964), and Katzenbach v. McClung 379 U.S. 294 85 S. Ct. 377, 13 L. Ed. 2d 290 (1964), -- were not criminal cases, even though indictments for regulatory offenses may have been involved.

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n107 402 [redacted] 146, 154-157, 91 S. Ct. 1357, 28 L. Ed. 2d 686

n108 Id. [redacted] 52-53.

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b. United States v. Lopez

As observed above, n109 the majority in Lopez recognized the uncertainty unleashed upon the lower courts [*98] left to reconcile that case with other Commerce Clause cases. In reopening debate on issues once thought foreclosed, the majority opinion in Lopez walks a fine line between two different views expressed by justices who, while joining the opinion, also write concurring opinions. Two of the justices "counsel[] great restraint," 115 S. Ct. at 1634 (Kennedy, J., concurring), but one justice would "reconsider our 'substantial effects' test with an eye toward constructing a standard that reflects the text and history of the Commerce Clause without totally rejecting our more recent Commerce Clause jurisprudence." Id. at 1642-43 (Thomas, J., concurring). While the Court's opinion may represent a moderate position among the justices in the majority, the dissenters consider the decision "radical." Id. at 1651 (Stevens, J., dissenting) ("I also agree with JUSTICE SOUTER's exposition of the radical character of the Court's holding.")

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n109 See p. 50, supra.

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In one Eleventh Circuit case applying Lopez, [*99] that court concluded that, under the Commerce Clause, Congress possesses the power to enact the Freedom of Access to Clinic Entrances Act of 1994, Pub. L. No. 103-259, 1098 Stat. 694 (1994) (codified at 18 U.S.C. § 248). See Cheffer v. Reno, 55 F.3d 1517 (11th Cir. 1995). The Eleventh Circuit found support for Congress' conclusion that the "access act regulates activity which 'substantially affects' interstate commerce." 55 F.3d at 1520. In upholding the Access Act, it was not necessary to go beyond a very narrow reading of Lopez. That is to say, Cheffer involved a criminal statute, like the gun statute in Lopez; but unlike the gun statute, C[redacted]s had made findings that the activity regulated by the Access Act "subst[redacted]ly affects interstate commerce." The court accepted those findings a[redacted]uasive.

The Justice Department narrowly views Lopez as applying only to the facts of the Gun Free Schools Act. n110 Only wishful thinking, however, can lead to the conclusion that the holding of Lopez is applicable only to schools or guns-in-schools cases. Lopez could have chosen a narrower approach. Lopez could have narrowly limited its holding to federal [*100] criminal statutes under the Commerce Clause that involve no "substantial effect" on interstate commerce. It did not do so. Had Lopez taken such an approach, Cheffer need not have been decided any differently. More importantly, such a narrowed approach would not have opened to debate the fundamental turn taken in the late 1930s jurisprudence under the Commerce Clause, which the dissenters took pains to defend. As previously noted, until Perez v. United States in 1971, the Supreme Court did

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not actually confront the application of the post-1937 Commerce Clause jurisprudence to federal criminal statutes. Before and even since, the Court has tended towa[redacted]rrow construction of federal criminal statutes, thereby avoiding constitutio[redacted]ssues of federalism. See e.g., United States v. Bass, 404 U.S. 336, 92 S. [redacted]15, 30 L. Ed. 2d 488 (1971). Lopez could have, but did not, reach the [redacted] it did by disapproving Perez without thereby calling into question anything else about Commerce Clause jurisprudence from 1937 to 1971. n111

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n110 See Tr. of Hr'g at 4.

n111 A prominent "New Deal" advocate, Robert Stern, has written about Perez as being unrelated to the interpretation of the Commerce Clause put forth to justify 1930's economic legislation: "Even a lawyer who fought for a realistic interpretation which would recognize that in commercial matters the United States was one nation finds himself surprised at where we are now -- and at how readily the recent expansion is accepted." Robert Stern, The Commerce Clause Revisited: The Federalization of Intrastate Crime, 15 Ariz. L. Rev. 271, 284 (1973).

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[*101]

Instead, Lopez relies on Perez to categorize Commerce Clause cases as being divided into three: "First, Congress may regulate the use of the channels of interstate commerce. . . . Second, Congress is empowered to regulate and protect the instrumentalities of interstate commerce, or persons or things in interstate commerce, even though the threat may come only from intrastate activities. ... Finally, Congress' commerce authority includes the power to regulate those activities having a substantial relationship to interstate commerce." Id. at 1629-30 (citations omitted). Like Lopez, see Id. at 1629-30, this particular case involves only the third of these categories.

In discussing the third category, the Court repeatedly refers not simply to regulating activities which have a substantial effect on interstate commerce but to "regulating economic activity" which has a substantial effect on interstate commerce.

Section [redacted] is a criminal statute that by its terms has nothing to do with "commerce" [redacted]y sort of economic enterprise, however broadly one might define those ter[redacted]tion 922(q) is not an essential part of a larger regulation of economic [redacted]y, [*102] in which the regulatory scheme could be undercut unless the intrastate activities that arise out of or are connected with a commercial transaction, which viewed in the aggregate, substantially affects interstate commerce. Lopez, 514 U.S. , 115 S. Ct. at 1630.

In requiring that the object of the regulation, which "substantially affects" interstate commerce, must itself be "economic activity," (i.e., commerce) rather than merely "activities," the Court is being more faithful to Chief Justice Marshall's explanation in Gibbons v. Ogden. See text accompanying n.83.

Lopez also discusses and refutes the reasoning advanced by the government for justifying Congressional action in that case. The court found the government's

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"cost of crime" and "national productivity" rationales to be incorrect, because, under such reasoning, Congress could regulate any activity that might lead to violent cri[redacted] any activity affecting the economic productivity of individual citizens, "[redacted]dless of how tenuously [these activities] relate to interstate commerce." [redacted], 131 L. Ed. 2d 626, 514 U.S. , 115 S. Ct. 1624. By demonstrat[redacted]ow the inherent logic of [*103] certain rationales fails to place any meaningful limits on congressional authority, Lopez requires that there be a genuine causal connection between the regulated activity and interstate commerce. In so doing, the Court is being more faithful to Chief Justice Marshall's ends/means analysis in McCulloch. See n. 81 and accompanying text. In other words, the assumption that the regulation of any activity which has a substantial effect on interstate commerce is automatically "necessary and proper" is not appropriate under Lopez. Thus, the Lopez majority criticizes the dissent for their willingness to gloss over the tenuous connection between gun possession at a school and interstate commerce. As Chief Justice Rehnquist notes, "depending upon the level of generality, any activity can be looked upon as commercial." Lopez, 514 U.S. , 115 S. Ct. at 1633 (Rehnquist, C.J.). Such reasoning, "lacks any real limits," id., and would lead to the acceptance of a general police power at the federal level. Id. at 1634. See also Northern Securities Co. v. United States, 193 U.S. 197, 402-403, 24 S. Ct. 436, 48 L. Ed. 679 (1904) ("Commerce depends upon population, [*104] but Congress could not, on that ground, undertake to regulate marriage and divorce. If the act before us is to be carried out according to what seems to be the logic of the argument for the government . . . I can see no part of the conduct of life with which, on similar principles, Congress might not interfere"). n112

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n112 Accord Maryland V. Wirtz, 392 U.S. 183, 204-205, 88 S. Ct. 2017, 20 L. Ed. 2d 1020 (1968) (Douglas, J., dissenting). Noting that state government itself is an enterprise that has a substantial effect on interstate commerce, the Justice Douglas stated that the logic of the case would lead to the conclusion that "the National Government could devour the essentials of state sovereignty, though that sovereignty is attested to by the Tenth Amendment." Id at 205. See also A.L.A. Schechter Poultry Corporation v. United States, 295 U.S. 495, 554, 55 S. Ct. 837, 79 L. Ed. 1570 (1935)
There is a view of causation that would obliterate the distinction between what is national and what is local in the activities of commerce. Motion in the outer rim is communicated perceptibly, though minutely, to recording instruments at the centre. A society such as ours "is an elastic medium which transmits all tremors th[redacted] its territory; the only question is of their size." Per Learned Hand, J., [redacted] court below. The law is not indifferent to considerations of degree. A[redacted]es local in their immediacy do not become interstate and national [redacted] of distant repercussions.
(Cardozo J., concurring); Polish National Alliance of the United States of North America V. National Labor Relations Board, 322 U.S. 643, 650, 64 S. Ct. 1196, 88 L. Ed. 1509 (1944).
The interpenetrations of modern society have not wiped out state lines. It is not for us to make inroads upon our federal system either by indifference to its maintenance or excessive regard for the unifying forces of modern technology. Scholastic reasoning may prove that no activity is isolated within the boundaries of a single state, but that cannot justify the absorption of legislative power over every activity.
(Frankfurter, J.).

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[*105]

Finally, [redacted] above discussion is devoted to what Lopez says; however, that case is als[redacted]eworthy for what it fails to say. The ease with which the Supreme Cou[redacted]ght have upheld the Gun-Free Schools Act of 1990 is striking. This point was not lost on the dissenting justices. The Court might have held that guns are articles of commerce that can be used to restrain commerce. 514 U.S. at , 115 S. Ct. at 1651 (Stevens, J., dissenting). It did not. The Court could have aggregated "the effect of all guns possessed in or near schools[.]" Id. at , 115 S. Ct. at 1658 (Breyer, J., dissenting) (citing Wickard, 317 U.S. at 127-28, 63 S. Ct. at 89-90); see id. at , 115 S. Ct. at 1651 (Stevens, J., dissenting). It did not do this either. The Court also might have considered whether Congress could have had a rational basis for concluding that the "regulated activity sufficiently affected interstate commerce." n113 Id. at , 115 S. Ct. at 1658 (Breyer, J., dissenting). Again, the court would have none of this. n114 See Lopez at , 115 S. Ct. at 1630-34.

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n113 While the majority in Lopez does not utilize the rational basis test, it does mention it, albeit in the context of warning against granting Congress too much deference in deciding the extent of its authority under the Commerce Clause. See Lopez, 131 L. Ed. 2d 626, 115 S. Ct. 1624, n. 2 ("Simply because Congress may conclude that a particular activity substantially affects interstate commerce, does not necessarily make it so.") (quoting Hodel, 452 U.S. at 311) (Rehnquist, J., concurring in judgment); ("Whether particular operations affect interstate commerce sufficiently to come under the constitutional power of the Congress to regulate them is ultimately a judicial rather than a legislative question, and can be settled finally only be this Court.") (quoting Heart of Atlanta Motel, 379 U.S. at 273) (Black, J., concurring)." See also n. 72, supra. [*106]

n114 In addition, the majority might have asked, but did not, whether Congress could have found that gun violence around schools creates a commercial problem, Lopez at , 115 S. Ct. at 1659 (Breyer, J., dissenting), or perhaps a serious economic threat to "consequently inadequately educated workers who must endure low paying jobs" and to communities and businesses that might otherwise gain from a well-educated work force. Id. at , 115 S. Ct. at 1661 (Breyer, J., dissenting).

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3. App[redacted] of Lopez to CERCLA.

Thus Lopez requires 1) that the statute itself regulate economic activity, which activity "substantially affects" interstate commerce. Id. at 1630; and 2) that the statute include a "jurisdictional element which would ensure, through case-by-case inquiry, that the [statute] in question affects interstate commerce." Id. at 1631. In applying Lopez to this case, the court finds it doubtful that the object of regulation in this case is "economic activity," i.e., "commerce," as that term is used in Lopez. It is true that at one [*107] point the defendant operated two plants, which are the focus of this litigation, and that these plants were surely engaged in "economic activity." These two plants, however, no longer operate and have not since 1982, long

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before this litigation was initiated.

Arguably [redacted] case might be somewhat different if the government were attempting [redacted]gulate a functioning facility. Although, the complaint includes an allegati[redacted]bout threatened releases, the fact remains that this suit seeks clean-up of [redacted] property. While environmental degradation generally may have an effect on interstate commerce, it is not clear to this court that the degradation at issue in this case is necessarily "economic activity" or that it has a "substantial effect" on interstate commerce. It is clear to this court that the law regulating real property has been traditionally a local matter falling under the police power of the states. n115

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n115 See e.g., United States v. Little Lake Misere Land Co., 412 U.S. 580, 591, 93 S. Ct. 2389, 37 L. Ed. 2d 187 (1973) ("Even when federal general law was in its heyday, an exception was carved out for local laws of real property.") (Burger, C.J.); Davies Warehouse Co. v. Bowles, 321 U.S. 144, 155, 64 S. Ct. 474, 480, 88 L. Ed. 635 (1944) ("The great body of law in this country which controls acquisition, transmission, and transfer of property, and defines the rights of its owners in relation to the state or to private parties, is found in the statutes and decisions of the state.") Hawaii Housing Authority v. Midkiff, 467 U.S. 229, 241-242, 104 S. Ct. 2321, 81 L. Ed. 2d 186 (1984) ("Regulation of [land] oligopoly and the evils associated with it is a classic exercise of the State's police powers.")

It is also worth mentioning that Congress agrees that reduction, control, and the prevention of pollution, and the collection and disposal of solid waste, are all the primary responsibility of state and local governments. See e.g., 42 U.S.C. § 7401(a)(3) (Clean Air Act); 42 U.S.C. § 6901(a)(4) (Resource Conservation and Recovery Act); 33 U.S.C. § 1251(b) (Federal Water Pollution and Control Act).

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[*108]

Given that Lopez does not limit its holding to criminal cases, n116 the government must demonstrate that its use of CERCLA is limited to the regulation of economic activity, i.e., commerce, which "substantially affects" interstate commerce. Congress (or the Executive on behalf of Congress) may regulate economic activity which falls within the local police power, but it cannot exercise a[redacted]al police power. It appears to this court that CERCLA generally represents [redacted]ample of the kind of national police power rejected by Lopez. It is not nec[redacted], however, for this court to reach such a conclusion, because -- at least in this case -- the application of CERCLA fails to meet the second criteria of Lopez.

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n116 See text accompanying n. 111.

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Even if the application of CERCLA to the facts of this case does generally meet the first test of regulating intrastate economic activity which

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substantially affects interstate commerce, it must also be shown that the statute has a jurisdictional [*109] element which would ensure, through case-by-case inquiry, that the [statute] in question affects interstate commerce." S. Ct. at 1631. Nothing in the statute provides for such a case-by-case inquiry. Nevertheless, assuming it had such a provision, the particular inquiry in this case clearly demonstrates that the activity in question has virtually no effect on interstate commerce. As demonstrated in the remedial investigative report, any contaminants still at Site 1 affect groundwater mostly by migrating through the locally-contained alluvial aquifer. This aquifer lies atop a miocene aquifer. The remedial-investigation report indicates there is little or no migration between the two aquifers, and there is no evidence that contaminants at Site 1 travel across state lines.

Accordingly, this court holds that EPA's attempt in this case to apply CERCLA liability against the defendant would exceed the power of Congress under the Commerce Clause.

VII. CONCLUSION

For the reasons set forth above, the federal government has no constitutional authority to do what it proposes at Site 1. The court therefore has no authority to sign or enter the proposed consent decree and hereby [*110] DENIES the motion n117 to do so.

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Because the court has reached this conclusion, there is no conceivable remedy to which the plaintiff would be entitled to under the complaint. This action is therefore DISMISSED with prejudice.

SO ORDERED this 20th day of May 1996.

W B Hand

SENIOR DISTRICT JUDGE

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